Optics and Collimation Mini-Review Meeting Summary

Deepa Angal-Kalinin

22nd January, 2004

Optics and Collimation Mini-Review Meeting

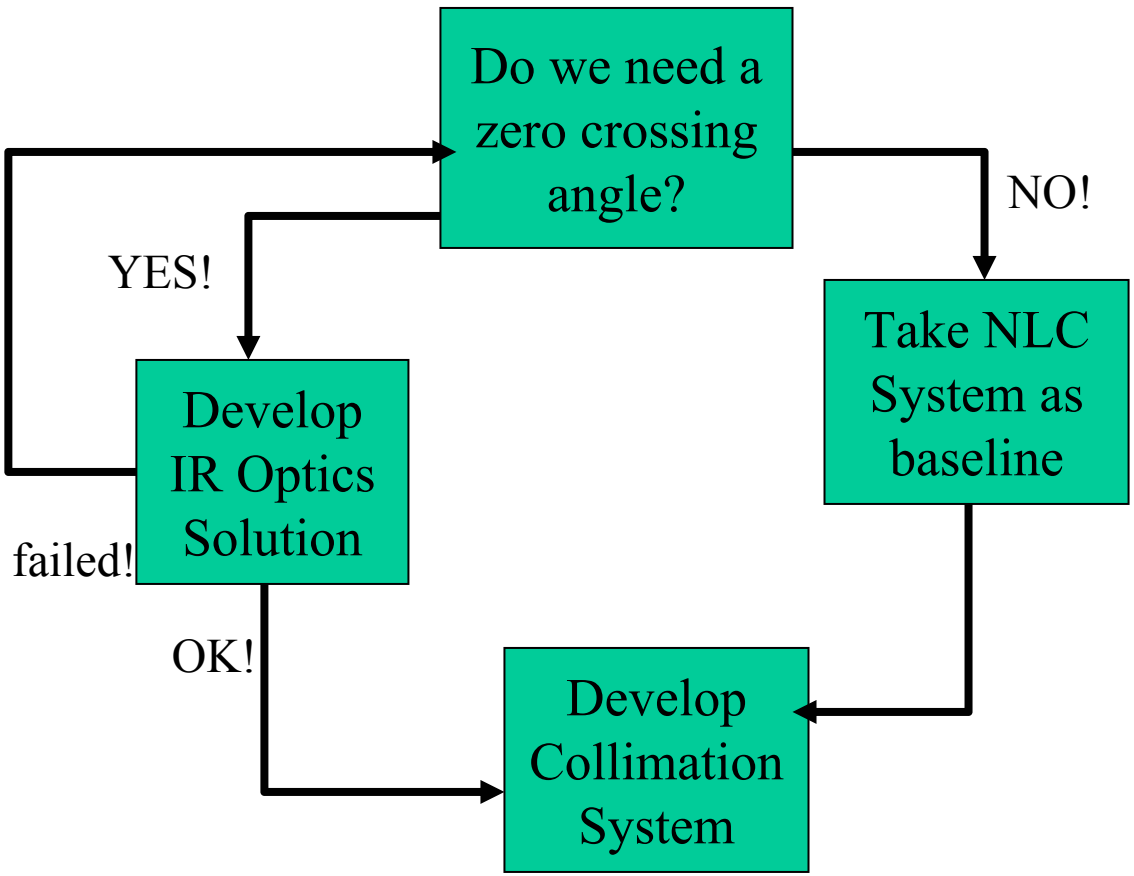
20th January, Zeuthen

Agenda

Introduction	Nick Walker
The current design	Olivier Napoly
TESLA TDR Collimation System	Nick Walker
Collimation requirements with & w/o crossing angle	Philip Bambade
Final Focus Design for crossing angle layout	Deepa Angal-Kalinin
Collimator wake field issues	Nigel Watson
Beamstrahlung on the septum blade	Karsten Buesser
Status of detector background simulations & comparison of Beamstrahlung pairs calculations	Karsten Buesser
IR layout	Achim Stahl
Report from crossing angle meeting	Philip Bambade

Participants : 18

TESLA BDS Issues

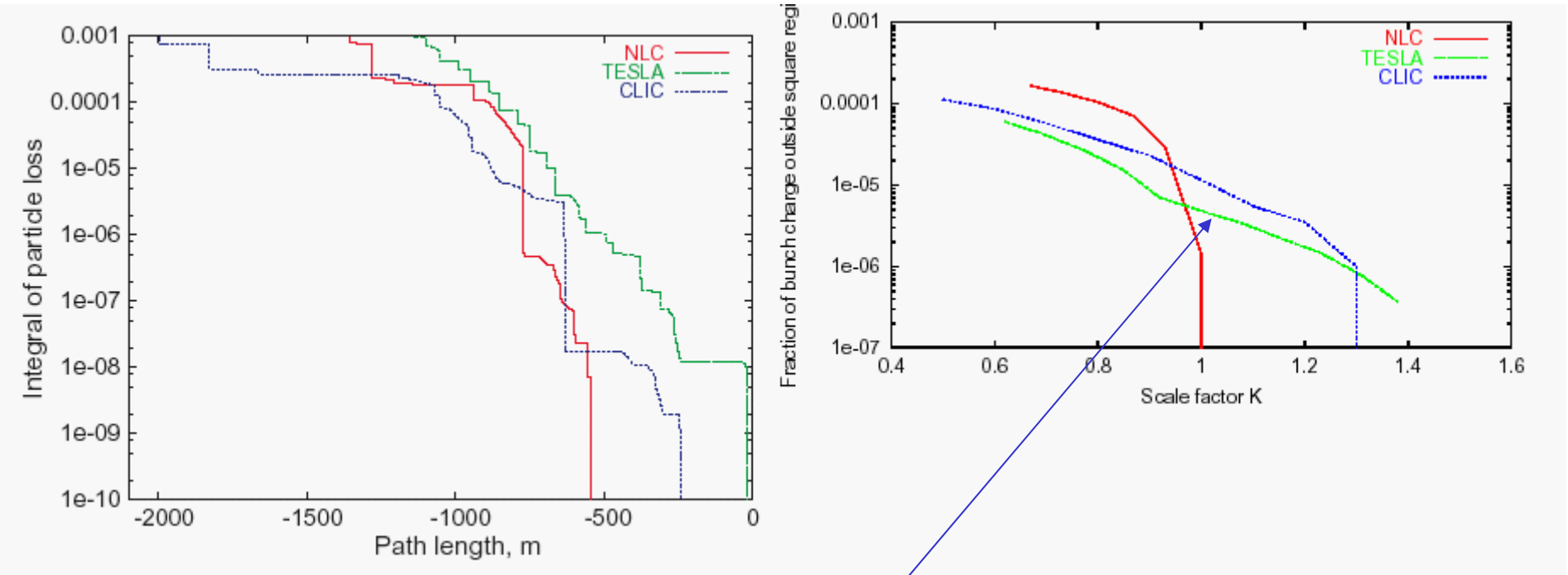


- Critical Issue: Extraction Line
  - beamstrahlung
  - spent beam
  - post IP diagnostics
  - crab crossing
  - tilted solenoid field
- Need (single) solution for:
  - incoming beam
  - beamstrahlung
  - spent beam
- Is small vertical crossing angle (Brinkmann) a real solution?

