A simplified 2D model for tracking the BB effect in the D0 scheme

G. Sterbini

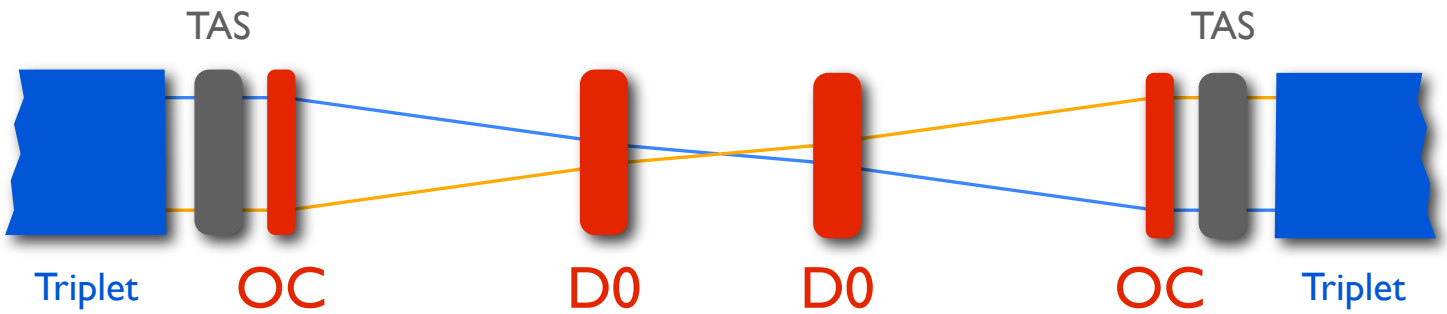
CERN AT-MCS-MA
EPFL SB-IPEP-LPAP

28th August 2008, LHC BB effects and BB compensation

Thanks to J.-P. Koutchouk, F. Zimmermann, W. Herr, D. Kaltchev and E. Laface

Outline

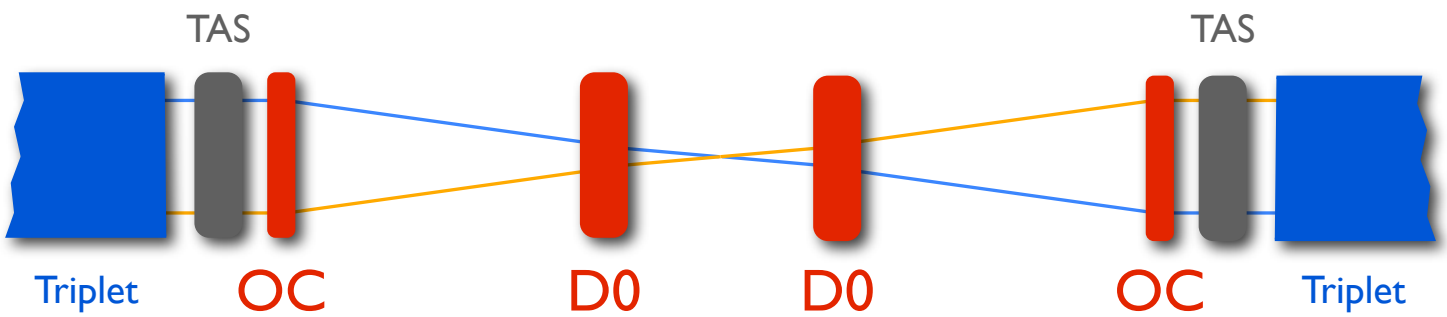
A short introduction...



The D0 scheme is a possible player in the Phase II Luminosity Scenario. It consists of two dipoles per each side of each experiment: teh D0 and the OC. There are several recipes for the upgrade: all are a different combination of the same ingredients

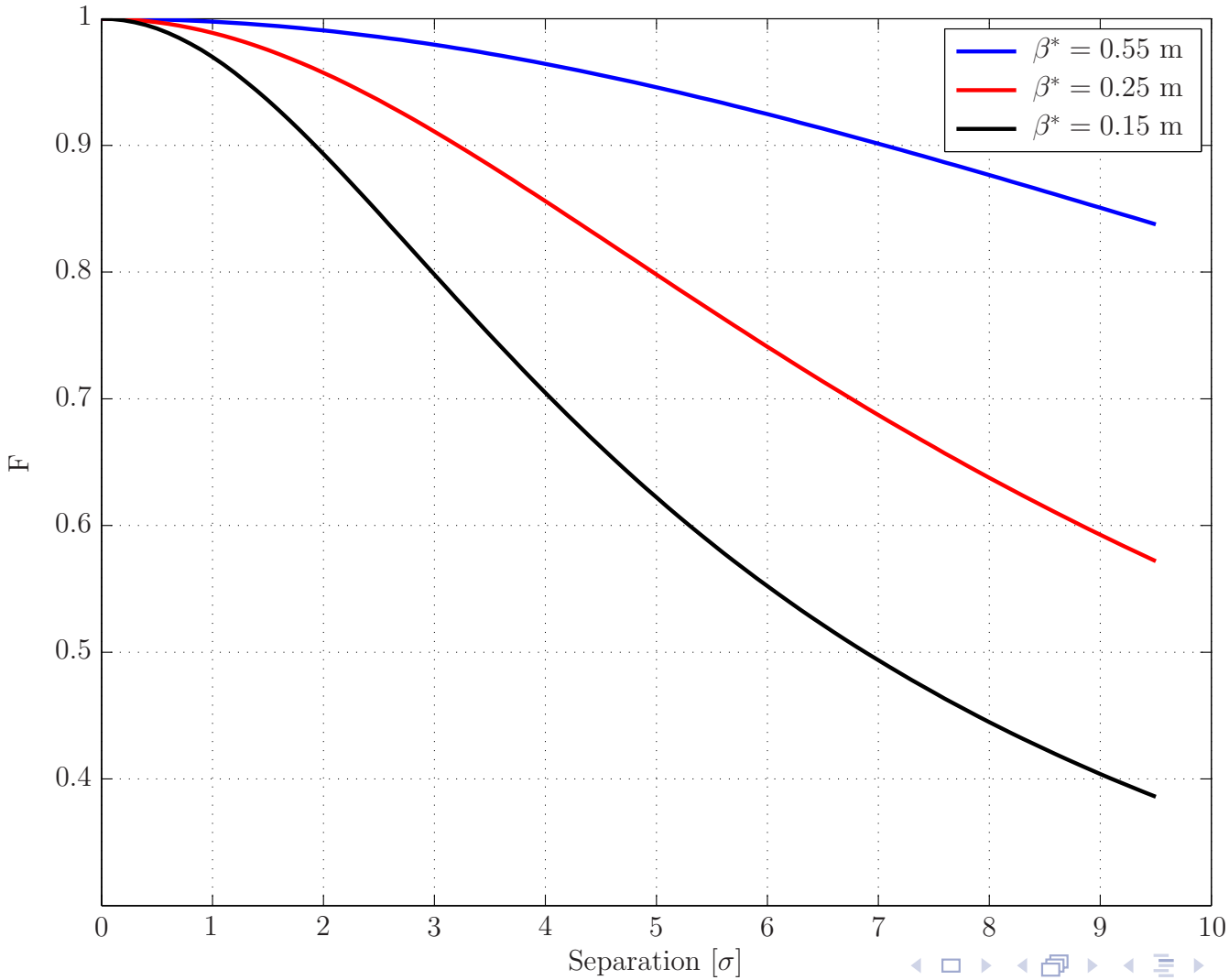
- more beam current
- lower β^*
- reduction of the θ_c at the IP

