



CERN Strategy for Crab Cavities

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CERN

US-LARP CM14

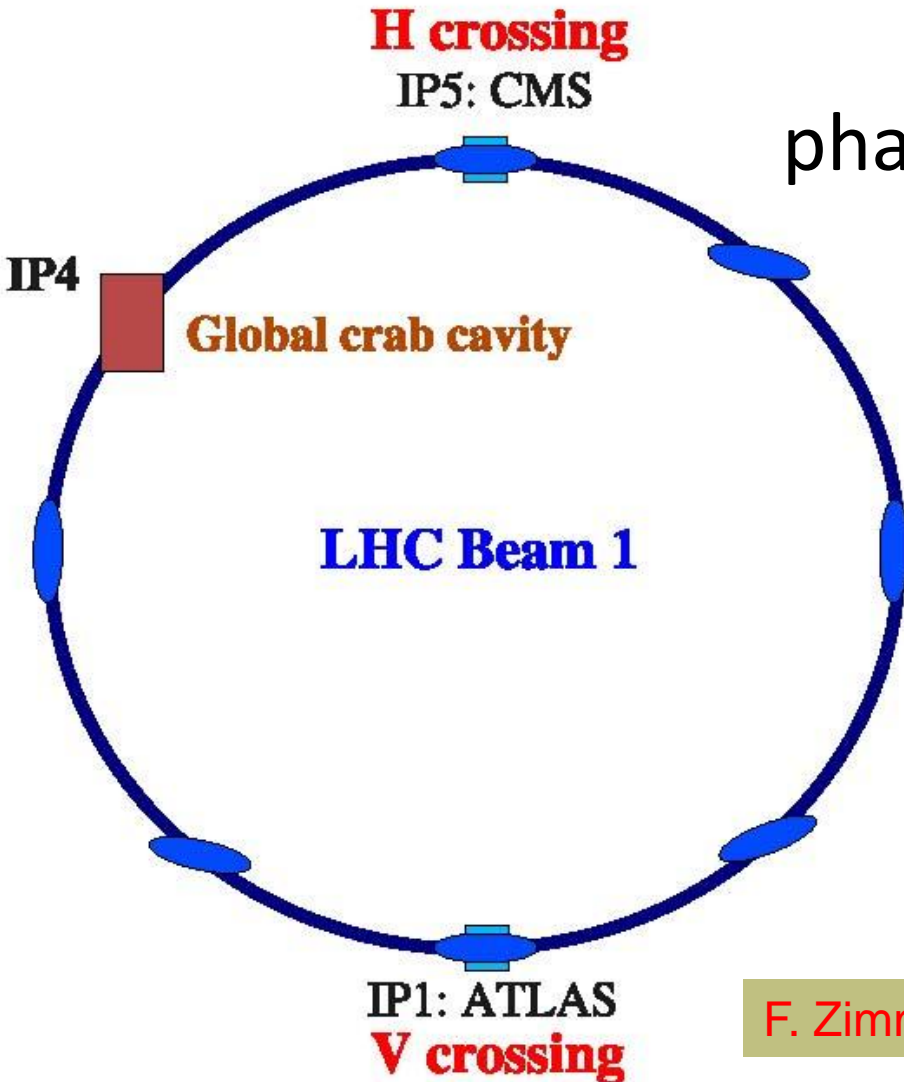
Fermilab, April 26-28, 2010.



