Status of the TESLA Beam Delivery System Lattice Design

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- Lattice Design since TDR
- Collimation Comparison - TRC
- Modifications in TDR lattice and associated problems
- Extraction line issues
- Alternate geometries for extraction
- Ongoing studies
- Plans

What has happened since TDR?

- Local chromaticity correction FFS solution for TESLA : O. Napoly & J. Payet.
- Collimation task force – TESLA, NLC and CLIC collimation was compared at 500 GeV using same set of codes.
- O. Napoly and J. Payet : introduced one more energy collimator to improve the performance.
- With TDR layout - MES section and the additional energy collimator – machine protection issues.
- Spent Beam Extraction Seminar : Dec'02
  - Karsten Büßer: Average Beamstrahlung power deposited on the septum blade (~0.3W–nominal beam, ~80W–realistic beam) :
  - Charged particle loss
  - Electrostatic separators, R& D on septum, dump & other considerations

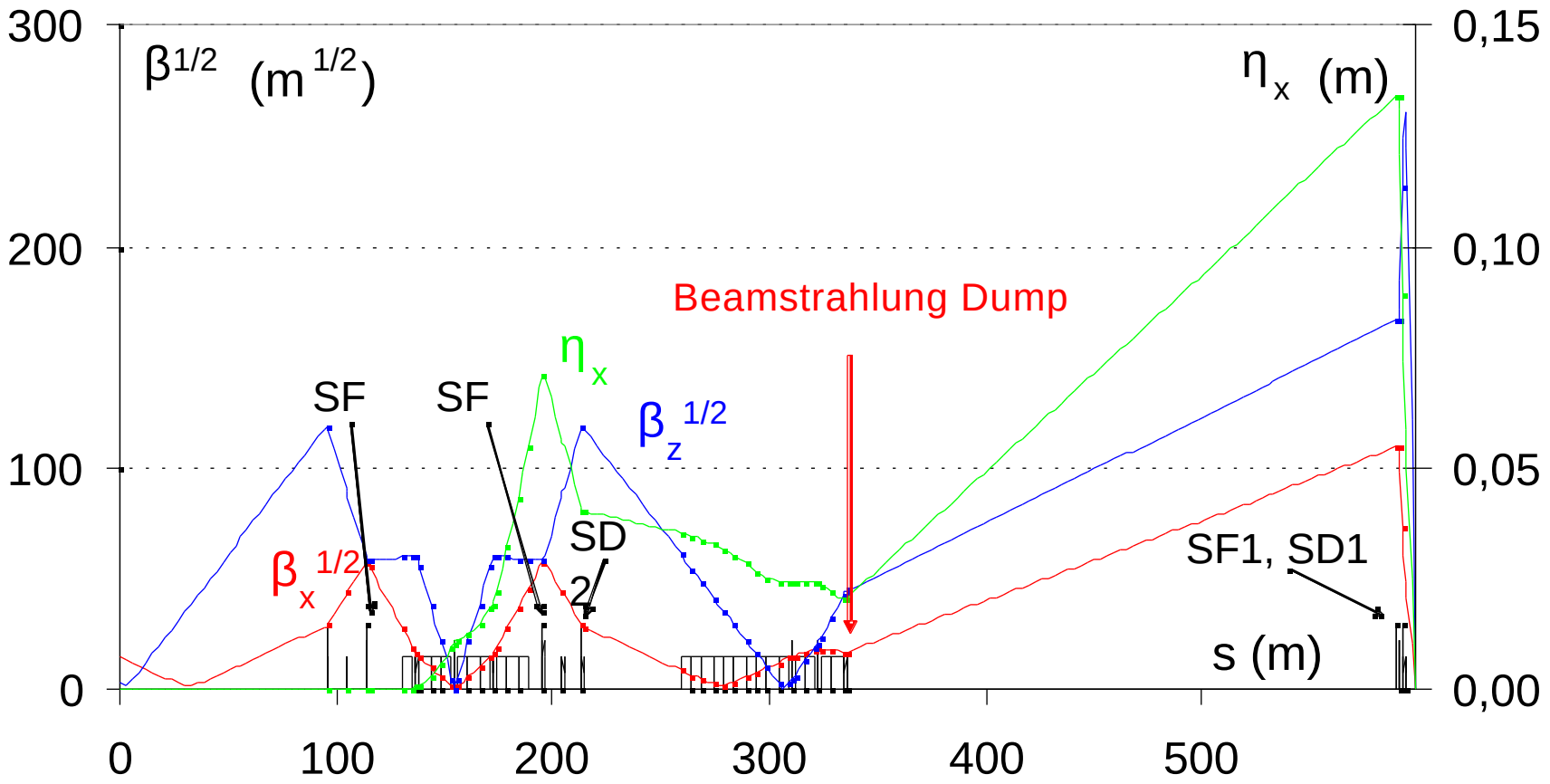
What has happened since TDR?

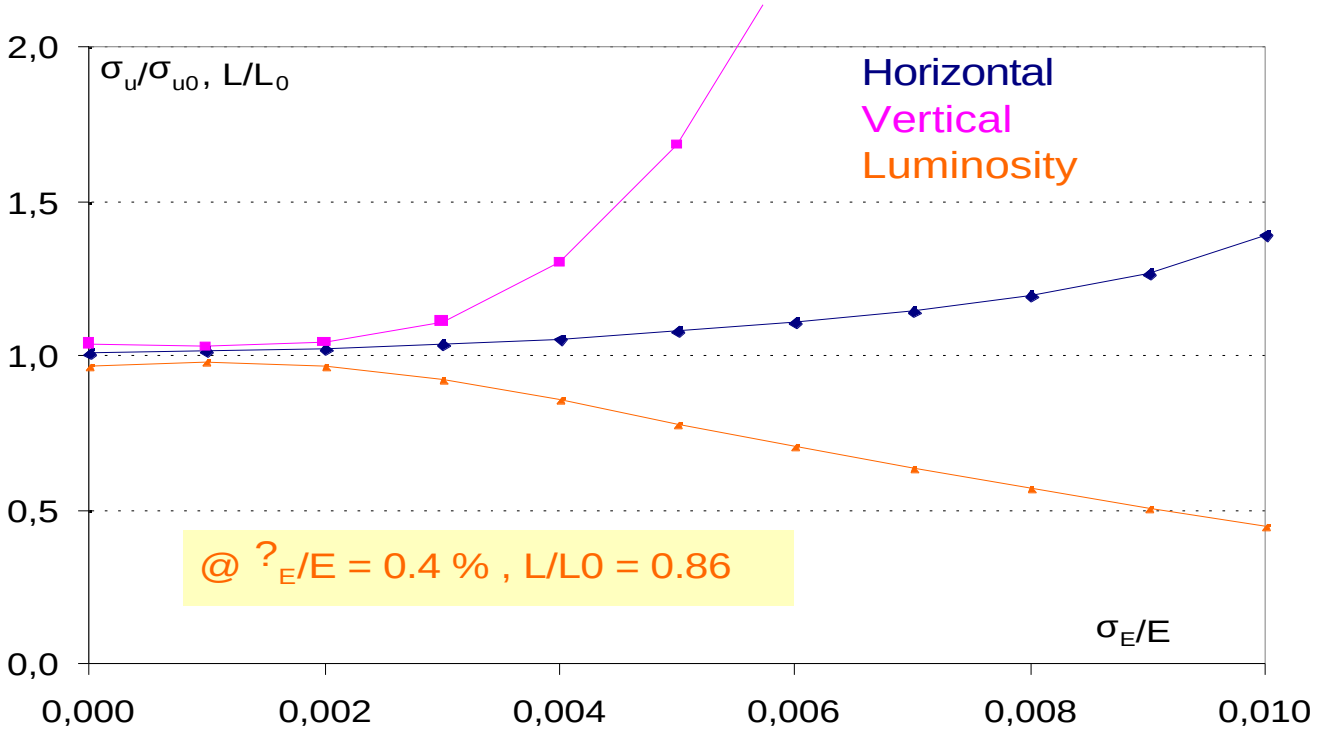
- R. Brinkmann suggested
  - to include a small (~0.3mrad) vertical crossing angle to shine the beamstrahlung away from the septum blade.
  - to reduce e-particle loss for the low energy tail particles – split the final strong doublet into quadruplet – optics solutions for incoming beam?

