Status and plans for the IR optics and layout

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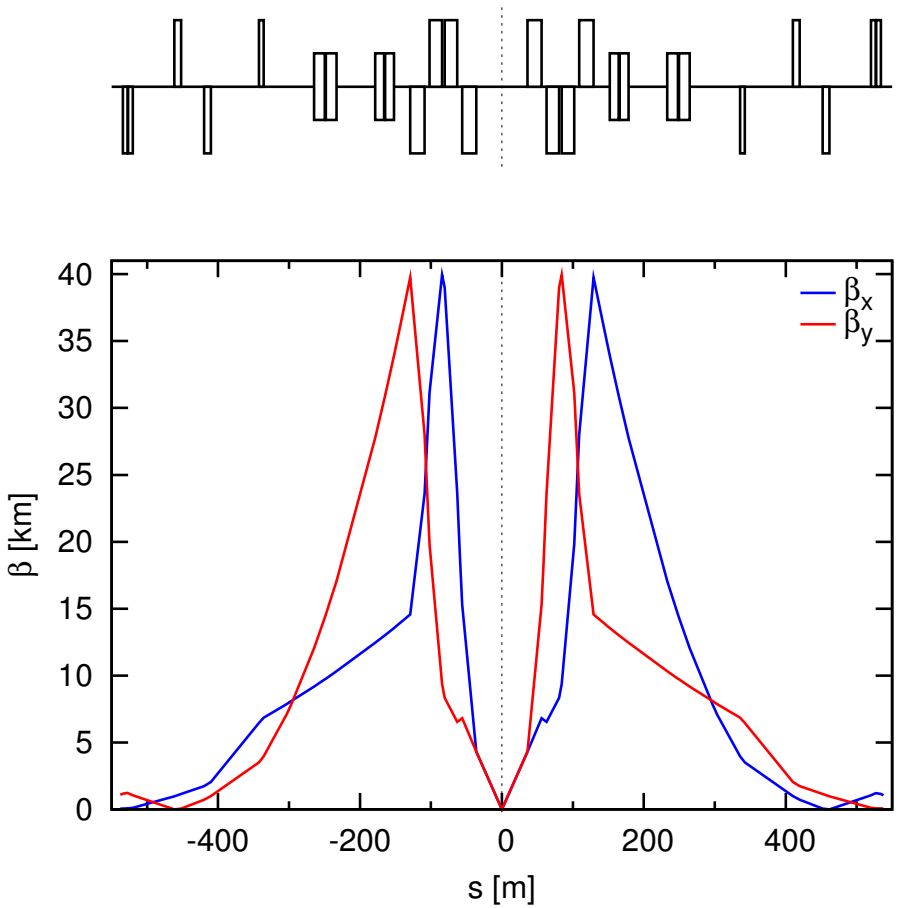
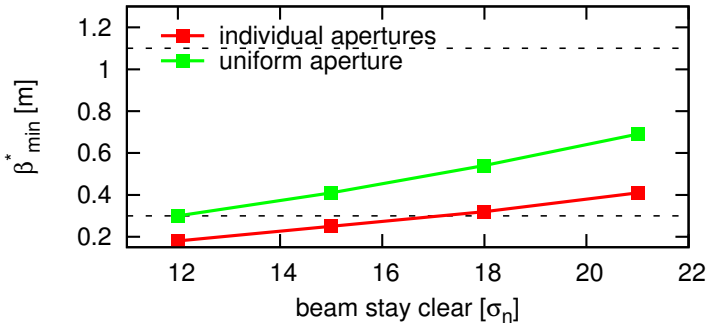
FCC-hh BDS meeting
June 1, 2015