A short introduction...

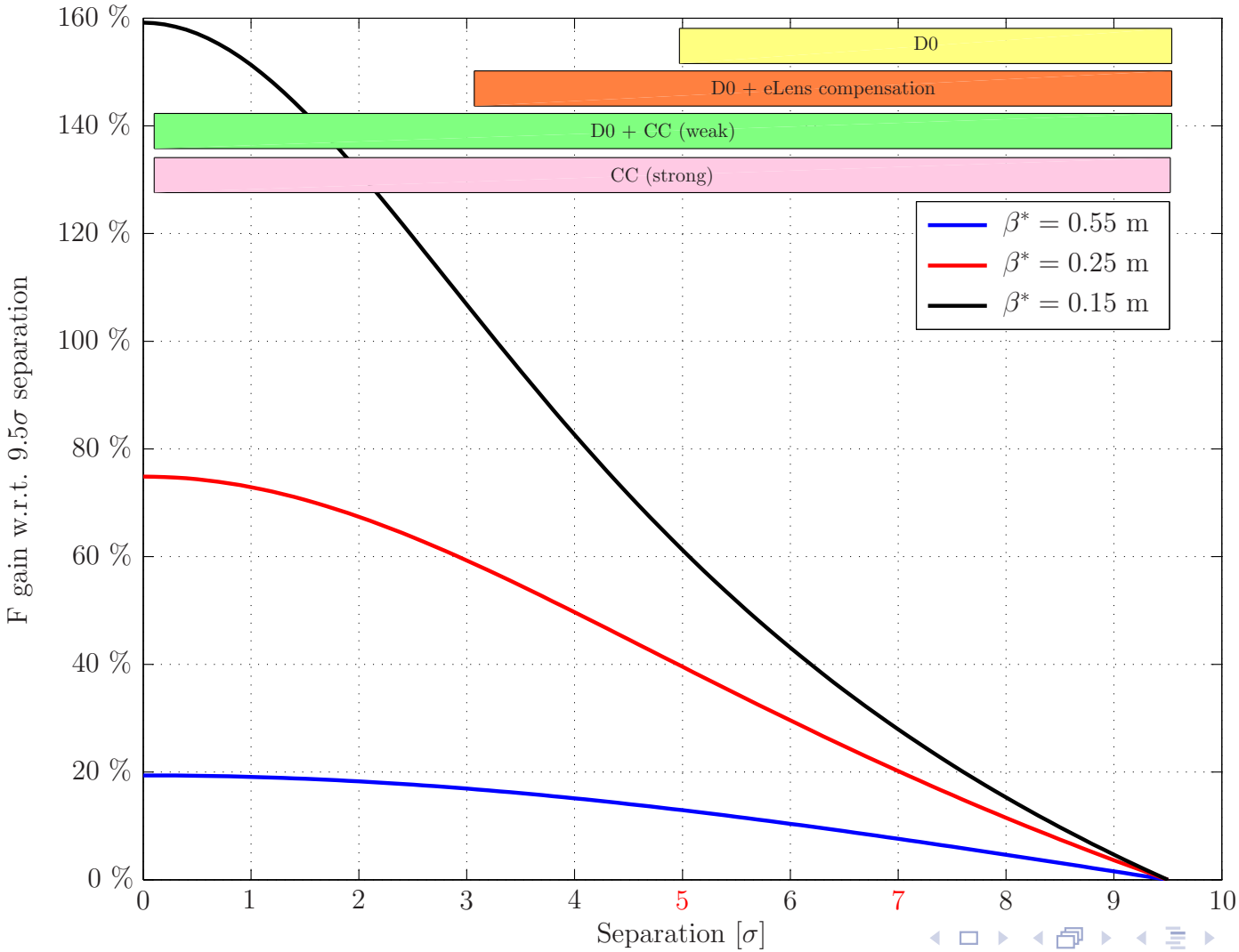


But the reduction of the for θ_c for boosting the luminosity enters in competition with the BB effect. D0, Crab cavities and Wire compensation are the three HW proposals to solve this problem. The possible dynamic change of θ_c (luminosity leveling) has to be taken into account. We need tracking tools and experiments...

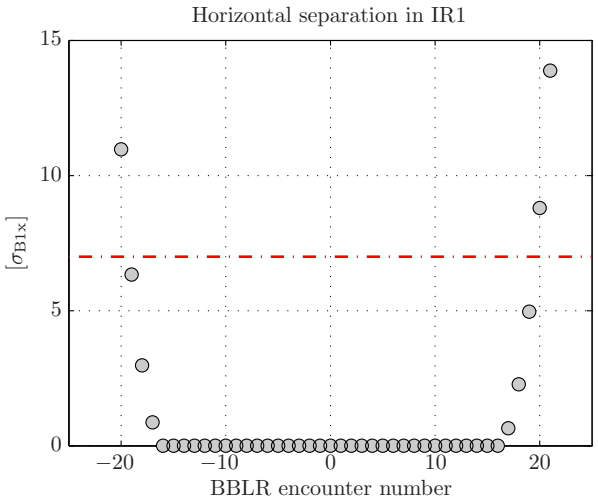
If you focus more you reduce the F factor. . .

