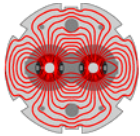
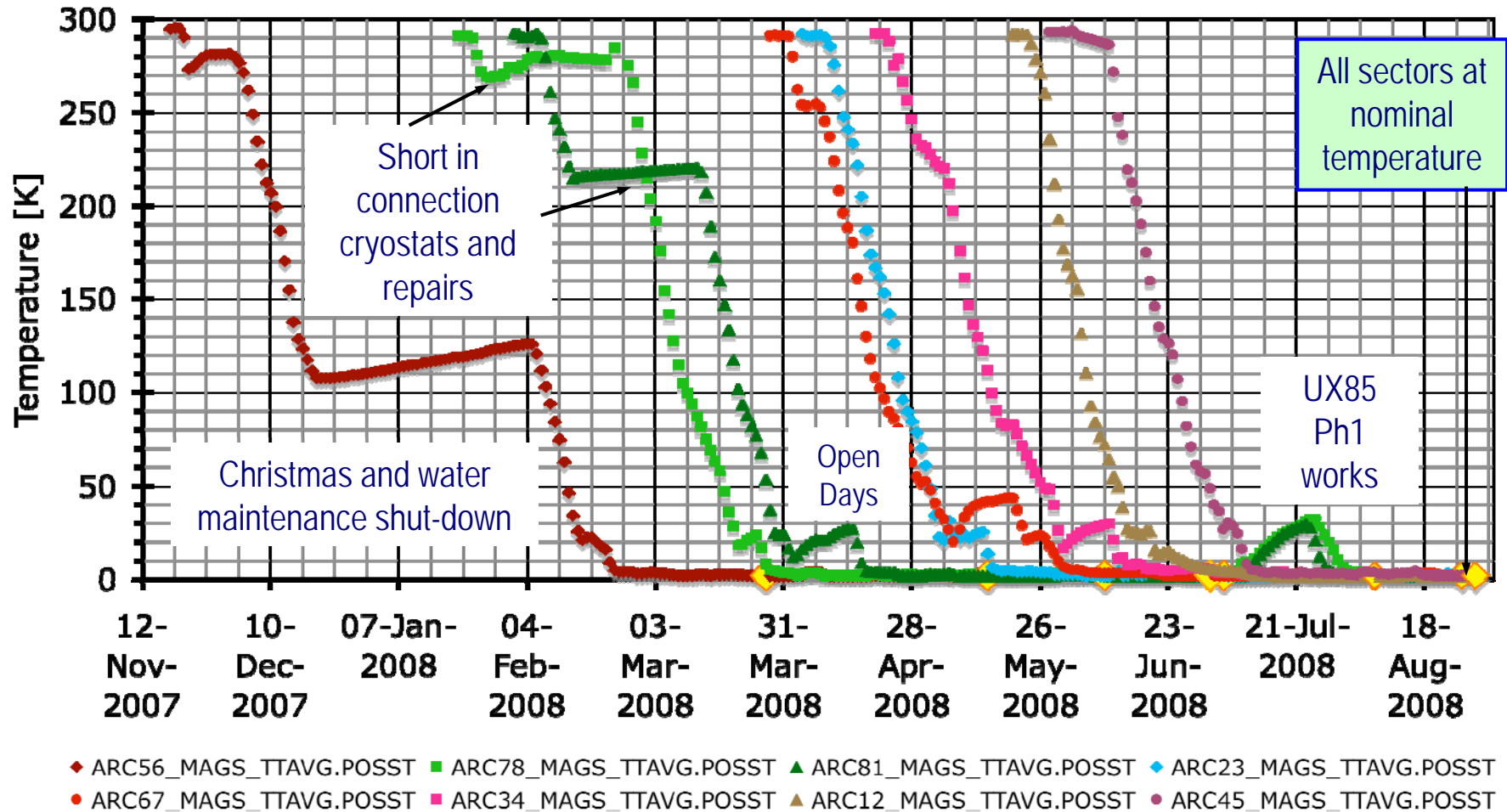


The LHC

- Is COLD
 - 22. August - all sectors simultaneously at 1.8K;
 - 30. August first cryogenics OK for complete machine
- Is almost fully commissioned
 - Powering of complete arcs & arcs together
 - 7/8 sectors up to 5.5 TeV (sector 56 to 6.5 TeV)
 - Robust performance
 - Tunnel closure – 5th September – LHC enters operation phase
- Becomes clear that it is the intersect of a number of huge systems that must all work more-or-less perfectly
- It worked
 - Injection tests
 - First commissioning with beam
- Euston, we have a problem

