SUMMARY OF SESSION 4
HOW DO WE MONITOR BEAM QUALITY?

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Up to the end of the 80's beam quality was mainly believed to be connected only to the intensity i.e. beam quantity. However, with the new colliders already functioning or programmed, new and more (also in safety) demanding production machines (e.g. isotope) and the many new 3rd generation synchrotron radiation sources that accommodate many experimental lines, the beam quality (BQ) issue has to be re-examined, re-evaluated and re-defined.

Accelerator Operations and the Management have also realized that accelerators are built to serve the experiments by providing beam and as in any 'commercial' business *quality* is an important factor. Different experiments however have different beam needs and tolerances thus BQ demands and definitions differ.

It would be desirable to define beam quality from the accelerator point of view; firstly for the experimenters needs and secondly for the simple reason that at experimental positions (detectors, beam lines) many things can go wrong, which may lead to a mis-interpretation of the beam.

In general BQ can be seen as the contribution from *three main factors:*

- *Beam availability* (uptime)
- *Beam monitoring* (to verify or improve quality)
- *Communication* (meetings, messages, displays, info to the users)

Some of the aspects of good beam quality are that it eases the problems with the experimentalists, attracts more users and thus makes more money available. In some cases like Jefferson Lab. or ELETTRA, beam quality is strictly connected to the lab performance and production bonus.

1. BEAM AVAILABILITY

The beam availability or Uptime has been defined as the <u>usable beam</u> delivered according to the schedule (even if it is not actually used for a certain period by the experiments). The uptime depends heavily on the organization of operations, automatism used, money available for maintenance/ interventions, the number of pre-accelerators and it is ranging from 60-95%. To improve on uptime one needs also archiving of the machine (e.g. magnet settings) and frequent 'operations meetings' where problems of the machine are discussed and responsibilities are defined. It is recommended that a cost-effective evaluation be performed for the desired uptime level just like for the safety issues. To increase the uptime performance one can think of:

- Redundancy of equipment
- Non interraptable mains
- Universal Power Supply spares
- Preventive maintenance
- Operations team that can troubleshoot and repair

2. BEAM MONITORING

In general parameters and methods depend on the specific machine. The users, however, are usually interested to know the following:

- Energy
- Intensity
- Intensity decay (lifetime)
- Luminosity-brightness-brilliance
- Stability

In order to get the necessary information the following beam parameters are involved (or displayed):

- Global/local orbit
- Beam dimensions – spot size
  - *Transverse:* pinhole imaging of Synchrotron radiation, wire scanners, residual gas monitors, quadrupolar pick ups, OTR screens
  - *Longitudinal:* streak cameras, topography methods that also reveal the longitudinal bunch shape in phase space.
- Emittance-coupling-tunes
- Momentum and momentum spread (OTR, synchrotron radiation spectra)
- Polarization
- Spectral quality on dedicated synchrotron radiation line
- Radiation losses
- Collimators position
- Bunch purity
- Transfer functions
- Intensity stability (top-up, lasers on the gun)
- Beam bunch stability control (rf plungers/HOM shifters, rf cavity temp. tuning, super conducting cavities, feedback)
- Magnet cycle-beam destination

It is also recommended to have some supporting software available like an Alarm handler, Process log and beam parameter archiving.

3. COMMUNICATION AND PROCEDURES

All agreed on the following strategy towards experimentalists:

- Display messages from the Control Room
- Display relevant machine parameters
- Allow archive searching since also experiments need machine/beam data

From the tactics point of view one should:

- Anticipate the problem – inform of a bad quality beam

- Communicate with transparency
- Carefully hear any complains and be honest
- Only a careful selection of messages and alarms should be available (not alarming unnecessary the users, might not be interested, not blaming equipment groups)
- Intra-division meetings (at the most once per run)

From the organization point of view the following *roles* were mentioned for contacts with the experimentalists:

- *Operations* liaison (operations person that is directly communicating with a certain experiment)
- *User support* or run or experiment or floor *coordinator* (a user representative that brings the user's demands to the control room, preferably the only user allowed to phone to the control room)
- *X-ray beam line position expert* (for light sources). A machine division person who verifies the good functioning of these monitors in case of complains.

As available *tools for communicating* with users were mentioned: the TV screens, telephones, loudspeakers and Internet. Especially about Internet there is a great interest that all communications and displays go also via this way.

4. IN CONCLUSION

Beam Quality applies to all accelerator facilities - small and large.

A single parameter may be sufficient to characterize the BQ for a certain experiment. However, there are usually many experiments and that single parameter may depend on many others (e.g. luminosity). Thus in practice many parameters are defined.

It is possible to connect these parameters in a weighted way to a single fictitious quality indicator that continuously ranges the beam quality from 0-100% (blue line on the right) as it is done at ELETTRA (Fig. 1).

Fig. 1: Beam Quality Controller

One must not forget that ‘clients’ may well be always right but on beam quality issues only 10% of the complaints are due to a bad beam. However this needs to be proved by *beam quality monitoring* and the following presentations will give us a more detailed account on how this is done.

Finally it is the wrong tactic to ask the opinion of users on the quality of the beam they are using. One should first define it according to their needs and then monitor it independently.