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REPORT OF THE TASK FORCE ON THE STUDY OF SL ACTIVITIES

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(SL/Div Reps)

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1. Mandate

The mandate of the Task Force was twofold:

I. To analyze the activities of the division and to group them into three categories:

- core activities, i.e. those to be executed by CERN staff,
- activities that can be entrusted to an outside contractor but where the responsibility and the progress control stays at CERN (this category is further subdivided into two, cf. chapter 4.), and
- activities that can be farmed out.

II. To make recommendations on recruitment, restructuring, and concrete candidate areas for farming out.

It was not part of the mandate to investigate the financial aspects of farming out.

2. Report Structure

This report consists of the present overview and summary part, and appended in-depth contributions dealing with the individual groups and the visit to an outside organization.

In this first part we give some general information, discuss prospects and potential problems of farming out which are of general nature and aspects which came up repeatedly in the analyses of the various groups.

3. Procedure

Before starting the individual group analyses the Task Force met Bo Angerth and Vince Hatton who provided general information on the various possibilities of farming out. Michel Vitasse explained the point of view of the staff association towards potential problems.

Detailed information gathering in the groups was in general done in discussions between one or two members of the Task Force and the Group Leader and the Sections Leaders of each group. Therefore the responsibility for the contents of the appendices remains with the respective authors. Because of its nature as accelerator theory group SL/AP was not considered.

Additional information from outside CERN came from a visit to ESTEC (European Space Research and Technology Centre, Nordwijk, NL), a meeting with SERCO (International Task Management Contractor, UK), and experience from other laboratories such as DESY and KEK.

4. Criteria

In the following we define our criteria to classify activities into the three categories.

- Core:

  This category comprises activities requiring deep knowledge (or many years of experience) of accelerators, their operation, the user needs, the application of technologies related specifically to accelerators, or knowledge of particularities of working in the CERN environment.

- Subcontracting:

  - On the CERN site:

    This concerns activities during peak-load periods (e.g. shutdowns), which may require high qualification but not irreplaceable expertise on CERN-specific (accelerator-related) issues, or activities which are of general nature but must stay for obvious reasons on-site (e.g. routine maintenance of installed equipment).

  - Outside CERN:

    This comprises all kinds of industrial support that is exploited within the framework of CERN projects. Typical examples are: Series production of equipment following a prototype, modifications to industrial equipment to meet specific needs, general software tools, or computing and networking facilities.

- Farming out:

  In this category we put activities that can be completely specified and of which the development, production, installation, and probably part of the commissioning and continuation is done under the primary responsibility of the contractor. Examples of farmed out activities are presently found only in fields that do not require CERN-specific (accelerator related) expertise (e.g. buildings, common fluids, electricity, telephone service).

5. Comments on Farming Out

Experience from commercial and research organizations shows that massive farming out is not a good approach - in terms of motivation, efficiency, and cost - and many of them are coming back to a scheme where more work is done in-house (e.g. ESTEC, see report in appendix I). Moreover it is an illusion to believe that farming out is a means to save a lot of staff.

On the other hand farming out of some tasks should allow staff people to concentrate on their core activities. Therefore activities which can reasonably be farmed out should be given out; CERN should not compete with industry in the sense of duplication of effort.

Only those activities with clearly defined goals and limits are amenable for farming out or subcontracting.

CERN has to keep a high level of expertise on CERN specific activities in house.

The contract partner for farming out is not necessarily industry. Projects can also be "farmed out" to universities, other accelerator labs, or other CERN divisions. In each case the conditions change significantly.

The different nature of collaboration with contract partners in case of farming out requires a significant modification of the CERN rules for the acceptance of contract conditions. The simple rule of taking the "cheapest" offer is certainly not sufficient.

CERN as research institution has the problem of the "iterative development" since the detailed final specifications are often not known at the beginning or change during the course of a project. "Crash programs" - a working concept applied with increasing frequency in recent years - do not go along well with the idea of carefully written specifications and hence with farming out.

CERN accelerator divisions do not only build accelerators following the initial specifications. In collaboration with the scientific community they often deviate massively from the initial project and go beyond what has initially be foreseen. It is hard to imagine that a division of pure "specification writers" would be able to give such creative input to the user community.

Successful farming out requires good project management and specifications; one cannot expect a good product or service with bad specifications.

Last but not least: **Motivation can never be farmed out.**

6. Proposals

6.1. General Issues

If farming out is to be successful the CERN Training Service should provide training on project planning and management following the ISO and ESA standards.

The communication between operators, application software programmers, general controls, and equipment controls people should be intensified to be mutually better informed about goals and strategies. To this sake we propose to organize a division-wide workshop (like the Controls User Forum in Chamonix, 1990). This should be followed by regular meetings between people from operations working on controls issues, controls people, and the controls link men of the equipment groups. This should allow to spread information about existing solutions, future requirements, guidelines and recommendations, and firm intentions about components which will be maintained or abandoned in the future. In the long run this could facilitate farming out and help to avoid duplication of effort.

6.2. Recruitment Policy

Many of our present contract people are in fact a replacement for missing CERN staff. Their irreplaceable expertise should not be lost. To prevent that to happen in the future contract and "régie" people should not be put on core activities.

A change in the recruitment policy for technicians should be made to recruit the majority via the operation groups, under such contractual conditions that about half of them can be provided with an indefinite contract in the division at the end of their term. This would be in the spirit of the current recruitment policy for academic staff via the EIC posts. For this a structure must be put in place to allow suitable training of control room technicians for their future tasks.

6.3. Candidates for Farming Out

Apart from a number of other suggestions which can be found in the individual group reports the following **immediate** topics have been identified which could serve as test cases:

- Office informatics (PC and Macintosh hardware and software installation, user consultancy, repair) (SL-DI)
- Office infrastructure (space, furniture, painting, removal, etc.) (SL-DI)
- Storage (spare parts, radioactive material) (SL-DI)
- Field bus diagnostic software package (SL-CO)
- Replacement of SPS orbit acquisition system (SL-BI)
- Extension of the kick surveillance and diagnostics of the fast pulsed magnets (SL-BT)
- Replacement of the power converter for the SPS dipole magnet test stand (SL-PC)

7. Conclusions

Our analysis confirms the present organization of the division. Most of the posts are core positions. Therefore we do not propose revolutionary changes.

Farming out can not be used to dump problems to companies. It can not solve the problem of missing staff in core positions. However farming out should enable the staff to concentrate on core activities.

If there is no success in farming out the candidates above (which to our mind are evident and look promising) there is no point in pursuing this subject any further.

Appendix A

Analysis of SL-BI

H. Schmickler

1. Introduction

The SL-BI group is in charge of all beam instrumentation concerning the LEP and SPS accelerators, the corresponding transfer lines and the experimental zones linked to the SPS. The responsibility comprises the conception of the instruments, their construction, commissioning and maintenance.

For the past years the focus of the group has been more on LEP instrumentation. A large workload has been sustained since LEP startup by various monitor development, improvements and modifications needed to cope with the new modes of LEP operation: pretzel scheme and bunch train scheme notably.

But after the commissioning of specific LEP200 instrumentation the activities for LEP will enter into a (short) maintenance period before coming to a complete end. On the other hand activities on LHC instrumentation will start up, which should be quite similar to the LEP activities.

The work on SPS beam instrumentation in general is maintenance and modernization of old equipment. But also as in the case of LEP the changing machine requirements (leptons in the SPS, low intensity heavy ions and most important the ever changing user requirements in the experimental zones) impose a considerable work load.

For the analysis a structure along beam instrumentation activities and not along the present substructure of the BI group has been chosen.

2. BI Activities

2.1. Beam Position and Trajectory Measurements

This is the largest activity in the BI-group. Due to historical reasons the tasks are split into two sections with LEP and SPS responsibilities. Each individual position monitor is not a complicated system, but the enormous amount of monitors renders the systems complicated. The size of the systems imposes constraints on the conception (mainly cost optimization) the construction, installation and maintenance.

The critical part are the position detectors themselves. The technologies involved are high precision mechanical engineering, vacuum technology, very high frequency signal technology and precision (and low noise) signal detection. All developments have been made as core activities. (Some experience was imported from other accelerator centers.) This entire knowledge has to be maintained at CERN and there should not be any change in this philosophy for the future. On the other hand the experience of LEP shows that the conception of the front end electronics and data acquisition chain including low level software can profit from know-how in industry. It should be stated that the technology of ultra high frequency and precision signal detection is not a common knowledge in industry and that some collaboration for transmission of knowledge would be needed in the beginning. So the acquisition system of position data up to the concentration of all monitors information for high level application programs can be farmed out. As concrete example for the near future the orbit acquisition system in the SPS (COPOS) can be identified. The system is already for many years in operation and does not provide all functionality that is requested by the users and that could be delivered with modern front end computing facilities. Secondly the system needs still to be maintained for a long period in time. If one wishes to gain experience within BI with farming out of a large scale project this acquisition system is a good candidate.

2.2. Beam Current Measurements

Beam currents are measured either using the sum signal of electromagnetic couplers or by current transformers. In both cases the intrinsic knowledge of the front end detectors is a core activity. In the case of current transformers CERN made a transfer of technology to an external firm from where some entire beam intensity measuring systems have been bought since.

The data acquisition and data processing for beam current measurements can be classified as simple tasks of recording a few numbers as a function of time. This task can easily be specified and farmed out. In the case of LEP modern DSP techniques are used for powerful life time measurements and on line correlation with machine events (injection etc.) This application has evolved over the past years and has been permanently adopted to the needs of machine operation. This sort of development has to be considered as core activity.

2.3. Betatron Tunes

In the simplest case an instrument for betatron tunes consists of a (sensitive) beam position monitor, a beam kicker and a multi-turn recording facility. From the turn to turn data the eigenfrequencies of the beam motion (i.e. the tunes) can be calculated. In reality the instruments provide much more sophistication like mountain range displays for time varying spectra, chromaticity measurements or as in the case of LEP phase lock continuos tune measurements and tune feedback loops. The complexity of these applications and the amount of machine physics involved defines this task as core activities.

2.4. Collimators, Stoppers, Screens

These activities comprise the remotely controlled movement of material blocks or detection screens in or out of the beamlines. The technologies involved are precision mechanical engineering, vacuum technology and high quality surface treatment. The restricted amount of combined knowledge in these domains in industry make it difficult to identify farming out possibilities. The control of the motors for the in/out movements is a standard industry technology and recent installations have been successfully done with strong industrial support.

2.5. Beam Loss Monitors

For this activity monitors sensitive to charged particles or photons are placed at strategic points in the accelerators in order to protect other equipment (via interlocks) or to inform the machine operators about abnormal loss rates. The most common detection techniques are current measurements in ionization chambers or solid state detectors. The actual detector layout and position is a core activity requiring deep knowledge of particle interaction with matter as well as accelerator physics. The readout of the beam loss counting rates is a trivial task and mainly determined by cost considerations. Here again industrial support seems to be appropriate.

2.6. Beam Profiles, Emittance Measurements

Several monitors are installed in each accelerator in order to measure the longitudinal or transverse beam profiles. Different detection principles are exploited: Synchrotron light emission and imaging onto cameras (UV light) or onto strip counters (x-rays). Wire scanners passing a very thin wire at a high speed through the particle beams. Rest gas ionization chambers imaging the space distribution of rest gas in the vacuum system, that has been ionized by the circulating particle beams. Secondary emission monitors. In general there is only one or very few instruments installed. Each instrument requires deep knowledge on the individual detection techniques. The whole activity is a core activity.

2.7. Luminosity Monitors

This activity concerns presently only LEP. The existing monitors have been developed as core activity acquiring knowledge of electromagnetic calorimetry. These monitors have provided very useful information from the LEP start-up as they were faster than the monitors of the LEP experiments. Presently the speed of at least the DELPHI detector is comparable. In general the physicists have a larger interest of a precise on line luminosity monitoring and have much more manpower available to maintain the calibration. The LEP monitors are occasionally recalibrated using the information of the LEP experiments. For LHC the update speed should not be a limiting factor as the total cross section is very high. If luminosity monitoring is requested for the LHC this activity should be farmed out to universities participating in the experimental program of LHC.