Nick Walker, 20/01/04

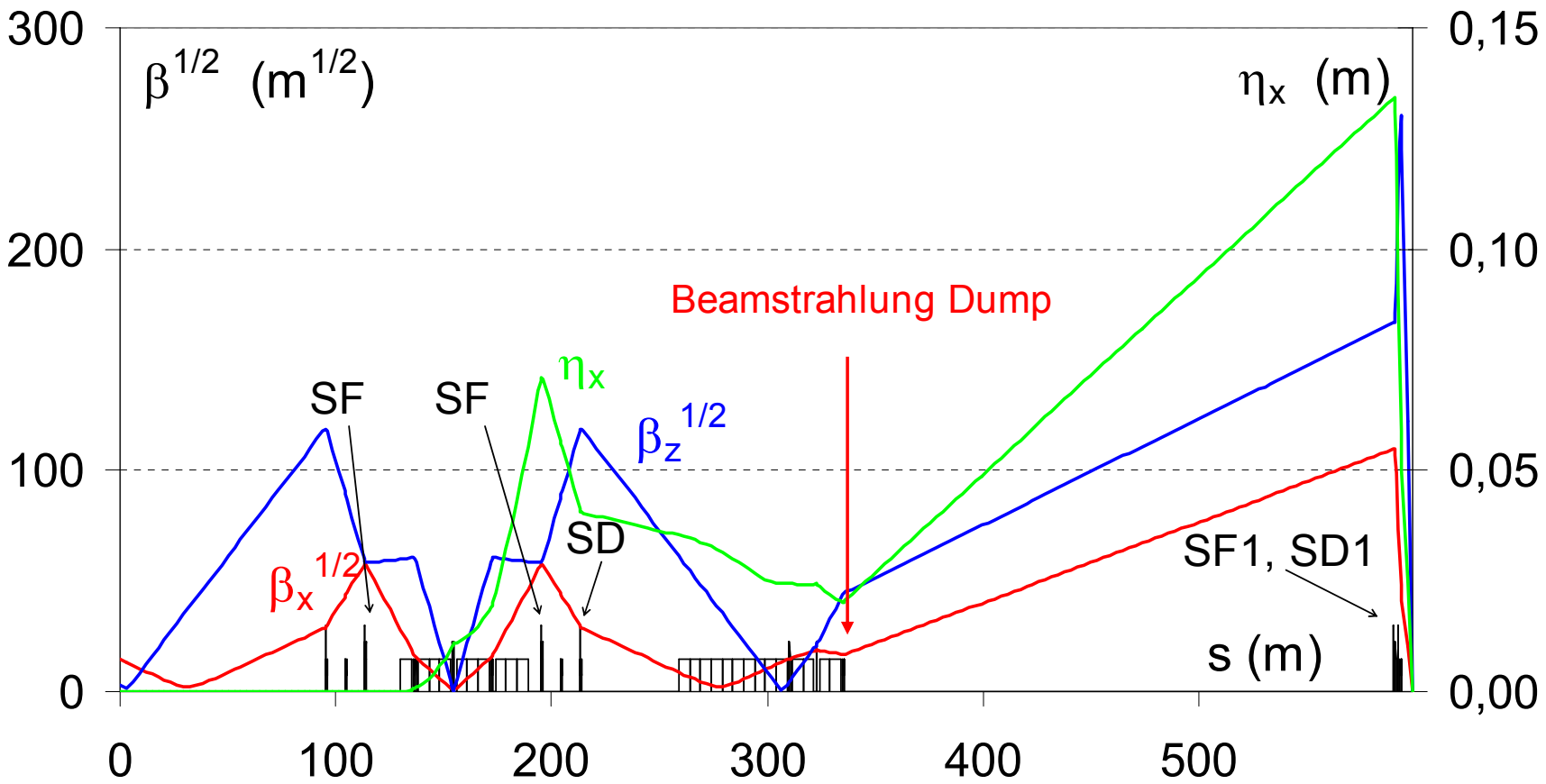
TRC results

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)

