MDI Session Summary

16 talks and discussions

Highlights

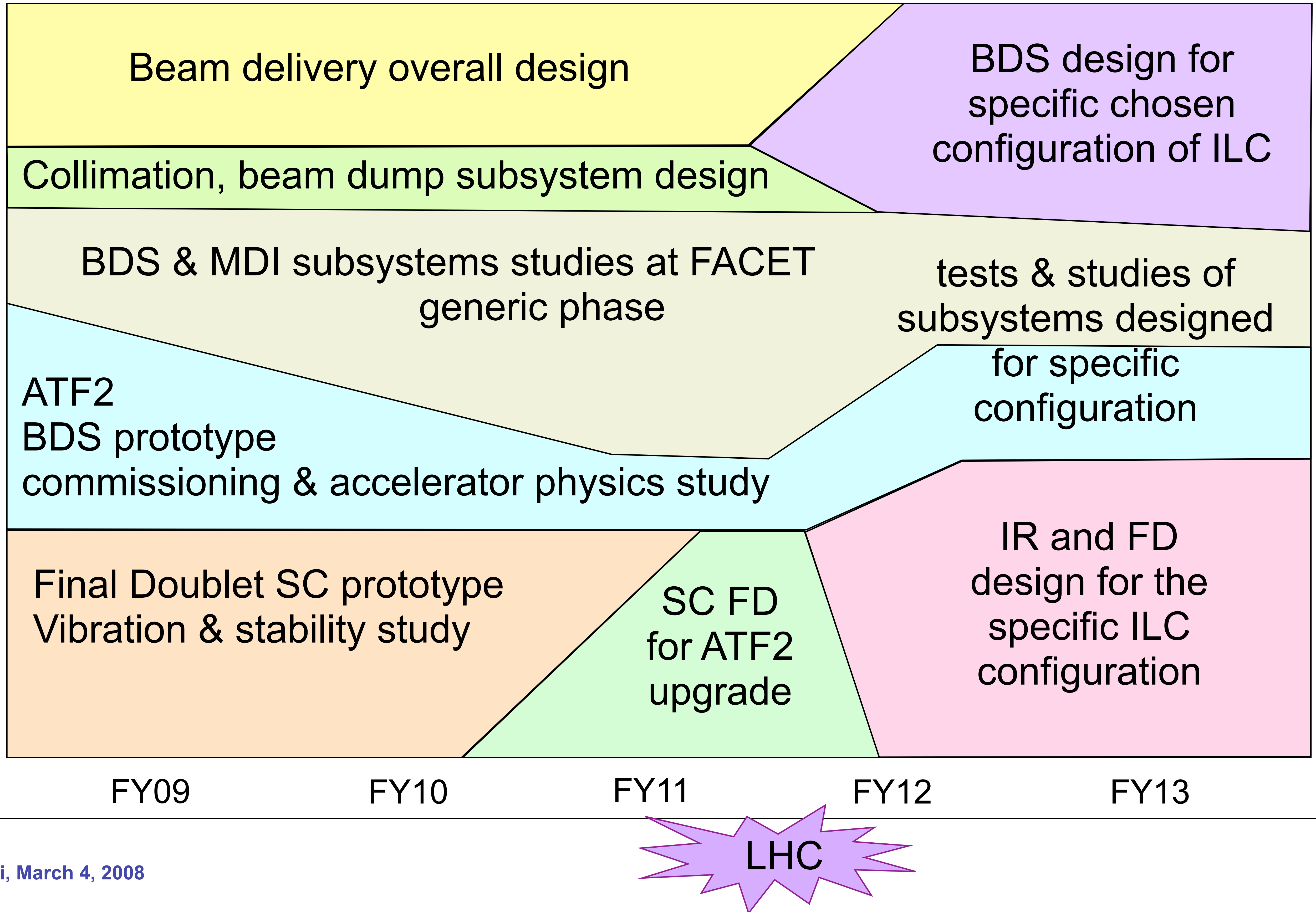
T. Tauchi

TILC08, March 6, 2008,
Sendai, Japan

BDS-MDI sessions at TILC08, Sendai

	Program GDE BDS (ACFA MDI)	Talks / lead discussions	Critical and strategic questions, or comments
4th, 9:00-10:30	Strategy, program and planning ACFA plenary in para.	Goals and plans, IDAG -- LOI schedule with RD	How to organize tasks in two phases, 2010 and 2012
4th, 11:00-12:30 MDI-BDS	IR IR integration I IR integration II L* FCAL	Andrei - plan and goals of the meeting Brett -- Updade on FD and IR integration Markiewicz -- SiD MDI Engineering Update Andrei-- Luminosity as a function of L* Grah -- Forward region calorimeters	 position adjustment system and correction coils for QD0 and SD0 CMS-style integration and assembling Luminosity as a function of L* Real time feedback from luminosty measurement
4th, 14:00-15:30 MDI-BDS	CLIC-MDI polarimetry γγ crossing angle pair mon.	Schulte -- CLIC IR & MDI and a view to push-pull Kaefer - BDS polarimetry Takahashi - γγ state of the art and research plan, what system tests can be done at ATF2, ESA -- Seletskiy(Andrei)-- CLIC crossing angle study	Common study items of MDI - push pull at CLIC ? - crab cavity - LHC upgrade ? - collimation - wakefield, survival, crystal channeling - crossing angle 14mr v.s. 20mr
4th, 16:00-17:30 BDS	CLIC-MDI ATF2-FD	Schulte -- CLIC BDS design Andrei -- Approach for solution of CLIC IP stability CLIC-ILC work, discussion and planning	Common study items of BDS - intra-train feedback digital v.s. analog - flight simulator to be developed at ATF2 - instrumentation - BPM, laserwire, feedback, luminometers etc.
5th, 9:00-10:30 MDI-BDS	small angle ATF2 nano-monitor@push-pull Background	Bambade - Updated 2mrad design Suehara -- Shintake IR mon. Coe - Monalisa Abe -- GLD background	Alternative BDS BSM at IP for commissioning ? Nanometer monitoring at IP for push-pull Updates of backgrounds in detectors
5th, 11:00-12:30 BDS	IR integration plans cost-reduction	Parker -- ATF2 SC FD Discuss and prepare detailed IR integration plans Discuss BDS cost saving proposals	 Cost reduction - 250GeV, E&P only at extraction line, common dump
5th, 14:00-15:30 BDS	Joint with Concepts	Present and discuss IR integration plan	
5th, 16:00-17:30 BDS	Summary	Meeting with PMs Finalize IR integration plan, prepare summary CERN-ILC	