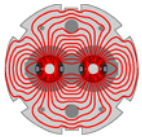


First cool-down of LHC sectors

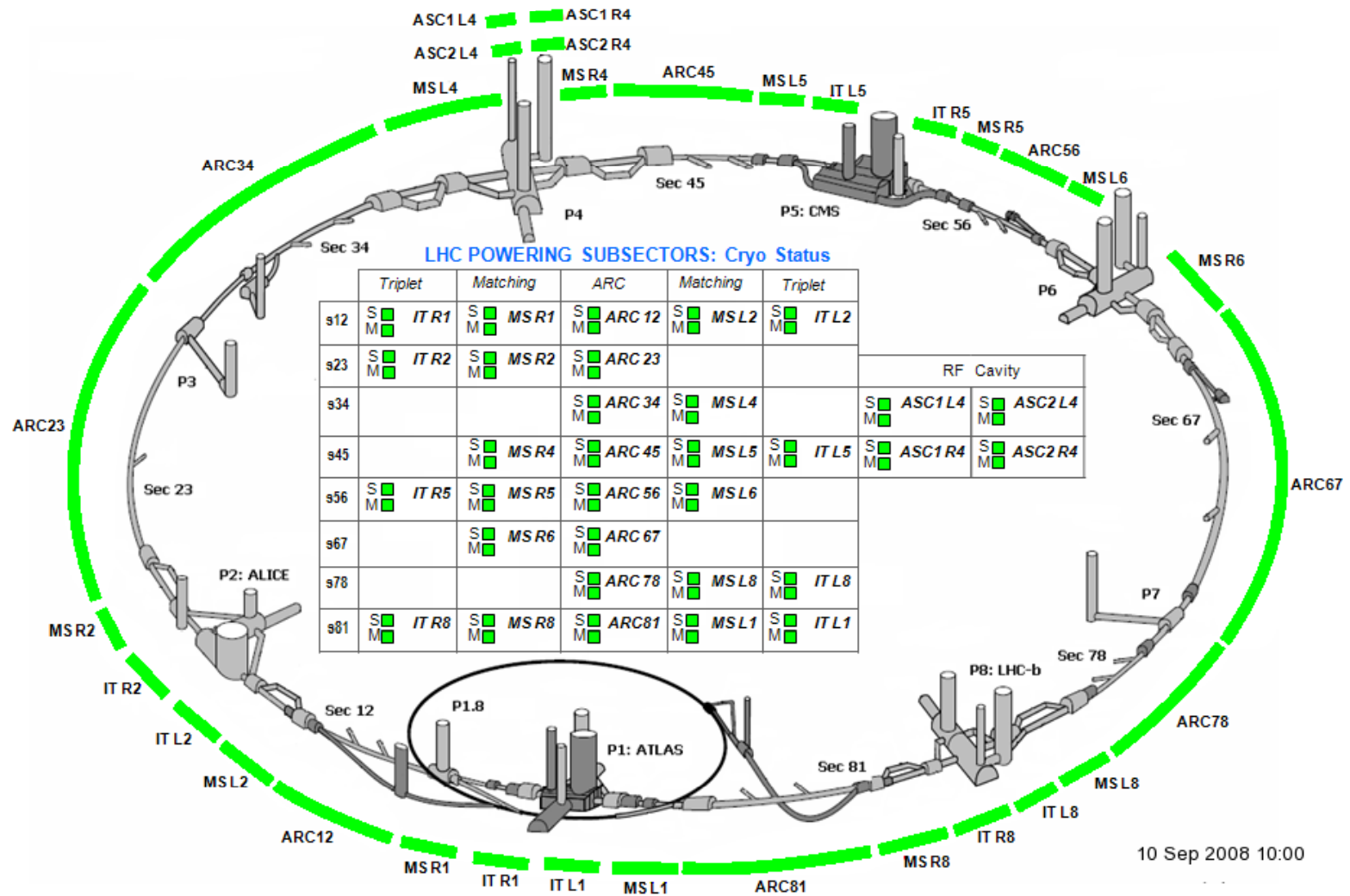


Cooling sectors + Cryo tuning + Powering activities

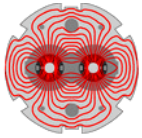
S. Claudet



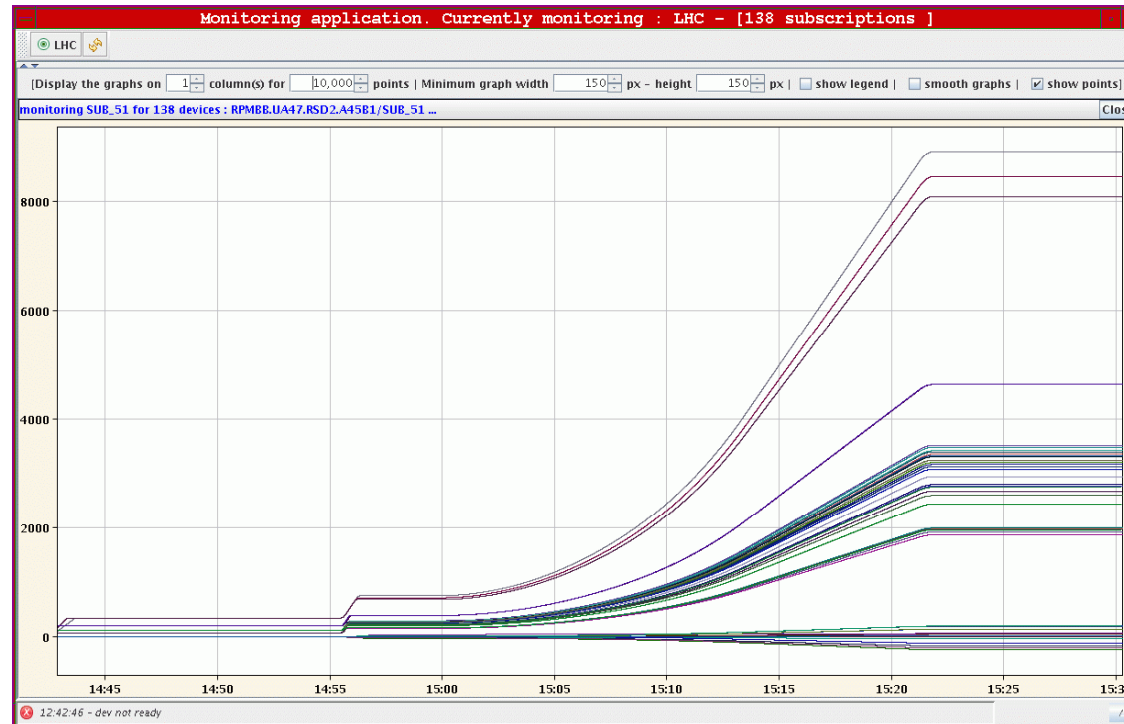
It's COLD



LHC Cryogenics on 10. September

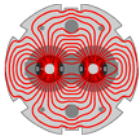


Most circuits - good for 5.5 TeV

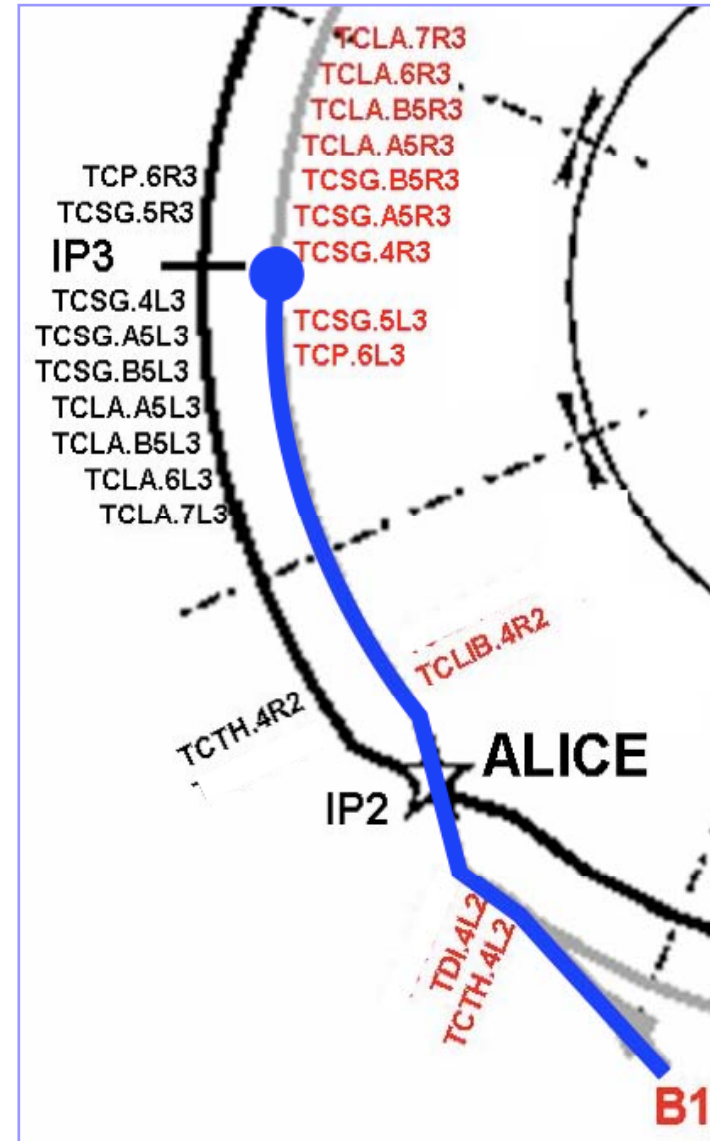
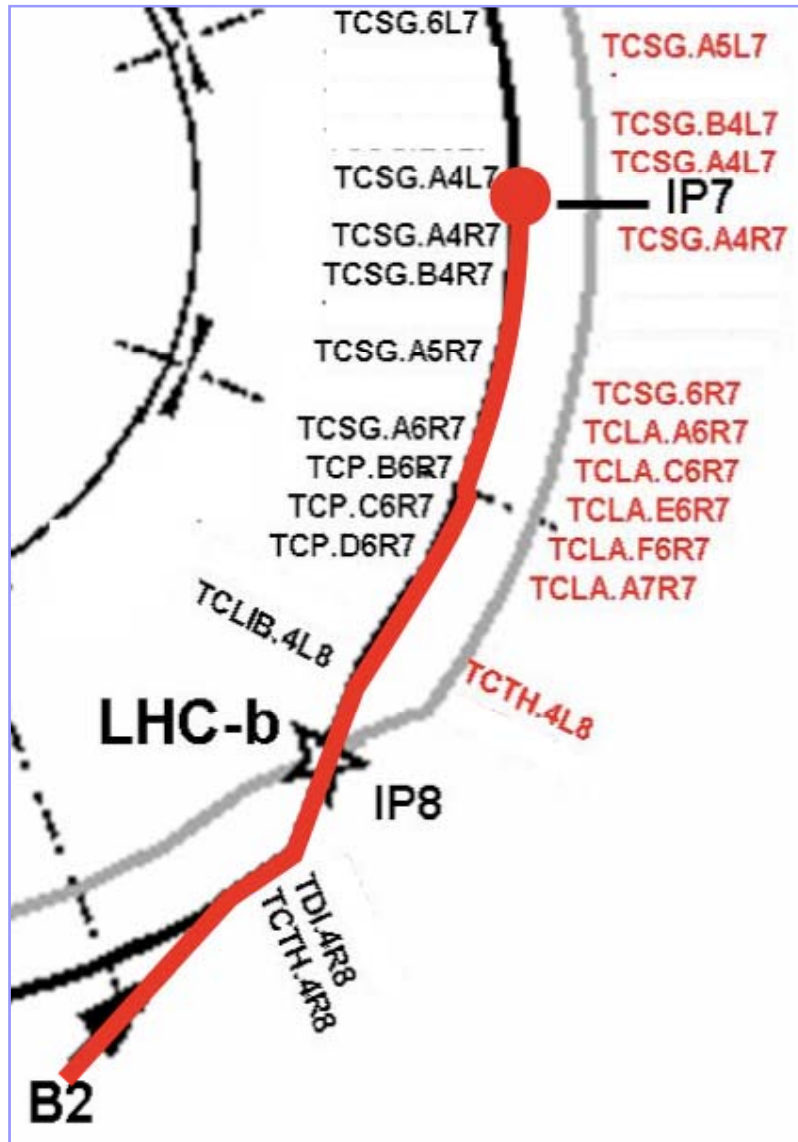


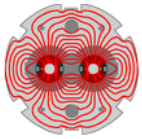
Hardware commissioning

- Powering of complete arc & arcs together
- 7/8 sectors up to 5.5 TeV (sector 56 to 6.5 TeV)
- Robust performance of nearly all 1700+ magnet circuits