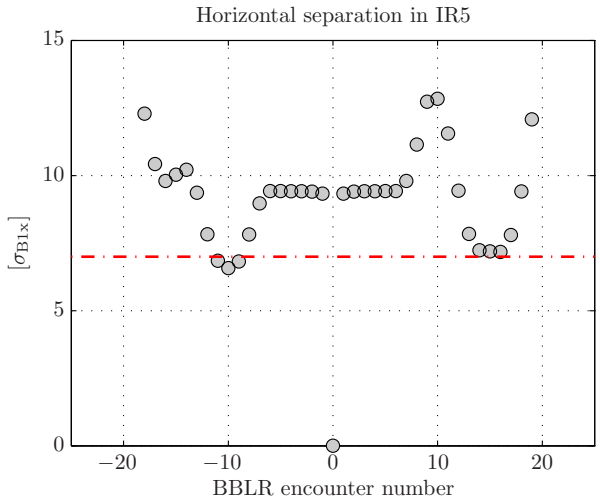


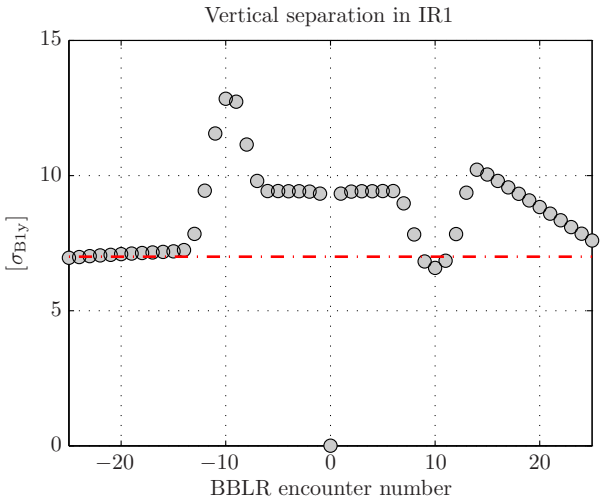
To recover the geometrical loss. . .

