High-β* with crossing angle ?

- Excluded for very high-β* TOTEM / ALFA

- Potentially very interesting for ALICE proton operation as pointed out by

  Rainer Schicker / ALICE - Heidelberg :

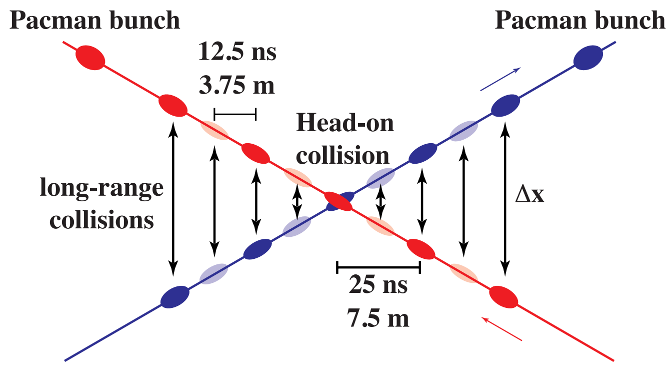
  running ALICE at intermediate β*, in the 30 - 100 m range could then be done in parallel to physics operation over longer time periods

  this may open a new window for studies of diffractive physics including processes of smaller cross-section which require longer running

Here :

first, rough estimates, as requested before next LHCC (21/3) & Lumi days (End of Feb.)

Rough estimate of β* with crossing - separation and geometry



Low β* (< L*) beam size and separation increase ∝ Δs,
⇒ separation in units of σ about constant around IP

Instead high β* :
beam size ~ constant = σ*, separation in σ increases
as ΦΔs. Φ is the crossing angle
Limited by first parasitic crossing
50 ns bunch spacing much easier than 25 ns (2×, 4× in β)

Require > 6 σ at first parasitic crossing

$$\frac{\Phi \Delta s}{\sigma^*} > 6 \qquad \sigma^* = \sqrt{\beta^* \epsilon} = \sqrt{\beta^* \epsilon_N / \gamma}$$

P_{bream} TeV/c	β^*_{max} in m, for 25 ns spacing	β^*_{max} in m, for 50 ns spacing
3.5	31	126
4.0	36	143
6.5	58	233

estimate done for Φ = 285 μrad, standard 3.75 μm emittance

Full check requires actual optics with crossing bump and check of magnet strength ⇒

Crossing bump & kmax of corrector magnets

Phase advances between correctors reduced compared to low-β optics

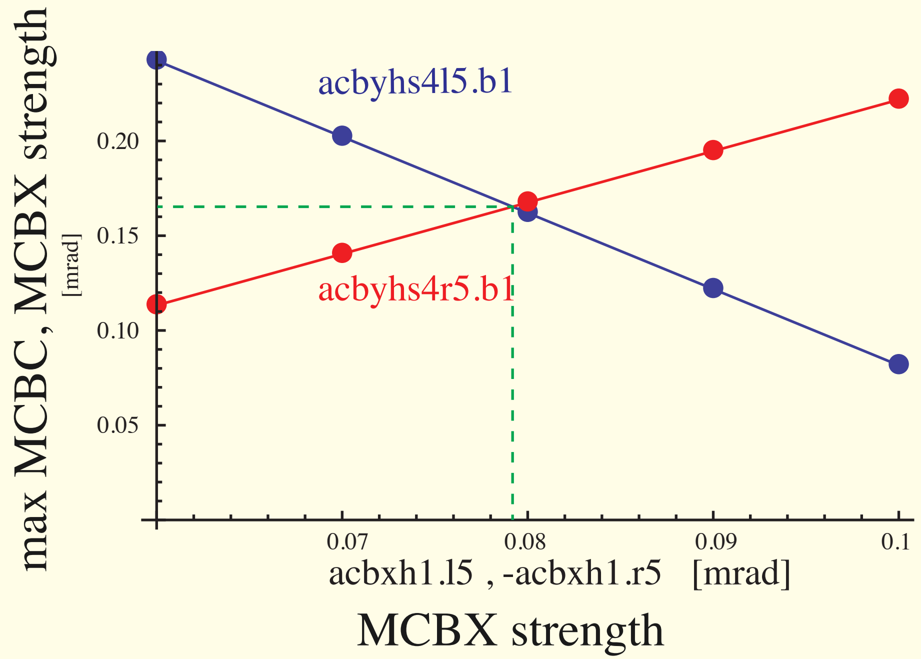
Can result in strengths required for 285 μrad bump which exceeding kmax

A real check requires actual optics.