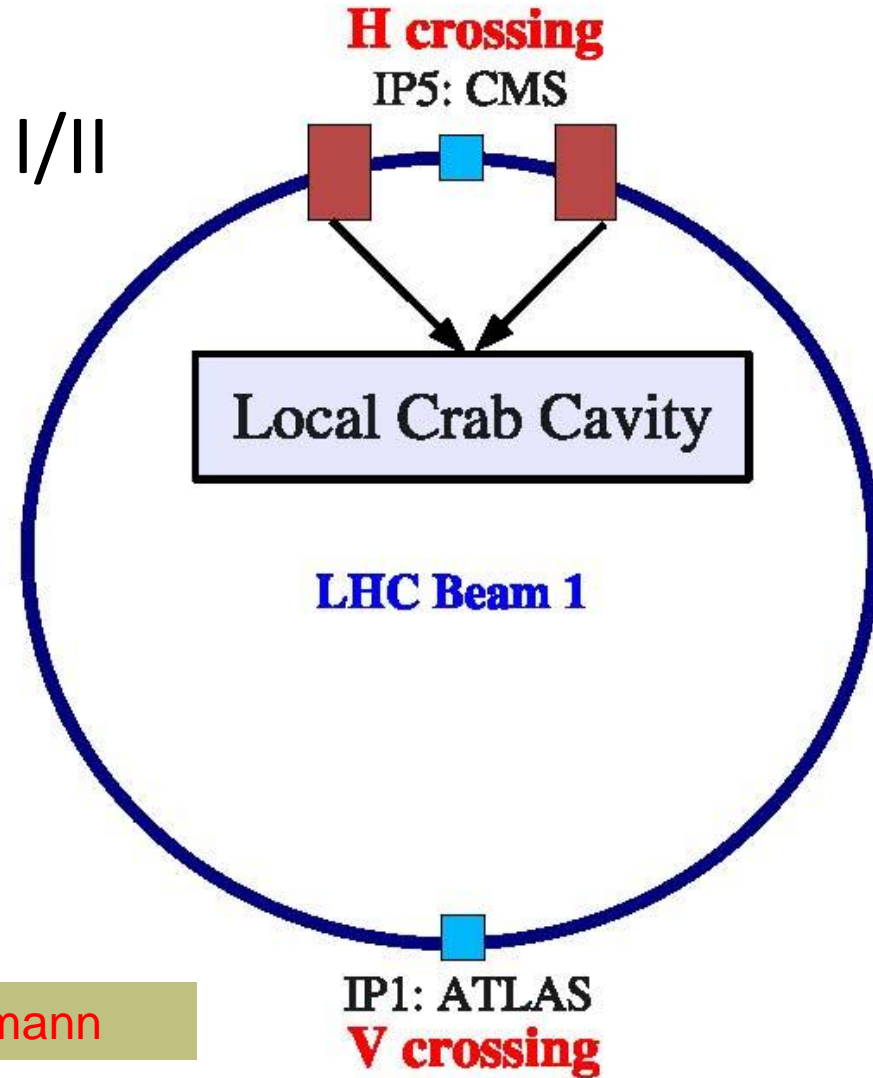
CERN Strategy for Crab Cavities



- Crab Cavities – Introduction
- CC09, Chamonix 2010
- IR Upgrade
- Compact cavities
- Study Issues
- Conventional cavities
- Milestones
- Conclusions



phase I/II



F. Zimmermann



CC Workshop 2009 & Conclusions



- Time scale for 2014/15 shutdown too short, even to install a Global Scheme in IR4
- Space reservations in IR4 for ADT upgrade and ACN installation needed to be kept open
- Better to longer-term pursue Local Scheme around the experimental IRs, using compact cavities.
- 'Down select' the compact cavity options

CC09 Wind-up meeting

- **Crab Cavities considered a very attractive option** compared to intensity increase, further work strongly encouraged by CERN management.
- **BUT** Do not use LHC as a test bed !
- Issues with machine protection to be studied
- **Test a Crab Cavity first in SPS**
Look at possibility of installing the ex-KEK crabs in SPS.