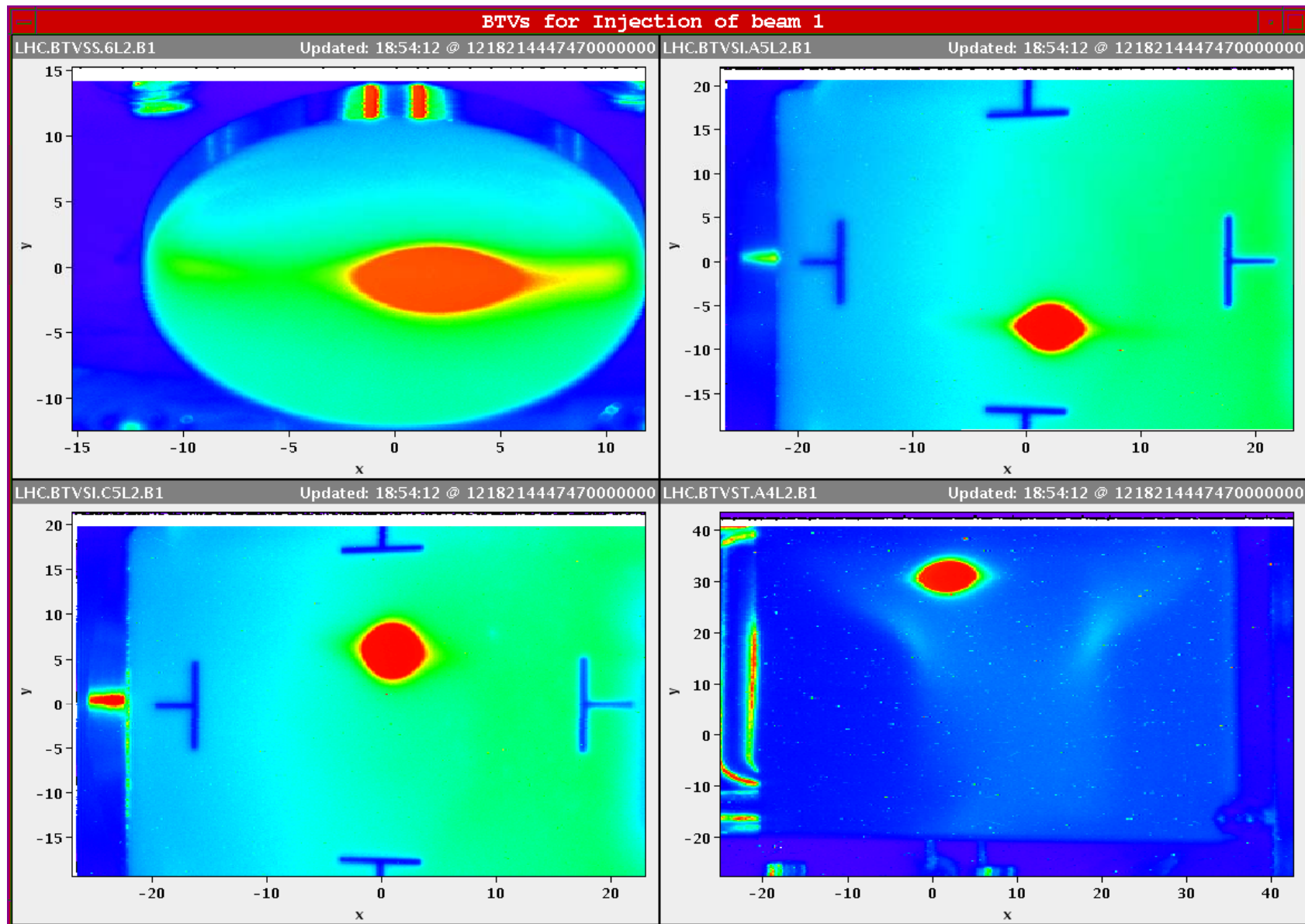


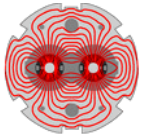
It works! Injection tests



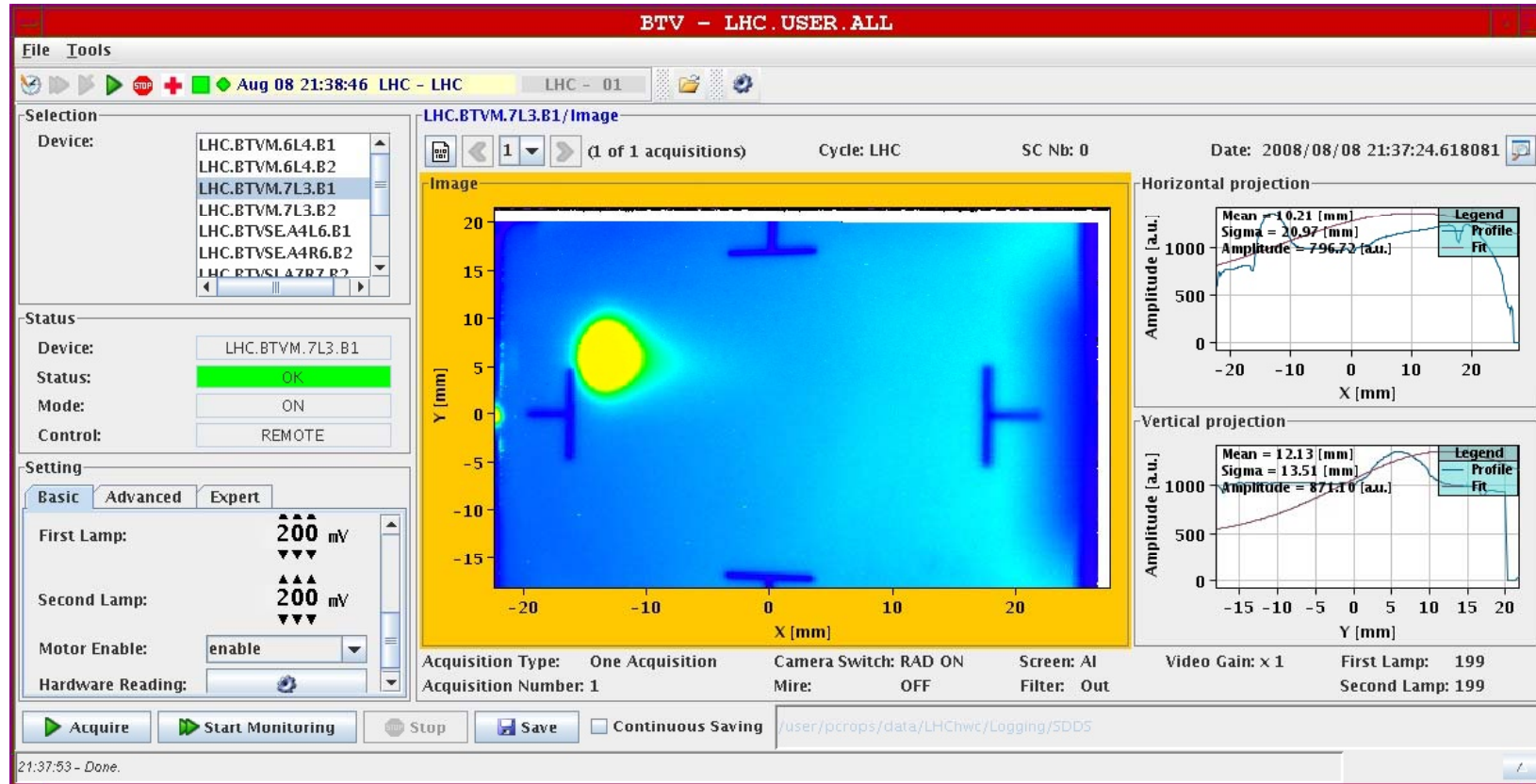


First Beam in LHC

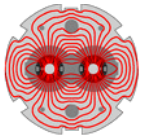




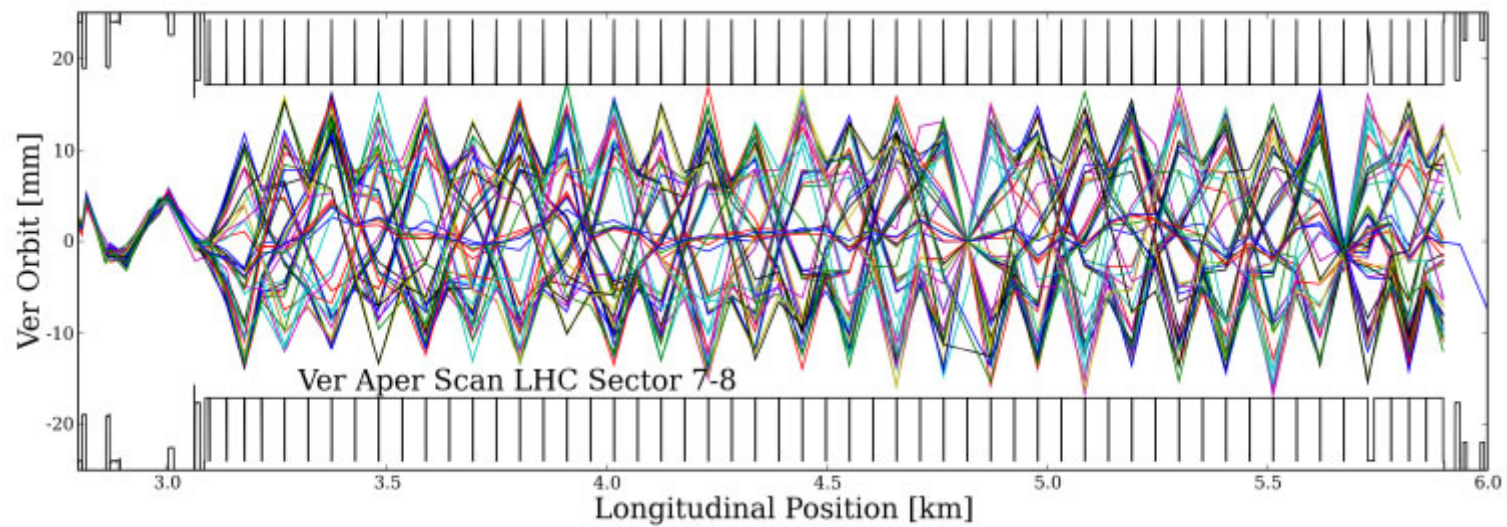
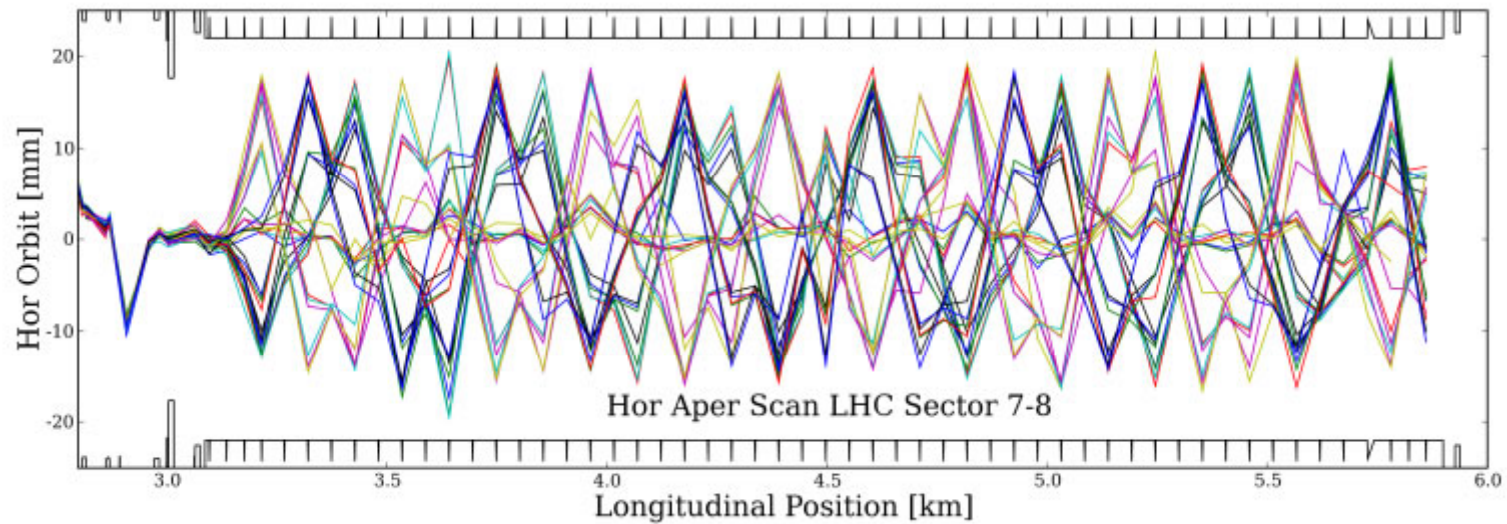
First beam to IR3

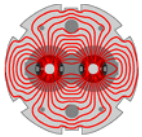


Beam stopped on collimator jaw



First gentle aperture scans