- Optics and collimation review meeting – Zeuthen, January'04 to discuss the problems with TESLA BDS optics, collimation & extraction.
- Crossing angle meeting was held a day before to discuss the impact of crossing angle on physics.

What has happened since TDR?

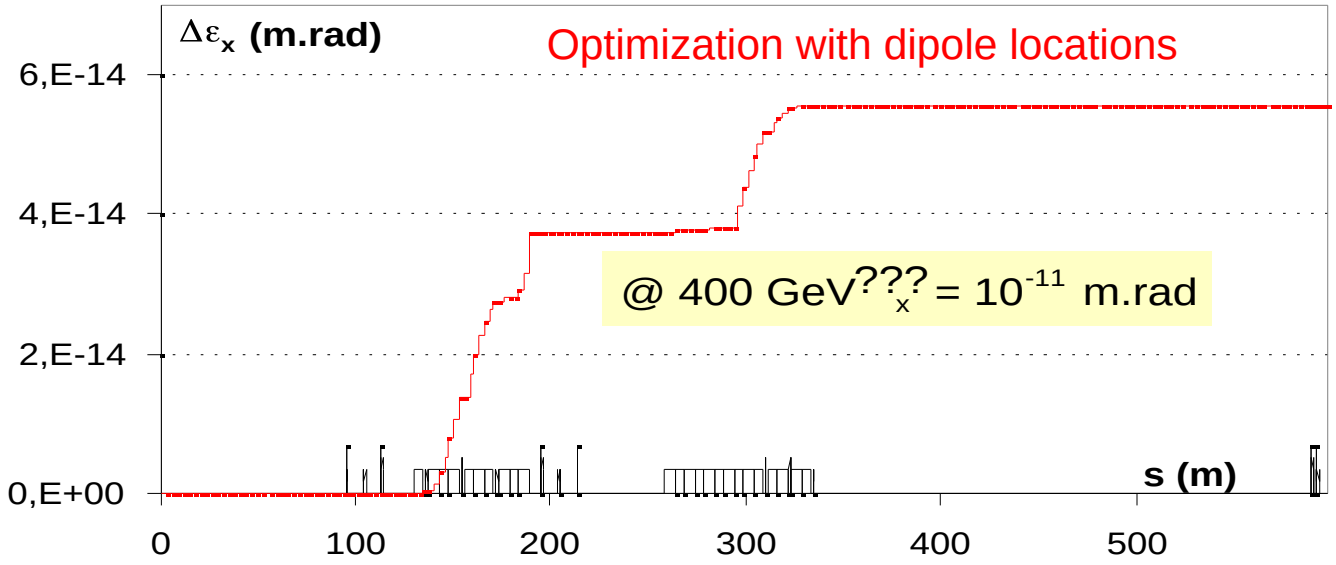
- Final focus lattice with local chromaticity correction for L*= 3m, 4m,5m in TDR length constraint of 600m – by O.Napoly & J. Payet





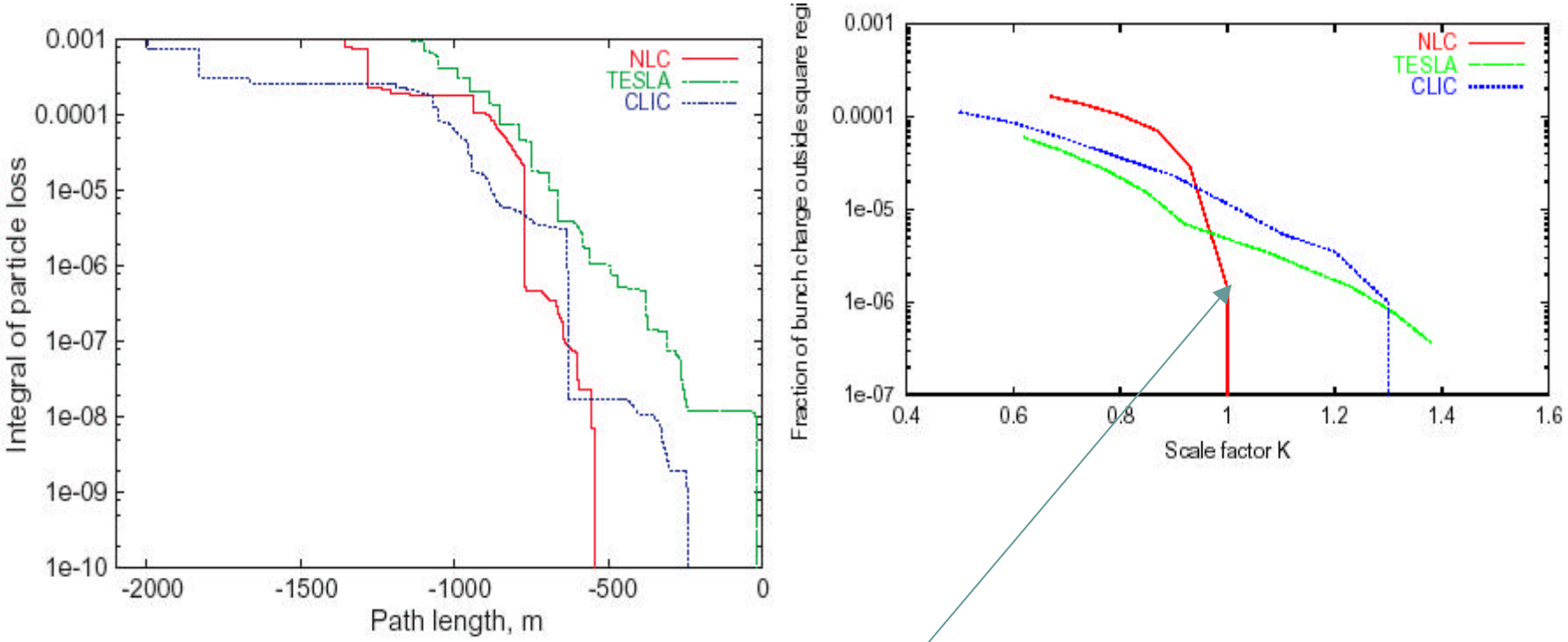
Beam sizes and Luminosity

Emittance growth with S.R.



