Topics…

- LMC actions
- ALICE bunches
- LHC upgrade

LMC Actions

LMC actions assigned to me / MPP on the 29.04.2009:

- Damage scenarios and probabilities for beam pipe

  HIGH priority

- Quantify effects of interlocking failure for moving vacuum valve with circulating beam

  MEDIUM priority

and yesterday…

- Quantify likelihood of quenching the bus-bar with beam with FLUKA simulations

LMC : valves (1)

Main issue:

- S34-like incident damage mitigation relies on closing the beam vacuum valves asap.
- Present valve closure logic:
  - Set USER_PERMIT to FALSE.
  - Wait for BEAM_INFO to switch to FALSE.
  - Close valve.
- Issues:
  - BEAM_INFO is not a high reliability signal. And strictly speaking is not a proof of absence of beam…
  - During commissioning (this summer) the USER_PERMITs are strapped for BIS & LBDS tests → BEAM_INFO forced to FALSE to allow valves to close… Ugly !!

Proposal (BIS team, RS, JW) – to be discussed with TE/VAC:

>> Remove BEAM_INFO 'feedback' from the closure logic

LMC : valves (2)

Valve closing and beam not dumped?

- Interlock signal path:
  - Vac. electronics (switches…) → CIBU : reliability?
  - CIBU → BIC → LBDS : very high reliability – SIL3/4.
- It is an issue !

  Last Saturday 09.05.2009 at 02:09 a fast valve closed in the SPS. Beam lost over 3-4 turns at injection.

  No beam interlock, status claimed to be open – switch failed !
- LHC valves have 2 switches (open & close) while SPS valves only have one switch (tbc) >> should be more reliable at LHC.
- Speed of valves:
  - Sector valves close in ~5 sec, could be reduced to 3 seconds (M. Jimenez)
  - Fast valves would close in ~50 ms (none in the LHC !).

LMC : valves (3)

- Assuming 3 seconds to close and an aperture of 45 mm:
  - speed of 15 mm/s
  - beam sigma at 7 TeV : ~0.1 to 0.2 mm (depends on beta).

  >> 'Worst case' : speed ~1 sigma/6 ms = 1 sigma/65 turns

  The BLMs should be fast enough to catch the losses:

  - thresholds and sensitivity ? Probably OK in particular because losses are likely to distribute over some distance. TBC.

  - simulation to confirm? Sixtrack including interaction with valve…

- For a fast valve the speed increases to **~1 TURN / SIGMA**.

  >> much faster than D1 failure !

  >> cannot guarantee protection by BLMs – delay to dump up to 3 turns !!

Damage to beam pipe

- Probability: the probability of damaging the vacuum chamber with beam should in theory be negligible over the lifetime of the LHC if the MPS performs as we expect.

  But…

- Consequences of a beam impact: we should pursue FLUKA/GEANT simulations for reasonable scenarios including

  beam impact angle,

  beam size effect

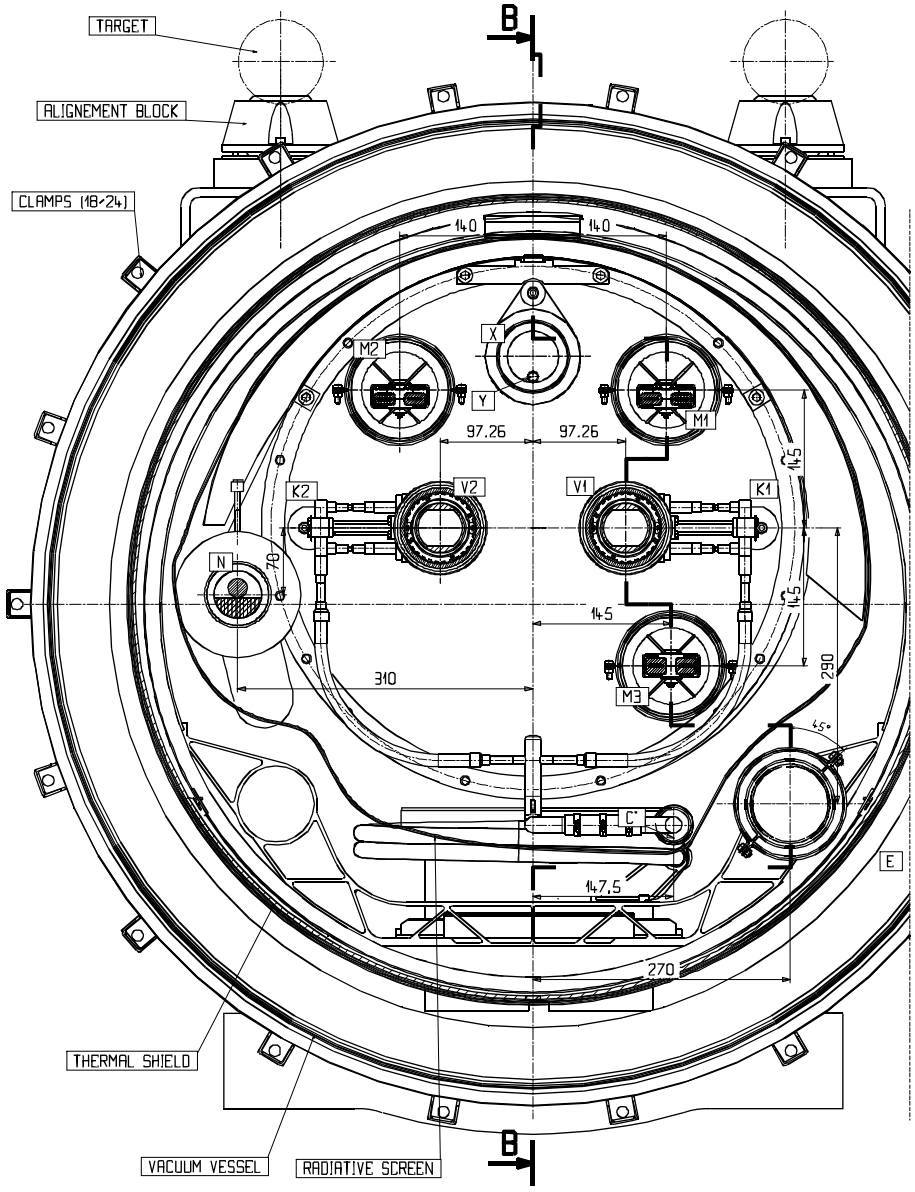
  to assess what element would fail first (beam screen + cooling channel, cold bore, SC cable….).

