Merging Flat-beam MD and Long-Range tests with 25 ns beams

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Long range beam-beam MD: motivations

- Long range interactions reduces dynamic aperture, i.e. losses and lower lifetime

- Scaling of losses:
  - Separation (α, β^*, ε)
  - Number of encounters (for 50 ns beams, none for 25 ns)
  - No experience with 25 ns!
  - Dependence with intensity: 1 case only

β^*	$\alpha/2$	N_b	d_{sep} (losses)
1.5 m	120 μrad	1.2×10^{11}	5 σ
1.5 m	120 μrad	1.2×10^{11}	5 σ
0.6 m	145 μrad	1.2×10^{11}	5 σ
0.6 m	145 μrad	1.6×10^{11}	6 σ

details in "**CERN-ATS-Note-2012-070 MD**"

Long range MD: plan

- Trains 25 ns bunches colliding in IP1, IP5 and maybe IP8 or IP2 find the on-set of losses due to reduction of dynamic aperture
    - Start from large crossing angle and reduce it in steps till losses are observed
- Present $\beta*$ and crossing angle at limit (might end up on losses on-set)
- Need to step back to larger $\beta*$ = 1 m ok!

New $\beta*$ $\Longrightarrow$ Collimation validation (2 shifts required) …

Then long-range MD: 2 fills
- First fill: IP1 and IP5 1 train (tot of 60 LR encounters) repeat as previous MD, what counts is normalized separation
- Second fill: two possibilities (depending on simulations):
    - 2 trains to have also LR in IP8 and IP2, to test largest number of interactions
    - 1 train to test intensity effect, bunches with different intensities

From BB no problems if we have flat beams

Flat Beams MD: motivations

From Chamonix 2012 W.Herr et al "Performance (luminosity) reach of LHC after LS1"

Smaller β^* - sure, but:

Luminosity versus beta*
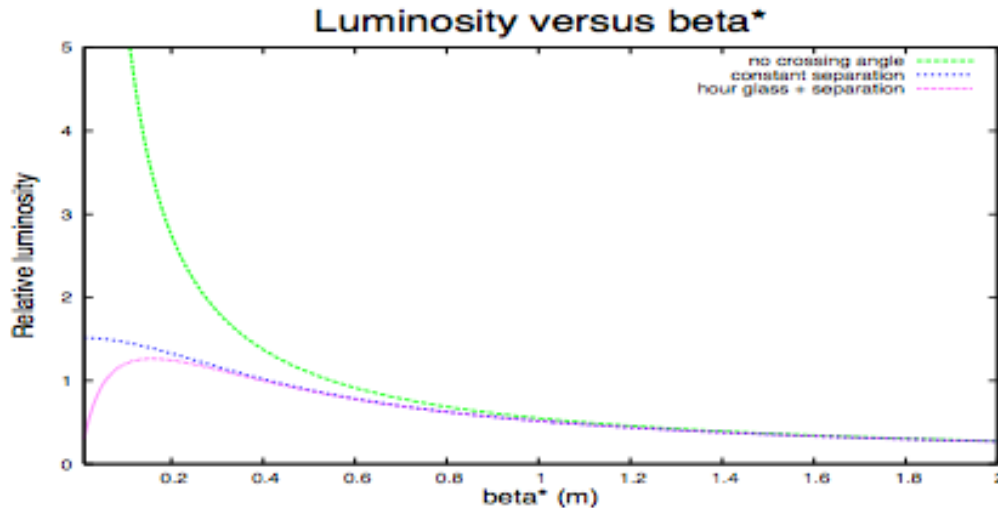
- ▨ Luminosity for different β^* (round beams, constant intensity)
- ▨ Without and with crossing angle (for $10\ \sigma$), hour glass effect
- ▨ Small β^* require crab cavities (not for 2015)
- ➡ No point to go below $\beta^* = 0.5$ m
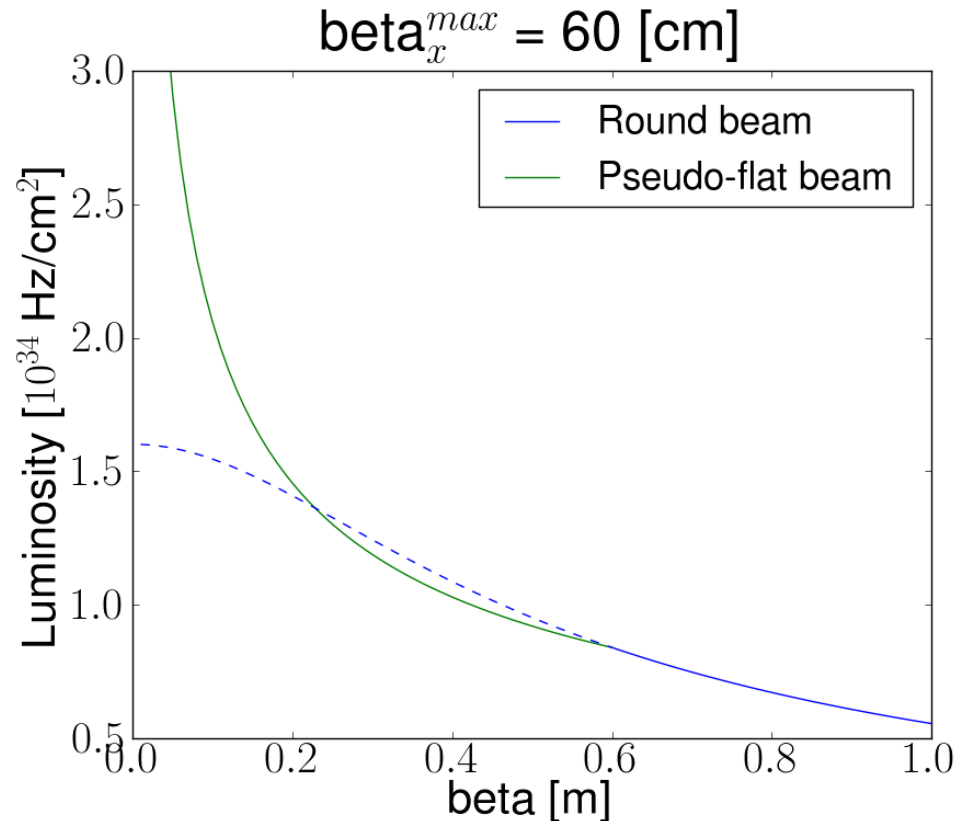
Reduced β^* round beams (big geometrical loss factor)
Round beams "limited" at approx 0.4 m...

Flat beams allow to go to smaller β^* in sep plane and keep larger in crossing plane

Flat Beams MD: motivations
From Chamonix 2012 W.Herr et al "Performance (luminosity) reach of LHC after LS1"

Aperture limit in sep plane comes from sep bump at end of squeeze
With Collide&Squeeze we will gain back some aperture
In crossing plane LR separation kept constant
Gain in luminosity by squeezing in sep plane

With this option we will push the limits were we have margin and keep LR relaxed

Flat Beams MD: motivations

Other potential improvements:

▷ Small emittances allow further squeeze of β^*

▷ $\beta^* = 0.4$ m not out of reach
   (but geometric loss $\approx$ 30 - 40 %)

▷ Pseudo-flat beams (a la $Sp\bar{p}S$, 1982 - 1991):

→ $\beta_x^* \neq \beta_y^*$ → e.g. (0.5,0.3) higher $\mathcal{L}$ than (0.4,0.4)

→ In principle: $\Delta Q_x \neq \Delta Q_y$ (head-on)
   but 10σ crossing angle <u>equalizes</u> tune shifts !

