Comments towards a Crab Crossing system in the LHC

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LBNL

Outline

- ## Where we are….
  - SPS test considerations

- ## Defining the LHC baseline
  - Additional questions

- ## Schedule Considerations
  - beyond the SPS test

SPS vs. LHC

- SPS
  - 3-4 year focus
  - Streamlined goals to simplify systems and provide more fundamental answers
    - Ie. Does crabbing work with proton beams?
    - Validate design(s) with beam
    - We don't need active alignment to verify this
    - No testing of this CM in the LHC
    - Validate LLRF, MPS….

- LHC implementation will need SPS results + much more

Questions for the LHC- Cavity

- Specifications:
  - Cavity design (H vs V)
    - is the ability to kick in both planes a requirement for all cavity geometries?
  - Crab in both planes at both IPs? (ie. kissing)
  - What is the *final* operating gradient/kick per cavity? Final aperture?
  - Impedance budget

    --> what is the acceptable n of cavities, HOM damping requirements...
  - Field quality requirement?
- Quench protection and response
- MPS
- Adopt this FPC design?

Questions for the LHC - Cryomodule

- See Ofelia's presentation
- Active alignment?
- Chose Cryomodule configuration
  - N of cavities per CM?
    - In each IP
      - 4x2 – requires 16 CM + 2 spares
      - 2x4 – requires 8 CM + 2 spares
      - 1x8 - requires 4 CM + 2 spares
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-
- Develop Spare CM and cavities strategy

We will need to finalize all of the above (and more) before defining a baseline design of the cryomodule for the HL-LHC. Most of the questions should be answered in TDR (2016).

Example of LHC configuration

- Single CM with 8 cavities
  - Would need 4 + 2 spares (H and V configuration)

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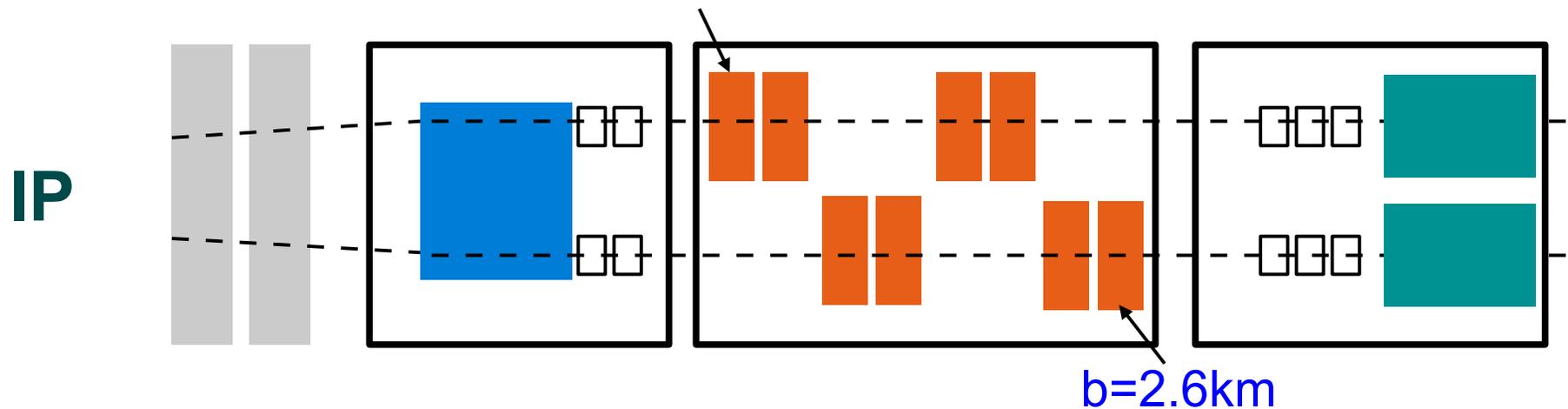
Cavities for the LHC: H and V

- Even with one cavity design, must repeat a lot of engineering integration to rotate in the second plane
  - But we use a single core RF cavity
- We could implement two separate RF designs in the LHC
  - And we could have a tested solution for each plane, but smaller cavity production runs
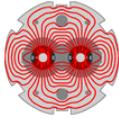
What will go in the SPS?

- Establishing selection criteria
  - Major item in this review
  - See next talk

- Will be ready to select in ~ one year
  - When test data will be available

- Provocative comment for cavity selection

  Any cryomodule to meet requirements and pass SM18 Horizontal test in 2016 has a great chance to be installed in the SPS

- Could test two different CM
 - Some luck required

- CERN will decide
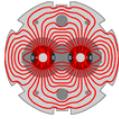
Path to the SPS test

- Multi-disciplinary working group at CERN
  - Coordinated by Alick MacPherson

- All cavity development is in close collaboration with CERN (each team)

- LARP cavities in Niowave fabrication plan
  - Followed by T. Nicol
  - Defined check points (as shown) by design teams

- Cavity production integrated in the plan presented this morning

Working with Industry

- Defined interfaces
  - T. Nicol (FNAL) is the main POC for LARP
  - Each team appoints a signoff person
- Production processes with defined check points for each design
  - Cavity teams participate in key verifications
- Meeting and reviews as needed
  - Defined by production process
  - Each cavity proceeds independently
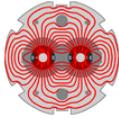- All documentation in the EDMS system (CERN)
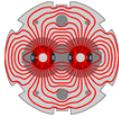
Path towards LHC

- Plans for final CM design start during the SPS test in 2017
- Possible Horizontal tests of an additional cryomodule in SM18 (if needed)
- Build production prototype LHC cryomodule by 2019
  - Final configuration, full features
- Start production in 2020
- Install in 2023

Conclusions

- The SPS validation program described in this review is only a subset of the most important features needed for the final LHC system

- Need the answers for LHC configuration by TDR in 2016
  - Freeze requirements so we can design

- Available time to complete LHC installation is reasonable but not excessive
  - Must start as soon as SPS tests begin

Questions?