Current MDI activities and a future plan for ILC

T. Tauchi, KEK

The 7th ACFA Workshop on Physics and Detector at the Linear Collider, National Taiwan University, Taipei, 11 November, 2004

What is MDI ?

MDI is Machine Detector Interface.

Machine : Beam Delivery System (BDS)
from LINAC-end to beam dump

collimation, energy/polarization, final focus,
extraction (energy/polarization) and beam dump

Detector : Interaction Region

experiment (physics; Higgs, Top, W/Z, SUSY, extra-D ...)

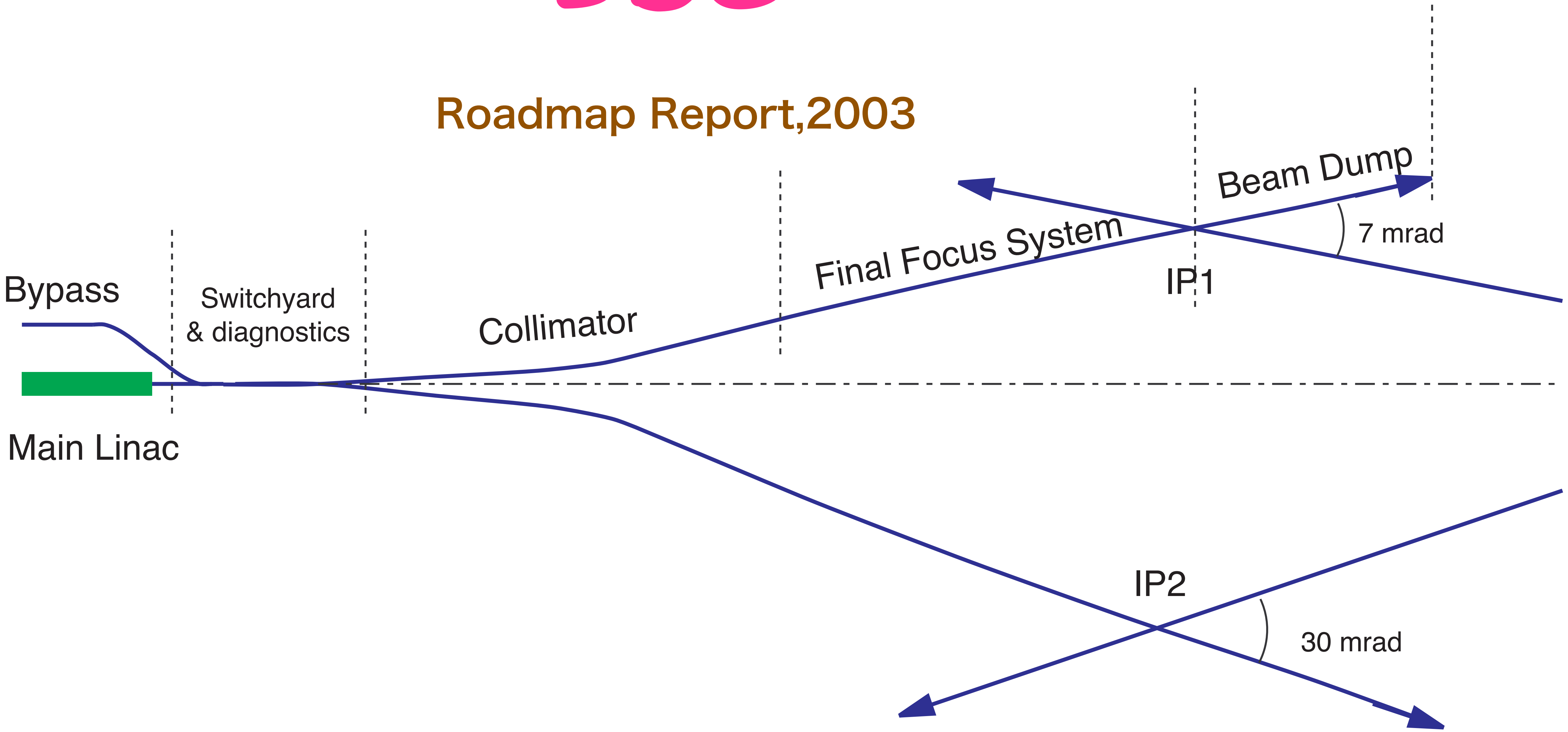
luminosity, background and minimum veto-angle

Primary Role of MDI

Major task of MDI is to compile requirements from the experimental side in order to communicate the accelerator physicists for designing the BDS.

BDS

Roadmap Report,2003



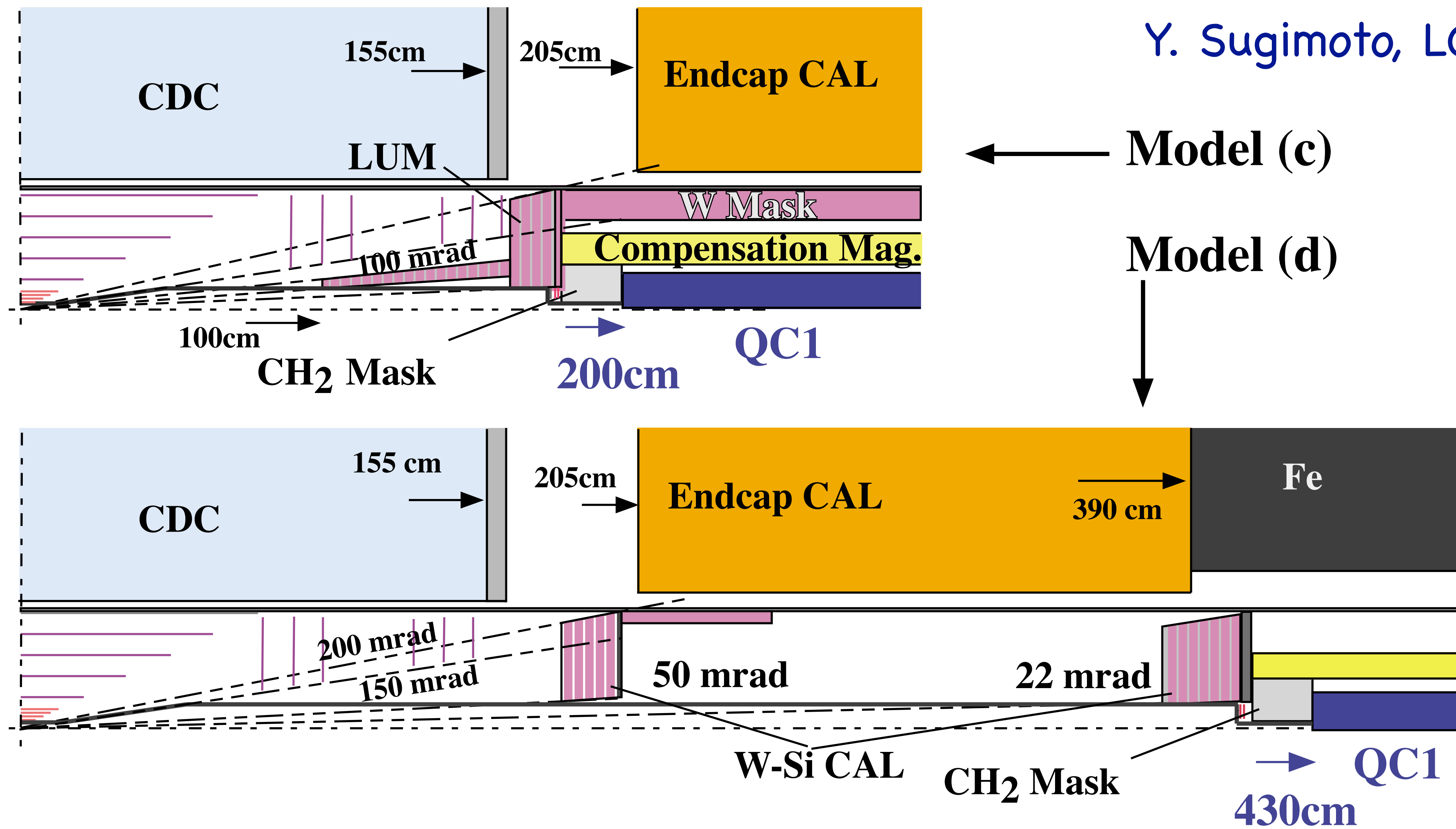
Crossing angle (headon, V–0.3mrad, 2mrad, 7mrad, 20mrad, >30mrad@γγ)