Beam Delivery 5yr plan, ATR

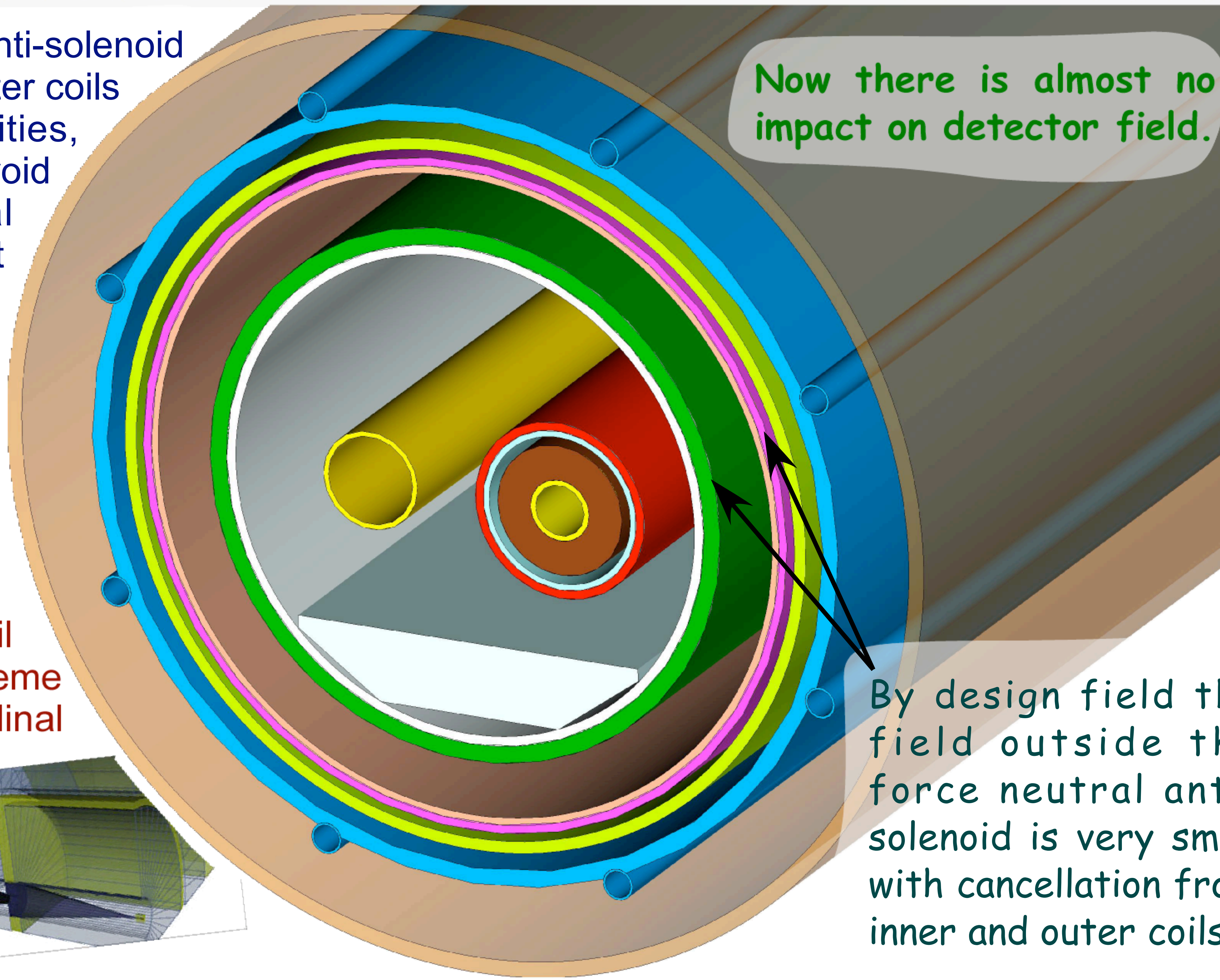


Benefits for US of BDS R&D

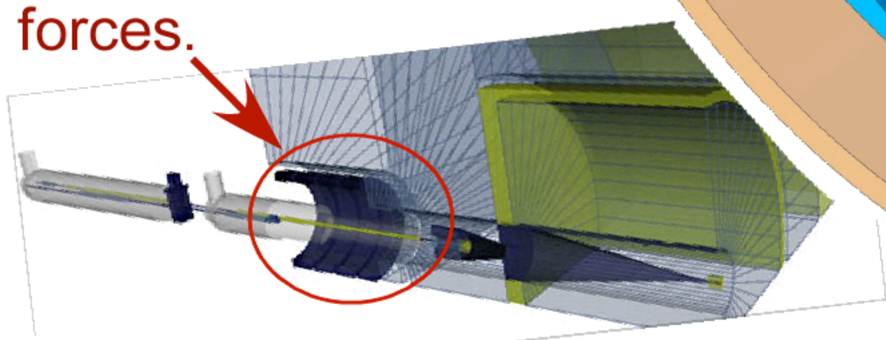
- **Direct: maintain leadership in key areas of US expertise, needed to reach the energy frontier**
- **Indirect: synergy with US science**
  - **ATF2: advanced accelerator study and beam handling applicable to any single path beamlines such as LCLS, XFEL…**
  - **Instrumentation, high availability power supplies, etc., are applicable to many future projects such as NSLS-2, LCLS…**
  - **Interaction region integration and FD design: synergy with LHC IR upgrade and Super-B IR**
  - **Collimation research: synergy with LHC, already engaged in design of LHC II-stage collimation system**
  - **Crab cavity design: already engaged in LHC crab.cav. study**