2.8. Polarimeter

Polarimetry will to my knowledge not be needed for LHC. Therefore this activity will need little effort in the medium future. Nevertheless the present activity needs a special attention. The LEP polarimeter has been developed as core activity exploiting equipment (laser, optical systems) from industry. But the complementary research to make polarized beams possible in LEP and the development of the tools for energy calibration by resonant depolarization are the best example of collaboration of a BI team with university. Without the contribution of technical and research students the LEP polarization program would not have been possible. So whenever future activities in the BI group come so close to basic research a similar approach should be chosen.

2.9. Instrumentation of Experimental Zones

This activity includes a huge amount of equipment used for beam steering in the experimental zones, for beam quality monitoring and for beam parameter and particle definition (spectrometry). Most of the equipment is used on-line by the experiments. The work is very different from the above activities. The monitors and their data acquisition have been build over the past 20 years and have now to be maintained and reinstalled according to the requirements of the beam users.

The reinstallation and exploitation is done as core activity in close collaboration with SL-EA. As much as the analysis of EA shows, this part has to stay a core activity with eventual support of "Prestation de Service" manpower. The maintenance of the data acquisition systems is entirely BI responsibility. The corresponding section is faced with a variety of about 230 different electronic modules with 2 to 500 pieces of each. Some of the modules can no more be bought or repaired in industry. So in the current framework

all maintenance here has to be core activity. On the other hand one finds here a large potential for farming out: If in the future the above electronic will be replaced by modern equipment, the conditions for farming out are ideal. The delays do not play an important role and the requested products can be fully specified as a working solution already exists. If one searches corners where to gain experience in SL with farming out, one could envisage here on a sample basis the replacement of obsolete equipment and software.

2.10. Software Support

The software support of all instruments is unified in one section with one person attached to various activities. The support comprises low level equipment programming (primary data acquisition, signal treatment in DSPs, motor control...), system programming (operation systems and networking) and application programming on workstations. The activity requires deep knowledge of software tools combined with knowledge in instrumentation and machine physics and is therefore a core activity. To a large extend industrial support is used for software tools and for operating systems.

3. Conclusion

As a very general statement one could subdivide beam instrumentation into highly specialized front end detectors that require also in the future full coverage by CERN staff and data acquisition and control systems that are presently done by staff with industrial support. The latter part provides some potential for farming out. As a potential candidate in this line the modernization of the SPS orbit acquisition system has been identified.

A system in beam instrumentation must be conceived with flexibility to cope with future unforeseen changes in machine operation modes. During the whole construction period of LEP (1981 to 1989) an operating scheme with more than 4 bunches per beam was mentioned but never considered as a possible option. The effort to adopt the pretzel and bunch train mode of operation would have been much more difficult if large parts of the data acquisition systems had been done in farming out.

Organigramme for SL-BI Group (31.10.94)

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J. Borer A. Barbier D. Cocq A. Manarin E. Rossa G. Vismara	**SL-BI-TA**	**Beam trajectories** *BOM* *BEXE* *Photon rings*
L. Vos B. Halvarsson H. Jakob J.P. Papis	**SL-BI-EM**	**Electromagnetic detectors** *COPOS, TLPOS, TIPOS* *SPS Q-measurement* *SPS betatron phase measurement* *BOSC* *SPS and LEP BCT's*
R.Jung J.P. Bindi G. Burtin J. Camas R. Colchester G. Ferioli J. Koopman J. Mann M. Sillanoli J.M. Vouillot	**SL-BI-PM**	**Photon detectors and mechanics** *S.E.M. detectors* *Screens and TV's* *Wire scanners* *BEUV telescopes* *Collimators* *Beam stoppers* *SPS and LEP motors*
K.D. Lohmann O. Berrig C. Beugnet A. Cojan M. Desroziers J. Fullerton P. Hirbec H. Schmitz J. Spanggaard	**SL-BI-EA**	**Detectors of SPS secondary beams in experimental areas** *Liaison with SL-EA Group* *EA detectors exploitation* *LEP Q-meters* *EA CAMAC modules* *SPS and LEP power supplies* *SPS and LEP electronic services*
R. Schmidt B. Dehning J.P. Ferri	**SL-BI-SI**	**Silicon detectors** *Luminosity detectors* *Polarimeter detectors* *Crystal extraction detectors*
A. Burns J. DeVries J.J. Gras G. Morpurgo J.-J. Savioz	**SL-BI-SW**	**Software support** *SPS and LEP software services* *Streak camera* *BST*

Appendix B

Analysis of SL-BT

V. Mertens

1. Introduction and Conclusion

In general, work in the BT group is prototyping or work in small series on very diversified equipment, requiring deep, multi-disciplinary knowledge (ultra high vacuum, combined with high voltage or pulsed high power, and metallurgy).

The overall conclusion is that most areas work really at the limits of staff (resp. "missing staff") numbers (i.e. core people), if the present flexibility in responding to new demands and the speed in service is to be maintained. In a few cases some possibilities to subcontract parts of the work have been identified, which go beyond that what is already been done. One recent project appears to be a good candidate for farming out.

In the following the SL-BT sections are discussed in more detail, their principal activities, specific problems and prospects for farming out, and considerations which result from the individual discussions. For reference, an updated organization chart of the group is appended.

2. BT Activities

2.1. Electronics and Controls

This section consists of 12 staff (4 engineers, 5 technicians, 3 cablers) and 4 contract people. The team deals with the development and maintenance of all equipment and control electronics and the equipment level software for all BT equipment (defined in more detail in the discussion of the other sections below), in some cases also the application software. Members of this team also perform to a large extent the piquet services for the various systems.

Much of the electronics work concerns prototyping. If there are small series to be constructed, they are normally already given (either directly or via MT) to firms (PCB boards, modules); this will in the future be intensified by giving complete assemblies (equipment controllers or sets of equipment controllers) out, but also by more outside repair work. A considerable part is piped through central CERN services (mechanical work, serigraphy, printed circuits including documentation, etc.).

Even most of the electronics prototyping work could, in principle, be subcontracted to firms (possibly working on-site for faster response times), which holds also for other prototyping or maintenance work done within the group. However, people have to feel strongly responsible for their products and the success of the overall team. This seems nearly impossible to obtain if people cannot stay long enough attached to the team, if e.g. the subcontractor is changed after a short period for ostensible economic advantages or if the people of the subcontractor themselves change too often. For a number of applications (e.g. fast high voltage triggers) a lot of special experience is required concerning the proper electronic design and the PCB layout. Trials to give such work to inexperienced (non-core) people has been repeatedly unsuccessful in the past.

In general, the earlier a project is completely defined the more complete work can be given outside. Unfortunately this was quite seldomly the case in recent years (several LEP "crash projects", prototype work for LHC pulser evolution, etc.). For future larger projects where the specifications are well enough known beforehand (or refurbishment of existing setups, e.g. a possible modernization of the remaining old SPS electronics, provided the necessary money can be found) there is much potential for a large-scale farming-out. Unfortunately, this sector suffers from a severe historic lack of documentation which needs first to be generated.

As far as software is concerned there was a wide historic spread of approaches and techniques. Following a restructuring in 1990 this has meanwhile been much improved, a process which will be continued over the next few years. Experience during this process has shown that basic tools which contain virtually no equipment dependencies are good candidates for farming out (or their provision on a wider, e.g. divisional, scale). The tailoring of the tools to the equipment needs to stay in the hand of the equipment specialists, i.e. the core people, to guarantee the desired response time in case the specifications are not yet fully known at the beginning or in case rapid modifications become necessary.

Software to control and read out industrial equipment (like for example digital storage oscilloscopes) and/or to visualize data from such equipment should not be written in-house; instead, integration of such software into the overall controls concept should be facilitated. The same holds for the integration of industrial off-the-shelf hardware. In this context it is also important to know which possible, easy-to-use solutions exist, to have clear, stable guidelines, to be informed for which systems the support will be guaranteed over the next years or which new components will be introduced in the near future. To avoid duplication of effort there could be a regular forum or an information system (perhaps in form of a data base) which provides developers with an overview of all useful hardware and software developments and solutions which could readily be re-employed by other teams.

To perform the piquet service in a satisfactory manner it takes several years of training, regarding the multitude and the diversity of the BT equipment. To obtain the same service from an outside firm it would take far too many people to guarantee the 24h service within a few hours for two third of the year. There seems therefore no reasonable possibility to farm this kind of activity out (which itself already requires a considerable number of "core" persons).

An activity requiring less profound knowledge of the equipment which would therefore prosperous for a future farming out is the management of the spare parts and the documentation (drawings, ...). To be more economic this should be organized on a divisional scale.

2.2. Extractions and Separators

This team comprises 14 staff (4 engineers (of whom one R&D), 5 technicians, 5 mechanics) and 4 contract people. This area covers the SPS electrostatic and magnetic septa and related equipment, and the various LEP separators (vertical, Pretzel, Trim Pretzel, test area TAZ, Bunch Train scheme, etc.).

It is felt that this area is currently also at the minimum staff and contract numbers to carry the assigned responsibilities and to be able to perform upcoming "crash projects" with the desired flexibility.

There is quite few routine or larger scale maintenance work which would be suited for farming out. Maintenance is often dealing each time with a different item requiring deep knowledge of the location and the equipment and much flexibility to achieve the desired work in the relatively short access periods, thus requiring real specialist intervention. Maintenance or refurbishment of radioactive SPS material is only possible outside CERN with a huge effort (special transport, precautions in the contracting firms).

The SPS work concerns mainly prototypes. The only area dealing with small to medium series, the LEP separators, produces usually only prototypes and subcontracts the fabrication of the subassemblies, like tanks, electrodes, etc. The pieces are then assembled and tested at CERN, making use of the existing facilities (e.g. clean shop, conditioning area). This equipment is quite complex and requires much combined high-tech knowledge, ranging from ultra high vacuum over high voltage to metallurgy, often at the limit of the technically possible or close to the physical breakdown of the material. The required knowledge could perhaps be found in some high-tech parks with which one would have to conclude long-term contracts to guarantee the firm a reasonable return of their infrastructure investment (possible under present purchasing rules ?). However, to farm the final assembly and testing out is considered to be very risky, since outside firms could, to make profit, try to hide weaknesses during the production in the final complex product which would only appear after some years of operation, thus severely hampering a smooth running of the machines (this could perhaps be better controllable applying ISO 9000). The quite fragile equipment would also suffer too much during the transport. That way working methods which look attractive at the first glance could prove disastrous in the long run.

There seems to be a possibility to give all future vacuum tests out, but this would probably have to be dealt with by (external) people under the supervision of the AT vacuum team. Other technical tests, like HV checks, could also be subcontracted for execution on site. If more work is given out the resulting loss in flexibility must be calculated into the delays of the projects. As experience shows this often leads to surprises.

In the preparation phase for LHC there seems to be more potential for successful farming out. The LEP separators and perhaps one of the SPS extractions will be laid off, thus requiring less overall maintenance from the team. New magnetic septa will have to be constructed for the extractions towards the LHC. Since these are not yet radioactive and simpler than electrostatic septa, larger subassemblies (e.g. the coils) could be given out. More work might be implied with a neutrino extraction to the Gran Sasso and a possible crystal extraction setup. However, there are yet too many unknown constraints to draw more detailed conclusions at this moment.

Another factor influencing the way the work is done is the investment into spare parts. If more spare parts are bought one could afford to send things back to industry for repair instead of getting them fixed in place.

2.3. Fast Pulsed Magnets

This team consists of 9 staff (4 engineers (of which one R&D for LHC), 3 technician, 2 mechanics) and 2 contract people (+ 1 contract person "on loan" from SL / BT / TA)). The sector deals with all magnets and pulsers for SPS and LEP kicker systems - injections, extractions, q measurement, and dumps.

As for the septa and separators area this needs much in-depth knowledge of a multi-disciplinary work field, often working at the limit (beyond the normal use of equipment in most industrial sectors). Again there is no firm combining all know-how necessary to offer these assemblies right from the shelf. Practically all work concerns prototyping (resp. "series" of 2 - 3 pieces, including spares). Components which can be properly specified and fabricated in industry (like vacuum chambers, pieces for pulsers etc.) are already given out; however special treatment, like surface refinement, or final assembly and tests are done in-house, partially by contract people. Other institutes could contribute more in this process in the future, but their role is still unclear.