ALICE/IP2 has a vertical crossing angle

Estimate here based on the existing 90 m optics for IP5, matching a horizontal crossing angle

only 2.5° between MCBYH.4R1.B1 and MCBCH.5R1.B1



Would require strong MCBY ~ 160 μrad at Q4, the normal limit is 96 μrad @ 7 TeV

and MCBX ~ 79 μrad
single MCBX limit ~ 67 μrad @ 7 TeV

using here as usual anti-symmetry MCBX settings; strength left = - right (needed for b1/b2)
and just one of the 3 MCBX
Could probably gain by matching individually left and right with several MXBC

Conclusion, very preliminary

Encouraged by the very successful start in 2011 at $\beta^* = 90$ m in IP1/5 using external tune compensation :

- there is potential for intermediate $\beta^* \sim 30 - 100$ m with crossing angle compatible with standard physics, interesting for ALICE / IP2 after LS1

- separation much easier with 50 ns bunch spacing, allowing for higher β^* than 25 ns
- may be limited by power convertors on correctors used to produce the crossing angle bump

  depends on optics details, use of several MCBX and extending bumps beyond Q6 might help

  could also try $\beta x^* \neq \beta y^*$, with reduced β^* in the crossing plane

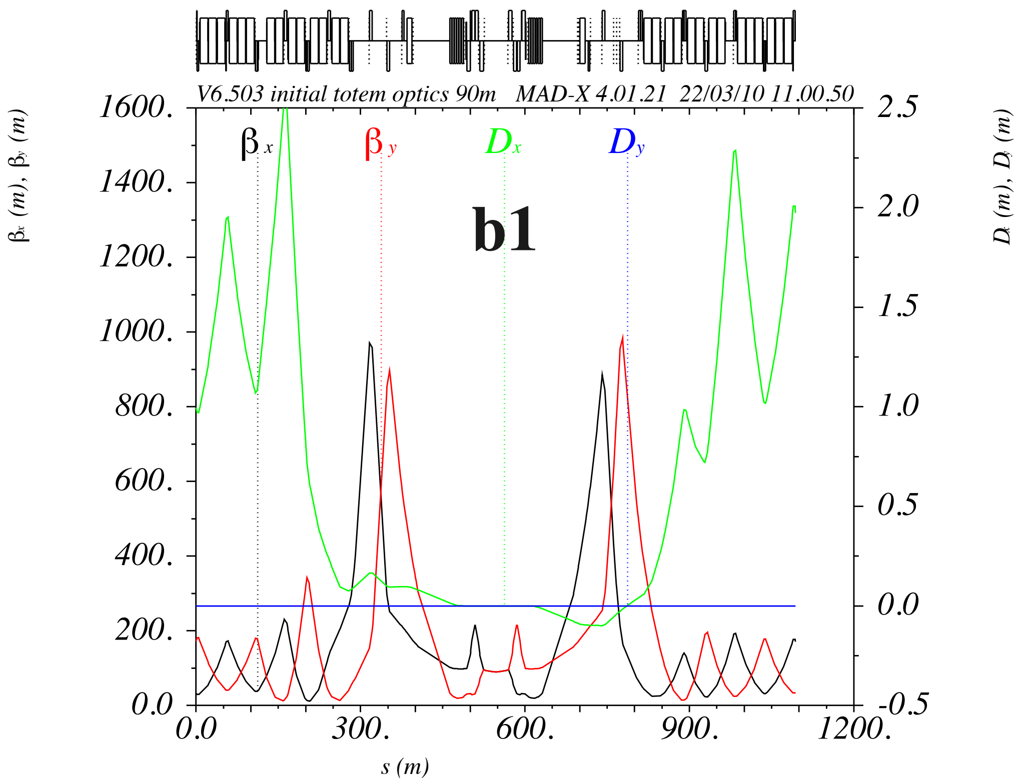
A full study requires the development of dedicated high-β^* optics for IP2

