Technical systems in the BDS

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Thanks to the input of many: D. Angal-Kalinin, G. Burt, B. Dalena, J.L. Fernandez, L. Gatignon, M. Modena, J. Osborne, J. Resta, H. Schmickler, D. Schulte, A. Seryi, J. Snuverink, G. Zamudio

IWLC 2010, October 2010

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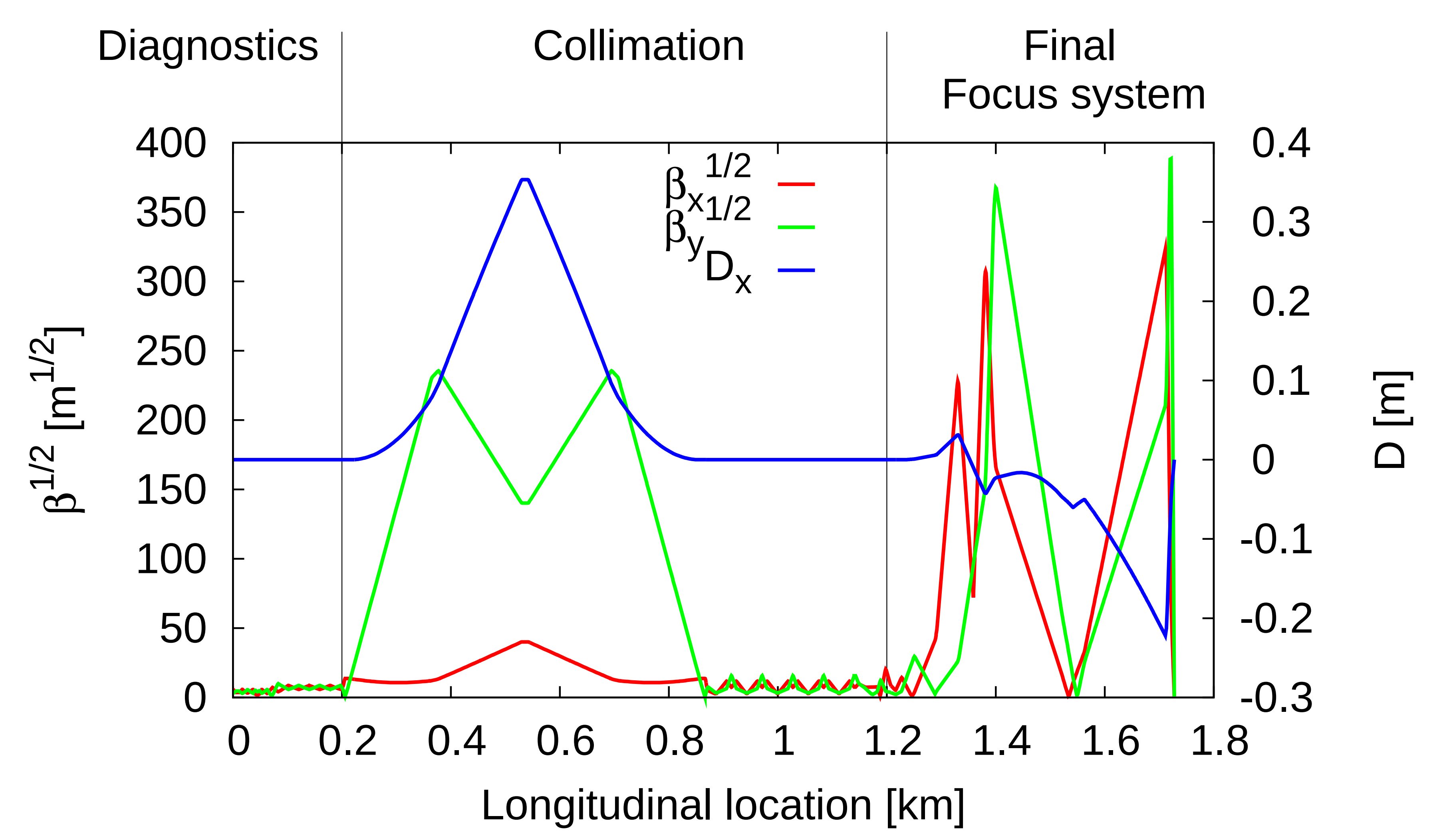
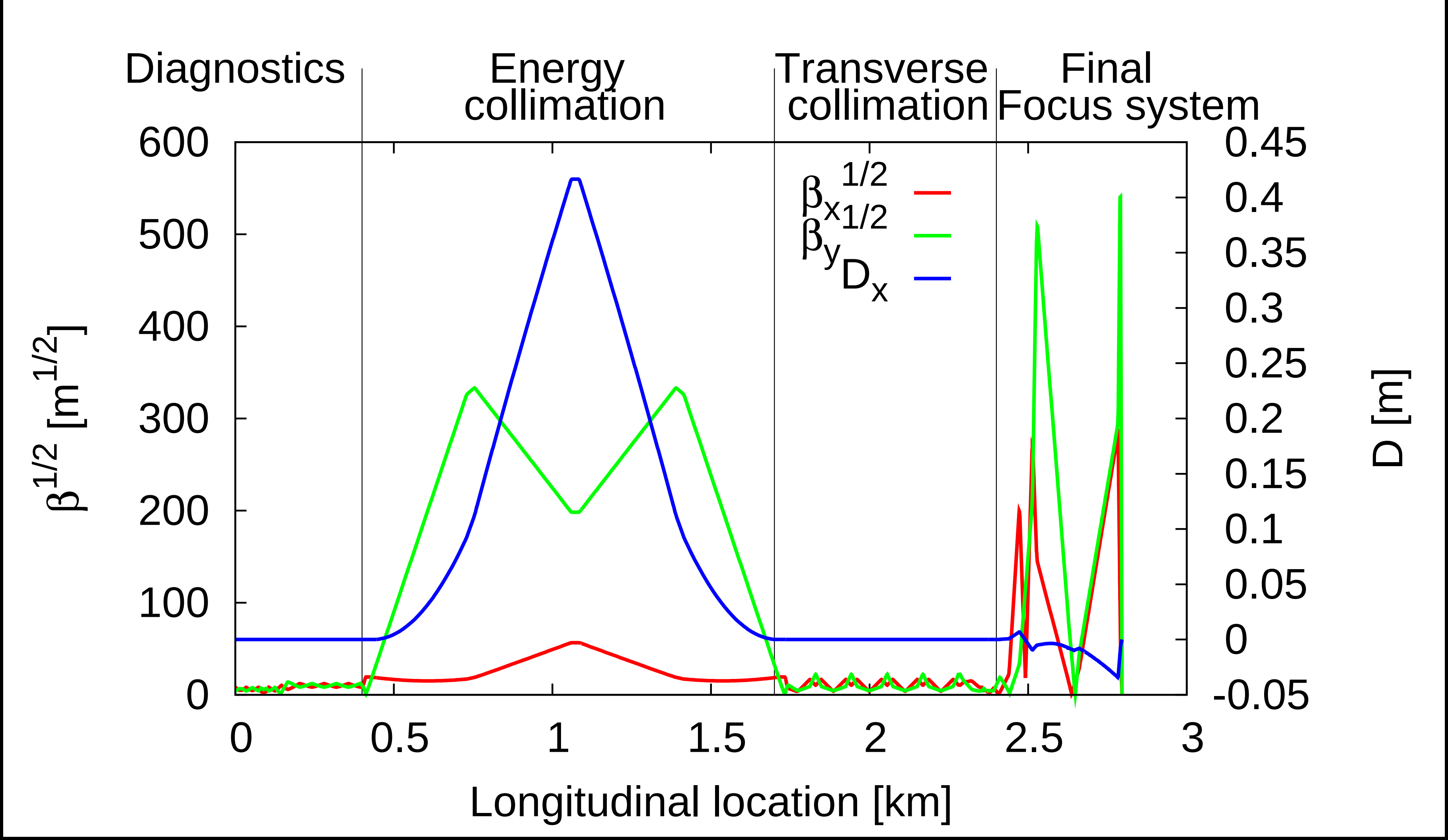
- 500 GeV and 3 TeV BDS optics, beam pipe aperture and layouts
- instrumentation: emittance, energy measurements
- tune-up dump
- Polarization measurement
- Collimation
- FFS, different L* and tuning
- QD0 specifications
- Crab cavity specifications
- magnets, quads, dipoles, specs