  - **FACET and ESA research: reach out to laser and plasma science communities, engaging them in our scientific quest, thus increasing scientific value of ILC**

Force Neutral Anti-Solenoid Design

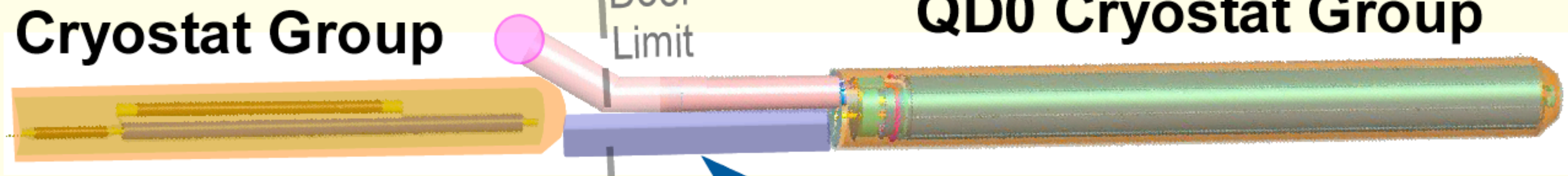
By constructing anti-solenoid with inner and outer coils of opposite polarities, it is possible to avoid large longitudinal net forces so that anti-solenoid can be combined with the other magnet coils inside the QD0 cryostat.



Previous large coil anti-solenoid scheme had large longitudinal forces.

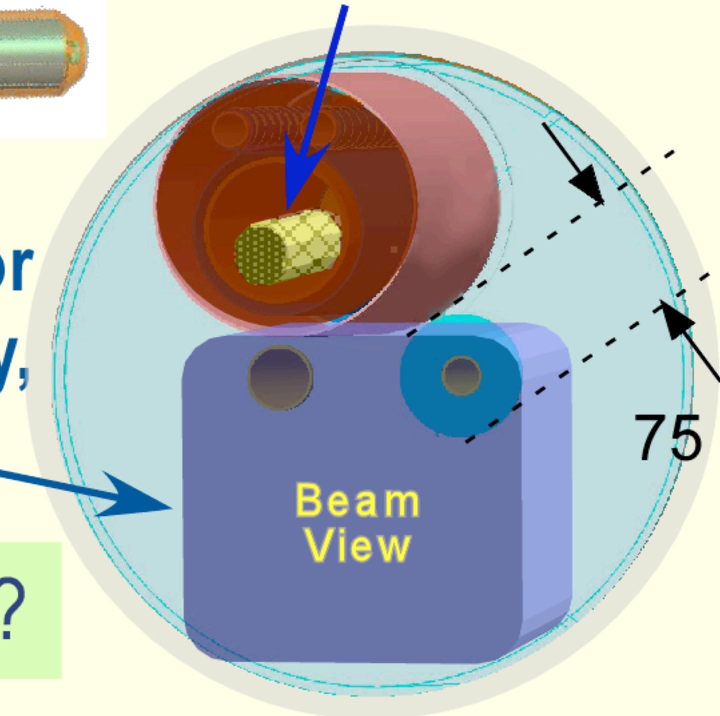


Cryogenic Considerations & Push-Pull



Remember we have similar space constraint in the "garage position" unless we cut into transfer line (say for major repair or upgrade).

Only this space available for beamline flanges, kicker body, vacuum pumps and valves.



Now asked to open 2.5-3 m?

