

ATC/ABOC Days 2007

Session 3: The LHC Injector Chain

Session Presentations

Introduction (schedule and planning)	P.Collier
Keeping Linac2 Going Until Linac4	R. Scrivens
<i>& Instrumentation</i> Controls \wedge Issues Through the Backbone	R. Steerenberg
Rapid SC Changes; Can it ever work	J. Wenninger
Beam Loss and Radiation Issues with High Intensity Beams	S. Gilardoni
Operational Issues in the Low-level Beam Controls of the PS	S. Hancock
The SPS Beam Dump	J. Uythoven

Shutdown 2007-2008

We will need a minimum period for certain activities - e.g.

- Linac2 maintenance (8 weeks for RF Amplifiers)
- MTE Installation

The length of the shutdown also determined by activities in the LHC

- Now likely to need longer to hardware commission more sectors.
- Also many other activities in the LHC will have to be fit in this shutdown.

The Start of the Shutdown will be determined by the engineering run

- It might run up until the beginning of next year
- If it is late – could some work be done in the injectors before?

The next 18 months are going to be messy for scheduling and planning

In the injector chain we need to be flexible for the scheduling of the runs

And be ready to start our shutdown works when required

We should begin to plan each critical activity as a block and see how they can fit together into an overall schedule

Linacs

... Hope is that Linac4 will be ready for injection into PSB around 2011.

... Linac2 Actually has fairly low Fault Rates ...(~2% downtime)

↪ Consolidation plan for the linac itself – PO, BI , Slits etc.

↪ Source breakdowns a little worrying and not completely understood

↪ 100kCHF/year to be spent on Linac (2 & 3) RF

↪ More needed on infrastructure (presently 5kCHF/year) -> 20kCHF/year

... Main Worry for Linac2 is the Vacuum tightness of the RF tanks

↪ Secondary vacuum systems used to control the vacuum level – works ok.

↪ If Linac4 does not go ahead, new RF tanks would have to be built

... Linac3 Not treated during the session – but has a longer lifetime than Linac2 ...

... Demineralized Water Situation for LEIR/Linacs seems critical – Not enough to go round!

↪ A solution for this should be proposed – with linac4 in mind?

Controls Issues (1)

A large number of specific points were raised during the 2 talks touching on controls.

- **More than 24 users should be investigated by AB/CO for the timing**
 - ↪ Limitations appearing for SPS and PS/PSB already ... Front End Memory
- **The 'Passerelle' is a vital tool presently for operations and Studies**
 - ↪ Alternative to maintaining it ... lots of new applications to develop
 - ↪ Must be maintained until the pre-injector re-engineering is achieved (similar tool will be needed even then)
- **A new Orbit Acquisition application for the PS Will be needed during 2008**
 - ↪ Every effort should be made to use the SPS (LHC) one.
- **OASIS is a vital part of the Operations arsenal of Diagnostics**
 - ↪ On Average, >200 Signal connection requests per day during operation
 - ↪ Performance evolved dramatically through the year - very welcome

Controls Issues (2)

- **TT2 Samplers; are the only means of diagnosing timing/cycling problems in this line**
 - **Noise on these makes them almost useless ... long running problem**
- **Working Point Control:**
 - **Problems in SPS and PS during 2006**
 - **SPS Q' problems due to a bug in LSA : Fixed**
 - **PS Software has been re-written several times to cope with changing environment ... never manage to get it fully into service! Also evolving with new PFW arrangement**
- **Organization of Renovation, Upgrades/Changes (CPS)**
 - **Startup 2006 several new pieces of equipment did not work properly as they were not correctly defined and implemented in the control system**
 - **Needs a close collaboration between CO, OP and Eq. Groups. Especially wrt. Naming, Timing Definition and Interfacing.**

Instrumentation Issues

Several Instrumentation Problems were Highlighted in the Session

- **Tune and Chromaticity:**
 - PSB Broken, PS 100kHz Noise problem - not reliable.
- **Wire Scanners:**
 - PS, PSB: Timing problems, and un-reproducible calibration
- **Orbit and Trajectory**
 - PS: CODD not working during part of the year. TT2 Trajectory not available to PS Applications
 - SPS Offsets on most beams in 2006 due to changes to optimize for 75ns beam

Request for Priorities : But these are all fundamental measurements!

