ABT/BTP MD studies

ABT/BTP, OP, Collimation, BLM, QPS teams

Tests To be Performed

- Injection Studies:
  - LHC 25 ns injection
  - Nominal emittance and injection quality (IQ): TI2 (Lene)
- Investigation on MKI UFOs at injection (Tobias)
- Quench margin at injection
- Finish TCDQ angular scan (not done!)

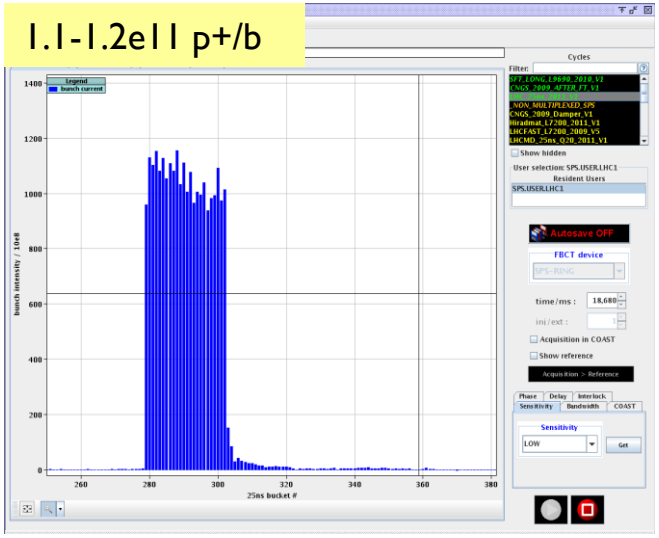
Injection Studies

Reminder

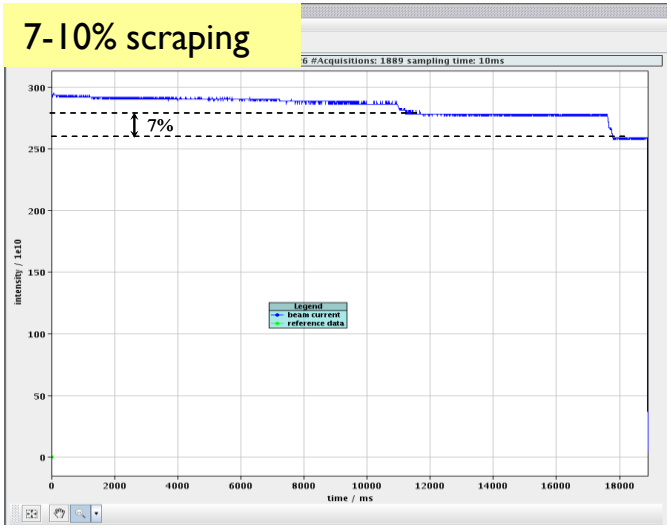
- Injection of beams with different parameters from the SPS has to be studied with a view to exploring the **parameters** likely to be needed for **future LHC operation**.
- Injections have to be attempted with **large transverse emittances**, **longer bunch length** and **different bunch spacing**, **including 25 ns batches**.
- **Limits** have to be investigated in terms of **beam losses**, **protection device settings**, **injection/abort gap cleaning**, **emittance preservation**, **intensity transmission** etc.
- An attempt has to be made to **calibrate** the **scrapers in the SPS**, address **reproducibility** and check the response on the TCDIs.
- The effect of **transverse blow-up** and **longitudinal blow-up** has to be studied.