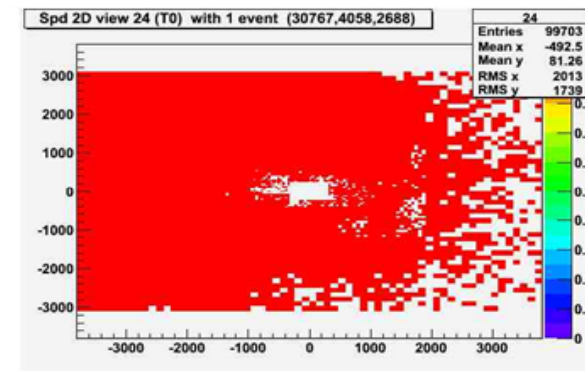
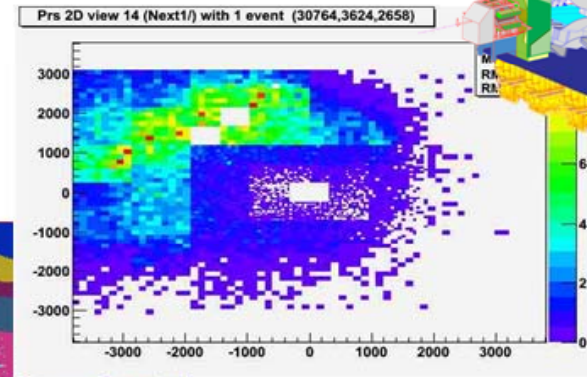
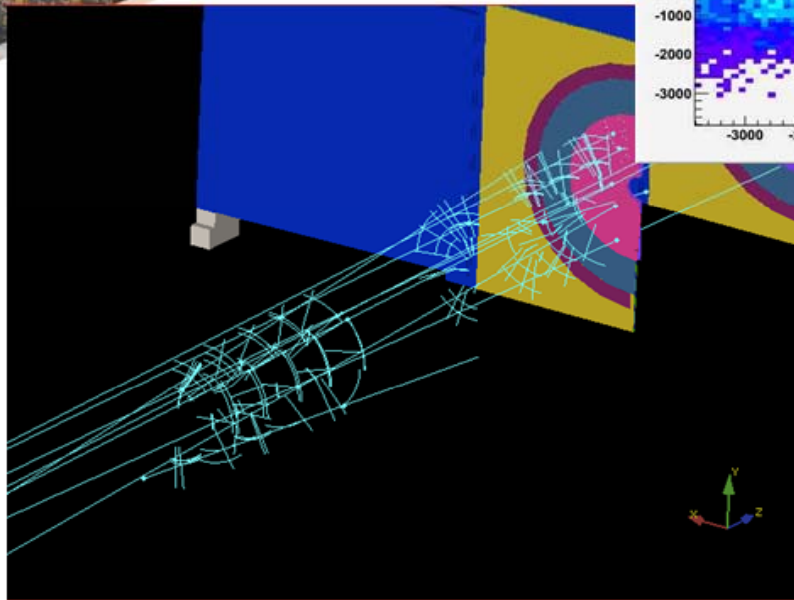


First events



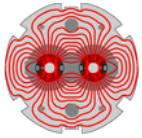
LHCb events with beam on TED!

- Scintillator-Pad and Preshower detector ON and used for triggering
- VELO 5 out of 21 modules ON in both VELO halves
 - Successfully time-aligned the VELO!

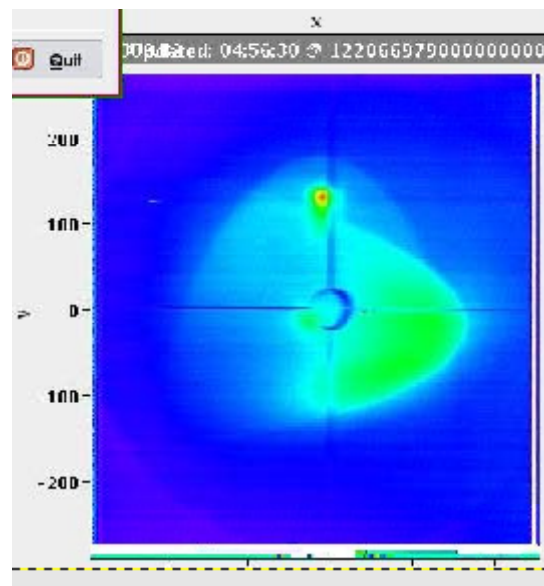
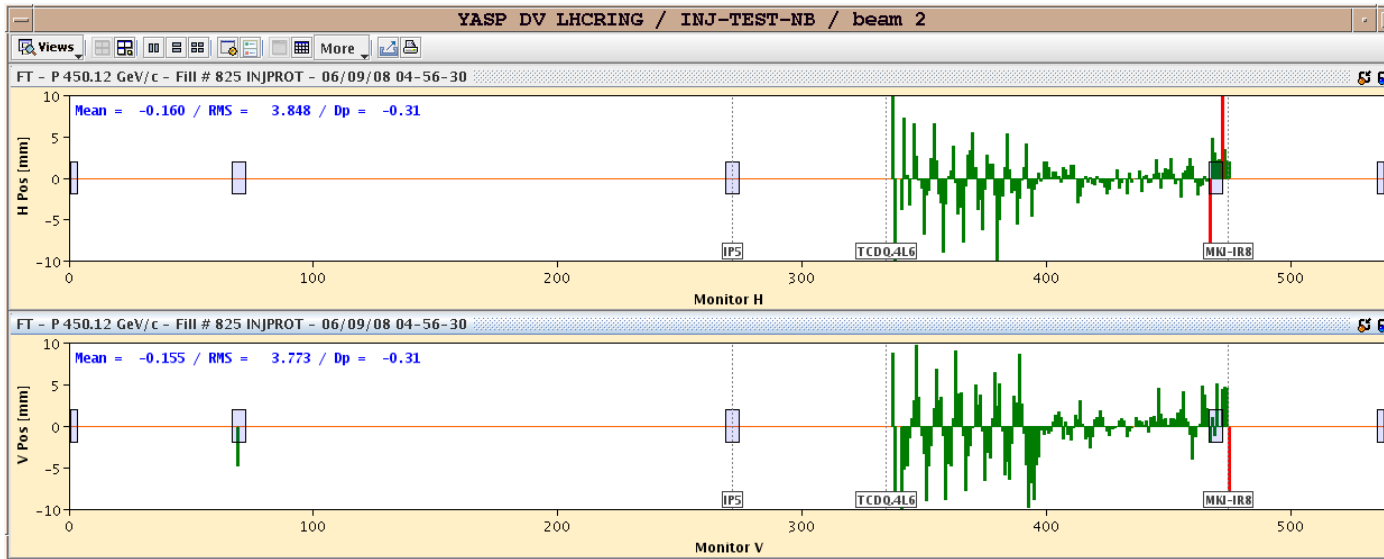