Hard to prioritize between Tune, Orbit and Emittance!

But PFW matrices MUST be measured in 2007 before HW changes ...

Other Diagnostics/Controls

Magnet Interlocks :

- For the PS the responsibilities are not clear (SPS seems ok ...)
- SPS CIS (MPS Interlock System) also controls Pulse Start/Stop
 - ↪ Computer system getting old – Renovation foreseen here?

B-Trains - In spite of many discussions the full responsibility is not allocated to the agreement of everyone.

FESA

SPS Will be almost fully Fesa'd for startup 2007

PSB/PS Instrumentation is progressively being shifted over

For the first time we are working towards a common solution for all accelerators!!

RSC (not the Royal Shakespeare Company)

Rapid Supercycle changes are already possible:

- ↪ Have been used in 2006 to optimize the physics output from the SPS.
- ↪ Timescale ~1 minute for changing
- ↪ Some indications the overall average transmission suffers ...

Request made for a Supercycle Change Warning Mechanism ...

- ↪ Issued by OP team 10-15 mins before a change
- ↪ Giving new SC composition, Propagated to all facilities
- ↪ Flexibility will be improved when more USER are available ...
- ↪ Some (known) limitations on time to change SC from scrapers and ZS

Some Magnetic (and other) Effects still to be understood in the SPS

- ↪ Impact on SC organization
- ↪ Effort to improve the PC regulation underway (already very good!)

Beam Losses in the Injector Chain (PS)

An Impressive number of studies have been done and a programme of tests established in 2007 to quantify the outcome.