  Q: Can we (re)use simulations of quenches from M. Sapinsky?

  >> couple with simulations of bus-bar (in FLUKA model??).

- Candidate for following this issue would be J. Blanco Sancho (proposed by Rudiger).

Bus-bars



Not evident how one can hit / quench the bus-bars (>> higher threshold) without at the same time quenching the surrounding magnets…

TBC.

Candidate for beam impact scenario : closed bump @ 450 GeV

- Some numbers:
  - Orbit corrector dI/dt = 1% of Imax.
  - At injection θmax ~1.2 mrad → dθ/dt = 12 μrad/s.
  - Arc β = 180 m, kick of 12 μrad : bump of ~2 mm = ~2 sigma.

  >> a simple 3 corrector bump could grow at 2 sigma/s.

- Protection:
  - Local BLMs.
  - Orbit/corrector surveillance by SIS :

    - the orbit corrector currents sampling and SIS : frequency ~ 0.5 Hz
    - threshold of 2sigma (25 μrad) on the correctors

    >> Latency implies detection when bump reaches <= 6 sigma !

Alice (ghost) bunches (1)

- There are plans by M. Ferro-Luzzi & ALICE to inject some 12 low intensity bunches (~1E10) for ALICE together with high(er) intensity bunches for the other experiments.

- Consequence:
  - BPMs use a *sensitivity switch* to avoid spurious triggers from reflections with high intensity bunches. Threshold is ~ 5E10.

    If bunches >> 5E10 are mixed with low intensity (< 5E10) bunches : low intensity bunches are invisible.
  - If the other bunches are > ~5E10, the sensitivity switch of the BPMs will make the 'ALICE' bunches invisible for the BPM system.

    >> no way to measure the position of those bunches with BPMs (but visible on BCT, synch light monitor (in b-by-b mode), head-tail monitor).

    >> 'invisible energy' in the beam.

Do we care ?

Alice (ghost) bunches (2)

- **Yes**
  - We care since we do not know precisely where the bunches are, even if it is unlikely that their orbit is very different from other bunches (beam-beam effects should not exceed ~ sigma).

- **'No'**
  - Long range beam-beam may lead to poor(er) lifetime on some bunches, transforming a initially homogenous bunch intensity distribution into a mix of high and low intensity bunches, the later becoming invisible.

    >> we may get the a similar 'invisible energy' from beam-beam – TBC.

We should consider recommending a limit on the amount of invisible energy introduced by design.

LHC upgrade

- Upgraded LHC triplet design is advancing. New triplet layout is emerging. We have to follow up (who?).

- At PAC09 a statement was made that the LHC upgrade (10x lumi) has no real MPS issues (quote of B. Goddard, R. Assmann & K.H. Mess).

  I'm not convinced that this is correct if one considers that more intensity / smaller beam sizes will make failures more critical (shorter reaction times).

  - In combination with phase 2 collimators made of Copper, this could be a nightmare (even if the collimators may rotate).

» Asked for 'semi-permanent' support from ABP to ensure longer term continuity in the simulations and help wrt upgrade – not much success so far.