The 500 GeV BDS

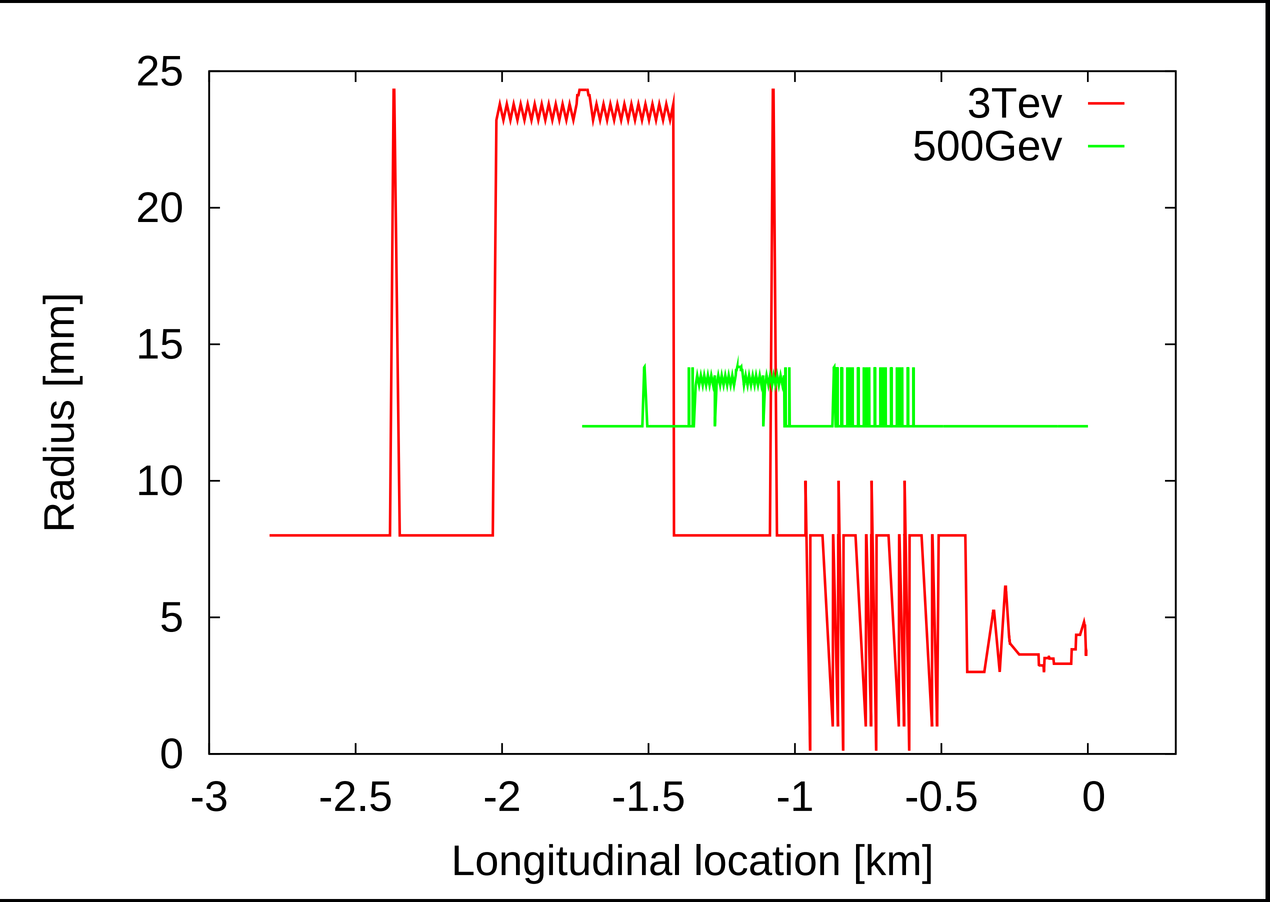


The 3 TeV BDS



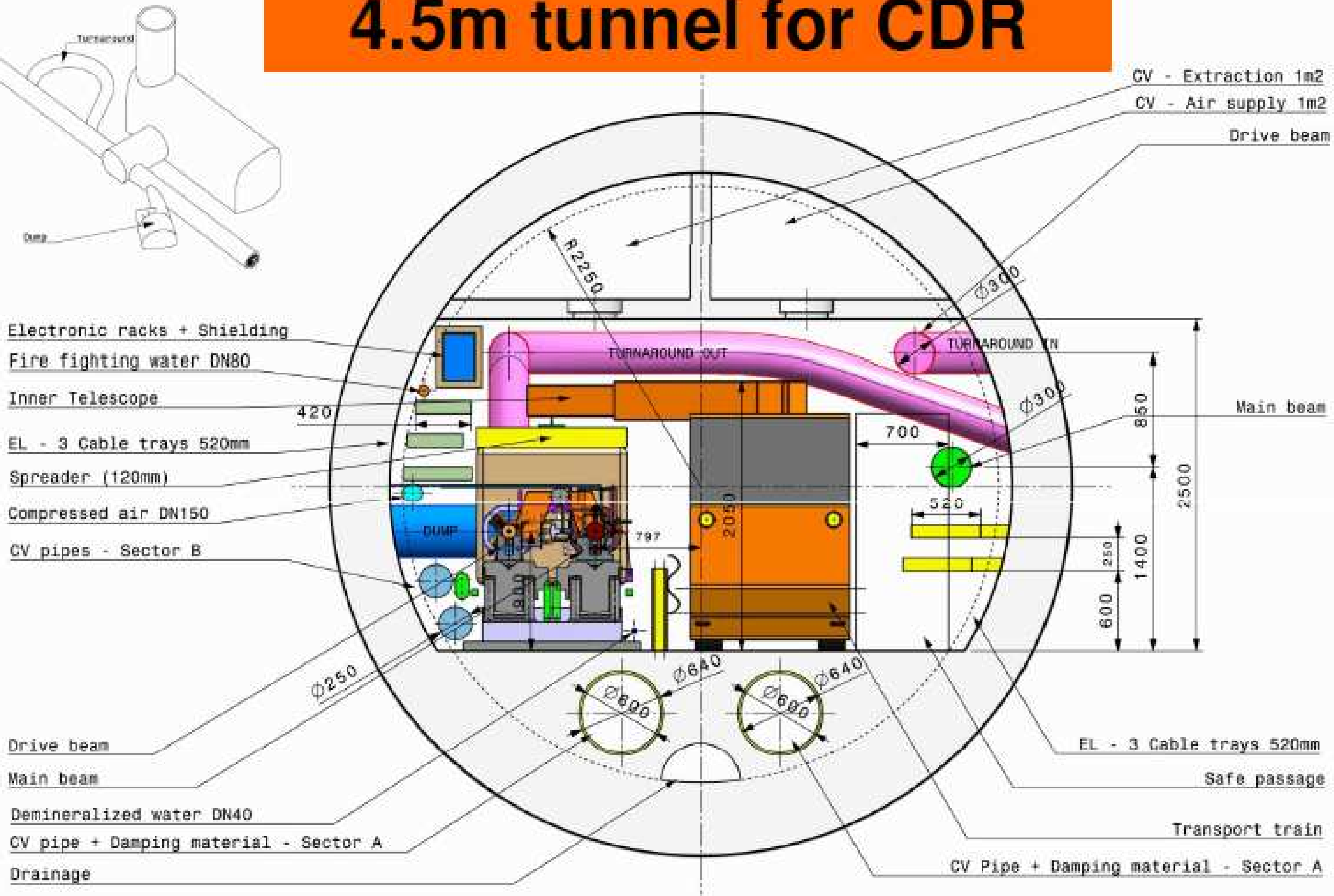
Diagnostics
Energy collimation
Transverse collimation
Final Focus system
600
500
400
300
200
100
0
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
0
0.5
1
1.5
2
2.5
3
$\beta_x^{1/2}$
$\beta_y^{1/2}$
D_x
$\beta^{1/2}$ [$m^{1/2}$]
D [m]
Longitudinal location [km]

Beam pipe apertures



Reference beam pipe radius 8 mm at 3 TeV and 12 at 500 GeV. Tight apertures (3-5mm) at 3.5 TeV (FFS).

4.5m tunnel for CDR

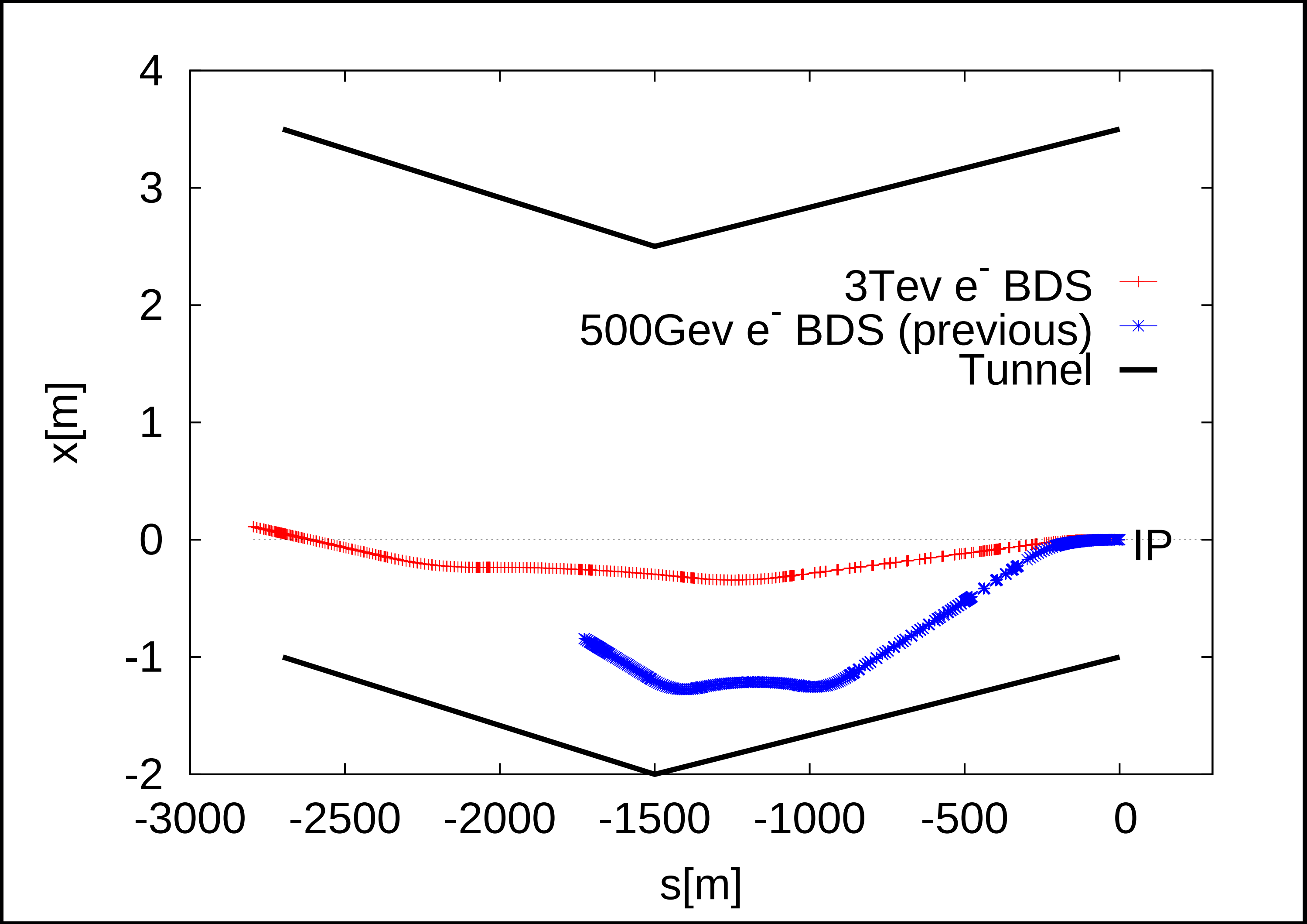


CLIC - Typical Cross Section - Diameter 4500mm - Junction with Turnaround - 1:25
Draft - J.Osborne / A.Kosmicki -October 12th 2009

