

## Resumen

CERN es el Consejo Europeo de la Investigación Nuclear. Es el mayor laboratorio de física de partículas, donde científicos de todo el mundo estudian la estructura de la materia y las fuerzas que las mantienen unidas para así conseguir entender mejor el comportamiento y el origen del Universo. Actualmente se está construyendo el mayor acelerador del mundo (ya en su fase de puesta en marcha), el Large Hadron Collider (LHC) situado en la frontera franco-suiza, ocupando un túnel 27 km de longitud excavado 100 m de profundidad.

Para inyectar partículas en el LHC son necesarios otros aceleradores más pequeños que ya se encontraban anteriormente en el CERN: el acelerador PS (Proton Synchrotron) y el SPS (Super Proton Synchrotron). Para transferir partículas de un acelerador a otro es necesario un sistema que las extraiga con la menor pérdida posible del haz. Por ello, se está construyendo un nuevo sistema de extracción "Multi-turn extraction". Este proyecto, conocido como MTE, se prevé que esté completamente instalado y testeado a finales de junio de 2008.

El proyecto MTE está siendo llevado a cabo por diferentes secciones del CERN. Este proyecto se centra en una de ellas, "KPS Section" (Kickers of the Accelerator PS). Hasta este momento, toda la información de la sección relacionada con el proyecto MTE se encontraba en diferentes formatos y localizaciones, tales como ordenadores personales, carpetas archivadoras, libros o en el conocimiento de los trabajadores de la sección.

A lo largo de este proyecto se describe el diseño y creación de un nuevo sistema de gestión y almacenaje de información seguro, rápido, ágil y fácil en su manejo. Para ello se han utilizado las herramientas ya existentes en el CERN: EDMS (Engineering Data Management System), DFS (Distributed File System) y páginas web. Además, se describe la creación de una página web donde se centraliza toda la información de la sección relacionada con el proyecto MTE y se facilita el acceso a la información por parte de todos los trabajadores.

Para finalizar, se realiza una planificación detallada del proyecto MTE pero únicamente aquellas tareas en la que participan los trabajadores de la sección KPS.





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# 1 Glossary

Explanation of the terms used in this document:

**AB:** Accelerators and Beams Department at CERN.

**CERN:** European Organization for Nuclear research. It is the world's largest particle physics laboratory.

**DFS:** Distributed File System.

**Dipole:** Accelerator magnet formed by two poles and used for bending the beam.

**EDMS:** Engineering Data Management System.

**KPS:** Fast Pulsed Magnets (kickers) of the PS Complex. It is also the name of one of the section of the AB department at CERN.

**Kicker Magnet:** Electromagnets that switch on just long enough to “kick” the particles out of the synchrotron ring and along a beam line.

**LCH:** Large Hadron Collider, the new particle accelerator at CERN.

**MP5:** Commercial asset lifecycle management system tool provided by Datastream, inc.

**MTF:** Equipment Management Folder is a Web application for equipment management. formerly known also as ‘The Manufacturing and Test Folder’

**PS:** Proton Synchrotron at CERN.



**Quadrupole:** Accelerator magnet formed by four poles and used for focusing the beam.

**2n-pole:** Accelerator magnets formed by 2n poles and used for correct the orbit and physic parameters of the beam, e.g. sextupole, octupole, decapole,...

**SPS:** Super Proton Synchrotron at CERN.

**SQL:** Data sublanguage for databases access.

**Thyratron:** High peak power electrical switch which uses hydrogen gas as switching medium.





## 2 Introduction

### 2.1 Motivation of the project

When I was in the last year of my Industrial Engineering studies, I was convinced that CERN was the perfect place for successfully completing them while getting experience in both a very complex project and an exciting multicultural environment.

I knew that CERN was carrying out the installation and commissioning of the new collider LHC. I guessed this would be an amazing opportunity to apply and broaden the tools and skills I have acquired these years at the university on a project whose challenges are beyond any others. Moreover I was really interested in working in an international environment.

At the beginning of 2006 CERN proposed me to carry out a part of a data management project for 14 months. I accepted because it had crucial importance in my personal and engineering skills development.

The origin of this project arises from the need to create a new system to manage all the information of the MTE (Multi-turn extraction) Project. At that moment it was really difficult to access to quick and reliable information related to MTE Project that was used by the members of the KPS (Kickers of the accelerator PS) section. This is the reason why it became necessary to create a better system to do the follow-up and management of the information. Moreover, the responsible in the KPS section decided to make a detailed planning of the MTE Project focused on the the tasks under the section responsibility. This planning needed weekly updates depending on how the tasks were evolving.

I was in charge of the creation of the new information management system and, together with my supervisor at CERN, the planning of the tasks of the KPS within the MTE Project.



## **2.2 Objective of the project**

In a laboratory like CERN, with a really large number of employees and associated staff in constant change, and where it is necessary to handle such a quantity of pieces, documents and projects, it becomes essential to have some vehicle systems of data management, in order to keep the information safely stored, accessible to all the workers and updated.

Thus, basically the objective of this project is to detail the main activities that have been done in order to plan, design and create the new system of information management, the detailed planning of the project MTE within the section KPS, and the web site that simplify the storage and search of all the information and documentation of the project related to the KPS section.

## **2.3 Scope of the project**

This project is divided in 12 chapters.

The first chapter collects a glossary of terms used through the project. Followed by two introductory chapters. One concerning this project itself and the second giving the first introductory vision to what it is CERN, the laboratory where the project has been carried out.

The fourth chapter explains the MTE project, its precedents, the evolution from the idea to the design and its implementation.

The next chapter, the fifth one, presents the current system of storage and management of



information at CERN and its used tools: EDMS, MTF and DFS

It is in the sixth chapter where the design and creation of the new system of information management of the section KPS inside the MTE project is exposed, as well as the system created to store the presentations. Following this chapter the reader can find an account of the web site created to store and centralize all this information.

The chapter eight makes a description of the planning of the MTE project, both general form and detailed for the KPS section. In addition the chapter details the budget of the project.

The ninth chapter is a CBA (Cost Benefit Analysis) of the project done by the author.

In the lasts chapters it will be found the conclusions and future developments, the acknowledgements and the references of the project.

## **2.4 Viability study of the project**

An essential aspect at the beginning of a project is to analyze, before to the accomplishment of any study, its viability. This analysis has to be carried out from several points of view, being the most relevant the technological, the legal and the economical approaches.

From the technological point of view, the viability is assured, since it arranges of the facilities and tools necessary for the fulfillment of the aims of this project.

As for the legal viability, no impediment exists for the development of the project. The





necessary computer programs are installed in the laboratories and offices at CERN with its corresponding licenses.

The financing of the project is guaranteed by the Program of Technical Students at CERN. This Program is the manager of supporting the expenses, either with own funds or with some of the possibilities of financing of the different groups of work inside the flowchart at CERN in which every group has an own budget.

Also there is the possibility of evaluating the viability of the project from the social point of view. It is a project made on small scale but that it is part of a great global project which aim is to investigate the origin of the universe. This aim is so fundamental that it reverberates to all the areas of the society, this explains the participation and involvement of so many countries in it.



## 3 Introduction to Cern

### 3.1 What is CERN?

CERN is the European Organization for Nuclear Research. It is the world's largest particle physics laboratory, where scientists unite to study the building blocks of matter and the forces that hold them together and to reach a better understanding of the behavior of the Universe. CERN exists primarily to provide the scientists with the necessary tools to study high energy physics. These are the accelerators, large machines that accelerate particles to almost the speed of light and detectors to make the new particles visible

CERN is located on both sides of the France-Swiss border in the north of Geneva (*Figure 3.1*) and it was founded in 1954. Nowadays it is composed of 20 Member States. (*Figure 3.2*) [1].

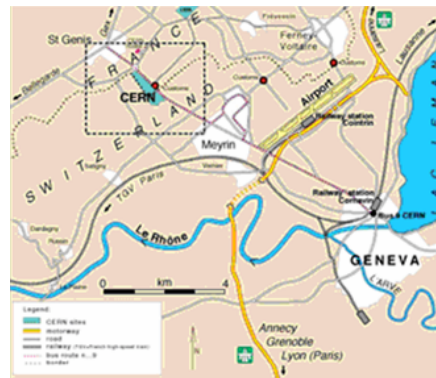


Fig. 3.1 CERN's location



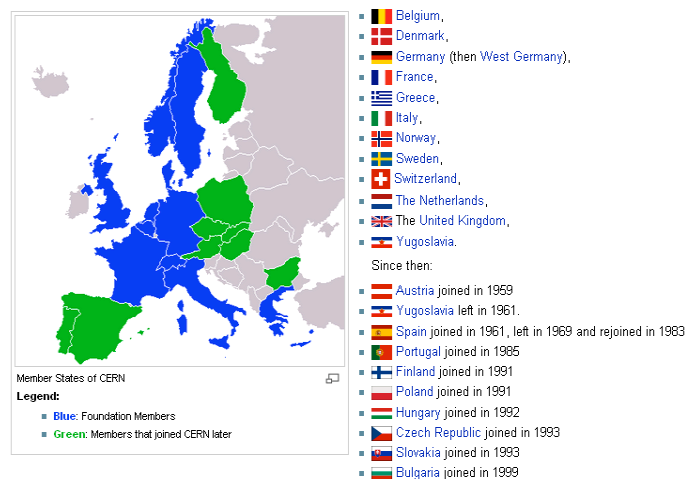


Fig. 3.2 the 20 Member States of CERN

Scientists have found that everything in the Universe is made up from a small number of basic building blocks called elementary particles which are governed by a few fundamental forces.

Some of these particles are stable and form the normal matter; the others live for fractions of a second and then decay to the stable ones. All of them coexisted for a few instants after the Big Bang.

Since then, only the enormous concentration of energy that can be reached in an accelerator at CERN can bring them back to life. Therefore, studying particle collisions is like "looking back in time", recreating the environment present at the origin of our Universe.

CERN operates a network of six accelerators and a decelerator. Each machine in the chain increases the energy of particle beams before delivering them to experiments or to the next more powerful accelerator. Currently active machines are:

- Two lineal accelerators generating low energy particles for the injection into the Proton synchrotron (PS). One is for protons and the other for heavy ions; these are



known as Linac2 and Linac3, respectively.

- The PS Booster, which increases the energy of particles generated by the linear accelerators before they are transferred to other accelerators.
- The 28 GeV Proton Synchrotron (PS), built in 1959 and still operating as a feeder to the more powerful Super Proton Synchrotron (SPS).
- The Super Proton Synchrotron (SPS), a circular accelerator with a diameter of 2 kilometers built in an underground tunnel, which started operating in 1976. It was designed to deliver energy of 300GeV and was gradually upgraded to 450GeV. It has been operated as a proton-antiproton collider, and for accelerating high energy electrons and positrons which were injected into the Large Electron-Positron Collider (LEP). From 2007 onwards, it will inject protons and heavy ions into the Large Hadron Collider (LHC).
- The On-Line Isotope Mass Separator (ISOLDE), which is used to study unstable nuclei. Particles are initially accelerated in the PS Booster before entering ISOLDE. It was first commissioned in 1967 and was rebuilt with major upgrades in 1974 and 1992.
- The Antiproton Decelerator (AD), which reduces the velocity of antiprotons to about 10% the speed of light for research into antimatter.

At present, CERN is building the Large Hadron Collider (LHC) in the old tunnel of the LEP collider. Two large detector experiments, ATLAS (*A Toroidal LHC Aparatus*) and CMS (*Compact Muon Solenoid*) will look for the Higgs boson, a particle predicted by the latest theories of modern physics. After the estimated start of these detector experiments, the LHC will collide protons at a center of mass energy of 14TeV. Besides the acceleration



of protons, the LHC will accelerate lead nuclides up to a total collision power of 1150TeV which is almost equal to the power density in the universe short after the Big Bang. Together with ATLAS and CMS, two other experiments will be fed by the LHC: a dedicated heavy ion detector, ALICE, which will exploit the unique physics potential of nucleus-nucleus interactions at LHC energies, and LHC-B, which will carry out precision measurements of CP-violation and rare decays of B mesons (*Figure 3.3*). Because of the huge amount of events produced during operation, 800 million collisions per second, the detectors and the computer facilities have to handle as much information as the whole European telecommunication networks combined.

Not only high energy physics are practiced at CERN. The desire to discover new physical laws led to many new inventions in the fields of informatics and engineering. Tim Berners-Lee proposed in 1990 a distributed information system, based on 'hypertext'. By hiding network addresses behind highlighted items on the screen, information can be linked between several computers. The chosen name for this new invention was the "World-Wide Web".

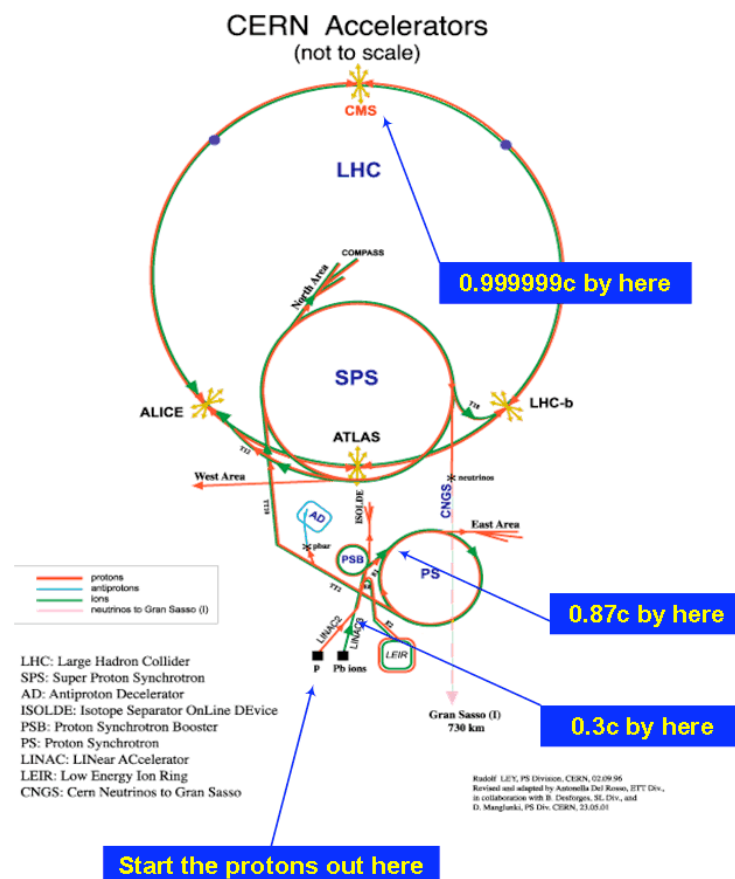


Fig. 3.3 The CERN network of interlinked accelerators and colliders.



## 3.2 The Large Hadron Collider (LHC)

### 3.2.1 High Energy Physics Today and the LHC Project

As has been introduced above, particle physicists have found that they can describe the fundamental structure and behavior of matter within a theoretical framework called Standard Model. This model incorporates all the known particles and forces through which they interact, with the exception of gravity. It is currently the best description we have of the world of quarks and others particles. However, the Standard Model in its present form cannot be the whole story. There are still missing pieces and other challenges for future research to solve.

Why there is such a range of masses for the particles is one of the remaining puzzles of particle physics. Indeed, how particles get masses at all is not yet properly understood.

In the Standard Model, the particles acquire their masses through a mechanism named after the theorist Peter Higgs. According to the theory, all the matter particles and force carriers interact with another particle, known as the Higgs boson. It is the strength of this interaction that gives rise to what we call mass: the stronger the interaction, the greater the mass.

If the theory is correct, the Higgs boson must to appear below 1 TeV. Experiments at the others accelerators at CERN have not found anything below 0.11 TeV.

These and others questions like the elementarity of quarks and leptons, the search of new quarks families or the origin of matter-antimatter asymmetry in the Universe, will be addressed by CERN's new accelerator, the Large Hadron Collider (LHC), which is currently in the last step of its commissioning.



The LHC [2] is a 27 km long circular accelerator that will collide two counter-rotating proton beams at a centre of mass energy of 14 TeV. This energy is seven times higher than the beam energy of any other proton accelerator to date.

It is planned to complete the machine installation and to start operation at the beginning of 2008.

### 3.2.2 LHC Layout

The LHC has an eight-fold symmetry with eight arc sections and eight long straight sections. Two counter-rotating proton beams will circulate in separate beam pipes installed in the same magnet (*twin-aperture*). The beams will cross over at the four experiments resulting in an identical path length for each beam (*Figure 3.4*).

Each arc consists of 23 identical cells, giving the total length of 2465m. Cells are formed by six 15m dipole magnets and two quadrupole magnets (these dipoles and quadrupoles are called lattice or main magnets). Dipole magnets are used to deflect the beam in a circular trajectory whereas quadrupole magnets act as lenses to focus the beam. The lattice quadrupole magnets and the corrector magnets of a particular half-cell form a so called short straight section (SSS) and are housed in a common cold mass and cryostat.

At the beginning and the end of the straight sections a dispersion suppressor cell, consisting of four quadrupole interleaved with four strings of two dipoles each, is in charge of correcting the orbital deviation due to the drift in the energy of the particles. The four long straight sections where the experiments are located are formed by the dispersion suppressors and the insertion magnets. These insertion magnets guide the separated beams to a common pipe where they are focused by the so called inner triplet magnets in order to get even tighter beams before the collisions take place inside the detectors.



The injector complex includes many accelerators at CERN: linacs, booster, LEAR as an ion accumulator, PS and the SPS. The beams will be injected into the LHC from the SPS at an energy of 450GeV and accelerated to 7TeV in about 30 min. They can then be used to collide for many hours

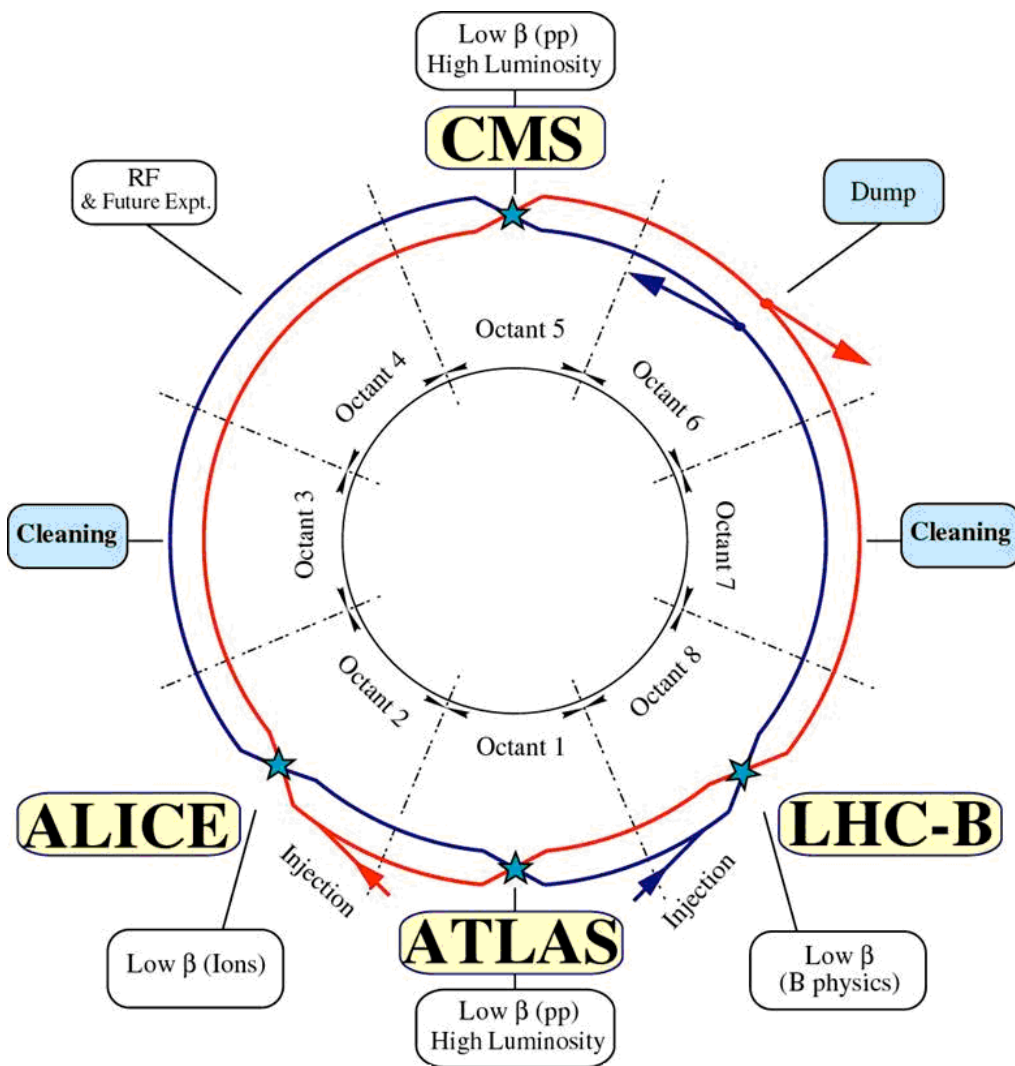


Fig. 3.4 LHC Layout





## 3.3 The CERN PS Complex

### 3.3.1 Introduction

The Proton Synchrotron (PS) [3] is one of the oldest constituents of the CERN accelerator chain. In fact, CERN was actually founded for its construction, but at that time nobody would have believed that it might still be working, running, accelerating for a wide variety of different 'customers' almost 50 years later (it was built in 1959). Actually, it just has got ready for the LHC era.