NLC-like Optics



@ IP η'_x = 10 mrad

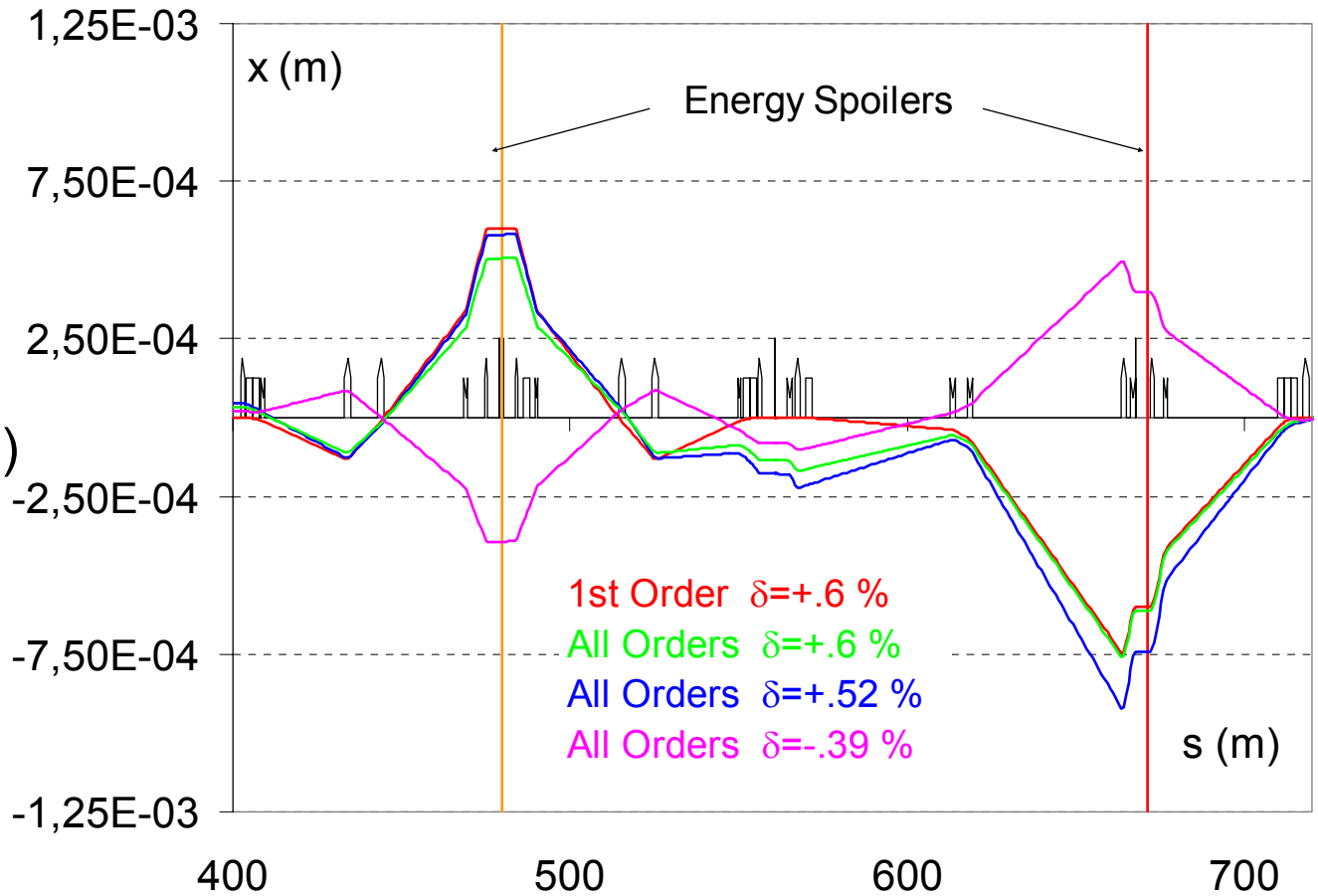
O.Napoly,20/01/04

The collimation section

We use the TDR collimation section with some changes :

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

($\Delta\Psi_x = 2\pi$ between the 2 energy spoilers)



O.Napoly/J.Payet, 20/01/04

Conclusions

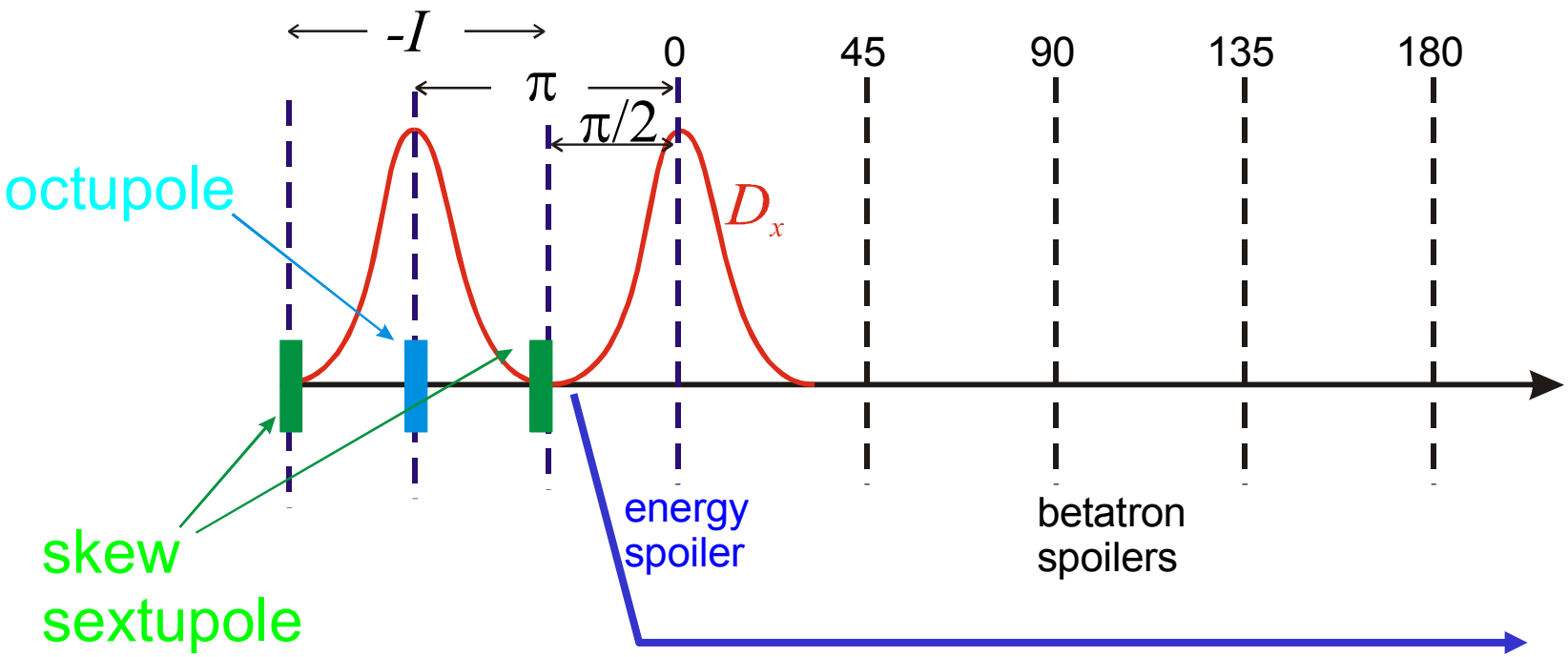
Design of l^* = 5 m new TESLA final focus is possible within the 600m TDR length constraint. Two solutions are investigated, using the NLC chromaticity correction scheme. For the both cases :

- The momentum bandwidth is comparable or better than the TDR.
- The collimation requirements are about a factor 2 tighter than the TDR.
- The code BETA develops a new tool to investigate the impact of off-energy particle collimation.
- The spent beam extraction through final doublet is roughly equivalent.
- Several optimizations are still needed

type	l^* (m)	η'_x (mrad)	L/L_0 @ 0,4%	$\Delta\varepsilon_x$ (m.rad)	β Spoiler H/V (mm)	δ Spoiler (mm)	δ Acc. (%)	H/H_{TDR}	L (m)
TDR	3	0.0	0.73	$6.6\ 10^{-14}$	3.0 1.0	4.0	-	1,00	630
Hybride	5	2.6	0.70	$2.0\ 10^{-13}$	1.8 , 1.2 0.7	0.9 , 0.7	-0.42 , +0.57	0,57	662
NLC	5	10.0	0.86	$5.6\ 10^{-14}$	1.8 , 1.3 0.7	0.8	-0.39 , +0.52	0,56	599

