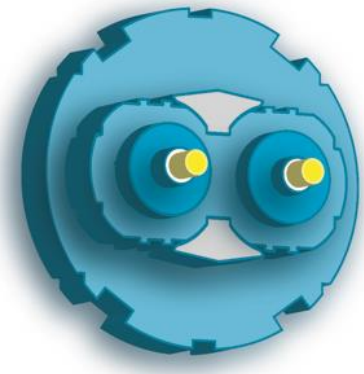


High Luminosity LHC

Status of BBLR compensation within HiLumi project

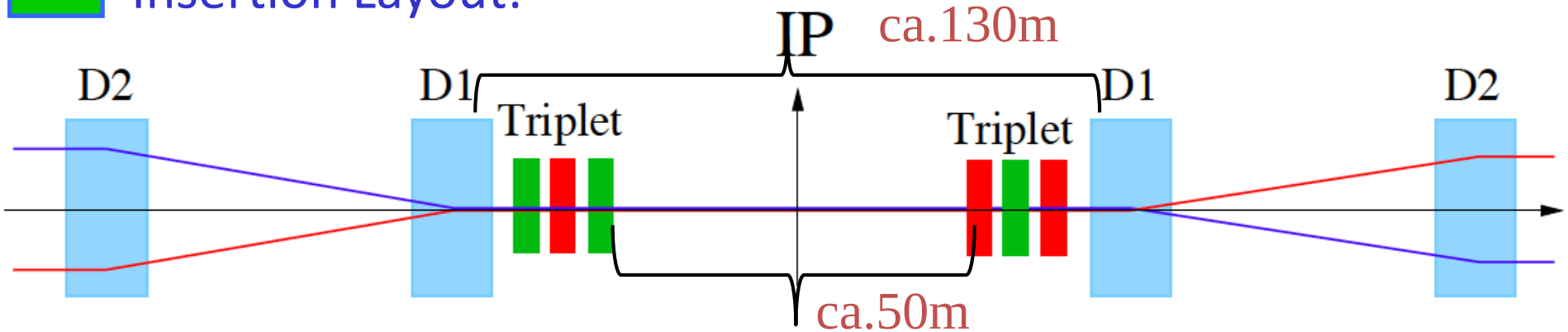
The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

LRBB Compensation & HL-LHC

- HL-LHC Challanges
  - ➔ LHC IR Layout & geometry imply virtual encounters for 25ns
  - ➔ Crossing angle transforms these to Parasitic encounters
  - ➔ Non-linearity and HL-LHC bunch intensities imply > 12 σ
  - ➔ Large aperture and loss in instantaneous Luminosity

HL-LHC Challenges: Crossing Angle I

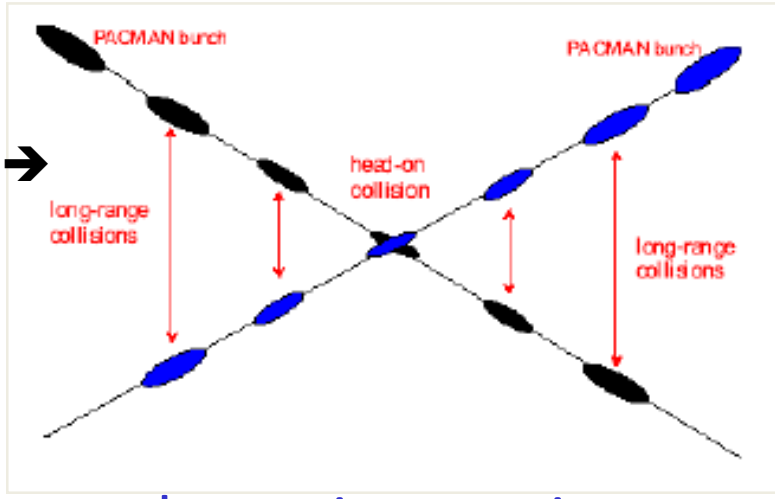
Insertion Layout:



Parasitic bunch encounters:

Operation with ca. 2800 bunches @ 25ns spacing ➔ approximately 30 unwanted collision per Interaction Region (IR).