The present - good - engineering capacities are very advantageous for a good synergy and cross-checking effect when - as at present - many new things have to be developed.

In the future retiring technicians could to some extent be replaced by (essential: long-term) contract people. When the LHC projects have to be carried out (SPS extraction, LHC inflector, LHC dump kickers), 4 - 5 more contract people are needed for several years to do the final assembly, the testing, and the installation.

In the framework of the new bunch train scheme the precision of the LEP injection kicker timing has become a more critical issue than before. Therefore, the surveillance of the kick amplitude and timing has to be considerably extended. The diagnostics and surveillance of other kicker system needs also to be modernized and extended. Since these surveillance systems are rather independent from the existing kicker electronics and since the requirements are well known this project is a good candidate for farming out.

2.4. Targets

This team comprises 5 staff (2 engineers (of whom one R&D for LHC), 1 technician, 2 mechanics) and one contract person (currently working for SL / BT / FP)). Their activities concern development and maintenance for all SPS targets stations, internal and external dump absorber blocks, collimators, and scrapers, and the LEP dump absorber blocks, as well as studies in view of the LHC dump absorber installations.

After some major developments in the previous years (LEP dump, new target T9), the SPS and LEP equipment now requires only maintenance or smaller improvements to increase yet the reliability. Faults occur only relatively little, but staff numbers must be maintained if rapid interventions are desired in case several faults occur at the same time. For the LHC development work a further engineer will be needed.

Also in this area much documentation has still to be produced or brought up-to-date. In case of major dismantling or refurbishment work on this extremely radioactive material (SPS case) external people are hired to share the dose ("radiation outfarming"). It is envisaged to use more "tele-manipulators" in future installations to avoid unnecessary accesses to the equipment.

2.5. Transfer Lines and Extraction Studies

In this area we are at the minimum of staff people (2 engineers) to provide the necessary engineering capacities to cover all areas and to ensure the flexibility to satisfy upcoming requests rapidly. The activities range from setting up the SPS extractions and maintaining their quality over the running period over studies for extractions, beam lines, and injections for LHC to studies and MDs in view of possible future systems (e.g. crystal extraction). In general, a lot of in-depth experience is required to be efficient in this field.

Farming out is already practiced, but in a different sense. Considerable work is done by technical or post-graduate students, for which CERN pays only relatively little ("educational outfarming"). This should be maintained like this or even strengthened.

Work is characterized by the use of many, quite complex software tools which have mostly been developed in-house, partially in collaboration with other institutes and over long periods. The maintenance of some of these tools, their possible extension and adaptation to the - technologically and accelerator-wise - evolving environment, as well as the development of additional tools of general interest could be specified and entrusted to an outside contractor. However, this needs to be organized on a wider scale since these tools are usually also used by other teams or even other laboratories. CERN should in any case keep the capability to tailor these tools quickly to its needs.

Groupe "Transfert de Faisceaux" - SL/BT
Organigramme

Chef de Groupe : *WEISSE Eberhard*

Secrétariat : CREPIN Bernadette

Aimants pulsés rapides (SL/BT/FP)	Canaux d'Extraction - Séparateurs de Faisceaux (SL/BT/ES)	Lignes de Transfert - Etudes d'Extraction (SL/BT/TL)	Cîbles - Absorbeurs (SL/BT/TA)	Electronique - Contrôles (SL/BT/EC)
SCHRÖDER Gerhard	*KALBREIER Wilhelm*	*HILAIRE Alain*	*PERAIRE Serge*	*MERTENS Volker*
BERTIN Joël [3]	BALHAN Bruno	GYR Marcel	BARISY Armand	BREAVOINE Bruno [3]
CHAPPUIS René	BONVIN René	WOUDSTRA Martin [2]	DEL TORRE Gualtiero	BOBBIO Piero
DUCIMETIERE Laurent	CRETIN Pierre [3]		EMERY Faustin [3]	BRETIN Jean-Louis
DURY Jean-Marie	CRIADO Gilbert [3]		ROSS Murray	CARLIER Etienne
FAURE Patrick [3]	DEDIEU Bernard		ZAZULA Jan	CASTELLI Giovanni
GUILLOT Jean-Claude	DELUEN Jean-Paul			DIEPERINK Johan
JANSSON Urban	DUCRET Robert			GARLENC Victor
LAMOUILLE André	GARREL Noël			GAYOSO Manuel [3]
SCHLAUG Martin [1]	GELARD Didier [3]			GRILLET Guy-Pierre
TRÖHLER Roland	GODDARD Brennan			LAFFIN Michel
VOSSENBERG Eugène	GUINAND Roger			MARCHAND Alain
	HEBRAS Philippe [3]			MARMET Gérard [3]
	KEIZER Reinder			PIANFETTI Jean-Paul [3]
	MERLE François			TERNULLO Jean
	OCTOBON André [3]			VERHAGEN Han
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	SOUBEYRAN Jacques			
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1) Stagiaire Doctorant
2) Stagiaire Technique
3) Personnes en Prestations de Services

Appendix C

Analysis of SL-CO

P. Charrue

1. Introduction

The SL controls group consists of 50 staff and 14 non staff. The group is divided into 8 sections each responsible of a specific task.

The controls group has two main tasks to achieve: The first one is to install, maintain and upgrade the control infrastructure made of workstations, networks, front-ends and field-buses. The second task is to provide equipment groups and operation groups with software to operate the accelerator. The emergence of standards (TCP/IP, Ethernet, X11, ISO/ESA specifications) as well as supported home made packages (RPC, NODAL, SL-EQUIP,...) give us more flexibility and better performance.

I will describe the main sections of the group, try to classify the tasks of the group and then write some remarks and conclusions.

2. Workstation Section

This section consists of 7 staff and 2 non staff. This section has two main tasks: managing (this means buying, maintaining, upgrading) workstations (Apollo/Domain and HP/UX), Hewlett Packard file servers and X-terminals as well as developing and maintaining Video and Teletext transmission.

3. Application Section

This section consists of 7 staff and 5 non staff (in which you can count at least 3 as "missing staff"). The main tasks of this section are to provide a support for the equipment groups and the operation for application software as well as maintenance (and sometimes development) of home made packages (Alarm software, error handler, X graphic packages, generic servers, black boxes,...) A great amount of effort is also used for archiving and checking in operational software (SLAPS/SLOPS). The alarm team (2 staff and 3 non staff) provide a CERN wide service from this section.

4. Network Section

This section consists of 8 staff and 4 non staff (in which you can count at least 2 as "missing staff"). The major task of this section is to manage the SL network infrastructure. This implies the installation, maintenance and surveillance of a very wide network with lots of different connections (Token Ring, Ethernet, fibers, TDM, ...) and different types of nodes (bridges, gateways, X-terms, PCA, DSC, file servers). This section also looks after the supported field buses and their equipment (1553, MPX). And finally, the management of the host tables is also done inside this section. Few developments are made, mainly in the field bus domain. In the network domain, only standard and supported solutions are used and bought. Even the surveillance is now made with standard products (Hewlett-Packard OVW for display and snmp protocol).

5. PC Section

This section consists of 3 staff and 1 non staff. They are responsible for the system integration of the Front End computers for LEP and SPS and of the main fileservers. They are also maintaining and developing in-house packages (NODAL, RPC). In addition, LynxOS devices drivers and snmp tools are developed inside this section.

6. VP Section

This section consists of 7 staff and 1 non staff. They are responsible for the hardware and the software of the Front End computers for LEP and SPS. Three people are working mainly in hardware and are installing and maintaining about 300 PCs and VMEs. Small hardware developments are made mainly for the field bus controllers (1553 NBC for PC and VME) or very specific VME cards (SAC). Software developments can be separated in several parts. One consists of the "Bureau des plaintes" of all users of the SL Controls infrastructure: a phone number (5568) and a staff is sitting just to answer the phone and respond to requests of our users. The system management for different platform (XENIX, LynxOS) is also one of the tasks of this section in collaboration with the PC section. In addition, a lot of effort is made for equipment access software (1553, GPIB, BITBUS, RS232, ...) or in house packages maintenance and development (SL-EQUIP).

7. Timing Section

This section consists of 4 staff. They are responsible of the hardware of the accelerator timing distribution for SPS and LEP. In this field, some hardware developments are made due to the specificity of the SPS and LEP timing. But the main task of this section is to maintain the installed hardware.

8. Area and Experiment Section

This section consists of 3 staffs. They are responsible for two main tasks. The first one is to give the LEP and SPS physicists means to access accelerator data. The second one is to rejuvenate the SPS zones control system. These two tasks are definitively core activities due to their deep knowledge of the overall control system and its history.

9. Discussion

One can consider that the CO group is providing services to all other equipment and operation groups of the SL division. The people from CO propose a control infrastructure, maintain, and update it. Our major task consists of maintaining the installed material and software.

There is not so many hardware development made in house. Only few people are involved in new hardware developments and these developments are mainly done in the field of field-buses where we need special bus controllers or RS232-1553 connections. These hardware developments must remain a core activity because of the needed background and huge investment in in-house systems. These hardware developments are a good mean of

remaining informed and be able to write good specifications if needed.

About software activities, we can consider two aspects: The first one is the maintenance of the running programs and packages we have developed in-house. About every software engineer spend most of their time to maintain their old developments. This task is a core activity by definition. We cannot ask an external firm to maintain our software. The second aspect in software activity is the new development. Here we can give this task to outside firms, especially now as we gain confidence with the ESA software Specifications. A complete project (the SPS interlock package) has been specified by one software engineer following the ESA standards and then has been given to an outside firm. This experience was very instructive and we should be able to submit any new well defined software to external firms. Our software engineers must move from software writers to software specifiers and be able to follow-up the projects with external firms. But the operational and maintenance aspects as well as the real cost of the project must be looked at carefully.

Other activities of the CO group is buying and installing hardware for workstations, network and front end computers. This activity must be a core activity for the design of the overall infrastructure. The final cabling and installation is already done by contracts people working in the CO group and by staff technicians.

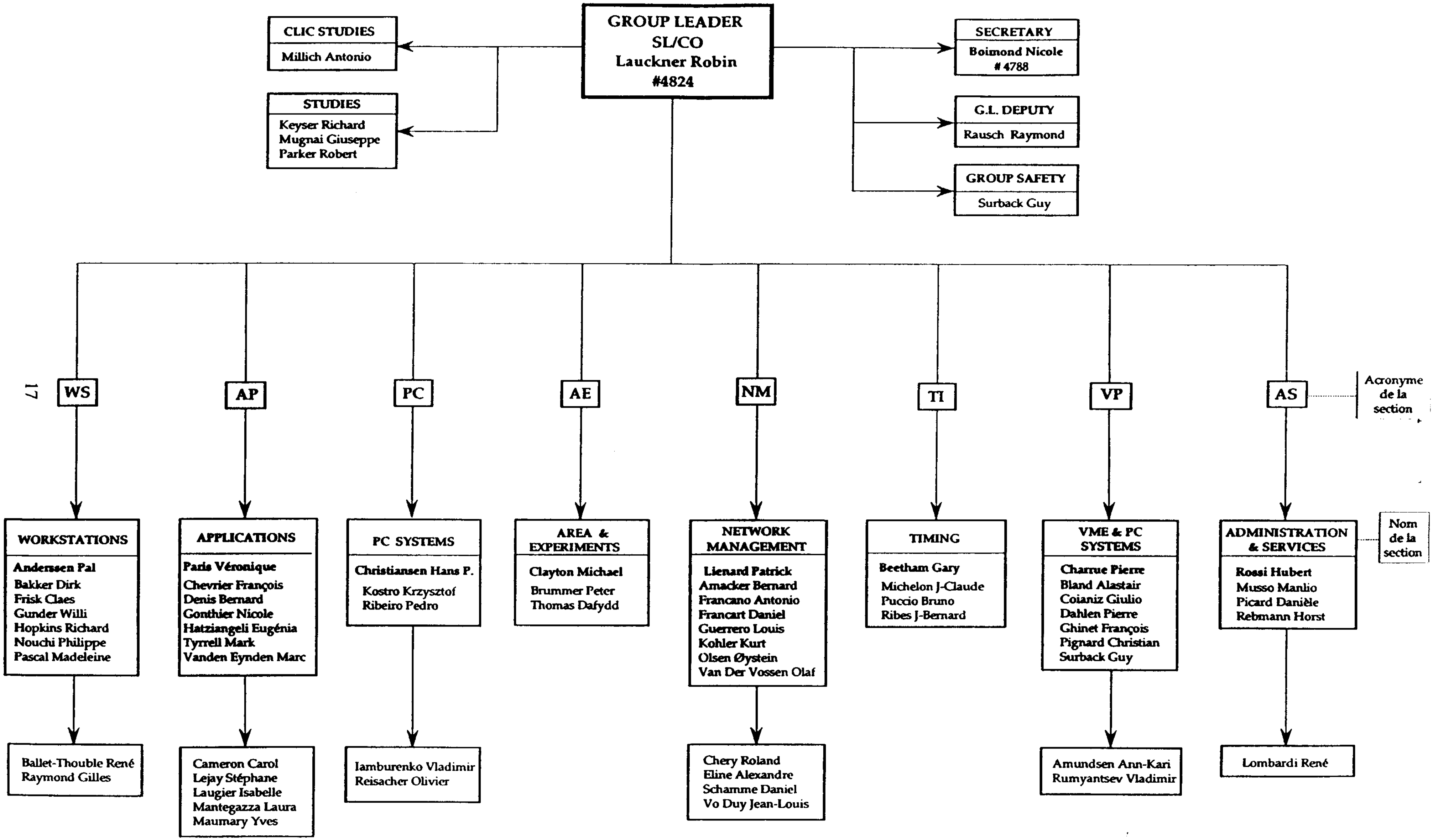
10. The "Unthinkable"

