



# Session 1 : Review of 2010 Operations

Malika Meddahi – Laurette Ponce

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

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/cm<sup>2</sup>
- Integrated luminosity: ~ 45 pb<sup>-1</sup>

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

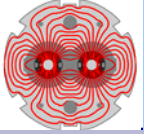
- LHC Filling
- Intensity step increase
- Roll back to 2010 stable beams

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

Call is Physics only with  $>2e32$  Hz/cm<sup>2</sup> peak luminosity and several tens of pb<sup>-1</sup> have been collected !

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

**The challenge (2011 – 2012):  $>5$  fb<sup>-1</sup>**

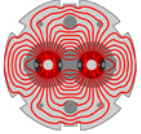


# Operation challenges -

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)

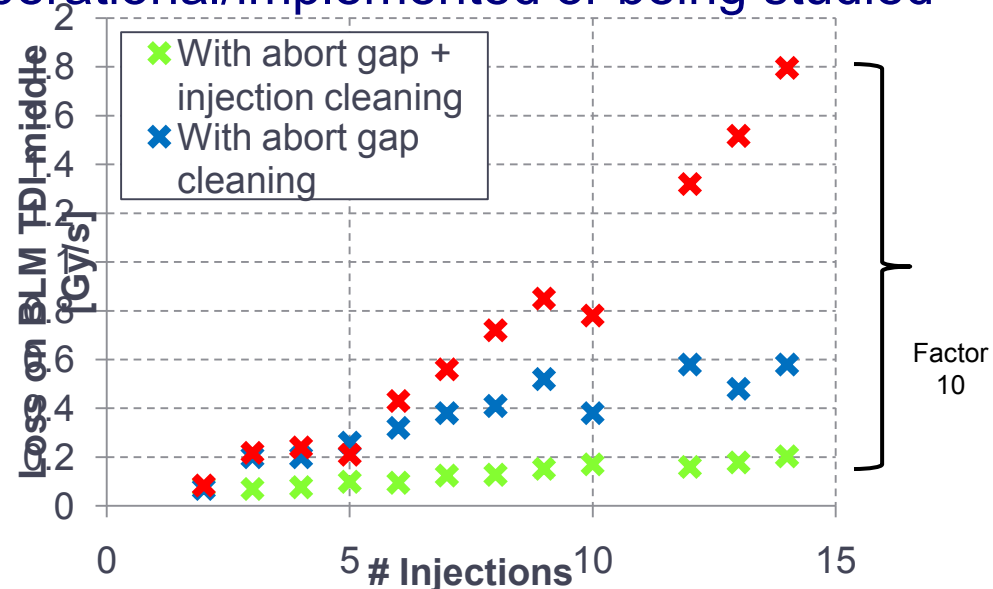
## ❑ Injection losses

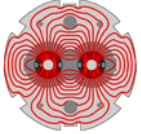
- Planned intensities in 2011: **OK** – emittances  $\sim 2\mu\text{m}$

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

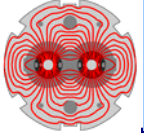
- ❑ E-cloud confirmed (50 ns > 75 ns > 150 ns)
- ❑ Pressure rise are expected to be 2 X higher at 50ns vs 75ns
  - Most sensitive in recombination zones
- ❑ Very encouraging results for 2011: vacuum cleaning and beam scrubbing does work at Cold and RT in the LHC
- ❑ Expectations from the Scrubbing week:
  - 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

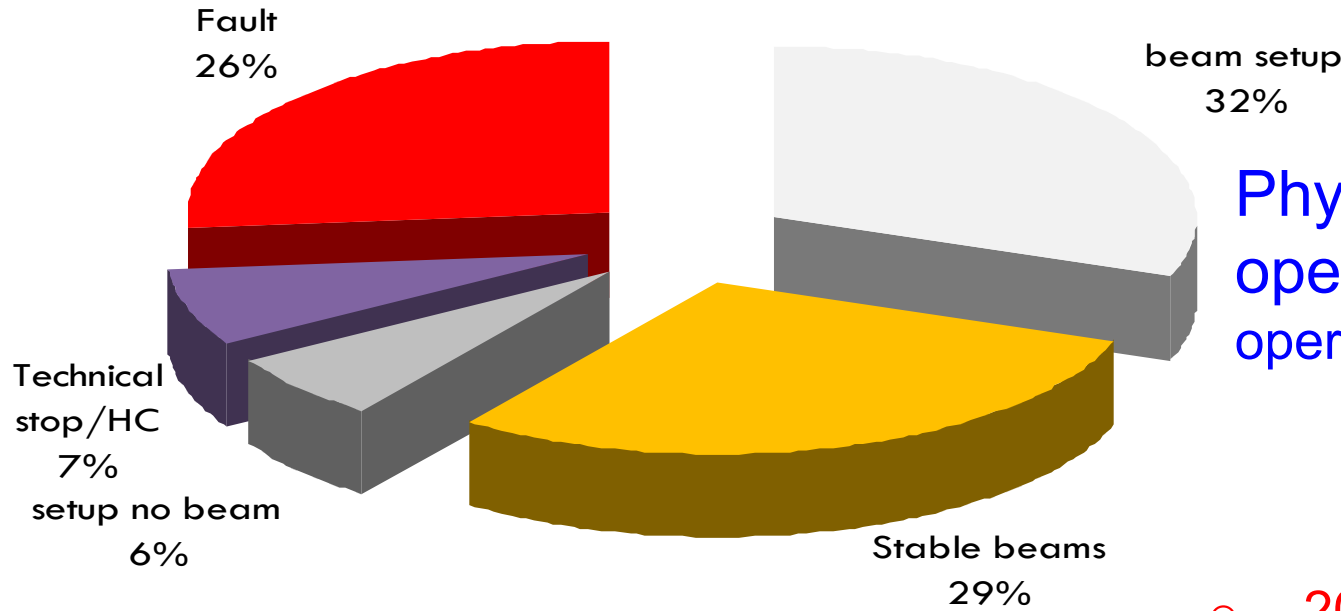
- ❑ Expect to be able to reach 200-300 b with 75 ns without scrubbing
- ❑ See effects on beam (incoherent and coherent)
- ❑ Scrubbing with large emittance ( $>3.5$  urad), high intensity ( $>1.2e11$ ), 4x36b of 50 ns beam
  - Also time needed to reach this at injection ( $>> 2010$ ) – some days at least
- ❑ 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



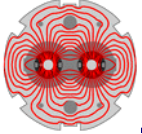
Physics oriented  
operation:  
operation efficiency:

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 PBS 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