15 Oct 2009

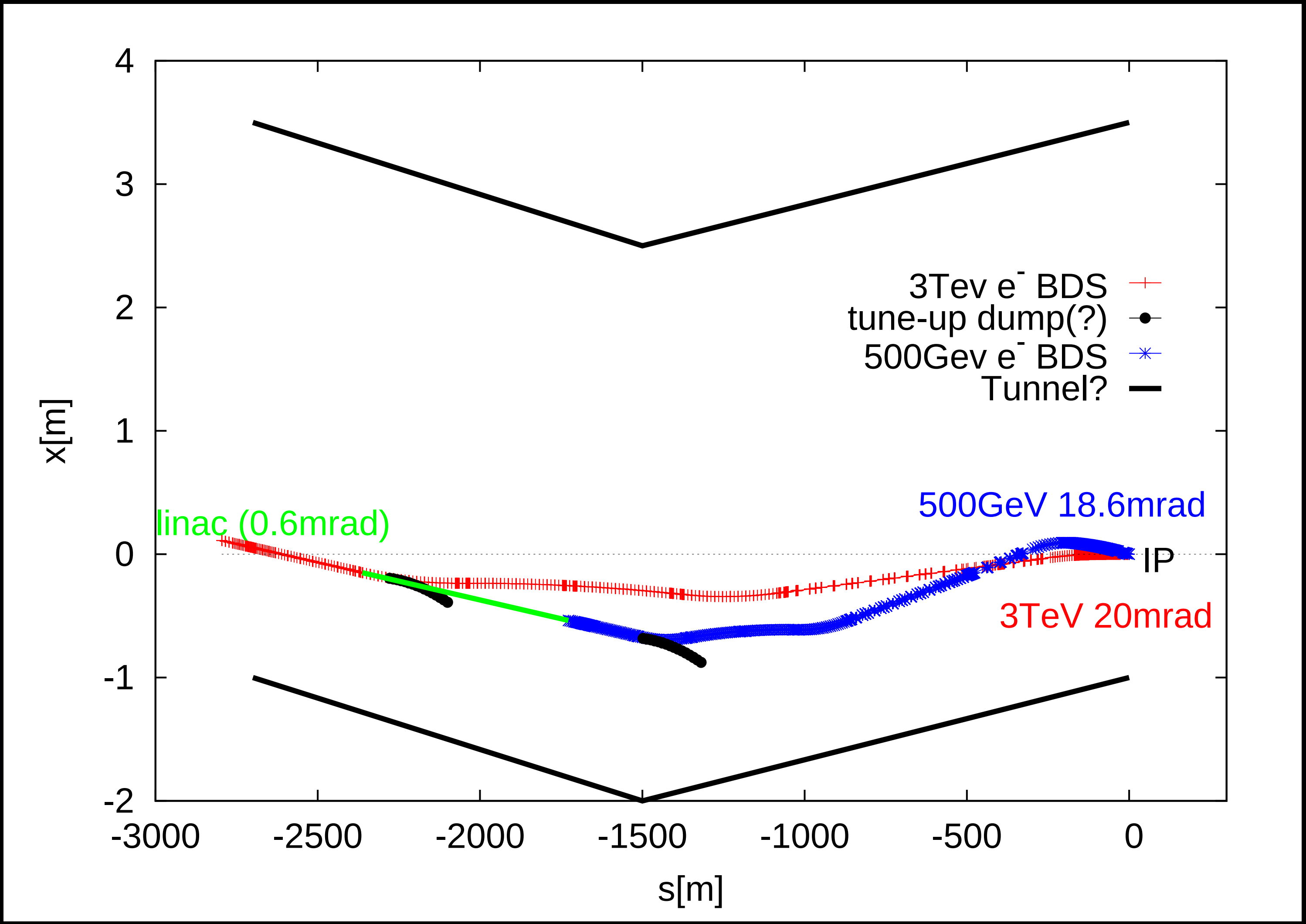
John Osborne : GS-SEM Civil Engineering

The layouts and the tunnel in 2009



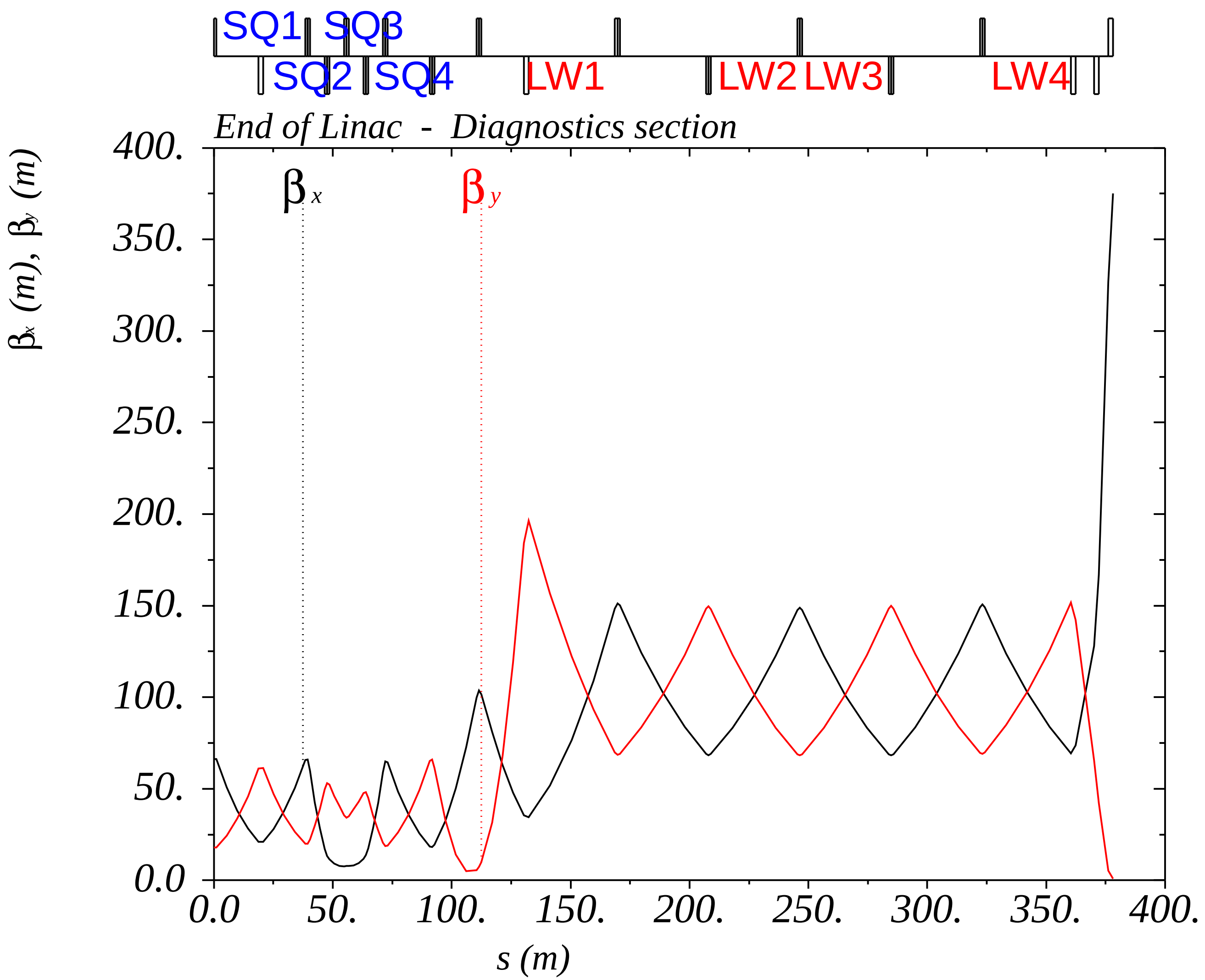
Not enough space for both beam lines!

The layouts and the tunnel fixed



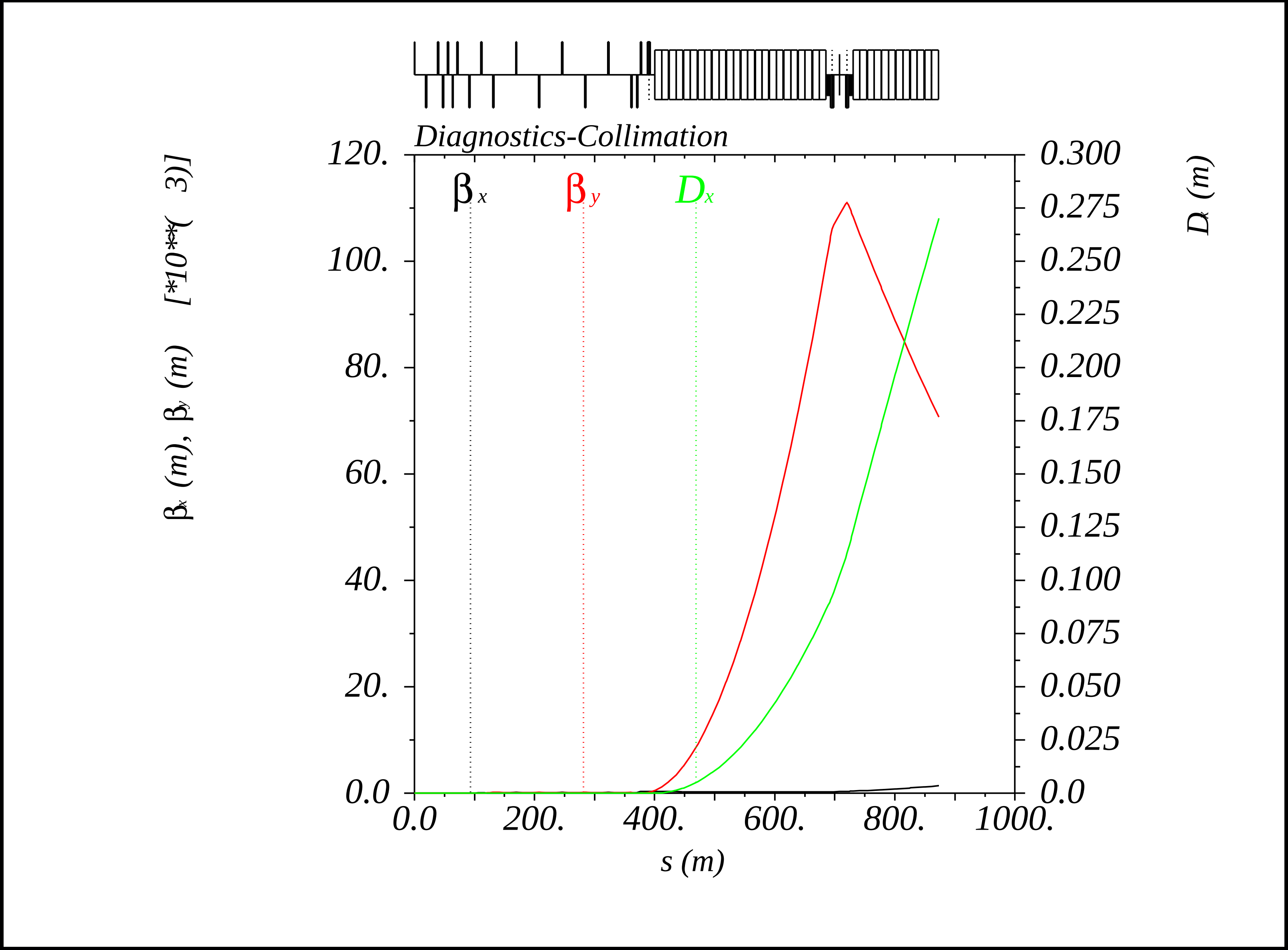
Enough space and both beam lines aligned to the linac