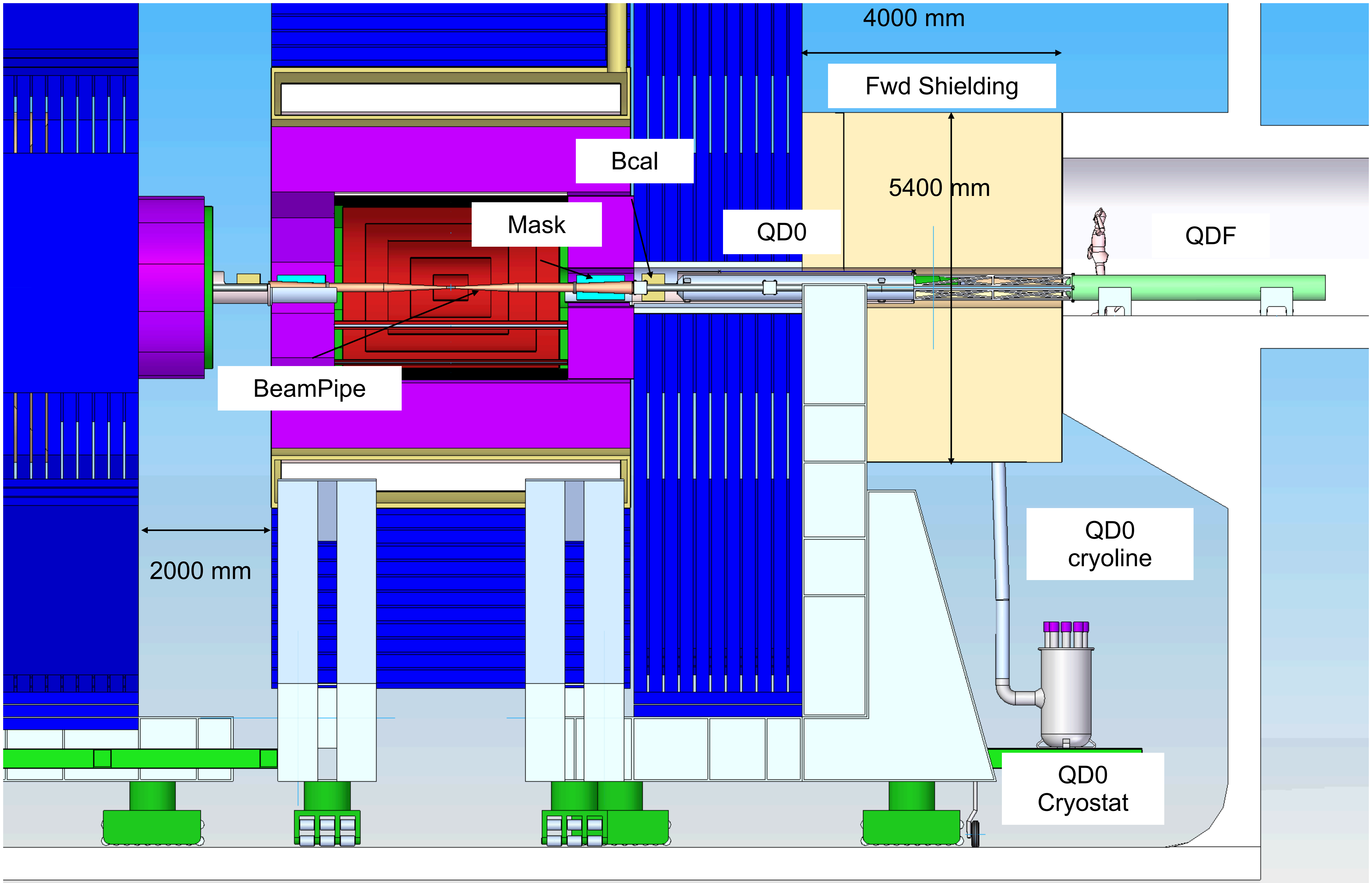
For **sizing the connection** between QD0 and the service cryostat we take the maximum 1.9K heat load to be 15 watts (14 static + 1 dynamic). Note that QD0 is conduction cooled and when the area for He-II gets very small then minor changes in parameters, such as the size of the cable bundle, can then make a big difference in performance and cool down time.

By adopting a 1 watt budget for dynamic heat load we had better be sure to consider all possible energy deposition scenarios (beam tuning, upsets, wakefield heating etc.).

