

# HHH-2008 Follow Up Discussion, Comments & Questions

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## phase 1:

### - optics up to $\beta^*=0.25$ m

feasible without moving Q4, Q5?

review: 120 mm, 120 T/m, 0.25 m,... no solution which matches these conditions exactly; close solution with 126 T/m is unstable; large motion of matching quads gives robust solution;  $\beta^*\sim 0.35$  m? **optics needed a.s.a.p.; could also reconsider magnet parameters**

- phase -1 beam-beam tune shift? OK

- schedule; radiation can affect duration

## phase 1 cont'd:

- **intensity limit for phase-1 IR** more severe than for nominal IR? # **long-range beam-beam** collisions; phase-1 IR may lose location for **beam-beam compensator**
- determine trade-off  $\beta^*$  / intensity for a given optics!

## phase 2:

- **feasibility of very low  $\beta^*$ ? 0.15 m with Nb3Sn at 1.9 K** (LARP results) ; lower emittance may help?!
- **feasibility of low emittance?** e-cloud instability & IBS get worse; injection errors, kicker ripple etc more critical; so far not much better than spec.
- **feasibility of large intensity?** already  $1.7e11$  is hard in SPS ; explore  $\sim 2.4e11$  level with linac4? **ultimate corresponds to LHC RF limit and to collimation phase-2 limit**

## phase 2 continued

- **should we assume #evts/cross < 200?**  
what are the costs?; leveling desired
- **leveling**  
demonstration or test in the LHC ; feasibility not excluded ; orbit correction in store works at RHIC and Tevatron ; very natural for crab cavities
- **extent of luminous region** effect of pile up?
- **lifetime of magnets?**

## energy deposition:

- can we state that this is **not an issue?**, i.e. we can always shield?
- phase 1 OK; phase 2 = 4 x phase 1, but Nb<sub>3</sub>Sn has a factor 3 radiation tolerance w.r.t. NbTi, - no issue? critical parameters like gradient, crossing angle etc can affect the **loss pattern**; not a showstopper; cooling capacity sufficient? incomplete modeling of heat deposited in yoke – missing thermodynamics in FLUKA
- magnet lifetime 500 fb<sup>-1</sup> – improved by shielding?

## HERA upgrade:

- importance of alignment and stability
- HERA experience taken into account for LHC phase 1 and 2?

mostly insufficient preparation and design ; effect of CMS stray field?

## Integration:

- **D0 possible in ATLAS**
- **is 13 m good enough in CMS for D0?**
- **requirements on the detector**
  - vacuum chamber** longitudinal extent +/-50 cm ; separation at injection ; operation with different  $\beta^*$

## Linac4, SPL, PS2, SPS upgrade:

- **brightness, emittance and intensity?**  
relation, preservation
- dependence on **bunch spacing**

**low periodicity of PS2 optics?!**

## **FAIR:**

- is **aperture of 2-3  $\sigma$**  sufficient?
- can one rely on **space charge for beam loading compensation & pre-compression?**

## Low Emittance:

- **damage limit for collimation** already at the edge for nominal LHC; gets worse with lower emittance; present emittance optimum for collimation? (smaller is bad for damage, larger is bad for cleaning efficiency)
- **Landau damping** reduced by low emittance

**high field magnets:**

path to smaller  $\beta^*$ ?

and to higher energy

**fast cycling s.c. magnets:**

alternative for PS2?

SPS2+

## **FFAGs:**

can they be used at CERN?

are they better than a LINAC?

## **beam-beam & b-b compensation:**

can we predict LHC beam-beam lifetime  
within a factor of 2?

prediction of tune shift limit

validation of e lenses

**D0:**

13-m slot “OK” for ATLAS and CMS

- what input is missing?

**flat bunches:**

how flat do they need to be?

scheme for LHC

## **electron cloud:**

impact on PS2 design

role of re-diffused e-

e-cloud impact on collimation, ion  
avalanche

**electron cloud solved?!**

## **crab cavity:**

excellent progress

how to make the down selection?

## collimation:

with errors intensity limited to 3-4% of nominal

15 h -> 1 min speed up of set-up time

efficiency for phase-2 with errors? is the ideal gain maintained?

are crystals the solution?

## **perspectives:**

meeting format

format of dissemination