Option 1: $L^* = 36\,\mathrm{m}$



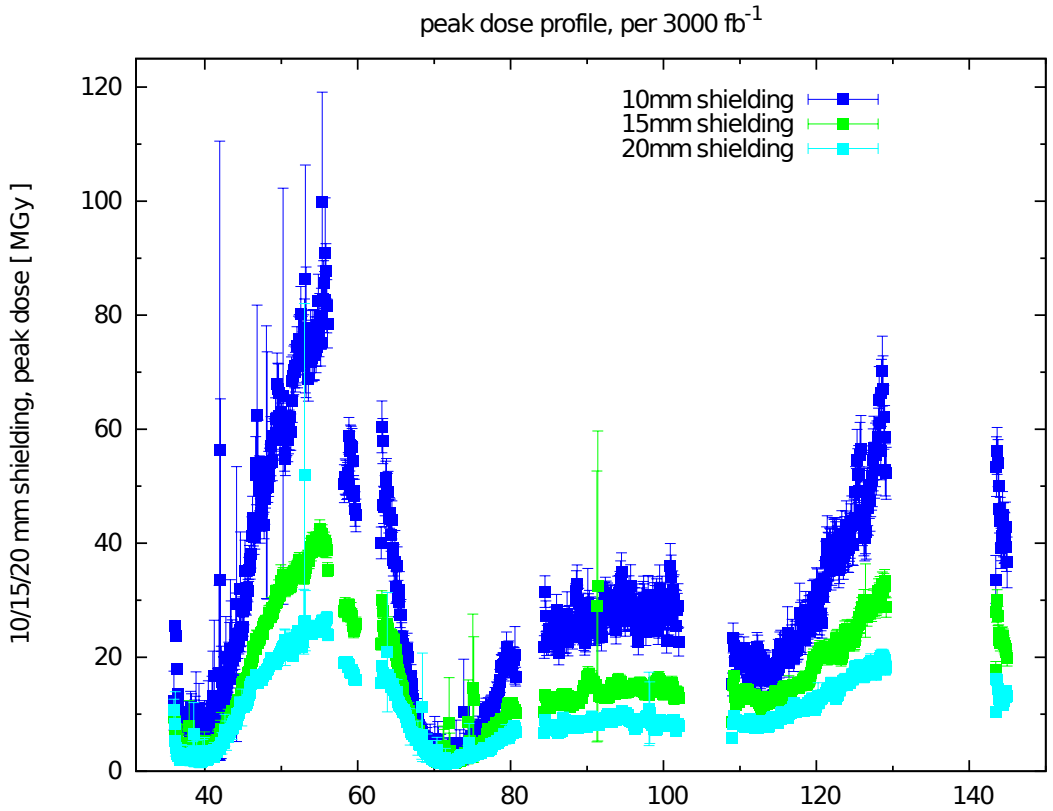


β^* reach with $B_{max} = 11\,\mathrm{T}$.

- β^* gain of 1.6 for individual apertures

FCC-hh interaction region design $\beta^* = 0.3\,\mathrm{m}$

Option 1: $L^* = 36\,\mathrm{m}$



Simulations by F. Cerutti and I. M. Besana

Chromaticity:

$$\xi = \frac{1}{4\pi} \int k_1 \beta(s) ds$$

For $\beta^* = 0.3\,\mathrm{m}$:

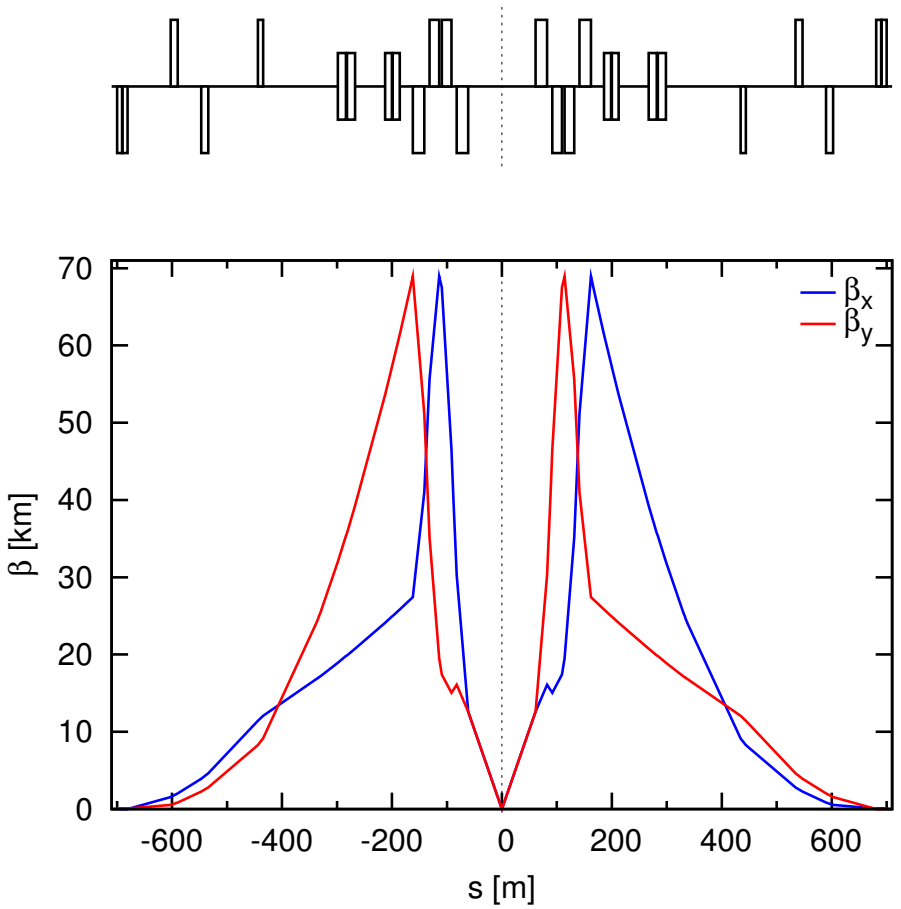
$$\xi_x = 47.2$$

$$\xi_y = -61.5$$

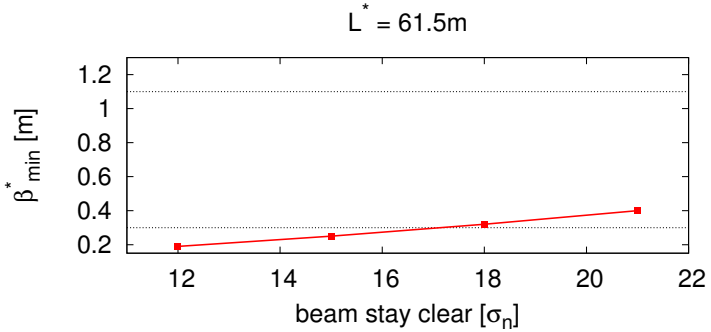
(per side, triplet only)

- dose seems acceptable for 15mm shielding at $3000\,\mathrm{fb}^{-1}$, for higher luminosity, optimization is required

Option 1: $L^* = 61.5\,\mathrm{m}$



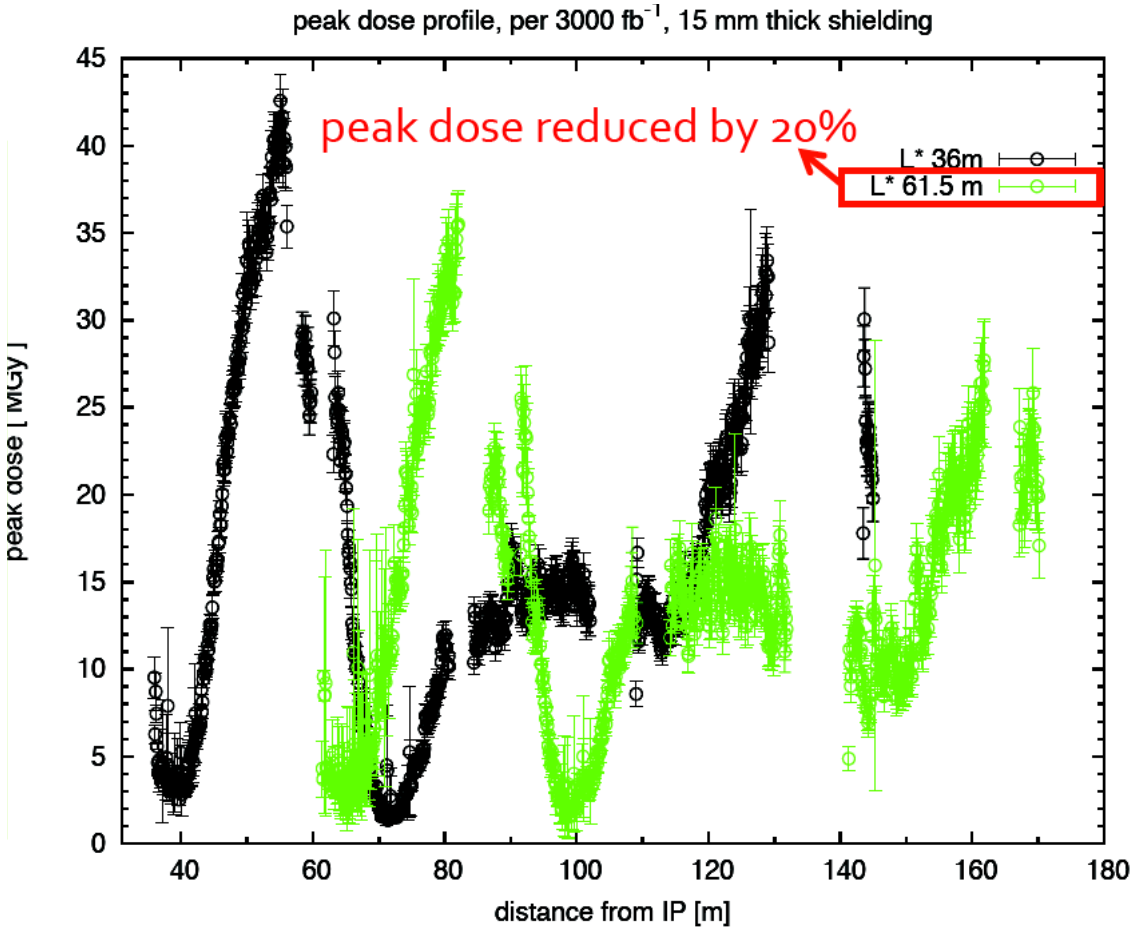
- makes use of HL-LHC triplet magnets (SLHC V3.1b)
- aperture and beam size scale similary $\Rightarrow$ impact of shielding decreases for larger aperture