Collimation task force TRC

Simulation (A. Drozhdin) of collimation with beam halo shows no hard edge for TESLA system → some particles can reach IR



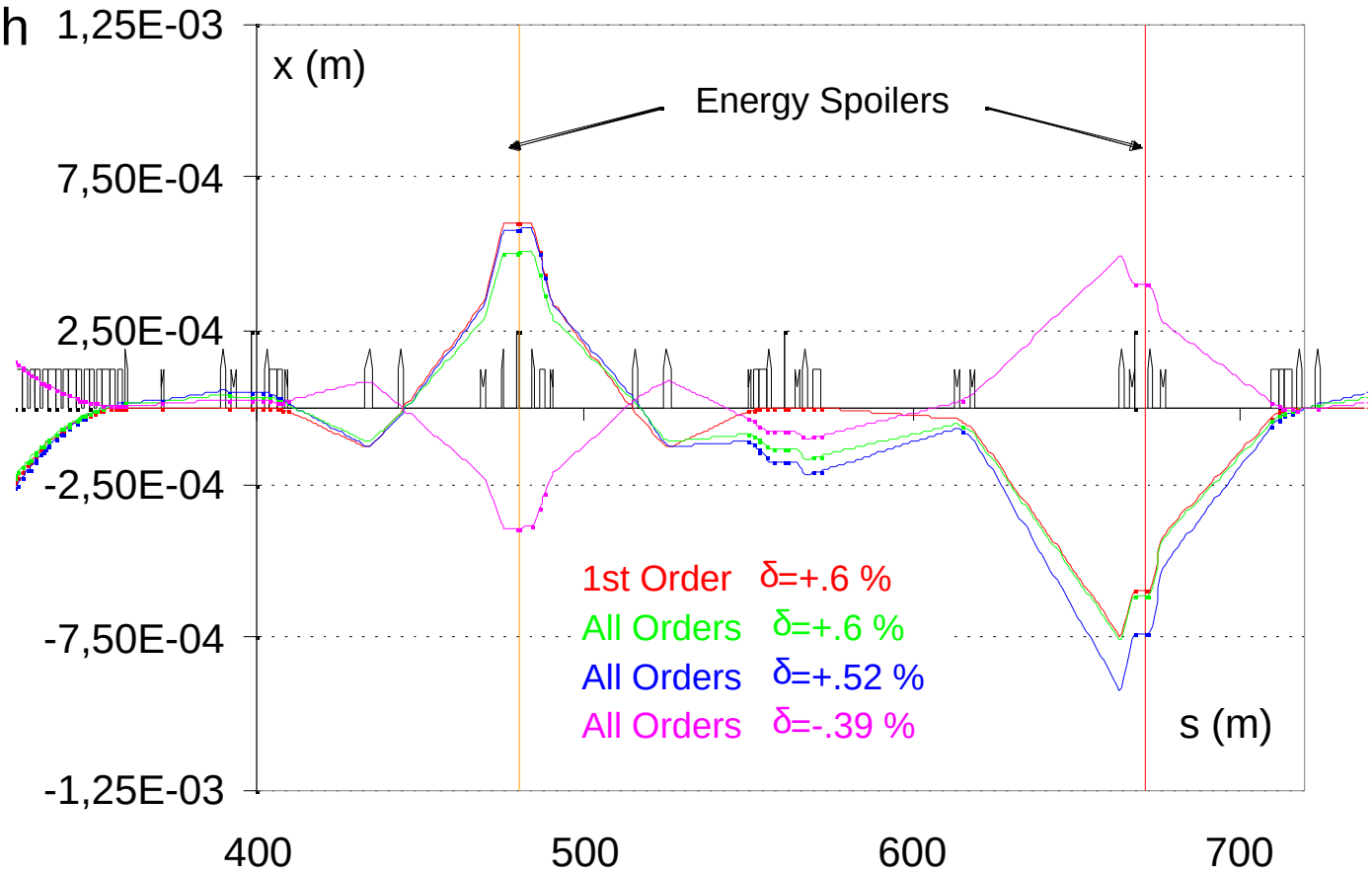
Bad performance of TESLA system ***not*** due to scattering, but appears to be optics! (confirmed by results of G. Blair)

O.Napoly & J.Payet : proposed to include one more energy collimator to improve the performance.

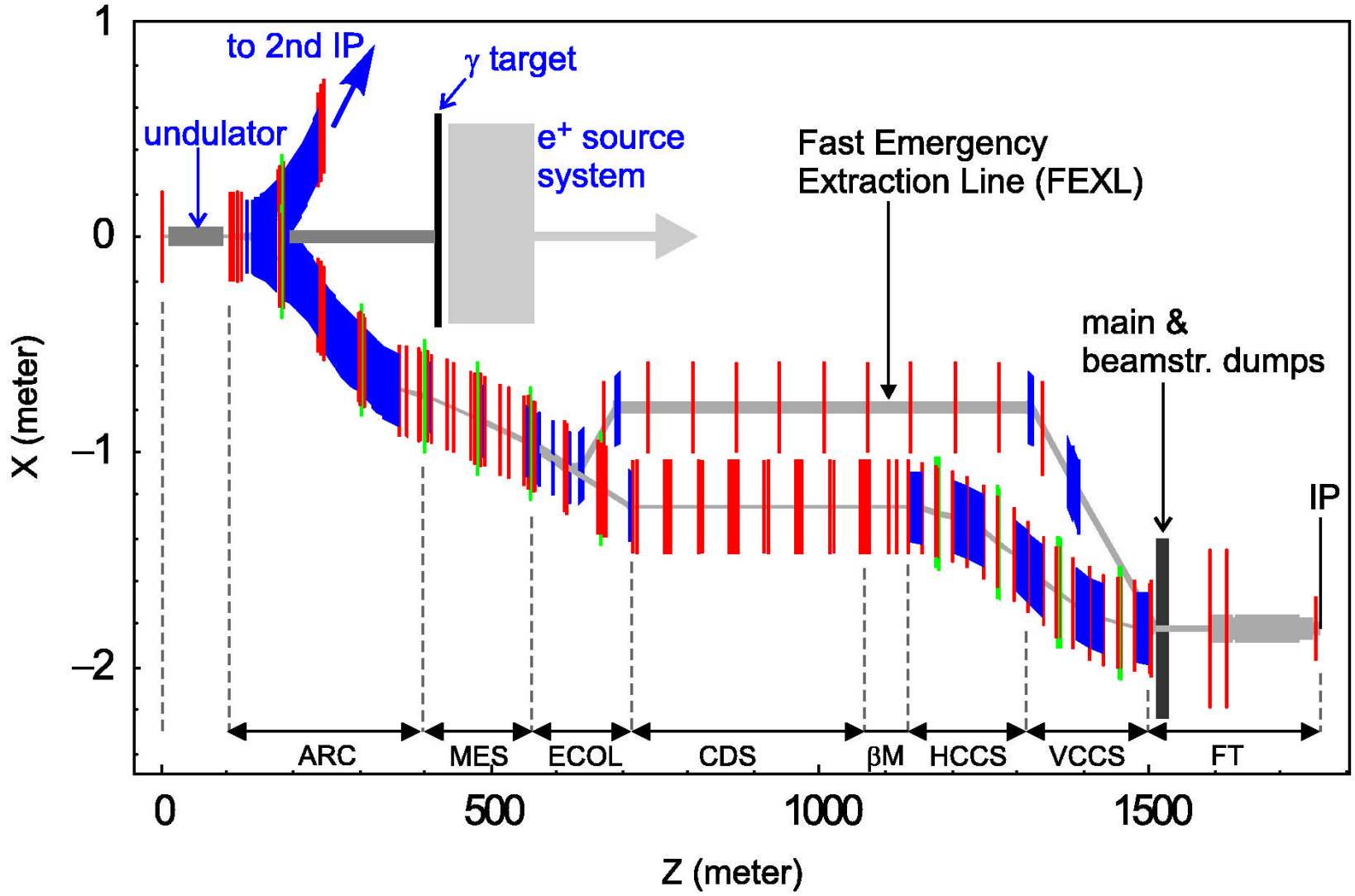
Used the TDR collimation section with some changes :