2 IP's for 2 "identical experiments"

Precise energy and polarization measurements

Backgrounds (muons and synchrotron radiations)

IR



Y. Sugimoto, LCWS2000

L* : Distance of QC1 from IP

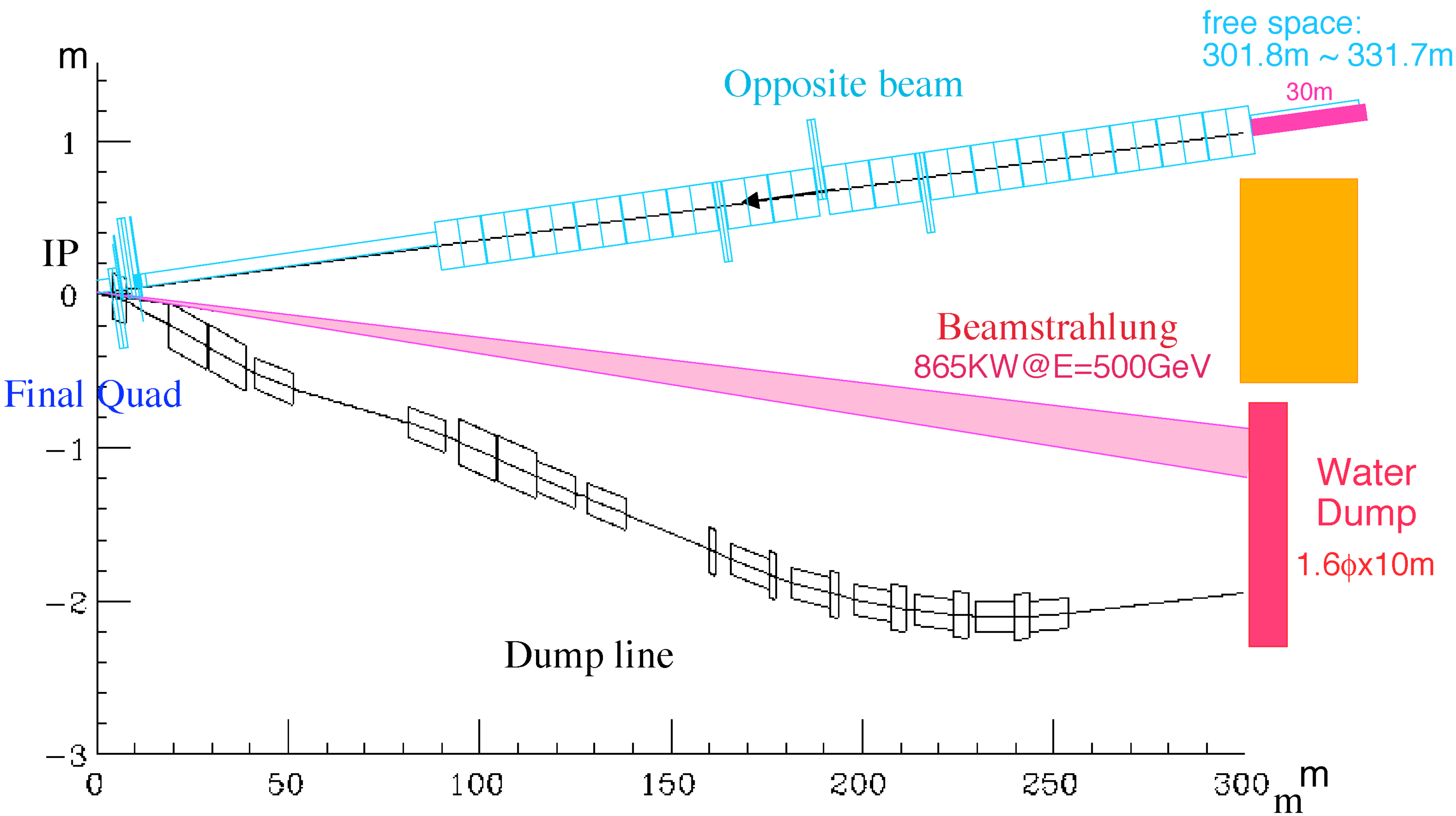
Vertex R (the innermost radius)

Minimum veto-angle (very forward calorimeter)

Backgrounds (pairs, mini-jets, backscattered γ and n)

Instrumentations (pair monitor, feedback, Shintake monitor ...)

BDS: Extraction Line



Crossing angle

Choice of final quadrupoles (L*)

Precise energy and polarization measurements

Backgrounds (disrupted beam, back-scattered n and γ.)