FCC-hh interaction region design $\beta^* = 0.3\,\mathrm{m}$

β^* reach with 140 mm aperture and 150 T/m gradient

Option 1: $L^* = 61.5\,\mathrm{m}$



Simulations by F. Cerutti and I. M. Besana

Chromaticity:

$$\xi = \frac{1}{4\pi} \int k_1 \beta(s) ds$$

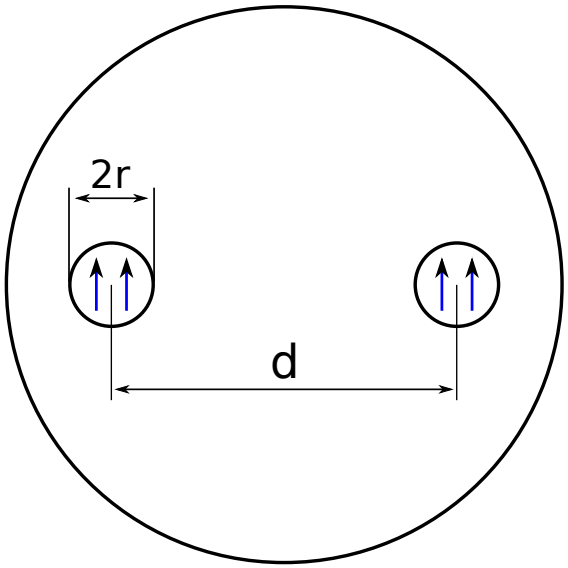
For $\beta^* = 0.3\,\mathrm{m}$:

$$\xi_x = 81.0$$

$$\xi_y = -64.2$$

(per side, triplet only)