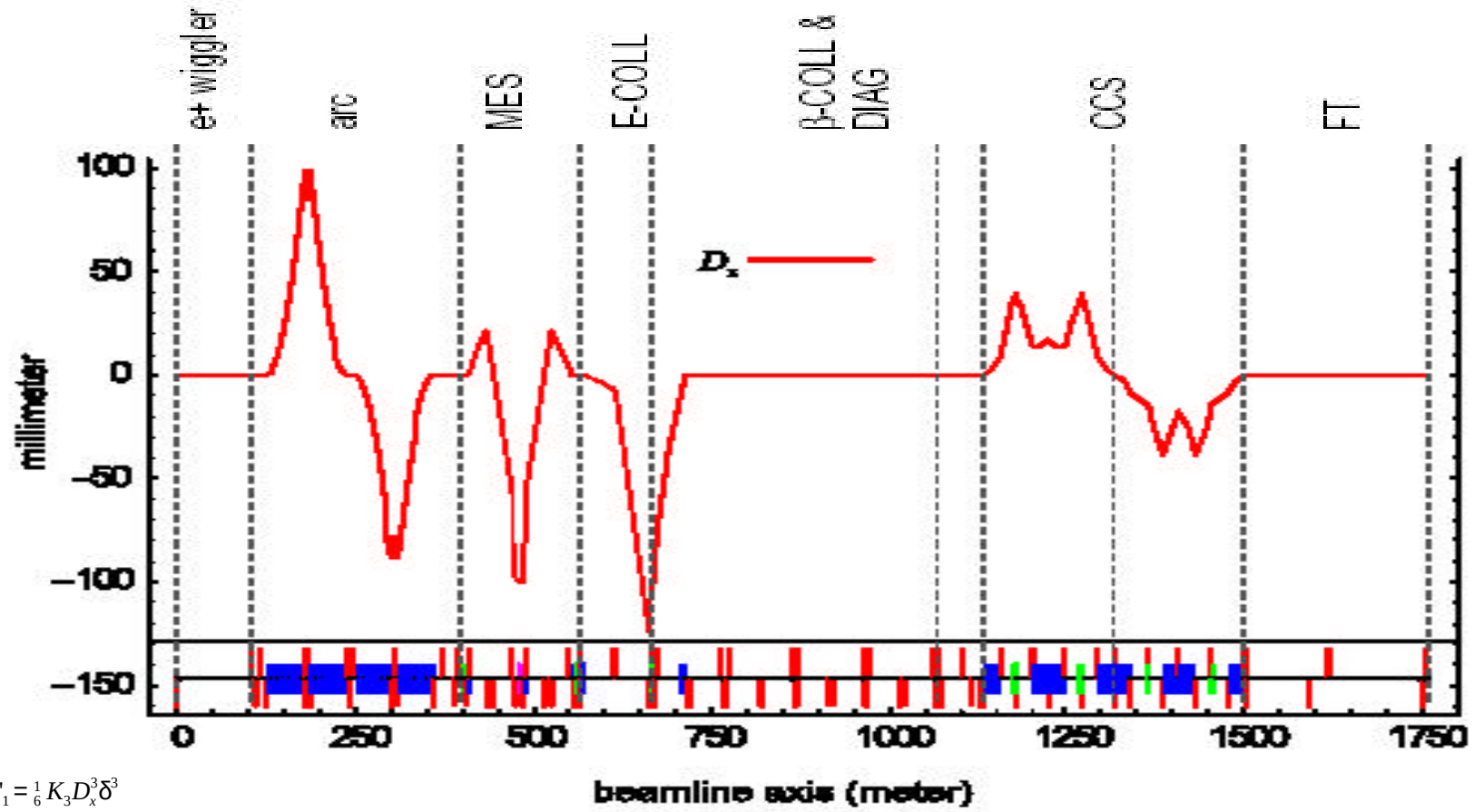
- Reverse the first dispersion bump
- Introduce a second energy spoiler

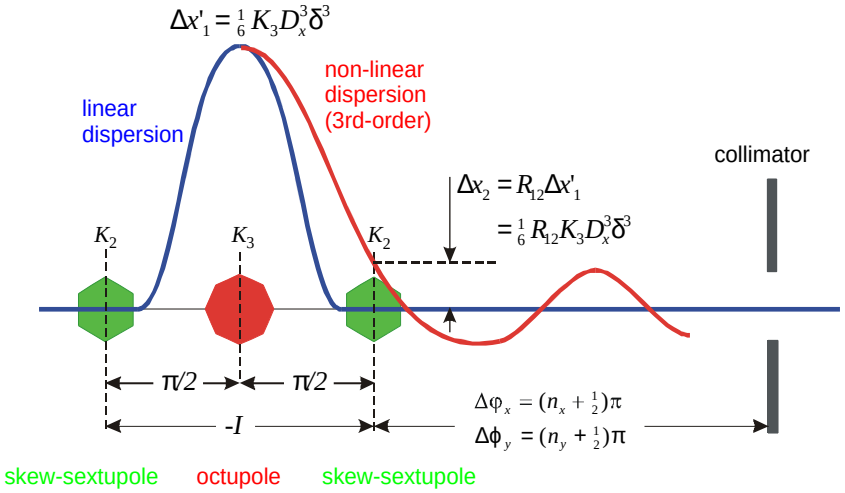
($\mu_x = 2\pi$ between the 2 energy spoilers)