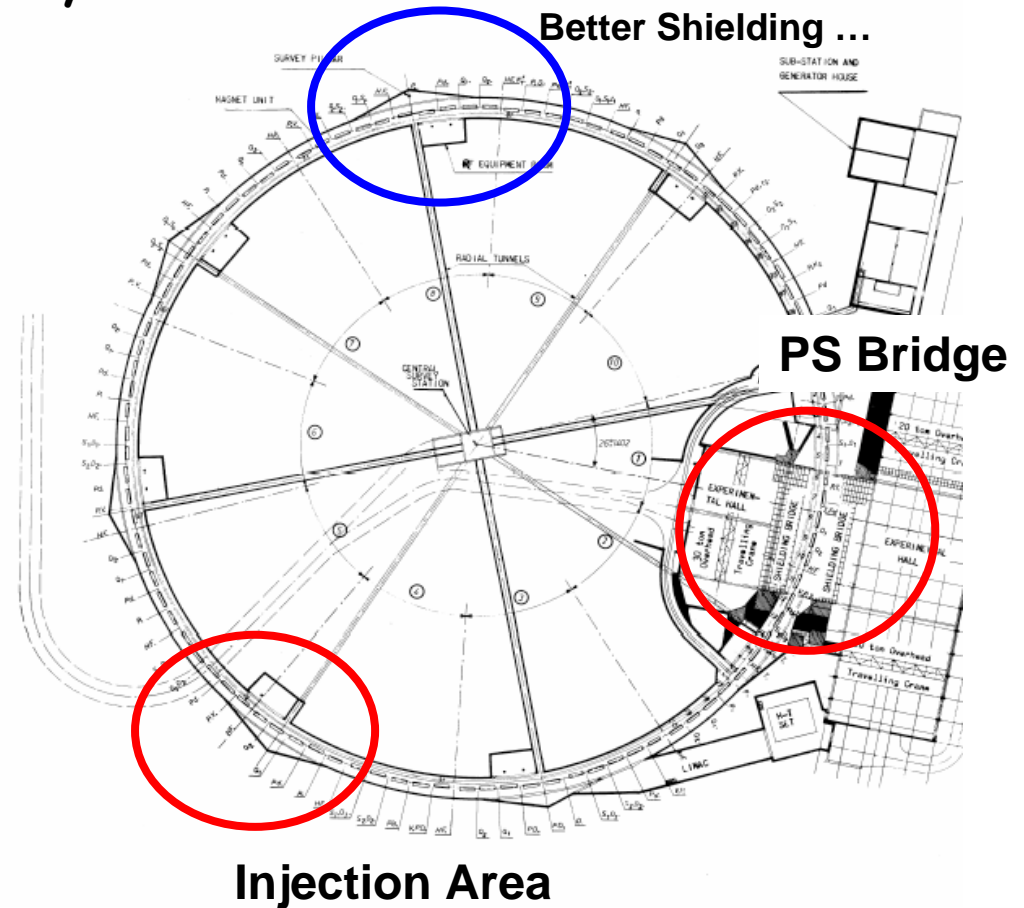
Losses at Extraction

Due to beam scattered during the process and de-focussed by the QKE05

Impact around SS9 close to PS Bridge and in the injection Area.

Cannot avoid them (with CT) – but can move them by moving the QKE

Move QKE to SS73 should concentrate losses in SS73-78 where the tunnel shielding is better



The Best Solution long Term : MTE with losses <1%

PS Beam Losses (cont.)

Losses at Transition

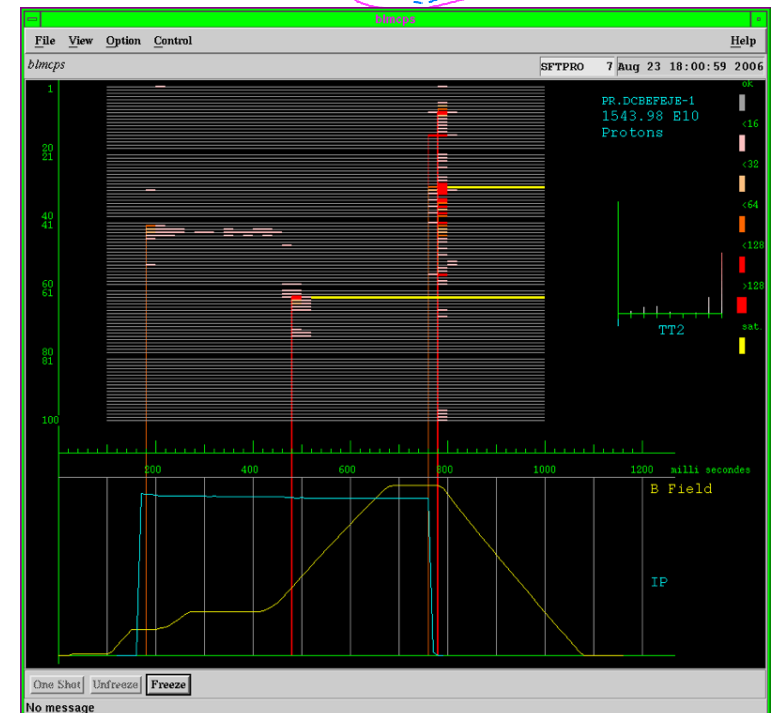
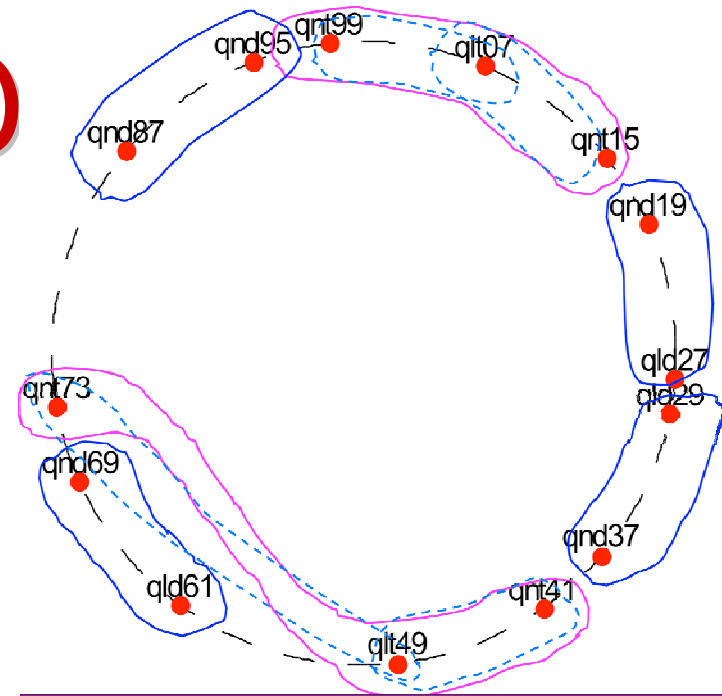
Gamma Jump Quadrupole arrangement (doublets and triplets) produces large beam envelope around SS63 combined with orbit distortion