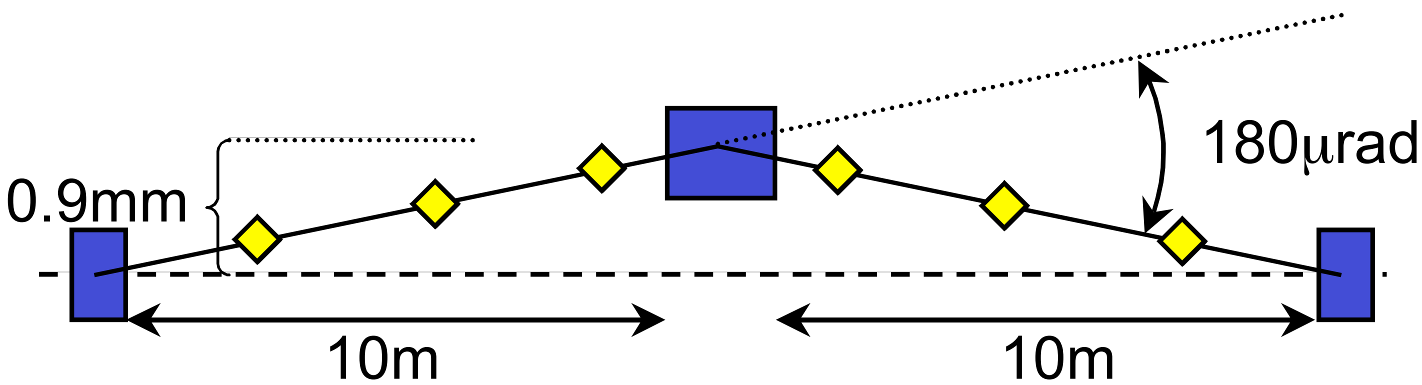
Summary of MDI issues

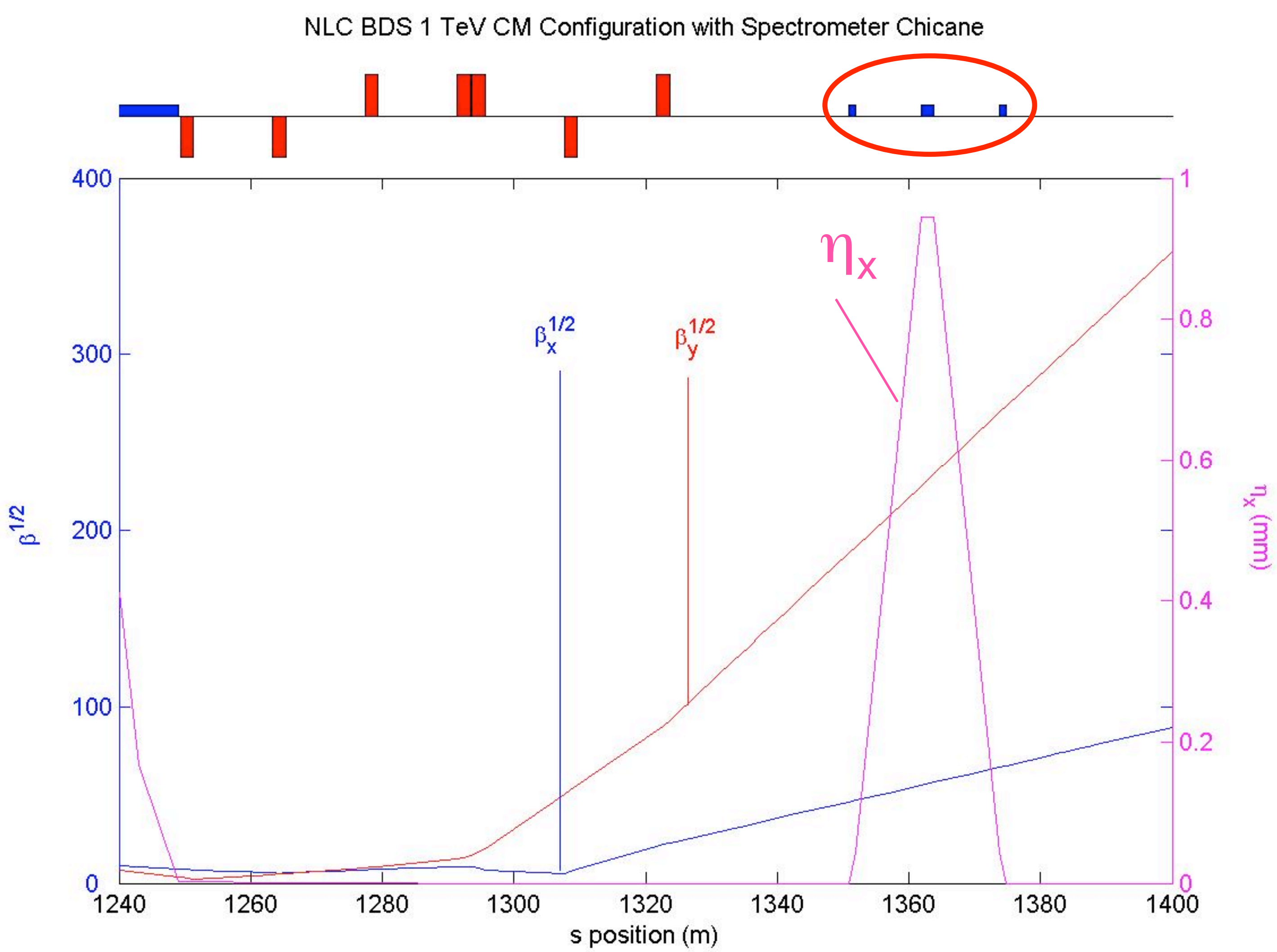
System	Machine	Detector
BDS	Crossing angle 2 IPs; "identical" experiments Collimation depth Precise E/P measurements	Backgrounds: μ, synchrotron γ
IR	L* : distance of Final-Q from IP	Min. angle: very forward cal. Precise luminosity measurement Backgrounds; pairs, mini-jets, back-scattered γ, n Instrumentation; pair/Shintake monitors, feedback, Nano-BPM, laser-wire etc.
Extraction	Crossing angle Choice of Final-Q (L*) Precise E/P measurements	Backgrounds; disrupted beam, back-scattered γ, n Beamstrahlung monitor

E measurement TESLA-TDR

M.Hildreth, LCWS04, 21 April 2004

BPM-based Spectrometer





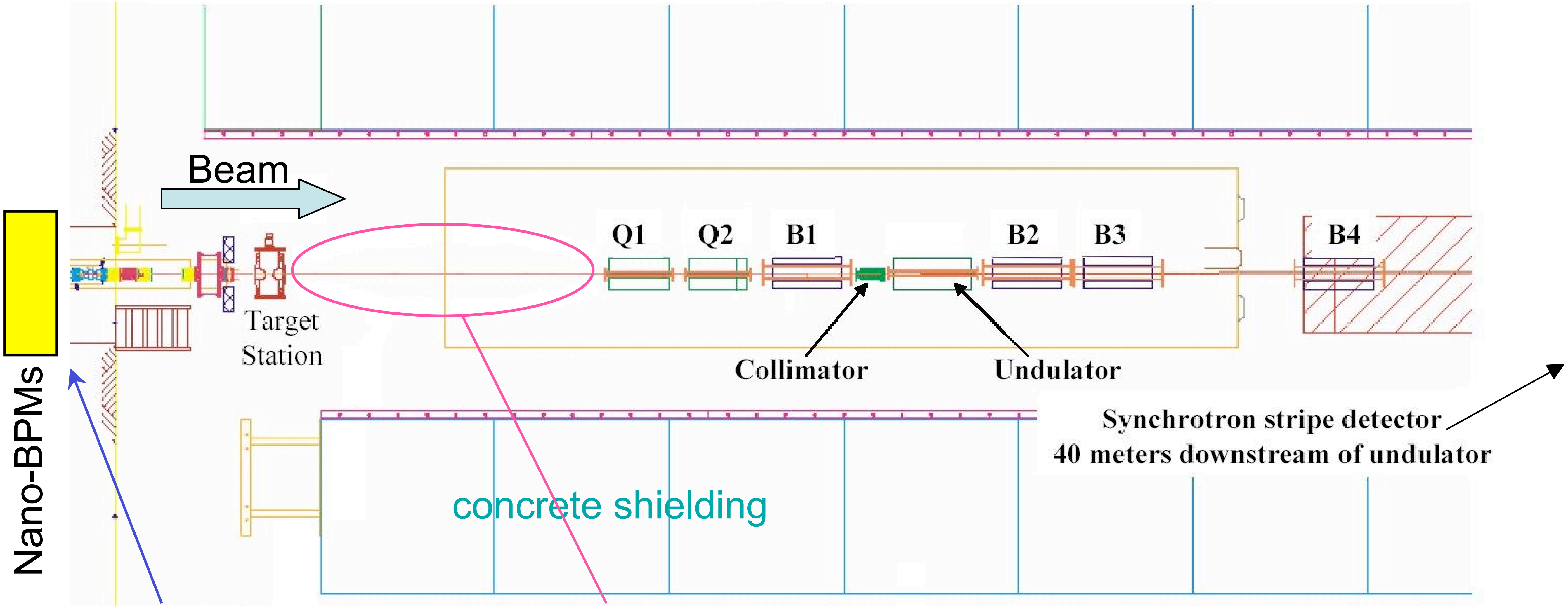
Design Considerations:

- limit SR emittance growth
  - 360μrad total bend ⇒ 0.5%
- available space in lattice
  - no modifications necessary, yet
- 10m drift space maximum one can consider for mechanical stabilization, alignment
- 37m total empty space allows for BPMs outside of chicane to constrain external trajectories
- *Tiny* energy loss before IP
- non-ideal β-variation?

⇒ Constraints lead to a required BPM resolution of ~100nm (Resolution ⊕ Stability)