TDR BDS Layout

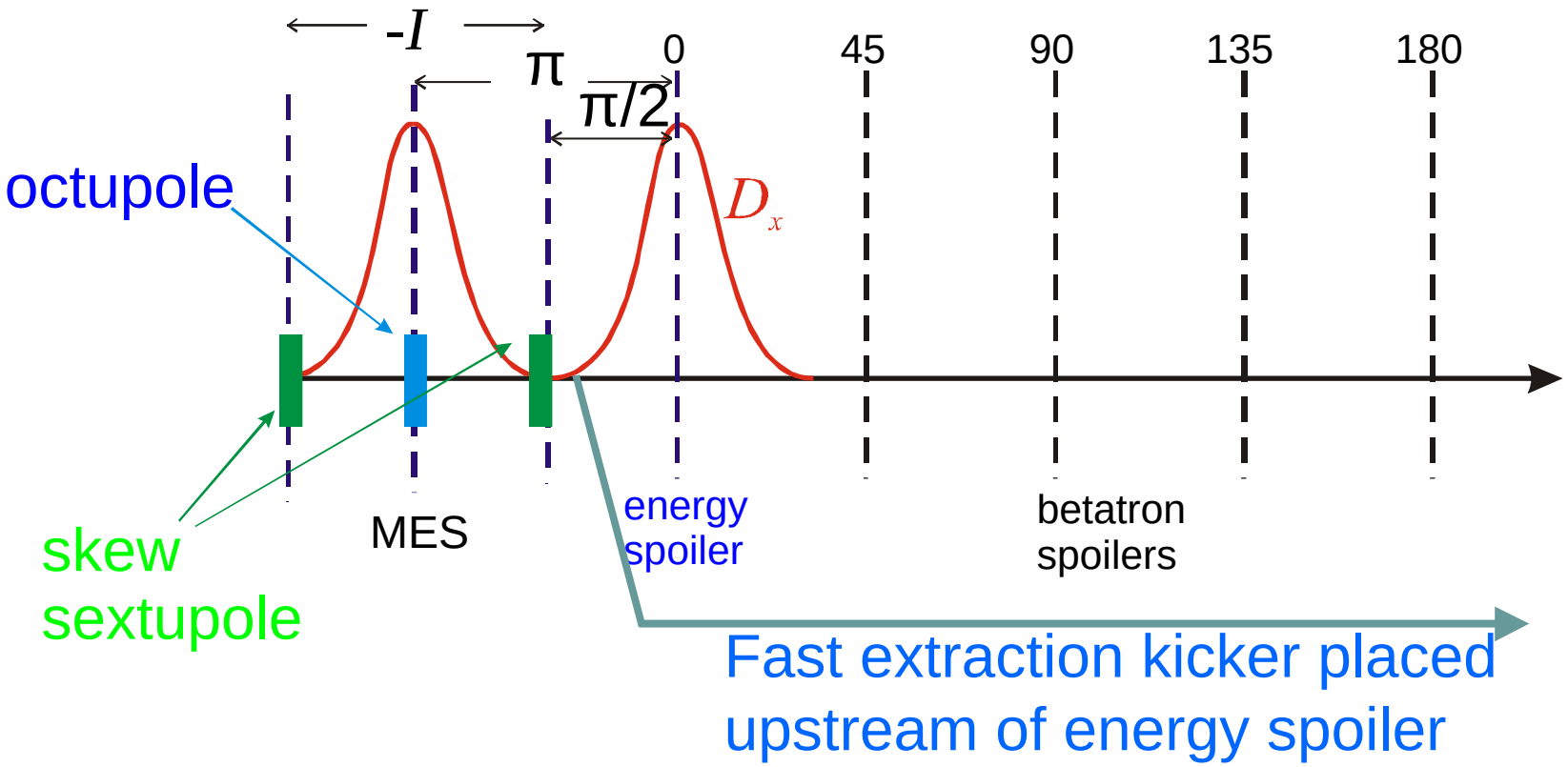






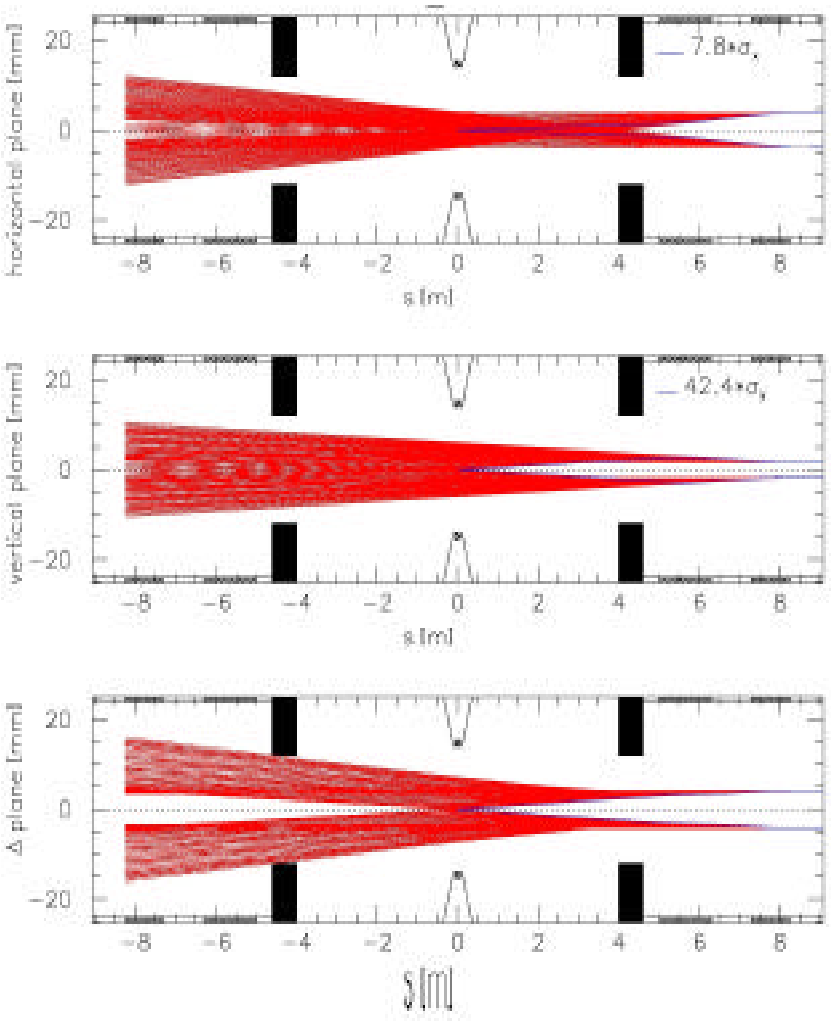
With TDR layout, this scheme doesn't work : one of the energy collimator comes before magnetic energy spoiler… machine protection issues!

Energy Spoiler Protection & Fast Extraction



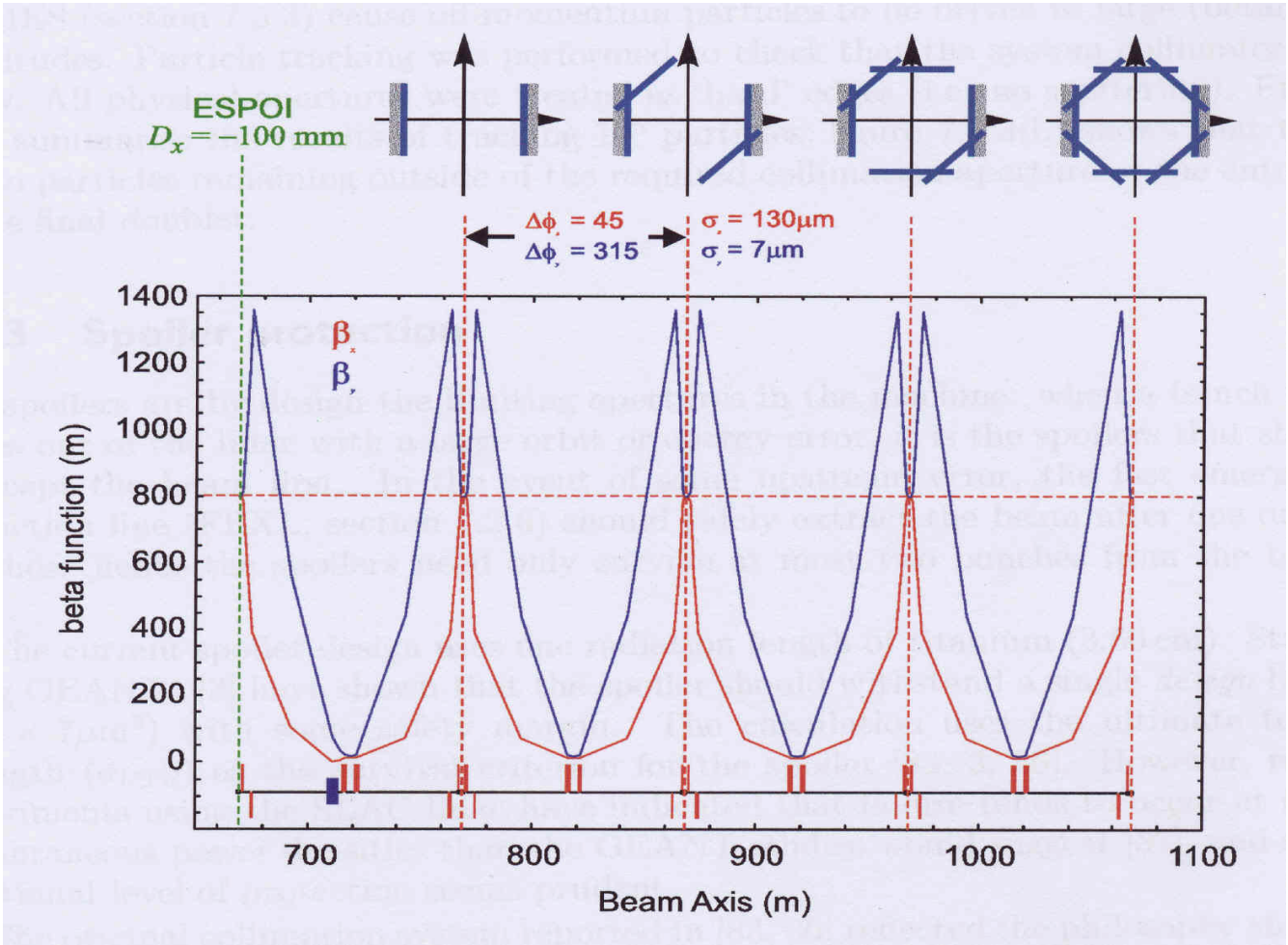
- passive protection against 'fast' energy errors
- assume pure β-oscillations less likely