Beam in SPS

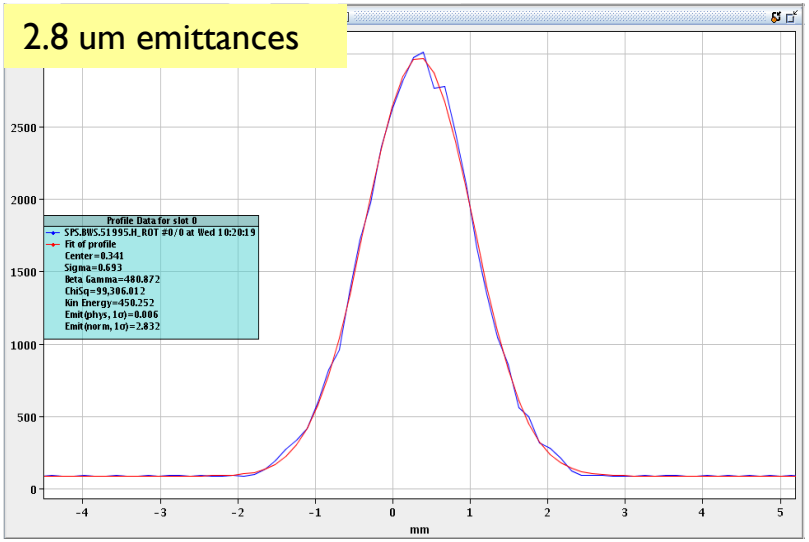
1.1-1.2e11 p+/b



7-10% scraping

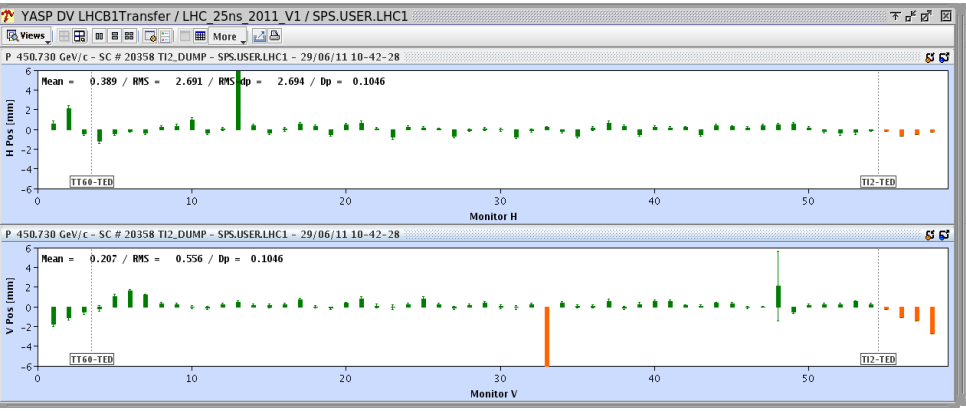


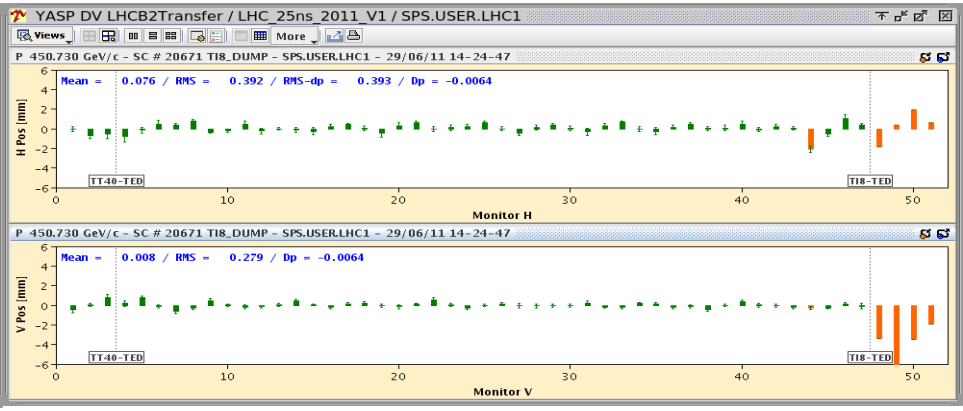
2.8 um emittances



Extraction and transfer lines

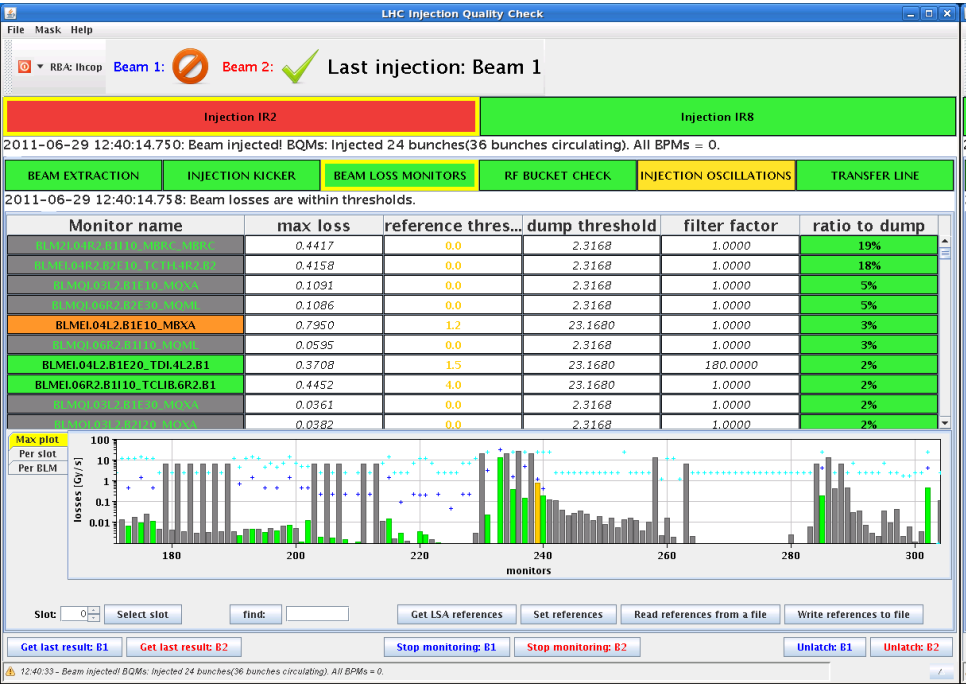
- Some issues with TI 8 settings after copy from 50 ns cycle
  - 60 urad corrections suggested
  - Cured by “driving” settings again
- After fix trajectories good wrt 50 ns (200-300 um RMS)