One strange idea (?) is "why not putting all people working for software for controlling SPS and LEP equipment in the CO group ?". We could imagine that BT, RF, BI, PC, etc. people working for control software join the control group and that the control group offers its services and its solutions to the other groups. This may save a lot of effort and only the common solutions for accessing equipment and making application software will be used. This idea will avoid the duplication of efforts and of solutions.

This idea could be revised in a more feasible way by enforcing the exchange of information between all these people working for controls. Regular meetings, seminars and collaboration would also avoid the duplication of efforts and of solutions. We can even formalize a bit more in creating a Control Software Management Board Committee composed of a chairman, people from equipment groups, from the operation group and from the CO group. The mandate of this "board" would be to follow all problems and development from the beginning. This would allow to build coherent solutions and maybe to make some efficient sub-contracting of parts of software.

CONTROLS GROUP ORGANIZATION CHART

Version : 01.09.94



Appendix D

Analysis of SL-DI

F. Bordry, P. Charrue, K. Elsener, and V. Mertens

1. Personnel and Office LAN

This section consists of 3 staff persons (1 engineer, 2 technicians), and one contract person. The section leader is Personnel Coordinator and Training Officer for the division. Due to the required intimate knowledge of the division and the people and the necessary confidentiality this task is undoubtedly a 'core' task.

Besides this function the team deals also with the computing support of the division, as far as office equipment - PCs and Macintosh's - and coordination of VM activities are concerned. This implies purchase, installation, and repair of office informatics and partially networking hardware, purchase and installation of software, supply and maintenance of additional software tools, network administration and consulting of users in problems of every-day computing.

Much of the common software is supplied and maintained by services outside of SL in the context of the NICE initiative which avoid duplication of effort. In-house hardware repair and maintenance is limited to interventions which can be done relatively quickly; for that purpose a stock of essential components is kept. This task is performed by a contract person. Repair work which would take longer or require more detailed electronics knowledge (e. g. monitors) is given to outside firms. Due to the rapid technological progress in this field, repair is often not even economic. Much equipment is therefore simply scrapped.

This office computing support could in principle be entrusted to an outside company since it is in no respect typical to CERN or to accelerator work. It could for example be imagined that all office computer equipment is leased for a certain period after which it is replaced with new hardware which is more adapted to the - typically increasing - needs. Broken parts would be repaired or replaced within the terms of the leasing contract. To guarantee rapid interventions and to solve smaller problems in situ a team of the leasing firm could be installed in an SL office. A repair service could also be placed close to CERN in one of the "technoparcs" from where also network administration could be done.

Considerations of this kind were made already earlier. They led so far to the conclusion that an outside service of this kind would be several times more costly than the present solution. Even disregarding this argument it would be necessary to prove that a different way of working would result in better quality of service or higher reliability before such a decision is taken. Current purchasing rules also disfavor such a procedure since no firm can be guaranteed a contract over many years which only would justify the necessary local investments.

2. Divisional Administration

This section comprises one staff (1 secretary), one contract person full-time and another half-time, as well as one half-time "régie" person. The group secretaries (5 staff (5 secretaries), 2 contract persons) were to some extent also considered under this heading.

This area deals with the administrative matters of the division - link to personnel , allocations, claims, links with the group secretaries, supply of office furniture, organization of removals, organization and maintenance of electronic forms for the use in the group secretaries, and the like. The SPS archive organization is partially located here. A central 'Economat' service is maintained, complementing the local ones closer to the groups.

Parts of this central service imply a high degree of confidentiality which can therefore only be fulfilled by a staff person. Other parts like 'Economat', office furniture etc. can equally well be given to contract people working on site as it is already the case.

Group secretaries obtain information from this central administrative service, forward information to it, keep local 'Economats', and perform other general secretary functions to the group, like typing or copying. Since their work deals with less confidential information retiring group secretaries could in the future be replaced by contract people, a process which has already be started. To provide good continuity and to reduce the training effort these people should stay for longer periods - at least several years. This argument holds also for contract people in the central administrative service. Otherwise one risks that qualified and well trained people disappear too rapidly onto positions with better conditions. Write-ups should be made of important and/or CERN specific administrative procedures to avoid that knowledge disappears together with retiring or leaving people.

Tasks which occur repeatedly for all groups could be centralized or at least massively be supported by the central administrative service - more as in the past - to avoid doubling the effort by the group secretaries. This concerns the organization of travel including the link to the travel agency, the organization of events like workshops, the bookkeeping of all personnel information and so on. To accomplish this task the central administrative service should be reinforced. Some of the group specific 'Economats' could be grouped together to building 'Economats'.

3. Budget and Planning

This section, comprising of 3 staff (1 administrative officer, 1 technician, and 1 secretary) is responsible for the correct management of the budget of the division. They do not do any book-keeping, but rather use the tools provided by the FI division. Their activities comprise to discuss the budgets with the groups, to distribute and re-distribute money according to the needs (small projects; large number of budget codes for most groups), the administration of bills (sending them to the groups and back to FI, etc.) and the follow-up of the budgetary situation throughout the year (including appeals to the groups to respect their budget).

There are not many prospects for farming out given the already low staff number in this area. Often used tools come already from outside SL (e.g. BHT, EDH, ...).

4. SPS Main Ring and Administrative Services

This section comprises of 5 staff and 5 contract people. The main activities inside this section are SPS Safety officer, SPS shut-down and technical stops organization, DSO deputy, SL space management, LEP safety officer, SL division inventory, and over 15,000 cubic meters of storage. This storage is supervised by one staff. Four contract people are working full time on this activity.

Some points of discussions came from the following:

- Should the inventory which is currently being looked after by a contract person not better be done by core people to ensure continuity?
- The storage may be a good candidate for farming out.
- Having seen the bill for painting an office, wouldn't it be cheaper to have a painter at CERN?

5. LEP Main Ring

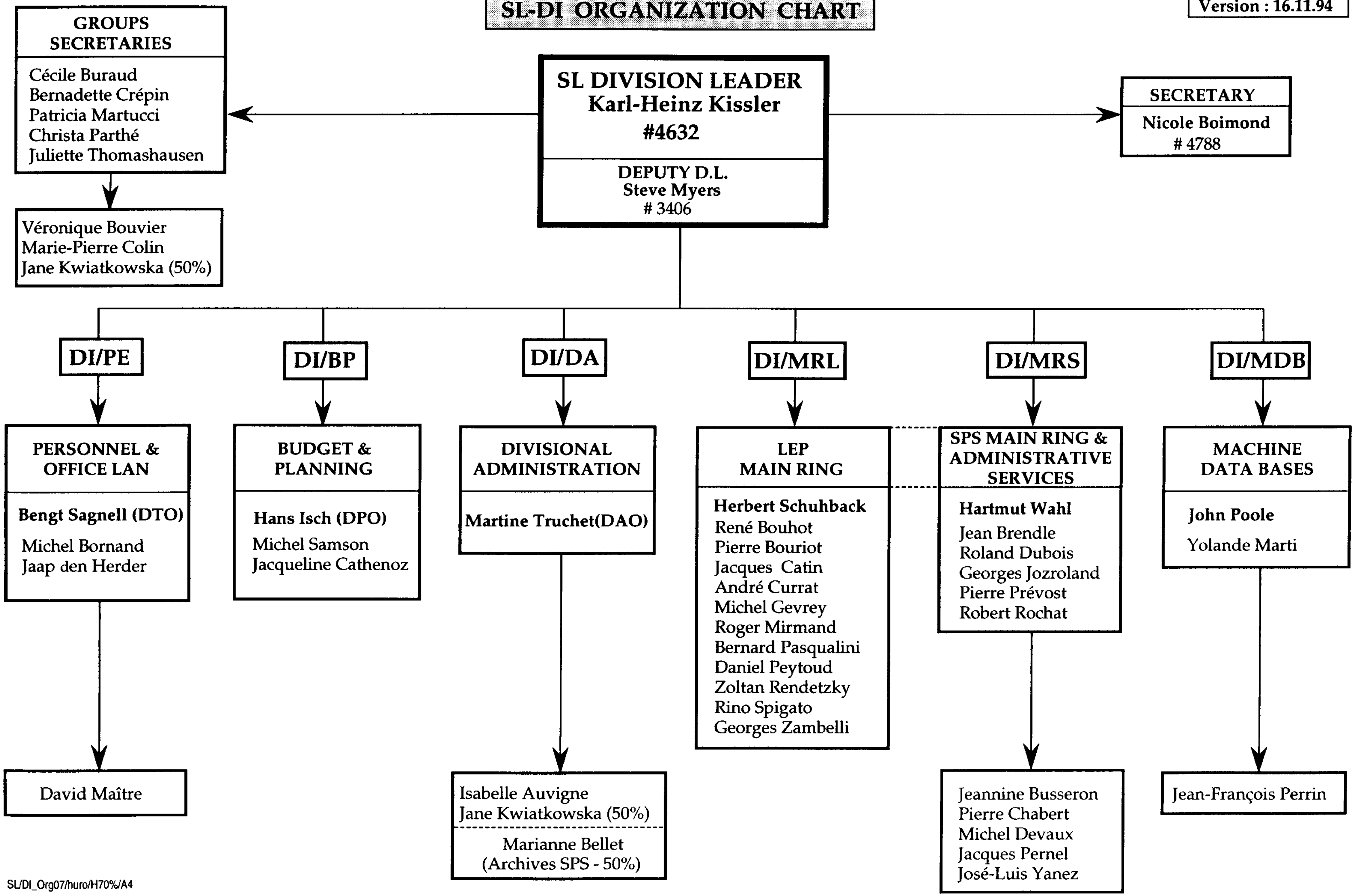
The main responsibility of this team (12 staff) is the LEP logistics. One staff is looking after the administrative matters, organizes the tunnel access and patrols and the training of the contract people which need to make some work inside the tunnel. Another function taken by this section is the coordination of the LEP shutdown.

The main effort is done by site managers who have a lot of practical work to achieve. They are located in the even pits of LEP where they maintain logbooks containing a lot of information, control everything going from the lavatories to the installed magnet and vacuum equipment, perform the role of TSO deputy, coordinate the use of electric cars in the tunnel, make periodic surveys in the odd pits, and also in the SPS pits. They are also taking care of the neighborhood of the LEP pits by keeping their area as clean as possible and by participating in a noise reduction campaign.

