The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.
News from WP4 – HHRF system

Background

- RF/LLRF currently setup for extremely stable RF voltage (minimize transient beam loading effects). Less than 1° RF phase modulation (7 ps)
- To continue this way, we would need at least 200 kW of klystron forward power at nominal beam current (0.58 A DC)
  - Klystrons saturate at 200 kW with present DC parameters (ultimately 300 kW). Sufficient margin necessary for reliable operation, additional RF manipulations etc.
  - The present scheme cannot be extended beyond nominal. Graphs for nominal (1.15e11 ppb, 25 ns, 7 TeV, 0.58 A DC), ultimate at 450 GeV (1.7e11 ppb, 25 ns, 0.86 A DC), ultimate at 7 TeV

Presented by T. Mastoridis BE-RF
News from WP4 – HHRF system

- Not possible for nominal/above nominal currents due to excessive power required
- Accept cavity phase modulation
- The distance between bunches will not be strictly constant but the same for beam 1 and 2, therefore collisions will be always at the IP but with slight spacing modulation (75 ps peak-to-peak modulation)
- Crab cavities will have to follow this modulation to avoid bunch-to-bunch differences in the “crabbing”
- No expected effect on transverse dampers behaviour (tbc)
News from WP4 – HHRF system

• Preliminary design of the cavities and HOM ongoing.

• Questions:
  • Need to synchronize layout at some point to take into account for their presence/aperture
  • Is the impact on transverse beam stability assessed (if we run in bunch lengthening mode)? I understand that the impact on beam induced heating has been assessed (Benoit for LMC talk).
News from WP3/10

• Presentation on dose and power estimates
Coils:

- $\text{Nb}_3\text{Sn}$: IT quadrupoles
- Nb-Ti: orbit correctors, super-ferric magnets, D1

Aperture:

- 60 mm TAS
- 150 mm Inner Triplet + CP
- 160 mm D1

10 cm gap in the beam screen in the middle of the interconnects

SS cold bore
W absorbers
SS beam screen
Dose and power estimates

Longitudinal peak dose/power profile on inner coils

- $\sqrt{s} = 14$ TeV pp collisions
- Dose: $\bullet$ -
- Power: $\bullet$ -

$\text{power @ L} = 5 \times 10^{34} \text{ cm}^{-2} \text{s}^{-1}$

10 cm beam screen interruption in the interconnects
Power evaluated on the entire radial cable, dose on the innermost 3 mm
Beam screen gap interruption has a significant effect for the following interconnects: Q2A-Q2B, Q2B-Q3 and Q3-CP.
150 mm aperture D1

Magnetic field map shrunk according to the different magnet aperture

D1 longitudinal peak dose profile

\[ \sqrt{s} = 14 \text{ TeV pp collisions} \]

- 160 mm - 10 cm gap
- 150 mm - 10 cm gap
- 150 mm - 50 cm gap

150 mm D1 aperture with 50 cm gap in the upstream interconnect is still a viable option
Comparison with present LHC Inner Triplet

HL-LHC peak dose at same level of present LHC Inner Triplet, although with 10 times more integrated luminosity.

Present LHC beam screen interruptions:
- Q1-Q2: ~ 45 cm
- Q2-Q3: ~ 15 cm

F. Cerutti, L. Esposito
News from WP3/10

• Open points:
  • Smaller aperture of the D1 magnet 160 mm ➔ 150 mm does not change significantly the radiation level. Can we reduce the aperture (at constant beam screen aperture) provided that this has no negative impact on the radiation downstream (crab-cavities, Q4,D2...)? How the radiation at D1 depends on the shielding thickness in Q1?
  • Margin for reduction of the shielding at Q2 within the limit of 20 MGy/3000 fb-1?
  • Margin for further increase of shielding at Q1 and potential advantage in terms of radiation downstream?
  • BPMs are one of the reason for the interruptions of the shielding (at least 50 cm). Need to clarify the design and possibly add shielding around the BPMs?
WP3/10

- Open points:
- Motivation for the number of BPMs
From WP3/10

At Q1-Q2-Q3-CP-D1:

1. He gap: 1 mm → 1.5 mm
2. Cold bore: ID 138 mm → 137 mm
3. Tungsten absorbers (6 mm thickness)
   Annular gap: 0.5 mm → 1.5 mm
4. Sliding rings ~ 0.5 mm (included in 4)
5. 2 mm thickness octagonal BS.

ID (inscribed circle): 121 mm → **118 mm**

**Question:** Is that compatible with optics?

Need to have table with nominal sizes and tolerances to see the relative impact and motivation of the aperture reduction drivers.

L. Esposito, E. Todesco
Questions for us

• Aperture and impact on performance. Cost of the tolerances in performance.

• Impedance and e-cloud:
  • Impedance: effect of welding
  • E-cloud and impedance: need to evaluate resulting heat load on the beam screen $\Rightarrow$ required for cryogenics to define the design of beam screen capillaries (as an example)

• Present assumed tapering in the transitions between beam screens of different aperture is 15 degrees, $\sim 1 : 4$ (radial/long.) ratio: OK? (R. Kersevan)
WP2 changes

- **Rhodri Jones** to coordinate the efforts for **Task 2.7** on “Intensity limitations from existing LHC hardware”. 
Task 2.7: Intensity limitations from existing LHC hardware - Mandate

- WP2 Task 2.7: Intensity limitations from existing LHC hardware – DRAFT Mandate
- Define the total and bunch current limitations deriving from the present LHC HW
- Review the observed limitations during the 2012 run
- Guarantee coherence in the analysis and solution of the potential HW intensity limitations
- Extrapolate to HL-LHC parameters and identify potential HW limitations resulting from:
  - RF transients on main and auxiliary systems (HHRF, Crab cavities, etc.)
  - HOM on RF cavities and Transverse dampers
  - Vacuum instabilities, thermal induced desorption (e.g. on collimators), etc.
  - RF heating in collimators, beam instrumentation, kickers, other vacuum structures
  - Beam instrumentation
  - Beam dump, absorbers, injection/beam dump protection elements
  - Collimators
  - Beam screen cooling circuits
  - Radiation protection and radiation issues
- and possible mitigation cures.
- Liaise with Task 2.4 and with other WPs (e.g. WP9: cryogenics, WP4: crab cavities and HHRF, WP10: energy deposition & absorbers, WP13: Beam Instrumentation, WP14: Beam Transfer and kickers)
Next meeting

- **Tuesday 11/6/2013 at 16:00 in room 6-R-018**

- **Agenda:**
  - General information (Gianluigi)
  - D2 Field Quality (Ezio)
  - Possible scenarios for LIU/HL-LHC upgrades (Oliver)
  - Round Table