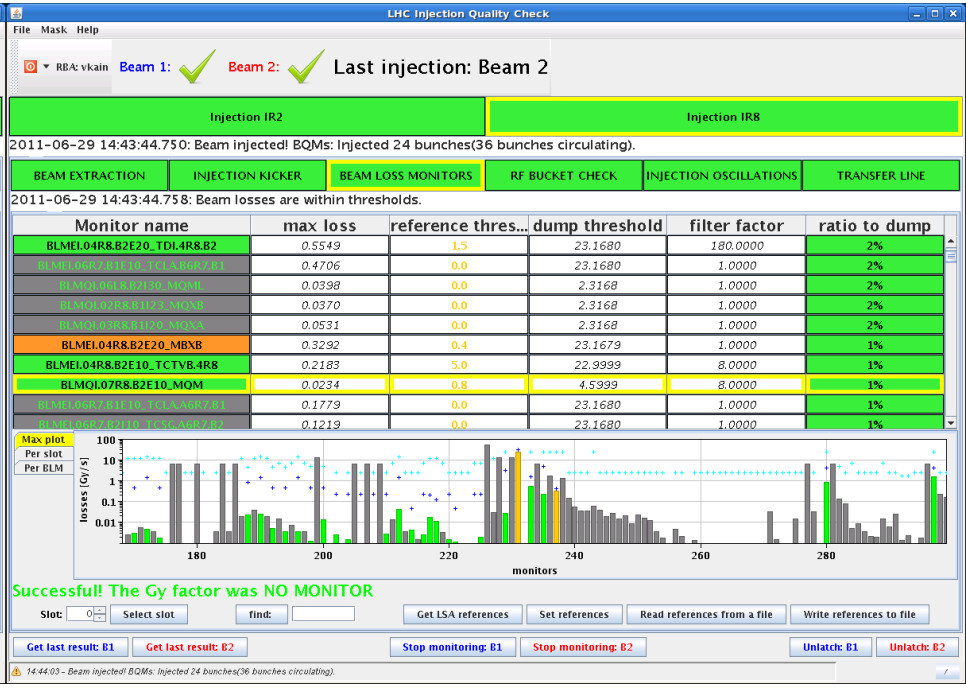




Losses in injection region

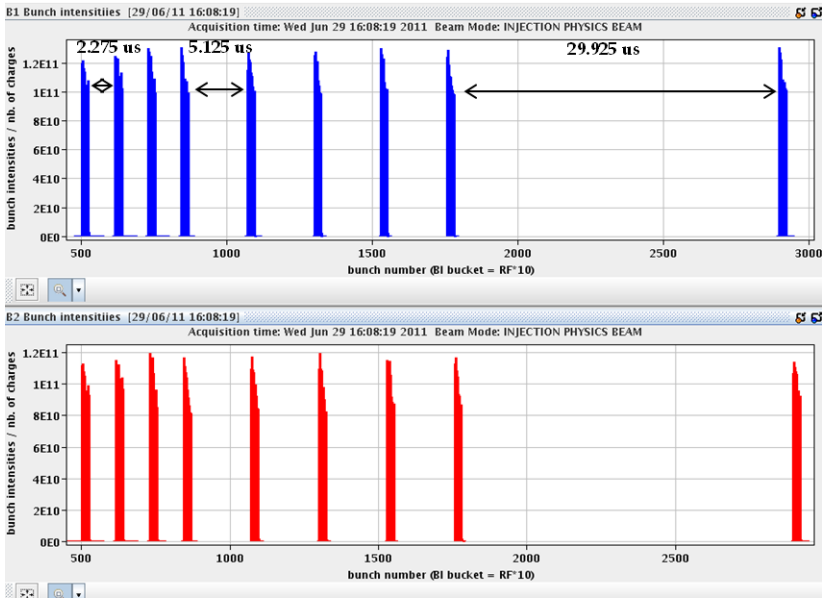
- Transversely very clean
  - same or betterspecific loss as 12b at 50 ns…
- Longitudinally (capture loss) higher than for 25 ns
  - Factor 2 higher on TDI