SLAC End Station A Test Program

- BDI equipment tests in “realistic” (=dirty) environment

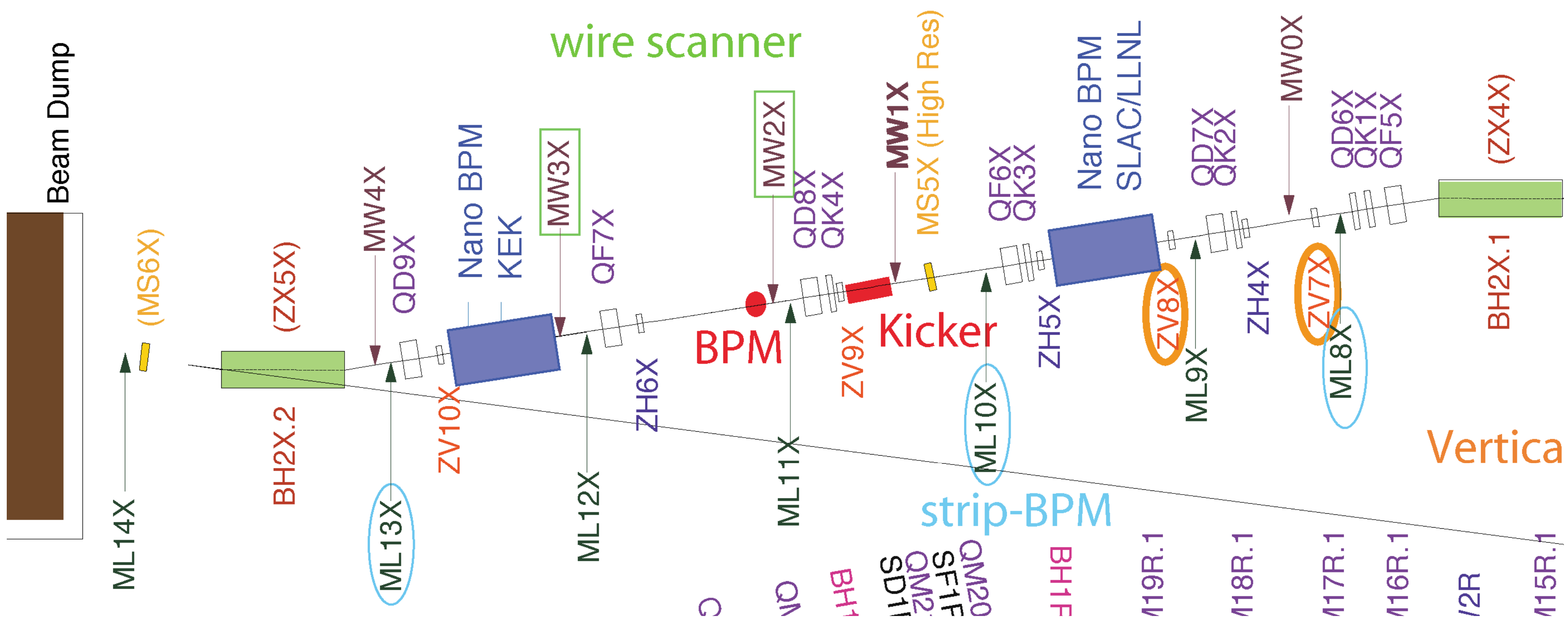


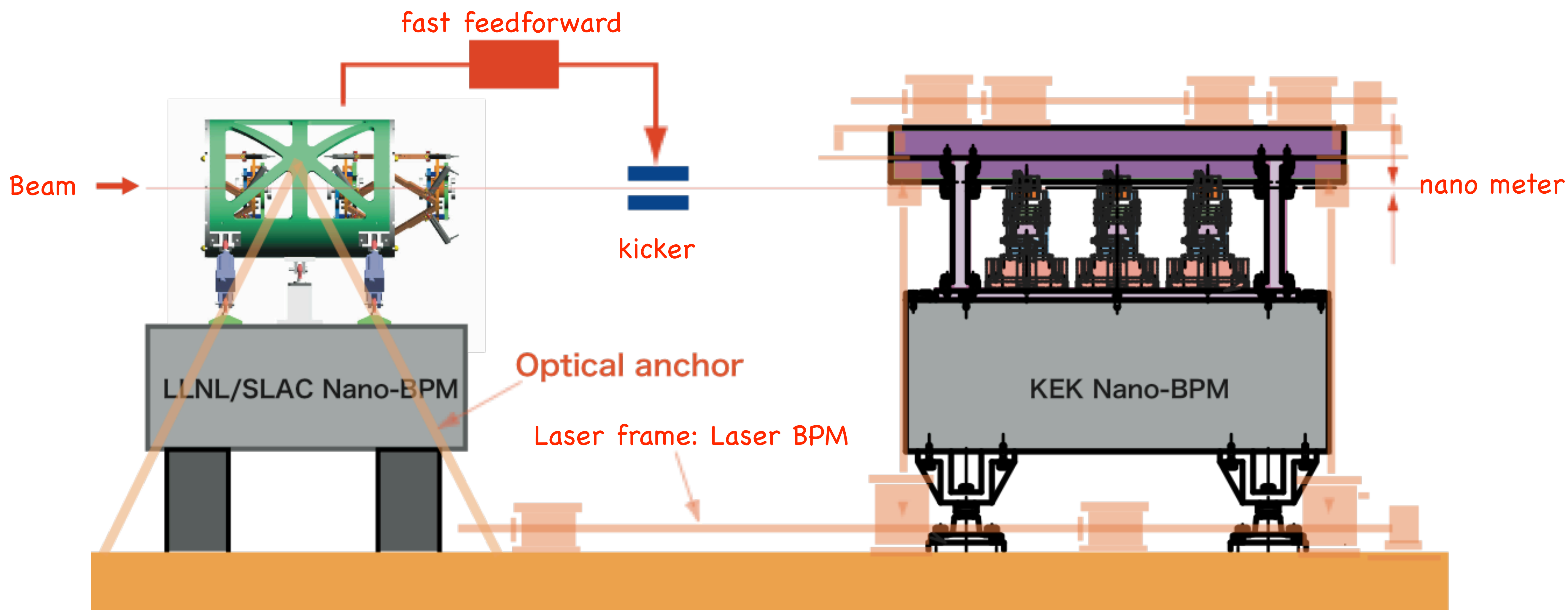
Existing RF BPMs can be used for stability, resolution tests

5 meter region to mock up IR/forward region with masking, FONT, pair detectors

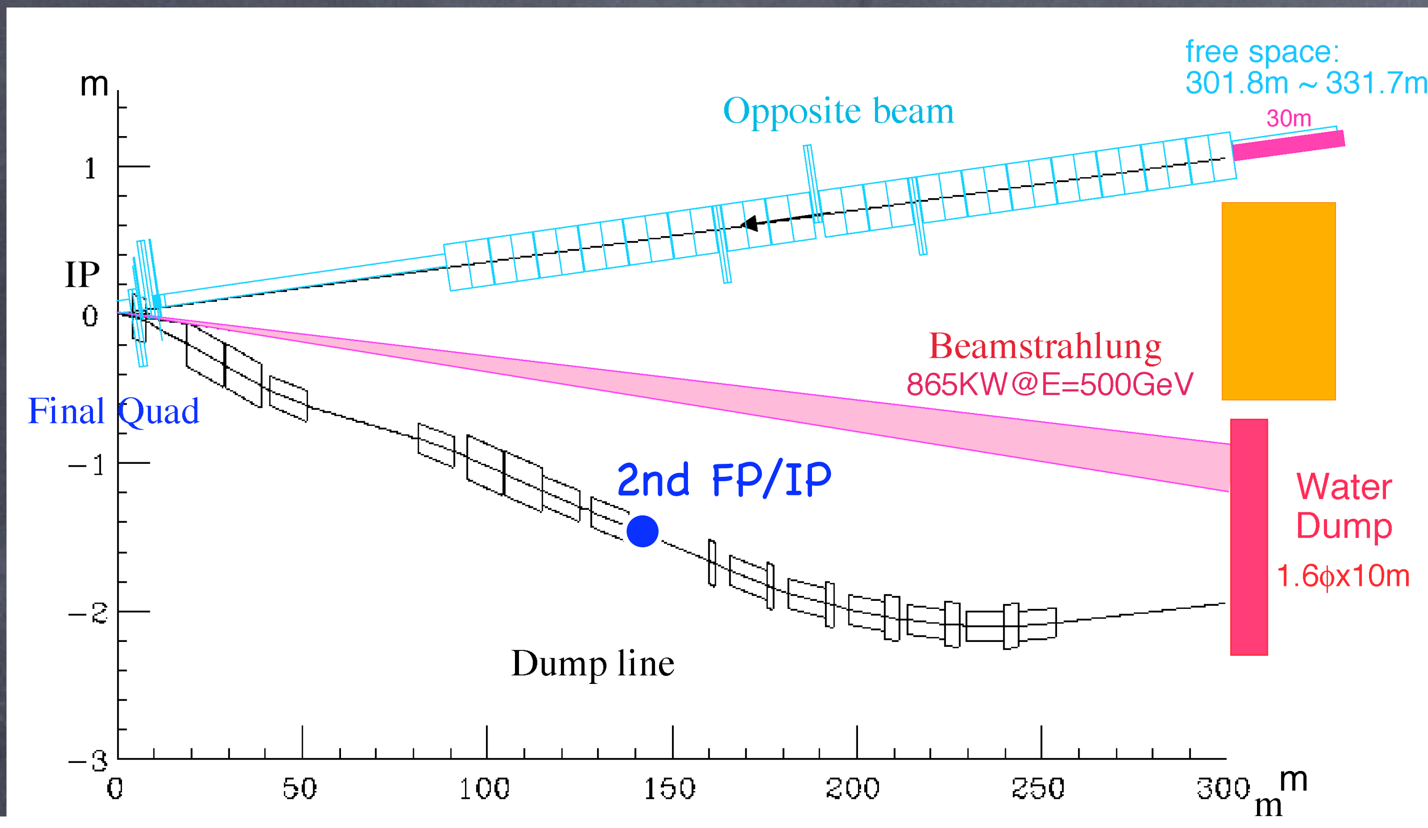
Beamline components scavenged from SPEAR, other SLAC surplus