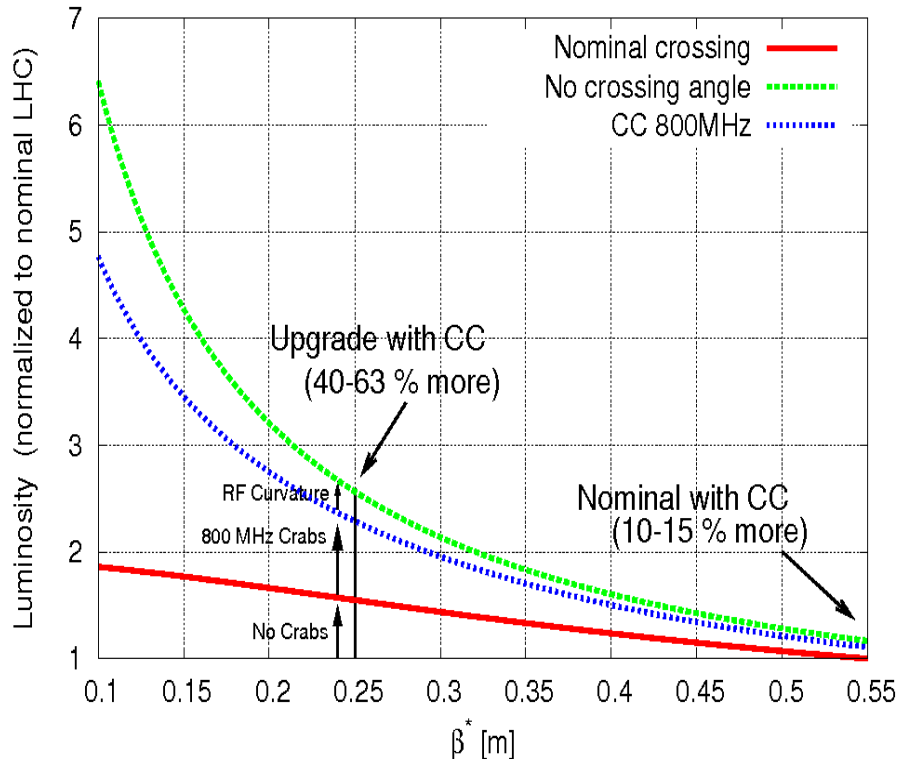
Nominal luminosity 1.0E34 with 1.1E11 particles/bunch

Ultimate 2.3E34 with 1.7E11/bunch (Needs cryo upgrade in IRs)

Upgrade for 5-6E34, keeping 1.7E11 needs (amongst other things)

- New triplets with lowest possible β^* (~ 20 cm), based on high field Nb3Sn (or Nb3Al)

- **Compensation of geometric effect with crab cavities**



Considerable
luminosity increase
for $\beta^* < 25$ cm

Main Goal : Compact Crab Cavities for LHC Local Scheme

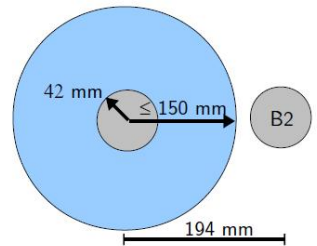
Since CC09 down-selection has evolved..

Some candidates fitting in the normal 194 mm beam separation regions:-

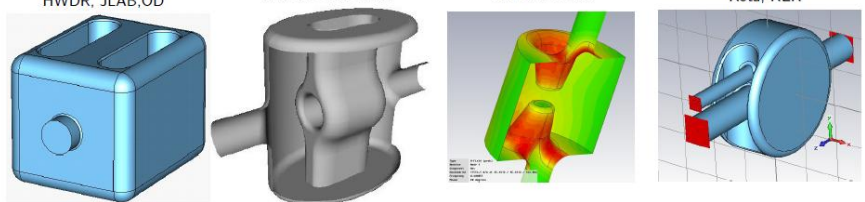
HWDR JLAB	J. Delayen
HWSR SLAC	Z. Li
DR UK,JLAB	G. Burt/H. Wang
Kota KEK	Kota

Covered in talk by R. Calaga, and dedicated talks by J. Delayen and Zenghai Li.