One last activity of these site managers is the door control. They are located near the entrance gate and should be controlling people going in and out of the site. We think that this activity should be farmed out to mandated people like the ones which are at the Meyrin and Prevessin main entrances. These people are wearing an uniform and are mandated to control people and cars driving through the entrance gate. The farming out will allow the site managers to concentrate on their main tasks listed above.

SL-DI ORGANIZATION CHART

Version : 16.11.94



SL/DI_Org07/huro/H70%/A4

Appendix E

Analysis of SL-EA

K. Elsener

1. Overview of the SL-EA Activities

1.0 General

The SL-EA group has the responsibility for the SPS beam-lines downstream of the targets, plans and changes the layout of the experimental areas and assists experiments and tests of the SPS fixed target programme and heavy ion programme (exception: the neutrino beams and experiments). The SL-EA group therefore forms the link between machine operation and the experiments. The group has to work distinctly different from most other CERN groups, because we have to follow the rhythm and "moods" of the SPS physics experiments and tests - more and more experiments consists of different groups from outside CERN, even outside the member states, and only few have support structures at CERN. Due to the character of physics experiments and tests, **spontaneous action and reaction rather than long-term planning** is often required from people working in SL-EA.

The **quality of the service** as "seen" by the SPS users in the experimental areas strongly depends on the quality of the work done by the members of the SL-EA group - they get the credit, but also the blame.

Work in SL-EA often consists in **co-ordinating the collaborative effort** with the power converter and areas operation group (SL-PC), beam instrumentation (SL-BI), controls (SL-CO), magnet group (AT-MA), surveyors (AT-SU), electrical installations (ST-IE), access system (ST-MC), heavy handling and transport (ST-HM) as well as manufacturing (MT-MF). These groups in turn are working with outside companies and contract labour.

At present, there are 6 secondary and tertiary beam lines serving the West Area (EHW1, EHW2) and 6 beam lines serving the North Areas (EHN1, EHN2 and ECN3) of the SPS, in total representing some 7 km of beam lines.

1.1 Related to SPS External Beam Lines

To conceive, design, install, set-up , maintain and adapt the SPS secondary beam lines to the needs of the fixed target experimental programmes including the heavy ion programme, physics based on primary protons and test beams for detector R&D.

Three types of activities:

- "projects" (e.g. K12, ions)
- shutdown activities (e.g. beamline modifications, maintenance)
- short term/last minute changes after schedule meetings

1.2 Related to SPS Experimental areas

Provide liaison with the experiments and tests. Plan the layout of the Areas. Install large pieces of equipment for the experiments. Study and supervise construction of support structures of experimental equipment and detectors. Povide and modify infrastructure in the Areas.

1.3 Example: SPS users in 1994

(according to schedule version 3.4(!))

- 12 experiments (WA.., NA..)
- 21 tests related to WA/NA experiments
- 42 periods of RD.. activities
- 13 tests related to LEP experiments
- 9 tests "officialy" related to ATLAS, CMS, ALICE
- 7 tests related to H1 or ZEUS (HERA)
- 3 tests for TIS (RP), CERN
- 2 tests for SL-EA (crystals)
- 8 other tests

1.4 Example: Beamlines and Experiments / Coordination

SPS period P2A, weeks 26/27 1994:

- SPS schedule meeting Thursday, 16 June, 11:00
- SEAT (expt. areas technical meeting) Friday, 17 June, 09:00
- distribute planning Friday, 17 June, 16:00
- start work in the beamlines and expt. areas Monday, 20 June, 08:30

NOTE: work has to be timed according to the SPS stops / MD's etc. which recently have often been cancelled. Also, work has to be co-ordinated with the wishes of the experiments: if the SPS has breakdowns, the physics schedule is adapted (experiments are prolonged) and our work has to be adapted, too.

1.5. Liaison to LEP Experiments

The liaison to the four LEP experiments provided by the EA group (one physicist) concentrates particularly on the quality of the beam conditions delivered by LEP for physics data taking. A complex collimator system in LEP and a set of special signals provided by the experiments are used to control the unwanted beam induced particle backgrounds to the detectors. The EA group participates in MD experiments and optimisation studies during physics to understand and improve luminosity limiting effects in LEP.

EA participates actively in study groups aimed to improve the LEP performance, i.e. LEP_2 study group, Pretzel study group and bunch train study group.

2. Overview of the SL-EA Group Structure

2.0 General

The organisational chart of the SL-EA group is shown in the appended graph. The group represents a relatively small team of people with diversified skills and knowledge in a broad range of fields. This allows a fast, flexible and efficient response to the rapidly changing and evolving demands of the SPS users (see examples above).

Four liaison physicists for the SPS and one for LEP experiments are working in the group. Two technical assistants are providing the necessary software support and are helping with the work on the SPS beamlines. A 24 hour "beam-tuning" piquet service for approximately 200 days per year is provided for the SPS experimental areas by the 6 people mentioned here.

The group has only one section, for all engineering and technical aspects, with a section leader co-ordinating and supervising the activities in the different sub-sections (see below).

As can be seen in the lower part of the chart, contract labour represents already 40% of the total manpower of SL-EA. In most cases, the same persons have been working in the group for a large number of years. They have acquired specialised knowledge and experience (**"missing staff"**). This is a difficult situation, and the group would not want to go further in this direction.

In the following, a short description of the different sub-sections is given:

2.1. Gas for Experiments and Beam Detectors
(1 staff + 2 contract)

Provide various gases to the detectors in the experiments and to the beam line detectors. Explosive gases are being handled regularly.

2.2. Vacuum of Beamlines and Experiments
(2 staff + 2 contract)

Maintain and modify the vacuum system of the beam lines and frequently adapt the vacuum installations to the experimental layout of the areas.

2.3. Secondary Beams
(3 staff)

Install, maintain, adapt beam lines in the West and North Areas. Build install and maintain wire chambers, Cerenkov counters, FISC counters, etc. for beam instrumentation. Develop bending devices for bent crystal research with beam line applications.

2.4. Installation of Tests and Experiments
(4 staff, 7 contract)

Plan, install, modify the installations for test and experiments in EHW1, EHW2, EHN1, EHN2 and ECN3. Safety of the experimental areas (TSO, TSA). Beam dump changes and zone enclosures, according to the frequent changes of the programme.

2.5. Drawing Office
(3 contract)

Give extensive drawing support for experimental installations and secondary beam equipment, in close collaboration with 2.3 (Secondary Beams) and 2.4 (Installation). Draw and document beamlines and experimental areas.

3. Comments

Due to the **high flexibility** required and determined by the nature of physics experiments, as well as due to the high degree of **links with other groups at CERN** (who in turn use contract labour, farming out etc.), it seems clear to me that the SL-EA activities are typical examples of **core activities.**

New ways of organising the work could nevertheless be envisaged, or can at least be theoretically discussed:

Among ideas related to the engineering section, a more "result-oriented" approach can certainly be considered, with supervised teams of contract labour taking over entire tasks. However, this could only be done at a considerable cost: well qualified (i.e. expensive) supervisors of the external firm, and **more CERN staff** working as co-ordinators and supervisors in the SL-EA group. The frequent over-time and extra efforts made - which are characteristic for SL-EA staff as well as contract labour working closely together with them - could hardly be expected from these external teams, or only at a **very high cost. This solution is therefore not recommended.**

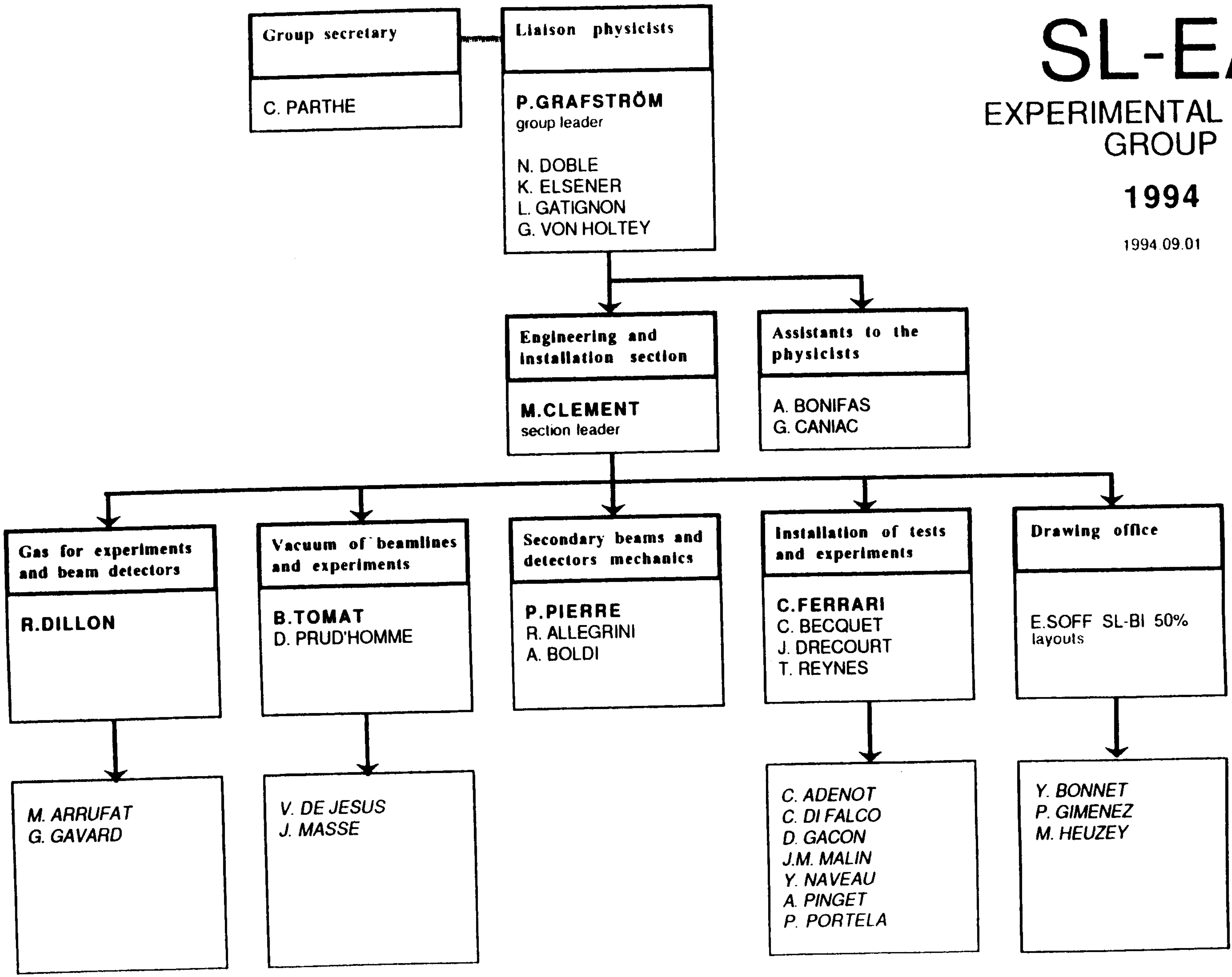
Concerning the beam-physics aspects, as well as certain projects and developments, the possibility of collaboration with universities (in particular in the form of technical students and PhD students working at CERN) could be intensified - this would, however, rather help to reduce the burden on the beam physicists, and can not be considered as "farming out".

SL-EA

EXPERIMENTAL AREAS GROUP

1994

1994.09.01



Appendix F

Analysis of SL-OP

P. Collier

1. *Areas of Responsibility*

Three groups are together responsible for the day-to-day running of the two accelerators in the division. These are the SL Operations group, the CRN and the Technical Control room staff. The split of responsibility is as follows:

- SL-OP: Responsible for the beam-related operation of the two accelerators, SPS and LEP; together with the transfer lines from the PS complex, between SPS and LEP and the north and west extraction channels of the SPS.
- SL-PC(CRN): Responsible for the installation, operation and first line intervention on the beam transfer lines from the targets to the SPS experimental zones. They also act as a first line intervention service for all SL power converters.
- TCR : Responsible for the services infrastructure of the accelerators, including cooling, cryogenics, electricity, vacuum etc.