Reduce by moving large envelope to place with bigger aperture and/or orbit bump in SS63

Losses at Injection

Need to disentangle Injection and Extraction Losses – presently half losses near injection region come from CT extraction.

Verification of Injection element alignment and develop aperture model of injection channel



Operational Issues in the LL-RF System of the PS

Can we make the RF controls in the PS simpler?

The longitudinal heart of the complex:

Mission Critical for LHC ...

- ↪ Where the bunch and beam structure for the LHC beams is generated (to say nothing of other beams)

Huge quantity of electronics and interleaved beam controls.

Good example of the discussion around Standby vs. Expert Services (session2)

- ↪ Is it possible to train a Piquet service to cope with such a complex and evolving system?
- ↪ Alternatively, can we rely on the good will/best effort of experts to diagnose and repair breakdowns in such a critical system?

Future All Digital beam control mentioned as a possible major simplification

- ↪ Is this true? What is the timescale for implementation?
- ↪ If nothing else, such a system may possibly be more remotely controllable and more piquet friendly.

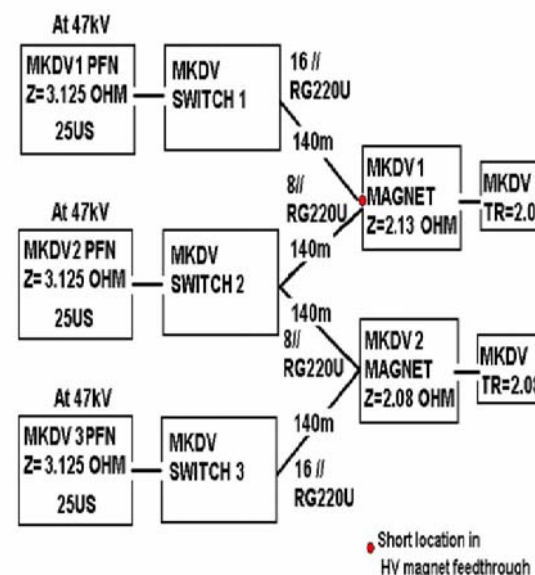
SPS Beam Dump

1. Out-gassing from the TIDVG block can cause vacuum problems in the nearby MKP Injection kickers

- Various options studied...
- The only sure way is to condition the block with beam ...
- But needs beam time!
- Alternative locations for the system – or external beam dump system are presently excluded.

2. Problems also with MKDV1 Sparks

- Reduced Voltage during part of the year
- Kicker shows signs of damage – repaired this shutdown
- Present arrangement of PFN should be modified to Separate the two kickers.



Conclusions

The LHC injector chain is in reasonable working order

- ↪ But we cannot neglect it
- ↪ Controls and Instrumentation remain delicate issues
 - ↪ If necessary we must set high priorities in the injectors - since LHC cannot work without reliable, quality beam
- ↪ Beam losses are an issue for all beams in the injector chain
 - ↪ We must clean up our act for CNGS - MTE
- ↪ The next shutdown will be tight in time and complicated by parallel activities in the injector chain and the LHC ...

The next 18 months will be acrobatic for everyone, especially planners and schedulers...