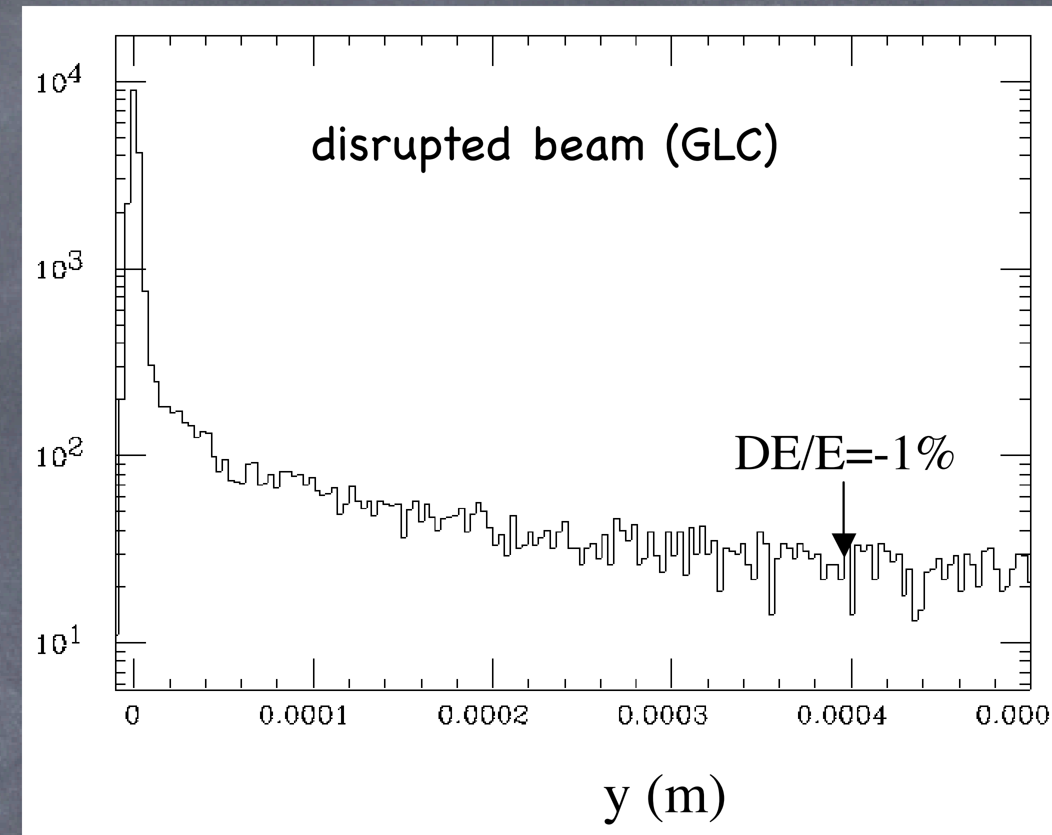
Nano-BPM at ATF extraction line

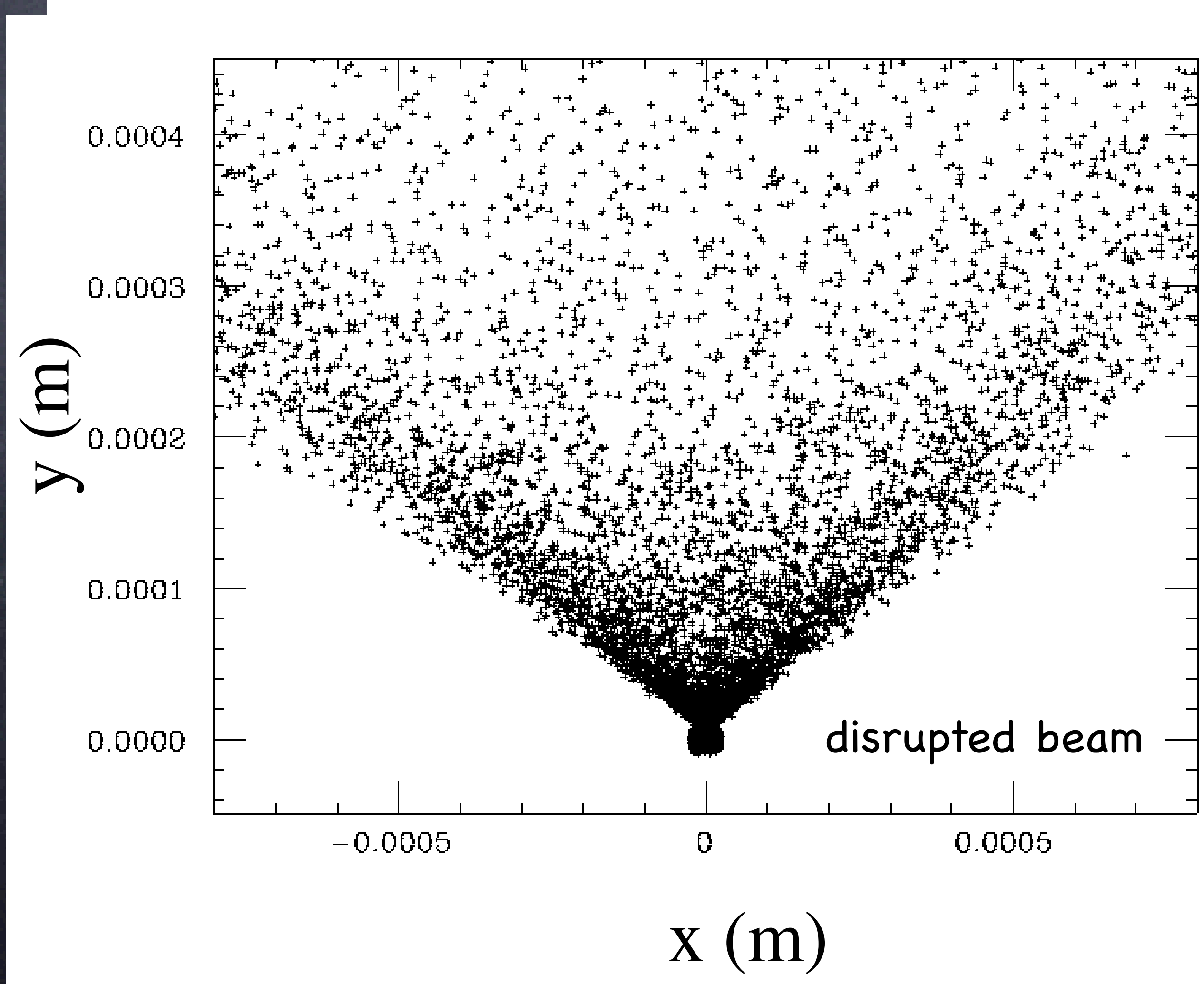


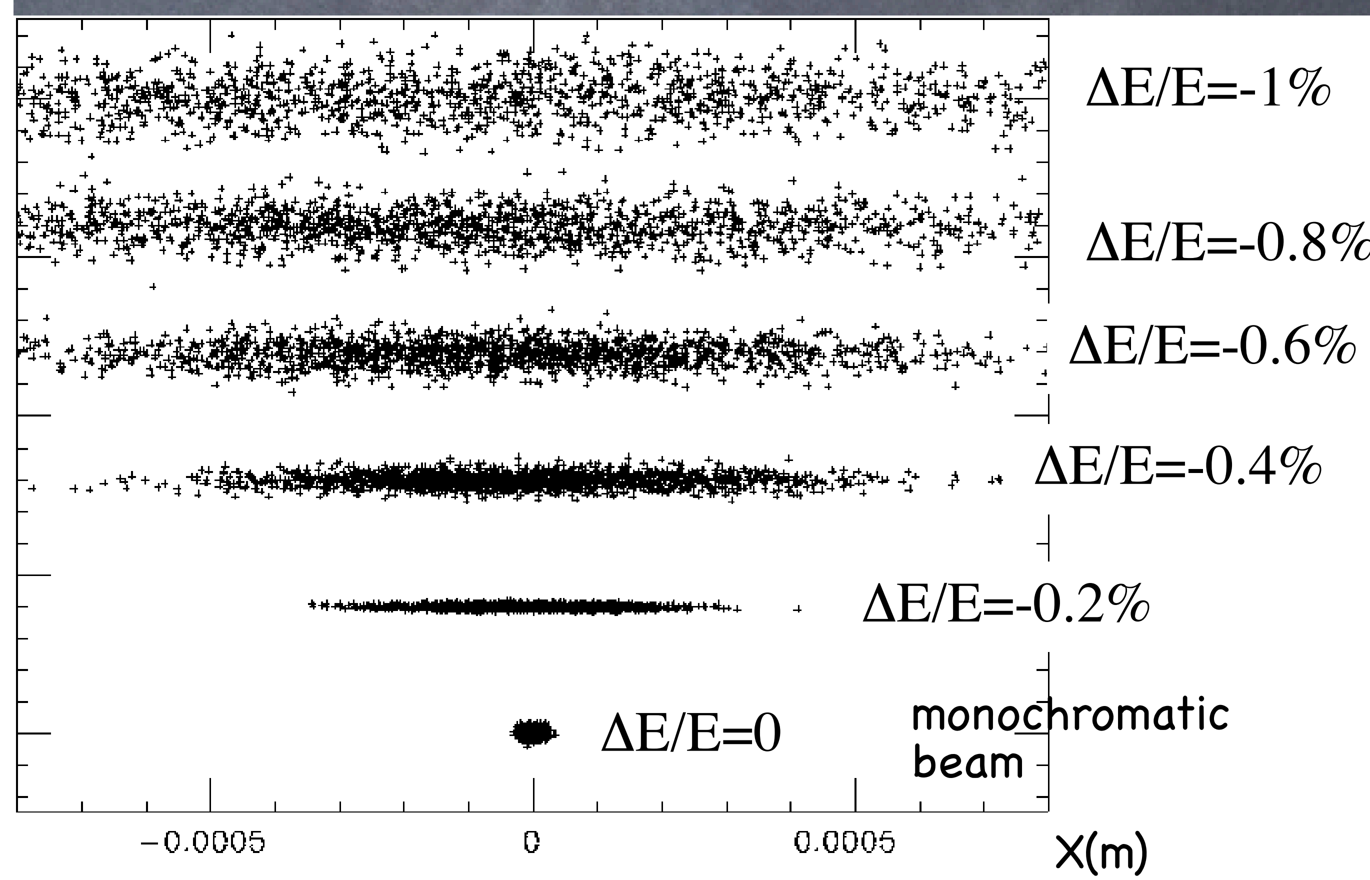


ΔE/E measurement at the 2nd FP/IP



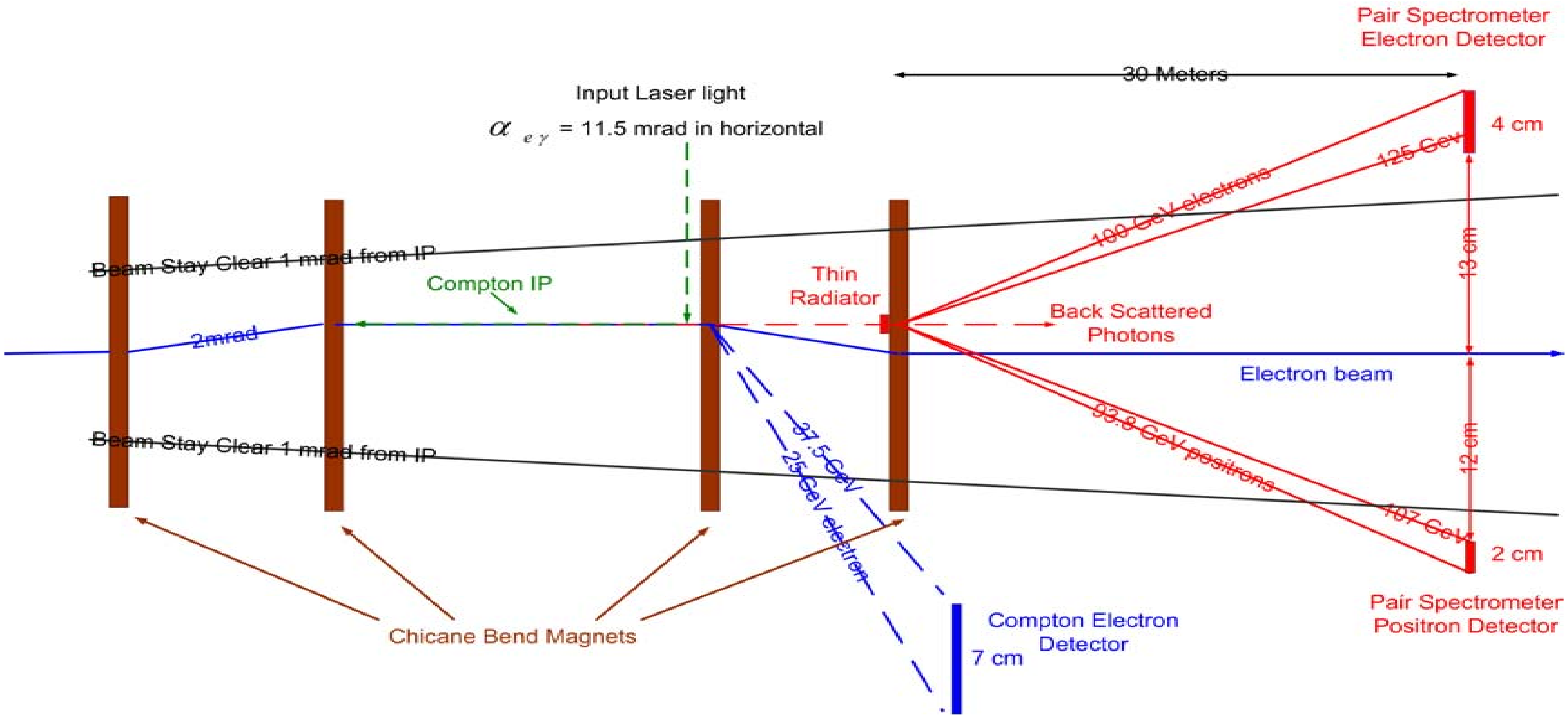






K.Kubo, LCWS2004

Extraction Line Compton Polarimeter



- Compton IP 60 meters downstream of e^+e^- IP
- 2mrad bend angle from analyzing magnet
- segmented gas Cherenkov detector, similar to SLD design
- multi-Compton mode with high power pulsed laser at ~17Hz

Also considering,

- pair spectrometer for backscattered photon measurement
- alternate detector technologies (ex. quartz fiber)