Halo Collimation



- VTX with ***r*** = 14 mm requires mask with ***r*** = 12 mm
- collimation required:
  - ***x***: 7.8σ [TDR 13σ]
  - ***y***: 42.4σ [TDR 81σ]
- Collimation requirements about a factor 2 tighter!
- Collimator wakefields?
- Reconsider choice of L*
- Tail folding octupoles

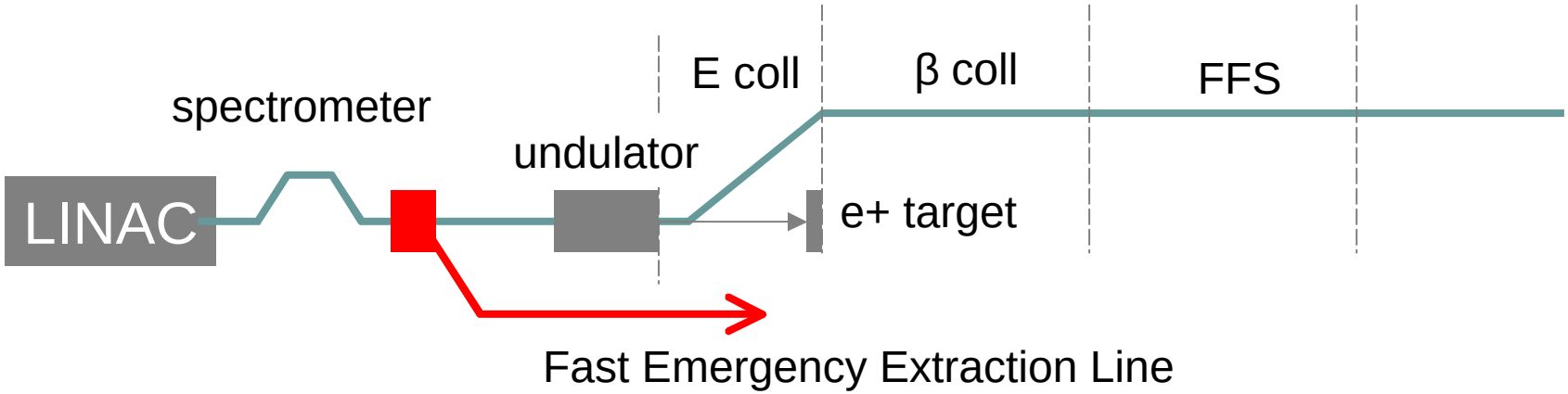
TDR Collimation



±45º lattice : some strange chromatic properties.

Balancing the second order terms was difficult in TDR……

Ideas presented by Nick Walker to change the TESLA BDS

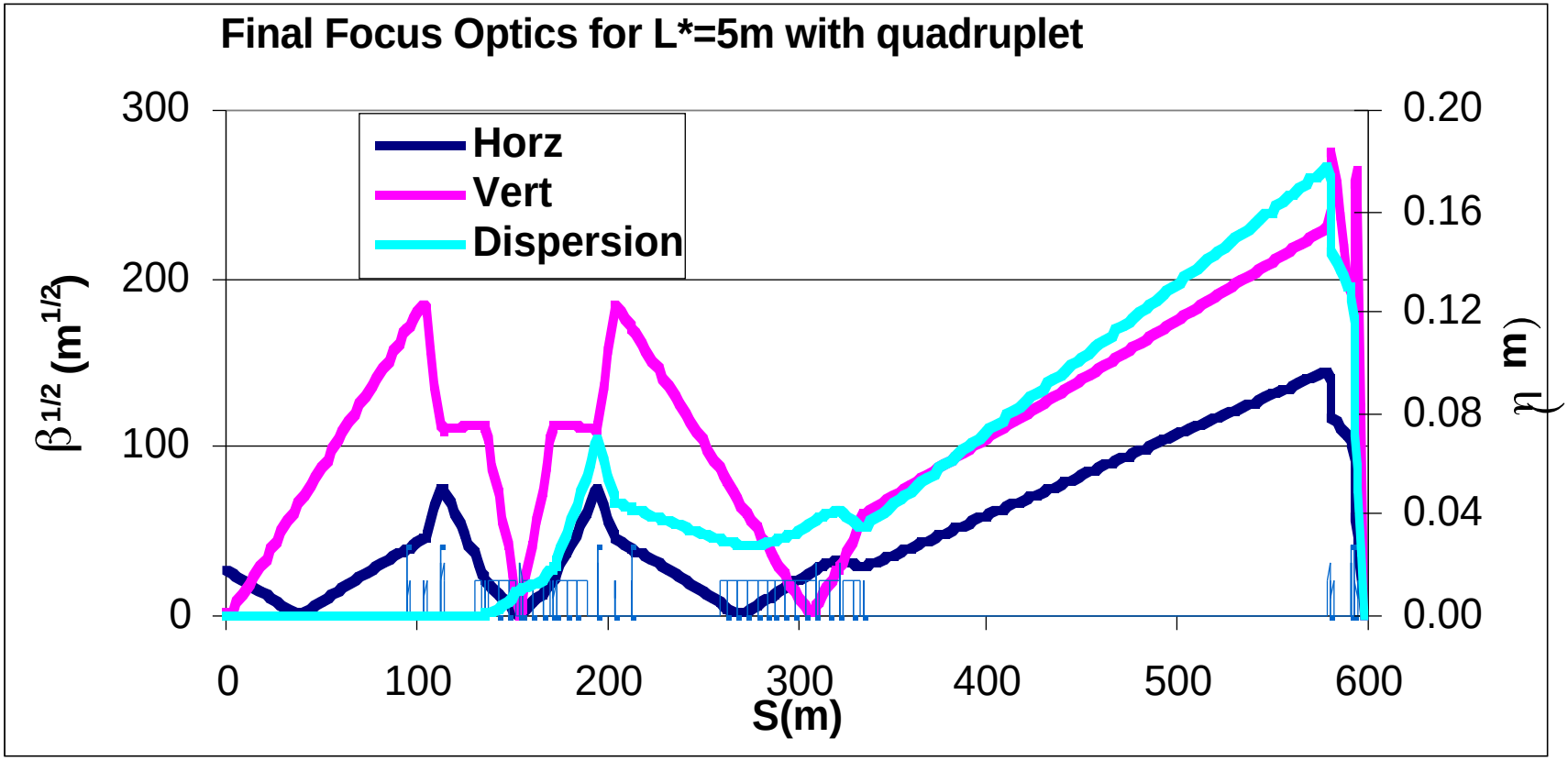


- Move Fast Emergency Extraction Line to exit of linac
  - upstream of e+ source on e- side
- Explore use of ‘e+ target bypass arc’ for energy collimation
- re-design (re-think) betatron collimation
  - current 45° lattice not good
- separate diagnostics station (emittance measurement)
  - ideally also placed directly after linac
- Other options…..