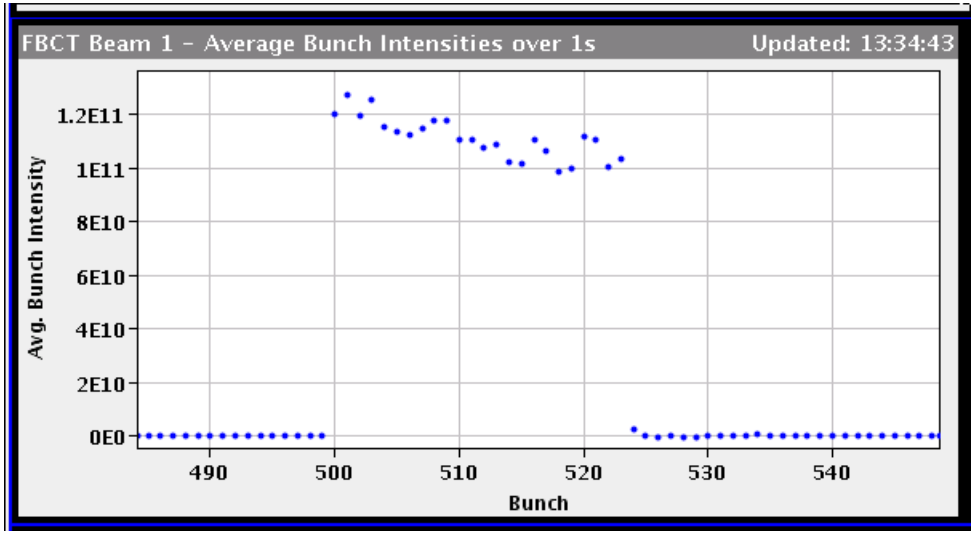




Intensity in LHC

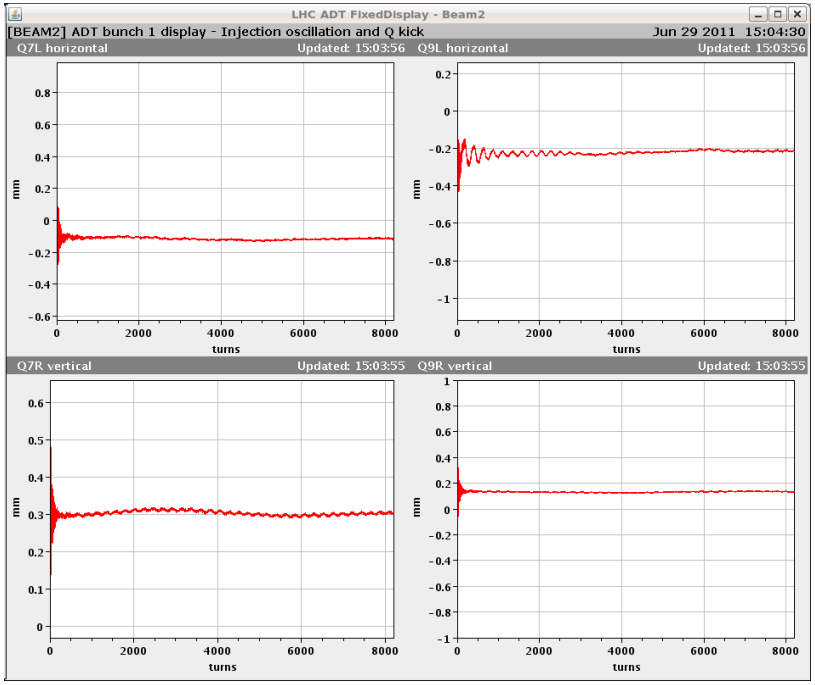
- 9 injections per beam (216b) of 25 ns
  - Spacing between batches of 2.275, 5.125 and 29.925 us
- See clear reduction in intensity along batch
  - Real or instrumental?
  - From SPS or LHC??