In all three cases staff are employed on shift work to oversee the operation. The services staff, manning the TCR, are now responsible for equipment on a CERN-wide basis and are no longer part of the SL division. A detailed treatment of the CRN is not attempted in this appendix, as it is dealt with as part of the SL-PC group.

2. Introduction (& Conclusion!)

The operation of the accelerators in the division is a core activity - and must remain within the control of CERN personnel. This paper therefore reviews the structure of the operations group and how this could be made more responsive to the global needs of the division.

3. Present Group Structure

The group is presently structured around the needs of operating the machines and consists of:

- 1 Group Leader
- 2 Coordinators
- 8(9) EIC's - 6(4) acting as machine coordinators, 3(5) acting as shift leaders.
- 11 Shift Leaders
- 8 Control Room Technicians

(Next years numbers in brackets).

During operation of the accelerators, the control room is staffed 24 hours a day by three shifts of three people, consisting of 2 shift leaders and a technician, or 1 EIC, 1 shift leader and a technician. Some of the EIC's perform the role of machine coordinator, which generally lasts for 1 week of operation. The number of staff available implies the following shift rates (neglecting holidays, illness, etc.):

- Coordinators 7 days shift every 21 days
- Shift Leaders 7 days shift every 16 days
- Technicians 7 days shift every 18 days

Machine Development periods are not counted in the above. Generally all EIC's form a pool to man every MD during this period. In addition many EIC's ask for, and perform MD's themselves. The period when the staff are not on shift includes a minimum number of compensation days - defined by the staff rules and regulations.

4. Classification of Activities

When LEP started up in 1989 the general services control was under the responsibility of the operations group. This kind of activity was generally related to industrial type controls and has been successfully farmed out by the group to another part of CERN. The remaining beam-related part is highly specialized and requires a great deal of experience to get the best performance out of the machines. It is considered here as a core activity. The general knowledge of accelerators which comes from operations is considered as valuable experience, even for people who are employed in other areas of activity within the division.

The Tristan accelerator at KEK uses industrial support to provide the technicians for operations. The result, by my observation, is a reduction in the team spirit of the people on shift. As a consequence the machine does not run as smoothly, or as well as it would with dedicated internal staff. The use of people from industry is limited, as they do not have sufficient experience of accelerator physics, and the service provided to the experiments suffers as a result. In Tristan they are generally used to survey equipment and switch it back on after a fault. They do not, generally, participate in the beam-related operation.

5. Recruitment Policy/Second Job

The operations group staff are not always on shift. On average the shift load over the year is about 50 to 60% (including compensation days). During the remaining time the staff are encouraged to work in other areas. At present there is no structure within the group to encourage the personnel to work in particular areas of need. Often people start working in areas of obvious perceived need for the group. As a result the majority of the group write control room software as their second job. At present, six of the eight control room technicians, and five of the eleven shift leaders spend most of their time, when not on shift, writing software. The division as a whole does not need such a high proportion of software writers.

For the engineers a policy of recruitment has been followed recently where candidates are chosen as much for the future needs of the division as their ability to operate the accelerators. The second job of engineers is therefore more clearly defined as they often have a pre-defined interest in an area of the divisions activities. In general the EIC's remain within the group for about 5-6 years where they gain experience in all aspects of accelerators. During this time they follow with their second job their other interests, which often form the basis of their work after leaving the group.

For the shift leaders and technicians no such structure exists. Technicians are now employed on term contracts (2x3 years) after which they must find another job. Some of them may be taken on as shift leaders, but not all. A shift leader would be expected to remain within the operations group for about 10-15 years. A change in the recruitment policy of technicians towards that used for engineers could help the division as a whole, by providing a pool of people who have valuable operational experience of running the accelerators. After completing their term in the operations group, they could be employed in other groups of the division. For this policy to work a new management structure needs to be put into place within the operations group. This would allow technicians and shift leaders to develop interests, within the framework of their second job, which are more useful to the division than at present. This framework could also encourage closer relations with the other groups in the division, such that a technician, for example, could work closely the RF group as his second job during the period he is employed as an operator. At the end of his period in operations an opening could be provided in the RF group to take on a well trained RF technician, with useful operations experience.

It is therefore suggested that an 'overlay' structure is designed for the operations group. This structure would be more similar to the other groups in the division, consisting of several sections and would exist in parallel with the structure in place for the day-to-day operation of the machines.

6. The Relationship Between PCR and CRN

At present in the SPS the SL-OP group is responsible for operation up to the targets of the west and north extraction channels. From there on the responsibility passes to the CRN who look after the secondary beam-lines to each experiment. They also provide a first line intervention service for all SL power converters. The PCR technicians are very experienced with beam-related problems, but have much less knowledge of the hardware forming the beam-lines. The CRN, on the other hand, are very experienced at troubleshooting equipment (power converters, magnets etc.) in the beam lines, but have little beam related experience.

The future organization of the CRN is under discussion at the present. One scenario would physically place the CRN personnel in the PCR, whilst retaining independence from the SL-OP group. It is my opinion that this approach would not be of any benefit to either group. . The early experience in LEP with the general services illustrates the potential pitfalls of separated functions within the control room. Instead, under these circumstances, a merger of that portion of the CRN dealing with operation of the beam-lines and the SL-OP group should be considered. This would imply that the present SL-OP technicians become capable of repairing the secondary beam-lines and the CRN technicians are trained to operate the main accelerators. The whole could be run from the PCR. **This does not necessarily imply that fewer people would be required on shift.** The benefit of this system would be a wider knowledge base for the operators and a closer relationship between the SPS experiments and the machine operators.

7. Applications Software

At present the relationship between the applications section of the controls group and the operations group is unclear. A large fraction of the software in use for operating the machines, has been provided by the operations group themselves. This is probably due to the fact that the operators can perceive more quickly (and easily) the software requirements and priorities for operation of the accelerators. If the operations group move towards a more global structure for activities outside operating the machines, then fewer people will be available to provide control room software. There will therefore be a need for the applications section of the controls group to take a bigger part in software development. For this to happen successfully, the applications section needs a greater understanding of how the accelerators are operated. In addition, if more software projects are to be passed out to industry, then the staff who specify the requirements need a very good knowledge of the accelerators and the way in which the software is to be used.

Appendix G

Analysis of SL-PC

F. Bordry

1. SL - Power Converter Group Mission

- Design, acquisition, operation, reliability and performance improvement of all the power converters for the SPS and LEP accelerators, their experimental and test areas.
- Operation of the secondary beam lines in the SPS experimental areas.
- Research and development of the power converter technologies for future accelerators (LHC) - Design, acquisition and maintain LHC test stands.

2. SL - PC Structure

7 sections to carry out the SL-PC mission:

Operation (CRN)
- Operation of the SPS North and West experimental beam lines (converters, access control, ...)
- Maintenance of access control software
- First-line interventions on all SPS, LEP and experimental converters

SPS converters exploitation
- Maintenance, repair and improvements of all SPS converters
- Operation support (liaison with PCR, CRN), support for MD
- Project support (upgrade and new installation)
- Magnet test stands

LEP converters exploitation
- Maintenance, repair and improvements of all LEP converters
- Operation support (liaison with PCR, CRN), support for MD
- Project support (LEP 2 and new installation)
- Magnet test stands

Experimental areas exploitation
- Maintenance, repair and improvements of all experimental area converters in SPS and LEP
- Cooling and electrical connection of magnets in the SPS experimental areas
- Installation of interlock circuits on spectrometer magnets
- Responsible for the infrastructure between magnets and converters (interlocks, connections terminal boxes...). Frequent changes to adapt the system to the schedule of experiments
- Operation support (liaison with PCR, CRN), support for MD
- Project support

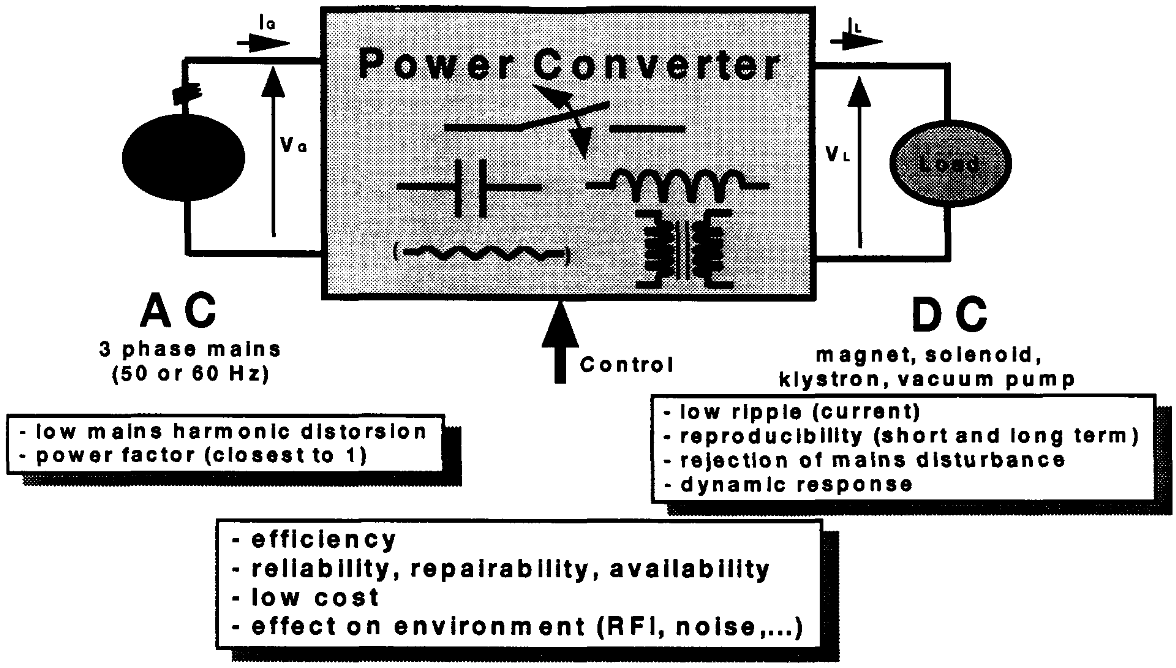
PS support
- LHC power systems studies (studies and development of new conversion topologies)
- Design, build and maintain LHC test stands
- Develop and maintain the highest level of current measuring expertise
- Operate a calibration laboratory for high currents
- Technical support for the other sections in the group
- Project support

Control support
- Studies and development of new control technologies
- Maintenance, repair and improvements of all controls hardware (LEP control cards and crate, SPS mugef)
- Operation support (liaison with PCR, CRN), support for MD
- Development and maintenance of all control software for the group
- Personal computer and instrumentation support

Group services
- Drawing office for the group
- Electronics manufacturing for the group
- Quality control expertise
- Budget forecast and follow-up for the group
- Group planning
- Contract labour management
- Administrative support (space, inventory, cars, ...)

3. Power Converter for Accelerators

Particle accelerators require a large variety of power converters for the magnets, klystrons, vacuum pumps and other equipment. For this purpose, static power converters are used to convert alternating current (AC) to direct current (DC). These power converters are required to provide high precision current over a wide range with low ripple and high stability (a few parts per million, ppm !). High precision control must be used to meet these requirements.