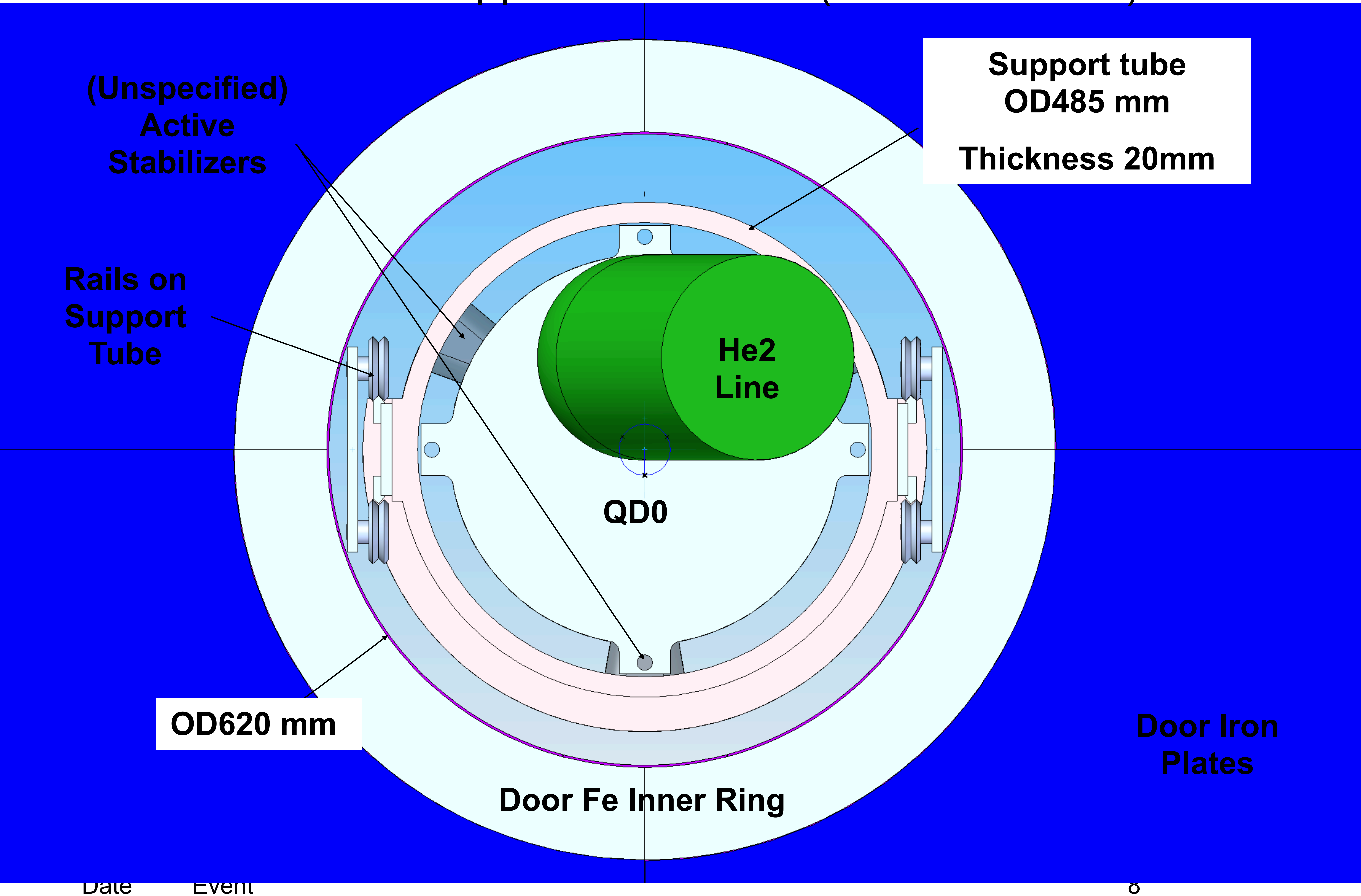
Machine-Detector Interfaces

SiD, T.Markiewicz

The first step is to translate the parameters in an engineering model, formulating technical solutions, clearances and components integration



QD0 support in the door (view toward IP)