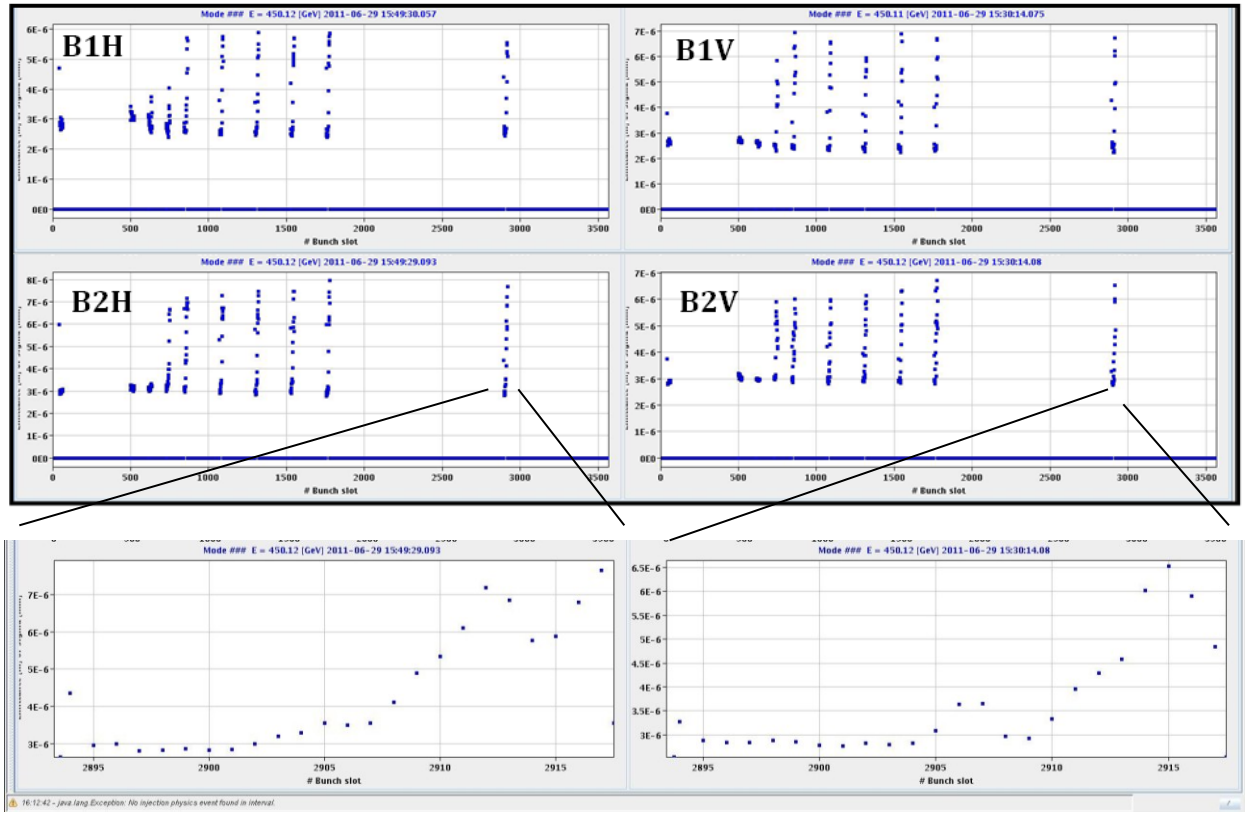
Damper

- Off for first injections
- Switched on after 1st injection for B2, after 2nd injection for B1
- Calculated 25 ns settings – no time for detailed setup
- No major problems seen

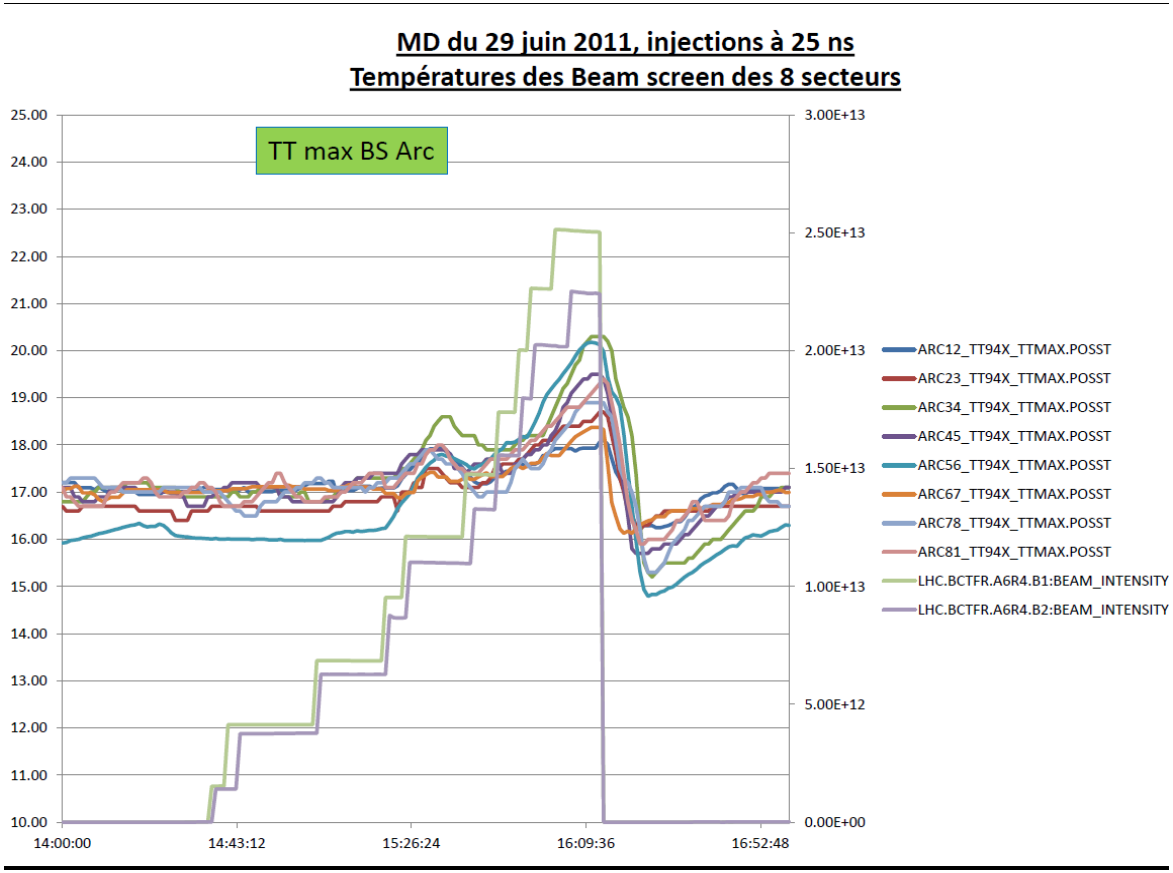


Emittances

- Initial two 25 ns batches for both beams looked good
  - 3.5-3.6 um with damper off
- Blowup along batch for subsequent batches
  - Factor 2 from BSRT. Same pattern for all batches