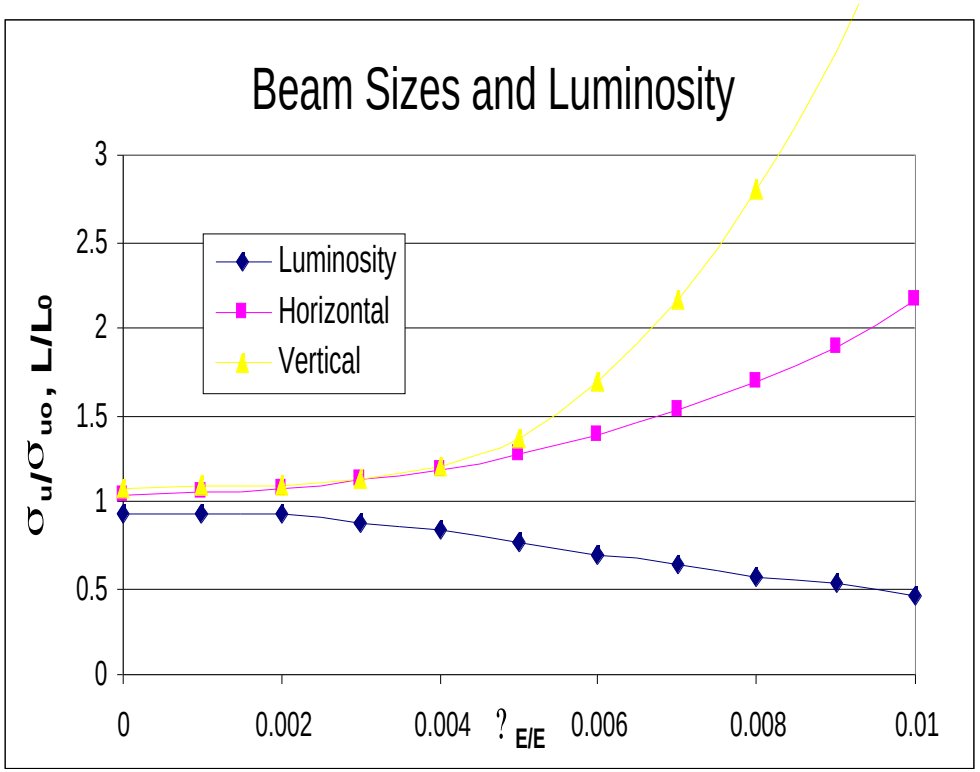
Extraction Line Issues ….

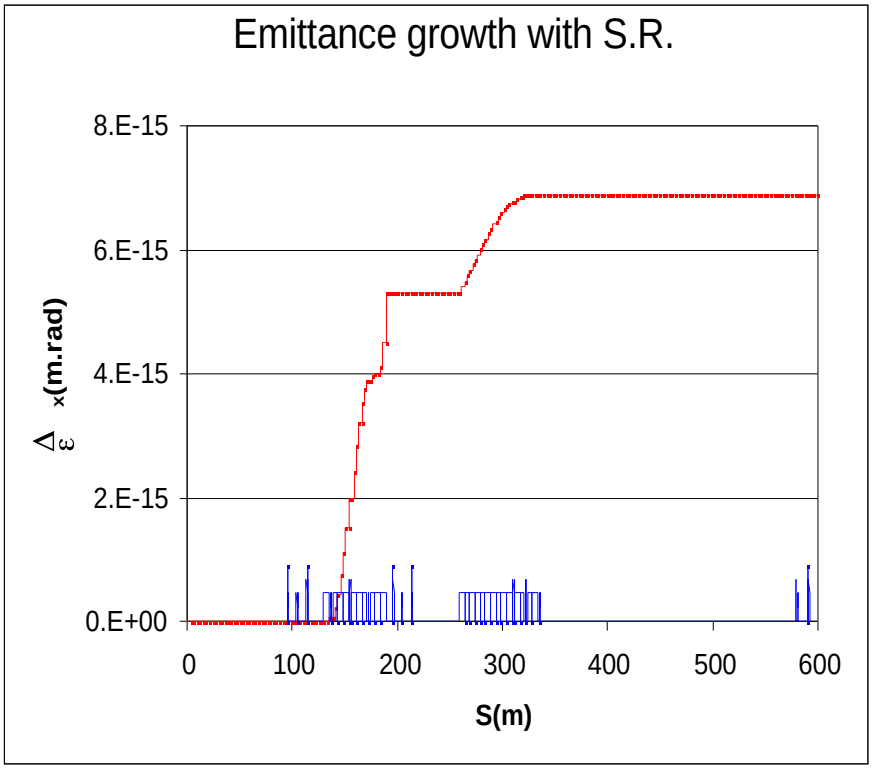
- Small vertical angle solution to reduce beamstrahlung on septum.
- Split final doublet into quadruplet to reduce e-particle losses.

Daresbury group found an optics solution to this problem.



L*=5m with final quadruplet



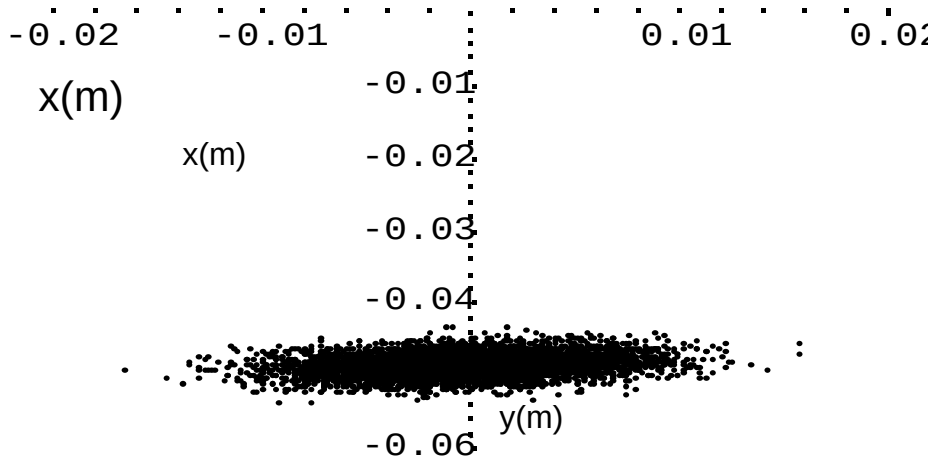


Further optimisations …..may give better results!

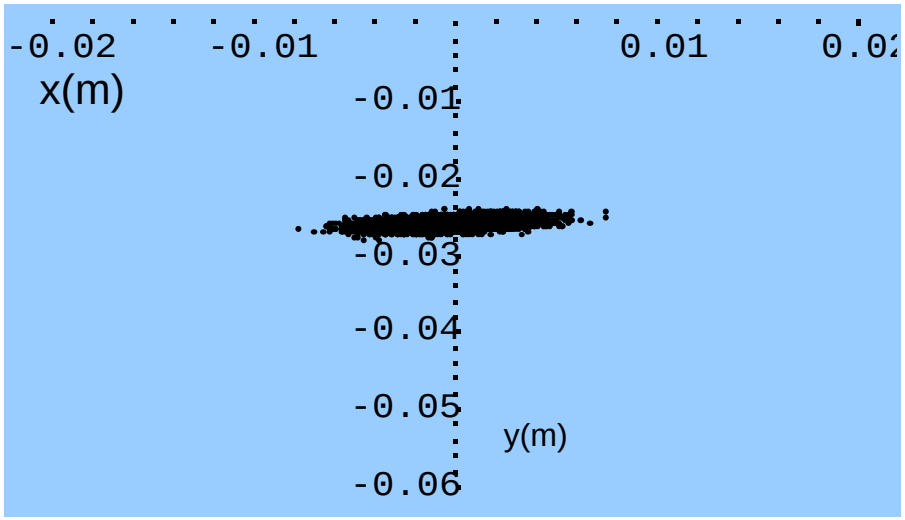
L*=5m with final quadruplet

Beam Sizes for –40% energy tail particles at MSEP (~50 m from IP) in the extraction line :