Diagnostics: emittance measurement

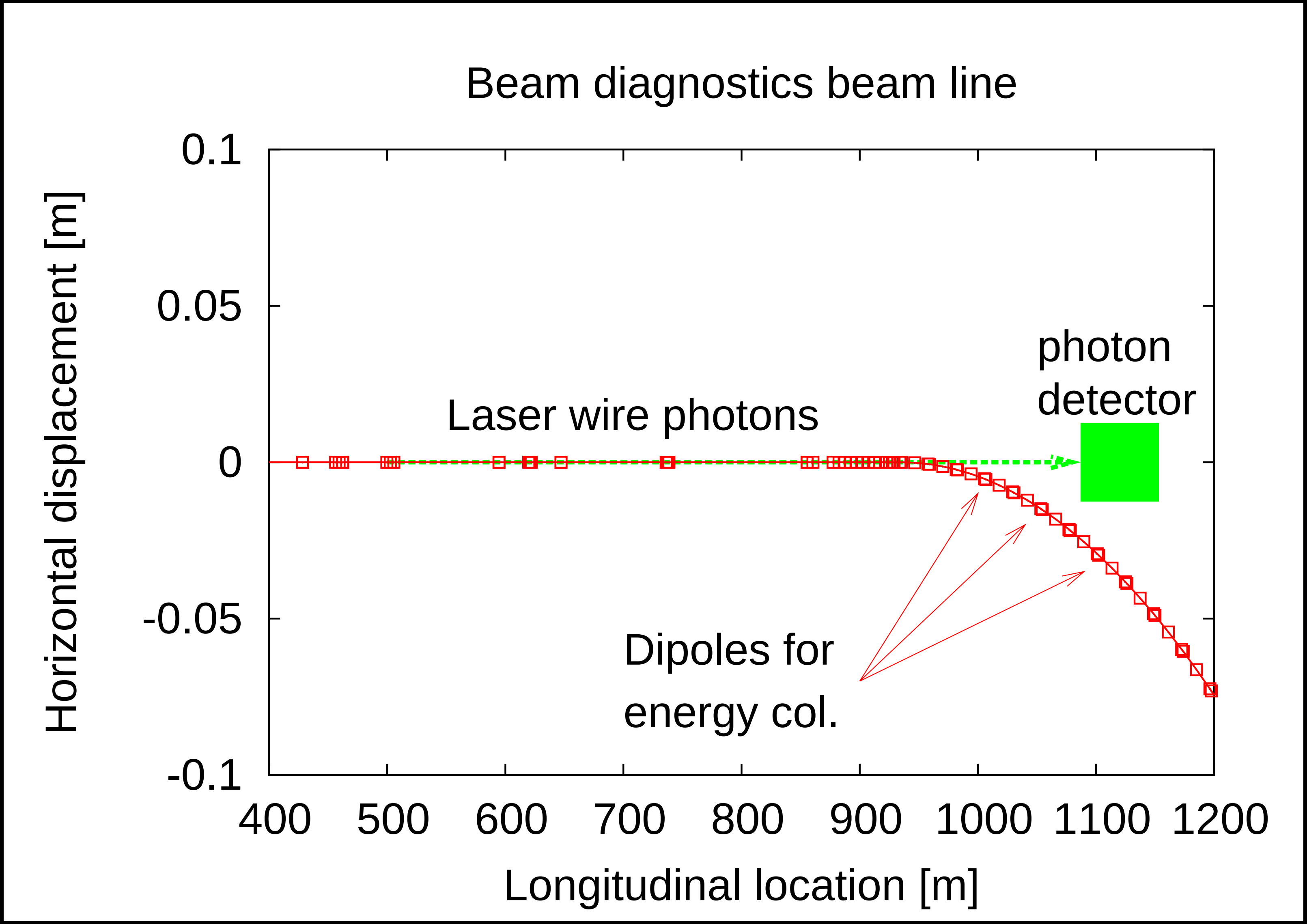


σ_y=$1\mu m$ @ Laser wires (for ϵ_y=20nm)