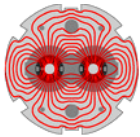
Sector test. August 23. 2008

R. Jacobsson



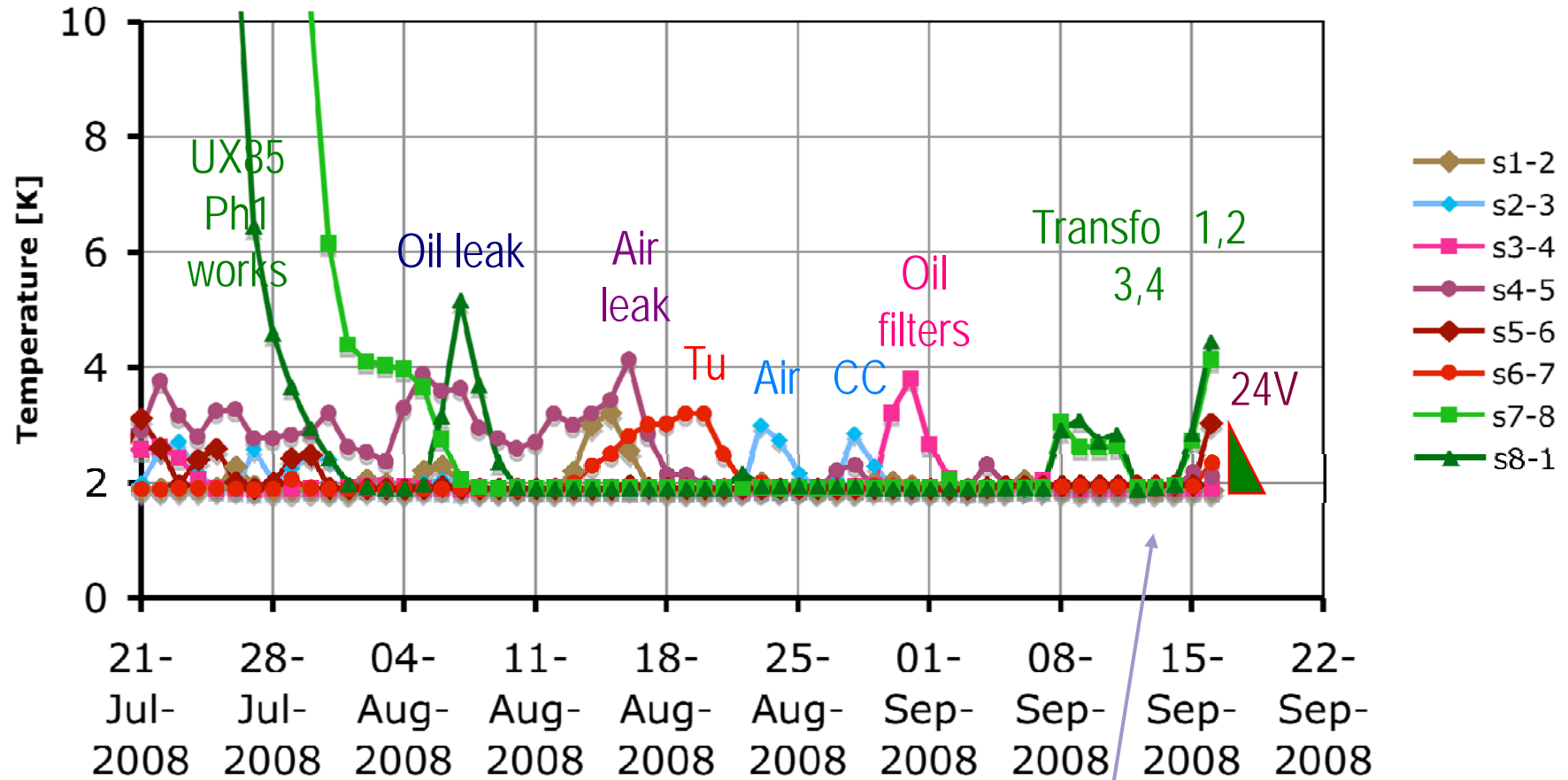
First beam to dump



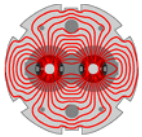


The intersect of a number of huge systems....

LHC sectors: Average temperature of ARCS

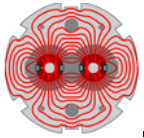


LHC Beams around the ring for the 1st time !



...which all worked nicely on the 10th September



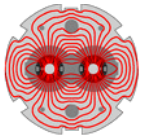


Injection test 5 - piece of cake!



3-10-08

EPOG - Status of LHC

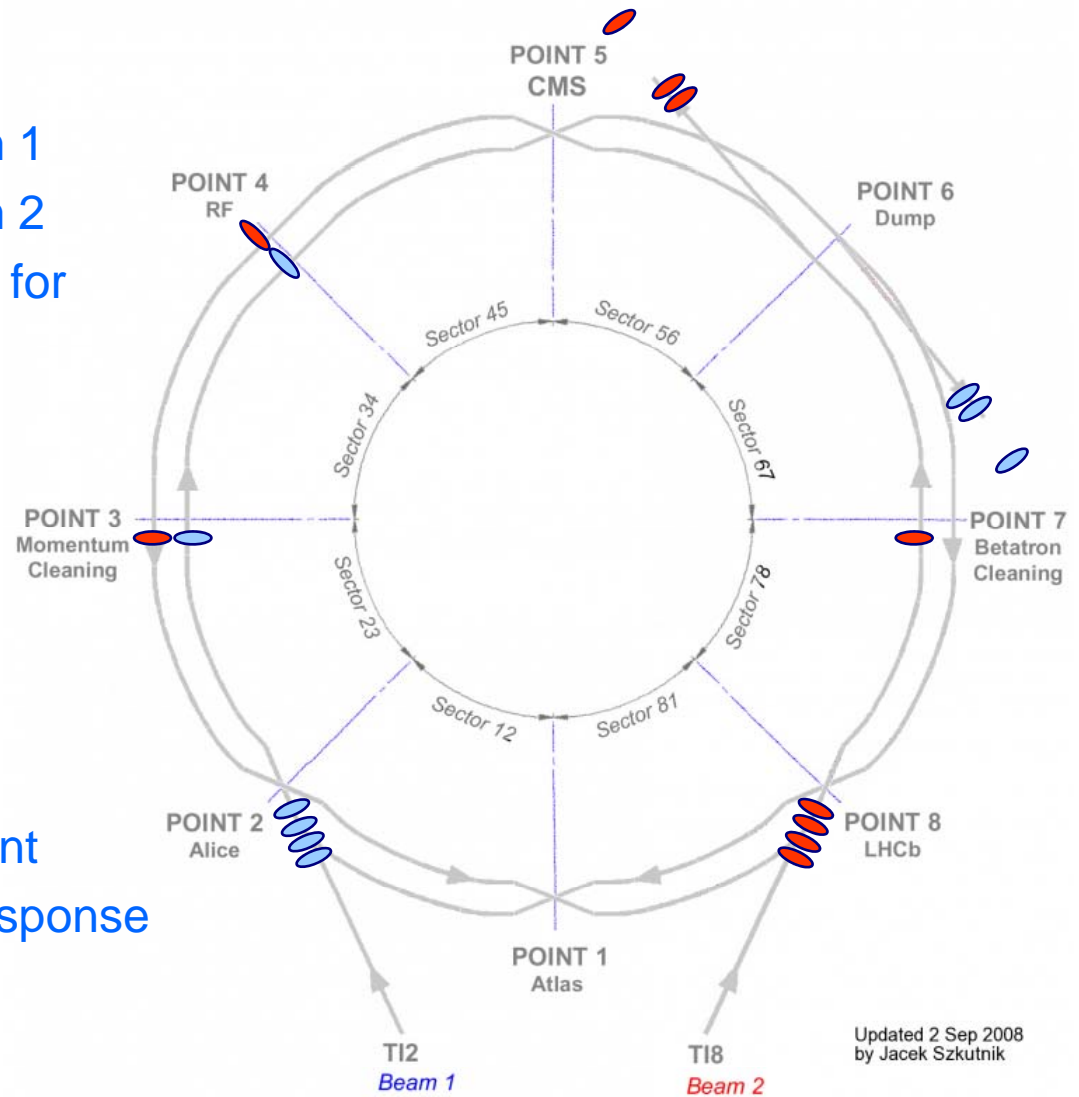


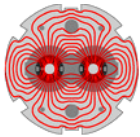
Beam Commissioning

- 10. September:
 - Established 1. Turn for Beam 1
 - Established 1. Turn for Beam 2
 - Established circulating beam for Beam 2