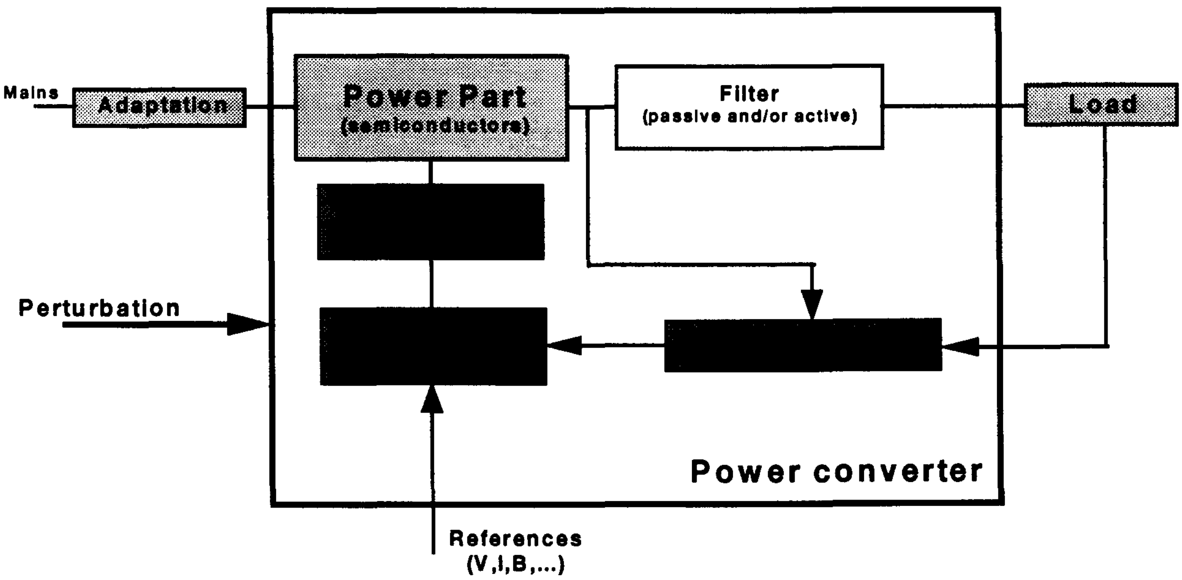
4. High Performance has to be Achieved

It is a compromise between all the precedent criteria. The compromise is dependent of the power converter function (dipole, chromaticity sextupoles, closed orbit correctors,...). The large range in power should be noted: from 300 W to several MW.

The different types of machines (SPS pulsed machine, LEP leptons collider, LHC super conducting protons collider) is an important factor for the optimization of this compromise.

These differences lead to various kinds of topologies: current and/or voltage bipolar or unipolar converters, thyristor rectifiers or switch mode power converters, passive filters and/or active filters, control strategy for current and voltage loops (analog and digital), ...

A power converter is made of several different parts: power (semiconductors : thyristor, IGBT, power MOSFET, MCT; passive components) and control (loops and function generators).



The power converters are a vital performance element in any accelerator. The precise translation of the beam's and/or the machine's needs into magnetic field requirements and hence amps, volts and their respective tolerances is a vital part of achieving high performance. A power converter can not be considered as an individual entity. To track the beams, especially during acceleration phase, the behaviour of the set of power converter - magnets (one or many magnets in a string) has to be precisely known (magnet model, transfer function between current and fields, dynamic multipoles,...)

The power converter specialist must understand the whole environment (exact operating modes that might be used in terms of cycles, sequences, etc.,..) not only to design, but also to operate a power converter. His specialist knowledge input into machine operation can be important for performance improvements.

To supply and operate a power converter, the following activities have to be undertaken:

- Establish the requirements and the specifications
- Design (simulation and/or prototype)
- Acquisition ([prototype], pre-series and series)
- Organization and supervision of installation
- Commissioning in the final environment (set of power converters with final loads and with beam !)
- Operation
- Maintenance (repair and preventive maintenance)
- Adaptation and Upgrading (crash program included !)

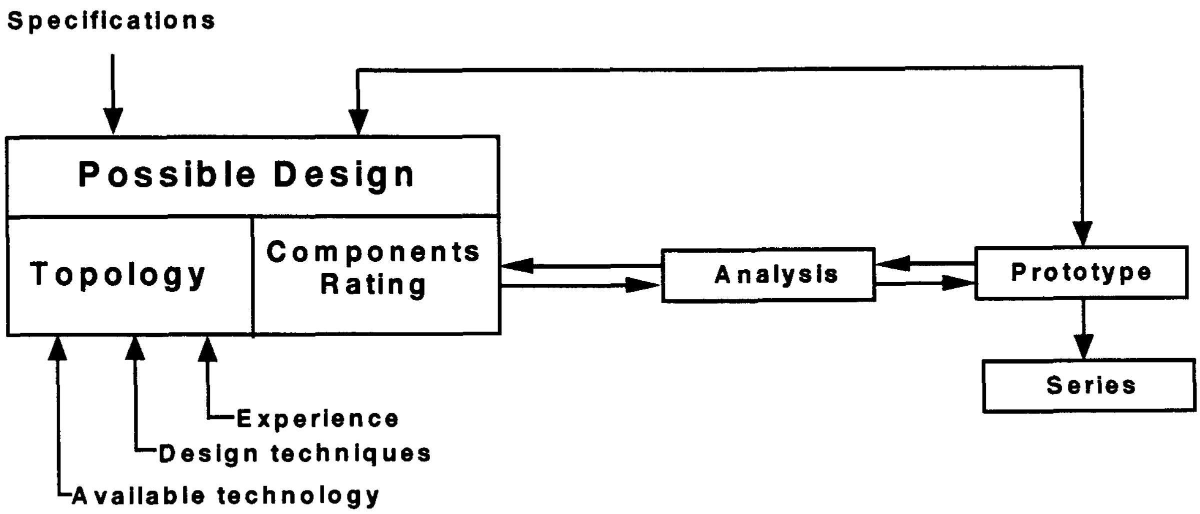
The design is an iterative analysis until certain specifications are met, and is characterized by the figure below.

5. Activities Classification

Core activities for CERN staff

Core activities: activities identifying the CERN's mission; service to physicists (high energy beams) and to the member states (spin off).

- study of new domain for high precision power converters: new topologies, control domain (adaptive control, fuzzy logic, neural control, sigma-delta ADC, ...), high current measurement,...
- development of test equipment for new technologies (exploration of the technically possible) : high-precision power converters, fast regulation, high reliability techniques, high current measurements,...
- establish the requirements for new equipment; numerous links with other groups : machine physicists, magnet or RF group (specification of the loads), control group,... The requirements have to be defined in the global context of the accelerator running .
- design of new power converters; simulation tools play an important role in the design phase but prototypes are essential in this technology field.
- maintain and improve state-of-the art knowledge in high performance power converters (power and control parts)
- production of the User Requirements Document (URD) for all the necessary software (ESA software engineering standards)
- operation of a primary Standards Laboratory for calibration of currents at the 1-20 ppm level up to 15 kA. Activity permitting to evaluate in an independent way the result of the outside companies. World-unique facility
- proposition for equipment improvements
- preparation of documentation for specifications and writing of specifications
- follow up and control of outside contracts (labour or result evaluation)
- preparation of system documentation for routine maintenance
- diagnostic in case of power converter related machine problems (performance diagnostic)



- daily follow-up of accelerators in terms of performance : liaison with control room and Machine performance committee
- regular tuning of equipment to maintain high performance
- to ensure the transfer of expertise between staff members (management of retirements or accidents) to avoid dependence on outside companies
- to ensure the transfer of expertise between CERN, member state industries and universities
- general management activities

On-site Activities for outside contractors

Industrial labour contracts (labour-oriented); additional manpower, in particular during peak-load periods.

- support for all core activities; missing staff role, especially:
    - regular surveillance, on-site repairs and unforeseeable maintenance of equipment to maintain availability and reliability; more flexible than specific maintenance contract.
    - spare parts management
    - building and modification of prototypes

Activities for farming-out

Farming-out: contractual relationship which gives full responsibility for an activity to a contractor/national laboratory/university (result-oriented). Can be on-site or off-site.

- software production based on User Requirements Document and following ESA software engineering standards
- prototype fabrication during design phase with a strong link with CERN staff designer. The two approaches (CERN prototype or mock-up and industrial prototype) are complementary. Technology transfer is an important point in this relationship.
- production of pre-series and series of equipment
- installation and commissioning of new equipment
- regular maintenance activities, especially during shut-down and technical stops (fans, transformers, main circuit breakers, capacitors, ...)
- certain on-site intervention on equipment (first line intervention). Class of contracts has to be defined : intervention delay ; *cost (short and long term), flexibility and continuity has to be evaluated.*
- repair of equipment, assuming enough spare modular parts or complete power converters; *but same remark as previous item*

The four last items could be specified during the calls for tender (MTBF specification and maintenance contract).

The criteria used to class all the above activities can be summarized:

Core activities:

- all activities linked with high performance
- activities requiring deep knowledge of accelerators or CERN environment; an activity requiring more than 6 years of presence at CERN is a core activity: accumulated accelerator experience and CERN independence

Contract labour activities:

- activities having peak-load periods
- high qualifications can be required but no irreplaceable expertise

Farming-out activities:

- all activities linked with availability
- activities requiring (high) industrial specialization but the existence of several potential companies must be evaluated to avoid a complete dependence. Back to the previous statement: accumulated experience.

General ideas:

- university or national laboratory participation during design phase (share Ph.D. direction for example) should be promoted and facilitated
- many of our present Prestation de Service are in fact a replacement for missing CERN staff. Do not under estimate their irreplaceable expertise

G. Fernqvist
Group Leader

P. Proudlock
Deputy Group Leader

B. Danner
Divisional Safety Officer

C. Buraud
Group Secretary

SL-PC-OP Operation

Operation of the SPS North and West experimental beam lines
First-line interventions on all SPS, LEP and experimental converters

B. Chauchaix

O. Aune	pt PS
P. Bailly	pt CS
A. Blin	pt EC
T. Boult	pt EC
C. Coupat	pt CS
F. Follin	pt LC
Y. Gaillard	pt CS
D. Hay	pt EC
E. Junnonen	pt PS
R. Koppanyi	pt LC
G. Maire	pt SC
L. Pereira	pt CS
B. Pichler	pt CS
A. Russo	pt EC
Vacancy	

SL-PC-SC SPS converters

Maintenance and improvement of SPS converters
Support to SL operation. Project support

P. Burla
J. Bonthond
J. Cadoz
B. Ducret
K. Fischer
J. Hofmann
C. Mugnier
B. Pires
A. Rubio
P. Schneckenburger

SL-PC-LC LEP converters

Maintenance and improvement of LEP converters
Support to SL operation. Project support. Database maintenance

A. Beuret
M. Brolli
L. Ceccone
R. Genand
Y. Jacquemard
J.P. Porte
R. Van Robays

SL-PC-EC Experimental converters

Maintenance and improvement of experimental area converters in SPS and LEP
Planning and execution/supervision of modifications to beam lines and experiments
Support to operation

J.C. Carlier
O. Bohner
S. Chiaramonte
D. Graskamp
J. Hudry
G. Muller
C. Valentini

SL-PC-PS Power support

Technical support for the other sections in the group
Project support. Studies and development of new conversion technologies.
High precision current measurements. Database development.
Design and maintenance of LHC test stands

F. Bordry
P. Campiche
K. Dahlerup-Petersen
A. Dupaquier
A. Issenbeck
J.C. Perréard
M. Royer

SL-PC-CS Controls support

Maintenance and improvements of all controls hardware
Development and maintenance of all control software for the group
Support to SL operation. Project support
Studies and development of new control technologies
Instrumentation and personal computer support.

J. Pett
I. Barnett
A. Dinius
D. Hundzinger
M. Leroux
P. Malacarne
H. Schwartz

SL-PC-GS Group services

Drawing office. Electronics manufacturing
Quality control expertise. Group planning
Budget forecast and follow-up. Administration support

R. Forrest
D. Arevalo
M. Devard
J.L. Drogrey
S. Marin
G. Meyer
F. Reiser
C. Ruiz-Llamas
D. Vintras

Appendix H

Analysis of SL-RF

P. Collier

1. Areas of Responsibility

- The maintenance (and further development) of the various SPS RF systems for Leptons, Protons and Heavy Ions i.e.: 100 MHz, 200 MHz SWC, 200 MHz TWC, 352 MHz (SC) and 800 MHz systems.
- The maintenance (and further development) of the conventional Copper RF system for LEP I, Consisting of: 8 RF Stations (124 Cavities), 2x1.3 MW 352 MHz CW Klystrons, HV and low-level controls etc.
- Maintenance/Development of the 1 GHz LEP Longitudinal feedback system. Consisting of: 1 Station of 4 cavities + RF supply, HV, low level controls etc.
- The development, construction, installation and maintenance of the superconducting RF system for LEP II. Consisting of: 12 RF Stations => 196 Cavities. Each station equipped with klystron(s), HV, low-level controls etc.
- Future RF System design studies/development. Notably of the SPS/LHC RF Systems and CLIC.
- Other equipment; such as SPS Robinson wiggler, LEP Transverse feedback system and the SPS Damper.