➔ Operation requires crossing angle



non-linear fields from long-range beam-beam interaction:

efficient operation requires large beam separation at unwanted collision points

➔ Separation of 10 -12 σ ➔ large triplet apertures & Luminosity loss!!

LRBB Compensation & HL-LHC

- HL-LHC Challanges
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- HL-LHC Baseline
  - ➔ Adopted Crab-Cavities and large aperture magnets!

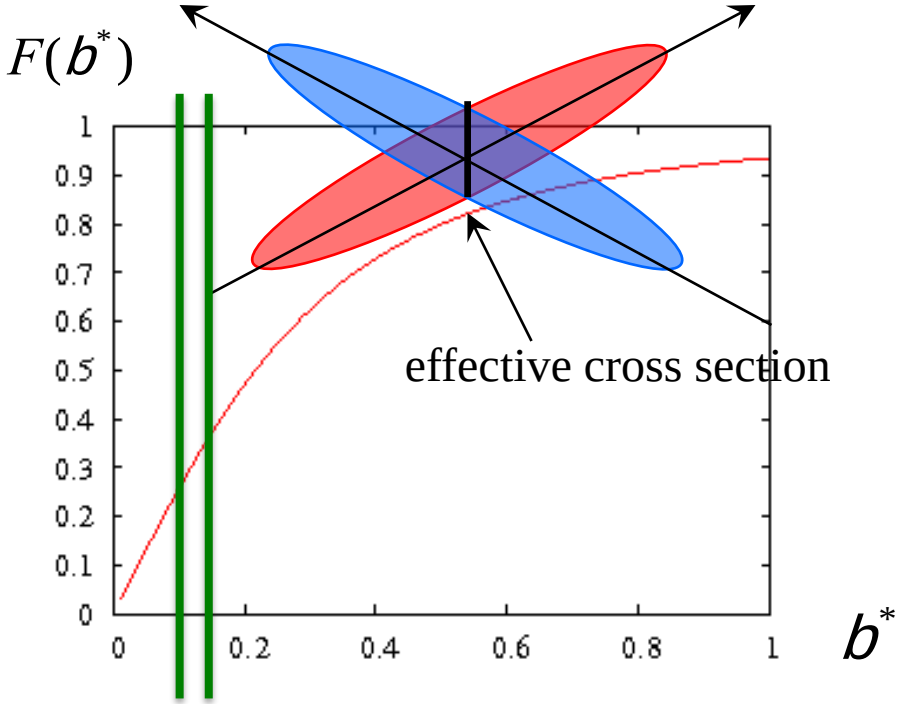
HL-LHC Upgrade Ingredients: Crab Cavities

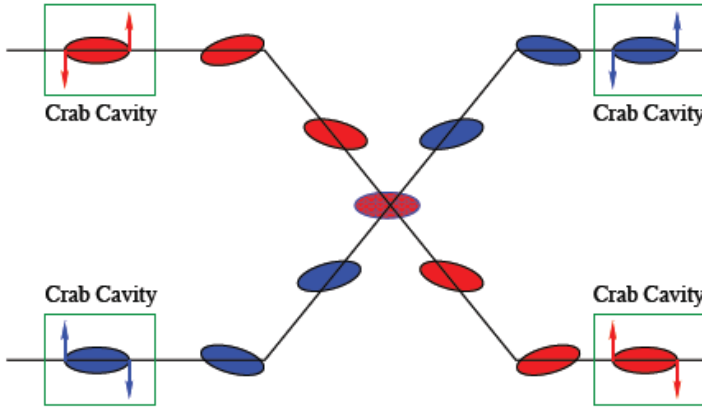
Crab Cavities: Luminosity Reduction Factor:

- Reduces the effect of geometrical reduction factor
- Independent for each IP

$$F = \frac{1}{\sqrt{1+Q^2}}; \quad Q^{o} \frac{q_c s_z}{2 s_x}$$

- Noise from cavities to beam?!?
- Impedance?
- Reliability & failure rate?





HL-LHC Magnets:

- LHC triplet:

  210 T/m, 70 mm bore aperture

  ➔ 8 T @ coil (limit of NbTi tech.)