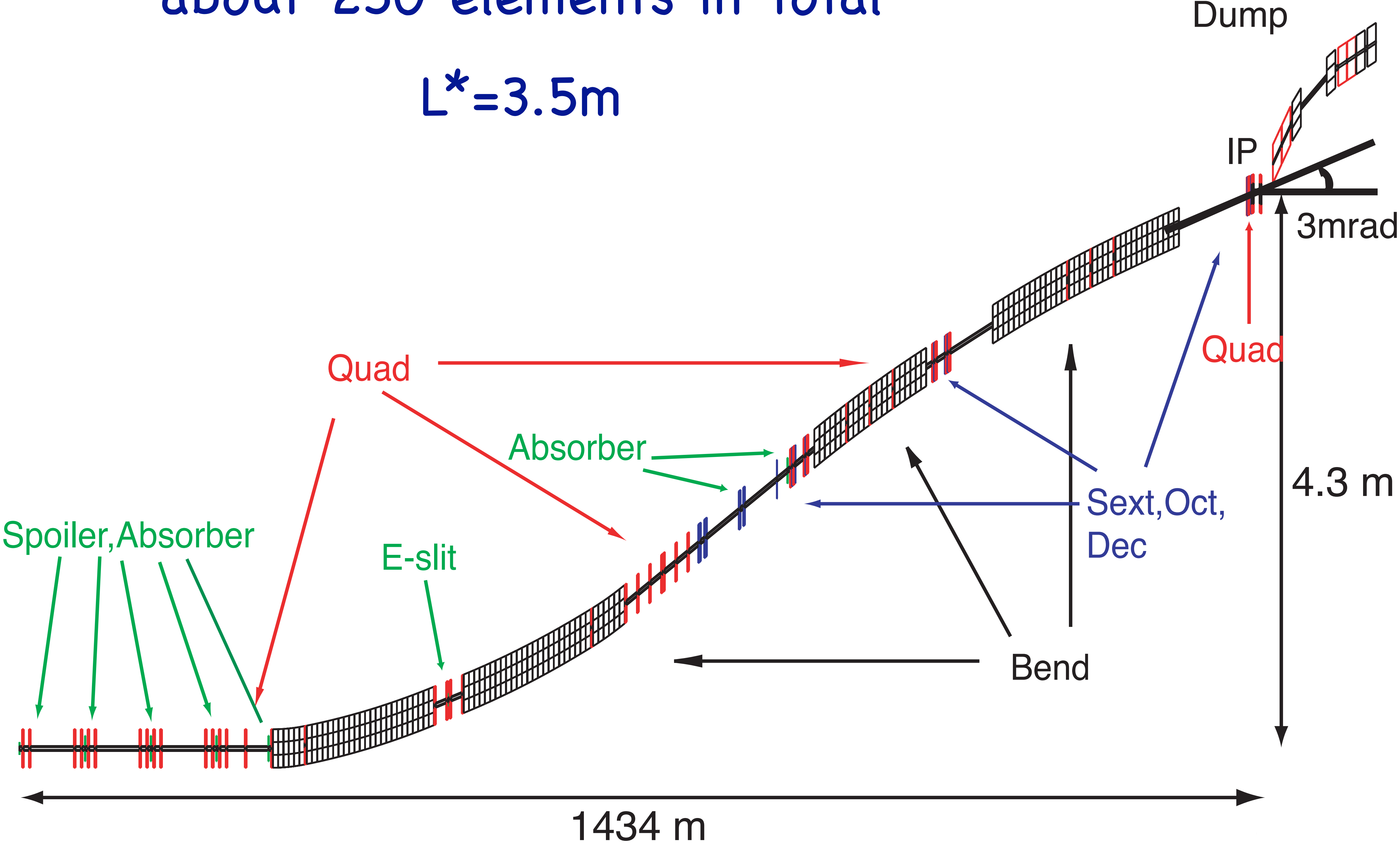
M.Woods, LCWS2004

BDS Simulation

Roadmap Report,2003

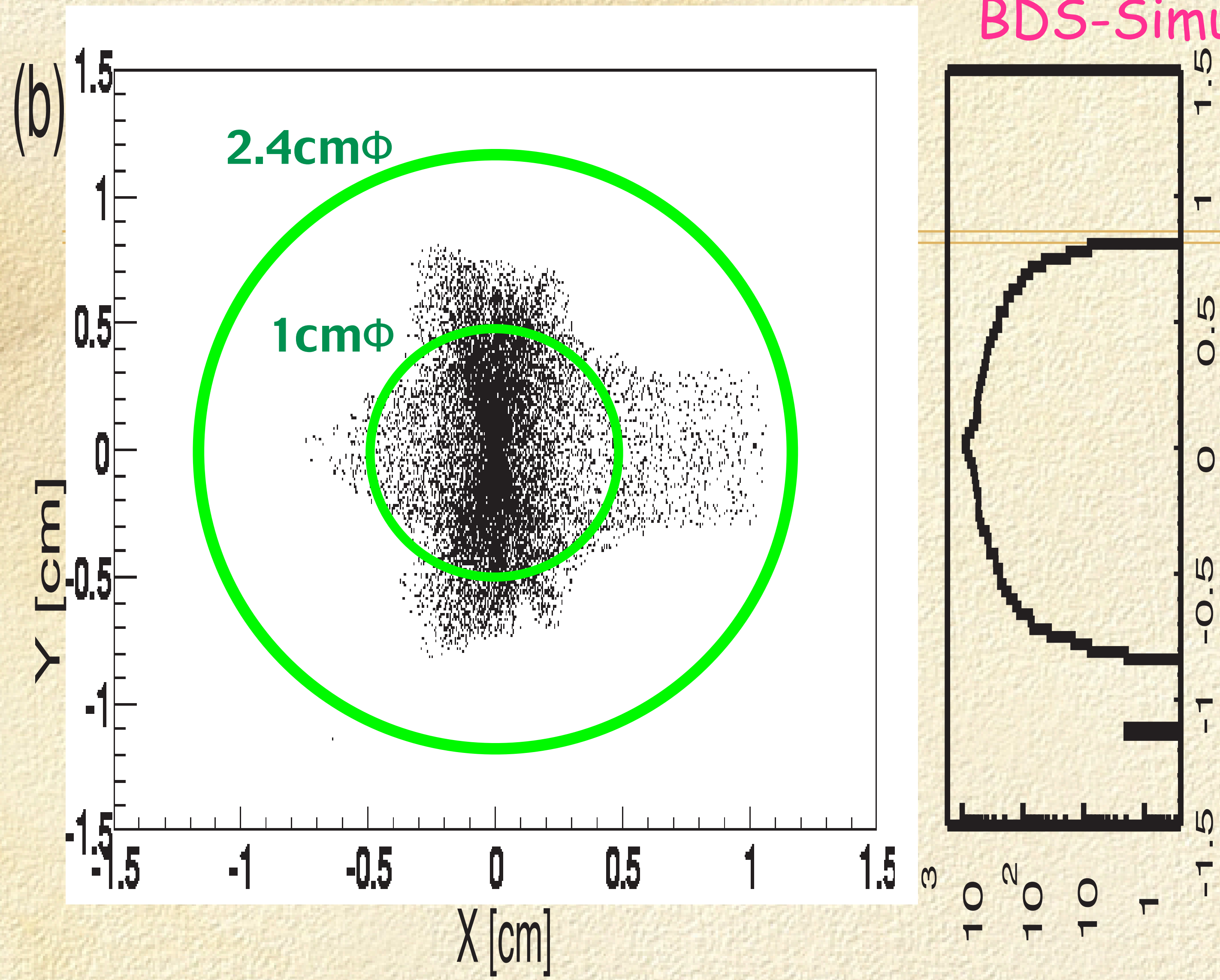
about 250 elements in total

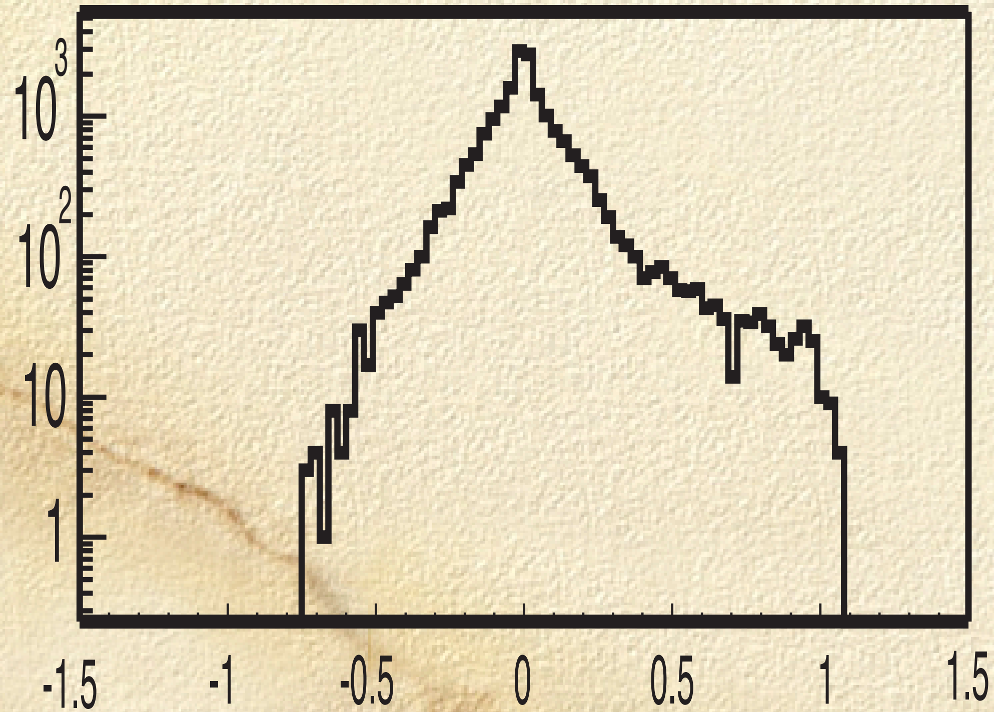
L*=3.5m



Vertex R : Synchrotron Radiations

BDS-Simulation (GEANT4) by K.Tanabe

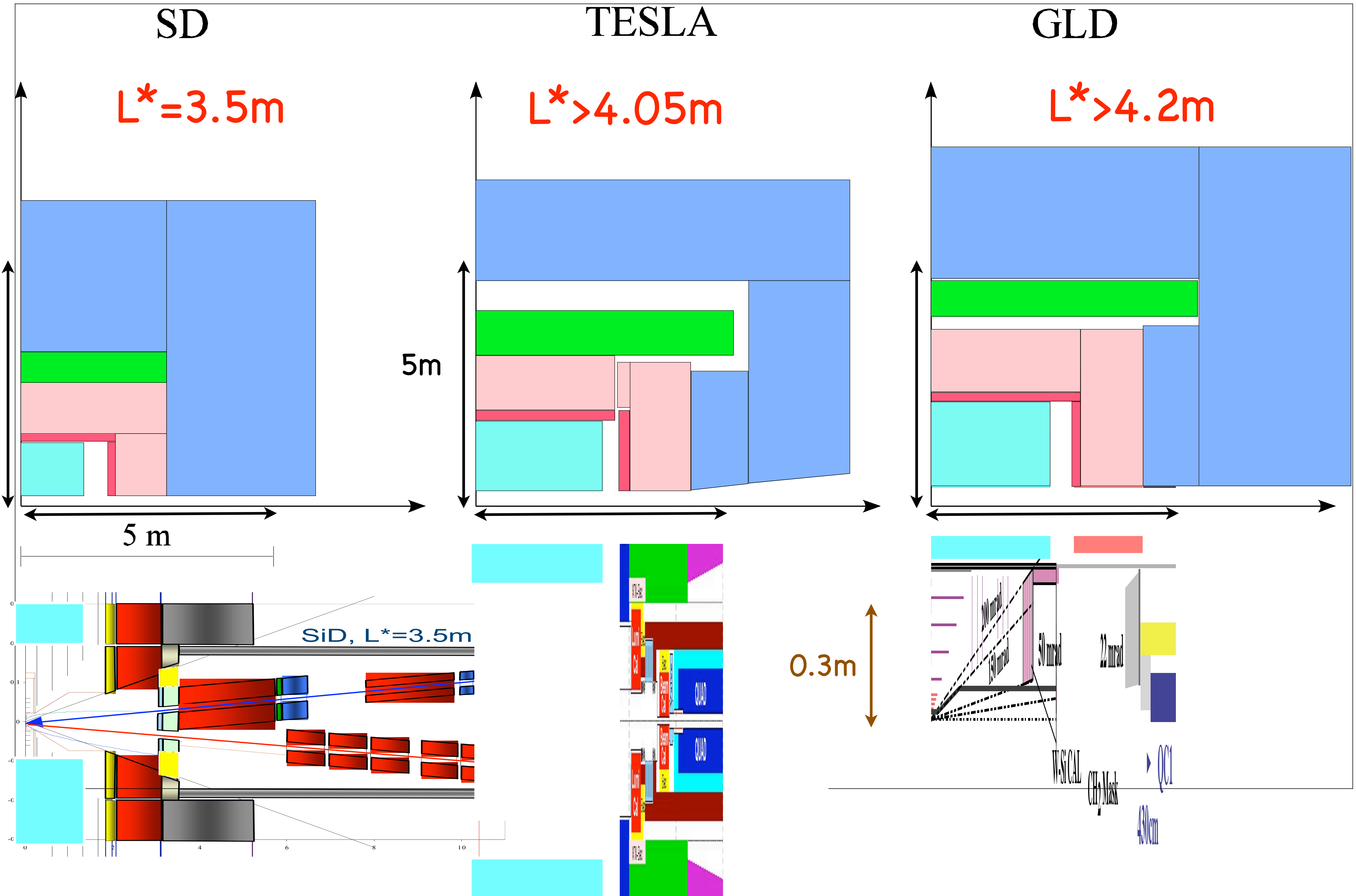




from Halo at IP
<E>=4.8MeV

GLC: L^*=3.5m
θ_c=7mrad
L/L_0=0.6
$12\sigma_x$ $53\sigma_y$

Choice of L*


SD
TESLA
GLD
L*=3.5m
L*>4.05m
L*>4.2m
5m
5 m
SiD, L*=3.5m
0.3m
QUAD
QUAD
W-Si CAL
CH2 Mask
QC1
430cm
22 mrad
50 mrad
150 mrad
200 mrad

Unified Task List of MDI issues

total 91 issues

UnifiedBDIRTaskList.xls

	A	B	C	D	E	F	G	H
1	Task_ID	Task	Topic	Speciality	Description	Begin	Due	Contributors
2	1	Experimental tests of compact optics	Beam Tests	Accelerator Physics	FF tests – at ATF / CLIC-3 / SLAC-line A/B	2005.9.1	TDR	with KEK, UK, SLAC, CERN participation
3	2	Electrostatic separator experimental tests in harsh environment, up to 500 GeV/beam, feasibility and reliability	Beam Tests	Experimental Physics		Now	CDR	PEP-II, KEK-B, ATF, UK ???
4	3	Experimental verification of backscattered photons in multi-bunch accelerator environment	Beam Tests	Experimental Physics		Now	TDR	LLNL
5	4	Experimental verification of photon-photon collisions	Beam Tests	Experimental Physics		Now	TDR	LLNL
6	5	Collimator material damage tests	Beam Tests	Experimental Physics		Now	TDR	SLAC
7	6	Collimator wakefield tests	Beam Tests	Experimental Physics		Now	TDR	SLAC, UK
8	7	BPM tests in IR-like environment	Beam Tests	Experimental Physics	ESA beam tests within 2-3 years from now	2 years	TDR	
9	8	Pair monitor prototype beam test in ESA	Beam Tests	Experimental Physics		2 years	TDR	