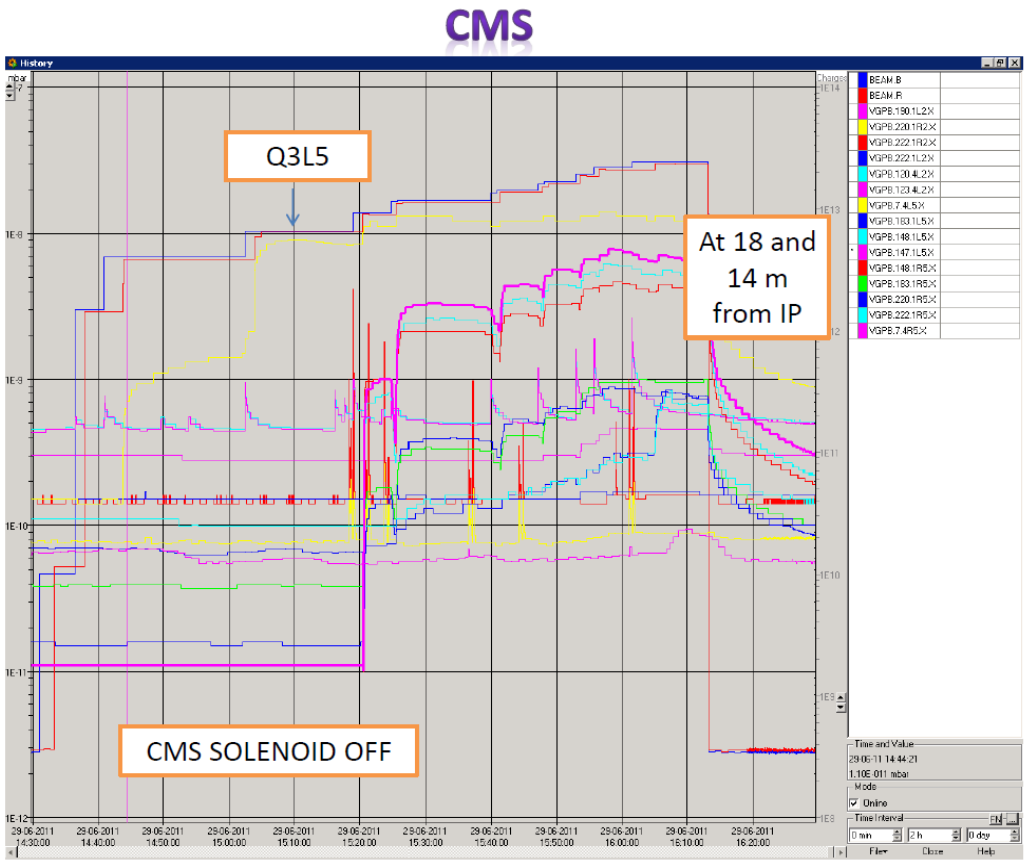
Beam screen temperatures



- "nothing dramatic has been observed. TTmax arcs only at about 20K, so nothing serious than would deserve being qualified of beam scrubbing

vacuum

- Moderate vacuum activity (note: all ecloud solenoids were OFF)



RF

- Looked reasonable
  - Tests made with switching off abort gap cleaning – to analyse
  - 25 ns batch was extracted from the SPS with 7.2 MV for the 200 MHz and 650 kV for the 800 MHz and a blow-up resulting in ~1.5 ns mean bunch length as measured at SPS extraction, with a spread of +- 200 ps (from 1.25 ns to 1.65 ns along the batch),
  - Capture was made with the nominal 6 MV RF in the LHC, and no RF adjustments were made.
  - Bunch profiles observed along the full 600 ns long batch (40 Gsample/s) and bunch-by-bunch phase, with first measurement at injection. Most data awaits detailed analysis. The bunch-by-bunch phase along the batch shows a ~ 20 degree spread with a parabolic shape that is consistent with the effect of un-compensated transient beam loading in the SPS cavities.

Summary/next steps

- No major issues seen
- Could accumulate over 200b in 24b trains
- Injection losses good – comparable or better than 50 ns
- Source of blowup along batches to understand
- Work to do on damper and RF adjustments
- Next MD – will aim to increase intensity per injection to 48, … 144b depending on ecloud issues

Quench Margin at Injection

Reminder

- Motivation: 18/04/2011 MKI D flashover
  - 36 bunches hitting the TDI with 75-90% of the nominal MKI deflection
  - Nearly all p+ of these 36 bunches impacted TDI/TCLIB ➔ 12 magnets quenched
  - **Check loss rate at Q6 in IR8 downstream the TCLIB ➔ scale for 288 bunches**

- The MD addresses the quench margin at injection with the help of special QPS monitoring on selected magnets, such as Q6.L8 downstream of the TCLIB in IR8 and Q4.L6 downstream of TCSG.4L6 in IR6.

- The MD requires controlled beam losses on the magnets and monitoring of the QPS signals. This required installing QPS monitoring also at this location.