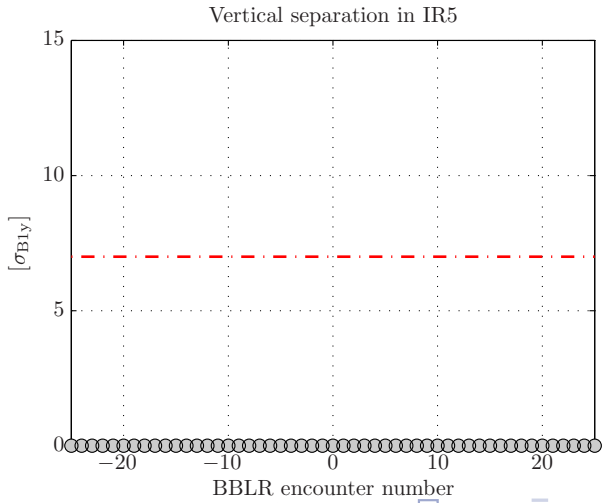


Nominal IR1 and IR5

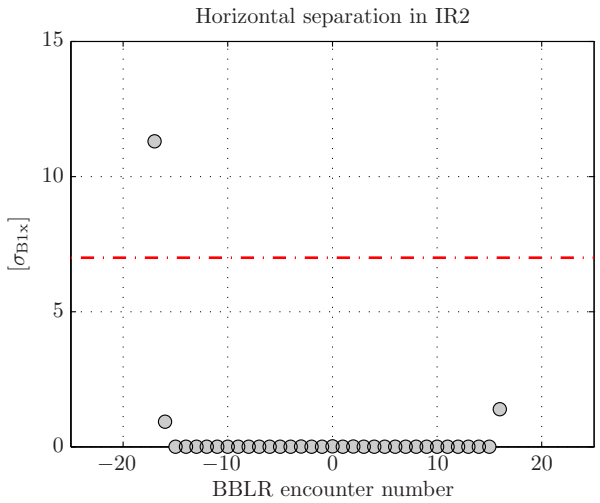


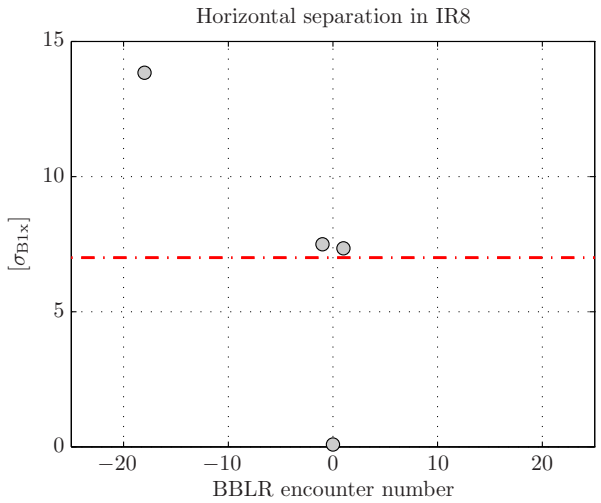


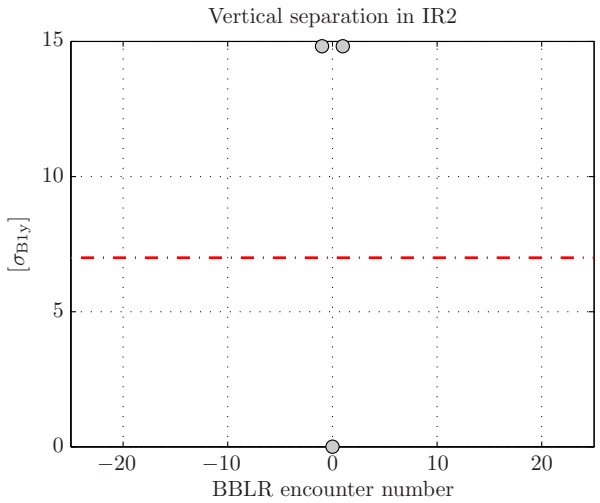


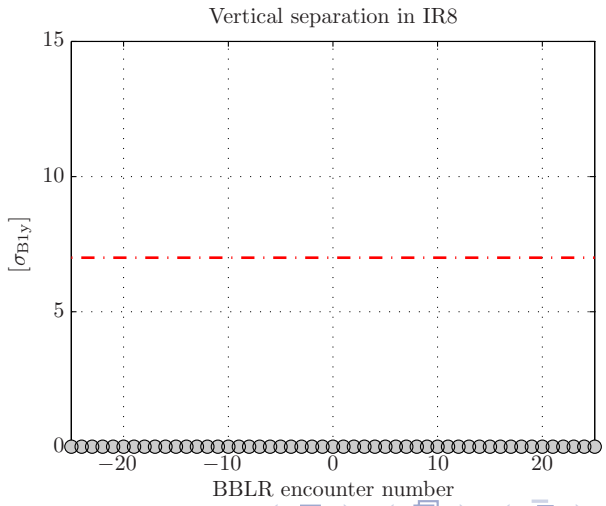


Nominal IR2 and IR8





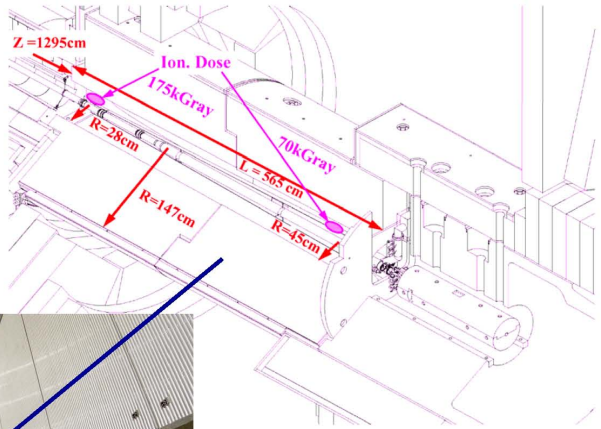




A possible position in ATLAS: a slot at 13 m!

Only place which make sense

Forward Shielding Region (JF) …. which need to be redesigned for SLHC in any case



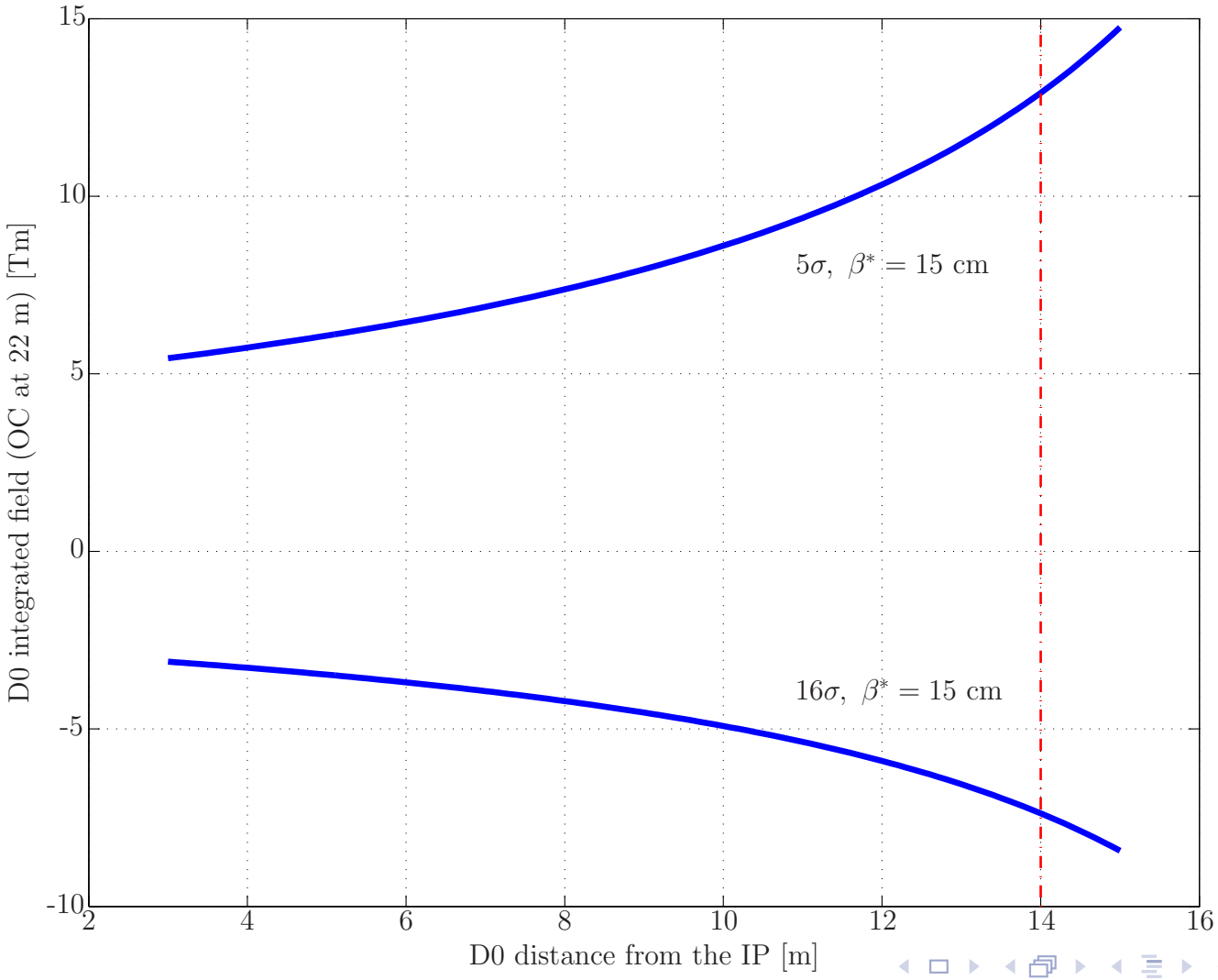
Courtesy of M. Nessi (“LHC Crab Cavity Validation”, 21st August 2008)

Shaping a proposal...