The activities of the group fall naturally into four areas:

- Maintenance/development of the various SPS RF systems.
- Maintenance/development of the conventional RF system for LEP I.
- Manufacture/installation/commissioning and maintenance of the SC cavity units for the LEP II project.
- RF developments - for (LEP II), LHC and CLIC.

2. General Comments

Much of the following discussion concentrates on the situation with respect to the LEP RF system, although most is equally valid for the SPS as well.

3. Developing RF Systems for Accelerators

The design of RF accelerating structures/cavities is a very specialized task which has no obvious counterpart outside the world of accelerators. For this task RF experts are needed who have a large amount of experience in accelerator technology. This is a classic case of a core activity. The only circumstances when this is not valid is when an RF system is required which was designed elsewhere. For example, ESRF could buy an 'off the shelf' RF system because the cavities are basically LEP I copper cavities, with minor modification. The longitudinal feedback in LEP is another case where CERN bought an operational system from another laboratory.

Once the cavity itself is designed the requirements can be specified for all the equipment which sits around them. This equipment can be placed in one of the following categories:

- The generation and transmission of the RF power to the cavities.
- Low-level controls for the RF power equipment and the cavities (e.g. loop controls and cavity tuning).
- Ancillary equipment - such as cooling, vacuum and (potentially) cryogenics.
- A general computer control environment for the ensemble of equipment.

The potential for farming out is different in each case.

In the case of RF power generation experience is available in industry. In general terms the power part of an RF system resembles a radio transmitter. Much of the equipment in use within the division was developed in partnership with industry. Examples of this type of equipment include thyratrons, klystrons, tetrode amplifiers, circulators, wave-guides and high-voltage protection equipment.

The low-level controls are more complex. Here many aspects are beam related and too specialized for non-accelerator experts, or cannot be specified a-priori sufficiently well for industrial development. An example of the second case is the cavity tuning system for LEP I. Here there were technical and theoretical difficulties which required many iterations to solve. In general the design of beam related controls should be considered as core, although related work such as electronic circuit design could potentially be done in industry.

Service equipment - for cooling, ventilation, vacuum, cryogenics etc. has been traditionally not been the direct responsibility of the RF group, but under the control of other groups or divisions within CERN. With respect to the SL RF group this can be considered as farmed out work.

The computer control system is one area which has been traditionally developed in-house, but has the potentiality for much more development with industry. The use of more industry standards (VME, GPIB, TCP/IP) has helped here, but much more could be done. The software is almost invariably developed by CERN staff, although more and more use is being made of industry standards.

4. Cavity Manufacture, Assembly, Acceptance and Testing

For copper cavities, once designed and prototyped the various components of the cavity have been manufactured in industry. Traditionally the various components have then been shipped separately to CERN and assembled here into complete cavity units. A rigorous scheme of acceptance testing has ensured good quality control. Once assembled the complete cavity units are power tested before installation. CERN has a large investment in the necessary infrastructure to perform assembly and testing (clean rooms, test stands etc.). The large manpower requirements for assembly have usually been met by contract labour.

With the main superconducting cavity contracts for the LEP II project this philosophy was changed so that industry would provide complete modules, in order to minimize the work done by CERN. In practice this means that the individual manufactured components are sent to the cavity manufacturers, who perform the final assembly into 4 cavity cryostat units. Acceptance testing before and after assembly assured good quality control. This worked okay until a serious problem with one of the components (the power coupler) was identified. Thus the situation arises where complete cavity modules are delivered to CERN for acceptance testing and are then dismantled again in order to install the final version of the coupler. The disassembly and modification process is delicate, with a significant failure rate. The amount of work required to be done by CERN has therefore been considerably higher than expected. Once again, contract labour is heavily used.

CERN has developed the very specialized technology to manufacture the SC cavities, notably the sputtering process for a niobium coating over copper. This technology has been transferred to industry for the series production. Experience with the series production has revealed the sensitivity of the process variations of some parameters; which could not have been analyzed during development. Constant interaction with the contracting companies has been necessary and required permanent negotiation.

5. Installation

For LEP and SPS, installation planning is done within the group. A heavy reliance is placed on the use of contract labour for this type of 'peak-load' work. Use has been made of industrial support for cabling and infrastructure installations. In general the mix between CERN staff, contract labour and industrial support has produced an efficient means of getting very complex equipment into the accelerators and into a working state. For technically simple, but large tasks; such as the LEP waveguide installation, industrial support firms have proved very successful. More complex installation tasks were done using contract staff.

6. Maintenance and Operation

From the first section it can be seen that the SL RF installations have become huge. The 16 RF units forming the LEP I system already require a tremendous manpower effort from the RF group. The addition of 12 more units for LEP II is going to compound the problem. The SPS, too, has a very complex installation. In this case compounded by the many disparate RF systems in use in the one accelerator. Certain, simple maintenance activities are already performed by industrial partners. This is usually 'shut-down' work and generally takes the form of preventative maintenance on large installations.

Responsibility for the correct functioning of the equipment during day to day operation is still within the group and in general is performed by CERN staff.

7. Conclusions

- The design and development of RF cavities is a very specialized field and requires real experts in the field to be resident at CERN.
- Transfer to industry of a very delicate technology, developed at CERN on a limited number of prototypes, requires continuous effort from CERN and the active collaboration of the firms involved, to resolve many unexpected difficulties. This is even more true if the technology transfer is attempted before the design of the product is completely finalized. The overall result is that

CERN does a lot more work at the end to cope with the disorganization of the planning.

- Large RF power installations (such as the LEP klystrons) have been developed in industry to CERN specifications. Here industry has sufficient expertise to perform the task well. For future projects, more areas could be attacked in this way. A good candidate might be the local RF control system.
- Final assembly, testing and installation have used contract labour a great deal. This has been successful, even for complex tasks. The main reason for this is that the same people have stayed with CERN for the whole of this phase. A large amount of experience is necessary for many of the tasks and it could not be done if the outside people changed often.
- The development of efficiency with experience, technical expertise and personal interest is very important for complex activities associated with the assembly, testing, installation and operation of these systems.
- Maintenance of equipment becomes more difficult as the development passes outside. Even if the equipment is developed by outside industry, CERN must maintain sufficient people who understand the installation in order to keep the equipment going and make any (inevitable) modifications. Most equipment is modified several times during its life - for accelerator performance reasons.
- The maintenance of the various SL RF installations is very consuming of manpower. Some areas of maintenance activity could be entrusted to industry. However general questions of response time, quality of service, technical expertise and personal interest of outside staff will need to be addressed.
- Farming work out always involves a longer lead time and a more rigid approach. It is best suited to those aspects of a groups activity that can be clearly specified in advance.
- In general more could have be farmed out. Most circuit card design, electronics racks, computers and software could have been developed outside however, it is important to keep sufficient expertise available within CERN to allow necessary modifications. This can only be achieved if the CERN staff are involved in the development. Such expertise does not come from writing requirements specifications.
- A less rigid approach to finance etc. needs to be taken by CERN. Are companies going to be interested when once they have produced a technical solution, the series production is put out to tender? For large contracts the present system of tender must be maintained - but perhaps the lowest price is not the only criteria For smaller contracts the system of tender is perhaps not so valid. There is little incentive for industry to get involved in (small) developments for CERN if it does not even know if it will be asked to make the production series. In addition the choice of another company might make later modifications more difficult.

SL-RF GROUP STRUCTURE

Group Leader: **D. Boussard**
Budget: **S. Hansen**
Secretaries: **P. Martucci**, **V. Chapon**

LEP RF, CLIC
(RF/LC)

S. Hansen

Carron G.
De Jonge L.
Frischholz H.
Juillard J. C.
Kropf H.
Lambert B.
Livesley S.
Olsen R.
Martinez-Yanez P.
Pecheur G.
Peschardt E.
Simonini A.
Sladen J.
Sunier W.
Thorndahl L.
Rugo E.
Wilson I.
Wuensch W.

SPS RF, LHC
(RF/LS)

T. Linnecar

Baudrenghien P.
Chapochnikova E.
Höfle W.
Lambert G.
Louwerse R.
Neumann O.
Rödel V.
Rossi V.
Sinclair W.
Stellfeld D.
Sutton B.
Wehrle U.
Wiencek R.

COUPLERS, RF POWER SPS
(RF/CP)

H. P. Kindermann

Candolfi M.
Gasser A.
Giguet J. M.
Griessen P.
Haebel E.
Heinzel D.
Herdrich W.
Malo J. F.
Mazars J.
Montesinos E.
Oude Moleman F.
Pistolato G.
Rochepeau G.
Stirbet M.

SC TECHNOLOGY
(RF/TE)

E. Chiaveri

Del Sole R.
Hänni R.
Insomby A.
Kubly M.
Magnani E.
Moriaud D.
Musso A.
Preis H.
Ruivet C.
Scharding A.
Schirm K.
Thony B.

SC PHYSICS, MEASUREMENTS
(RF/PM)

G. Cavallari

Bloess D.
Bressani G.
Dalmas C.
Durand C.
Guérin R.
Grabowski F.
Juras S.
Tückmantel J.
Weingarten W.

SC COMMISSIONING
(RF/CL)

G. Geschonke

Boiteux J. P.
Brown P.
Brunner O.
Jensen J.
Studer M.
Uythoven J.
Vitasse M.
Wiszniowski T.

CONTROLS
(RF/CO)

E. Ciapala

Arnaudon L.
Bracke E.
Brun R.
Butterworth A.
Disdier M.
Molendijk J.
Paccani M.
Pilchen Y.
Prax M.
Weierud F.

SL-RF/DB/vch

Appendix I

Visit to ESTEC

P. Collier and H. Schmickler

1. Aim

ESTEC in Nordwijk (Netherlands) is a European Organization comparable in size to CERN which is in charge of the conception, construction and testing of equipment for outer space missions. Nearly all the work at ESTEC is done using the concept of farming out. Hence P.Collier and H.Schmickler representing the task force group went to see prelevant people at ESTEC in order to import their detailed experience in farming out.

2. Results

- When creating ESTEC the concept of farming out was rigorously implemented. The striking consequences are very high costs and long delays between the collection of user requirements and launching of the final pay load into space.
- The industry partner of ESTEC is called the primary contractor to which ESTEC entrusts the responsibility for a complete project (i.e. a space mission). The size of these projects can be as large as some hundred million ECU's. The primary contractor then employs according to his choice secondary (and further tertiary) contractors for the task execution. This way ESTEC tries to avoid the enormous administrative overhead in managing the secondary contractors. The way CERN presently tries to employ farming out principles is acting as project initiator as well as main contractor.
- Once a project is entrusted to the primary contractor there is little chance for further modifications. In case of a satellite and its various payloads this seems reasonable. The final performance of any equipment and its interference with other equipment is known and can be computer simulated. As in addition any maintenance or repair are excluded after the launch, a very conservative design approach is taken and the equipment is usually exploited at a fraction of its design performance. In the case of CERNs large accelerators we rather look for ultimate performance and we design complex systems were the overall system behaviour can not be completely computer simulated. Hence throughout the exploitation period of an accelerator a high degree of flexibility and ability for modifications are demanded.
- The profile of the employees working at ESTEC is quite different from those working at CERN. In the case of ESTEC much more physicists and engineers working in an administrative way are employed.
- People working for longer at ESTEC loose contact to front- end technology and hence have difficulties in correctly specifying the user requirements. This effect one tries to compensate by employing young people on term contract basis throughout all sections of ESTEC.
- With the increasing demand of reducing the costs ESTEC is looking in these days for working concepts **avoiding** farming out.
- Farming out demands an enormous amount of journeys to industry. With the additional demand of "geographically just money return" the number and length of these trips is sometimes ridiculous.

3. Conclusion

The overall impression was negative and reduced the enthusiasm of promoting farming out as working concept in the SL division.

Farming out helps to reduce the number of staff working on a given project, but additional staff with different working profile is needed for administration and progress control. In general the costs are high.

Farming out is ideal for very well defined activities that exploit standard industrial technology or services.