O.Napoly, 20/01/04

Fast Extraction

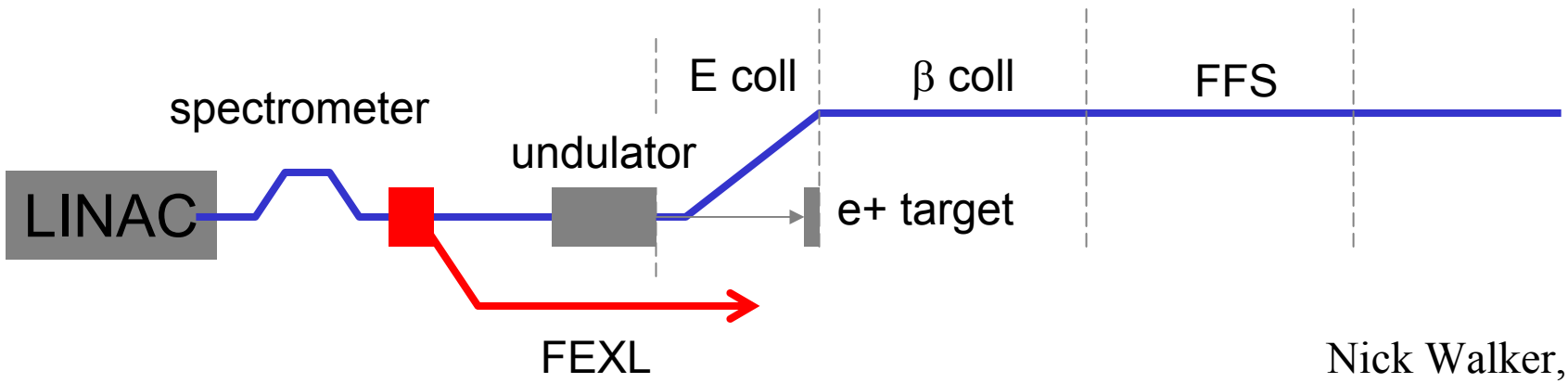


magnetic
energy
spoiler (MES)

Fast extraction kicker placed upstream of energy spoiler

Ideas

- Move FEXL 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 deg lattice not good
- separate diagnostics station (emittance measurement)
  - ideally also placed directly after linac



Nick Walker, 20/01/04

Collimation requirement with mask at s = 4.6m

hole size	horizontal	vertical
1.2 cm (head-one)	6.5 sigma	68.5 sigma
2.4 cm (crossing-angle)	13 sigma	137 sigma

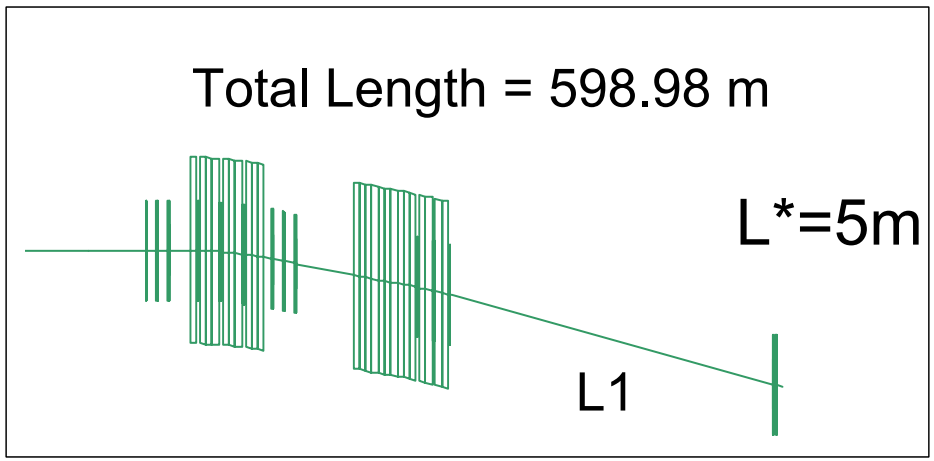
→ more relaxed !

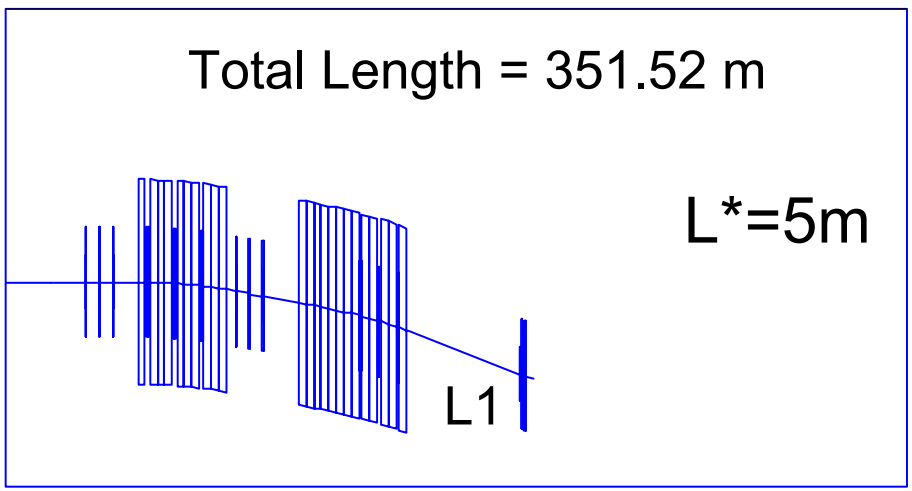
Further checks & work

- quads upstream of final doublet were checked to give less stringent requirement
- need to check & compare with Olivier Napoly's routine
- need to check higher order dispersive effects (Jacques Payet)
- probabilistic formulation to compute relevant photon rate at mask taking into account expected beam halo densities in TESLA and NLC / JLC → tracking

Philip Bambade, 20/01/04

Final Focus Design





Started with Jacques & Olivier's deck for FFS for head on scheme.

L1= 250 m →clear extraction path for the beamstrahlung to the beam dump.

