



Session 1 : Review of 2010 Operations

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Presentation	Speaker
LHC operation – as viewed from the Experiments	Massimiliano Ferro-Luzzi
Operational challenges – feed forward from Evian LHC operation workshop	Mike Lamont
Injection - issues and potential solutions	Verena Kain
Vacuum and Cryogenics observations for different bunch spacing	Jose Miguel Jimenez
Beam observations with different bunch spacing and overall synthesis	Gianluigi Arduini
How can we reduce the “no beam” time?	Walter Venturini Delsolaro
Optimisation of the nominal cycle	Stefano Redaelli

Aims:

- Review the LHC 2010 operation
- Identify weak points
- Propose possible improvements



LHC Operation – as viewed by the Experiments

Massimiliano Ferro-Luzzi

- **2010 has been terrific !**

Demonstrated the excellence of the LHC and of the people who built/commissioned/operated it.

- **2010 in numbers:**

- 1074 h of stable beams - out of ~6600h
- 147 fills with stable beams
- 2010 peak luminosity ~ $2e32$ Hz/cm²
- Integrated luminosity: ~ 45 pb⁻¹

- **2011 wish list: FASTER with ...**

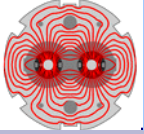
- LHC Filling
- Intensity step increase
- Roll back to 2010 stable beams

- **2011 could be the year of discovery**

Call is Physics only with $>2e32$ Hz/cm² peak luminosity and several tens of pb⁻¹ have been collected !

→ Go up quickly to $2e32$, then gradually increase to $\sim e33$

The challenge (2011 – 2012): >5 fb⁻¹



Operation challenges -

Mike Lamont

Feed forward from Evian LHC operation workshop – 7-9 Dec.10 –
1 day after the last beam – 7 sessions

- Come a phenomenally long way in 9 months
- Notable feature - remarkable maturity of some key systems after just a year
- Possible improvements, consolidation detailed for all systems
 - **Follow-up list done** – progress to be reported in the new LHC Beam Operation working group – Joerg Wenninger
- Some known problems incoming:
 - **UFOs, electron cloud, R2E...**
- Yes, the stored energy will be pushed up ...
 - **Continued importance of machine protection – no short-cuts**



Injection – Issues and potential solutions

Verena Kain

❑ Mechanics of injection

- Actions in progress to reduce the time spent at injection (injection procedure and strategy, more diagnostics, improved tools)

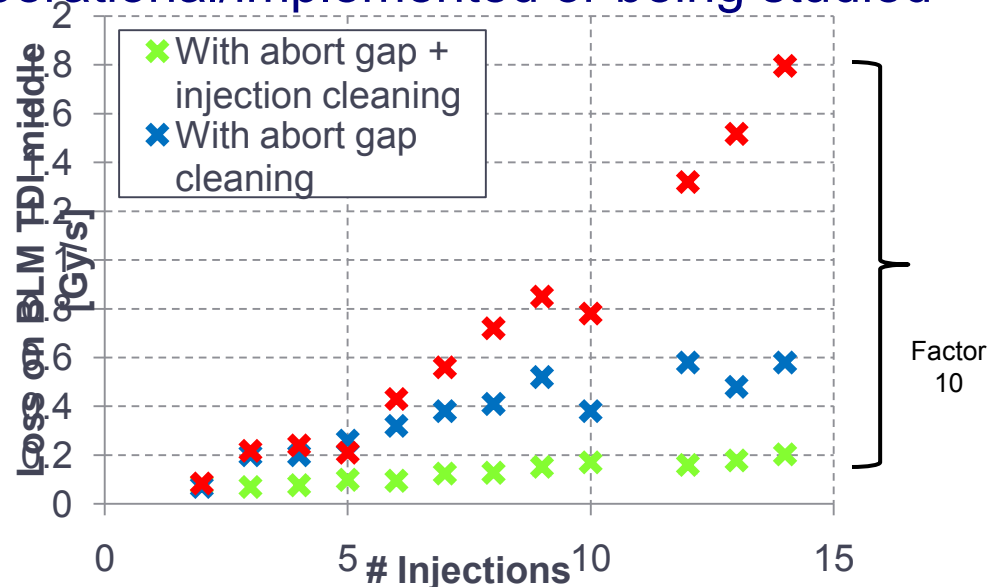
❑ Injection losses

- Planned intensities in 2011: **OK** – emittances $\sim 2\mu\text{m}$

Loss type	Losses in % of dump threshold B1/B2		
	48b	96b	144b
TCDI shower	23/24	<50?	<75?
Uncaptured beam	20/8	<40?	<60?