Designed for accelerating only protons from a 50 MeV linac, the PS has also accelerated antiprotons, electrons, positrons and heavy ions - nuclei of large atoms such as lead. It has even operated as a decelerator, slowing down antiprotons for injection into the Low Energy Antiproton Ring (LEAR). Its multitalented capacity will continue into the 21st century, when it will provide protons and heavy ions for CERN's new Large Hadron Collider (LHC).

At present, the PS has evolved into a complex of nine machines, delivering beams of protons, antiprotons, electrons, positrons and lead ions of various energies and intensities. It operates for about 700 hours per year. Numerous original beam manipulation techniques are regularly applied and new ones are currently being implemented and tested to adapt the PS Complex to its future role as the proton injector for LHC.

### 3.3.2 General Description

Almost fifty years after its construction, the 200-m diameter combined function PS machine remains the heart of the PS Complex (*Figure 3.5*)



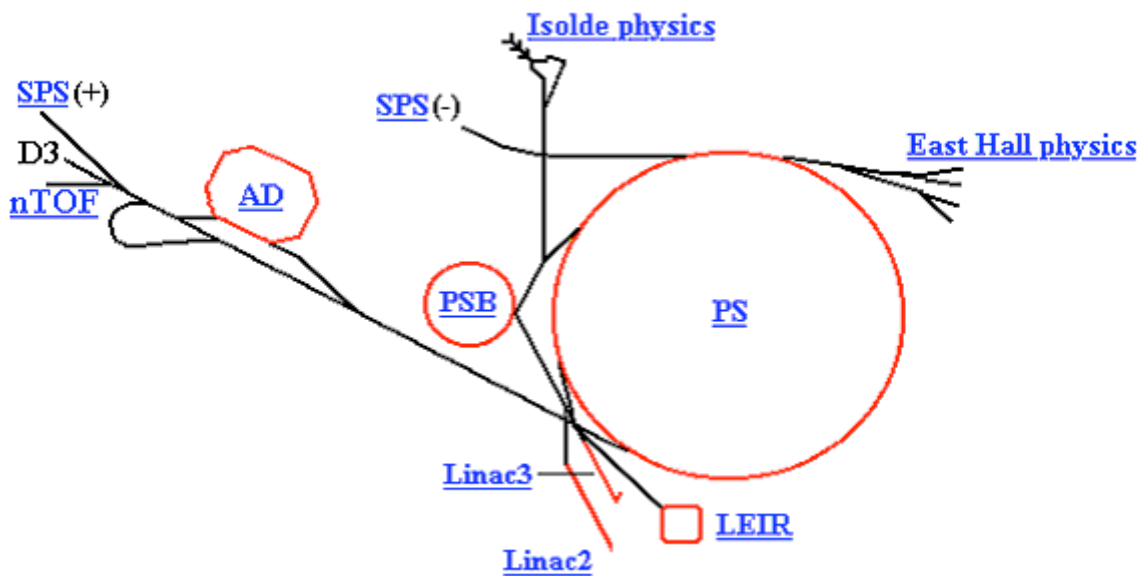


Fig. 3.5 The PS Complex

With 3 RF systems (9.5, 114 and 200 MHz), 4 injection and 4 extraction channels, it routinely processes five types of particles (protons, antiprotons, electrons, positrons,  $\text{Pb}^{53+}$ ) at momenta ranging from 0.6 to 26 GeV/c and at intensities between  $10^8$  and  $2.5 \times 10^{13}$  particles per pulse (ppp).

The rest of the complex consists of:

- Linac 2, producing protons from a duo-plasmatron source followed by a 750 keV RFQ and 3 Alvarez tanks operating at 200 MHz. Proton pulses are delivered at 50 MeV every 1.2 s, with a length from 10 to 150  $\mu\text{s}$  and an intensity of up to 180 mA,
- Linac 3, the last born of the PS machines, which uses one 101 MHz RFQ accelerating  $\text{Pb}^{27+}$  ions to 250 keV/u, followed by a cascade of three IH structures (one at 101 MHz, the other two at 202 MHz). The  $\text{Pb}^{27+}$  ions are injected from an ECR source



running in after-glow mode. After stripping by a carbon foil at the exit of the linac, 25 $\mu$ A of 4.2 MeV/u Pb<sup>53+</sup> ions are routinely delivered in 400  $\mu$ s pulses.

- The PS Booster (PSB), an assembly of four vertically stacked synchrotrons of 50 m diameter which accelerate the linac beams respectively up to 1.69 GeV/c for protons and 0.43 GeV/c/u for Pb<sup>53+</sup>.
- The Antiproton Accumulation Complex (AAC), made of the antiproton accumulator (AA) supplemented in 1987 with a collector (AC). Nine stochastic cooling systems are used in each ring.
- A 78.54 m circumference Low Energy Antiproton storage Ring (LEAR). It is equipped with six stochastic cooling systems, an electron cooler, a gas-jet target, and both fast and ultra-slow extraction systems.

### 3.3.3 PS as LHC injector

Following the time-old CERN tradition that new machines use the existing machines as injectors, the LHC will be no exception, with the proton supply coming from the accelerator chain Linac 2 - PS Booster (PSB) - PS - SPS. Among the very stringent LHC specifications the beam will have to meet, it has to fit into the tiny LHC dynamic aperture. This means that the beam brilliance (intensity/width ratio) at PS will be twice that was used in the past. [4]

The proposal to overcome this problem involves higher beam intensities from Linac 2, acceleration of one bunch in each of the four PSB rings, raising the PSB output kinetic energy from 1 to 1.4 GeV, and filling the PS with two PSB pulses.



The next drawing (*Figure 3.6*) shows the various stages of acceleration of both protons and ions on their way to injection into LHC.

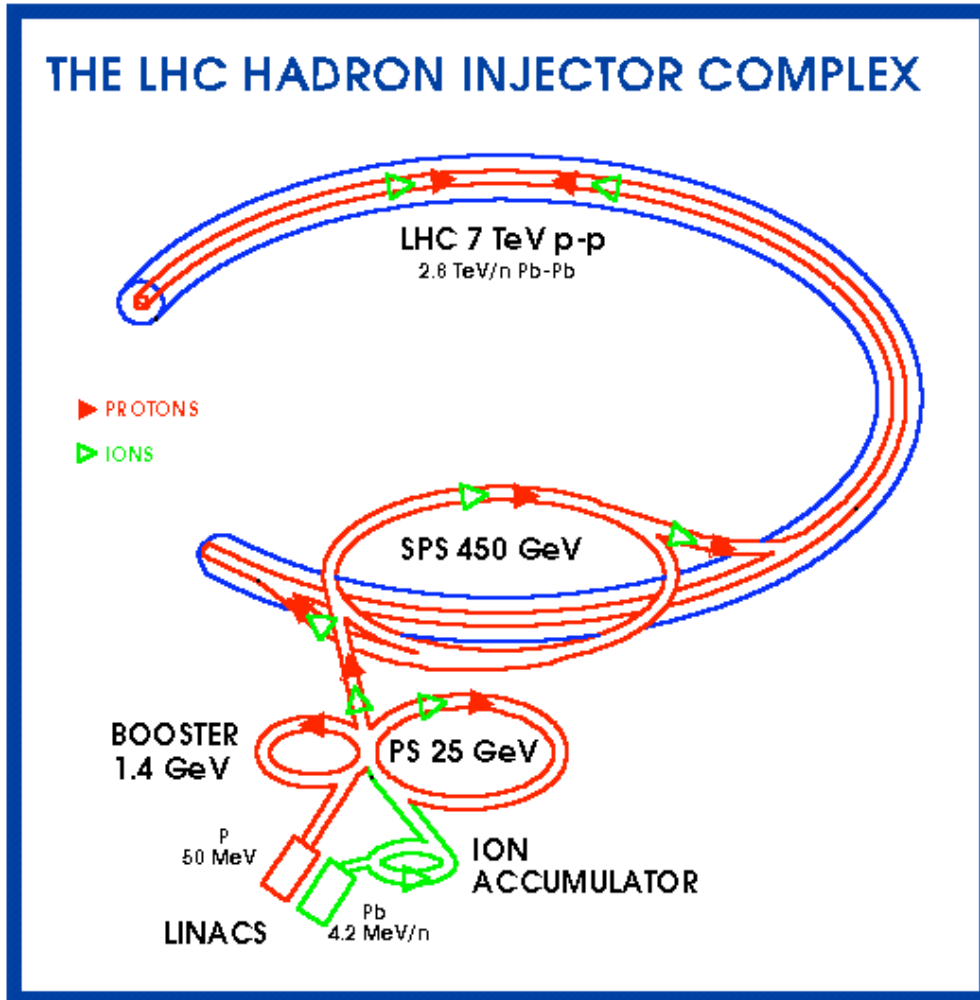


Fig. 3.6 Injection of protons and ions into LHC.

For protons, the Linac feeds the PS Booster synchrotron, the PS, the SPS and the LHC successively, whereas for ions there is an intermediate storage after the ion Linac (in the old LEAR machine, now called LEIR), and the Booster is omitted from the accelerator chain.



## 3.4 BT Group and KPS Section

### 3.4.1 CERN Structure

The organization at CERN is divided in Departments, these departments in Groups and these groups in Sections.

Currently at CERN exists 7 Departments: **AB** (Accelerators and Beams); **AT** (Accelerator Technology); **FI** (Finance); **HR** (Human Resources); **IT** (Information Technology); **PH** (Physics) and **TS** (Technical Support).

Specifically, this thesis is framed in **AB** Department, **BT** Group and **KPS** Section

**AB Department**, *Accelerators and Beams*, hosts the groups responsible for beam generation, acceleration, transfer, control and delivery for the CERN accelerator complex. The competence in the department include accelerator physics, particle sources, RF acceleration systems, power converters, beam instrumentation, controls, beam extraction and injection, targets, collimators and dumps, as well as operation of the whole accelerator complex. The Department is responsible for the specification, procurement and commissioning of the equipment for the above system for the LHC machine, as well as for the power converters for the LHC detectors. Approved research and development for the new accelerator project also reside in this Department.

**BT Group**, *Beam Transfer*, is involved in the PS complex, the SPS machine, the LHC Project and the CTF3 facility. It is in charge of the design, development, construction, installation, exploitation and maintenance of injection and extraction related systems (fast pulsed magnets, electrostatic and magnetic septa, including associated fast pulsed and high voltage power supplies, extraction protection systems), understanding of the underlying physics processes, and associated equipment-level control systems (hardware and software). The BT group has the overall responsibility (conception, layout and optics



design, equipment specification, performance follow-up, technical coordination, commissioning) for the LHC beam dumping system and for new beam transfer lines between accelerators and primary beam lines up to targets. BT performs conceptual and design studies for injection and extraction systems on new accelerators.

**KPS Section, *Kickers Pulsed Magnets***, is the section responsible for the design, development, construction, installation, exploitation and maintenance of all fast-pulsed magnet (kicker) systems of the PS complex. These kicker magnets are an essential link in a chain of hardware required for particle beam transfer between different parts of an accelerator complex.



## 4 MTE Project

### 4.1 Introduction

Charged particles can be extracted from a circular machine by two different methods:

- i) fast extraction (one turn)
- ii) slow extraction (several thousand turns)

In the first case, the whole beam is ejected from the machine in one turn by means of fast dipole (kicker) and septum<sup>1</sup> magnets. This technique can be used for transferring the beam either to a subsequent machine or towards a target for physics experiments. The latter method, is based on the effect of a third-order resonance: unstable motion generated by the separatrix joining the three unstable fixed points increases the particles' amplitude. This technique allows beam extraction over many machine turns (typically many thousands), and it is only used when delivering beam to a target for physics experiments.

In some special cases, an intermediate extraction mode called multi-turn extraction is needed. This is the case of the transfer between the CERN Proton Synchrotron (PS) and the Super Proton Synchrotron (SPS). The two machines have different circumferences, satisfying the relation  $C_{SPS} = 11C_{PS}$ . Hence, to fill the SPS completely one would require ten fast-extracted pulses from the PS (the empty gap in the SPS is needed for the rise-time



of the injection kicker). If the filling time has to be minimized, then the solution consists of extracting the beam over a few turns, instead of a single one. In practice, a **five-turn extraction** was proposed, allowing the SPS to be filled with only two PS pulses. Such an approach is called Continuous Transfer (CT).

The CT extraction has many inconveniencies that it will be explained later, and it is not very suitable for the planned CERN Neutrino to Gran Sasso (CNGS)<sup>2</sup> beam. This is a high-intensity proton beam: in its nominal version, the PS should deliver two pulses of more than  $3 \times 10^{13}$  protons each to the SPS. To increase the rate of good events for physics, thus reducing the data-taking time, efforts are being made to study a possible intensity upgrade by a factor of about two. In the new scenario, the beam losses related to the present scheme of the five-turn CT would not be acceptable, and the properties of the extracted beam (matching of phase space structure and transverse emittance) would not allow an efficient injection into the SPS.

That is the reason why since 2001 considerable efforts have been devoted to the study of a possible replacement of the continuous-transfer extraction mode from the PS to the SPS. In the quest for an improved extraction mode, a novel approach was proposed. This new extraction mode is called Multi-Turn Extraction (MTE).

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<sup>1</sup> The septum is a special type of resistive magnet used in the accelerator chains for the beam injection and extraction systems

<sup>2</sup> An experiment to send neutrinos from the CERN particle physics lab in Geneva to the Gran Sasso underground in central Italy, 730 km away.





## 4.2 Previous Multi-turn extractions at the PS: The Continuous Transfer (CT)

The Continuous Transfer (CT) was developed with the aim of delivering a beam at 14 GeV/c to the Super Proton Synchrotron (SPS) from the Proton Synchrotron (PS). This extraction mode, developed in the mid-seventies, represents the solution to the problem of transferring beam between two machines with different circumferences. Due to the difference in length, to fill the SPS one would require ten fast-extracted pulses from the PS. If the filling time has to be minimised, then the solution consists of extracting the beam over a few turns. The *figure 4.1* shows the scheme of the Principle of the CT extraction from the PS machine. Just before extraction, the horizontal tune  $Q_H$  is set to the value 6.25 and the closed orbit is modified so that the blade of an electrostatic septum intercepts the beam. Four slices are shaved off the main core and extracted as a continuous ribbon over four turns. The central part is extracted last, during the fifth turn, by changing the beam trajectory so as to jump over the septum blade. Another interesting property of such an approach is that the horizontal emittance of the extracted beam is decreased with respect to that of the circulating one.

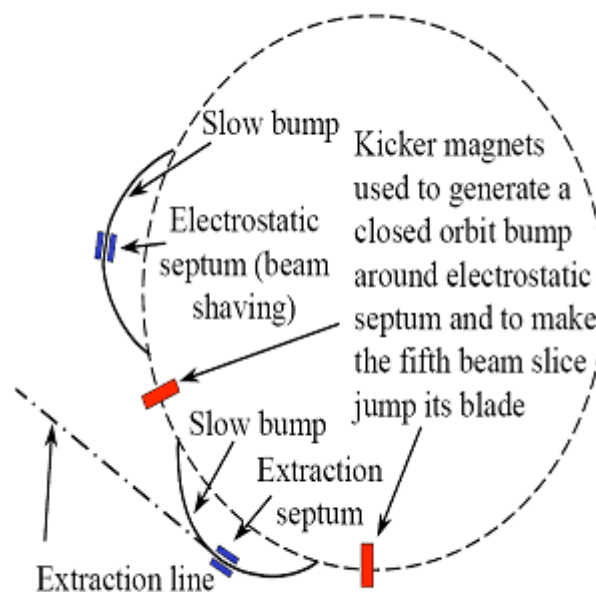


Fig. 4.1 Principle of the CT extraction from the PS machine scheme



However, a number of drawbacks are present:

- i) Beam losses, especially at the electrostatic septum, are unavoidable. They amount to about 15 % of the total beam intensity.
- ii) The extracted slices do not match the natural structure (circles) of phase space, thus generating a betatronic mismatch. This, in turn, induces emittance blow-up in the receiving machine;
- iii) The extracted slices have different transverse emittance. For the CT extraction, the optical parameters and the beam emittance are different for the five slices, thus generating different emittance blow-up at SPS injection. Furthermore, due to the fancy shape of the slices, the mismatch can be rather large.

### **4.3 The novel Multi-Turn Extraction (MTE)**

#### **4.3.1 The CERN PS multi-turn extraction based on beam splitting in stable islands of transverse phase space**

The novel Multi-Turn Extraction [5] is based on adiabatic capture of charged particles in stable islands of transverse phase space. It consists in generating stable islands in the transverse phase space occupied by the beam, by means of special magnetic elements such as sextupoles and octupoles, and to move the islands by slowly-changing the tune of the machine.

By varying the horizontal tune, particles can be selectively trapped in the islands by



adiabatic

Capture: some will remain in the phase space area around the origin, while others will migrate to the stable islands. As a result, the beam is split into a number of parts in transverse phase space determined by the order of the resonance used, without any mechanical device. The separation between the islands can be controlled so that enough space is available for the beam to jump over a septum blade with almost no particles lost.

A simple model representing the horizontal betatron motion in a circular machine under the influence of sextupole and octupole magnets was used (the motion in the vertical plane can be safely neglected). By assuming that the non-linear magnets are located at the same place and the single-kick approximation [10] is used, the one-turn transfer map can be expressed as  $\mathbf{x}_{n+1} = \mathbf{M}_n(\mathbf{x}_n)$  :

$$\begin{pmatrix} x_{n+1} \\ x'_{n+1} \end{pmatrix} = R(2\pi\nu_n) \begin{pmatrix} x_n \\ x'_n + x_n^2 + \kappa x_n^3 \end{pmatrix}, \quad \kappa = \frac{2}{3} \frac{K_3}{\beta_H K_2^2} \quad (\text{Eq 4.1})$$

where  $(x, x')$  are obtained from the Courant-Snyder co-ordinates  $(X, X')$  by means of the non- symplectic transformation

$$(x, x') = \frac{K_2 \beta_H^{3/2}}{2} (X, X') \quad K_m = \frac{L}{B_0 \rho} \frac{\partial^m B_y}{\partial x^m} \quad (\text{Eq 4.2})$$

$K_{2,3}$  = integrated sextupole (octupole) gradient

$L$  = length of the non-linear element



$B_y$  = vertical component of the magnetic field

$B_0\rho$  = magnetic rigidity

$\beta_H$  = value of the horizontal beta-function at the location of the non-linear elements.

$R(2\pi\nu_n)$  is a  $2 \times 2$  rotation matrix of angle  $\nu_n$ , the fractional part of  $Q_H$ . The map  $\mathbf{M}_n$  is a time-dependent system through the linear tune. The time-dependence allows varying the phase space topology, thus creating and moving the islands. Also, it allows trapping particles inside the islands. A slow variation of the linear tune, adiabatic with respect to the time scale introduced by the betatron oscillations, pushes particles to cross the separatrix and to be trapped inside the newly created islands. The trapping process has been simulated by using the model  $\mathbf{M}_n$  with  $\kappa = -1.6$ , while the tune  $\nu_n$  is varied according to the curve shown in *Figure 4.2*.

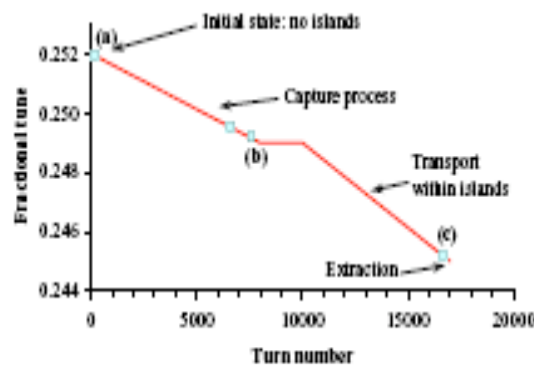


Fig. 4.2 Figure 2: Linear tune\_ as a function of turn number n

In the first part, the linear tune is decreased linearly from its initial value of 0.252 to 0.249. During this part, the capture process takes place. Then, a second linear decrease to the value 0.245 is performed which allows the island to be moved towards higher amplitudes



before extraction.

A set of Gaussian-distributed initial conditions has been generated, and its evolution under the dynamics induced by the map  $\mathbf{M}_n$  is shown in *Figure.4.3*.