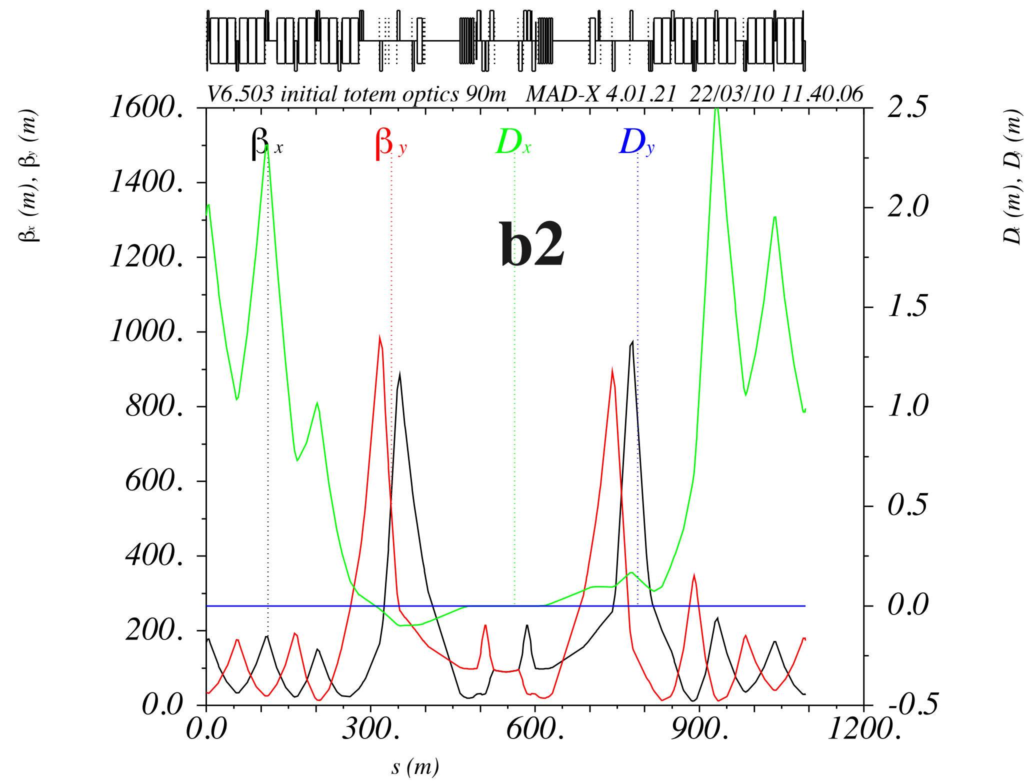
(doctoral student Pascal Hermes starting this year)

Backup

Current 90 m optics

here for IP5 with π in x and $\pi / 2$ in y to roman pot at 220 m, as used in 2011





ΔQx = 0.222 ΔQy = 0.055 **ΔQx = 0.220 ΔQy = 0.053**

With current cabling required to have quad strength ratios within **0.5 < b1/b2 < 2.0**

kq4.l5b1/	kq4.l5b2=	0.970945
kq5.l5b1/	kq5.l5b2=	1.04019
kq6.l5b1/	kq6.l5b2=	1.05394
kq7.l5b1/	kq7.l5b2=	1.5816
kq8.l5b1/	kq8.l5b2=	1.33077
kq9.l5b1/	kq9.l5b2=	1.03071
kq10.l5b1/	kq10.l5b2=	0.94919

kq4.r5b1/	kq4.r5b2=	1.10542
kq5.r5b1/	kq5.r5b2=	0.961367
kq6.r5b1/	kq6.r5b2=	0.938599
kq7.r5b1/	kq7.r5b2=	0.525421
kq8.r5b1/	kq8.r5b2=	0.571775
kq9.r5b1/	kq9.r5b2=	0.964224
kq10.r5b1/	kq10.r5b2=	1.05372

90m IP5, separation and x-ing bump