Reduced L1 = 75 m

NLC high energy line L1~75m (for masking SR from bends - first mask at ~40 m and second at ~35 m)

Low energy line L1~35m

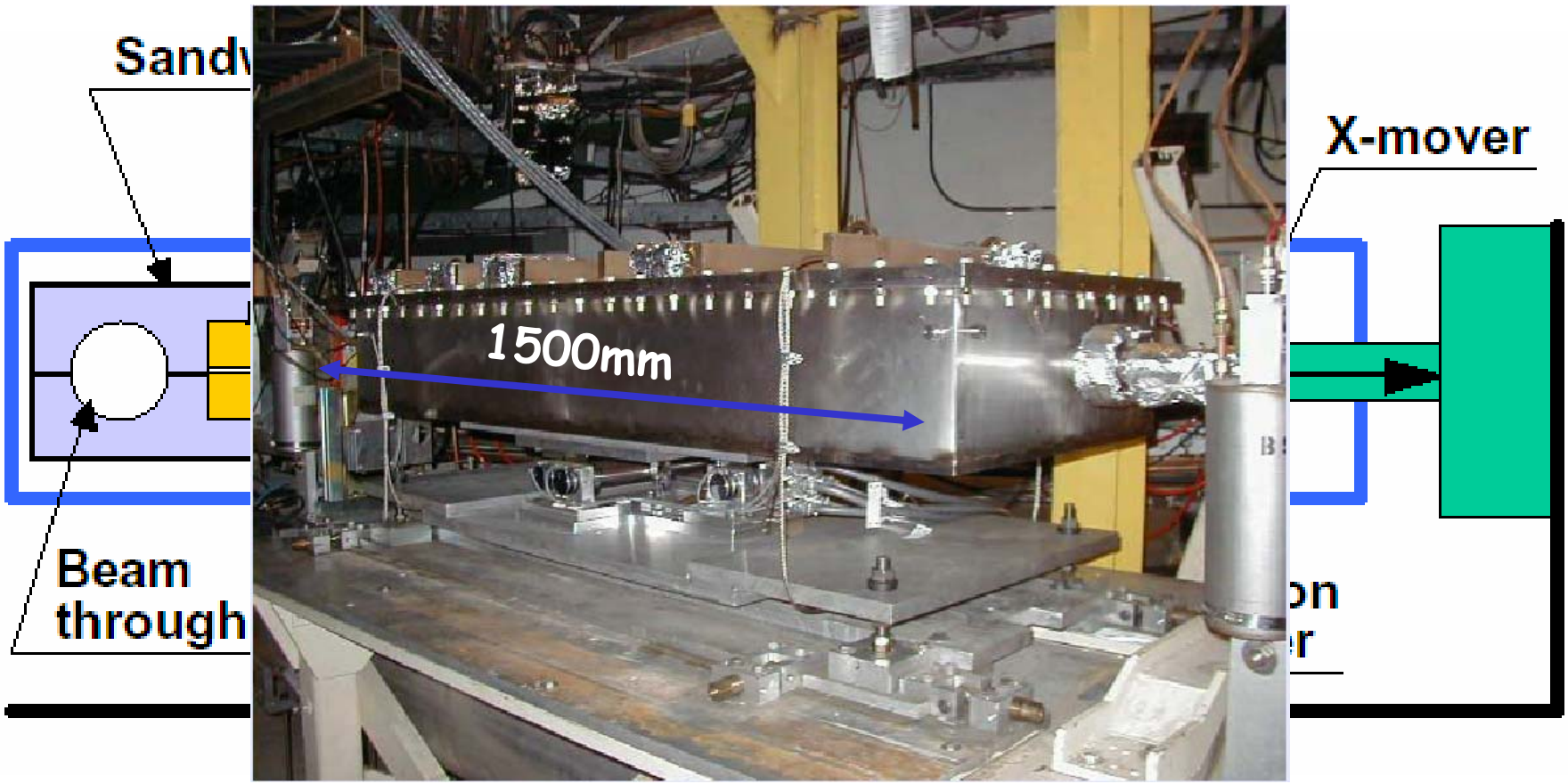
CollimatorWakefields

- WF in vertical plane important even in error free machine
- Collimator at betatron phase of FD most criticaL
  - Contribute to position jitter of beam at IP
- Factorise into geometric and resistive effects
- Very difficult to calculate analytically - possible for simple configurations
- Difficult to model, esp. for short bunches, shallow tapers, in reasonable time

SLAC CollWake Expt.

