A study for the phase 1 upgrade.

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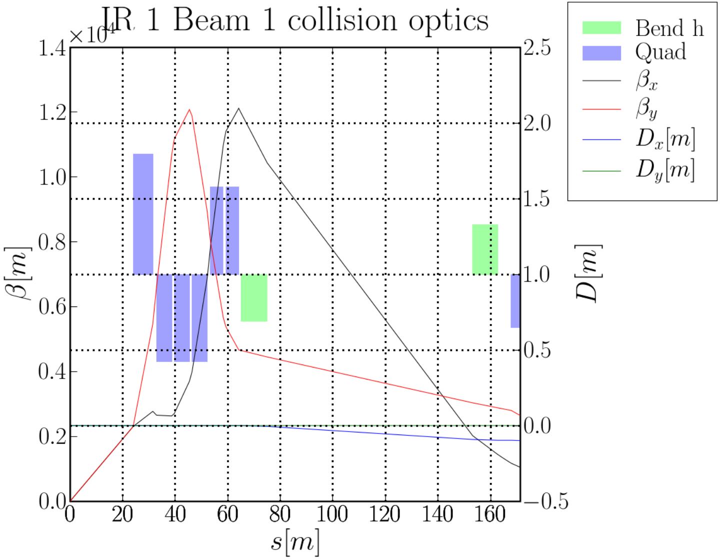
Introduction

Lowbetamax and symmetric are very similar proposal in terms of triplet gradient, triplet aperture, overall triplet lengths, peak beta function.
They differ a lot in terms of modularity, aperture margin in the matching section.
The aperture margin in the matching section does not depend strictly by the modularity, but by the exit condition in the triplet.
A different modularity can optimize the performance of a triplet with the "best" exit condition compatible with hardware constraints, but the "best" exit condition itself is not known.
I think that the "best" exit condition is worth to be found before any further iteration of the triplet.

Lowbetamax



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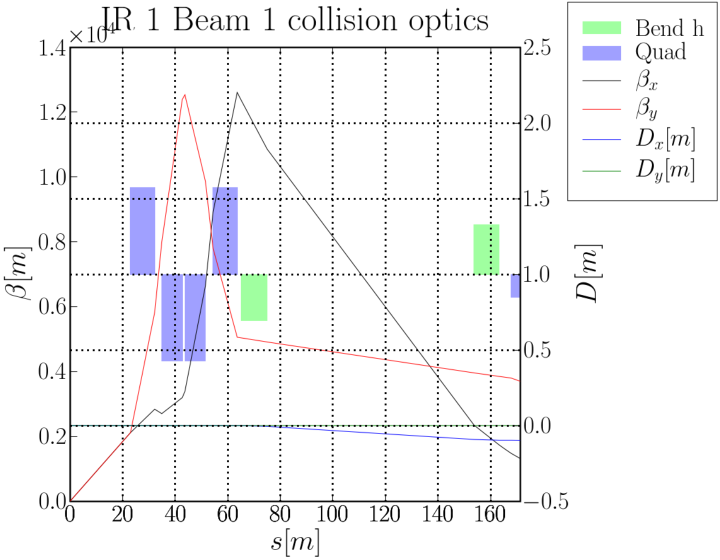
Symmetric



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Aperture bottlenecks

	Compact	Modular	Lowbeta	Symmetric	LHC
MQX, ap 1	20.026	14.141	7.821	15.466	7.215
MQX, ap 2	16.953	12.633	8.830	8.438	6.845
D1	5.303	6.379	7.607	7.323	7.431
D2	5.372	4.271	7.959	6.518	15.152
Q4	7.387	6.432	8.685	7.184	15.615
Q5	4.701	3.859	10.425	7.028	16.871

Data in terms on n1.

Problem

Once the aperture or the gradient is fixed, the limitation of aperture, strength, tunability, squeeze depends mainly on α_x, α_y at the end of Q3 because:

- The gradient or the aperture of triplet defines with a 10% the β_x, β_y, s of the end of Q3 regardless of the modularity (Q1 optimized or not, Q1 equal Q3 or not).
- α_x, α_y of the end of Q3 together with β_x, β_y, s of the end of Q3 defines exactly α_x, α_y, β_x, β_y at the beginning of Q4

Strategy

I propose to study the aperture, strength, tunability, squeeze using as free parameters α_x, α_y and as fixed parameters $\beta_x = 13$km, $\beta_y = 5$km, $s = 64$m at the end of Q3 (for the squeeze a simple scaling exists).

This study should select the “best” α_x, α_y and good optics for injection, collision and squeeze.

Once this is done it is possible to redesign the triplet with much stricter boundary conditions and use

- the gradients of the triplet (1 or 2 constrained parameters),
- the distance between the triplets (3 free but weak parameters),
- the lengths of the triplets (2 or 3 good parameters)

to approximate the boundary conditions previously found (3 conditions) and to fulfill the hardware constraints (lengths of the cryostats, inter-distance between cryostats, BPMs locations, B1-A1-A2 correctors locations).

The new triplets need to be rematched but, with already a good starting point, the process should be trivial.