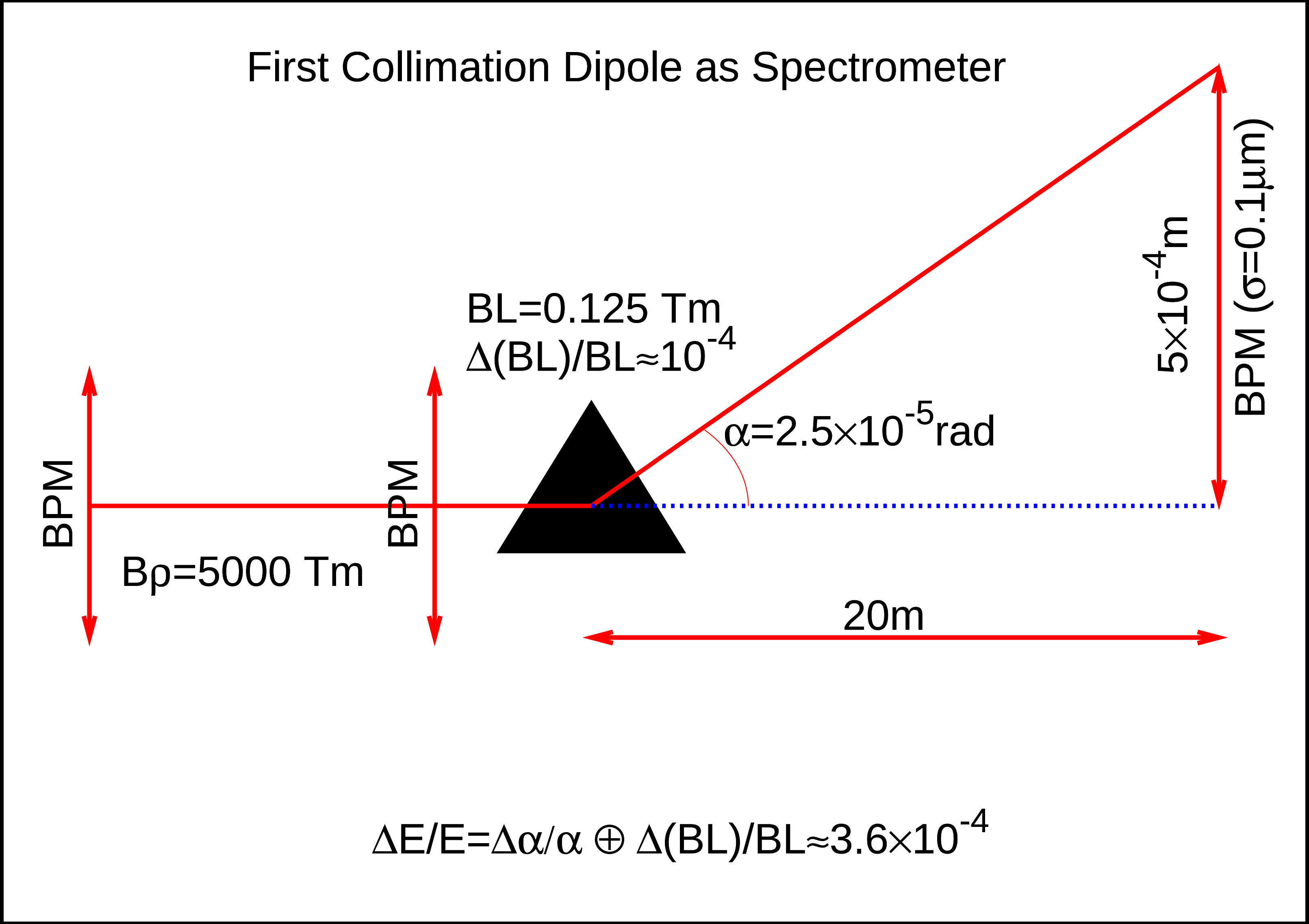
Diagnostics inside collimation



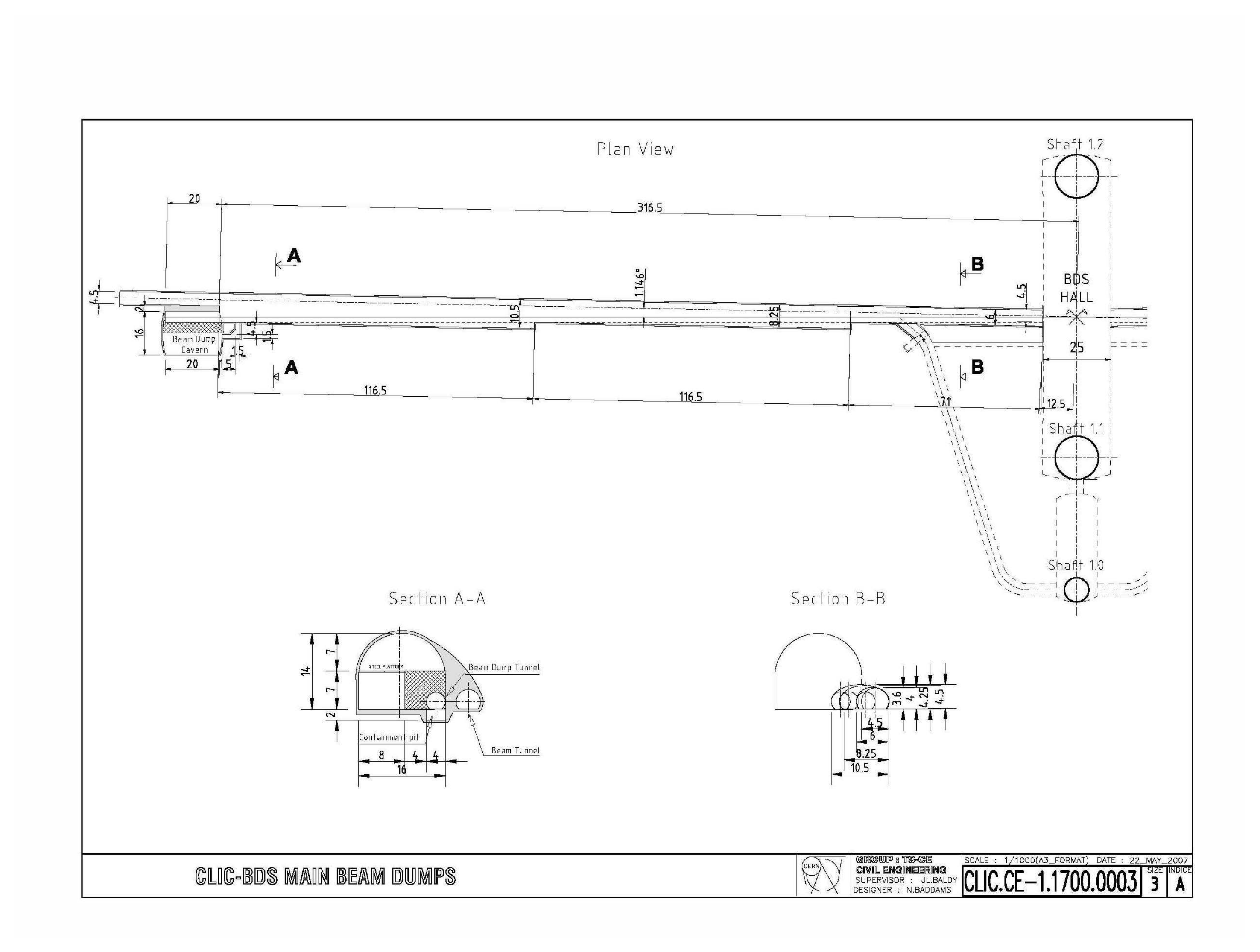
Layout & photon collection



CLIC compact energy measurement

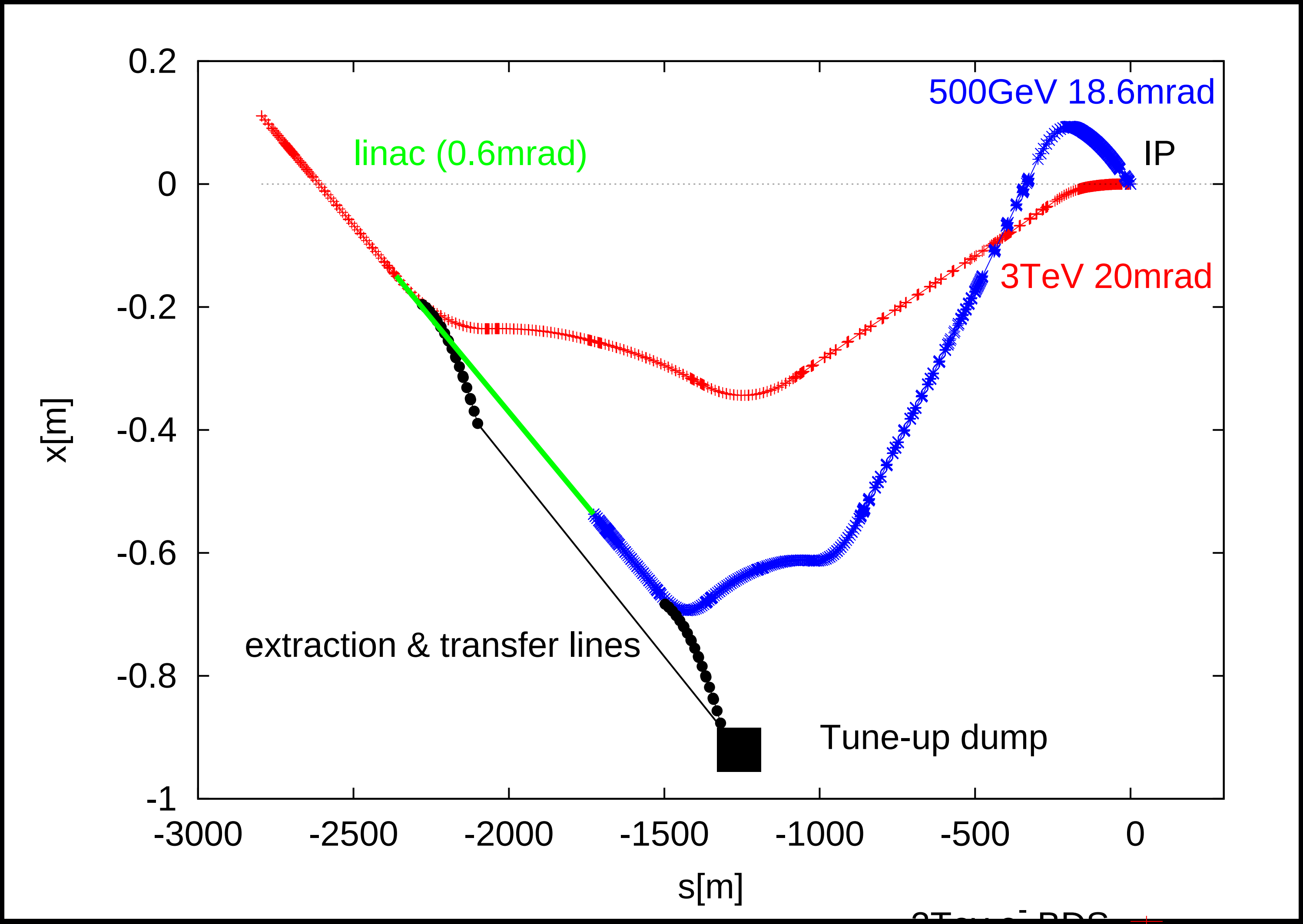


BDS dumps: tune-up and main dump



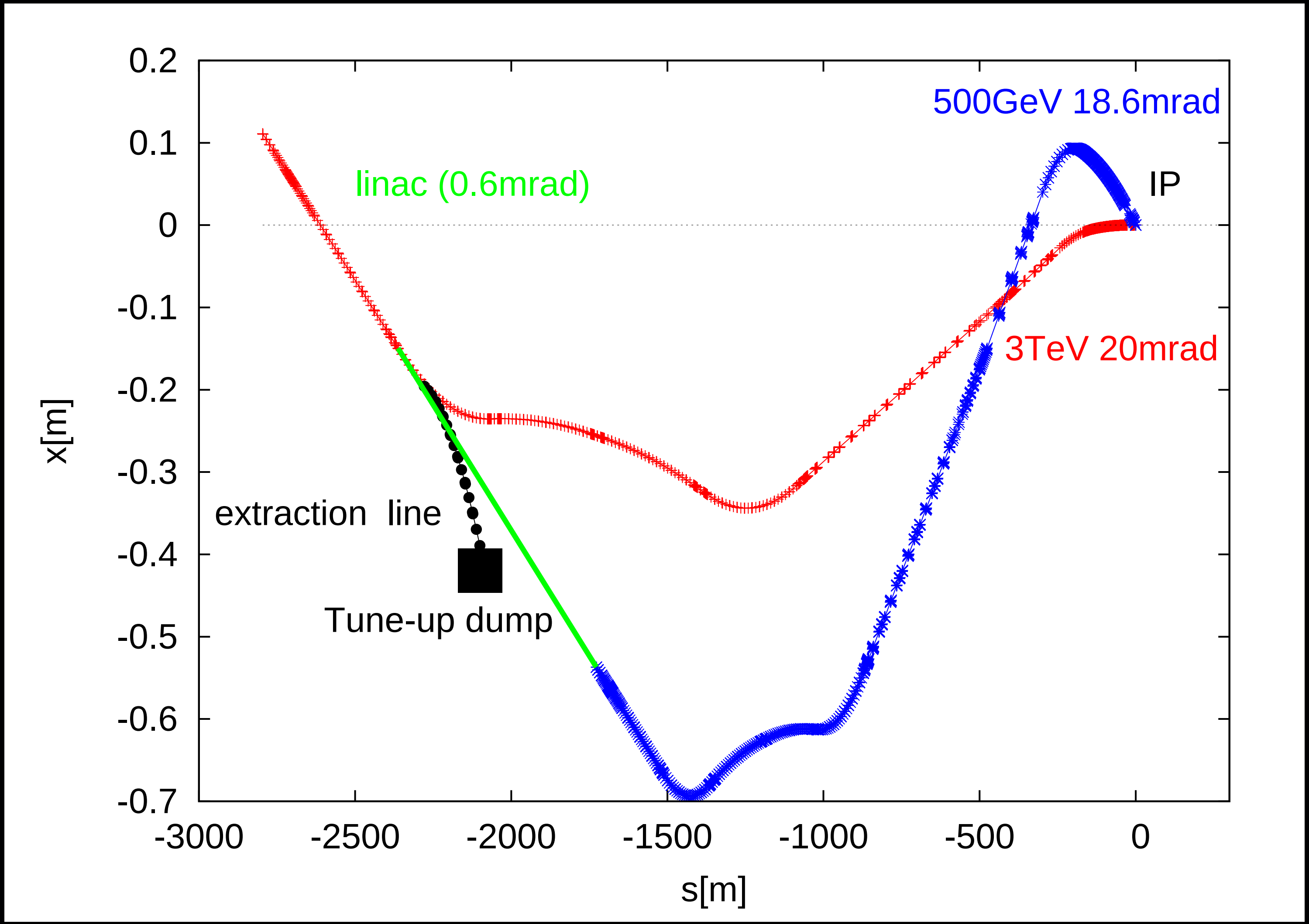
Tunnel widens up to 10m in the extraction region