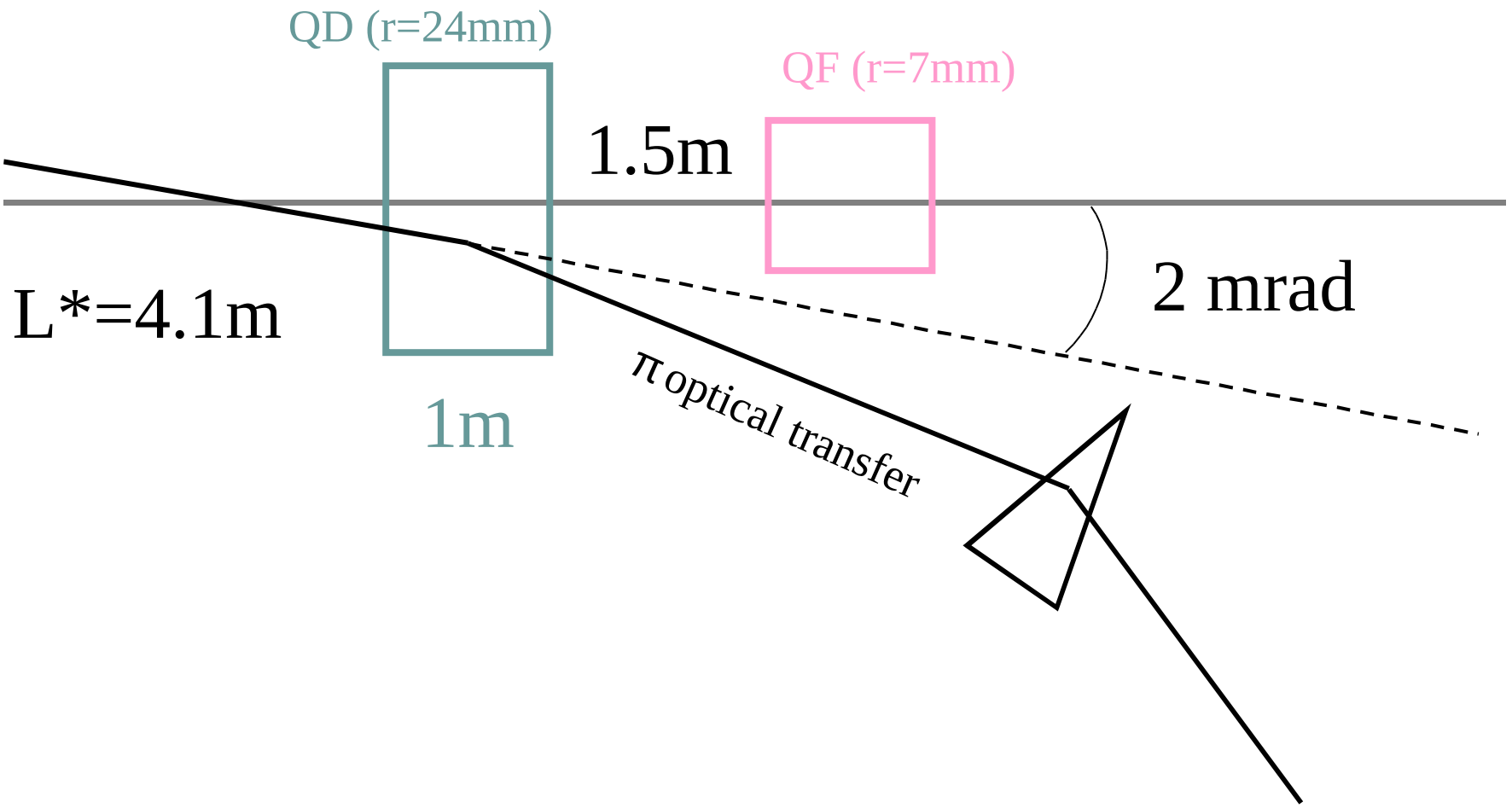
With doublet



With quadruplet



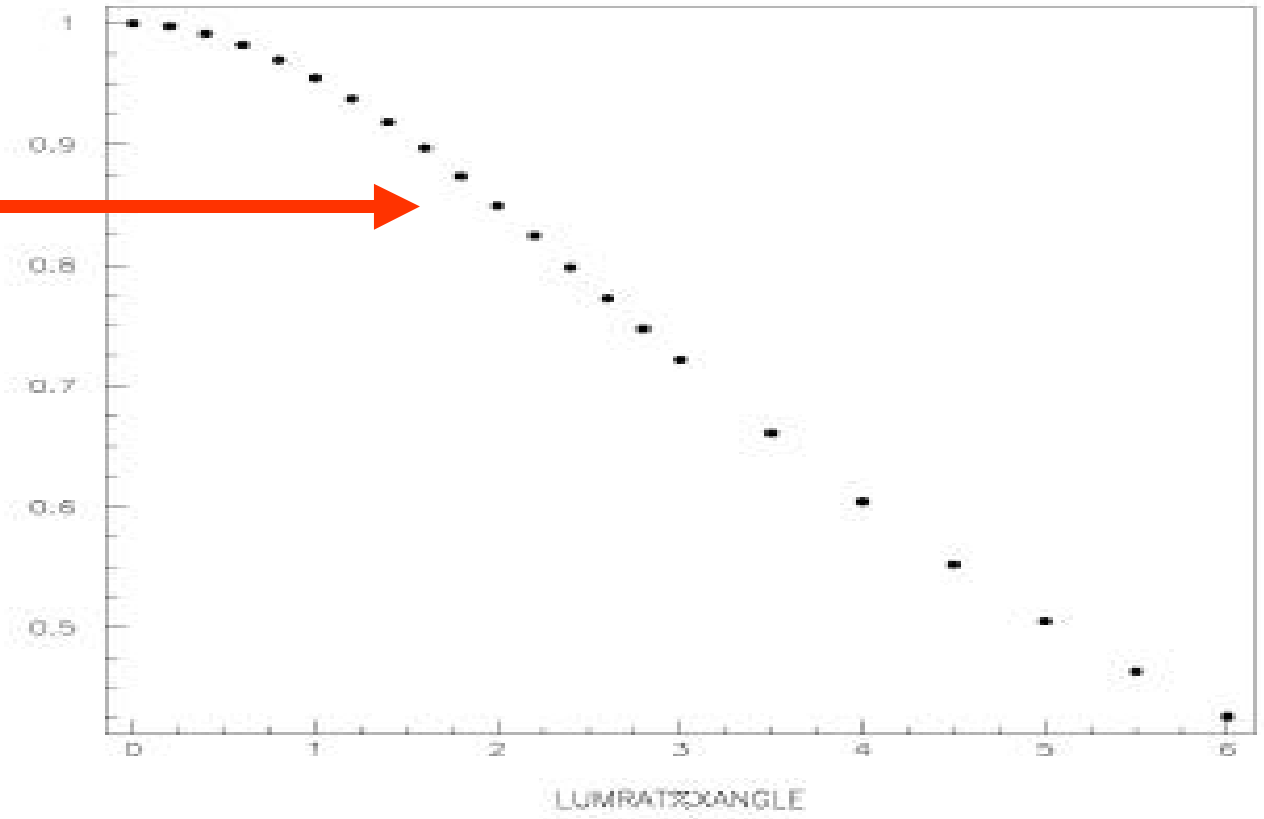
A small horizontal crossing angle (~2 mrad) is proposed by O. Napoly, J. Payet, Saclay & P. Bambade, B.Mouton, Orsay



Luminosity loss without crab-crossing for 2 mrad horizontal crossing angle

L/L_0

~ 0.85



geometric formula → 0.88

2θ[mrad]

Crossing Angle Choices for TESLA

- 300 μrad vertical crossing + quadruplet to reduce beam losses :Necessary R&D on reliable 50KV/cm, 20-30 m long electro-static separators.

- 2 mrad horizontal crossing angle → no electrostatic separators, 15% Luminosity loss without crab crossing, can be compensated by angular dispersion at IP.

- Large crossing angle like in NLC

Crossing angle working group to recommend the detector and physics implications.

Summary

- TESLA BDS design is being improved for incorporating local chromaticity correction section, better collimation and machine protection issues.
- Re-iteration on L*.
- FFS to be optimised for third & higher order terms.
- Alternative solutions for beam extraction suggested by Saclay, Orsay and Daresbury groups.
- The details of these designs including beam diagnostics need to be worked out.