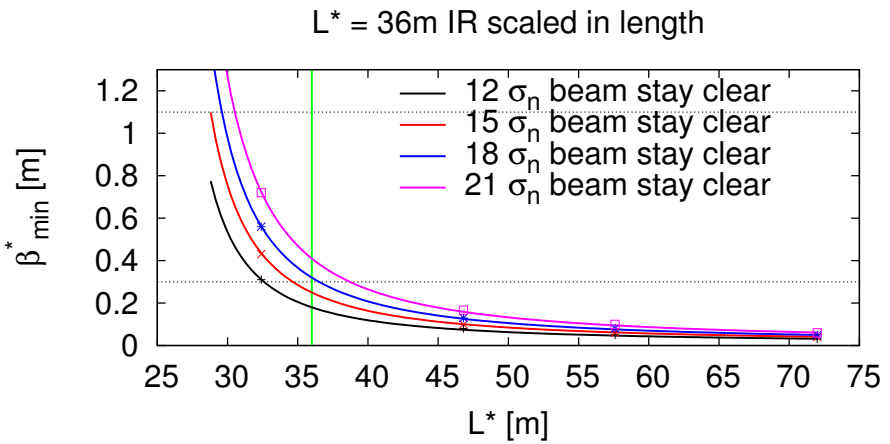
Update on magnet apertures

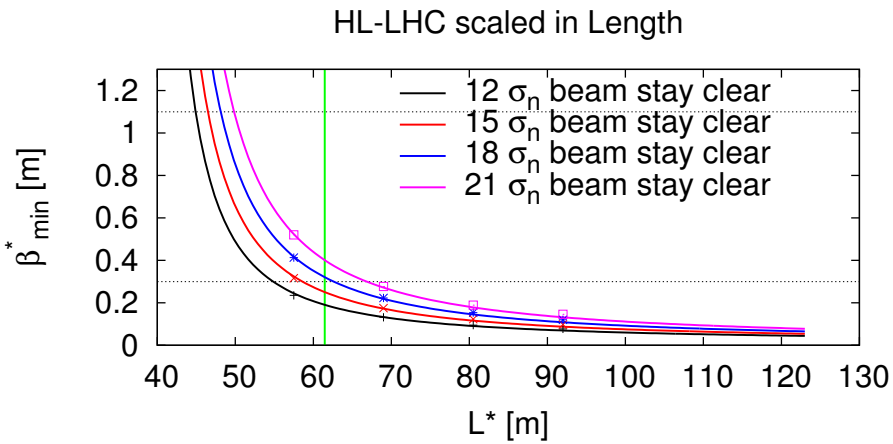


L^*	36 m	61.5 m
B_{D1}[T]	12	
B_{D2}[T]	10	
coil aperture $2r$ [mm]		
- D1.A	87	111
- D1.B	121	143
- D2.A	77	97
- D2.B	60	79
Separation d [mm]		
D2.A	264	
D2.B	294	

- if field requirements cannot be met at given aperture $\Rightarrow$ smaller field, longer separation section

Analytic length scaling

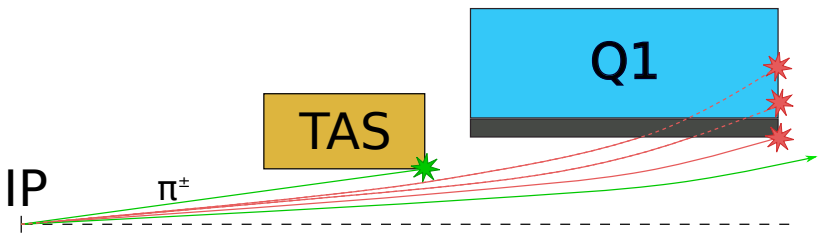


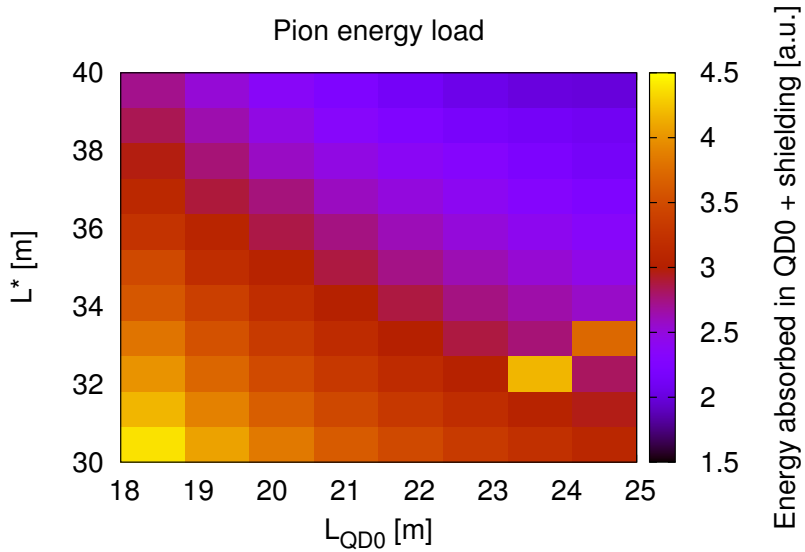


- scaling all lengths from a known and matched lattice
- larger crossing angle for longer triplet included
- Lines: analytically scaled, Dots: values found with MAD-X (no rematching of quadrupoles) $\Rightarrow$ good agreement
- both scaled lattices differ in ratio of L^* and $L_{triplet}$
- conclusion: make L^* as long as possible, make $\frac{L_{triplet}}{L^*}$ as large as possible
- limits: chromaticity and overall length

Pion tracking code

- Idea: implement radiation dose as a parameter in the triplet design $\Rightarrow$ need for fast estimates
- linear tracking of pions through Q1
- estimates dose on a hit/non-hit basis
- still much work to do





Result of an early run using some simplifications

Work do be done

- split Q1 to reduce radiation dose
  $\Rightarrow$ pion tracking code
- start caring about limitations of L^* and $L_{triplet}$:
  - Chromaticity $\Rightarrow$ **dynamic aperture**
  - magnet errors $\Rightarrow$ higher order multipoles and misalignments
  - total IR length
  - magnet cost ($L_{triplet}$)
  - study dose / β^* vs. L^* and $L_{triplet}$
    $\Rightarrow$ try to get an analytical scaling for $\frac{L_{triplet}}{L^*}$ as well?