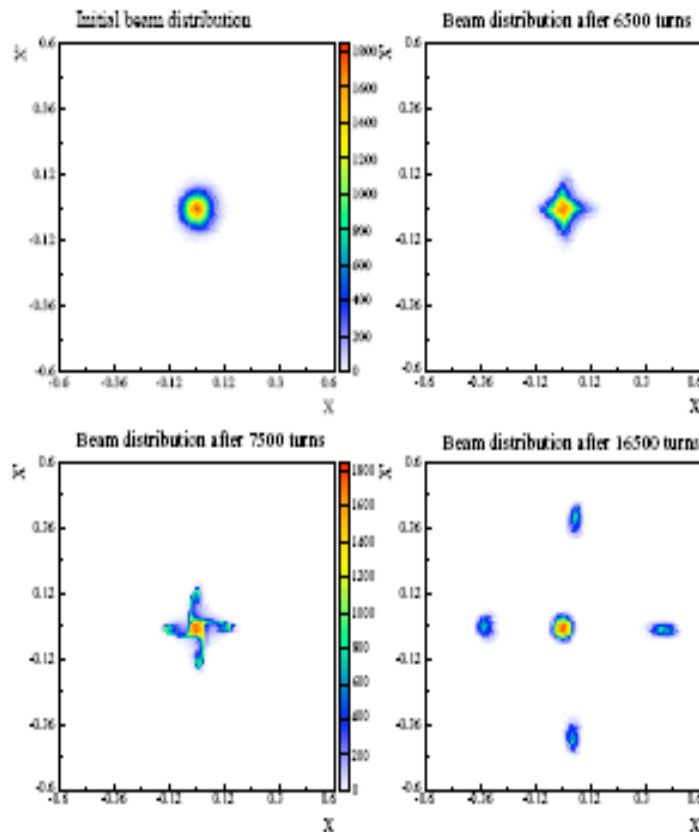


Fig. 4.3 Evolution of the beam distribution during resonance

The trapping process is clearly visible in the picture: it generates five beamlets, well-separated at the end of the process. No particle is lost during the trapping phase, nor when the islands are moved. Not only the five beamlets have similar surfaces, but also their shape matches the phase space topology very well, making the five parts similar as far as



transverse properties are concerned. It is worthwhile pointing out that the first four extracted beamlets have exactly the same emittance, as their shape is dictated by the same phase space structure, i.e. the island along the positive x axis. In this respect, the novel approach proves to be superior to the present CT extraction mode.

### 4.3.2 Implementation

The design of the MTE can be sketched as:

- i. *Beam splitting*: two sets, of two sextupoles and one octupole per set, will be used to split the initial single beam into the five islands, prior to the extraction. The choice of two sets is mainly dictated by the need to control and adjust the islands phase at extraction.
- ii. *Extraction*: the extraction point is where the magnetic septum for the beam extraction towards the SPS is located. Two bumps will be used, namely to displace the beam toward the magnetic septum blade (slow bump) and to extract the islands over five turns (fast bumps).
- iii. *Slow bump*: a set of dipole magnets will be used to generate the slow closed orbit distortion around the magnetic septum. Presently, four dipoles powered with a series/parallel circuit are used to extract the beams toward the SPS. In the proposed scheme six magnets, independently powered, are foreseen. The large number of elements is imposed by the aperture constraints, as it will allow shaping the bump so as to overcome potential aperture bottlenecks.
- iv. *Fast bump*: three new kickers will be used to generate the fast bump to displace the beam beyond the blade of the magnetic septum. The pulse length should correspond to five PS turns. Due to the need of ejecting the centre core of the beam, an



additional kick will have to apply at the fifth turn. For this purpose the kicker used for the fast extraction will be re-used together with a new device.

- v. Trajectory correction in the transfer line towards the SPS: even though in principle the extraction conditions for the novel MTE do not change from turn to turn, as one single island is used to extract the beam, the feed-down effects of the machine nonlinearities due to the extraction bumps could generate turn-by-turn variations of the beamlets positions at PS extraction. Such an effect could have a negative impact on the emittance after filamentation in the SPS. Hence, two kickers, capable of generating a deflection changing from turn to turn, will be used in the transfer line to correct for the variation in the extraction conditions (positions and angle). These two devices are already used for the present CT extraction mode.



## **5 Data Management at CERN**

### **5.1 Introduction**

In a laboratory like CERN, where there is employed a really huge number of people, who are changing constantly, and where is necessary to handle such a quantity of pieces, documents and projects, there are essentials some vehicle systems of data management, in order to keep safe stored the information, be accessible to all the workers and be updated.

Bellow, a small description of the data management systems that are used at CERN nowadays, and their relation with this thesis are detailed.

### **5.2 Engineering Data Management System**

#### **5.2.1 Background**

An EDMS (Engineering Data Management System) is a computational tool that is used to store, organize and control all engineering data throughout the design, manufacturing and maintenance phases. The EDMS project was launched in June 1997 and became an official service in 2000. Initially dedicated to the LHC project (machine and detectors) the scope of the service has become CERN-wide, providing document, engineering and equipment data management services to any CERN unit or CERN approved experiment. The EDMS Service has become a part of the CERN information system infrastructure and is now expected to be available anytime from any point in the world 24 hours a day. [6,7]





## 5.2.2 Why an EDMS at CERN?

The LHC machine and the experiments have an estimated lifetime of at least 25 years from the design stage to the decommissioning. The physicists, engineers and technicians are now working on various projects that will not be present forever and will be replaced by others as the years go by. To operate and to maintain these huge devices, technical documentation must be kept up to date for the benefit of the people who will work at CERN in the future. The PS and SPS machines are prime examples of CERN accelerators that have evolved over time to a state that their initiators could not have imagined.

The **EDMS** provides one single source of engineering data that helps people to find and share information. It also avoids duplication of data to preserve integrity and minimize the risk of losing information. The *Figure 5.1* illustrates the users of EDMS. [8]

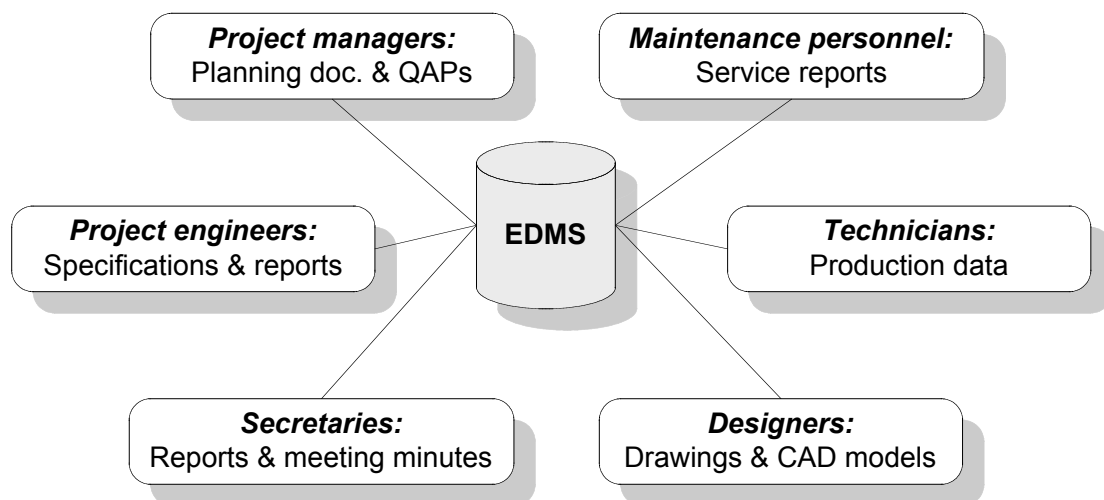


Fig. 5.1 Users of EDMS. One of the main reasons for using an EDMS is to have a secure and easily accessible deposit where all the important engineering information can be stored

## 5.2.3 EDMS Architecture

The architecture of the EDMS is schematically depicted in *Figure 5.2*. Axalant is a



commercial engineering data management system from an American company Agile. MP5 is a commercial asset tracking and maintenance management system from Datastream Inc., also an American company.<sup>1</sup> The EDMS Common Layer and the Web interfaces insulate a large majority of users from the inherent complexities of these systems. Access to other application specific databases can be provided on a case-by-case basis through the Common Layer mechanism

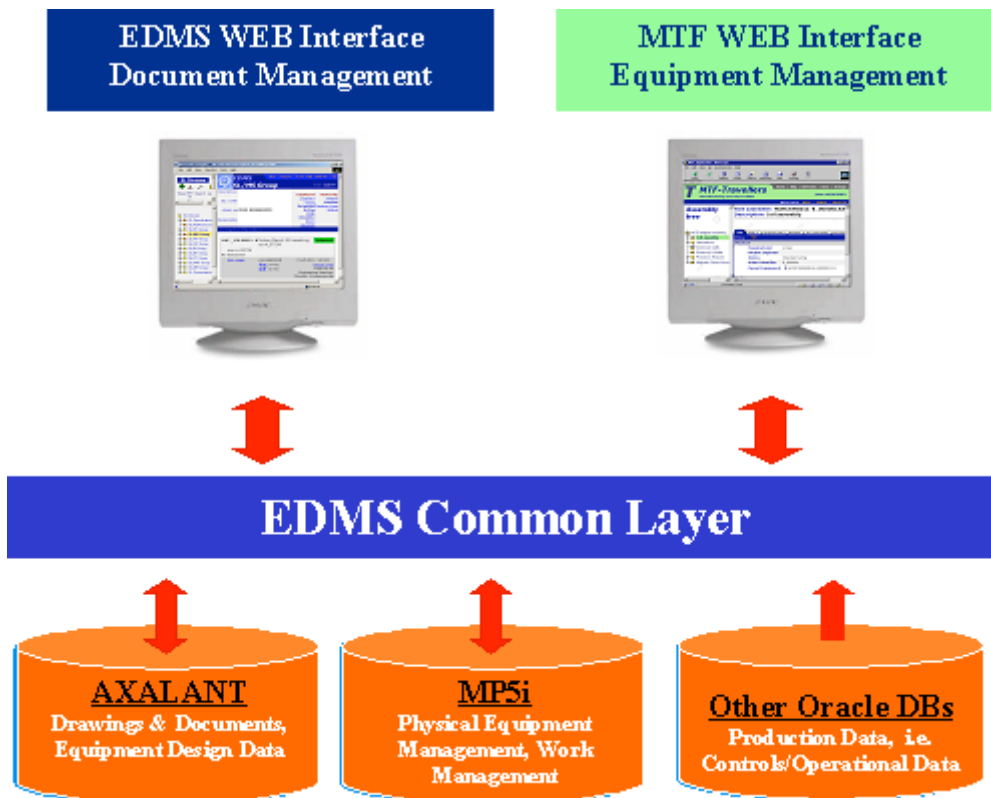


Fig. 5.2 EDMS architecture

<sup>1</sup> Refer to Appendix A. for further information of underlying systems of EDMS



## 5.3 MTF

### 5.3.1 Introduction

The Equipment Management Folder (MTF) application (formerly known also as ‘The Manufacturing and Test Folder’ and ‘Travellers’) is a part of CERN’s EDMS and was launched at year 2000. It became an official service in March 2001. MTF was developed to capture manufacturing and test data for the LHC project. The basic requirement was to provide trace ability of large quantities of complex parts manufactured in a geographically distributed environment. An important part of the MTF is the workflow tracking capabilities, handling data and documentation about the different steps in the manufacturing and test processes.

The MTF project was initially known as the “Travelers” project. The name “Traveler” was used as the system is intended to replace a real (in contrast to virtual) notebook that accompanies every LHC magnet. The notebook (traveling along with magnet) contains a

complete log of all events related to the magnet and its subcomponents lifecycle and characteristics.

### 5.3.2 Evolution of the service

The original clients for the MTF application were the magnet groups of the LHC division. They rapidly realized that the coordination effort for thousands of magnets needed for the accelerator would be huge if a paper-based system was to be used. These groups formulated the original requirements for MTF that manages the complex parts – an LHC magnet may be assembled out of thousands of parts. Since the LHC magnets are closely interrelated with many other systems in the accelerator, other groups collaborating with the magnet groups also became aware of MTF. These groups became interested to adapt MTF in their own project resulting MTF to be the central point for equipment management



issues in the LHC project.

### 5.3.3 System Architecture

As a part of CERN's EDMS, the MTF is a Web based application built on top of the EDMS Common Layer. In general terms, the MTF relies on the Axalant functionalities for equipment design and document management and MP5 is for equipment and workflow issues. The MTF is also an example of a system built from two initially disjoint commercial systems that has new functionalities that did not exist in either of the original systems.

Occasionally some data is not really relevant to other users or has a format that is not easily handled by the MTF then it is not stored in MTF. A link can be established between the MTF and any other Oracle database in which such data is managed, i.e. a relationship can be established between a certain type of equipment and a certain table, externally accessible Oracle database. [9]

## 5.4 Objects and structures in EDMS

Objects and their hierarchy are the core of data handling in Axalant and MP5. Both of these applications consist of many types of objects. The main types of objects in Axalant are *items*, *documents* and *projects*. Item represents the design of components or assemblies of a certain type. Documents represent descriptions of items or projects in any format. Project can be used for grouping of items, projects and documents together.

The four main types of objects in MP5 are *locations*, *systems*, *positions* and *assets*. The locations are physical locations of systems, positions and assets. The positions are functional positions (slots) that can be filled by an asset. The assets are physical objects and the lowest in the object hierarchy. The systems are collections of positions or/and assets that are related



to each other so that all parts are affected if one goes down. From the four main types of objects, MTF has been implemented only with three; the system objects are not used in MTF. The objects are visualized in the web interfaces (EDMS web and MTF) with icons as shown in the *Figure 5.3*.







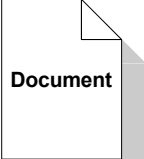







	General	EDMS Web	MTF
Project		 no documents attached  with documents	
Item		 no documents attached  with documents	
Document			
Slot			 slot with sub-slot structure  slot with equipment installed in it  empty slot
Asset			 a unique part  assembly of several parts

Fig. 5.3 Objects in EDMS



### 5.4.1 Project breakdown

A project breakdown structure (PBS) expresses the project hierarchically, with the main project divided into meaningful sub-projects (i.e. individual sets of tasks within the project). The project breakdown describes together with the attached documentation what to build or buy for a certain project. The projects can also be used to simply group information that belongs together.

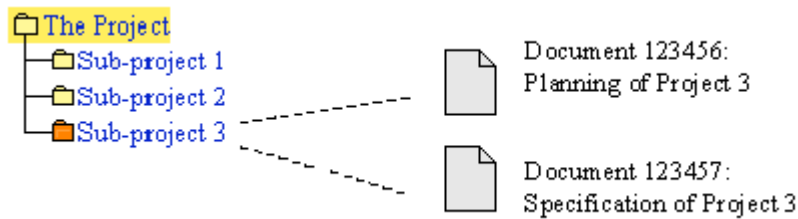


Fig. 5.4 A project breakdown is roughly outlining the project with all its related sub-projects.

### 5.4.2 Bill of Material /Assembly breakdown

The BOM (Bill of Material) or ABS (Assembly Breakdown Structure) can be seen as the outcome of a project and describes how to build something. A complete BOM with attached documentation contains all necessary information to manufacture the described product. The BOM is the basis for all equipment management in the MTF and represents the design specification for the manufactured pieces of equipment.



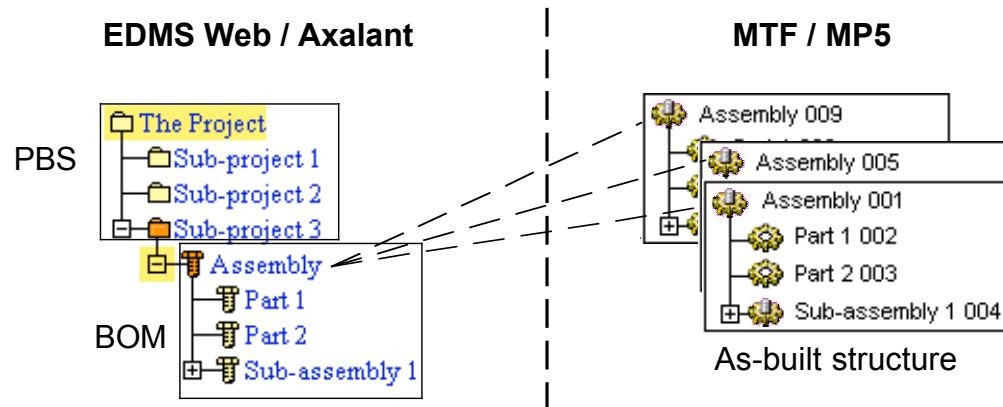


Fig. 5.5 Technical characteristics and documents related to the individual components can be attached to the equipment.

### 5.4.3 As-built structure

As-built structure is the hierarchy structure of assets in MP5. It describes how the physical equipment has been built and includes exact component names. It corresponds exactly to the design in Axalant (in BOM). The difference between BOM and As-built structure is that the BOM is virtual and does not physically exist while As-built corresponds to the real installations.

### 5.4.4 Slot layout

It can also be called a slot structure and it is the hierarchy structure of positions in MP5. Only an asset that does not have a parent asset can be attached to a position object. An asset can only be attached to one position at a time and correspondingly to the position can have a single asset filled at a time.



## 5.5 DFS

*Distributed File System*, or DFS, is a set of client and server services that allow a large enterprise as CERN to organize many distributed SMB (Server Message Block) file shares into a distributed file system. DFS provides location transparency and redundancy to improve data availability in the face of failure or heavy load by allowing shares in multiple different locations to be logically grouped under one folder, or DFS root.

DFS eases the process of transferring data from one file server to another file server. In this system the user do not need to know where actually the data resides or from which server they are getting the data. With the help of this system file transferred across multiple servers give user an impact as if these files exist in one place of network. In order to access the files the users need not to know the actual location of data or files.

The DSF become very useful:

- One wants to alter file locations or add file servers.
- There are multiple users scattered or using from different sites.
- The majority of users need access to multiple files or targets.
- The server load needed to be lowered.
- The users need continuous access to data.
- The company has websites for inside or outside use.





## 6 Data Management at BT group and KPS Section

### 6.1 Introduction

Most of the information which is used at KPS section, and specially all that is related to the MTE Project, is located in files stored in such different places as CERN servers, personal computers, books, folders, micro-films, or in the knowledge of the people who are employed currently at CERN. Therefore, it is really difficult to access to quick and reliable information. And that is the reason why it becomes necessary to create a better system to do the follow-up and management of the information.

Because of that deficiency in the data management, many problems come up when someone has to find all the necessary information about an equipment, a mechanical piece, a presentation, or any other document, since all of them are scattered in different places and most of them have different formats.

Another problem in the current management is that when someone manipulates the information, this might get lost. This way of handling the information is at least problematic and inefficient, and that is the reason why it appears the need to search a better way to manage all that knowledge. At the moment of selecting the tools to use in this project, using the tools that already existed at CERN was considered as the best option. Due to that, a few studies have been carried out to determine the functionality of the EDMS system, and there is no doubt about the satisfactory ability of this system to manipulate and store documents.

Thus, the main aim of this project is to store all data and information in DFS, EDMS and websites to facilitate and improve the use and managing of this information within the MTE project.



## **6.2 Classes of information and its supports.**

As it has been explained previously, the section KPS is responsible, within the MTE project, for the design, development, construction, installation, exploitation and maintenance of fast pulse magnets (kickers) at the accelerator PS. This class of magnets is essential in the chain of the hardware necessary for the transfer of the particles among the different parts of the accelerator. Each magnets system consists of hundreds of components, which information is located for the most part in folders and microfilms.

We are going to see both the supports and the information that is stored on them:

### **6.2.1 Folders**

In the folders there is stored all the information related to a piece that belongs to the magnets kickers, information about the physics characteristics of the piece or system, such as electrical or mechanical characteristics. Also there they include the history report and the current state.