At 1.19 GeV point
in SLAC linac

$\sigma_z \sim 650\mu$

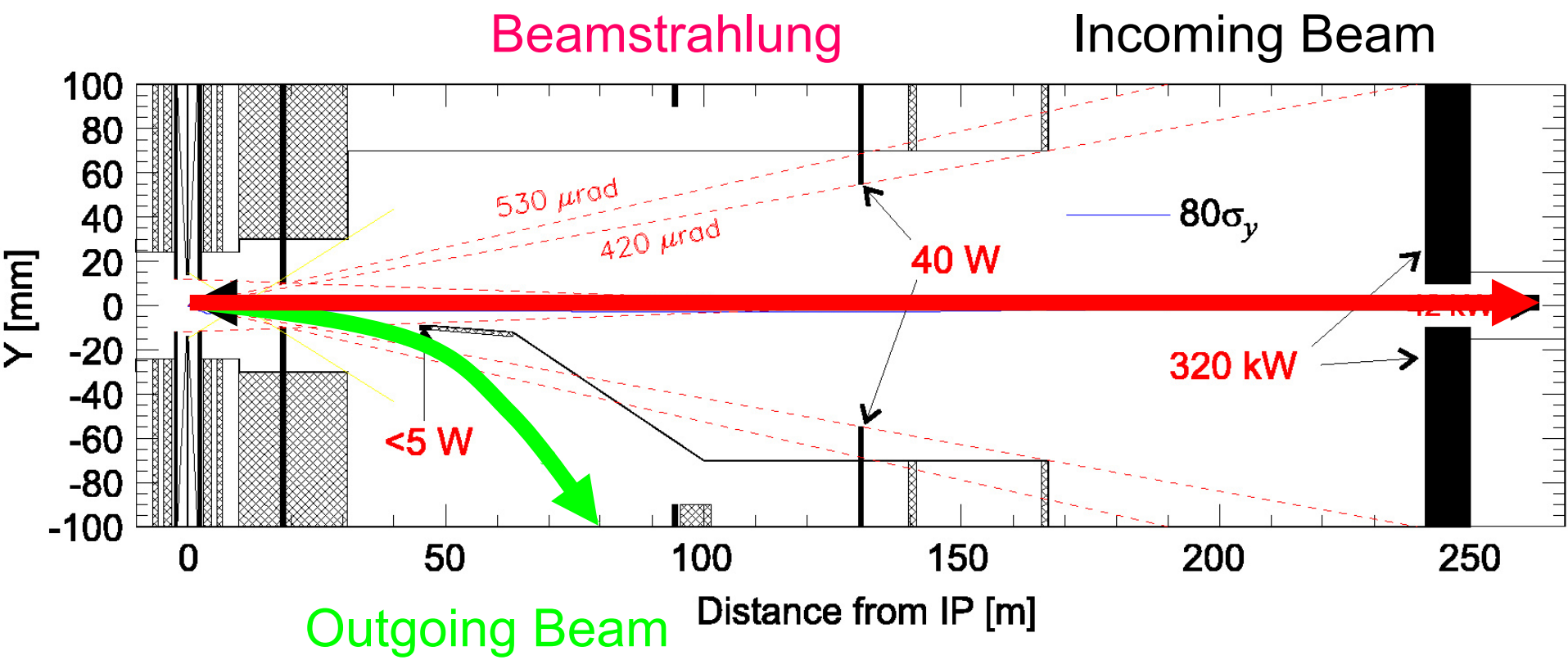


Magnet mover, y range = ± 1.4mm, precision = 1μm

Wakefield Reduction Methods

- Optimisation of collimator form – need reliable/validated predictions
- Ideal case - infinite long taper, circular
- Realistic - include constraints from finite size, longitudinal real estate
- 2-step tapers
- More complex shapes, non-linear tapers?
- Tail folding – but should be verified experimentally before relying upon this to solve all problems
- Increase vertex radius at IP?
  - cf Seryi at Halo'03/NLC MAC meeting? "to some extent vxd radius is a free parameter…"
  - Discussion

Beamstrahlung on the Septum Blade



K. Buesser, 20/01/04

Conclusion

- Under realistic beam conditions, 30-40 kW of Beamstrahlung are emitted under vertical angles larger than 0.155 mrad.
- Roughly half of the emitted energy is deposited in the septum shadow.
- Septum blade receives on average 80W.
  → Information from Efremov: 15 kW has to be cooled away from septum blade due to normal operation.
  → Septum will probably undergo no mechanical damage.
  → 40 kW of Beamstrahlung will irradiate the septum environment.

To be done

- Check backgrounds for the detector.
  → Backscattering
  → Pairs, neutrons with realistic beam
- Check charged particle extraction losses.

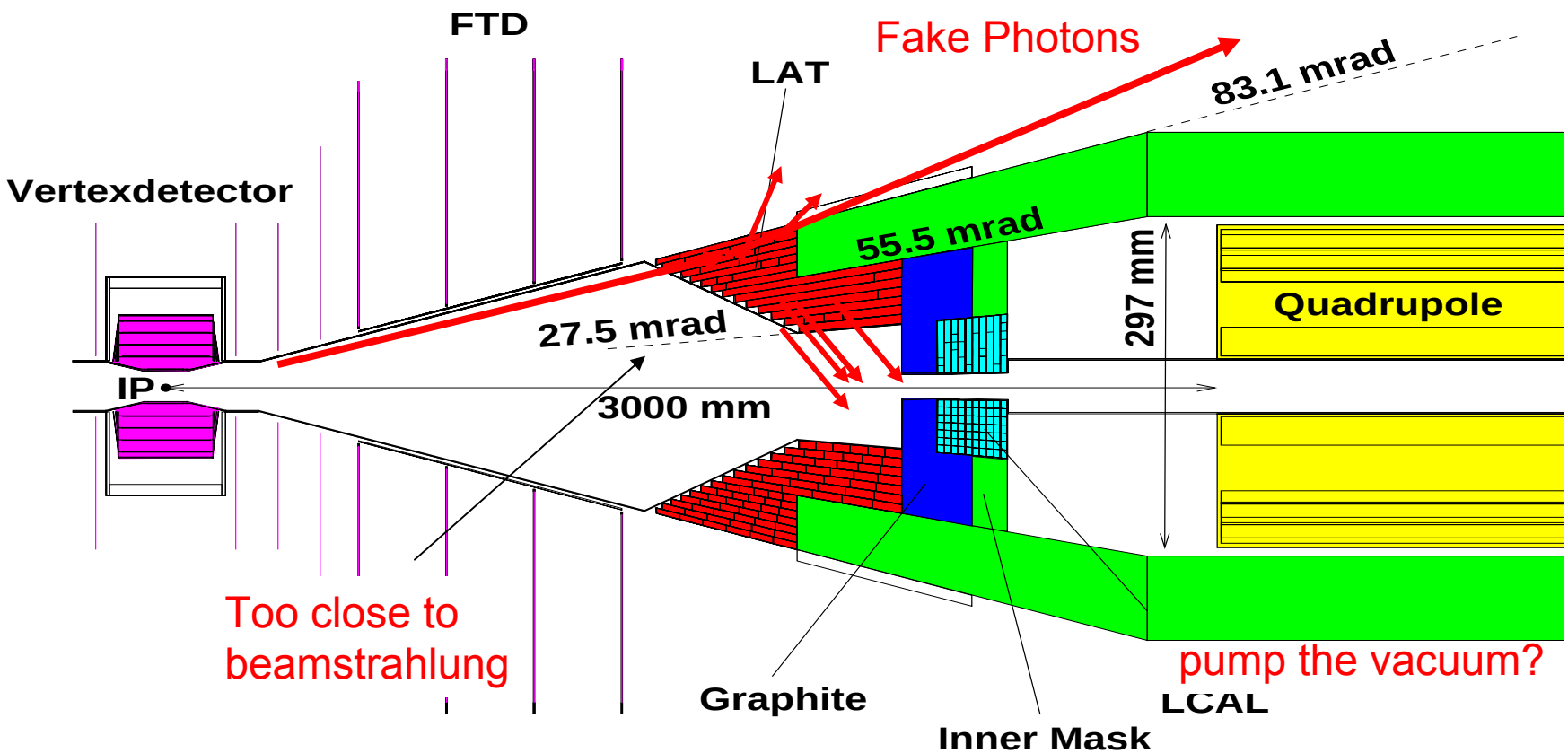
K.Buesser, 20/01/04

New Design of the Mask

- For L* = 3 m performance of the mask calorimeters is doubtful
- For larger L* things look easier
- Question: How much L* do we need?