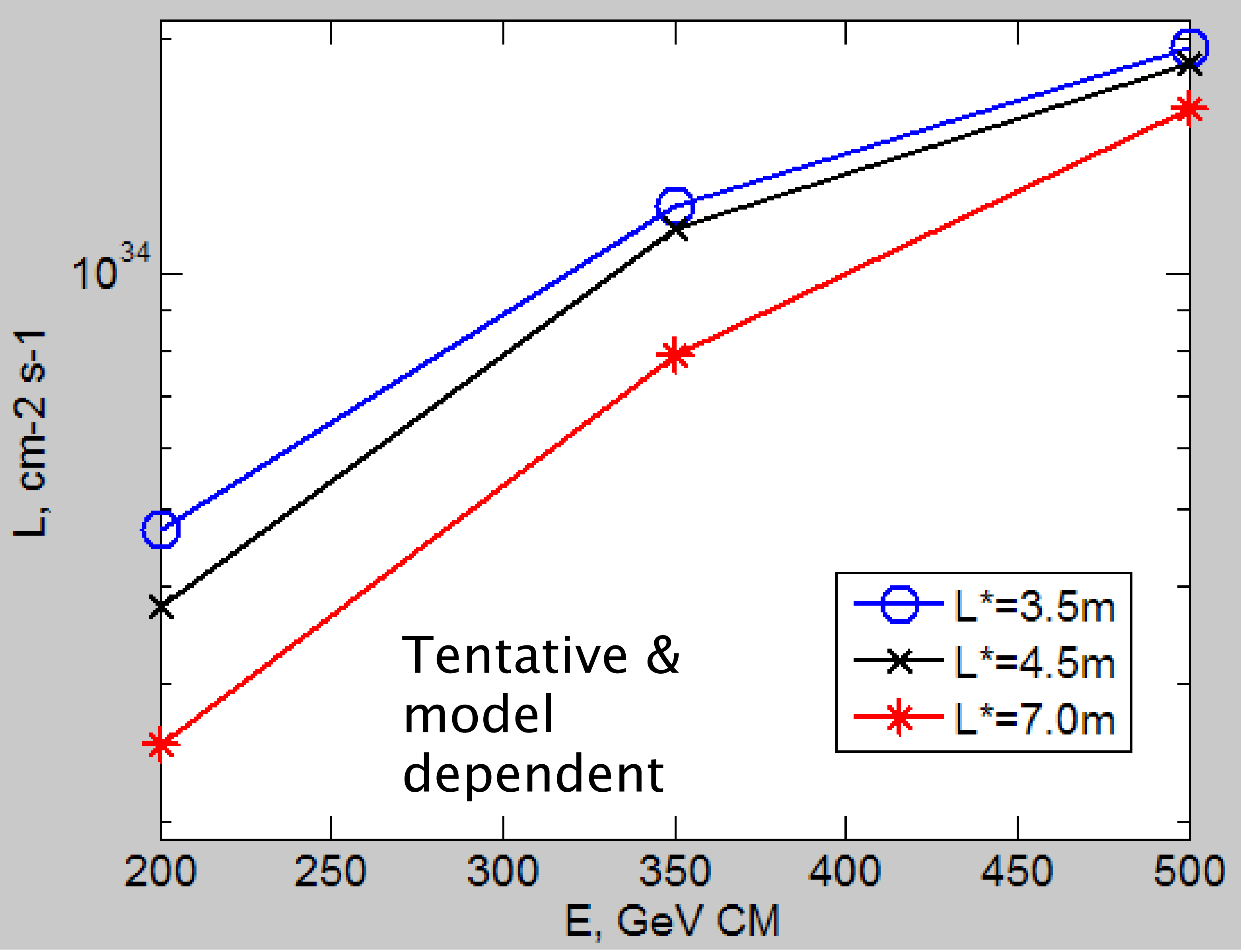


L* dependence

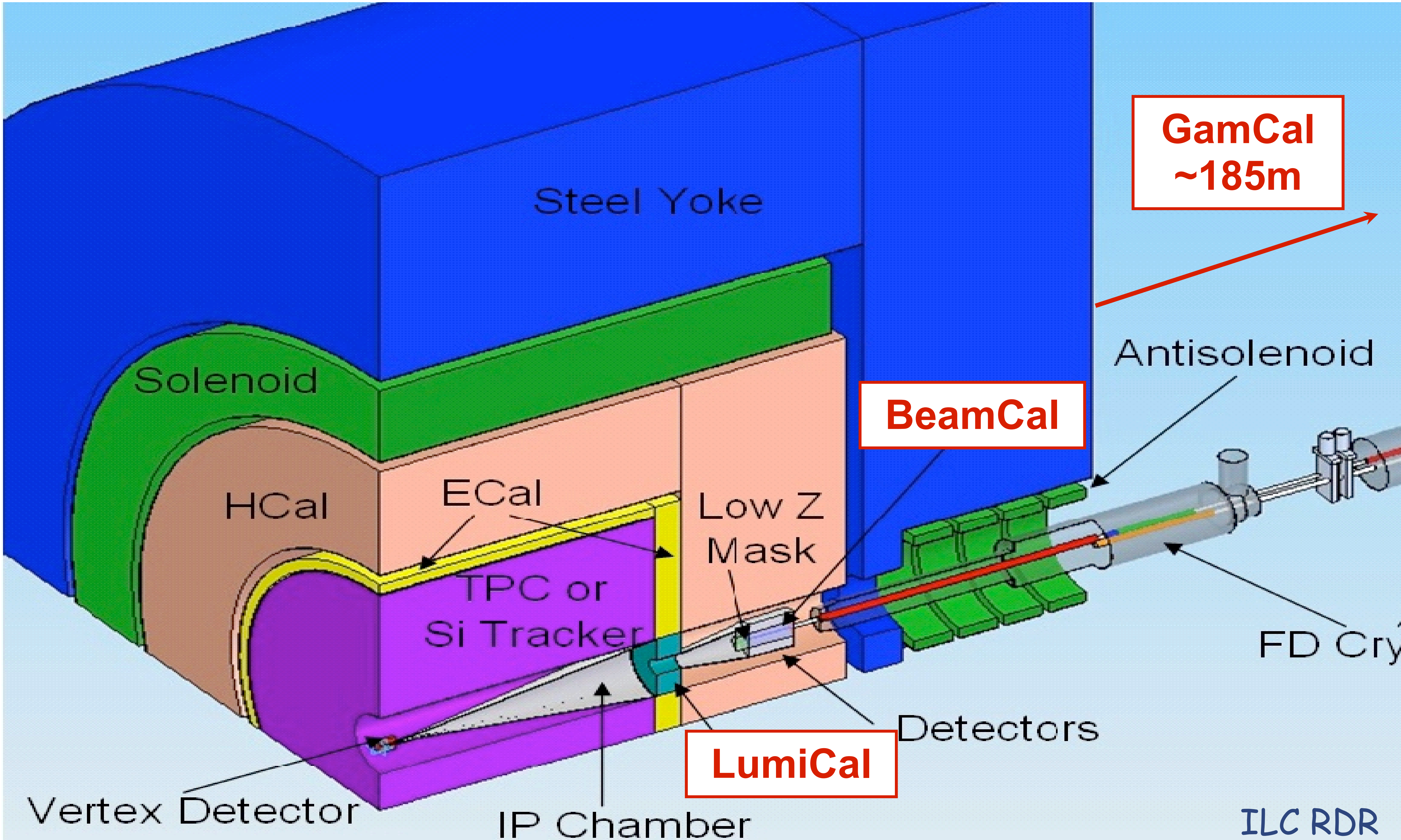
A. Seryi

• The original plan was to study the L* dependence (in the range of 3.5-4.5m) before the Sendai meeting. This plan cannot be now completed.
• Thus, results below are based on a model as of early December 2007, which was not scrutinized and may have some flaws, and too optimistic assumptions.
• The information, even tentative, may still be useful for discussion of detector optimization.
• The case of doubling L* also shown.