Let's see an example of the information that could be found in the folders:



TYPE: CX1171A		N°: 4047		Recu le: 11.73	
1 <sup>er</sup> Montage	Position	Date	Nbs Heures	Shots	
	FAK 71-73 Module 4 -MS-	15.12.86	1 <sup>er</sup> 300 + 161	x	
2 <sup>es</sup> Montage	Position	Date	Nbs Heures	Shots	
	Bat. 174 Module 11 -MS-	30.03.95	1.200	6.10 <sup>e</sup>	
1 <sup>er</sup> Pos.: 06.06.83		TOTAL		15.661	
Date Démontage		2 <sup>es</sup> Pos.: 25.05.95			
<p>NOTES</p> <p>Le 15.02.85: Tube neuf testé pendant 161 Hrs actuellement en stock au parallèle Bat. 174</p> <p>Le 06.06.83: Démonté de la 1<sup>re</sup> position ci-dessus car ce tube semble douteux, mais peut être d'autres composants mauvais, pour vérification à monter dans équipement de test au Bat. 174 - actuellement stocké au parallèle dans celui-ci -</p> <p>Le 30.03.95: Après montage dans la position indiquée ci-dessus fonctionne bien pour le test en cours</p> <p>Le 25.05.95: Ce tube était dans la 2<sup>es</sup> position indiquée ci-dessus il est <b>MORT</b> - Fil coupés - après avoir donné 1.200 Hrs - au total il nous a fourni 15.661 Hrs de service - Retourné à EEV le:</p> <p style="text-align: center;"><b>25.09.97</b></p>					

Type and number

Physics

History Report

Fig. 6.1 History report of a thyratron stored in a folder





### 6.3 Improvement in KPS information management

To improve the KPS information management we are going to use the already existing tools at CERN. Therefore all the information of the Kickers pieces that will be necessary for the MTE Project will be stored in the EDMS, DFS and the KPS section website. The three systems will have exactly the same structure in order to facilitate the access to the information.

. *Folders*: All the specifications cards of the kickers pieces stored in folders have been scanned and some folders have been created in the DFS to store them according to the type of piece.

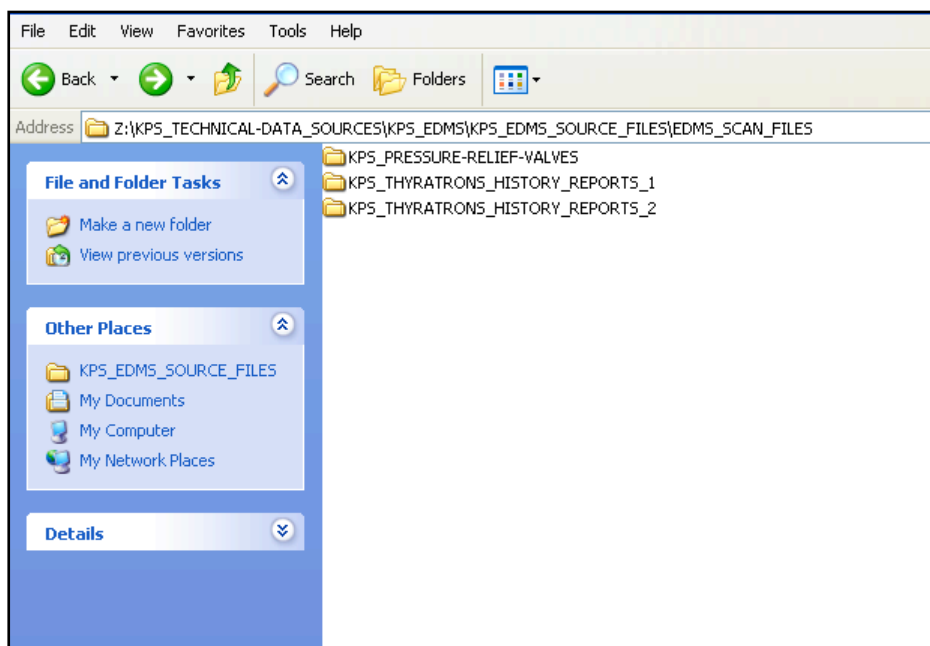


Fig. 6.3 Structure of DFS for the information stored in folders



In this example it is possible to see the folders created in the DFS that contain a specific type of pieces of the kickers, the thyratrons.

The same system has been used to store the specifications cards in the EDMS. Following the same structure:

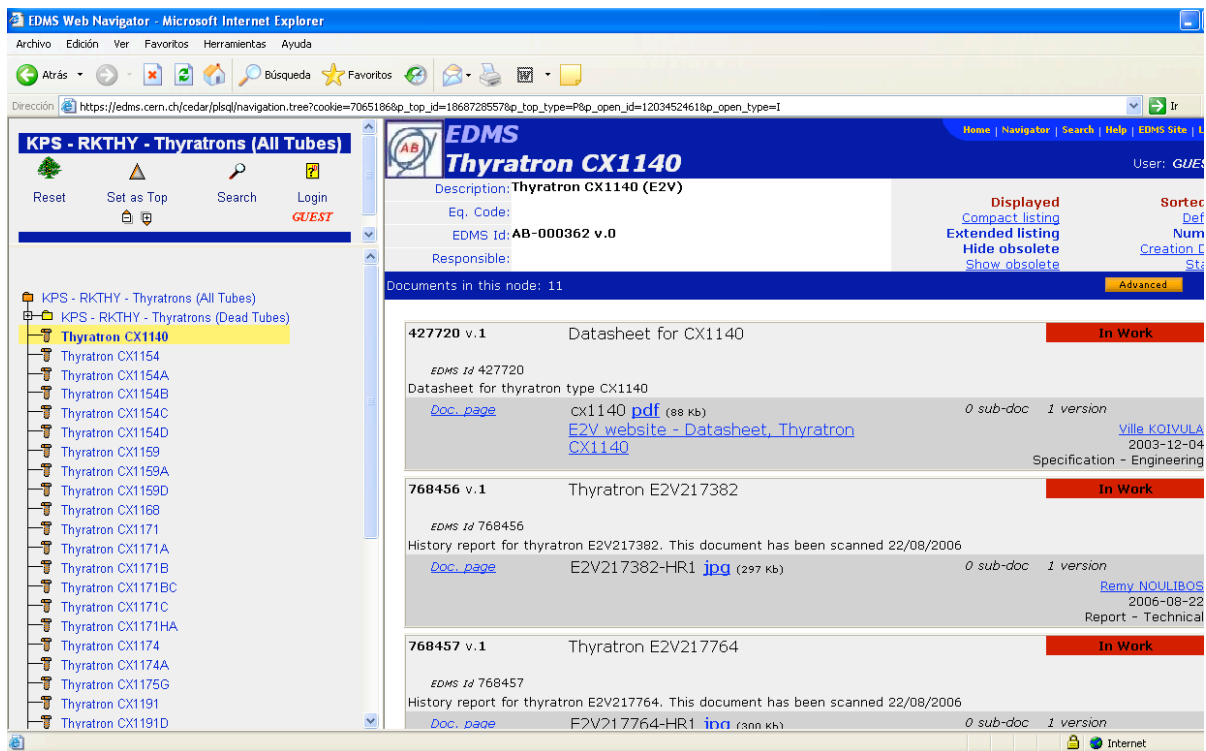


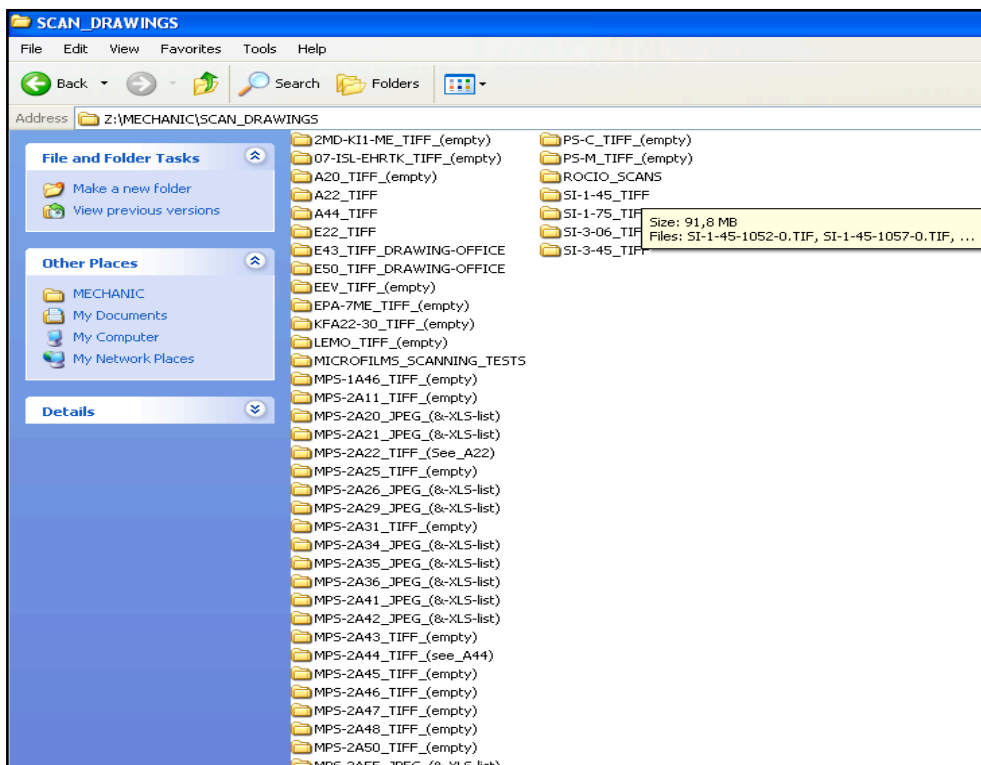
Fig. 6.4 Structure of EDMS for the information stored in folders



On the left hand one can see the same structure that in the DFS where every specification file has been classified according to the type of piece (in this case according to the type of thyatron). On the right hand one can see the access to the file.

. *Micro-films:*

Exactly the same thing than above has been done for the drawings that were stored in micro-films. First all the drawings have been scanned and, following the same structure, some folders have been created in the DFS to store them.



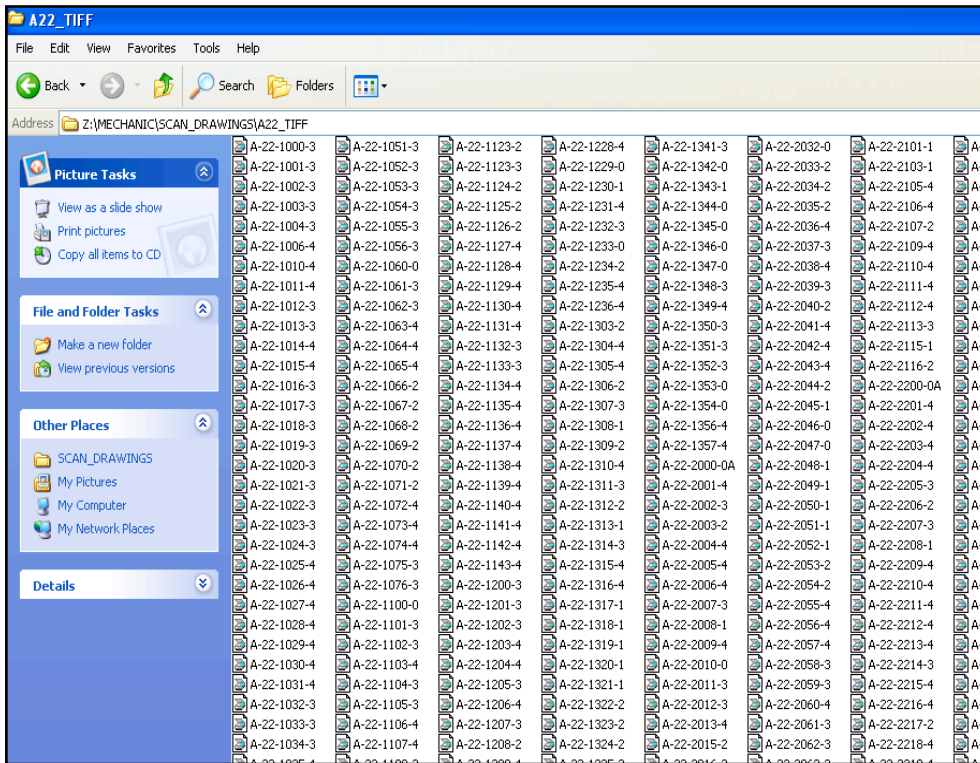


Fig. 6.5 Structure of EDMS for the information stored in micro-films





Finally, the same thing has been done for the EDMS, always following the same structure:

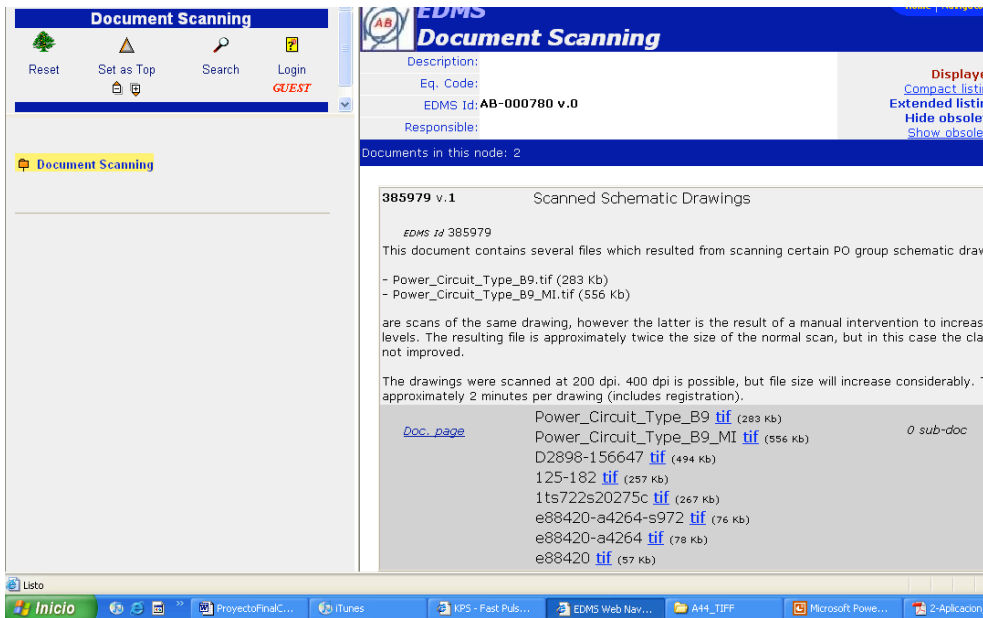


Fig. 6.6 Structure of EDMS for the information stored in micro-films

The last step of the improvement of KPS information management is create links in KPS website to facilitate the finding of the information.



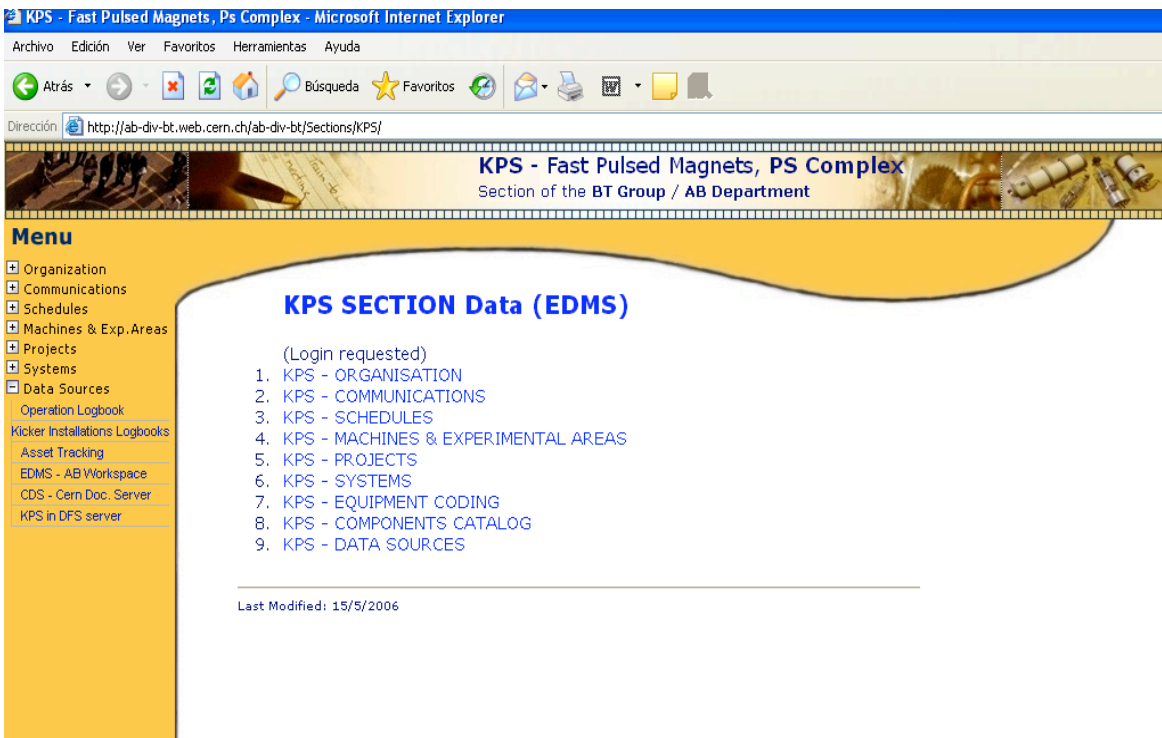
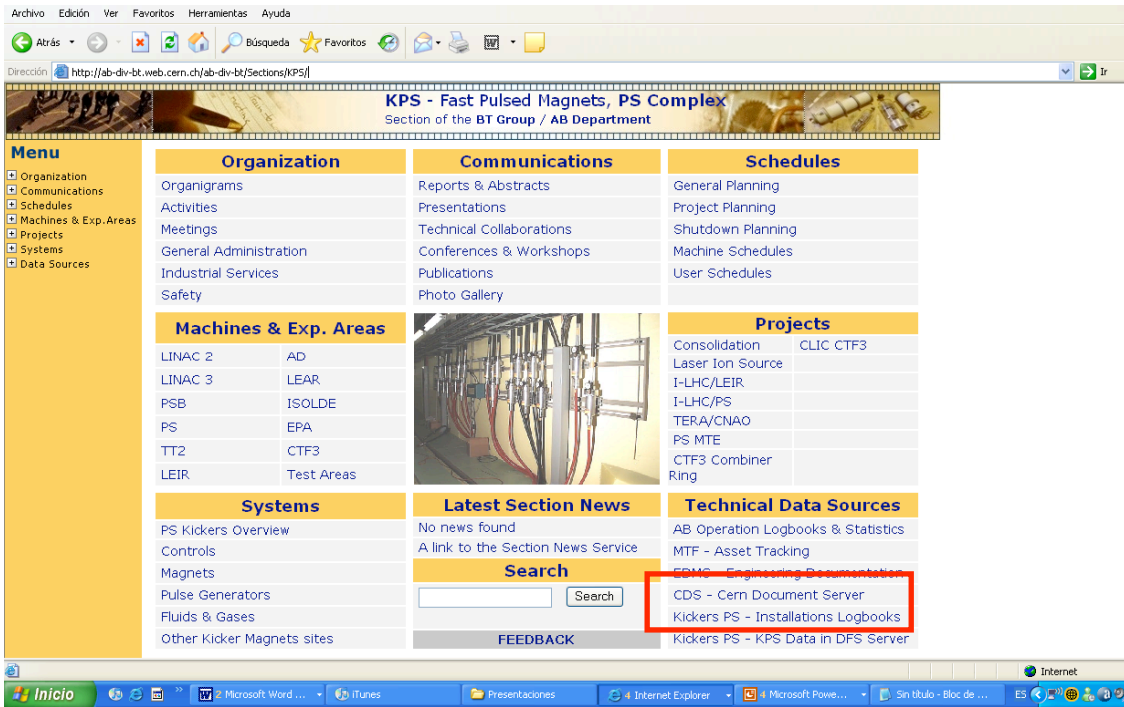


Fig. 6.7 Links to KPS website



## 6.4 Final structure of KPS information management

### 6.4.1 Final Structure

The scheme of the final structure of the KPS information management is described in *Figure 6.8*.

The storage of the information is divided in three different steps:

1. **DFS server:** the first step is to keep the information in the DFS server. Hereby a safety storage of the information is obtained. This serves becomes then the source of the information.
2. **EDMS server:** the next step is to store the information, that has the source in DFS, in the EDMS Server. The EDMS provides one single source of engineering data that helps people to find and share information. It also avoids duplication of data to preserve integrity and minimize the risk of losing information.
3. **Web server:** the last step is to create a link from the KPS website. Hence, it will be really easy and quick to find the information.