- Following days:
 - RF capture Beam 2

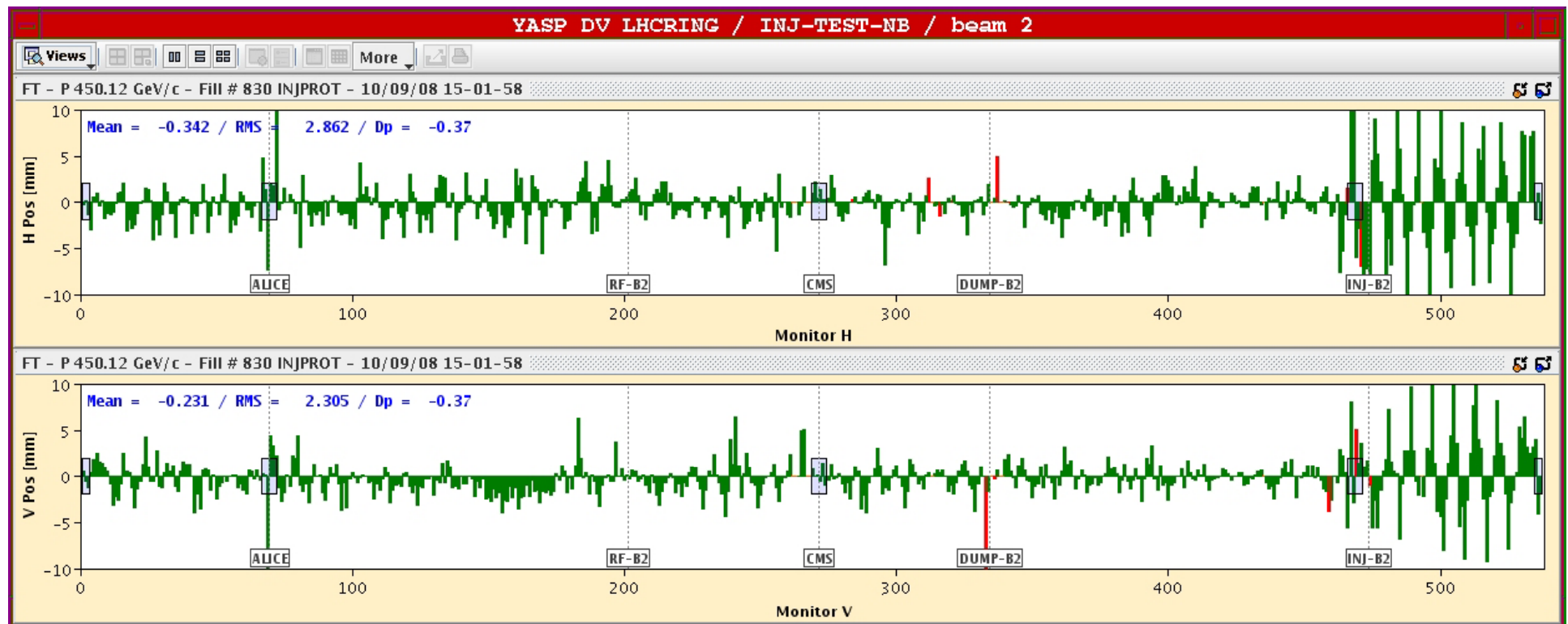
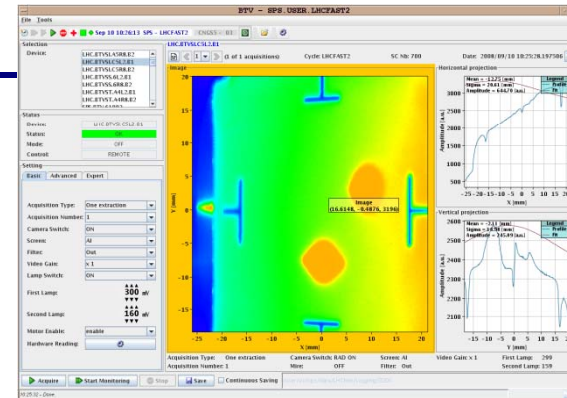
- First beam measurements
 - Orbit correction
 - Tune & coupling measurement
 - Optics verification via kick-response

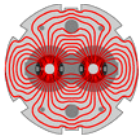




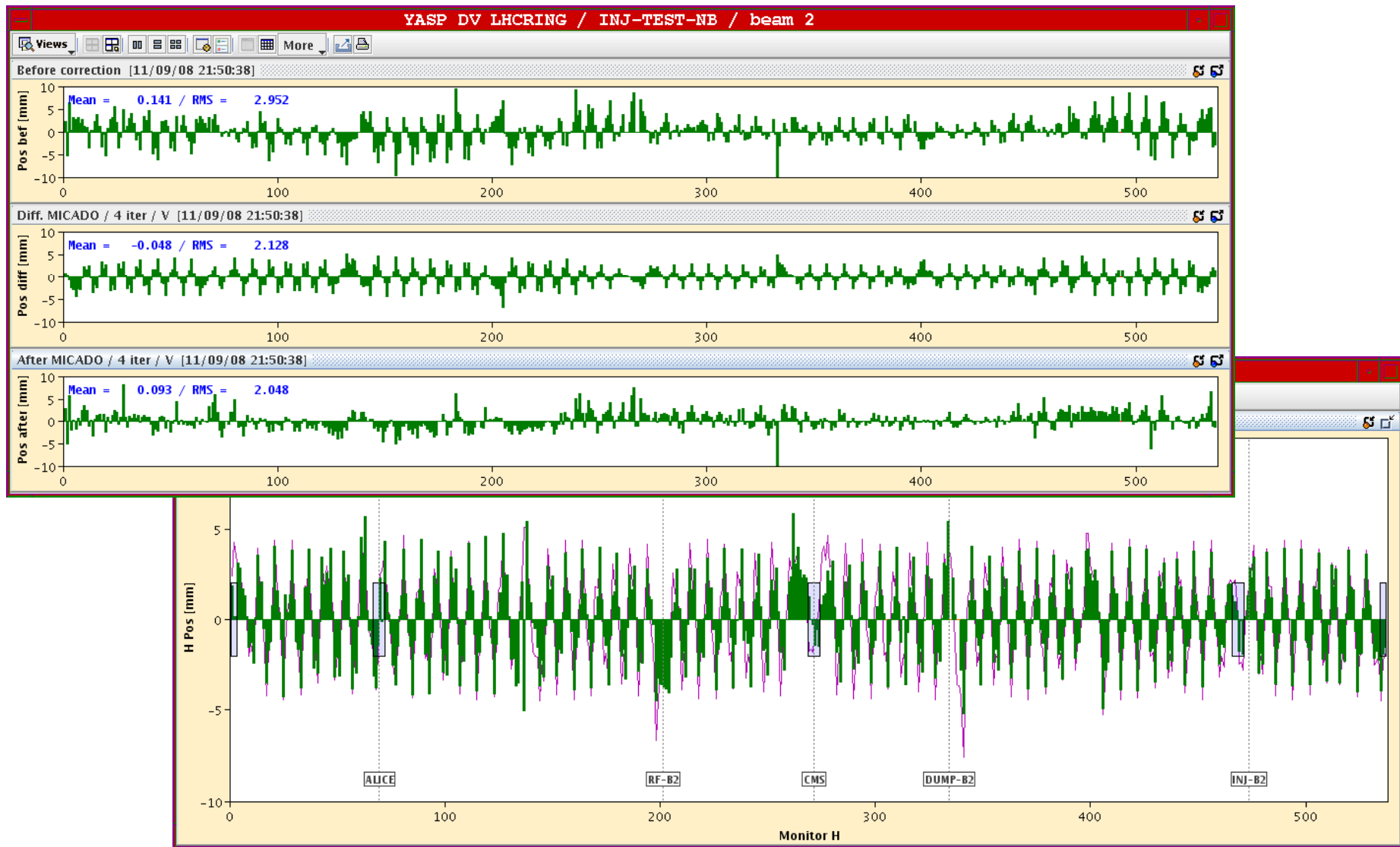
First Turn

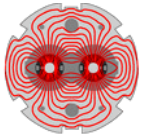
- ❑ First & Second Turn on screen
- ❑ First Turn on BPM system