1^{st} option: 2 extraction points



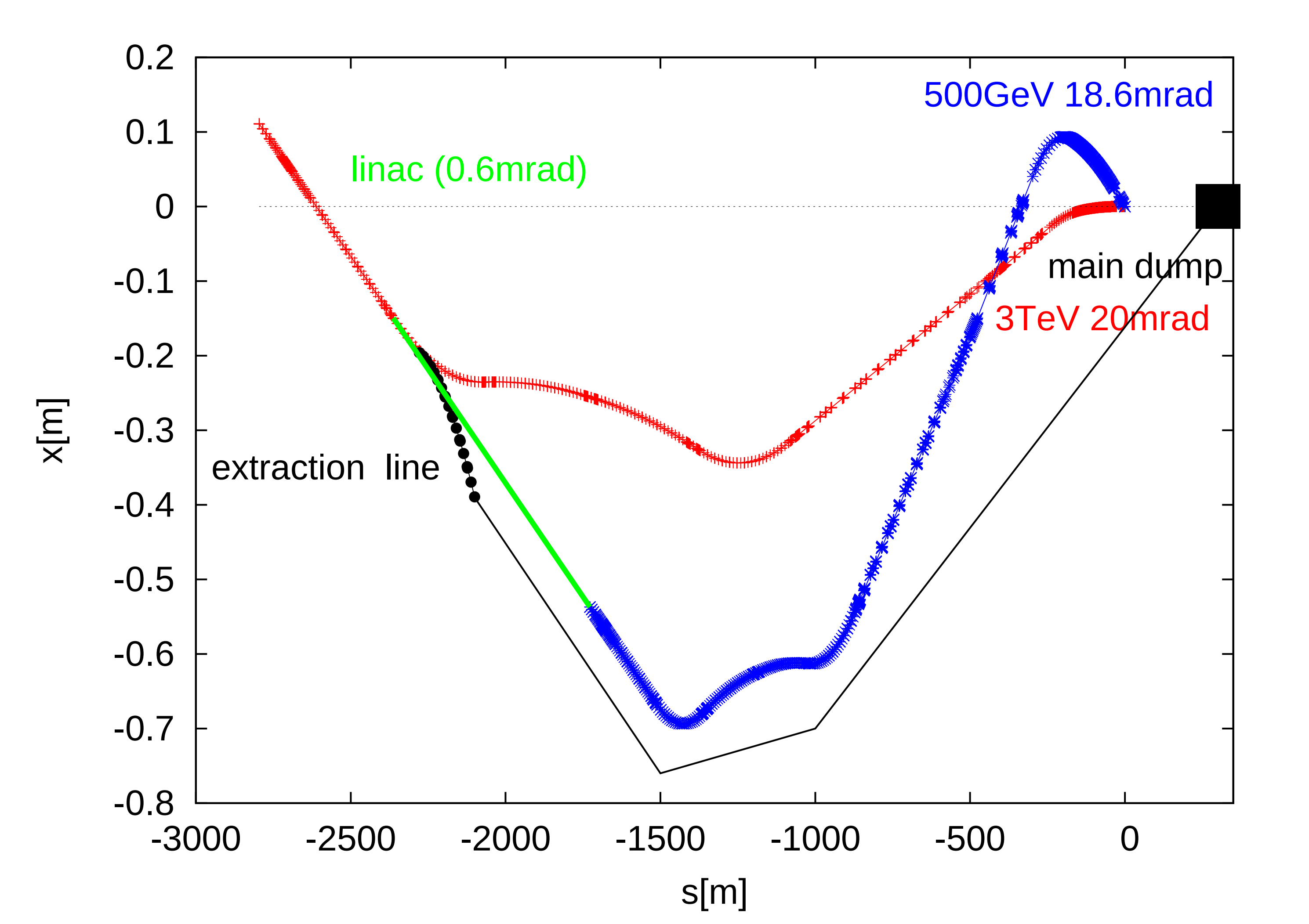
Total of 4 dumps

2^{nd} option: 1 extraction point



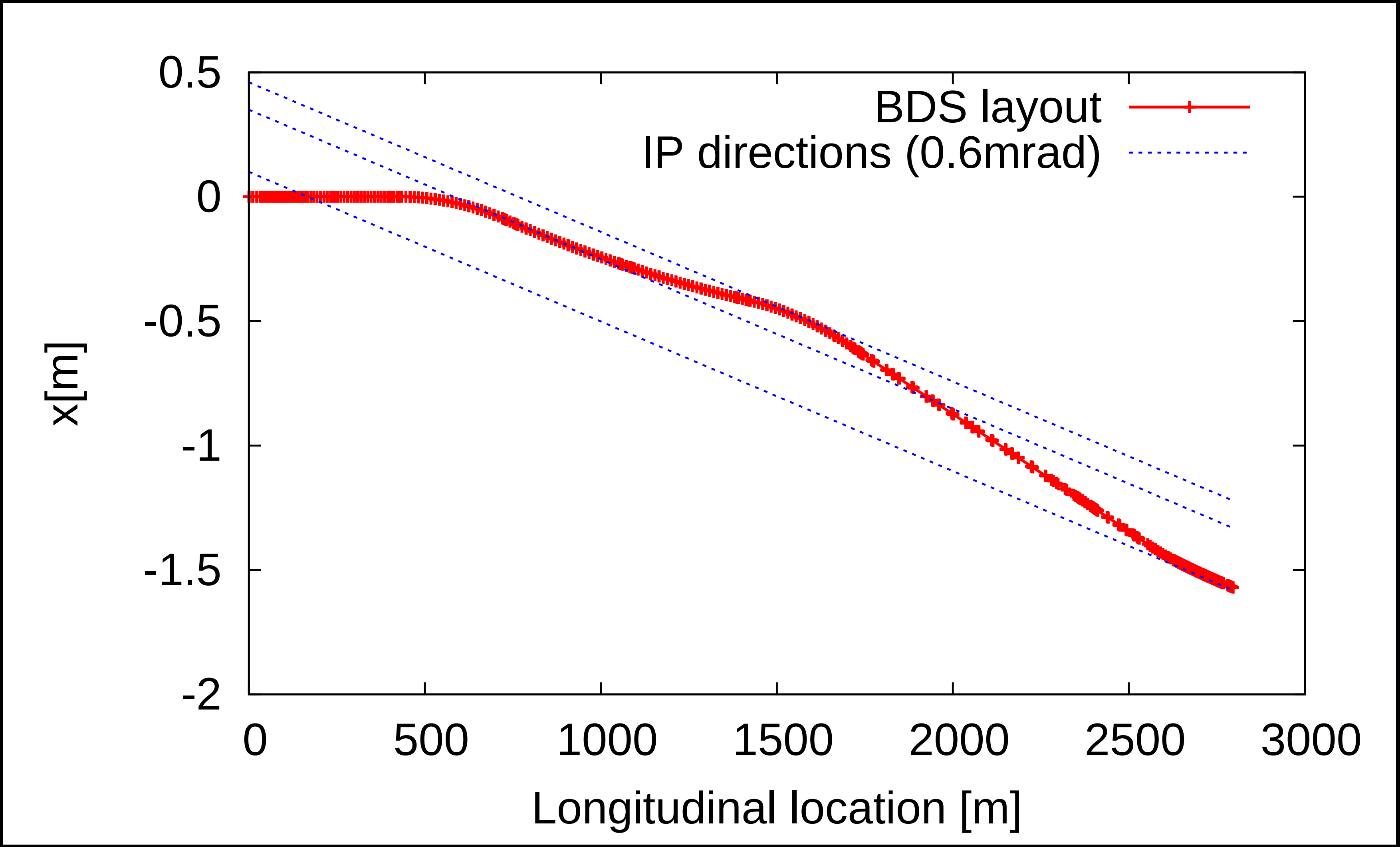
Total of 4 dumps

$3^{\rm rd}$ option: use main dump



Total of 2 dumps

Polarization measurement

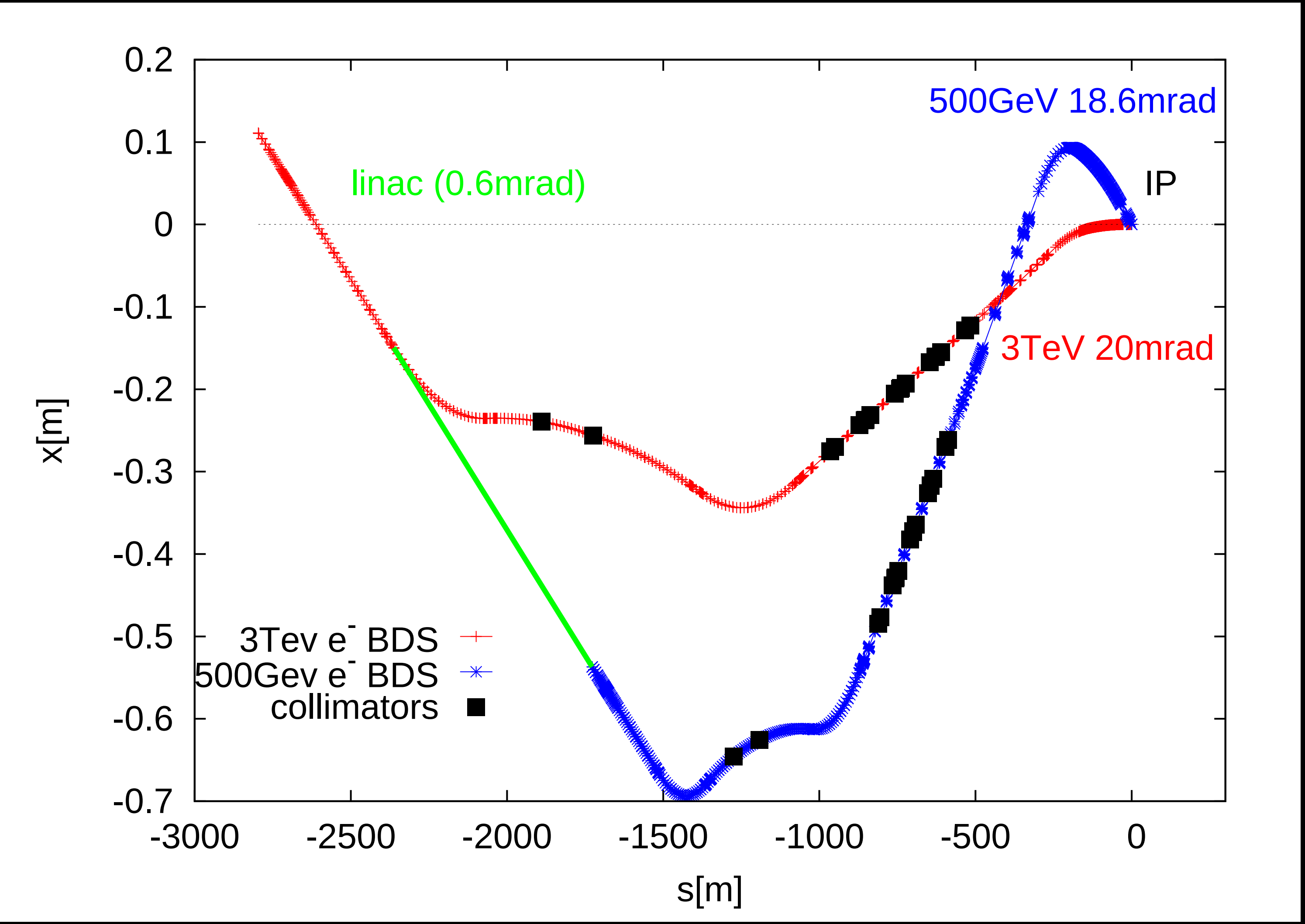


Best location parallel to IP at about 700m.

Polarization measurement (P. Schuler)

- IP laser at 742 m
- Standard Q-switched YAG laser (100mJ at 532nm wavelength)
- 10mrad and a laser spot size of 50 mm
- Compton electron detector at s=907 m
- 12 larger aperture dipoles (up to 300mm) are required from IP laser to the Compton electrons detector
- Resolution: 0.61% and 0.08% for measurement times of 1 s and 60 s, respectively