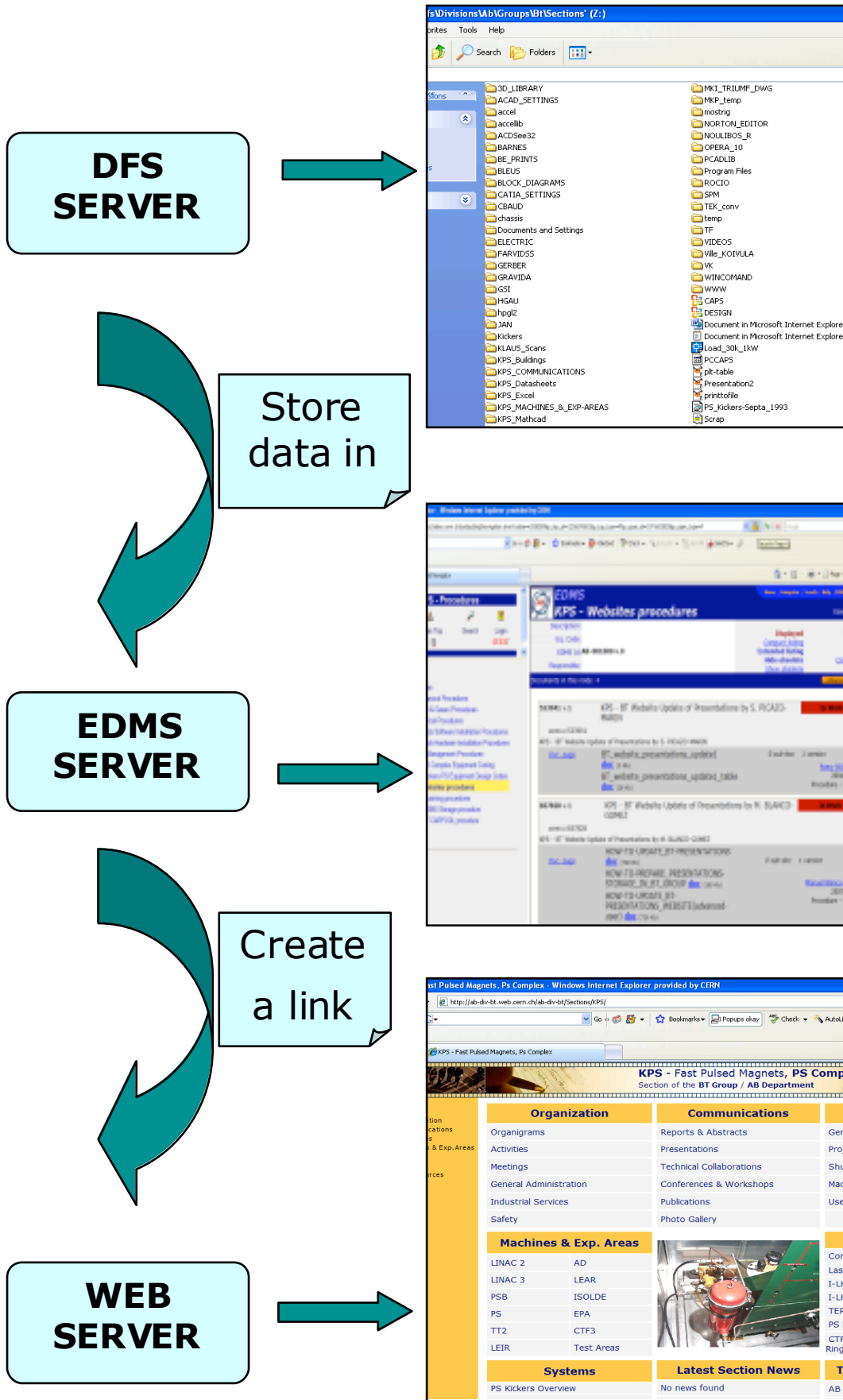


Fig. 6.8 Final structure KPS information management

## 6.4.2 The USER

The procedure that the user, that is to say any worker of the project MTE, will have to follow to consult any information with regard to any aspect related to the MTE Project, the BT group or the KPS section is explained in the following scheme:

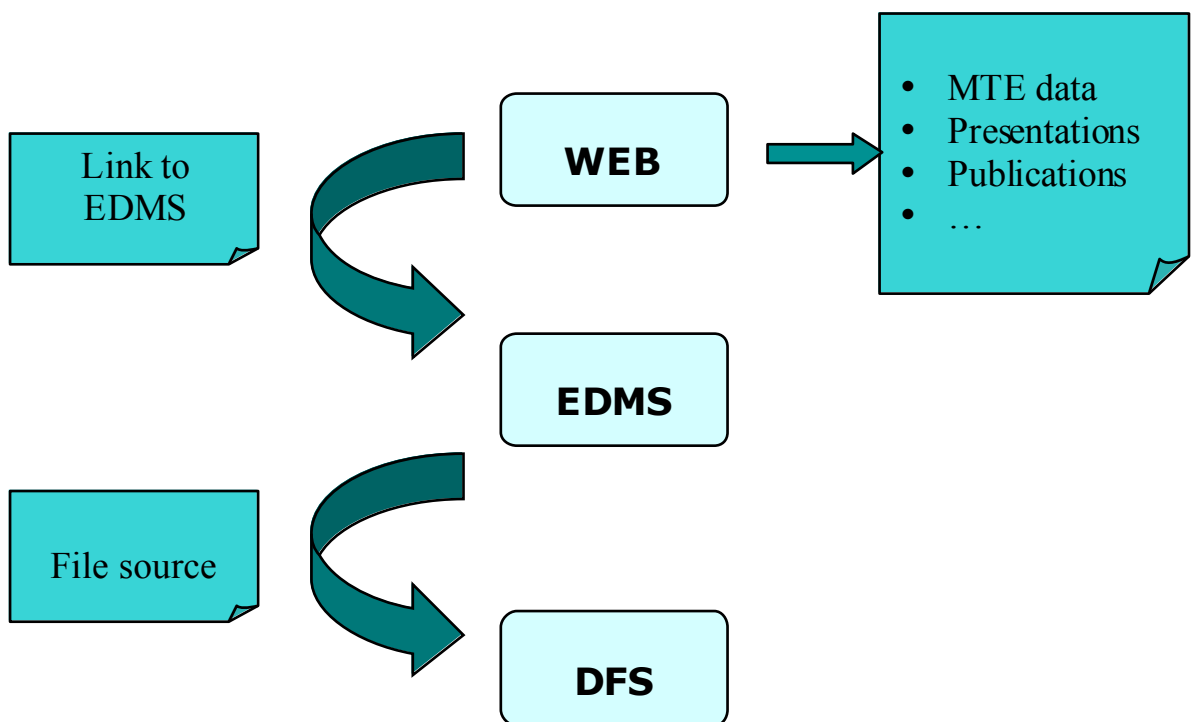


Fig. 6. 9 Procedure to consult any information

The first step that the user, interested on getting some information about the project MTE, has to do is going to the website of the KPS section. Once there, the user chooses which category of information wants to know or consult, whether it is a presentation, a



publication, the plan of a piece, or any other information.

When the user clicks on the corresponding name the link will lead him directly to the system EDMS. The files that can be consulted have their file source in DFS.

Hereby all the information is stored in the same format, location is fast and simple; the files are safe and it is almost impossible that these get lost. Moreover, as explained already, all the information is stored by the same structure.

## **6.5 Storage of Presentations**

### **6.5.1 Introduction**

In a laboratory like CERN, with a really large number of employees and associated staff in constant change, and where it is necessary to handle such a quantity of pieces, documents and projects, it becomes essential some vehicle to transfer the information to be able to coordinate the projects and that everyone that is working there could know how it is evolving.

For all that, the presentations become indispensable at CERN.

Once the presentation has been realized and has been exposed in a certain audience's present, this one must be stored so that anyone who needs the information could locate it easily. Thus, it is needed the creation of a system of storage and search of these documents with a few requirements that will be exposed hereinafter.

In the past, a system was designed for storage and search of the presentations related to the project MTE, but it was decided to extend it to all the presentations of the BT group and all its sections, including of course the KPS section.



## 6.5.2 Requirements

The storage of all the presentations must follow the following requirements:

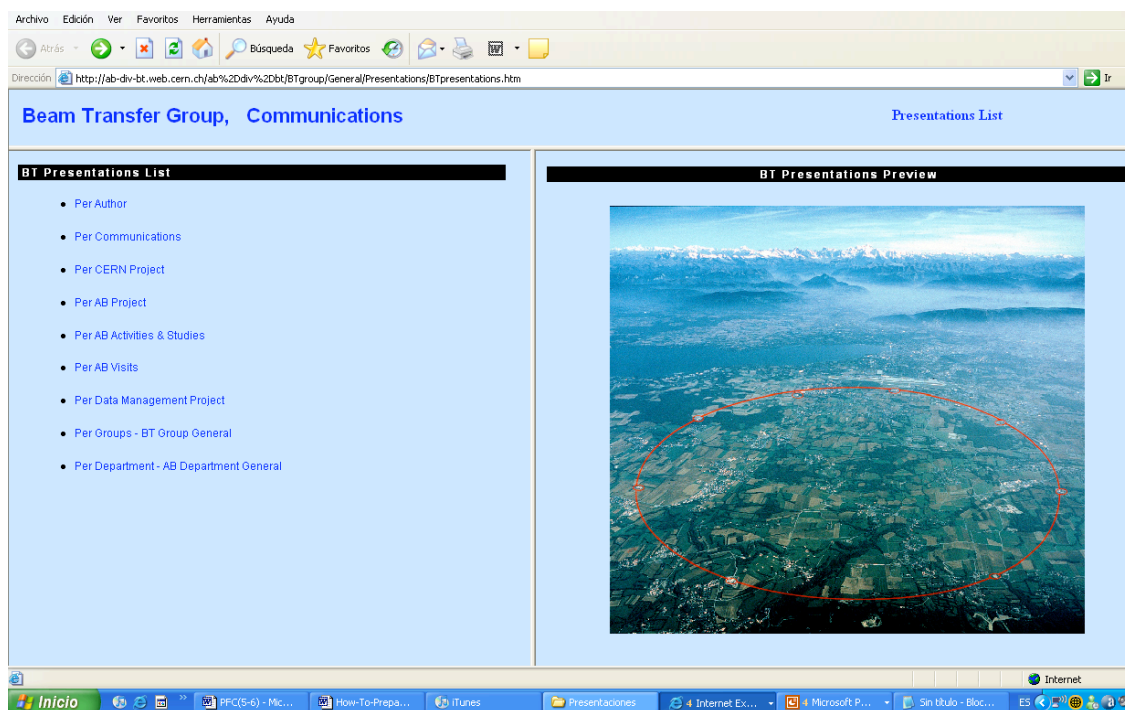
- The presentation document has to be accessible from BT website and KPS website.
- Before opening the presentation document, a quick preview of first page should be available.
- A powerful tool to search presentation documents by name, project, author, keywords, dates, etc. should be available.
- Safe data storage.
- Easy EDMS storage preparation.

## 6.5.3 Presentations website overview

As previously mentioned, it is necessary that the presentations documents will be accessible from the BT website and KPS website. That is why it has been created a new website that contains all the presentations and follows the mentioned requirements.

Now we are going to see an overview of this website and afterwards a more detailed explanation of the way used to store these documents in the web page.





Menus by criteria

Preview of the presentation

Fig. 6.10 Overview of the Presentations website

On the left side of the website there are menus by criteria. The presentations are classified under different topics. These topics are:

- Author
- Communications
- CERN Project





- AB Project
- Activities and Studies
- Visits
- Data Management Project
- BT Group
- AB Department

Thus, it is easier to find the desired presentation, since this one can be found following different ways and without need to know the exact title.

This is an example of the navigation through the structure of the website:

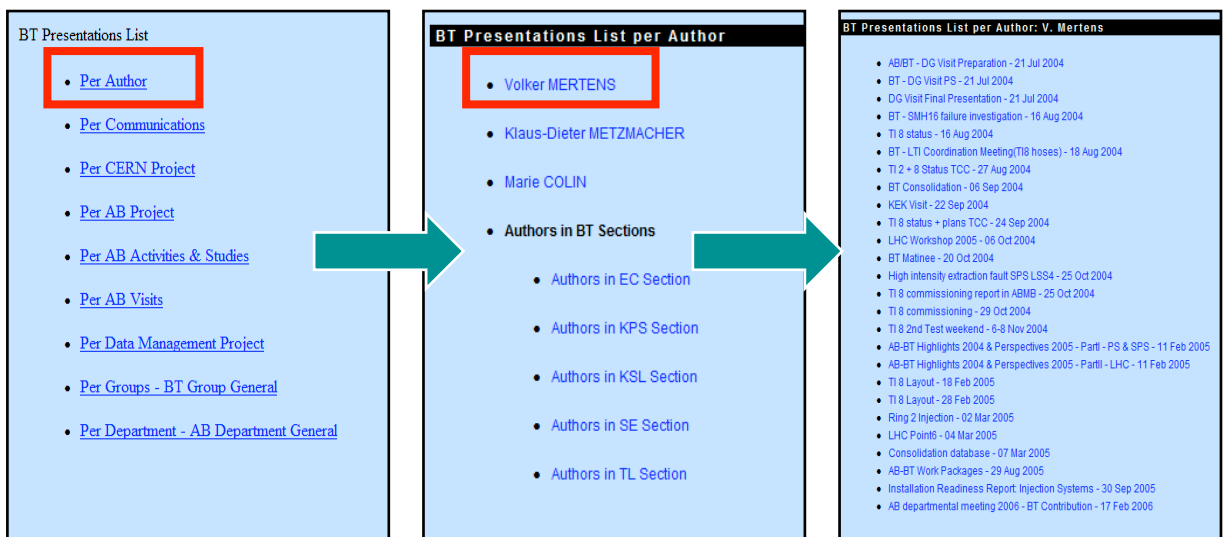


Fig. 6.11 navigation through presentation website



On the right side of the website there is a preview of the presentation.

If the user puts the mouse over the title of the presentation, on the right side appears a preview of the first slide/page of the presentation:

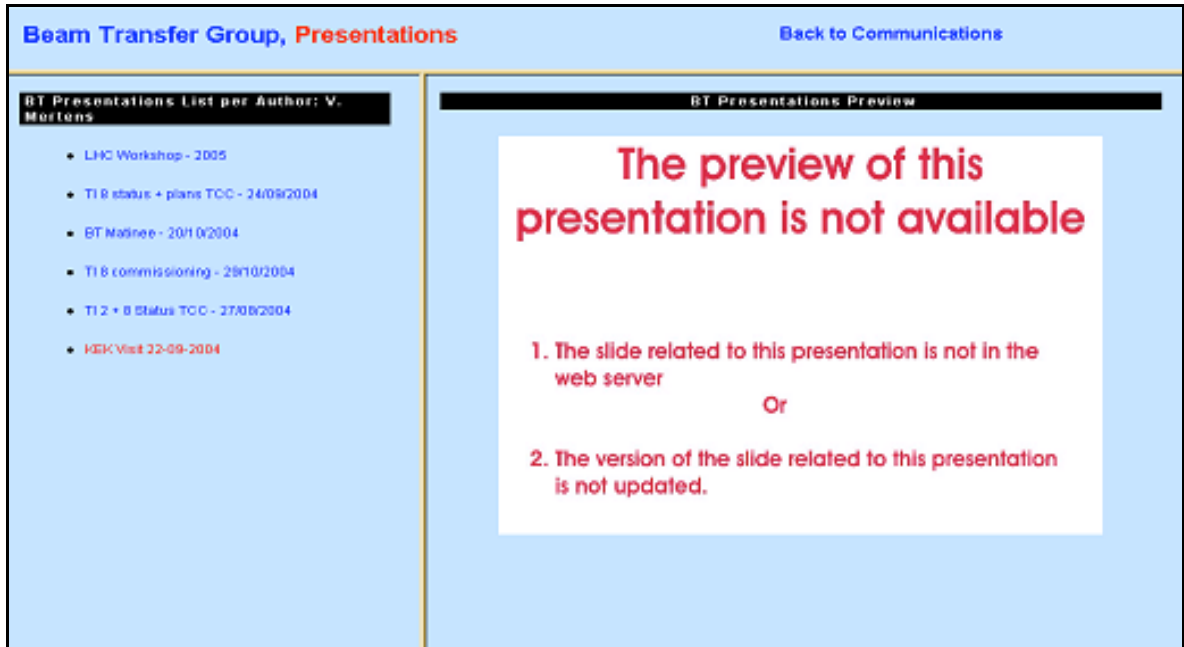
The screenshot shows a website interface with a blue header. On the left, under the heading "Beam Transfer Group, Communications", there is a "Presentations List" section. Below this, a sub-heading reads "BT Presentations List per Author: V. Mertens". A list of presentations follows, with the first three items highlighted in a red box: "AB/BT - DG Visit Preparation - 21 Jul 2004", "BT - DG Visit PS - 21 Jul 2004", and "DG Visit Final Presentation - 21 Jul 2004".

On the right side, under the heading "BT Presentations Preview", there is a preview of the first slide. The slide is titled "AB/BT equipment in PS Complex" and features a technical diagram of the PS complex. The diagram shows various components including ISOLDE, AD, PSB, PS, LINACS, LEIR, and CTF3. A legend at the bottom of the slide identifies symbols for "PS Complex" (red circle for 23 kV transformers, blue circle for 23 kV capacitors, green circle for 23 kV capacitors) and "LEIR Project" (red circle for 6 kV capacitors, blue circle for 23 kV capacitors, green circle for 23 kV capacitors). The slide footer reads "V.Mertens, K.-D.Metzmacher / AB/BT equipment in PS complex / 21.7.2004".

Fig. 6.12 preview of the first slide/page of the presentation

If the presentation is not available, instead of the preview of the first slide/page it appears this other one:





The screenshot displays a web interface for the Beam Transfer Group. The top navigation bar includes the title "Beam Transfer Group, Presentations" and a link "Back to Communications". The main content is divided into two sections:

- BT Presentations List per Author: V. Morlens**
  - LHC Workshop - 2005
  - T1 B status + plans TCC - 24/09/2004
  - BT Madree - 20/10/2004
  - T1 B commissioning - 28/10/2004
  - T1 2 + B Status TCC - 27/08/2004
  - KEK Visit 22-09-2004
- BT Presentations Preview**

The preview of this presentation is not available

  1. The slide related to this presentation is not in the web server

Or

  2. The version of the slide related to this presentation is not updated.

Fig. 6.13 Presentation no available

The first requirement for the storage of the presentations was that the presentation documents have to be accessible from BT website and KPS website. For that reason it has been created a link in both websites to this presentation web.



From the BT website: (<http://ab-div-bt.web.cern.ch>)

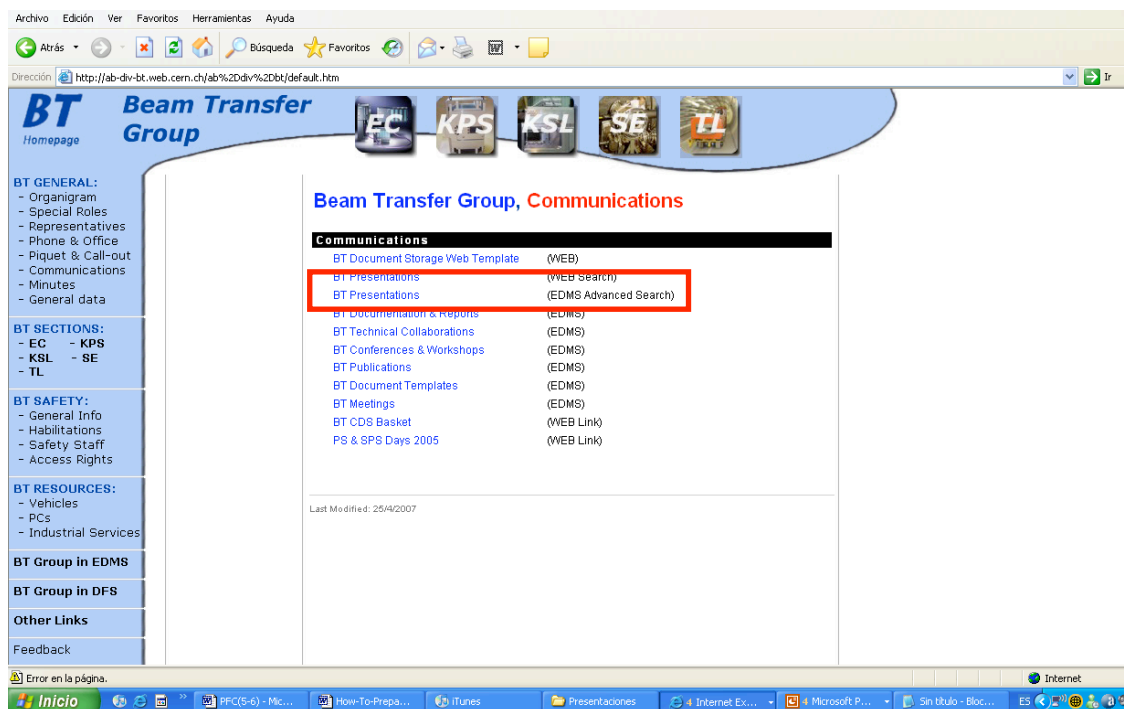


Fig. 6.14 Access from BT website



From the KPS website: (<http://ab-div-bt.web.cern.ch/ab-div-bt/Sections/KPS/>)

The screenshot displays the KPS website interface within an Internet Explorer browser window. The browser's address bar shows the URL <http://ab-div-bt.web.cern.ch/ab-div-bt/Sections/KPS/>. The website header features the title "KPS - Fast Pulsed Magnets, PS Complex" and the subtitle "Section of the BT Group / AB Department".