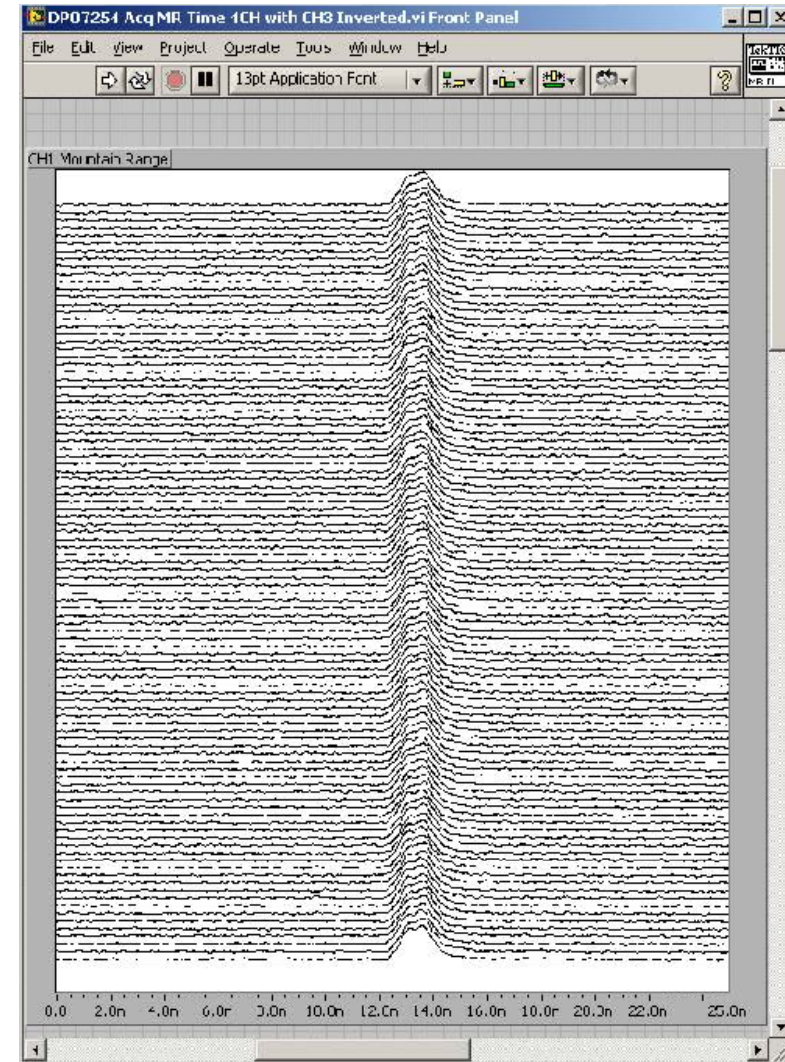
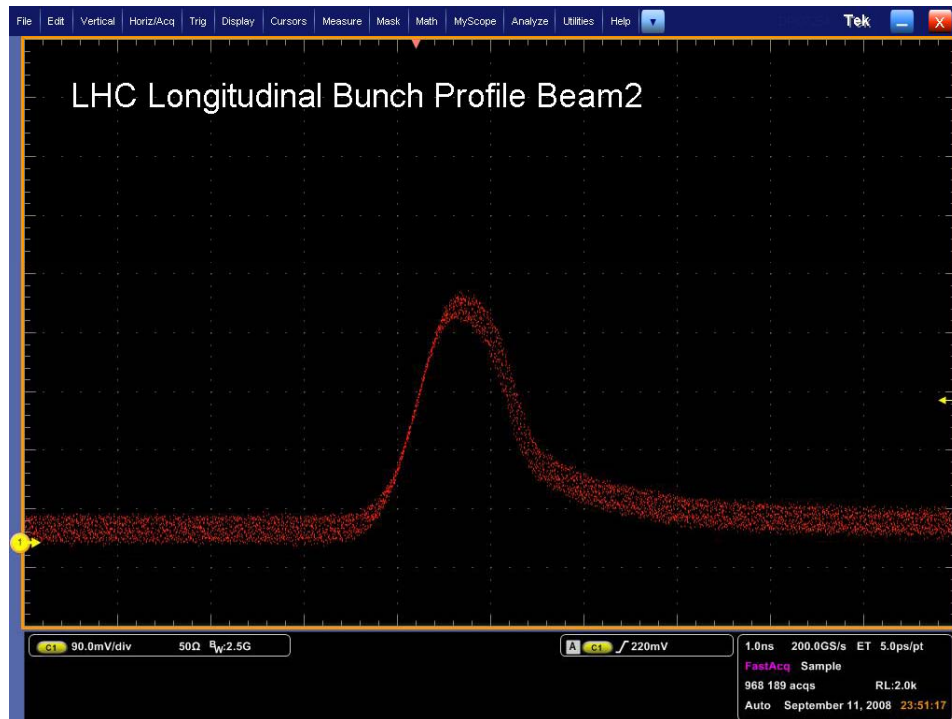
Closed Orbit and Kick Response for Full Machine

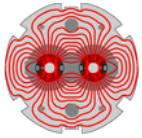




RF Capture

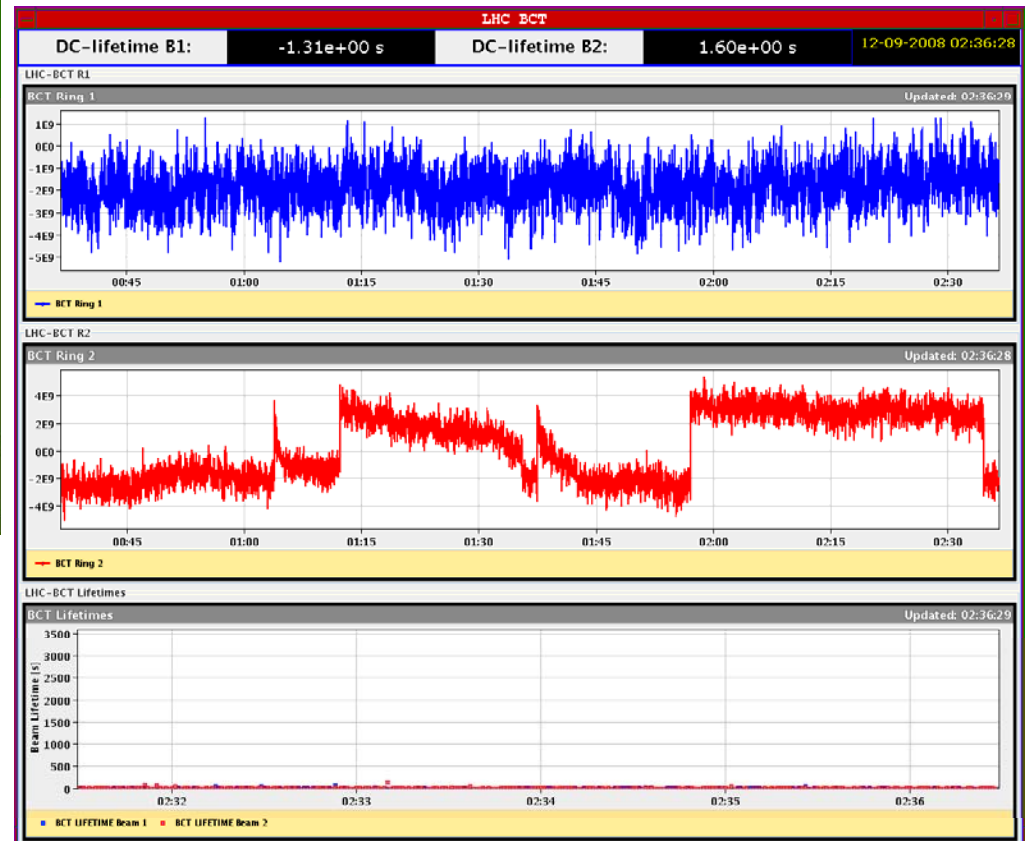
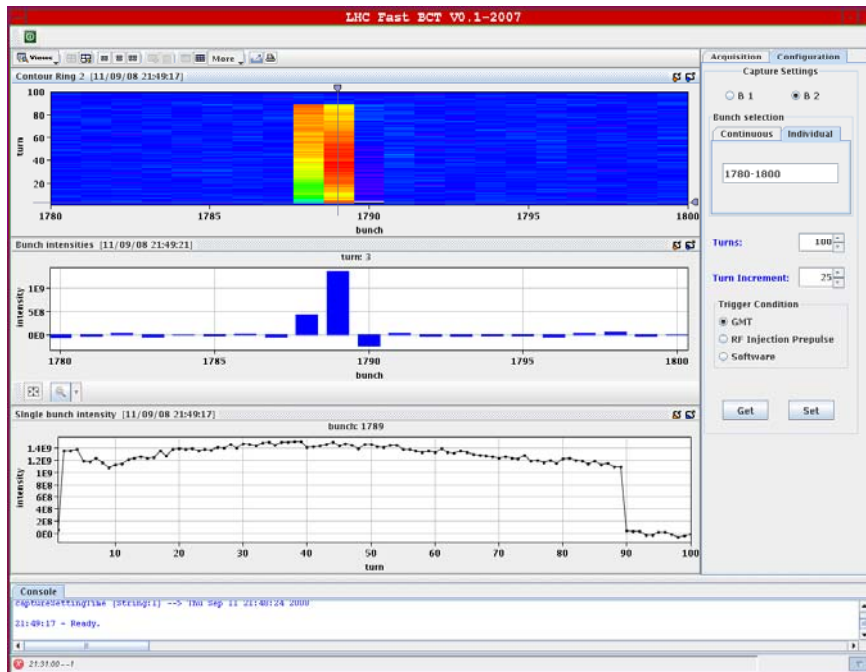
- ❑ Captured Beam Current
- ❑ Mountain Range display