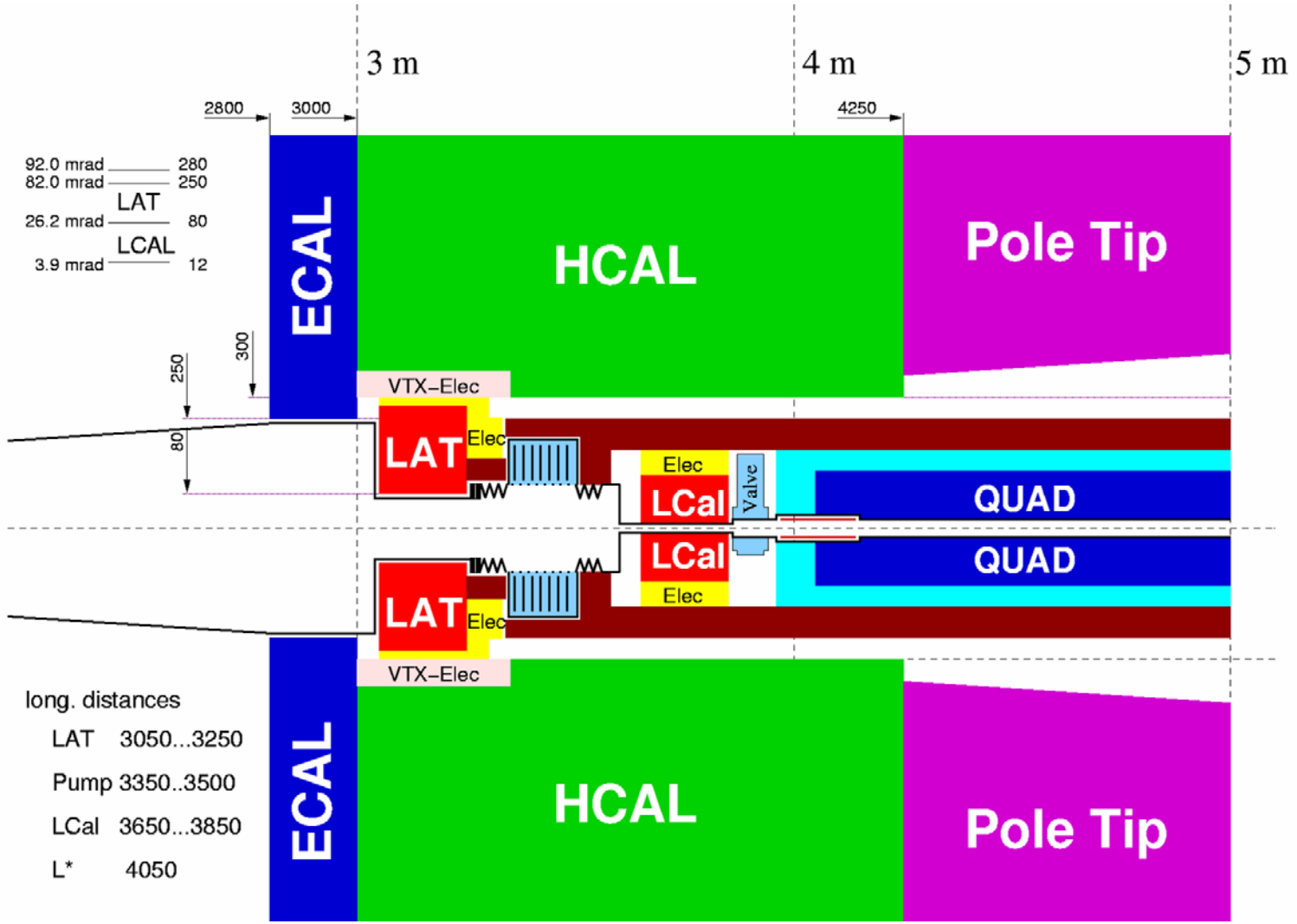
TDR Design

No space for electronics
Leakage makes precision luminosity hard



Proposed Design for l* ≥ 4.05m

Design by Achim Stahl (presented in Amsterdam)



New Mask Design

Advantages

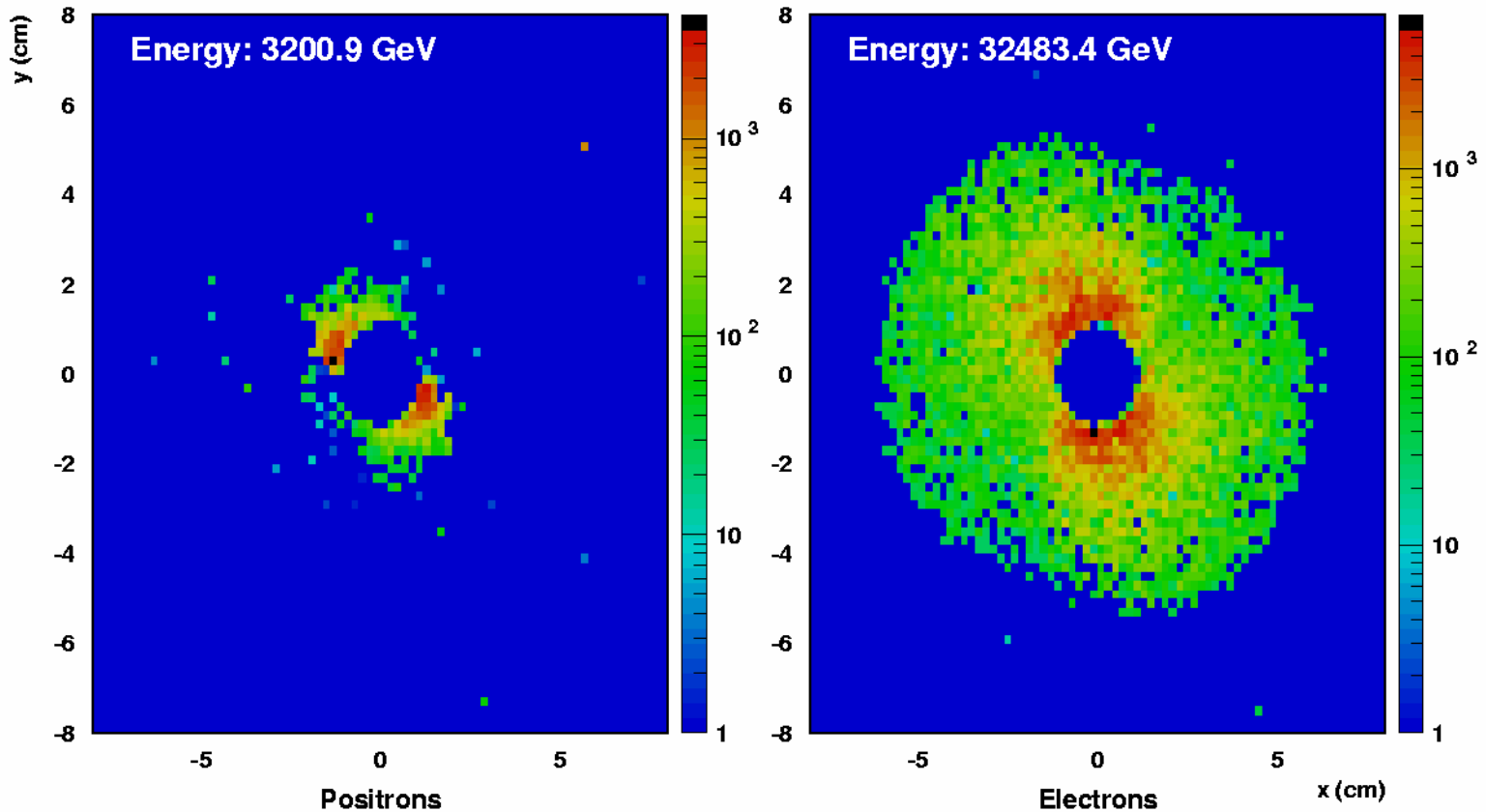
- Flat LAT geometry
- LAT is behind ECAL, no scattering of particles off the LAT edge into the ECAL
- Mask moved out of the tracking system
- Vacuum situation much better