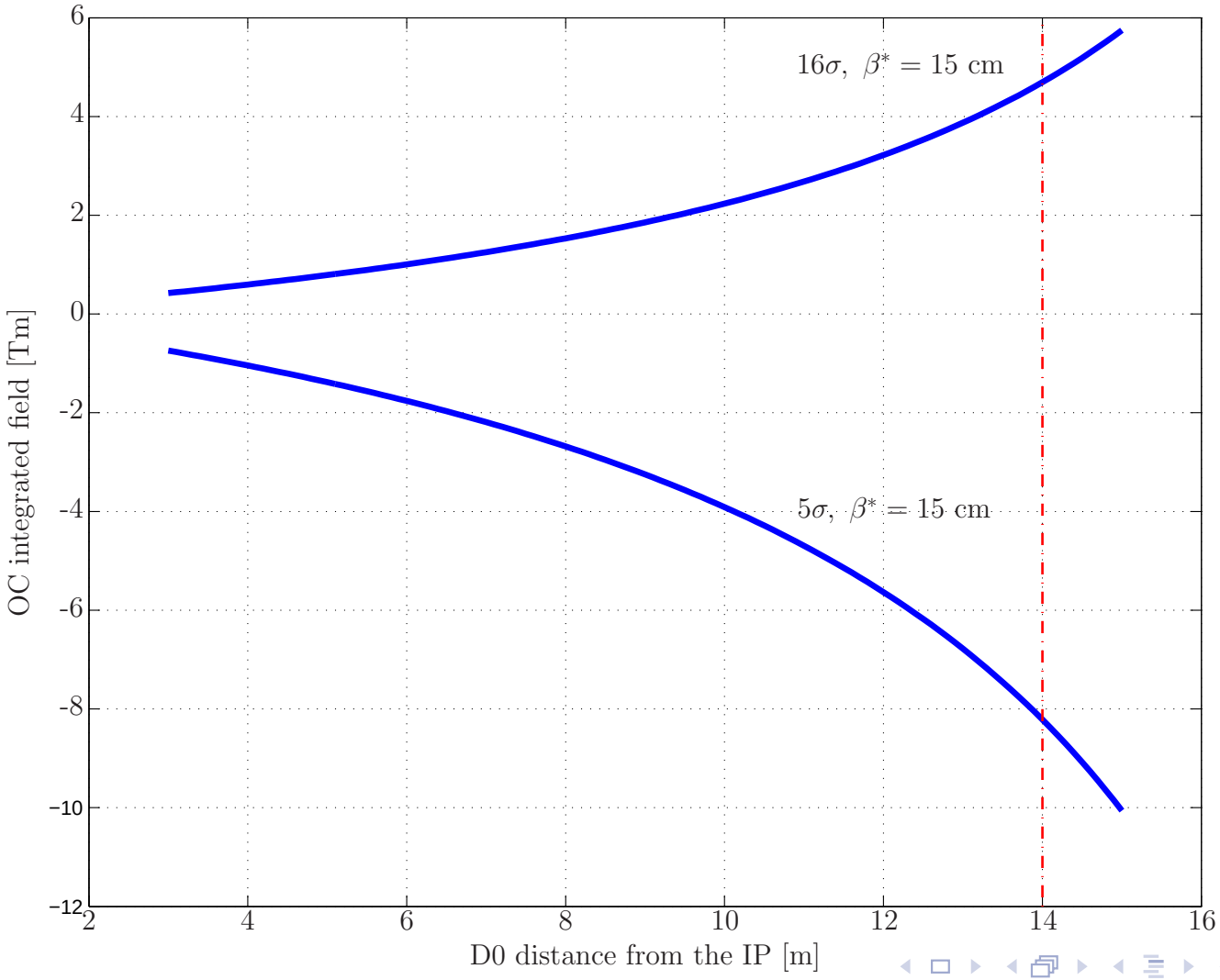
Let us assume

- to put the D0 at 14 m from the IP
- to put the OC at 22 m from the IP
- to have a mean separation in the triplet of 12σ
- to level L starting with a separation at the D0 of 16σ
- to have $\beta^* = 0.15$ m