The main content area is organized into several sections:

- Organization:** Organigrams, Activities, Meetings, General Administration, Industrial Services, Safety.
- Communications:** Reports & Abstracts, Presentations (highlighted with a red box), Technical Collaborations, Conferences & Workshops, Publications, Photo Gallery.
- Schedules:** General Planning, Project Planning, Shutdown Planning, Machine Schedules, User Schedules.
- Machines & Exp. Areas:** LINAC 2 (AD), LINAC 3 (LEAR), PSB (ISOLDE), PS (EPA), TT2 (CTF3), LEIR (Test Areas).
- Systems:** PS Kickers Overview, Controls, Magnets, Pulse Generators, Fluids & Gases, Other Kicker Magnets sites.
- Latest Section News:** No news found, A link to the Section News Service.
- Technical Data Sources:** AB Operation Logbooks & Statistics, MTF - Asset Tracking, EDMS - Engineering Documentation, CDS - Cern Document Server, Kickers PS - Installations Logbooks, Kickers PS - KPS Data in DFS Server.

A search bar is located below the "Latest Section News" section, and a "FEEDBACK" button is positioned at the bottom of the main content area. The browser's taskbar at the bottom shows several open applications, including Microsoft Word, iTunes, Presentaciones, Internet Explorer, and Microsoft Power...

Fig. 6.15 Access from KPS website



## 6.5.4 Presentations Search

A second requirement was that the creation of a powerful tool to search presentation documents by name, project, author, keywords, dates, etc. should be available.

When the user clicks in one of the presentations he goes to the EDMS, and from there he can choose between different formats (pdf. or ppt.). The system includes also two other files, the tif and the jpg, but they only show the image of the first page/slide of the presentation.

The screenshot shows a web browser window displaying the EDMS Document Information Page. The document title is "BT Matinee - 20 October 2004". The document number is 508764, version 1, and the EDMS ID is also 508764. The status is "In Work". The document is a technical presentation from 2004-10-20. The authors listed are Volker MERTENS, Klaus-Dieter METZMACHER, Mike HOURICAN, Luc SERMEUS, Alain ANTOINE, Jan UYTHOVEN, and Francesco CASTRONUOVO. The document is marked as "PUBLIC".

The "Files of the Document" section lists the following files:

File Name	Format	Size
BTmatinee-20-10-2004	ppt	39 Mb
	tif	38 Kb
	pdf	9 Mb
	jpg	54 Kb

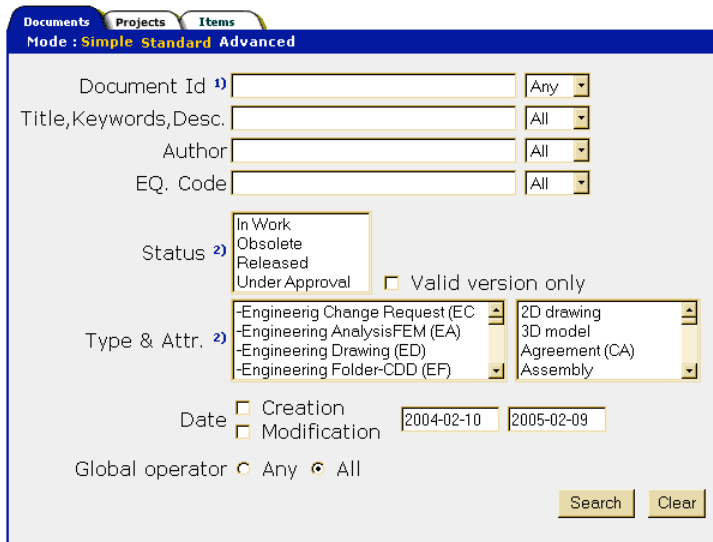
The "Sub-Documents" section is empty. The "Associated URL" section is empty. The "Context" section includes:

- What's next ?**: Change Status action expected from the originator, once all the files have been uploaded.
- Context**: AB-BT-WS
- Release Procedure**: DOC-OWNER : Release procedure without engineering check and approval process
- Equipment Code**: -

Fig. 6.16 Different formats for a presentation



Two different ways to search a presentation have been implemented: the first one is through the folders structure and the second one is using EDMS:



The screenshot shows the EDMS search interface with the following fields and options:

- Document Id:  Any
- Title, Keywords, Desc.:  All
- Author:  All
- EQ. Code:  All
- Status:  In Work, Obsolete, Released, Under Approval.  Valid version only
- Type & Attr.:  -Engineering Change Request (EC) 2D drawing, -Engineering Analysis FEM (EA) 3D model, -Engineering Drawing (ED) Agreement (CA), -Engineering Folder-CDD (EF) Assembly
- Date:  Creation,  Modification. 2004-02-10, 2005-02-09
- Global operator:  Any,  All
- Buttons: Search, Clear

Fig. 6.17 Using EDMS to search a presentation

Using EDMS the user can search any presentation document by name, project, author, keywords, dates.

### 6.5.5 Data Storage Structure: Domain and Subject.

All the presentation have a domain and a subject, both coming from the AB official website.

The AB Department Homepage is organized in different “domains” and “subjects” as we can see in *Figure 6.18*:



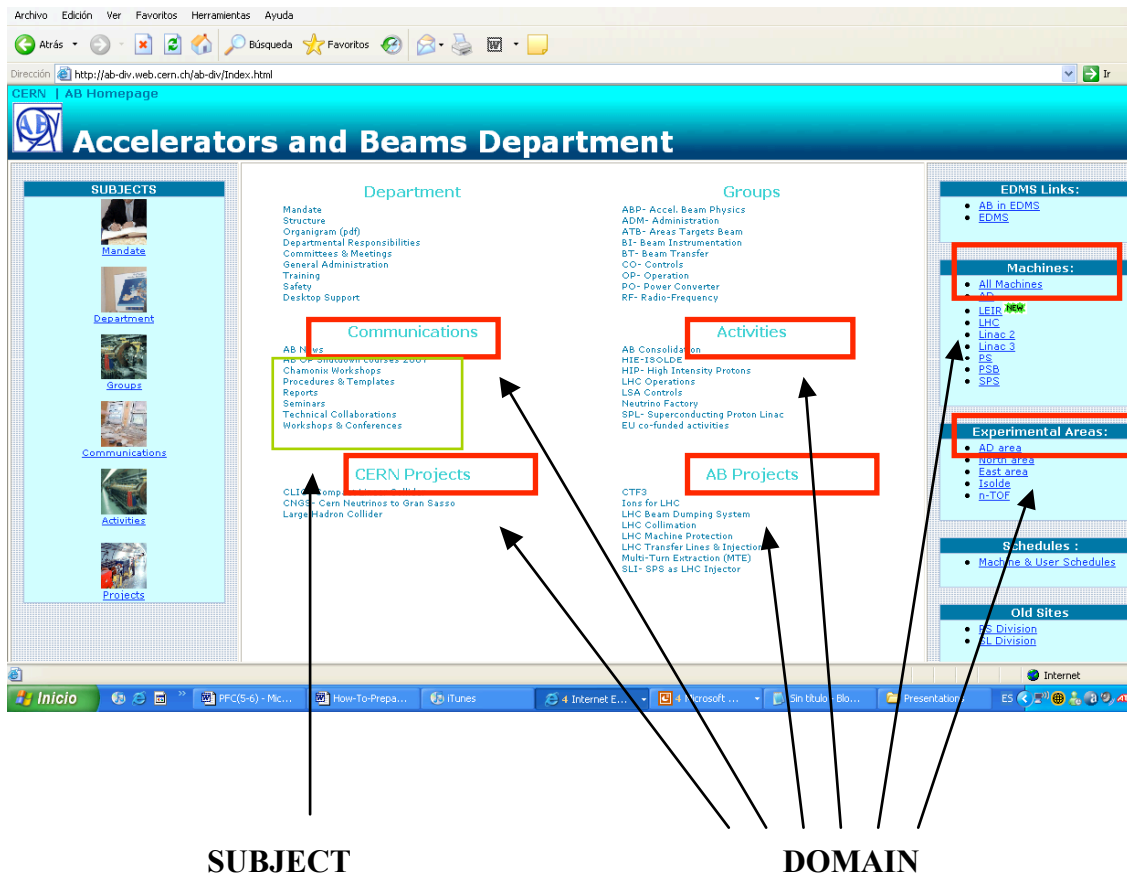


Fig. 6.18 Subjects and domains

Data should preferably be linked to machines and projects instead of administrative structures like Groups and Sections because they might change with time.

The preferred “domains” that we can identified here are the following:

- Machine
- Experimental Areas





- Communications
  
- CERN Project
  
- AB Project
  
- Activities

Inside the “domain”, we have to specify the “subject” related with the presentation (i.e. Communications is a domain while Technical Collaborations is a subject inside that domain).

The only exception is AB-BT Visits that is under the Communications “domain” in EDMS. This “subject” does not appear in the AB Department Website.

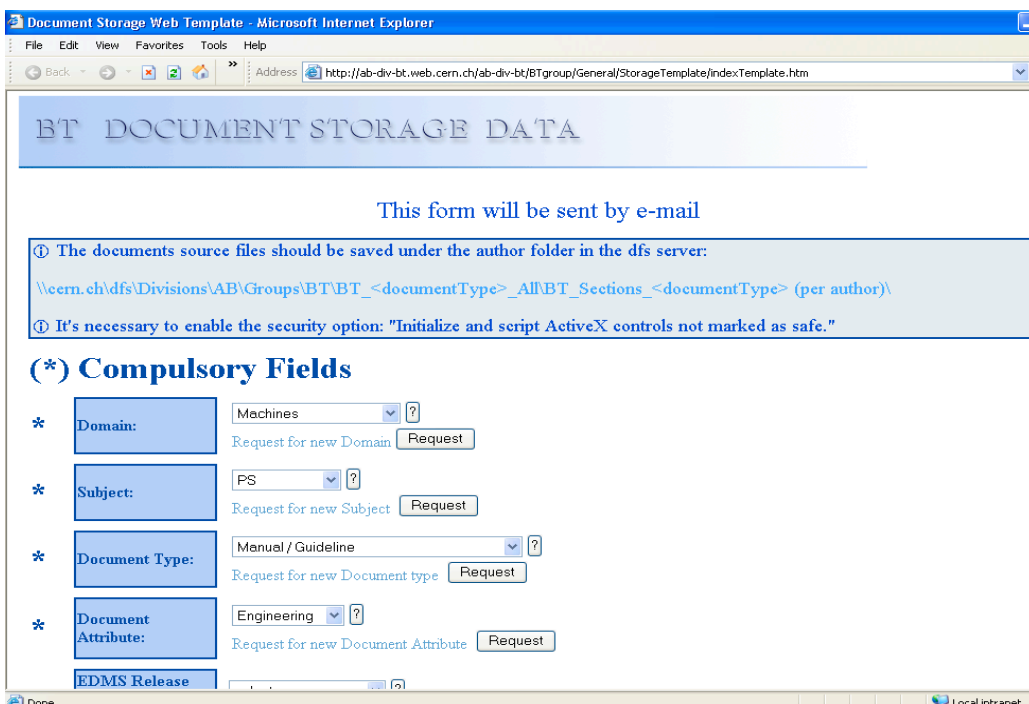
In order to prepare a presentation storage, the user has to choose one “subject” belonging to a “domain” in the structure of AB Department Website.

Subjects should never be attached to an administrative structure like Groups or Sections.



### 6.5.6 EDMS Storage Preparation.

A user that wants to storage a presentation, after selecting the “domain” and the “subject” of the presentation from AB Department Website, has to fill-in the following Document Storage Web template with information about the presentation.



Document Storage Web Template - Microsoft Internet Explorer

Address: <http://ab-div-bt.web.cern.ch/ab-div-bt/BTgroup/General/StorageTemplate/indexTemplate.htm>

## BT DOCUMENT STORAGE DATA

This form will be sent by e-mail

① The documents source files should be saved under the author folder in the dfs server:  
\\cern.ch\dfs\Divisions\AB\Groups\BT\BT\_<documentType>\_All\BT\_Sections\_<documentType> (per author)\

① It's necessary to enable the security option: "Initialize and script ActiveX controls not marked as safe."

### (\* ) Compulsory Fields

* Domain:	Machines	?
	Request for new Domain	Request
* Subject:	PS	?
	Request for new Subject	Request
* Document Type:	Manual / Guideline	?
	Request for new Document type	Request
* Document Attribute:	Engineering	?
	Request for new Document Attribute	Request
EDMS Release		?

Fig. 6.19 Web template with information about the presentation



To fill the web it is necessary to follow the following steps:

1. Fill the form:

**(\*) Compulsory Fields**

*	<b>Domain:</b>	Machines	?	Request for new Domain	Request	
*	<b>Subject:</b>	PS	?	Request for new Subject	Request	
*	<b>Document Type:</b>	Manual / Guideline	?	Request for new Document type	Request	
*	<b>Document Attribute:</b>	Engineering	?	Request for new Document Attribute	Request	
	<b>EDMS Release Procedure:</b>	select	?			
*	<b>EDMS Read Access:</b>	select	?			
*	<b>EDMS Document Title:</b>					?
		max=160 char.				

	<b>EDMS Release Procedure:</b>	Owner	?			
*	<b>EDMS Read Access:</b>	Public	?			
*	<b>EDMS Document Title:</b>	Title	?	max=160 char.		
*	<b>EDMS Document Description:</b>	Description	?	max=240 char.		
	<b>External References:</b>	External References	?	max=240 char.		
*	<b>Document Keywords:</b>	_ Keyword1 _ Keyword2	?	max=240 char.		
*	<b>Document Production Date:</b>		Calendar	?	format: yyyy-mm-dd	
*	<b>Author or list of authors:</b>					?
						max=240 char.

Fig. 6.20 Compulsory fields to fill



## 2. Attached files

\* **Contact person e-mail:**  ?

**Associated URL (CDD Folders etc...):**  ?

**Text to show for URL:**  ?  
max=160 char.

**Clickable text for URL:**  ?  
max=160 char.

\* **Files to be uploaded in the Document**

Z:\BT\_Presentations\_All\BT\_Group\_Presen

VM\_TCC\_291004.ppt

Do you want to fill another Document Form ?

Fig. 6.21 Step to attach the presentation files



### 3. Create an Excel File

Create Excel file and save it in `cern.ch\dfs\Divisions\AB\Groups\BT\BT_EDMS-Docs_CREATION` without changing the name and close the excel window

?

Fig. 6.22 Option to create an Excel file

The file that is created automatically has the following form:

EDMS Domain	EDMS Subject	EDMS Group Context	EDMS Document Type	EDMS Document Attribute
Machines	AD	AB-BT-WS	Reports	Technical

EDMS Release Procedure	EDMS Read Access	EDMS Document Title	EDMS Document Description
OWNER	Public	Work Summary	Work Summary

External References	Document Keywords	Presentation date	Author or list authors
	EDMS, MTF, Thyratrons, Counters, Presentations	22/02/2007	Vergara, Rocío

Contact person e-mail	Associated URL	Text to show for URL	List of Files with extension
<a href="mailto:rocio.vergara.fernandez@cern.ch">rocio.vergara.fernandez@cern.ch</a>			\\CERNHOME07.CERN.CH\Desktop_Srvergara\WORK SUMMARIZE February 2006 - May 2007.ppt\\CERNHOME07.CERN.CH\Desktop_Srvergara\File1.txt\\CERNHOME07.CERN.CH\Desktop_Srvergara\File1.txt\\CERNHOME07.CERN.CH\Desktop_Srvergara\File1.txt

Fig. 6.23 Excel file created with all the information of the presentation



#### 4. Send an e-mail to the link person

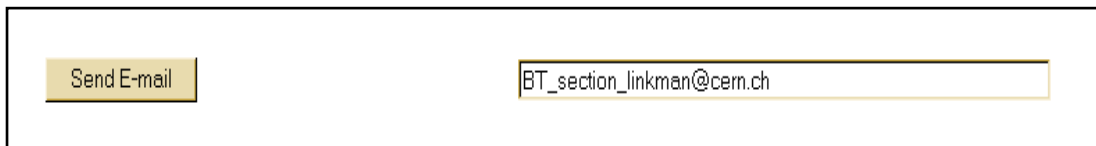


Fig. 6.24 Option to send an e-mail to the responsible

The e-mail is sent to the responsible person who is in charge of the presentation data, the e-mail includes the excel file.

### 6.5.7 Update Presentations

The final step is the update of the presentation document. The link person, who is in charge of the presentations data, has to do two actions:

- EDMS document creation
- Presentations Website Update<sup>1</sup>

---

<sup>1</sup> Refer to Appendix B for further information of Presentations Website Update procedure



## 6.5.8 Presentations: Future Steps

In order to improve the storage of presentations documents and the Document Store Web Template, there are some steps that could be followed in the future:

- Automate process

*For example, create PDF with Web Server...*

- To make the interface more clear

*For example, improve the help on line...*

- Use the same system to store another kind of documents

*For example, publications, reports, meeting minutes...*



## 7 KPS-MTE Project Website

### 7.1 Why a KPS MTE Project Website?

As it was said previously, in the project MTE there take part many groups and sections of CERN. For that reason, there is already a website where it is possible to find all the general information relating to the project (<http://ab-project-mte.web.cern.ch/AB-Project-MTE/>).

It is possible to find all the documents, planning, schedules, articles, presentations and publications of the project, but always in general terms. That is why we thought that it would be necessary to create a web page only for our section, the KPS section. In such way this it would be much simpler to locate all the information and documentation of the project related to the KPS section, and would give us certain independence.

The MTE project main website, contains all the information from every section that takes part on it, however for storing this information it is necessary to follow the procedures set by the webmaster and, very often, the time spent from the moment that a user orders an information until it is stored in the website, can be pretty long. On contrary, having our own webpage will speed up these tasks of storage, and the information will be always updated.

### 7.2 Requirements

After some meetings with the responsible of the section and different colleagues we decided that the novel web site will have to follow these requirements:





- KPS-MTE Website accessible from KPS website
- Data storage with the same structure as the KPS Management Data (EDMS,DFS)
- Safe data storage
- Easy to navigate and handily
- Constant update of the innovations in the project

### 7.3 Overview of the Website

According to all the approved specifications and requirements, it has been created the following web page, which is accessible from the official KPS website (as always, following the same structure than all the KPS data management):

Organization	Communications	Schedules
Organigrams	Reports & Abstracts	General Planning
Activities	Presentations	Project Planning
Meetings	Technical Collaborations	Shutdown Planning
General Administration	Conferences & Workshops	Machine Schedules
Industrial Services	Publications	User Schedules
Safety	Photo Gallery	

Machines & Exp. Areas	Projects
LINAC 2 AD	Consolidation CLIC CTF3
LINAC 3 LEAR	Laser Ion Source
PSB ISOLDE	I-LHC/LEIR
PS EPA	I-LHC/PS
TT2 CTF3	TERACNAU
LEIR Test Areas	PS MTE
	CTF3 Conesnet Ring

Systems	Latest Section News	Technical Data Sources
PS Kickers Overview	No news found	AB Operation Logbooks & Statistics
Controls	A link to the Section News Service	MTF - Asset Tracking
Magnets		EDMS - Engineering Documentation
Pulse Generators		CDS - Cern Document Server
Fluids & Gases		Kickers PS - Installations Logbooks
Other Kicker Magnets sites		Kickers PS - KPS Data in DFS Server



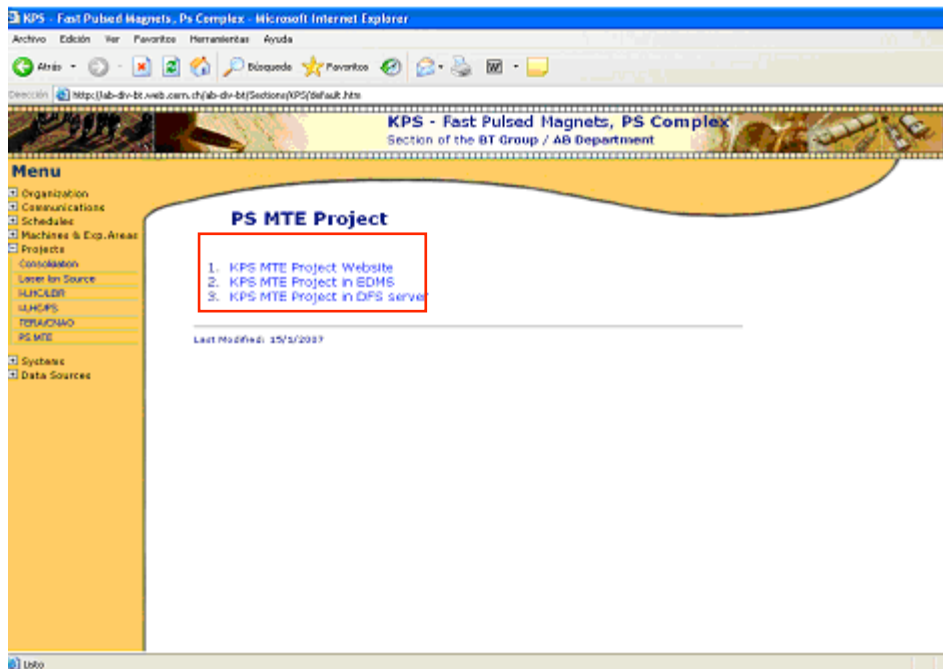


Fig. 7.1 Link to the KPS-MTE web from the KPS website



. The KPS-MTE Project Website:



Fig. 7.2 KPS-MTE Project website

In this web page it is possible to find all the necessary information related to the work of the KPS section in the MTE project.