- Tentative dependence of luminosity on L*
  - Reduced by ~10-20% for L* 3.5m => 4.5m
  - Reduced ~factor of two for 3.5m=> 7.0m



Design of the Forward Region



Requirements on BeamCal

- Use the pair background signal to improve the accelerator parameters.
  - **The spatial distribution of the energy deposition from beamstrahlung pairs contains a lot of information about the collision.**
  - **Use a** fast **algorithm to extract beam parameters like:**

beam sizes (σ_x, σ_y and σ_z)

emittances (ϵ_x and ϵ_y)

offsets (Δ_x and Δ_y)

waist shifts (w_x and w_y)

angles and rotation (α_h, α_v and φ)

Particles per bunch (N_b)

Basic Parameters

- CLIC aims to achieve a luminosity similar to the ILC level at much higher energy

		CLIC	ILC	NLC
E_{cms}	$[TeV]$	3.0	0.5	0.5
f_{rep}	$[\mathrm{Hz}]$	50	5	120
N	$[10^9]$	3.7	20	7.5
ϵ_y	$[nm]$	20	40	40
L_{total}	$10^{34}cm^{-2}s^{-1}$	5.9	2.0	2.0
$L_{0.01}$	$10^{34}cm^{-2}s^{-1}$	2.0	1.45	1.28
n_γ		2.2	1.30	1.26
$\Delta E/E$		0.29	0.024	0.046

- Luminosity is delivered in 50 pulses per second
- Each pulse lasts about $150\,\mathrm{ns}$, contains 312 bunches spaced by $0.5\,\mathrm{ns}$
- In ILC luminosity is delivery by pulses with 5 Hz
- Each pulse is about $1\,\mathrm{ms}$ long

$\Rightarrow$ Very different regime

- event reconstruction
- background conditions

- High energy also affect background level

Luminosity and Background Values

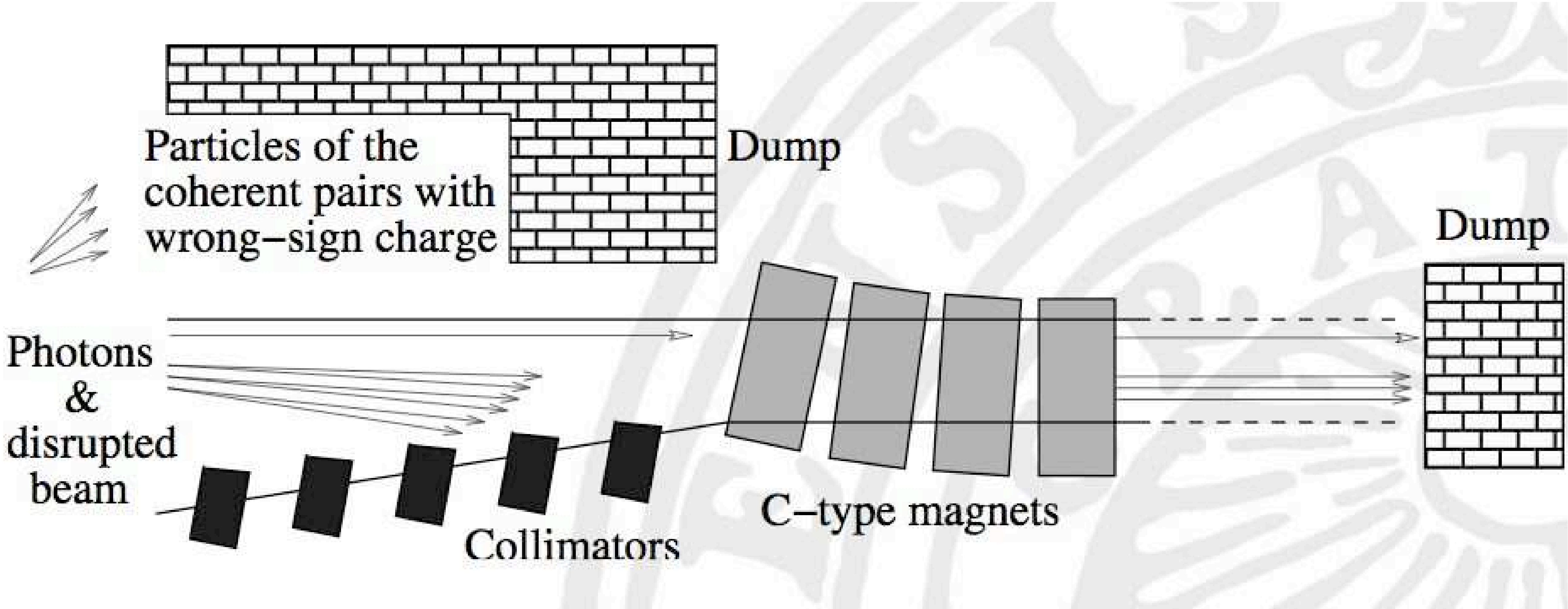
		CLIC	CLIC	CLIC	CLIC(vo)	ILC	NLC
E_{cms}	$[TeV]$	0.5	1.0	3.0	3.0	0.5	0.5
f_{rep}	[Hz]	100	50	50	100	5	120
n_b		312	312	312	154	2820	190
σ_x	$[nm]$	115	81	40	40	655	243
σ_y	$[nm]$	2	1.4	1	1	5.7	3
Δt	$[ns]$	0.5	0.5	0.5	0.67	340	1.4
N	$[10^9]$	3.7	3.7	3.7	4.0	20	7.5
ϵ_y	$[nm]$	20	20	20	10	40	40
L_{total}	$10^{34}cm^{-2}s^{-1}$	2.2	2.2	5.9	10.0	2.0	2.0
$L_{0.01}$	$10^{34}cm^{-2}s^{-1}$	1.4	1.1	2.0	3.0	1.45	1.28
n_γ		1.2	1.5	2.2	2.3	1.30	1.26
$\Delta E/E$		0.08	0.15	0.29	0.31	0.024	0.046
N_{coh}	10^5	0.03	37.0	3.8×10^3	?	—	—
E_{coh}	$10^3 TeV$	0.5	1080	2.6×10^5	?	—	—
n_{incoh}	10^6	0.05	0.12	0.3	?	0.1	n.a.
E_{incoh}	$[10^6 GeV]$	0.28	2.0	22.4	?	0.2	n.a.
$n_\perp$		12.5	17.1	45	60	28	12
n_{had}		0.14	0.56	2.7	4.0	0.12	0.1