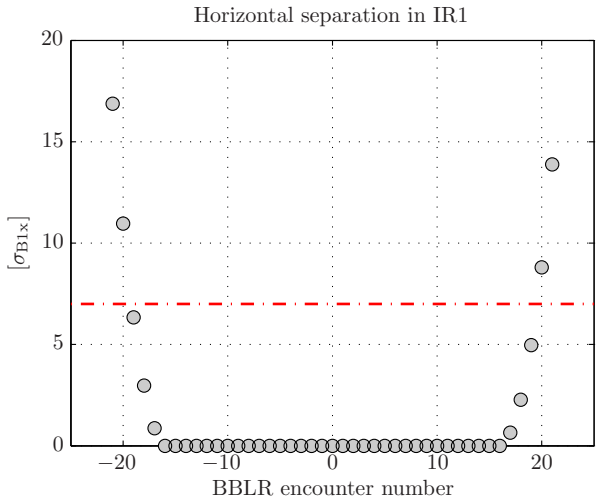
D0 integrated field

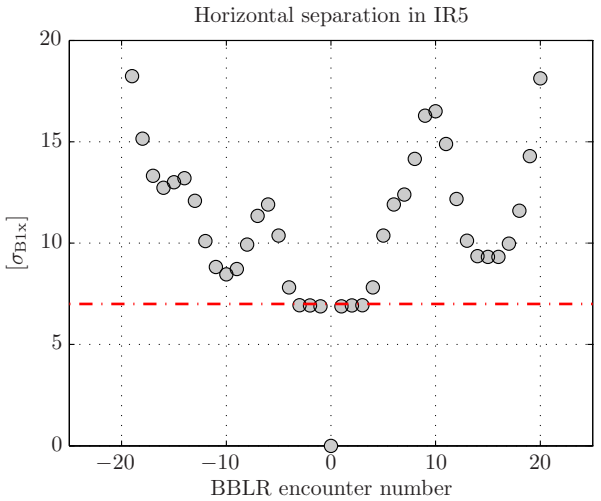


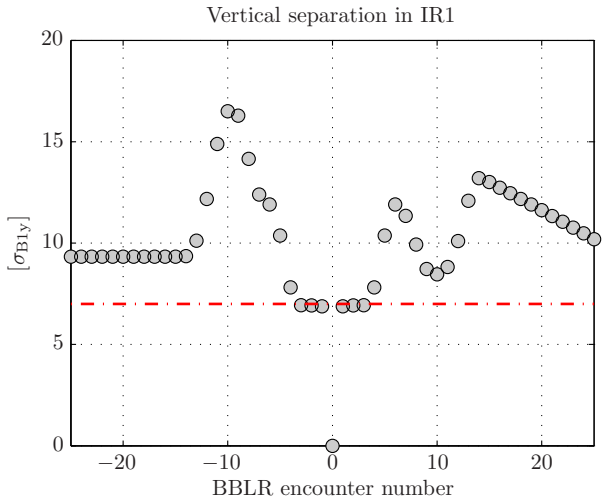
OC integrated field

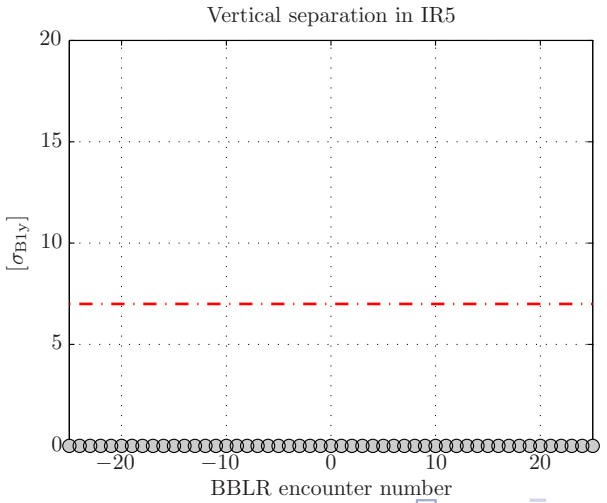


With 7σ we gain the 30% on the F factor

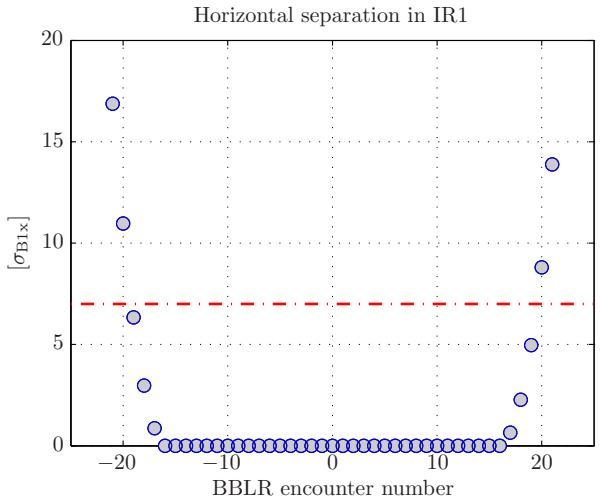


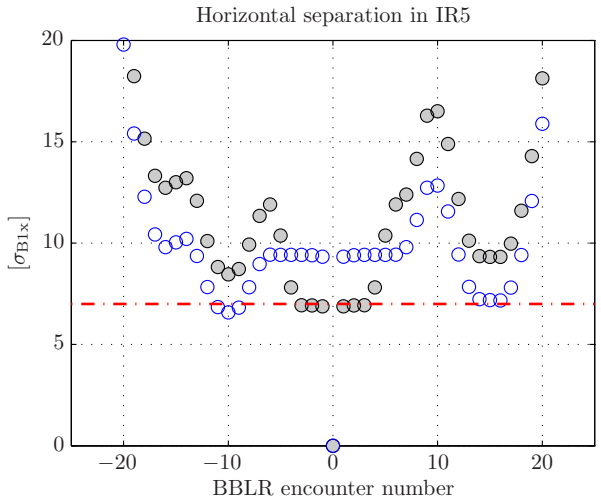


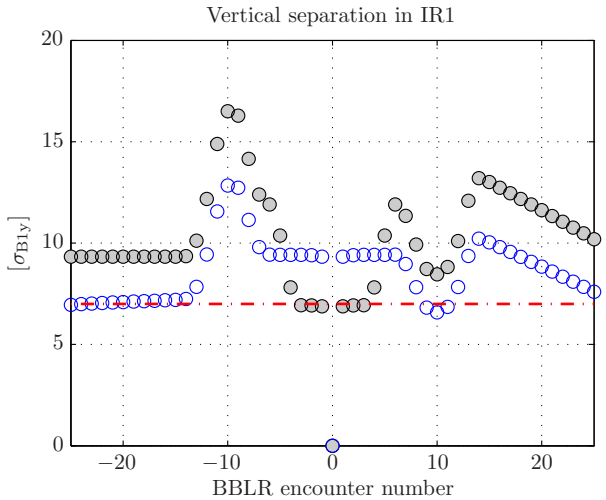


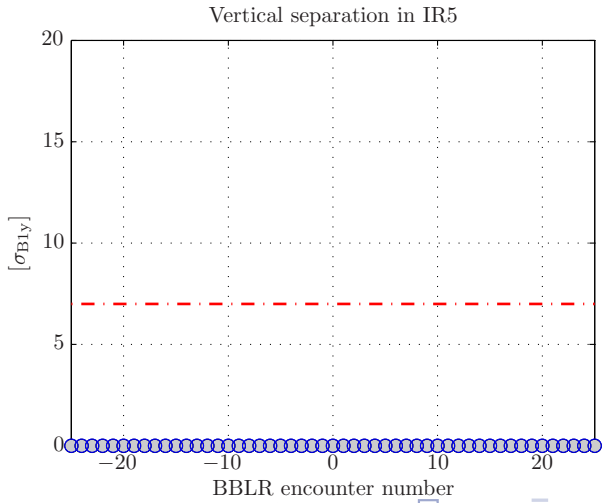


With 7σ we gain the 30% on the F factor







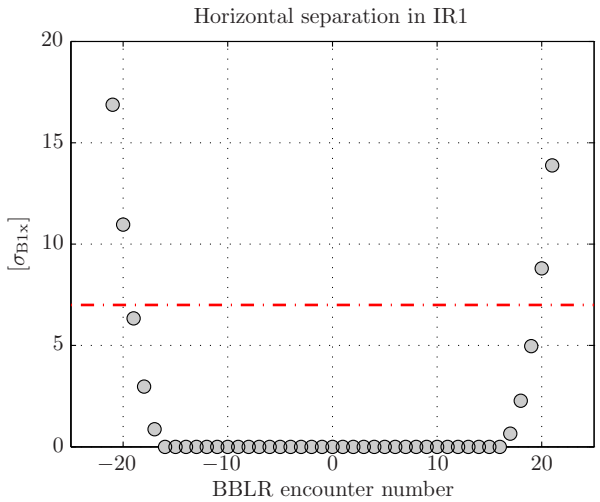


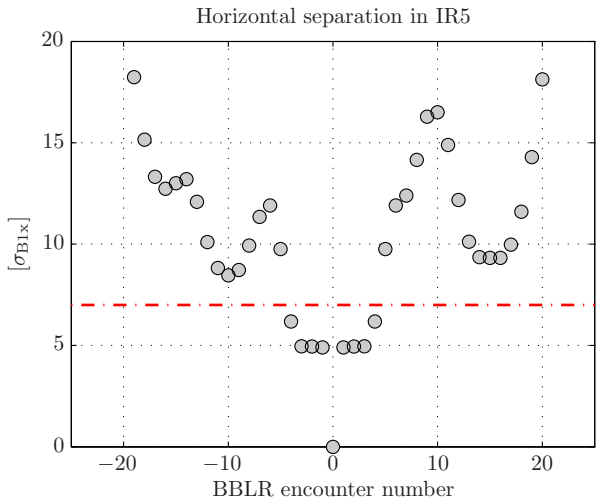
With 7σ we gain the 30% on the F factor

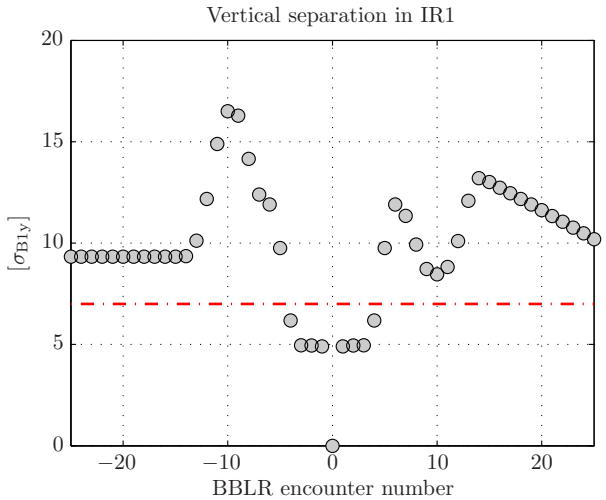
But. . .

