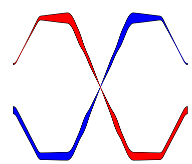
LHC Crabs: Summary, Q&A

R. Calaga, F. Zimmermann

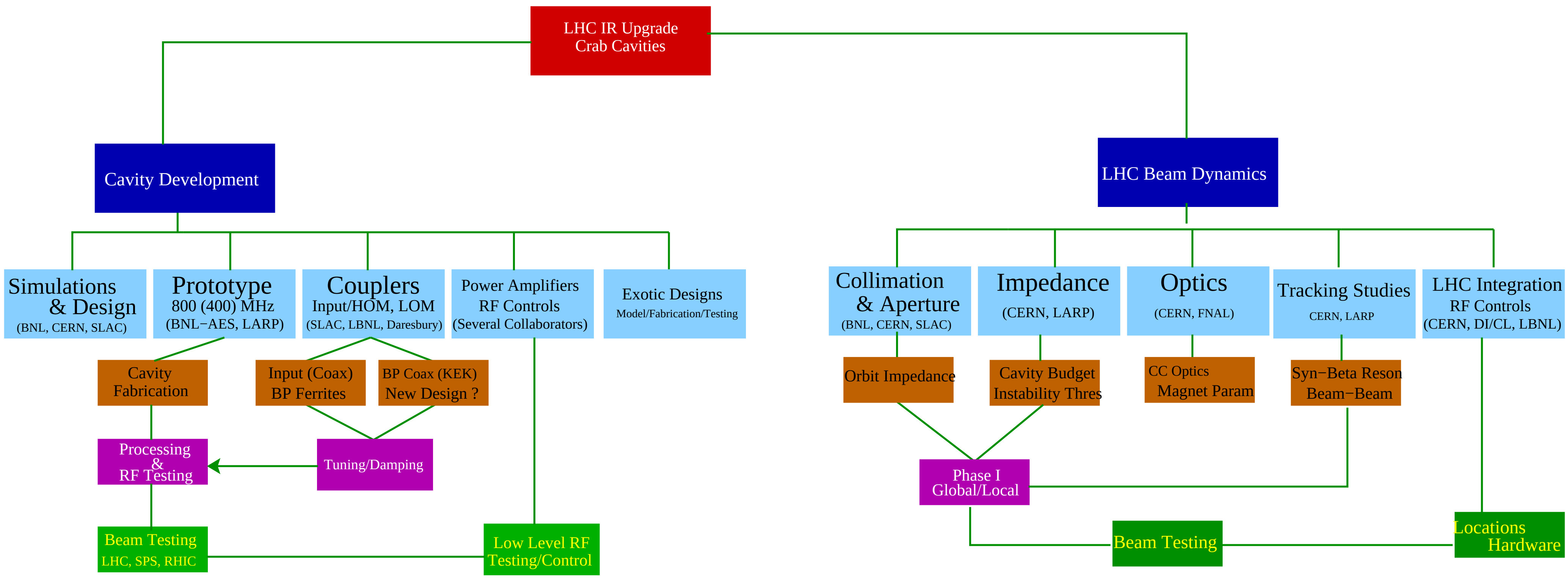
BNL, LARP, CERN



LHC-CC08: Feb 26, 2008

1^{st} Mini BNL/LARP/CARE-HHH Workshop

R&D Proposal



- Use TWiki as the central repository for design & simulation results
- Identify various people involved in different studies and consolidate
- What are current resources available & what are needed
- Timeline (Phase 0: 2010-11), (Phase I: 2013-14)

Charge & Conclusions

- Choice of Freq:
  800 MHz is best for Phase 0, lower frequencies if compact cavities are available. BB simulations + RF curvature (Ohmi ?)

- How much free space 10m for Phase 0 (IP4) & 20m for Phase I (IP5/1 with new optics)

- Global or Local Phase I

  - Collimation has to evaluate the exact loss maps and additional heat deposition from oscillating bunch. Configuration to allow for the extra 0.5σ orbit

  - Can we optimize the existing collimators to exploit oscillating bunch (longitudinal collimation) and reduce impedance

- Noise Effects: Need more strong-strong to understand any issues but current estimates and RF jitter suggests that LLRF can keep the jitter within required tolerances

- Design, Fabrication & Processing
  - Gradient of 2.5-3 MV for 2 cell 800 MHz cavity (E_{peak}¡40 MV/m, B_{peak}¡120 mT)
  - 1-2 crab structures/beam should be sufficient. Additional degrees of freedom from optics
  - 0.75 squash ratio is reasonable to fabricate and will fit in new optics with VV crossing
  - Cavity aperture $>$ 10 cm diameter
  - Various designs of couplers available, beam pipe coax + waveguide may be most effective and robust
- R&D Objectives
  - Adapt from previous R&D: LLRF, Couplers, Cryostat(LHC), Tuners
  - Focus priorities: Collimation, Impedance, Final cavity design and couplers, Common cryostat, Simulations, Simulations, Simulations & Measurement on models
- Cavity Impedance needs careful evaluation to establish single bunch & coupled bunch effects. Start with assumptions used for existing narrow band impedances in the LHC

- RF Control
  - Q_{ext} $10^5 - 10^6$?
  - Power handling - beam pipe coax + ferrites robust for high currents
  - Phase jitter control easily possible $\leq 1 \times 10^{-2}$ deg, need $\leq 1 \times 10^{-2}$ deg (800 MHz)
  - Power Amplifiers: IOT (50-100 kW) ?

Luminosity Leveling

Experiments prefer constant luminosity as opposed to very high at start & low at the end.

$$\text{events/crossing} = \frac{L_0 \sigma_{inel}}{n_b} \approx \text{const}$$

Some ideas exist:

- Reducing β^* during the store, hard in practice to precisely control and avoid spikes in detector signals
- Adjust crossing angle using dipole inside the detector, also hard to control the orbit during a store with additional difficulty of elements inside the detector
- Crabs offer a trivial and transparent way to achieve crossing angle control. Also SRF cavities with high Q_{ext} are natural for slow ramping of voltage
  - RF phase tolerance become losser if luminosity is leveled with CCs

LHC Crab Cavities ⟶ Next Frontier

Thanks for joining this exciting adventure

People Thinking about LHC Crab Cavities