- **HL-LHC triplet:**

  140 T/m, 150 mm coil aperture

(shielding, β^* and crossing angle)

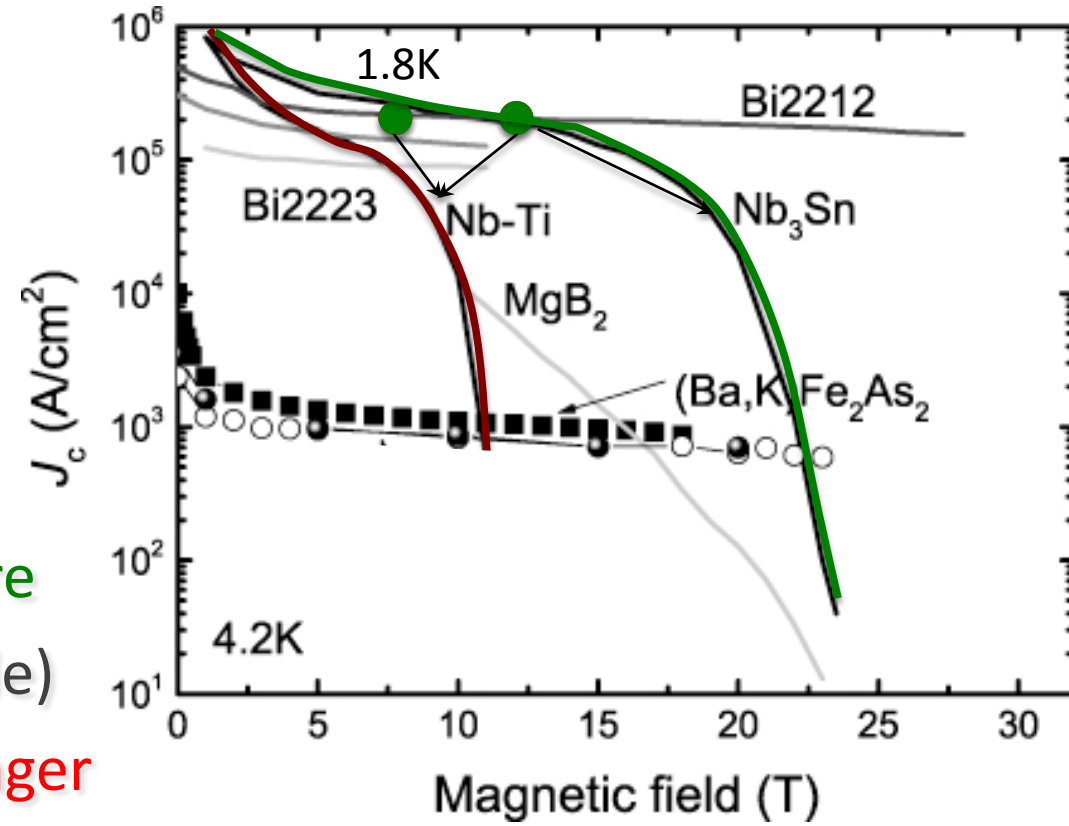
➔ ca. 12 T @ coil ➔ 30% longer

  - Requires Nb_3Sn technology

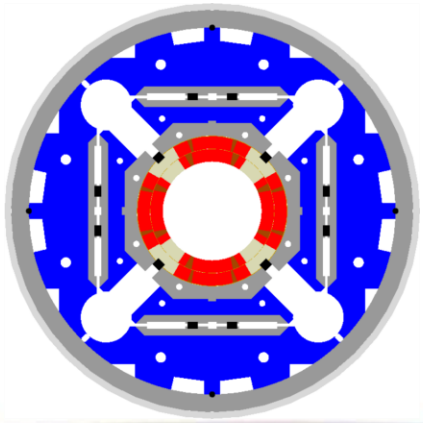
    ➔ ceramic type material (fragile)

    ➔ ca. 25 year development for this new magnet technology!

  - US-LARP – CERN collaboration



US-LARP MQXF magnet design Based on Nb_3Sn technology



LRBB Compensation & HL-LHC

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- HL-LHC Baseline
  - ➔ Adopted Crab-Cavities and large aperture magnets!
  - ➔ But LRBB compensation is still very interesting for HL-LHC:
    - ➔ RLIUP: Plan B with flat beams
    - ➔ Reduced X-in: relaxed CC parameters and additional options

…Phased Crab Cavity installation