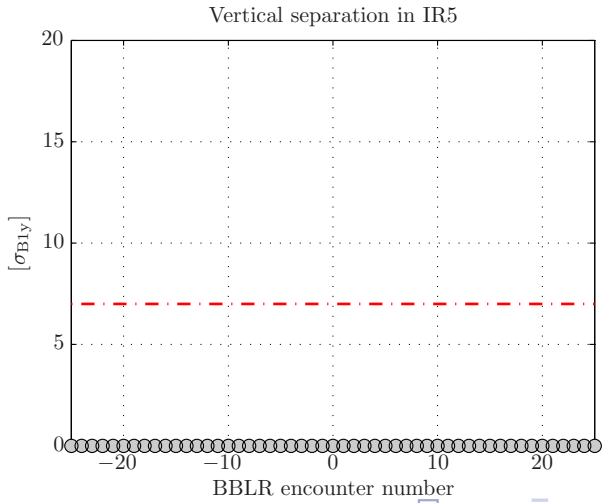
- Separation pattern similar to the nominal
- We need a bigger separation in the triplets 12σ
- The field request for D0 and OC is almost doubled w.r.t the position st 6-9 m!
- A complete study on the heat load has to be done.

With 5σ we gain the 60% on the F factor, but...

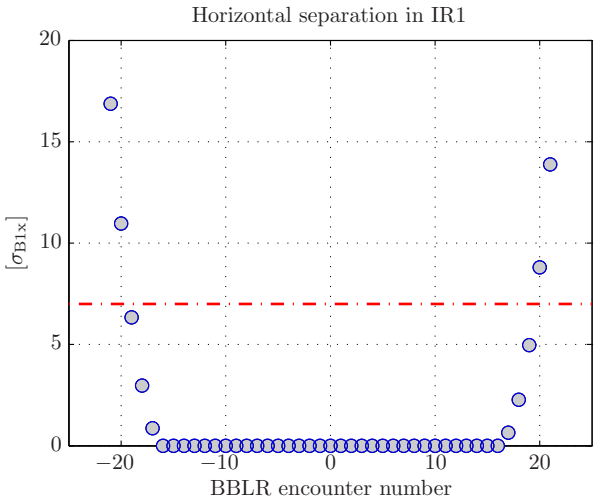


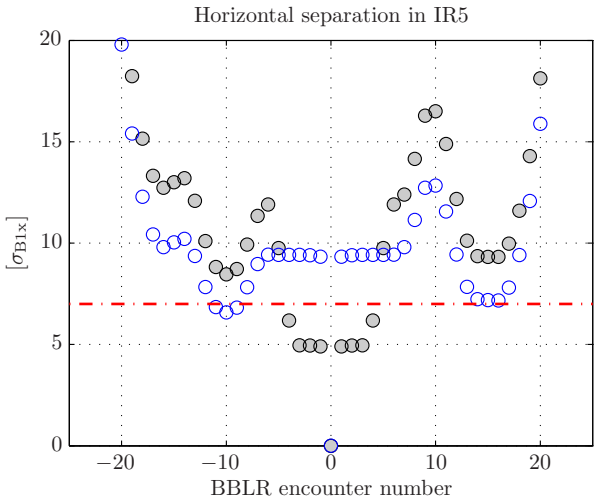


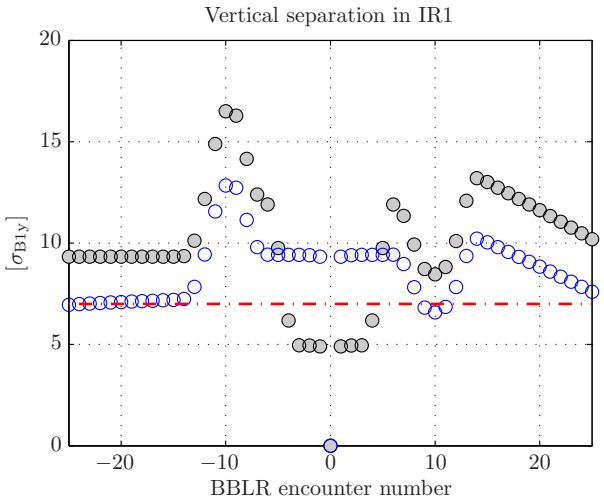


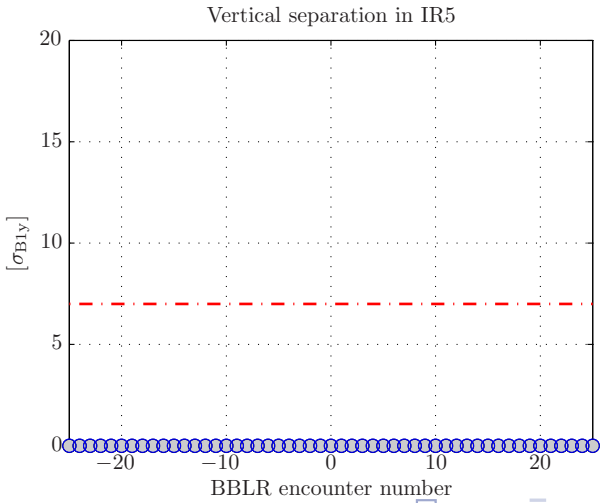


With 5σ we gain the 60% on the F factor, but...









With 5σ we gain the 60% on the F factor, but...

But...

In this case we have to study with tracking if the 6 encounters at 5σ per IP can be tolerated or not.
It is worth noting that if we consider the leveling only at the end of the run the 5σ separation will occur. But in this situation the beam current will be already decreased due to the luminosity leveling.

MORE IN GENERAL: Need of fast tracking

With the D0 and the leveling the parameter space becomes very large, we can vary the

- position/field of D0 and OC
- the IR optics (length of the triplets, position of D1)
- the N_b (during the leveling the BB changes)

It would be useful to a have a fast 2D tracking (weak-strong) to explore in a comparative way the different scenarios and to see if there is a correspoding effective HW solution. Only the promising solution will be checked in comprehensive way by 6D tracking (WS, SS, PACMAN...).

Need of fast tracking: keep it simple..

