

Global Collaborations Towards LHC Crab Cavity

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Thanks to Rama Calaga and Rogelio Tomas

Crab Cavity Validity Requirement Workshop

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CERN

Outline

- Potential for crab crossing in the LHC
- The challenges
- Statement of interest on behalf of CERN
- Collaborators & work plan
- Conclusions

Introduction

Crab crossing for LHC has for long been considered as an exotic solution of controversial feasibility. It has been getting momentum especially in the latest CARE-HHH workshops...

- after an implementation in KEK (electrons),
- with the disappearance of some upgrade options for LHC,
- and with the relative difficulties in integrating D0 dipoles in the detectors.

It shares with the D0 option a very efficient luminosity levelling principle.

This recent history explains why crab crossing in the LHC is not on the CERN R&D programme (White Paper) whose funding is totally allocated to priority projects for the years to come.

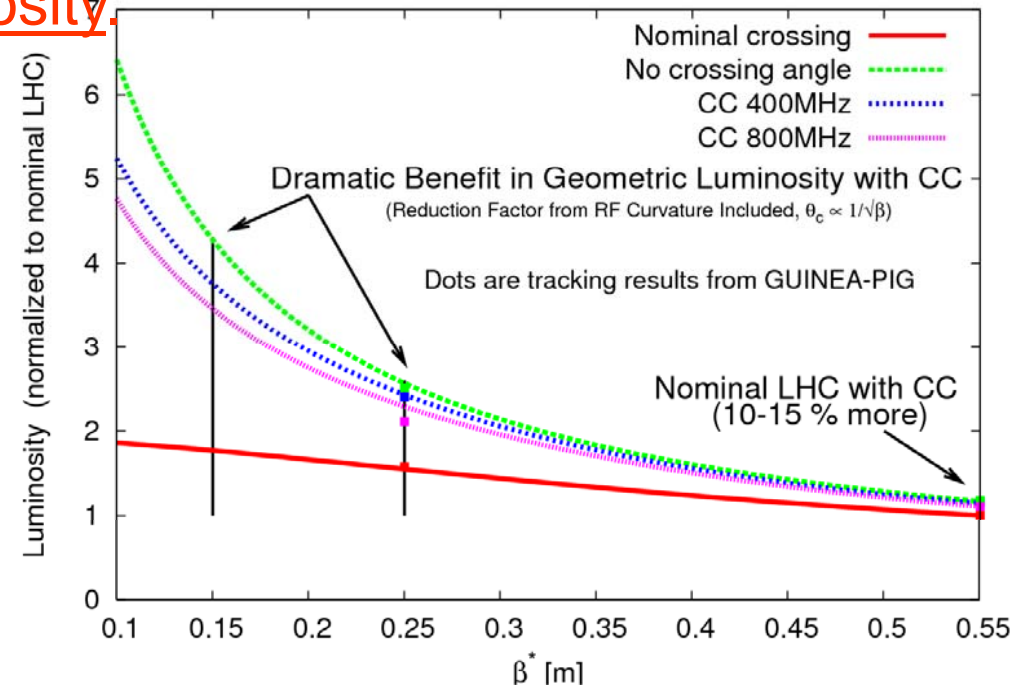
Nevertheless, beyond its solid challenges, the remarkable potential of crab crossing for the LHC upgrade deserves special attention and action:

Potential of Small Angle Crab Crossing

- About 15% luminosity gain for nominal LHC (55 cm beta*)
- About 50% luminosity gain for LHC Upgrade Phase I
- The two main advantages identified for the D0 scheme of the Upgrade Phase II:

- luminosity improved by a factor 4 with smaller beta* ,
- Suppression of the very fast decay of luminosity by angle levelling, with increased integrated luminosity.

- Flexibility for larger crossing angle if long-rang beam-beam is a problem
- Synergy with future projects (for example: LHeC)



Challenges...

from a performance point of view

- **High quality, reliability and robustness** of CC's and LLRF (time spent in machine studies is lost for integrated luminosity).
- **Understanding of beam dynamics for** the beam core and **the beam TAILS** in presence of imperfections (phase noise,...), lifetime, background levels, complexity of operations.
- Use of CC's optional; **transparency of CC's when not used**, in terms of beam dynamics and reliability.

Statement of Interest

Date: 07/23/2008

To: workshop organizers

Cc: Lyn Evans

After discussion with the LHC Project Manager (Lyn Evans), I will be in position in the August miniworkshop to say that CERN is indeed interested by the R&D on crab cavities, given their large potential in increasing the LHC performance. It shall be possible to install crab cavities as soon as they are available, at the condition that they cause no loss of performance, i.e. that they are properly integrated and are not seen by the beam when not used.

The interest of KEK, in addition to US-LARP and FP7-EuCARD is very much welcome.

Collaborators, Work Plan & Organization

Collaborators:

Confirmed: FP7 EuCARD: Cockcroft Institute & CERN, coordinator: P. McIntosh/DL (in synergy with CCs for electron colliders).

Expressed Interest and putting significant efforts: US-LARP

Expressed Interest recently: KEK

Strategy:

Test of Global CCs on LHC (or another hadron machine) followed by local CCs?

Work Plan:

Formally defined for FP7-EuCARD (cf. P. McIntosh)

Global work plan to be defined

Framework and Organization:

To be defined (except for FP7-EuCARD)

Conclusion

The high potential of crab crossing makes it really worth a collaborative international effort to arrive as soon as possible to an assessment of this LHC upgrade path.

UK FP7 (LHC) Proposal

- Targets the fundamental synergies for the design of crab cavity systems; not only in terms of the RF structure design and wakefield suppression, but also in the RF system control and full system integration and validation.
- Crab cavity and LLRF systems, developed for ILC, being tested right now.
- Proposal combines both LHC and CLIC CC R&D.
- For LHC:
 - Global system preferred:
 - Transverse beam separation restrictions,
 - Frequency limited to 400 - 600 MHz.
 - Emittance growth is a major concern:
 - $\sim 0.010^\circ$ phase tolerance required @ 400 MHz with 300 μ rad crossing.

The UK FP7 (LHC) Proposal

- STFC, CI-LAN and CERN collaboration.
- Total staffing: 1.5 FTE/yr (over 3 years)
- Total capital, consumables etc: 72k€
- Total LHC proposal cost: 670k€
- Deliverables:
 - As part of the global LHC-CC collaboration:
 - Cavity, couplers and tuner
 - LLRF system
 - Verify integrated system performance