→ squeeze further, (can avoid large crossing angle)

→ May simplify levelling with β^*
   i.e. luminosity increase, no change of crossing angle

From Chamonix 2012 W.Herr et al "Performance (luminosity) reach of LHC after LS1"

Merging the two MDs

LR MD

- **New β^*** on old optics

- **2 Shifts** collimators validation

- **MD 2 fills**

- First 1 train IP1 and IP5

Flat-Beams

- **New flat optics**

- **2 Shifts** for optics validation

  (separated by few days to allow corrections)

- **2 Shifts** collimators validation

- **MD 2 fills**

- Follow long range MD (for free)

2 extra shifts (pessimistic assumption)
to have in our pocket a promising option for after LS1
with Collide&Squeeze and BB LR

Summary:

- Long range MDs with 25 ns beams foreseen to have first estimates for after LS1 scenarios but need new setting for collimators

- Pseudo flat-beams MD gives possibility to squeeze further in separation plane gaining in luminosity (Chamonix 2012 talk) while LR effects constant/relaxed. Good option for Collide&Squeeze after LS1

- New Optics available for squeeze to $(\beta_x, \beta_y) = (1.2, 0.6)$

IR1

IR5
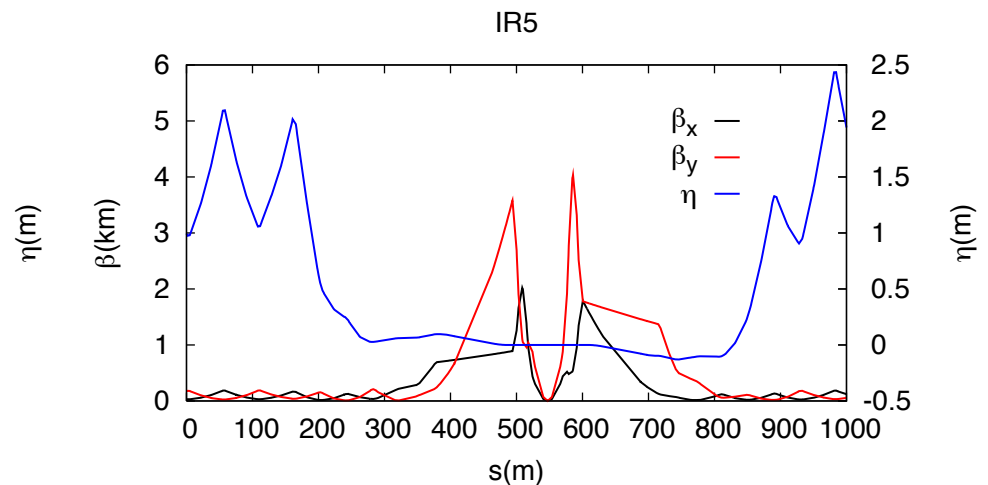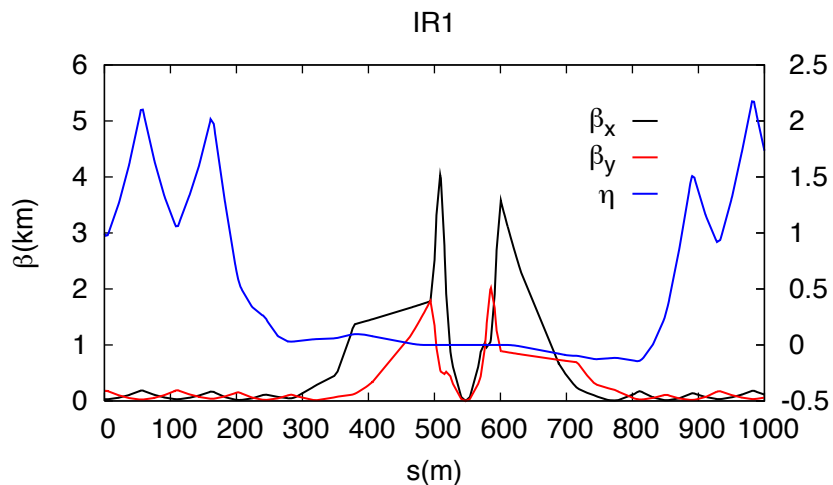
- **Merging the two experiments will require 2 extra shifts (few hours) for optics validation, no problems for BB MD.**