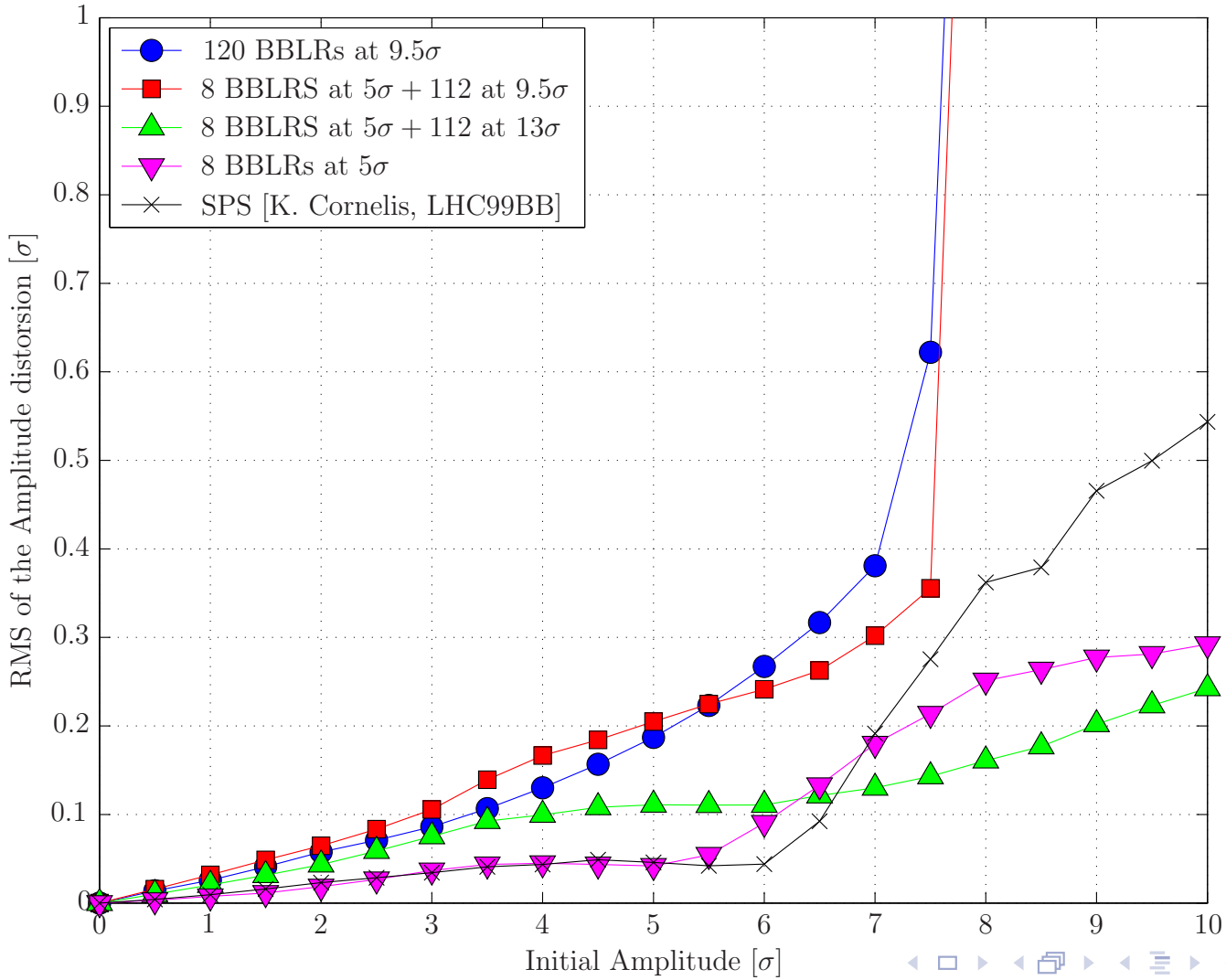
Approximations

- 2D system
- linear machine (apart HO BB and LR BB)
- limit the number of matrices' rotation by grouping the BB LR in families and neglecting the phase advance.

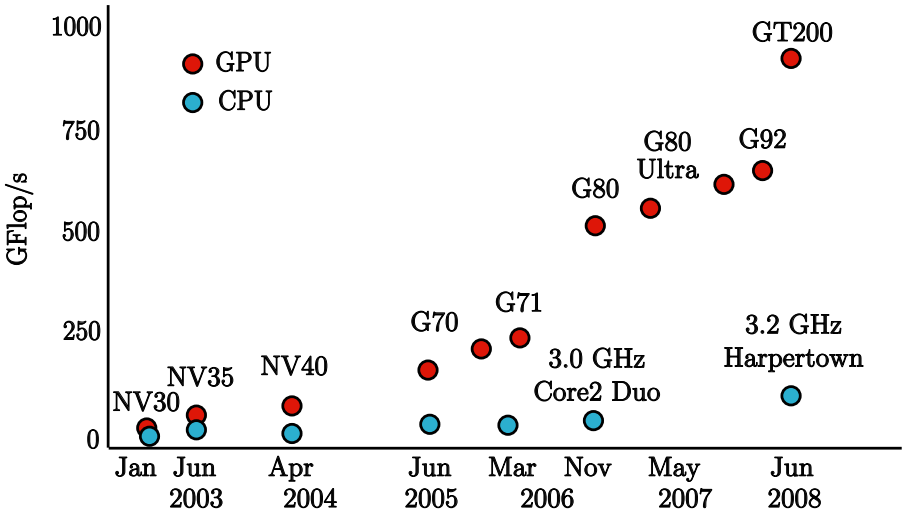
To make it more robust we

- average results over initial conditions
- average over tune
- include tune modulation
- The index of chaos considered is the RMS of the amplitude of the particle.

MORE IN GENERAL: Need of fast tracking



MORE IN GENERAL: Need of fast tracking



GPUs use in the tracking

There are new HW solution for high speed computation (GPU): it is possible one order of magnitude or more. But there is not the code portability.

(more info www.nvidia.com/object/cuda_what_is.html)

Conclusions

- Due to the big difficulties in the D0 implementation the detectors suggest to put the D0 starting at 14m
- These new positions have a significant impact on the required integrated field (13 Tm + 8 Tm)
- The energy heat load can be a major problem
- A D0 with 7σ separation at $\beta = 0.15$ m provides a gain of 30% on the F factor with an impact similar to the nominal LHC scheme but we need 12σ separation in the triplet
- The 5σ solution can present seriuos BB problems: a first 2-D tracking approach is being used for the moment but has to be still validate by complete tracking. W. Herr and D. Kaltchev are working in this direction.

Thank you.