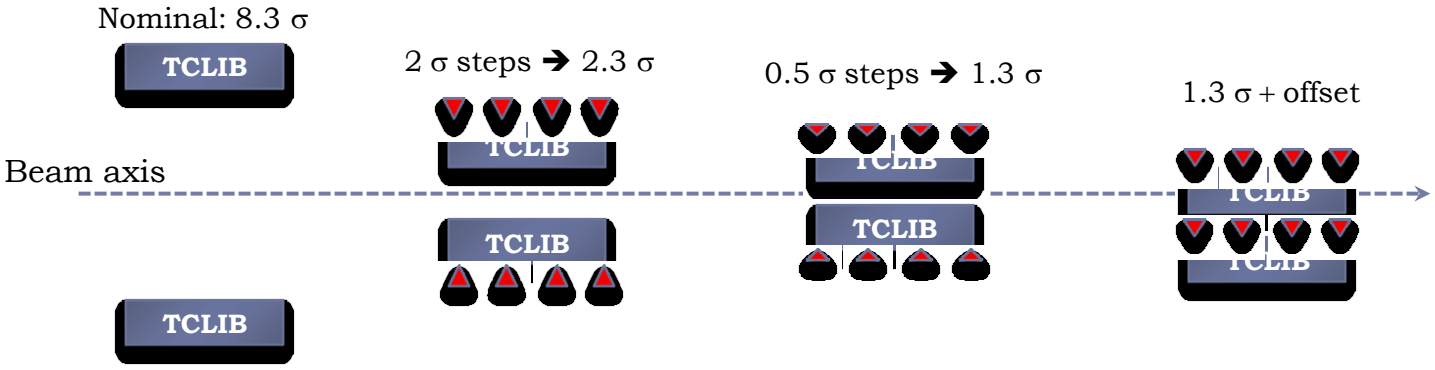
Quench Margin at Q6.L8: Method 1

- **BPM** in **point 6 masked** and all collimator **thresholds** open to **parking.**
- **TCP H and V**, for B2, in **point 7 closed** (-2mm offset, 1 mm gap) to stop the beam
- BLM not masked ➔ beam dump with **post mortem**

1) Pilot bunch 1e10p+

Emittance from SPS: **H =0.8 μm, V= 1 μm**

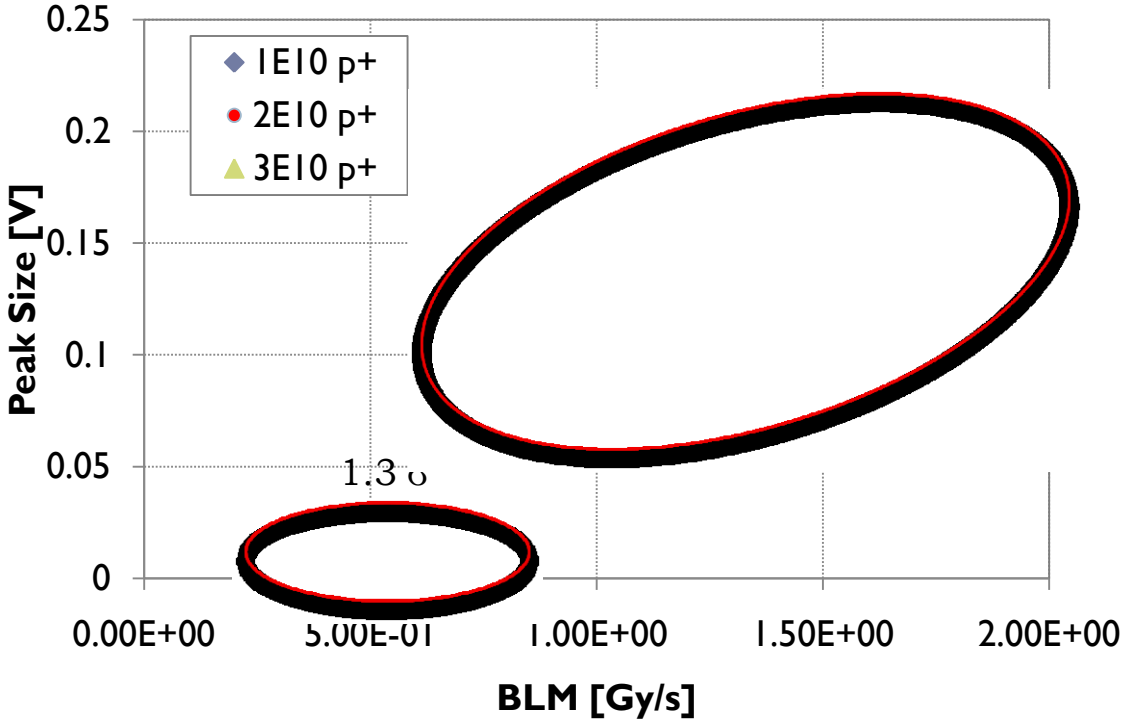
We took **2 shots** and checked **BLM (@ TCLIB, Q6** and **Q7**)and **QPS** for all the following settings:
1) TCLIB at nominal setting (**8.3 σ**)
2) Close TCLIB in **steps of 2 σ** until **half gap of 2.3 σ**
3) Close TCLIB in **steps of 0.5 σ** until **half gap of 1.3 σ**
4) We kept this gap and applied an **offset of -1 σ**
5) We kept this gap and applied an **offset of -2 σ**