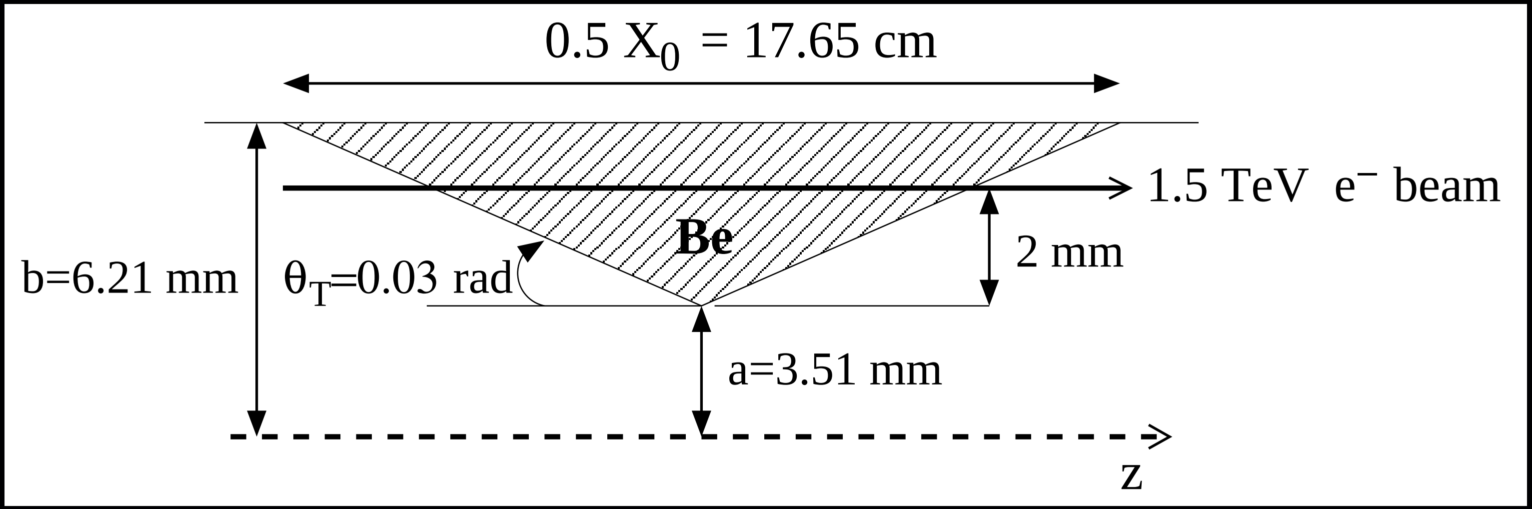
The collimators I



The collimators II

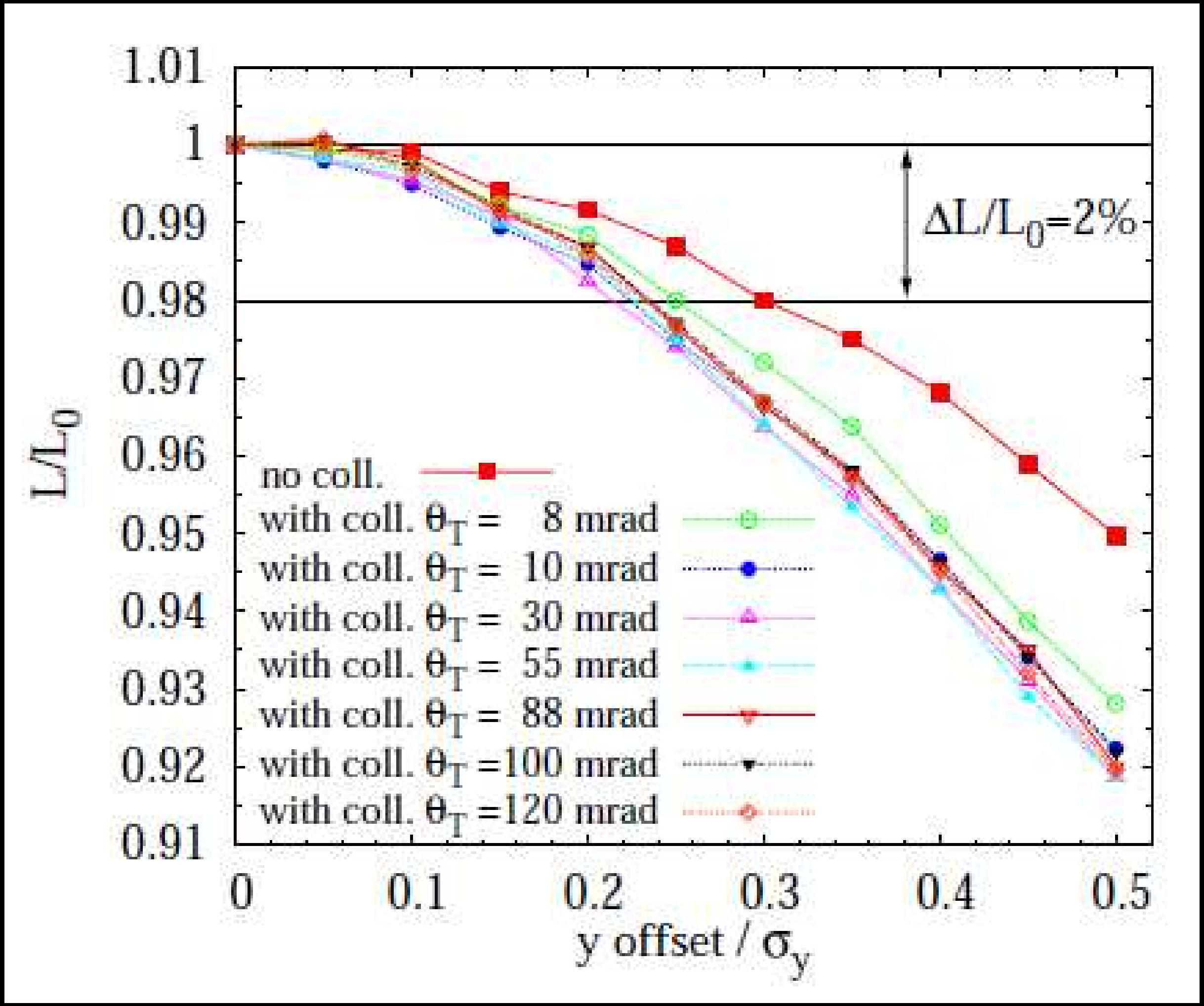
Name	β_x [m]	β_y [m]	D_x [m]	a_x [mm]	a_y [mm]	Geom.	Mat.
EYSP	1406	70681	0.27	3.51	25.4	rect	Be
EYAB	3213	39271	0.42	5.41	25.4	rect	Ti
the following $\times 4$							
YSP1	114	483.2	0.	8.	0.1	rect	Ti?
XSP1	270	101.3	0.	0.12	8.	rect	Ti?
XAB1	270	80.90	0.	1.	1.	ellip	Ti
YAB1	114	483.1	0.	1.	1.	ellip	Ti

The Be spoiler



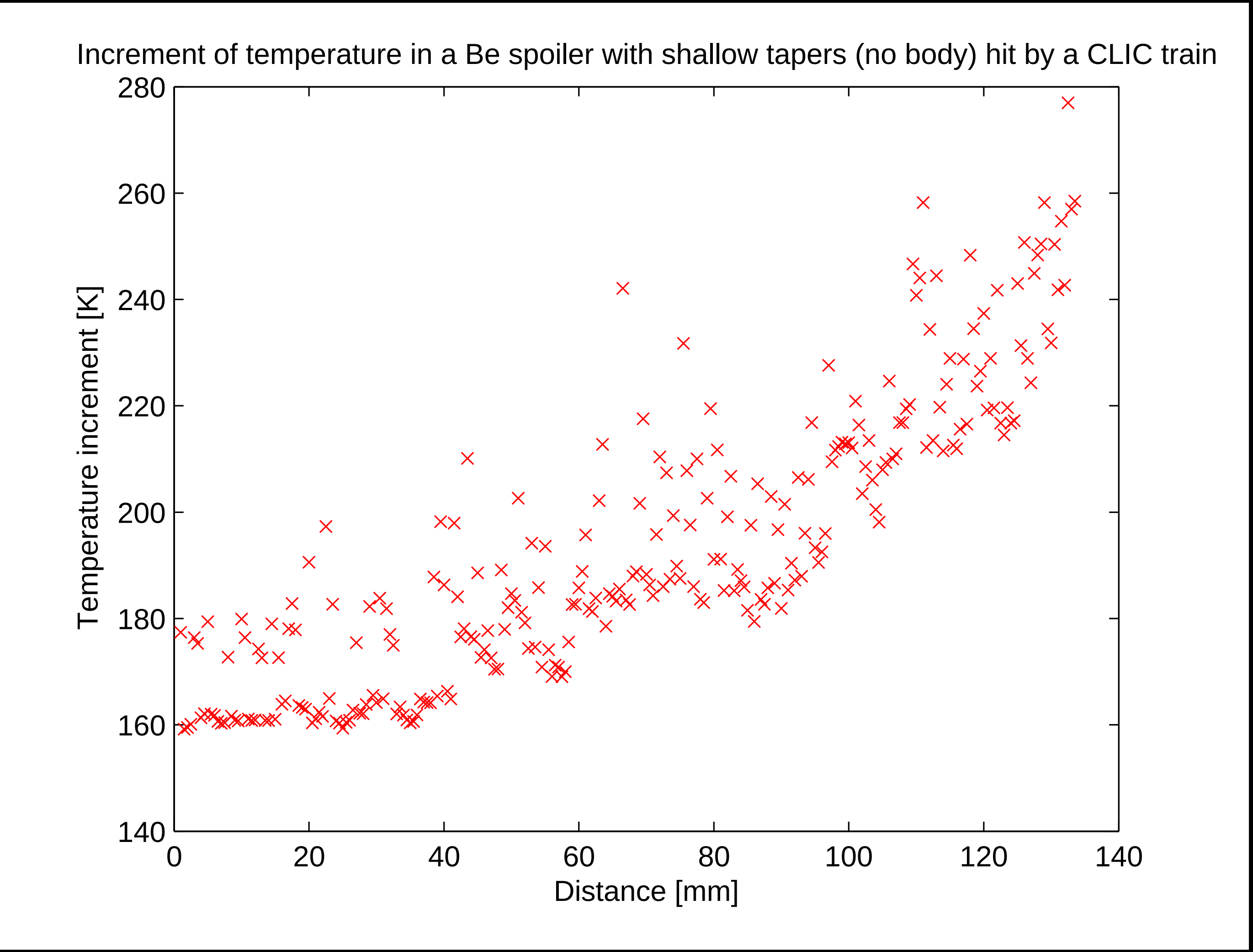
First design. Presently under optimization.

Spoiler angle optimization (J. Resta)



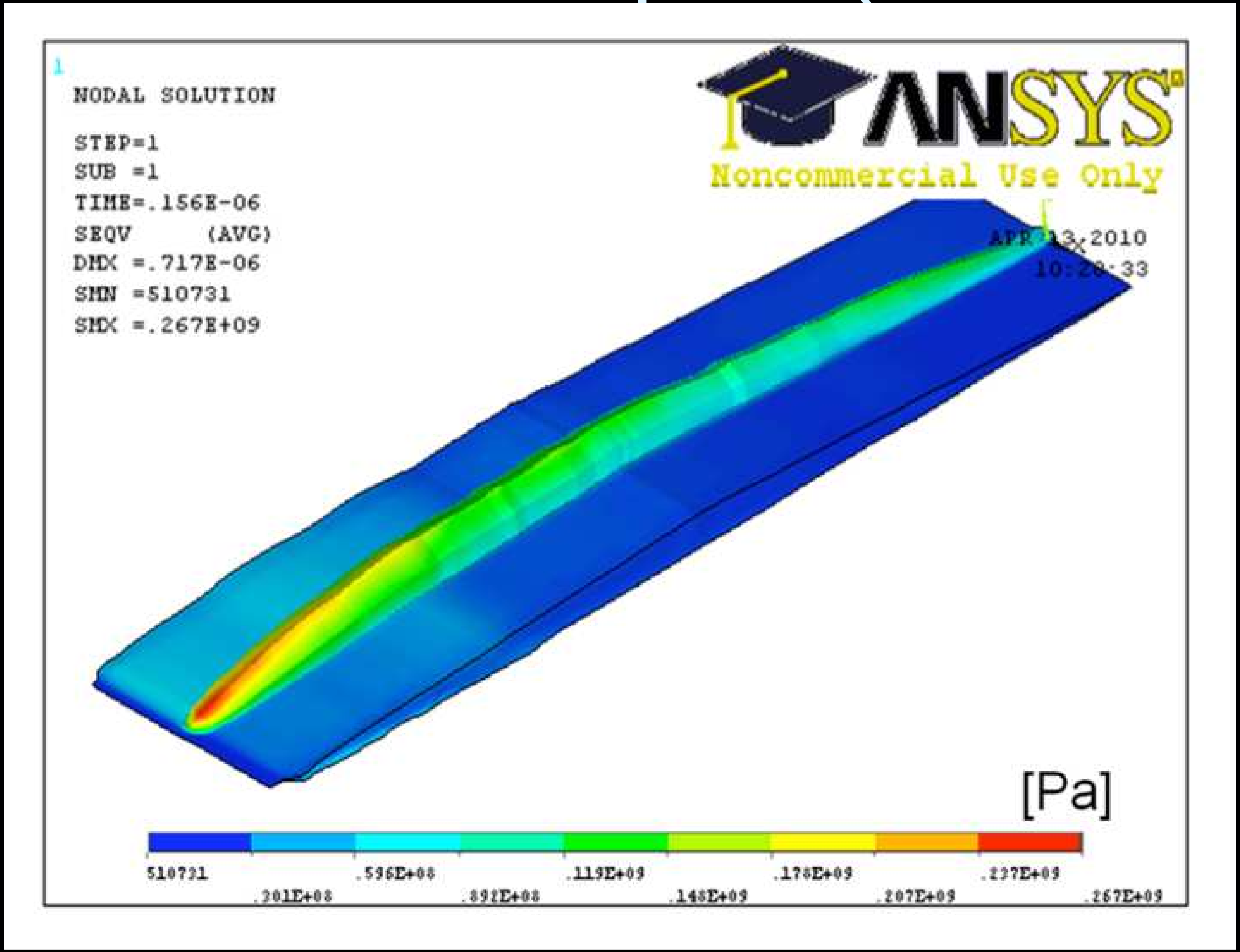
8 mrad tapering angle gives better performance than 30 mrad.