Tasks

- Adapt this design to x-angle geometries.
- How is the background situation ?
- How is the performance of the LAT/LCAL ?

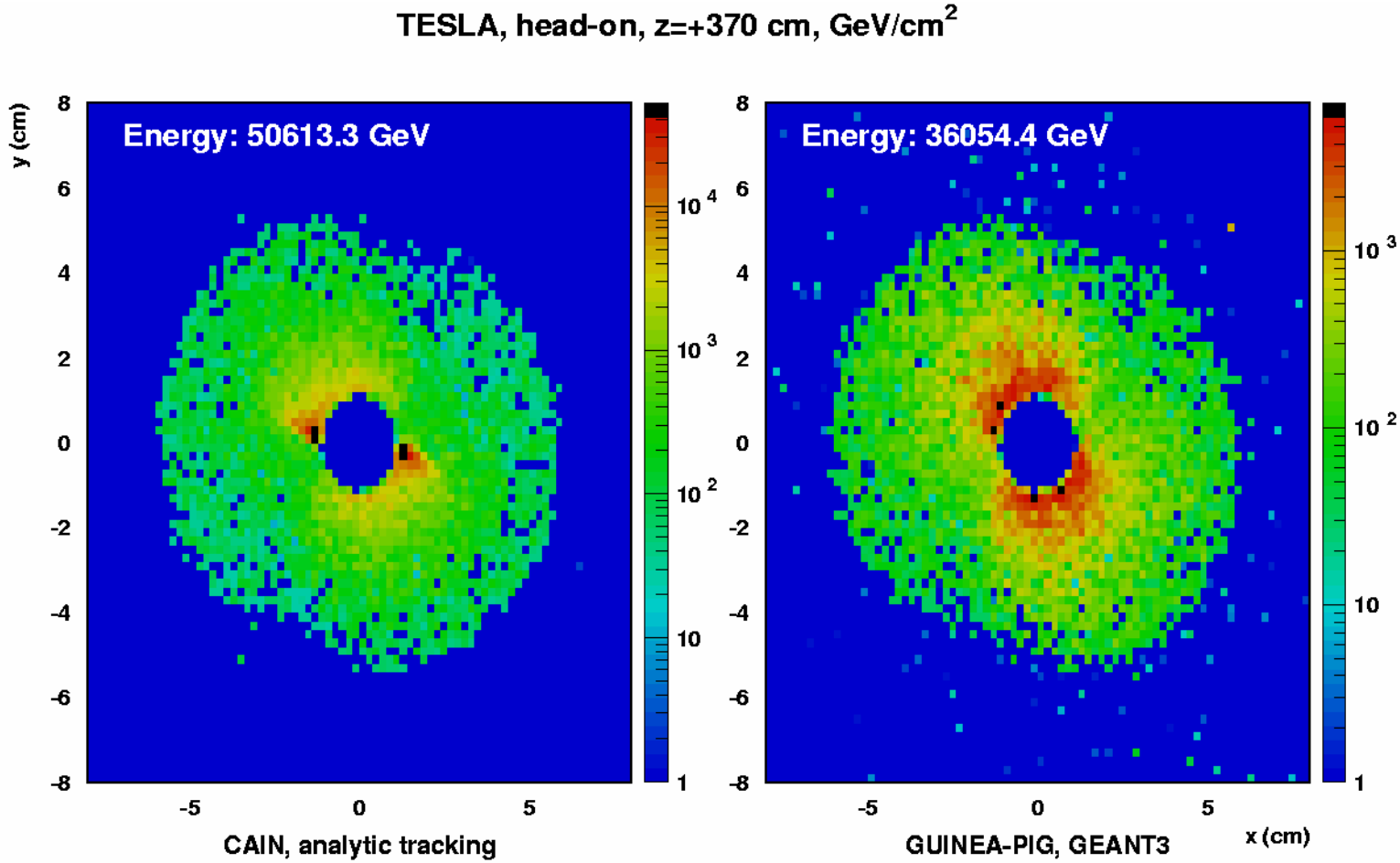
Deposited Energy on the BCAL per bunch crossing

TESLA Head-On z=+370cm



K.Buesser, 20/01/04

TESLA Head-On z=+370cm



K.Buesser, 20/01/04

Detector Backgrounds

- The pairs from beamstrahlung not only influence the performance of the forward detectors but are a significant source of direct and backscattered background for the detector
- The most important beam induced backgrounds have been studied in detail for the TESLA TDR detector
- These background levels will change when l* changes or a crossing angle is introduced
- To do: Update the simulations to
  - l*>4.05 m (using Achim‘s mask design for a start)
  - a finite crossing angle

- Work is in progress, results are promised for the LCWS’04 in April

Discussion and Plan

- Try to find optics solution with 0.3mrad vertical angle → check that incoming and outgoing beams satisfy the required conditions.

- Possible solutions for the electrostatic separators?

- Redesign the entire line → with good collimation + separate diagnostics section + machine protection & ensure that extraction can be safely done.