- Mitigation is partly already operational/implemented or being studied for higher intensity

- **Abort gap cleaning :**
excellent results
- **Injection cleaning:**
very promising results –
MD time required in 2011





Vacuum and cryogenics observation for different bunch spacing

Jose Miguel Jimenez

- ❑ E-cloud confirmed (50 ns > 75 ns > 150 ns)
- ❑ Pressure rise are expected to be 2 X higher at 50ns vs 75ns
 - Most sensitive in recombination zones
- ❑ Very encouraging results for 2011: vacuum cleaning and beam scrubbing does work at Cold and RT in the LHC
- ❑ Expectations from the Scrubbing week:
 - At least 3 orders of magnitude of vacuum cleaning are expected in RT after a week
 - 1 week of scrubbing should be enough to allow physics with 75 ns beams
 - ☞ IF WE CAN KEEP THE BEAM STABLE WITH 1 mA/m OF ELECTRON CLOUD BUILD-UP IN THE BEAM PIPES --- TBC
- ❑ Solenoids:
 - LSS1 and LSS5 entirely equipped during this winter Stop
 - Recombination zones equipped in IR2 and IR8



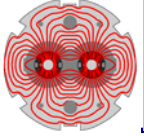
Beam observations with different bunch spacing and synthesis

Gianluigi Arduini

- ❑ Expect to be able to reach 200-300 b with 75 ns without scrubbing
- ❑ See effects on beam (incoherent and coherent)
- ❑ Scrubbing with large emittance ($>3.5 \mu\text{rad}$), high intensity ($>1.2e11$), 4x36b of 50 ns beam

Also time needed to reach this at injection ($>> 2010$) – some days at least

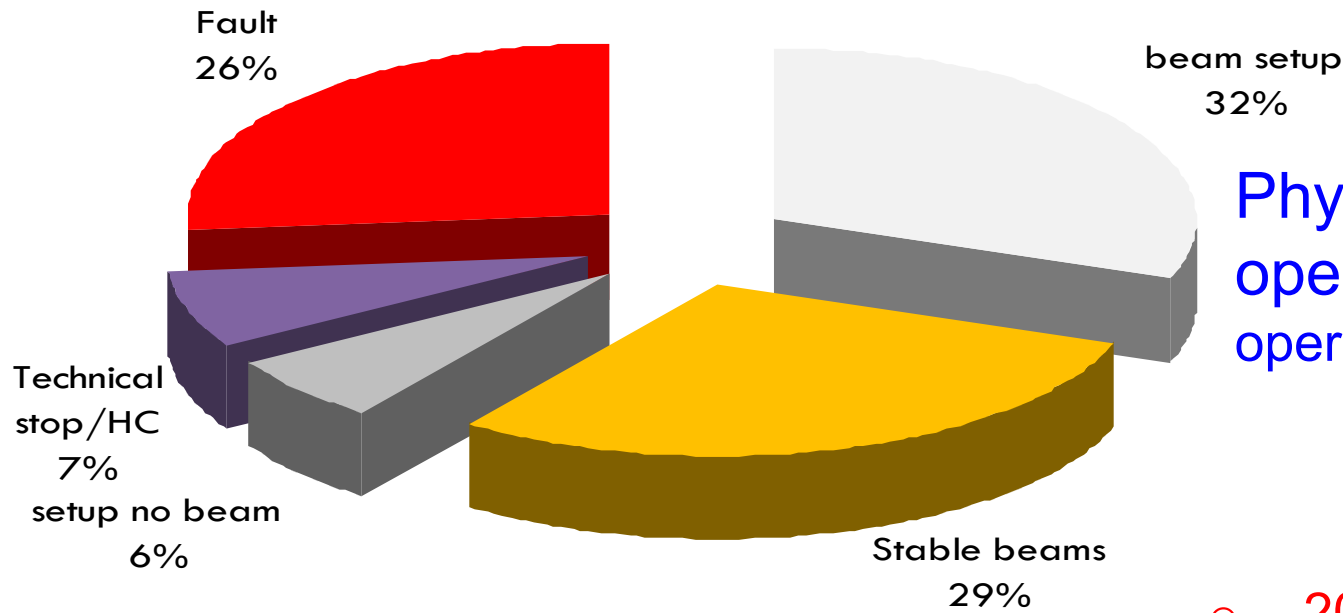
- ❑ 7 days of scrubbing + 1 day for validation and scrubbing result evaluation
- ❑ Simulation effort (build-up, instability thresholds, tune spread) for the LHC has been re-started to improve understanding (but takes time!)



How can we reduce the “no beam time”

Walter Venturini Delsolaro

August



Physics oriented operation:
operation efficiency:

0.2 -0.3



- 2011 L forecast
- Dedicated periods of identical mode of operation

- Reduce fault numbers: mitigation QPS, Cryo, PC
- Review TS frequency/duration
- Faster turnaround
- No pre cycle after short access



2011: minimum of 2h of optimum cycle is at reach!

- 1. Turnaround time was dominated by time at injection level**
→ Significant improvement for 2011 – V. Kain.
- 2. Energy ramp in 2011: like 2010, maybe 5 min shorter.**
- 3. The squeeze took about twice its minimum duration**
→ Significant improvement also for the squeeze
- 4. Manual phases are time consuming and can cause errors**
→ Limit manual actions – combined beam process for ramp, squeeze, collide to be tested in MD
- 5. We are not yet limited by the intrinsic time of functions**
→ Little gain from “aggressive” reductions of ramp and squeeze
→ More aggressive approaches are left as MD studies



Summary and outlook

Injection procedure and scenario

- Intermediate solutions for 2011:
 - Better communication and tools for better preparation of LHC beams
 - Over-injection: witness bunches OR later over-injection. Prepare both
 - Ready for exploiting dedicated physics cycles
 - Continue the beam loss minimisation campaign
 - Use cleaning (Abort Gap and injection slot)
- Preparation for 2012: need to put effort into development of new type of LHC injection requests (# of PS batches and # of PSB rings on the fly)

LHC for Luminosity operation

- Optimum 2h nominal cycle is at reach!
- 936 b with 75 ns operation after scrubbing
- Machine efficiency close to 0.3 for luminosity operation