10	9	Prototype IR in ESA	Beam Tests	Experimental Physics	at SLAC/ESA? By SLAC, UK ?	CDR	TDR	
11	10	BPM tests at ESA and ATF	Beam Tests	Experimental Physics		CDR	TDR	
12	11	Develop "disrupted" and "pairs" beam capability at ESA	Beam Tests	Experimental Physics		1 year	CDR	
13	12	EMI Test of VXD and Detector electronics	Beam Tests	Experimental Physics				
14	[illegible]	[illegible]	Collimation	[illegible]		[illegible]	[illegible]	[illegible]

Tasks | Choices | Choice-Task List | Sheet3

Schedule of workshops

- 1 November 2004, EUROTeV Kick-off meeting at DESY
- 9-12 November 2004, ACFA-LC workshop, Taipei
- 13-15 November 2004, ILC workshop at KEK; WG4
- 6-8 January 2005, MDI mini-workshop at SLAC
- 18-22 March 2005, LCWS05 at SLAC
- 23-27 May? 2005, BDIR workshop at Oxford/RHUL
- 14-27 August 2005, ILC workshop at SNOWMASS

Kick-off : ILC-MDI workshop at SLAC

6-8 January, 2005

SCOPE and GOALS:

- Evaluate "experiment impact" of the ILC design. The ILC Design impacts the ILC Detector and Physics, beyond just the delivered luminosity. The Machine-Detector Interface (MDI) group needs to evaluate how the ILC design impacts the Experiment (Detector design and physics capabilities) and how the Experimental requirements impact the ILC design.
- Give input to both the ILC Beam Delivery Group and the World-wide Study for ILC Physics and Detectors regarding critical choices, beam tests, the CDR and the TDR.
- Address viability and issues for crossing angle choices: head-on, 300-mrad vertical, 2-mrad horizontal, 7-mrad horizontal, 20-mrad horizontal, >20 mrad horizontal
- Form sub-groups working on individual topics, and identify available and needed resources.

Join us!

http://www-conf.slac.stanford.edu/mdi/default.htm