At the top of the screen it a few buttons link to all the stored information and documents (later we will see this in detail). On the left of the screen we find a small space devoted to the latest news of the project and just below, " More News " where it is possible to access to a file with more ancient news.

At the bottom of the screen there is a MTE Project mandate, that is to say, a little explanation about the project:



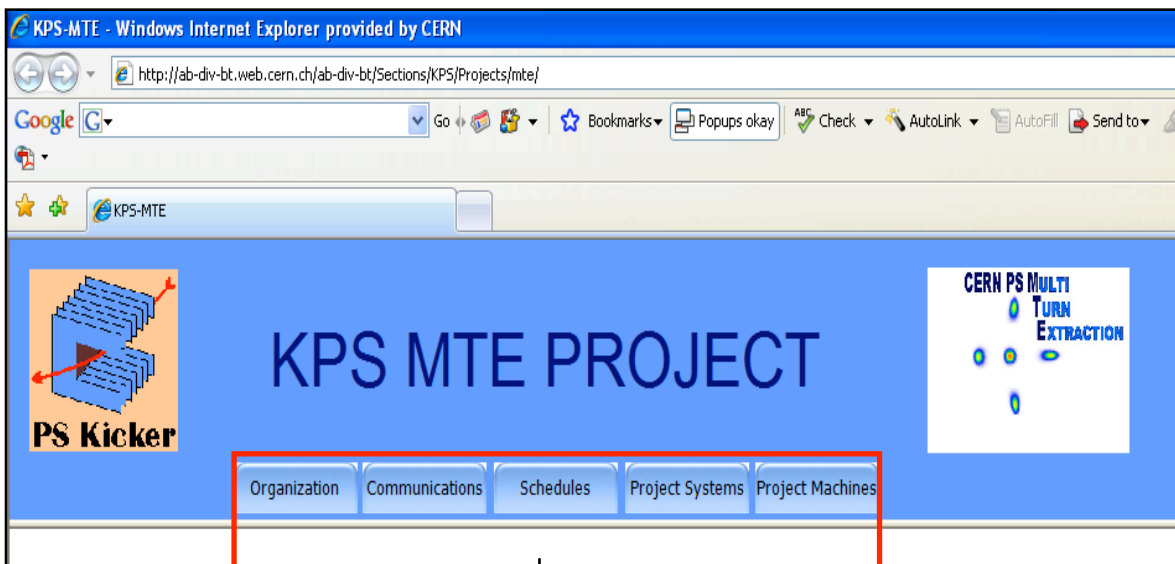
## About MTE

Since 2001 considerable effort has been devoted to the study of a possible replacement of the continuous-transfer extraction mode from the PS to the SPS. Such an approach, called Multi-Turn Extraction (MTE), is based on capture of the beam inside stable islands of transverse phase space, generated by sextupoles and octupoles, thanks to a properly chosen tune variation. Both numerical simulations and measurements with beam were performed to understand the properties of this new extraction mode.

The experimental study was completed at the end of 2004 and by the end of 2005 a scheme to implement this novel approach in the PS machine was defined and its performance assessed. The MTE Project has the mandate to implement and to commission the new extraction scheme

And finally, on the left side of the web page we find a series of links to other related websites: KPS homepage, MTE homepage, CERN website and a link to contact with the person responsible of this website.

Now we are going to see in detail the data management structure in this website:



Same structure EDMS



Fig. 7.3 Detailed structure of the web

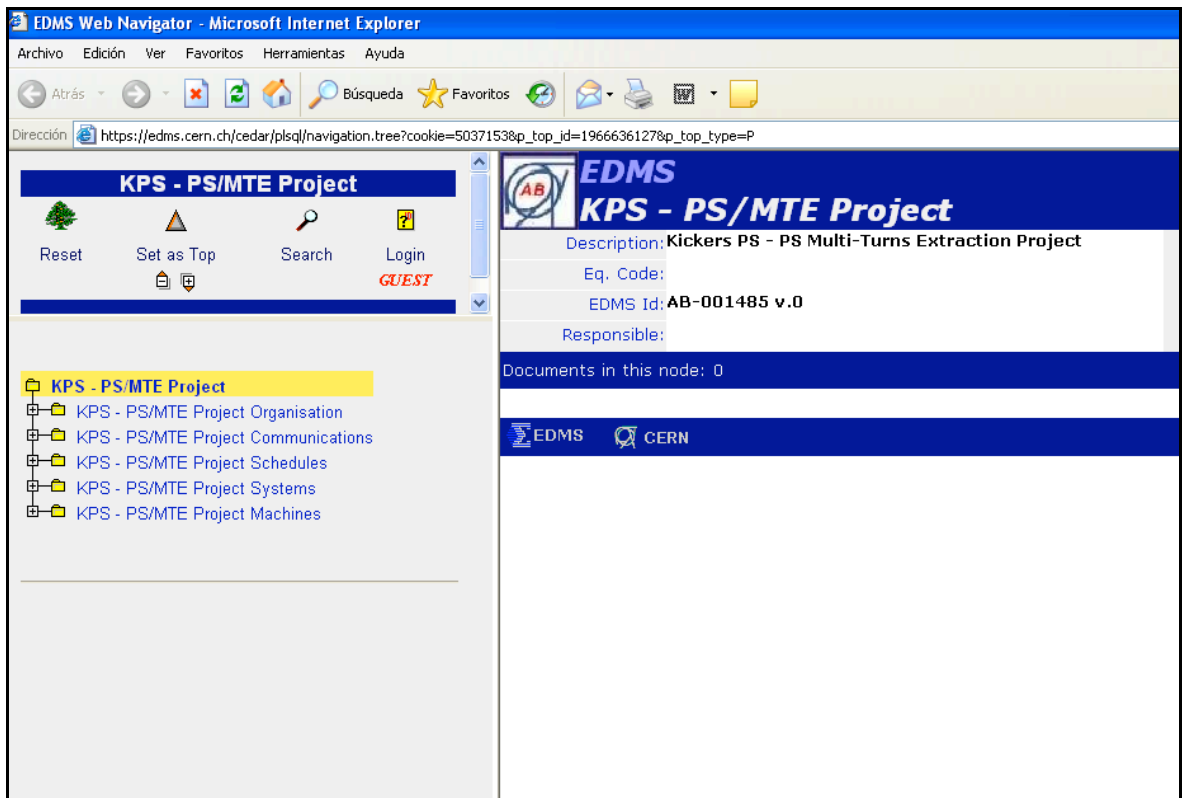


Fig. 7.4 Same structure of the EDMS as KPS-MTE web

When one clicks on one of the buttons, on the left side of the screen it appears a new menu with different options, always the same as for the EDMS structure:



For example:



Same structure

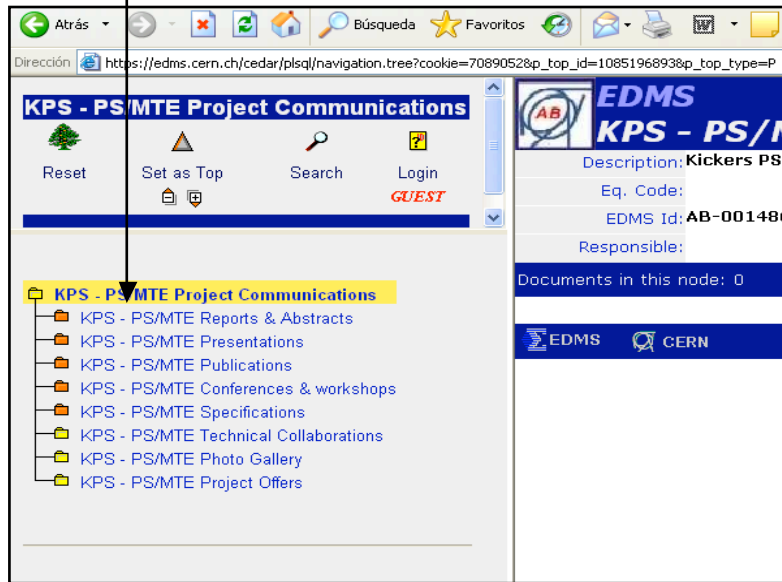
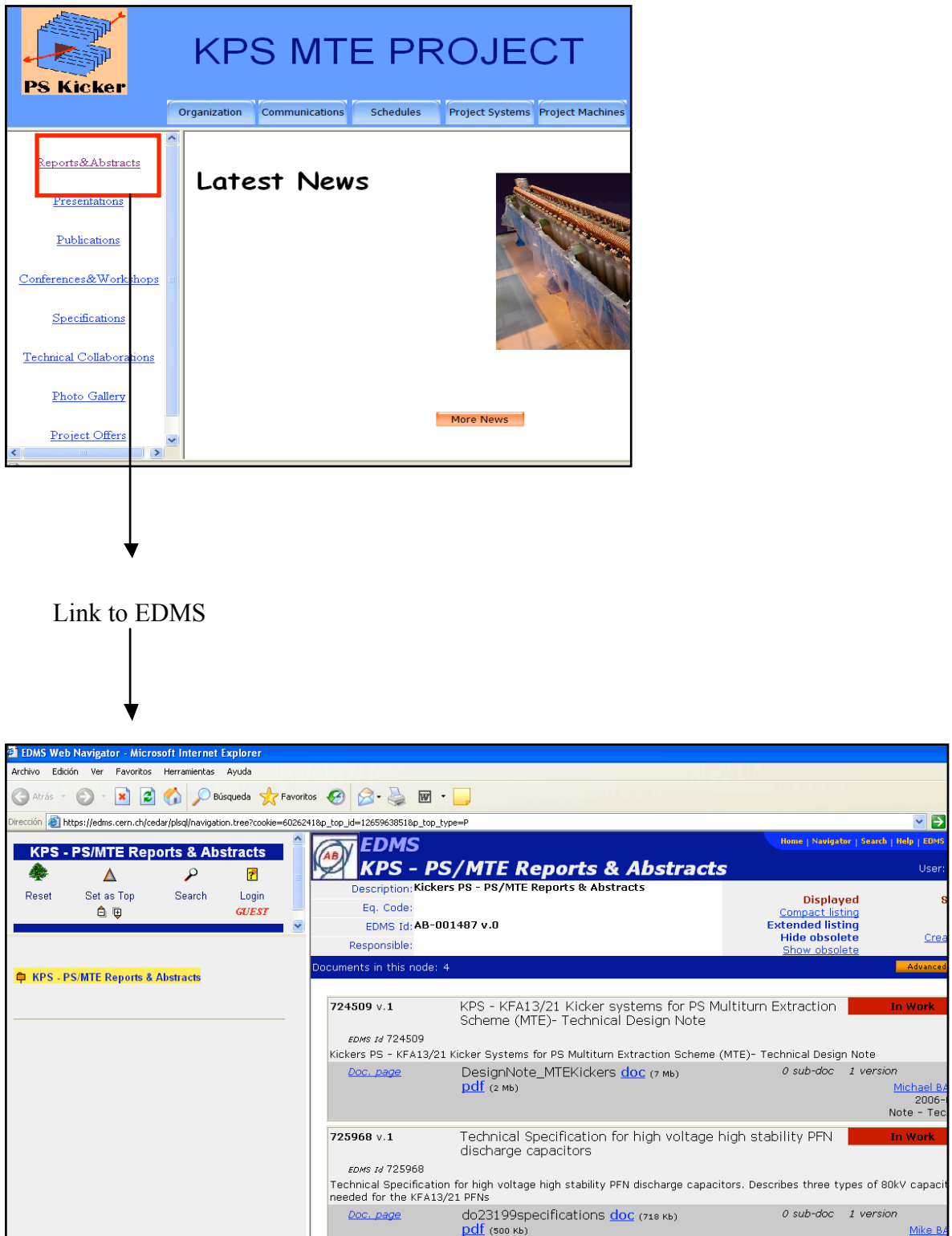


Fig. 7.5 Menu for the option communications and the same structure in EDMS



When clicking on one of the links of the menu on the left side of the website, we are addressed goes to the EDMS:



The figure illustrates the link between the web and EDMS Server. It shows two screenshots connected by a downward arrow. The top screenshot is the 'KPS MTE PROJECT' website. The left sidebar contains a navigation menu with the following items: Reports & Abstracts (highlighted with a red box), Presentations, Publications, Conferences & Workshops, Specifications, Technical Collaborations, Photo Gallery, and Project Offers. The main content area is titled 'Latest News' and features a photograph of a particle accelerator component. Below the photo is a 'More News' button. The bottom screenshot is the 'EDMS Web Navigator' interface in Microsoft Internet Explorer. The browser address bar shows the URL: [https://edms.cern.ch/cedar/plsql/navigation.tree?cookie=6026241&p\\_top\\_id=1265963851&p\\_top\\_type=P](https://edms.cern.ch/cedar/plsql/navigation.tree?cookie=6026241&p_top_id=1265963851&p_top_type=P). The page title is 'KPS - PS/MTE Reports & Abstracts'. The left sidebar has a search bar and a 'Login' button for a 'GUEST' user. The main content area displays a list of documents in this node:

EDMS ID	Description	Status
724509 v.1	KPS - KFA13/21 Kicker systems for PS Multiturn Extraction Scheme (MTE)- Technical Design Note	In Work
EDMS ID 724509	Kickers PS - KFA13/21 Kicker Systems for PS Multiturn Extraction Scheme (MTE)- Technical Design Note	
<a href="#">Doc. page</a>	<a href="#">DesignNote_MTEKickers doc</a> (7 Mb)	0 sub-doc 1 version
	<a href="#">pdf</a> (2 Mb)	Michael Ba 2006-1 Note - Tec
725968 v.1	Technical Specification for high voltage high stability PFN discharge capacitors	In Work
EDMS ID 725968	Technical Specification for high voltage high stability PFN discharge capacitors. Describes three types of 80kV capacitors needed for the KFA13/21 PFNs	
<a href="#">Doc. page</a>	<a href="#">do23199specifications doc</a> (718 Kb)	0 sub-doc 1 version
	<a href="#">pdf</a> (500 Kb)	Mike Ba

Fig. 7.6 Link between the web and EDMS Server



As we have been able to observe, all the information is stored in EDMS, that at the same time it has the file source in DFS. Thus, we can assure the requirement of safety data storage.

Another feature exists in this web page: the schedules.

One of the buttons corresponds to Schedules and when it is clicked, the following menu appears on the left side of the screen:



Fig. 7.7 Menu of schedules





Through this web page, we can see different planning about the MTE Project (always the part of the KPS section). There are three planning. The first one is the general one, "Project Planning"; The second and the third ones are the planning concerning the current month and quarter respectively.

At present, these two last ones get up-to-date in a manual way, but it is foreseen that in a near future they are updated automatically to improve the use and maintenance of the website.

If the user wants to know the general planning of the section KPS related to the MTE Project, it is enough to click on the first link, "Project Planning".

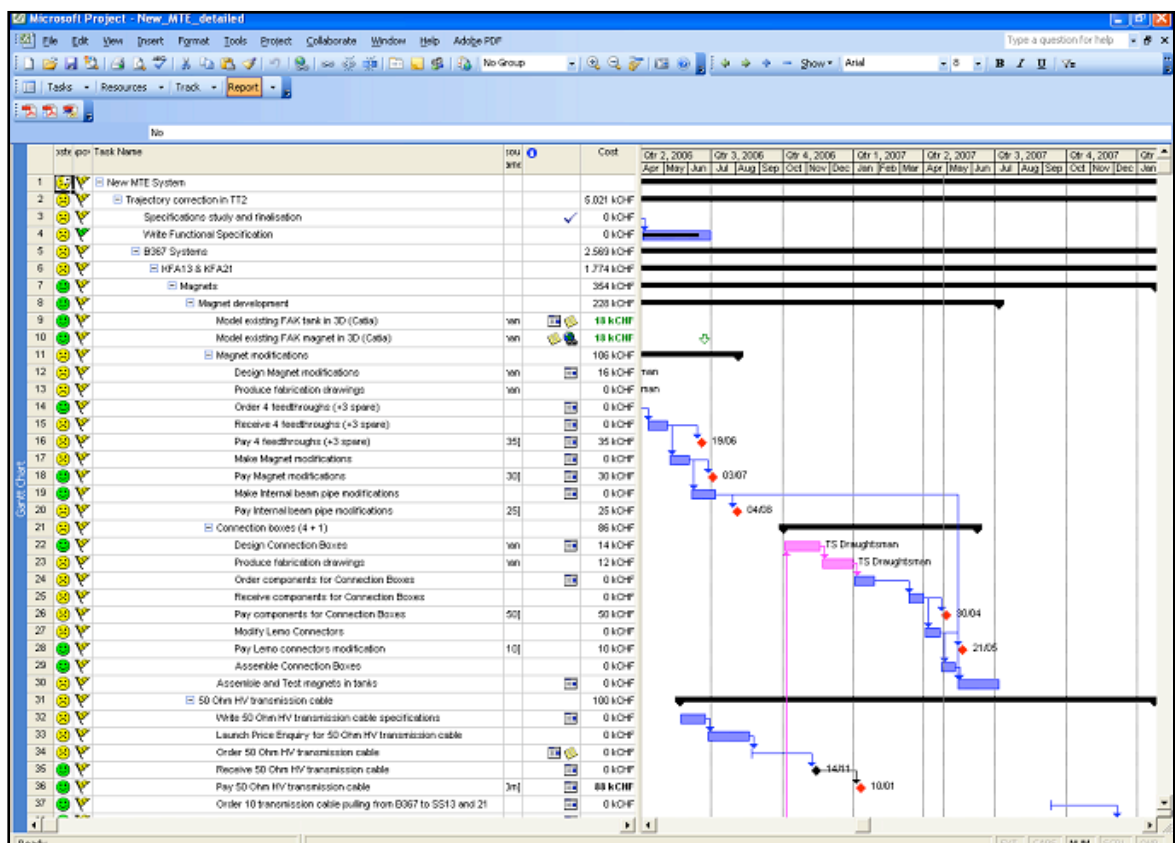


Fig. 7.8 Planning of the section KPS related to MTE Project



It is necessary to do the same thing if the user wants to see the planning of the current month or quarter. Let's see now, for example, the planning that appears when it is clicked on " Current Quarter Planning ":

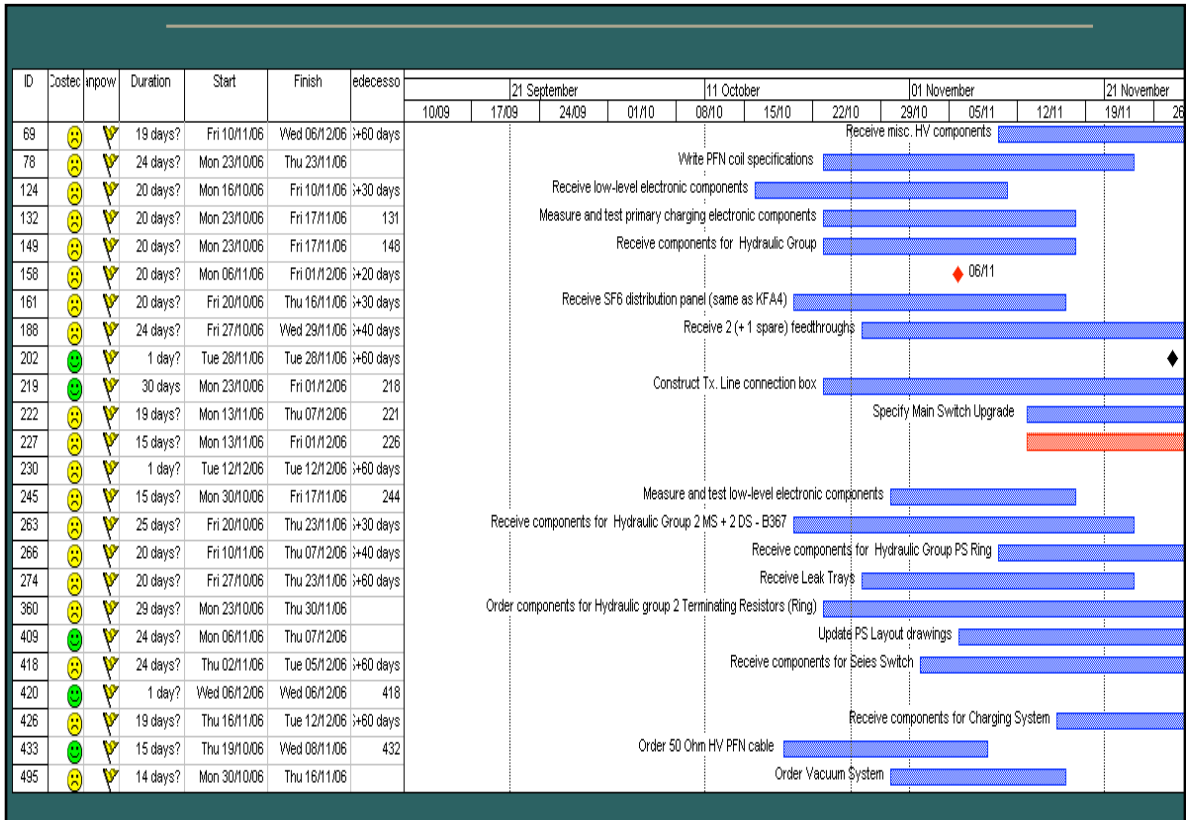


Fig. 7.9 Planning corresponding with the last quarter of 2006



## 8 KPS-MTE Project Planning

### 8.1 KPS Section in the MTE Project

As it has been said before, KPS is the section at CERN responsible for the design, development, construction, installation, exploitation and maintenance of all fast-pulsed magnet (kicker) systems of the PS complex. A Kicker is an electromagnet that switches on just long enough to “kick” the particles out of the synchrotron ring and along a beam line.