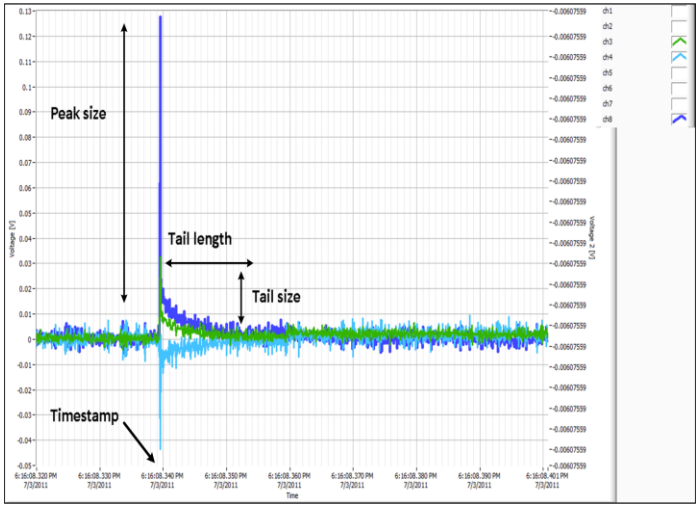


Quench Margin at Q6.L8: Method 1

2)Probe: 2E10 p+
Emittance from SPS: **H =0.8 um, V= 1 um**
Same procedure as before but we took two shots only from 2.3 σ half gap setting

3)Probe: 3E10 p+
Emittance from SPS: **H =1 um, V= 1 um**
1)Only **1.3 σ half gap** and **-2 σ offset**
2)1 shot with **1.3 σ half gap** and **-3 σ offset**





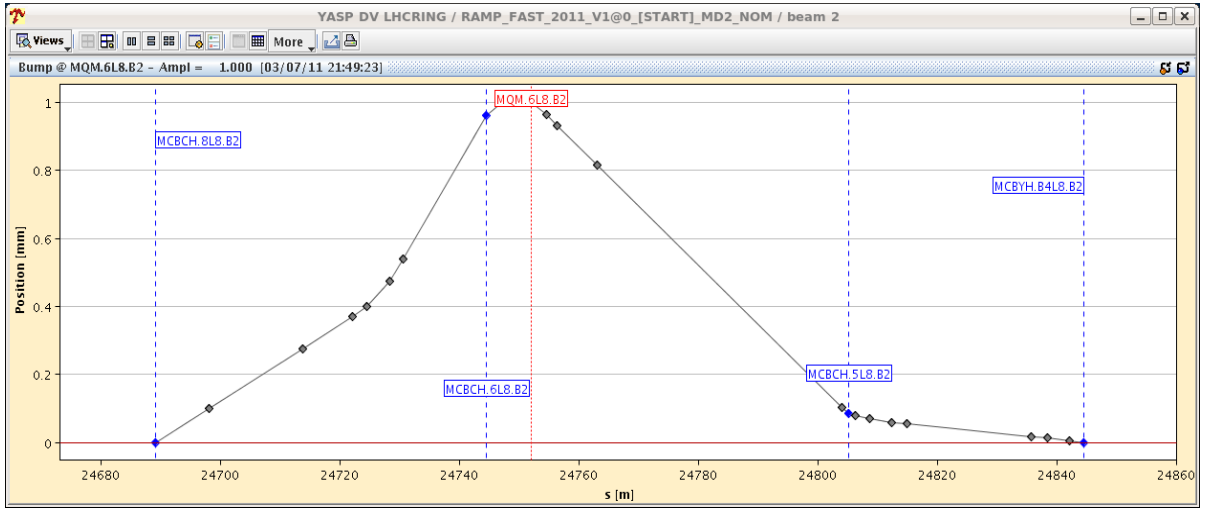
No Quenchino!

Courtesy of M. Sapinski and M. Jakub Bednarek

Quench Margin at Q6.L8: Method 2

1 pilot 2E9 p+:

- Check horizontal bump at Q6 with circulating beam -> beam lost for a bump of 20 mm



- Beam injected with this bump for 3 different heights:
  23 mm, BLM at Q6: 1000% above dump thresholds
  21 mm, BLM at Q6: 270% above dump thresholds
  25 mm, BLM at Q6: 900% above dump thresholds
  nothing seen by the QPS!!

Proposal for next MD: increase magnet current

Quench Margin at Q4.L6: Method 1

- TCP in point 3, for B2, closed to -4.5/-5.5 mm to stop the beam and get the post mortem
- Close TCSG to 1.7 σ gap plus -2 σ offset
- Same settings different intensities:

  5E9 p+

  1E10 p+

  2E10 p+
- Calibration data for direct dump BLM in point 6 (low intensity probe beams)
- Quench margin for Q4 at injection (high intensity probe beams) ➔ no significant data seen by the QPS.