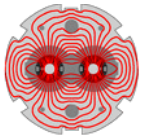




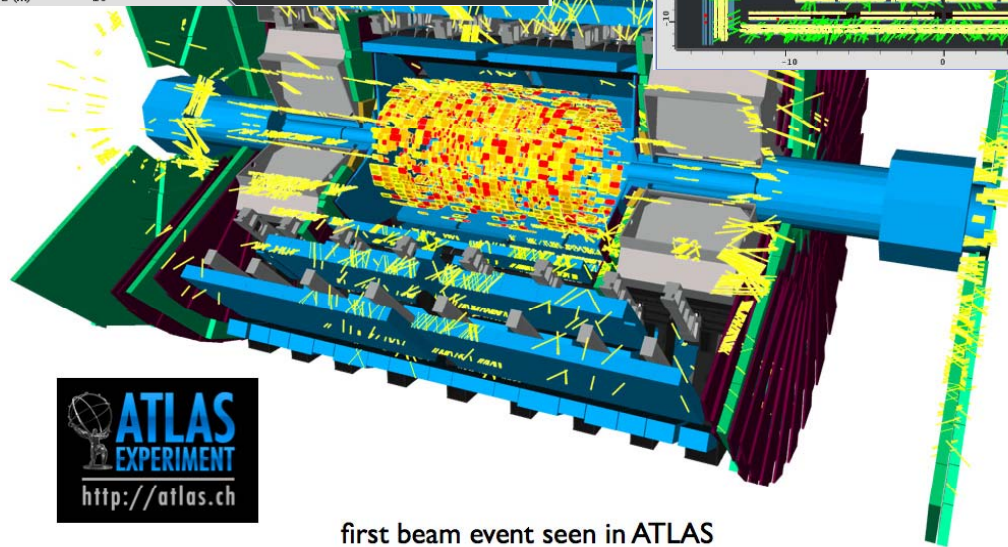
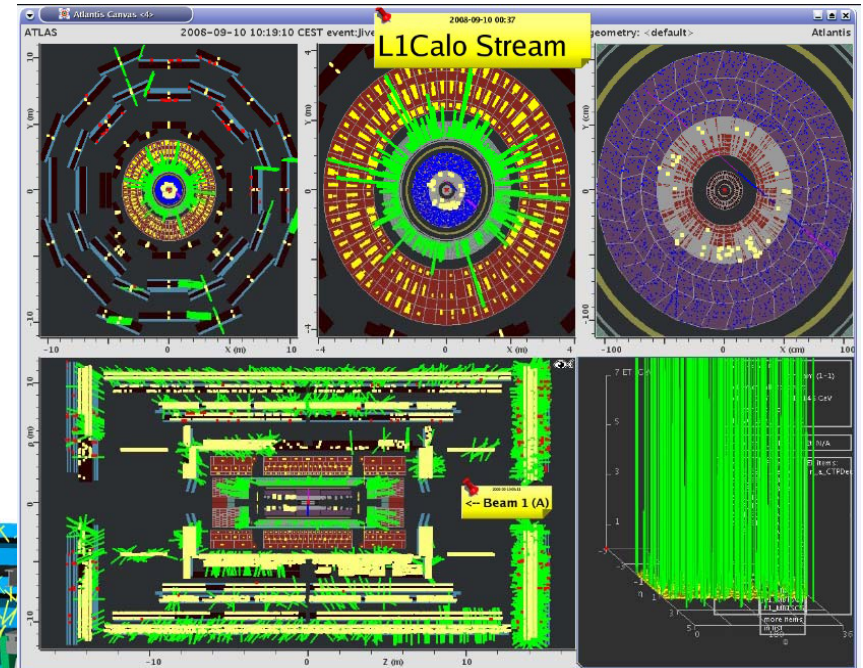
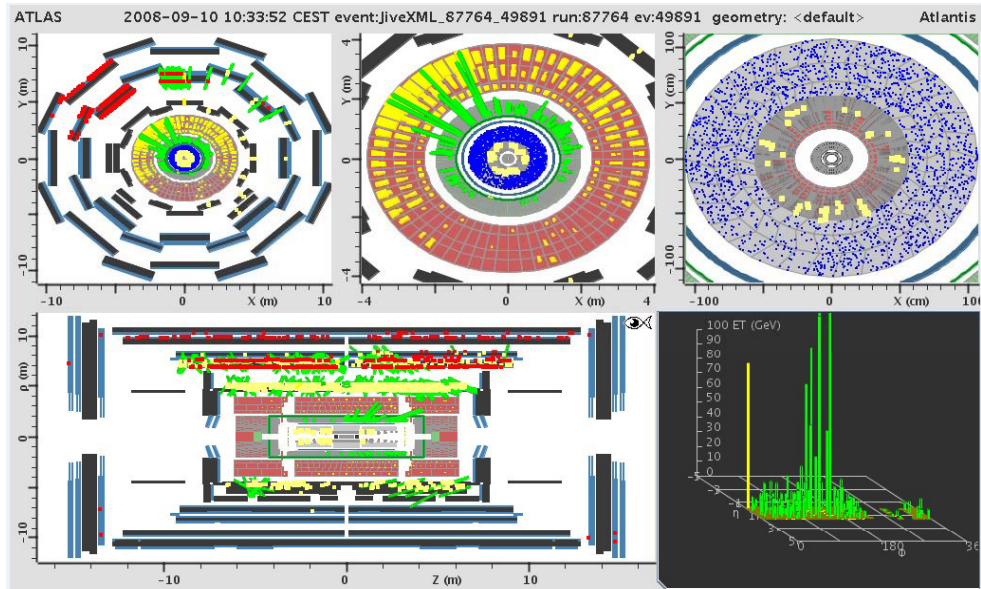
Beam Current Transformer and Beam Lifetime

- BCT versus bunch number and time: **several hours beam lifetime!**

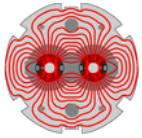




More events

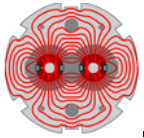


first beam event seen in ATLAS



Beam Commissioning

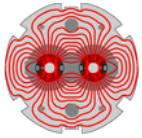
- Some higher dimensional power was with us on 10th September
 - helped by injection tests and some serious preparation
- Remarkably successful
 - Aperture clear
 - Main magnetic fields OK and excellently predicted
 - Beam Instrumentation
 - Controls & software
 - Access & machine protection
 - Achieved a truly remarkable amount in 2-3 days
 - BODES VERY WELL FOR THE FUTURE



It's big

- Large transformer failure on 12th September
 - Loss of cryogenics in point 8 (Arcs 78 and 81)
- Followed by
 - Smaller transformer failure
 - Lesser cryogenics problems
 - Temperature probes on current leads
 - etc...

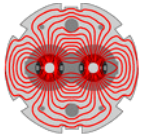
But essentially felt like regular operations on a big machine.



Friday 19th

- Test of main dipole circuit in sector 34
 - ramping to 5.5 TeV (9310 A)
 - 11:18 at around 8700 A
 - power converter trips
 - energy extraction system fires
 - wave of alarms
 - 103 dipoles quench

- Large Helium leak into tunnel
- Helium into insulation vacuum:
 - 3 SSS (quadrupoles) have moved – over pressure on vacuum barriers
 - State of dipole thermal shields to be checked
 - No damage to tunnel infrastructure



Sector 34

■ Possible cause:

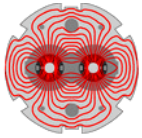
- quench and opening of busbar splice in SSS interconnect.
- open magnet interconnect next Monday
- clearly have to fully understand problem and prevent its reoccurrence

■ Consequence:

- warm sector up ~ 3 weeks
- 4-5 quadrupoles out for repair
 - re-cryostating – cold mass probably OK
- 8-10 dipoles out for re-cyrostating
- QRL and vacuum repairs in situ
- re-install magnets
- cool-down

■ Clear overlap with winter shutdown (NB injectors)

- First beam back to LHC – earliest 1st May 2009



Conclusions

- A extremely complex machine with an international profile that with a lot of effort:
 - has been brought to 1.9 K
 - has been almost completely commissioned to 5.5 TeV
 - has had a highly successful and very public three days with beam
 - has a serious technical problem
 - has the expertise and resources to fix the problem

**The physics potential of the LHC
remains enormous.**

It will work.