Temperature after beam impact



No risk of melting.

Stress from beam impact (J.L. Fernandez)



No risk of fracture, but collimators should be tested for compressive stresses up to 200 MPa.

Total and peak luminosities Vs L*

L* m	total lumi 10^{34}cm^{-2}s^{-1}	peak lumi 10^{34}cm^{-2}s^{-1}
3.5	6.9	2.5
4.3	6.4	2.4
6	5.0	2.1
8	4.0	1.7

Tuning performance for different L*

B. Dalena & G. Zamudio

L* [m]	prealignment [μm]	relative success [%]	absolute success [%]
3.5	10	65	87*
4.3	10	80	100
6	8	80	90
8	2	80	46

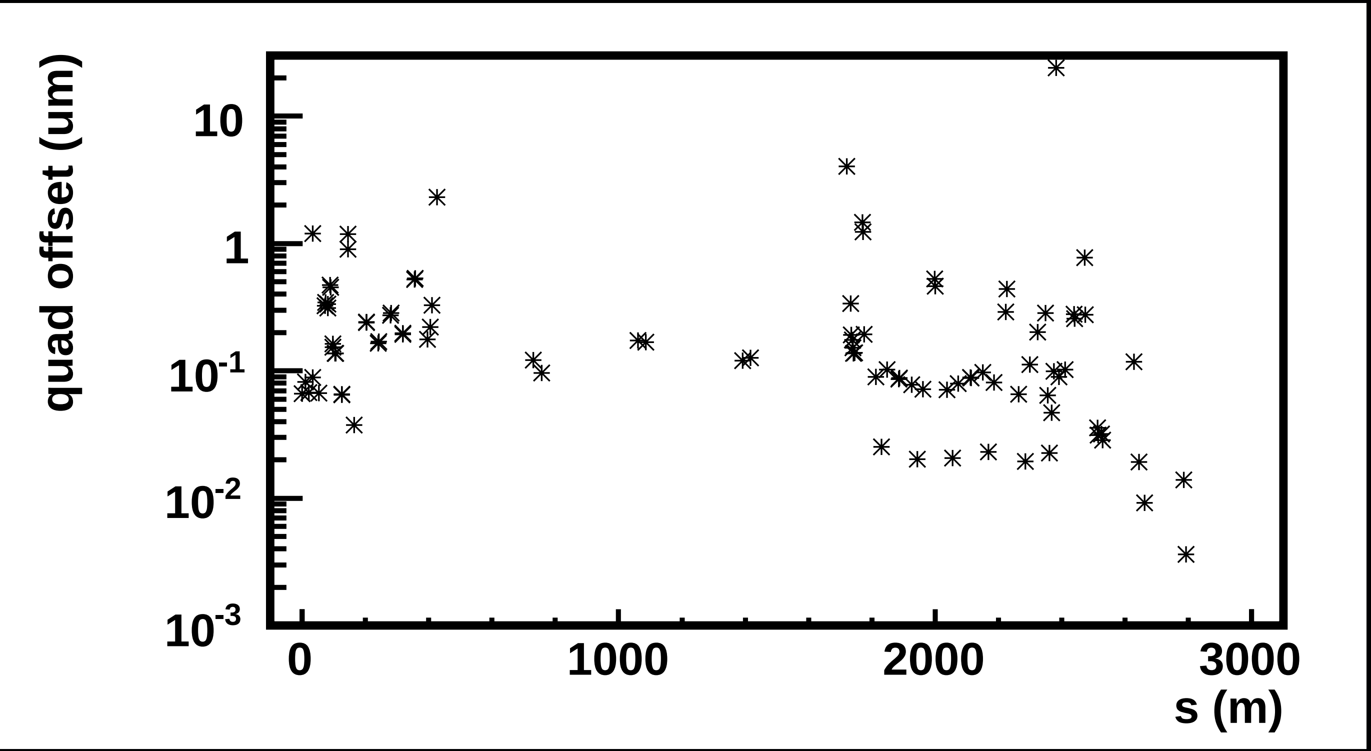
* very recent improvement with new design and tuning knobs

Some QD0 specifications

L*	m	3.5	4.3	6.0	8.0
Gradient	T/m	575	382	200	211
Length	m	2.7	3.3	4.7	4.2
Beam aperture	mm	3.5	6.7	8	8.5
Jitter tolerance	nm	0.15	0.15	0.2	0.18
Gradient tol	10^{-6}	5	5	-	3
Prealign.	μm	10	10	8	2
Long. prealign.	μm	25	-	40	-

2% luminosity sensitivity to quad offset

With corrected IP offset (J. Snuverink)

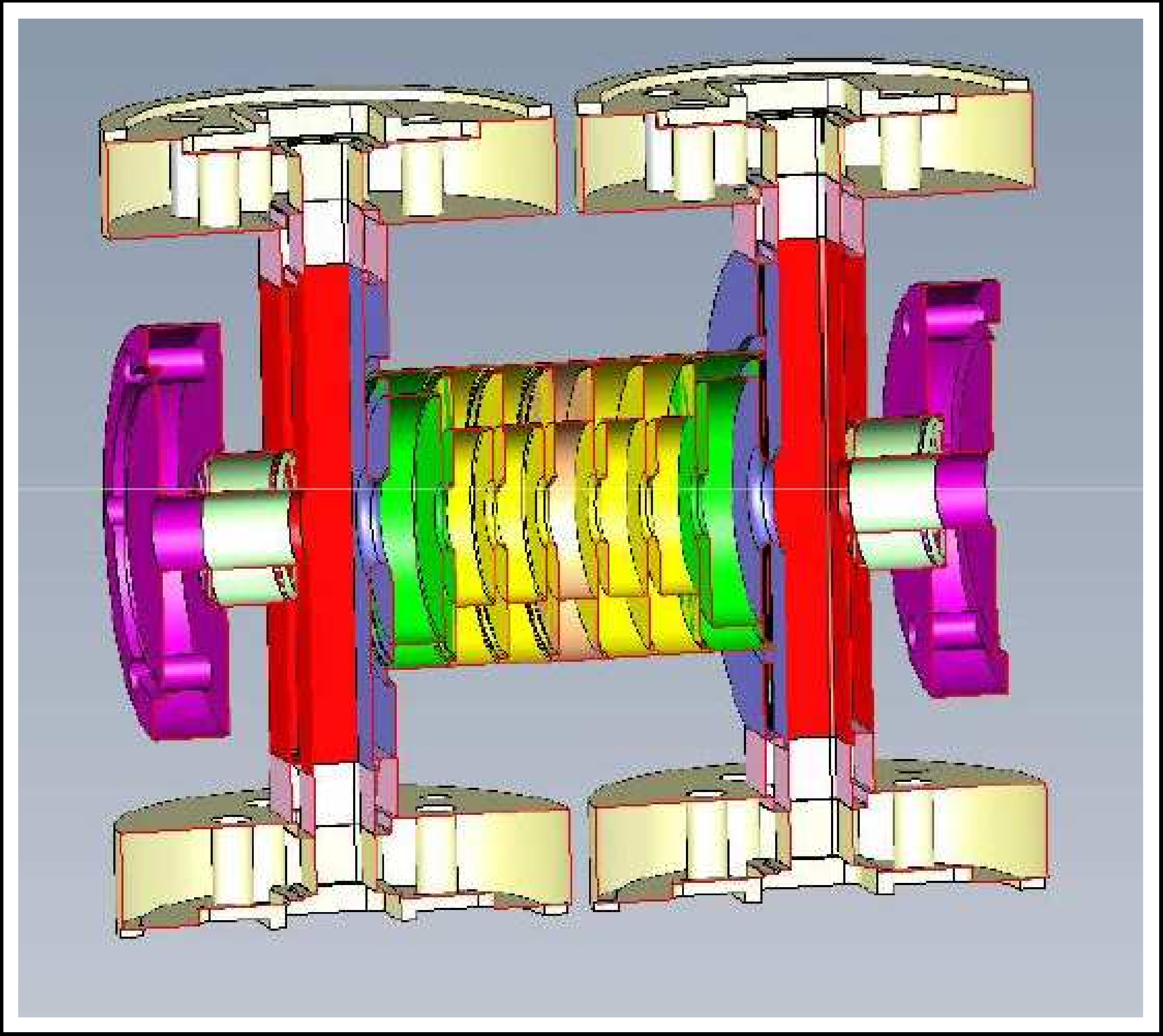


3 nm for QD0, 10-50 nm for a few quads and $>$50 nm for most. This gives and indication on the required BPM resolution.

BDS dipoles specifications

- BDS dipoles range between 20 and 120 Gauss
- Most need 24mm aperture (radius), few need 150mm.
- Field relative precission and jitter must be $\leq 10^{-4}$ (first promissing measurements from C. Spencer (SLAC))
- Sextupolar error at 10mm must be $\leq 6 \times 10^{-4}$
- Daniel suggested to use SC dipoles to shield stray fields

Crab Cavity (A. Dexter & G. Burt)



Crab Cavity specifications

- 12 GHz
- phase stability 0.02°
- amplitude stability 2%
- strong HOM damping
- New simulations from G. Burt show some perfomance reduction from ideal. To be followed up.

Adequate design and parameter choice needed to meet specifications.

BDS Numbers

type	quantity	total length
Dipoles	206	1.3 km
Quadrupoles	70	0.19 km
Sextupoles	18	34 m
BPMs	$\approx$100	-
Collimators	18	-

Summary - The challenges

- Jitter tolerances
- Pre-alignment tolerances
- Field jitter and accuracy
- Robust tuning