LHC NEEDS COMPACT CAVITIES 2008-2010



HWDR, JLAB,OD HWSR, SLAC-LARP DR, UK, TechX Kota, KEK



Compact cavities aiming at small footprint & 400 MHz, 3-8 MV/cavity



- Comparison based on basic common parameter set, e.g.
 - Beam separation 194 mm CL to CL
 - Beam pipe diameter 42 mm
 - Frequency 400 MHz
 - Integrated kick identical
- On the down selected options:
 - Do the full design (mech. drawings) – (perhaps also do this for other preferred designs)
 - Construct copper prototypes (to check construction methods)
 - Build Niobium versions
 - Do bare cavity tests
 - Construct couplers
 - Design of HOMs, RF components
 - Design & Build cryostats
- Test in SPS

A strong R&D program with hardware prototyping needs to continue.



Fundamental issues:

- Machine protection
- Collimation
- Orbit control, orbit feedback
- Impedance, Q external, power requirements



Inter
related

Operational issues :

- Tuning,
- Ramping,
- RF noise
- Effects of RF trips

See next talk R. Calaga



KEK Crab Cavity in SPS



- A working group under E. Metral (CERN) has made a preliminary study (end 2009) with some basic conclusions:- ***R. Calaga – next talk***

=> First tests could only be in 2012

- Power system (IOT) needed, LLRF & Controls
- Probably need to power test & condition before installing in SPS..

CRAB SPS Studies by Hyung Jin KIM (Acc Systems B)

'Conventional' elliptical cavities

- Global Scheme discounted due to time scale imposed by IR upgrade in 2014/5
- Space availability in IR4 was also a concern

BUT

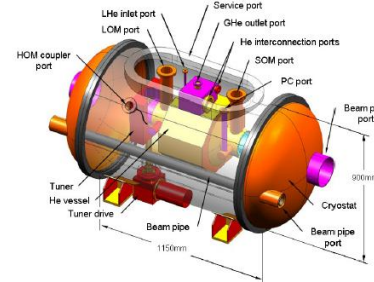
- Time constraints changed due to merging of upgrade phases (new proposal...)
- Space reservation in IR4 for ACN now less likely to be needed (SPS RF system upgrade)

Detailed study

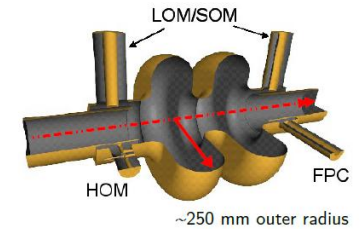
by Liling Xiao, Zenghai Li, CC09

CONVENTIONAL CAVITIES

- 2 cell elliptical cavity @800 MHz
- Strong HOM damping schemes
- Multipacting, thermal, mechanical etc...



2007-2009!



Conceptual cryostat design exists

Exact RF-cryogenic-mechanical interfaces to be finalized

Only possible in IR4

Test of Conventional CC in SPS or LHC IR4...

- Mitigation of risk on embarking on long R&D program for compacts
- Limited fundamental development needed
- Interest in doing a CC test in SPS at a nominal frequency (no bunch pattern restrictions)
- Possibility to test the cavity in LHC
 - Test of Global Scheme in LHC (with some luminosity gain possible)



Milestones :

Towards a full local scheme around IRs 1 and 5 in 2018.

- First compact cavity with cryostat mid 2014 ?
- SPS test of compact cavity 2014/15, use elliptical if this appears unachievable ?
- Possible test in IR4 could follow to demonstrate luminosity
- Production and test of compacts 2015-2017
- Installation 2017/2018



Conclusions



- IR upgrade Phases 1 & 2 may now become a single upgrade
- Crab cavities offer significant luminosity improvement, without intensity increase, important issue for LHC and the whole injector chain.
- **“Highly speculative”** but needs to be pursued vigorously
- Has become an integral & important part of the upgrade study (L. Rossi Task Force)
- **Baseline is compact cavities with elliptical as back up** for proof of principle & studies in SPS at an early stage
- Important beam studies need to be continued.
- There are many challenges:
Beam issues, machine protection, SC technology.....

⇒ ***Talks at this meeting***

⇒ ***Dedicated meeting on CCs Wednesday p.m.***