In the *Figure 8.1* we can see the accelerator PS in which the KPS Section has a series of kickers that in the figure appear as red dot (•)

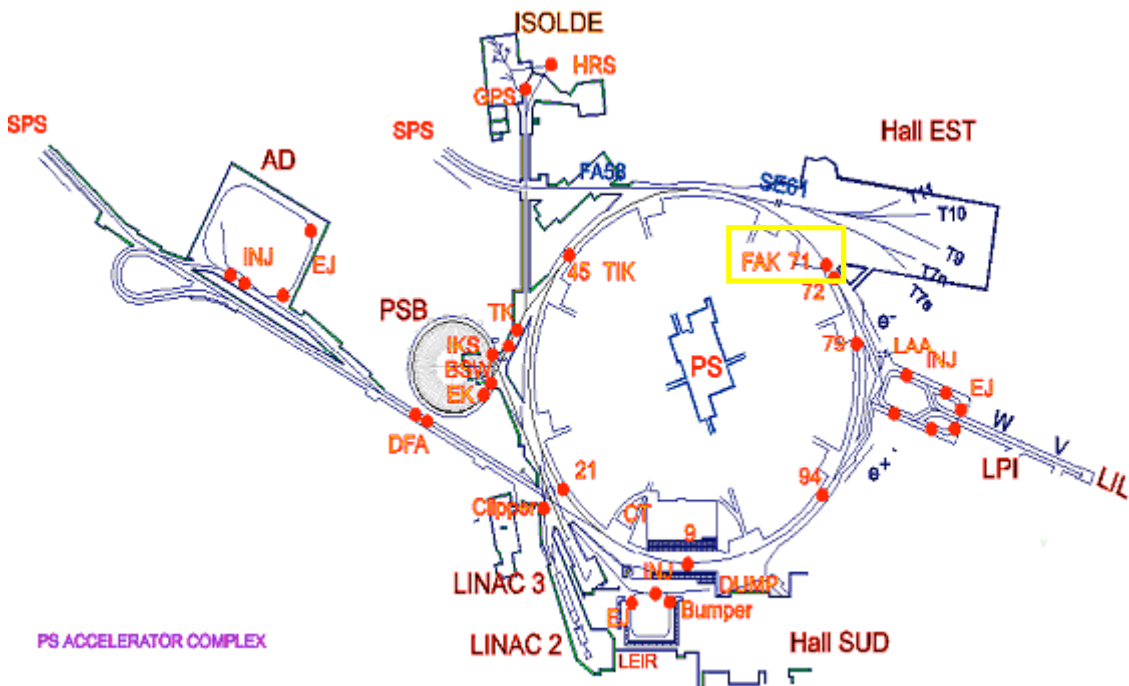


Fig 8.1 Kickers in PS accelerator complex



Each of these Kickers has associate an electrical drawing of the functioning of the same one.

These drawings are used by the technical personnel to know the components of the kickers as well as its way of functioning.

By way of illustration, one can see the Kicker KAF 71 (That in the previous figure turns is marked by a yellow box). In the next two figures (*Figures 8.2 and 8.3*) one can see a photo of this kicker in the PS accelerator and its electrical drawing.



Fig. 8.2 Kicker KFA 71

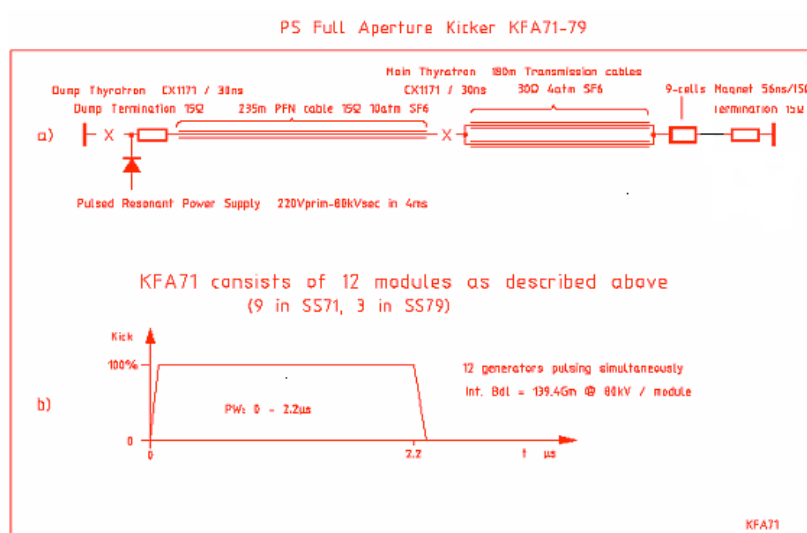


Fig. 8.3 Electrical drawing of Kicker KFA 71



Regarding the MTE Project, the KPS Section is the responsible about all related to kickers.

The following kickers are currently installed in the PS machine [10]:

- Injection kicker KFA45;
- Extraction kicker KFA71/79;
- BFA9/21 used for the CT extraction;
- Injection kicker for ions KFA28.

The following kickers will be installed for the novel multi-turn extraction:

- Two identical new kickers KFA13 and KFA21. The modules are similar to those of the extraction kicker KFA71/79;
- One new kicker KFA4. The modules are recuperated from the extraction
- Kickers for leptons;
- All the kickers currently installed in the PS machine will be also present.



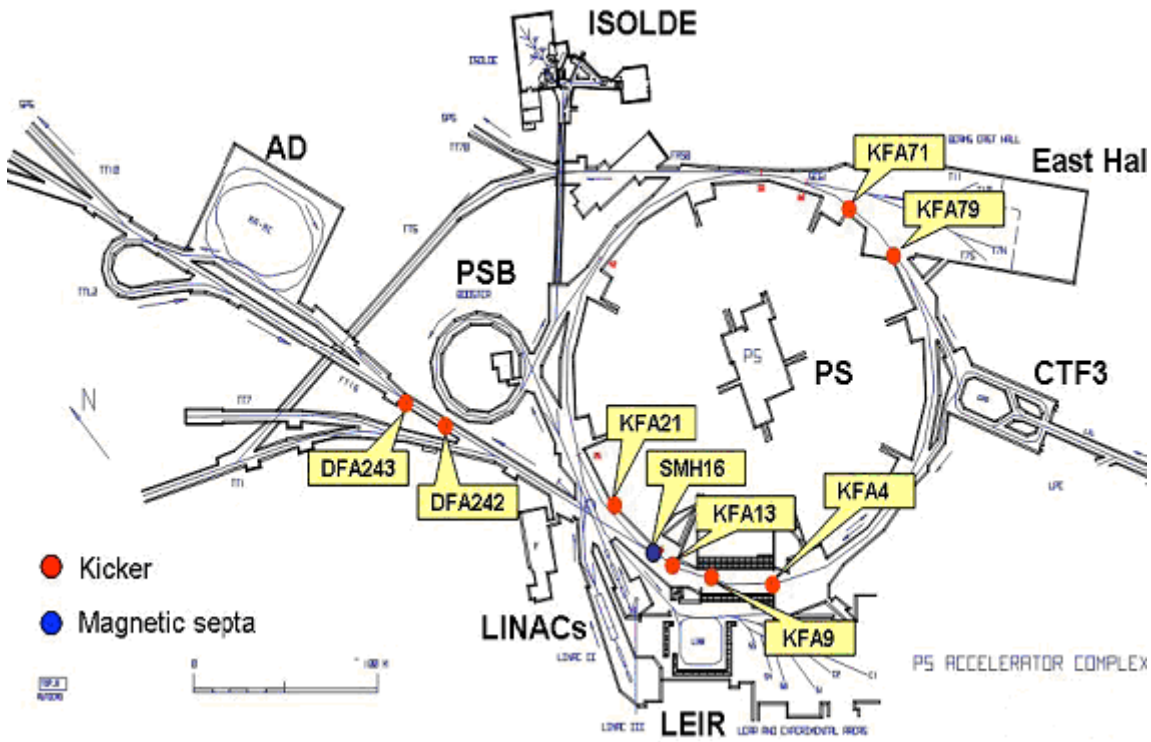


Fig 8.4 PS complex layout, indicating the location of the fast pulsed magnets (red dots) implied in the new PS multi-turn extraction



## 8.2 General planning: schedule and budget

At the beginning of 2005 a general schedule was made. Here are the milestones of the realization of the MTE project:

### **Shutdown 2005/2006:**

- Install slow extraction sextupoles.
- Replace magnets of slow bump 16 with type 205 magnets.
- General clean-up of the machine.

### **PS run 2006:**

- Launch production of the octupoles.
- Complete the study of the special vacuum chambers for magnet units 14, 15, 16 and launch the production.
- Complete the drawings for the new layout of the PS ring.

### **Shutdown 2006/2007:**

- Remove slow extraction sextupoles.



- Install new power converters for bump 16.

**PS run 2007:**

- Test the new layout of the slow bump 16 in operation.

**Shutdown 2007/2008:**

- Install kickers in the PS ring.
- Install modified vacuum chambers (straight sections and magnets).
- Install sextupoles and new octupoles.
- Move 80 MHz cavity.
- Install new wire scanner.
- Displace DFA243 in the TT2 transfer line.

**PS run 2008:**

- Commissioning of the MTE.





**Shutdown 2008/2009:**

- Completion of the spare tanks for the KFA71/79 kicker.
- Upgrade of kickers in TT2 line to achieve nominal performance.

In terms of the required budget to accomplish the installation and commissioning of the MTE, the summary data is given in *Table 8.1* together with the spending profile<sup>1</sup>.

Item	2006	2007	2008	2009	kCHF <sup>1</sup>
Kickers: material	880,00	2190,00	2110,00	320,00	5500,00
Kickers: manpower	292,31	471,79	384,62	51,28	1200,00
Power converters (capacitor discharge)	91,50	213,50			305,00
Power converters (TEKELEC)		240,00	60,00		300,00
Drawings	130,00				130,00
Magnets: octupoles	38,50	56,50	2,50		97,50
Magnets: quadrupoles	70,00	22,50	2,50		95,00
Magnets: sextupoles	22,00	50,50	2,50		75,00
Vacuum chambers	108,00	180,00	72,00		360,00
RF		28,40	7,10		35,50
Instrumentation		31,04	7,76		38,80
Controls	24,00	84,00	12,00		120,00
Workshop	15,00	15,00			30,00
Survey		5,60	1,40		7,00
<b>Total</b>	<b>1671,31</b>	<b>3588,83</b>	<b>2662,38</b>	<b>371,28</b>	<b>8293,80</b>

(1) the currency is the CHF (Swiss franc)

Table. 8.1 Total budget required for the implementation of the MTE.

<sup>1</sup> Refer to Appendix C. for see the detailed cost breakdown of the new MTE kicker system



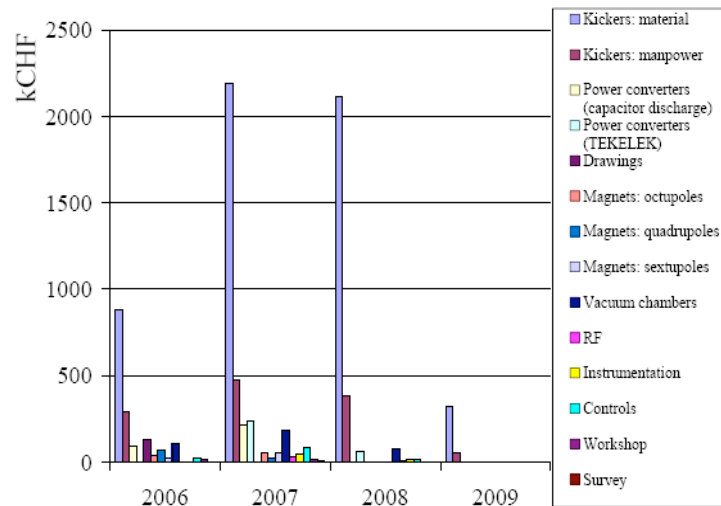


Figure 8.5 Plot of the spending profile for the overall budget for MTE implementation

### 8.3 KPS Planning in MTE Project

The responsible in KPS decided to make a detailed planning with only the tasks that are realized or it will be realized in the section. This planning was getting up-to-date weekly depending on how the tasks were evolving.

To update it, the director of the section Tony Fowler and the author went to meetings every Wednesday with three people in charge of the section: Remy Noulibos, Jan Schipper and GianFranco Ravidà. They were informing us whether the milestones were fulfilled or, in opposite case, which was the foreseen delay.



The figure below represents the last planning realized in December, 2006<sup>1</sup>:

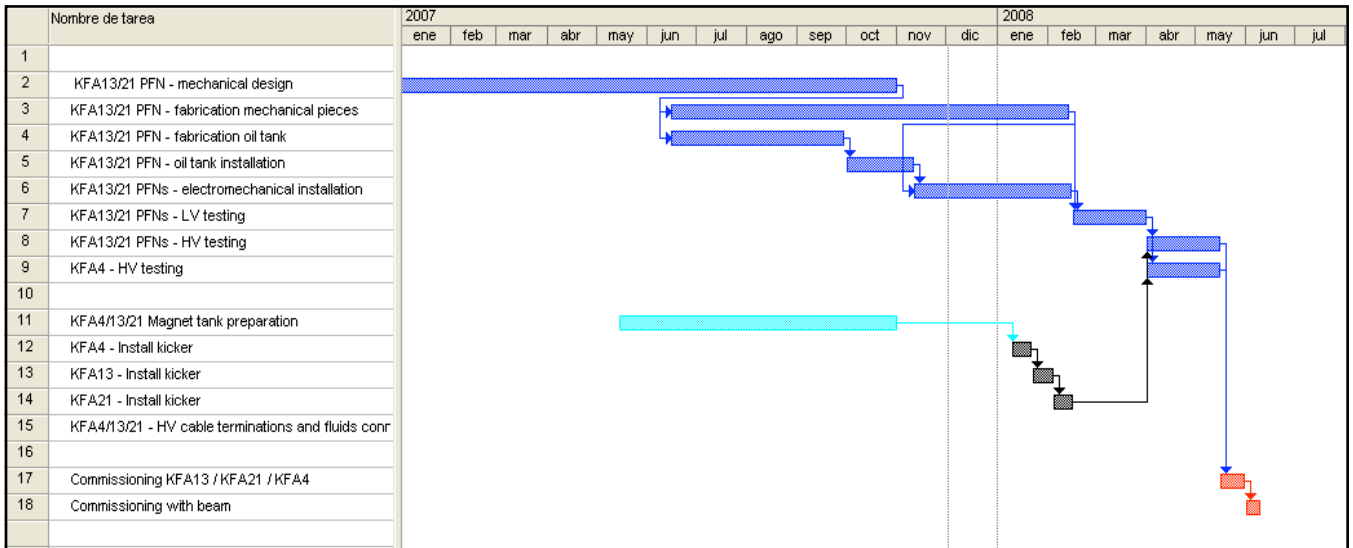


Figure 8.6 Last planning of the KPS section in MTE project (December 2006)

<sup>1</sup> The detailed planning is contained in Appendix D



## **9 Cost Benefit Analysis (CBA) of the project**

### **9.1 Background**

The Cost-Benefit Analysis (CBA) estimates and totals up the equivalent value of the benefits and costs to the community of projects to establish whether they are worthwhile.

This analysis is done to determine how well, or how poorly, a planned action will turn out. Moreover, cost benefit analysis finds, quantifies, and adds all the positive factors. These are the benefits. Then it identifies, quantifies, and subtracts all the negatives, the costs. The difference between the two indicates whether the planned action is advisable.

### **9.2 Cost of the project**

The cost of this project is expressed in terms of the cost of the work done by myself in this

period of 16 months. 14 months working at CERN and 2 month typing the project.

In the calculation it has been assumed a working week of 40 hours distributed in 5 working days of 8 hours. During the first four months the working day had to divide to attend to other projects, due to this, the working day during these months it was reduced at 20 weekly hours.



Period	Working day	Days	Hours
March - June (2006)	Half (4 hours)	81	324
July- April (2006-2007)	Complete (8hours)	192	1536
<b>Total</b>		<b>273</b>	<b>1860</b>

---

Table 9.1 Hours working at CERN in the project

To calculate the personnel cost it has been supposed a cost of 15 € per Hour:

Hours	Salary	Personnel Cost
1860	15€ / hour	<b>27.900 €</b>

---

Table 9.2 Personnel cost of the project

Other Costs:

Work	Hours	€/hour	€
Microsoft FrontPage Course <sup>1</sup>	40	12	480
EDMS Course	80	12	960
French Course	180	10	1800
Typing	180	10	1800
<b>TOTAL</b>			<b>5040</b>

<sup>1</sup> HTML editor and web site administration tool

---

Table 9.3 Hours of other concepts



Taking into account everything before detailed, the total cost of the project is:

<b>Concept</b>	<b>Cost (€)</b>
Work at CERN	27900
Training courses	3240
Typing	1800
<b>TOTAL</b>	<b>32940</b>

Table 9.4 Total cost of the project

### 9.3 Benefits of the project

The client of this project has been CERN and particularly the KPS Section.

This project bases principally on the creation of a new system of information management and the management and planning of the project MTE inside the section KPS. Therefore, the obtained benefits cannot be measured quantitatively, they are intangible assets. There has been created a service that in spite of not producing money, reduces the costs.

The principal intangibles assets are:

- Easy access to quick and reliable information
- Safe data storage
- Fast and effective to reach the information



## 10 Conclusions and future developments

This project describes the design and creation of a new system of information management for the KPS section at CERN related to the Multi-turn extraction Project (MTE).

A system of storage and management of information using the tools more common at CERN, EDMS, DFS Server and CERN websites has been designed.

This new system fulfill all the requirements that had been imposed at the beginning of the project:

- To keep safe stored the information
- To be accessible to all the workers
- To ease the to access to quick and reliable information
- To centralize all the information of the section in one unique server
- To use the tools already existing at CERN (EDMS, DFS, websites)
- To facilitate and improve the use and managing of this information within the MTE project through websites
- To keep the same structure in all the servers where the information is stored

The storage of the information divide in three different steps to follow:



- **DFS server:** a safety storage of the information is obtained.
- **EDMS server:** provides one single source of engineering data that helps people to find and share information. It also avoids duplication of data to preserve integrity and minimize the risk of losing information.
- **Web server:** providing an easy and quick search of the information

Moreover, it has been created a special storage for the presentation documents.

This new system of storage using the created website, fulfills the requirements imposed at the beginning:

- The presentation document is accessible from BT website and KPS website.
- Before opening the presentation document, a quick preview of first page can be available.
- A powerful tool to search presentation documents by name, project, author, keywords, dates, etc. is available.
- Safe data storage.
- Easy EDMS storage preparation.

It has also been created a webpage for the MTE Project specially devoted for the KPS section. In such way it is much simpler to locate all the information and documentation and to provide to the members of the section with certain independence. This website has a safe data storing (EDMS, DFS), the same structure as both EDMS and DFS server and it is





easy to navigate and handily.

Despite of the existence of a general MTE project planning it has been made a detailed planning with only the tasks that are under the responsibility of the KPS section. This planning is weekly updated depending on how the tasks were evolving.

Summarizing, several services have been created that considerably reduce the time and economical cost of the section and project management and follow-up.

The deadline for the MTE project completion is June 2008. In order to fulfill this goal on time, it has been necessary to improve all the data management systems. Towards this objective, a team is working on the creation of automate processes to upload and storage document, moreover, in KPS Section (and others sections of BT group) experts have started to use systems as the already used for the presentation storage to store other kind of documents such as publications or reports.



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