- Target is to have about one beamstrahlung photon per beam particle

  $\Rightarrow$ average energy loss is larger in CLIC than ILC

- Note: shorter bunches increase the photon energy but not the number

Post Collision Line Conceptual Design 2



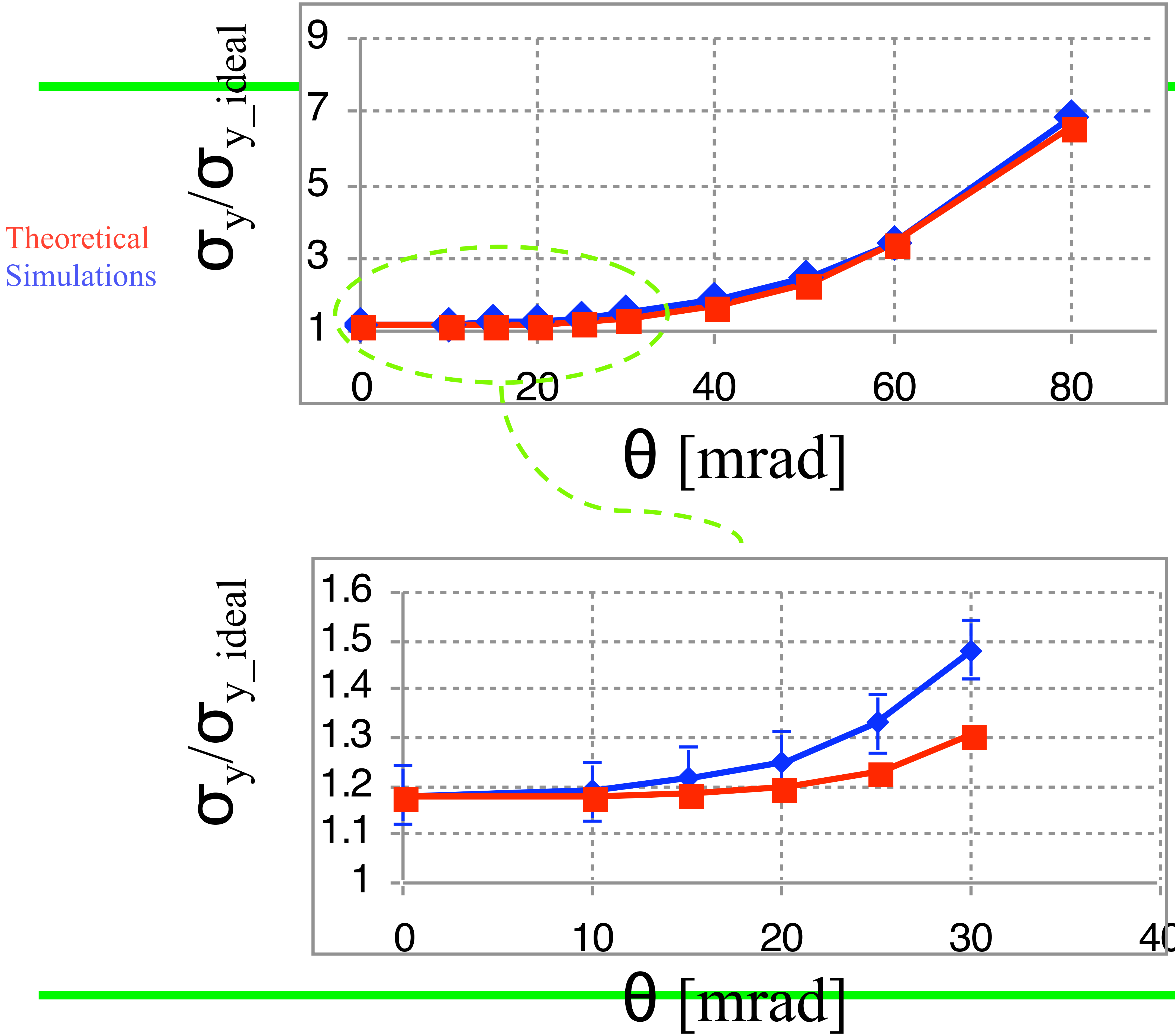
- Undisrupted beam size must be large at extraction window

  - litte impact of optices

  $\Rightarrow$ large distance to IP

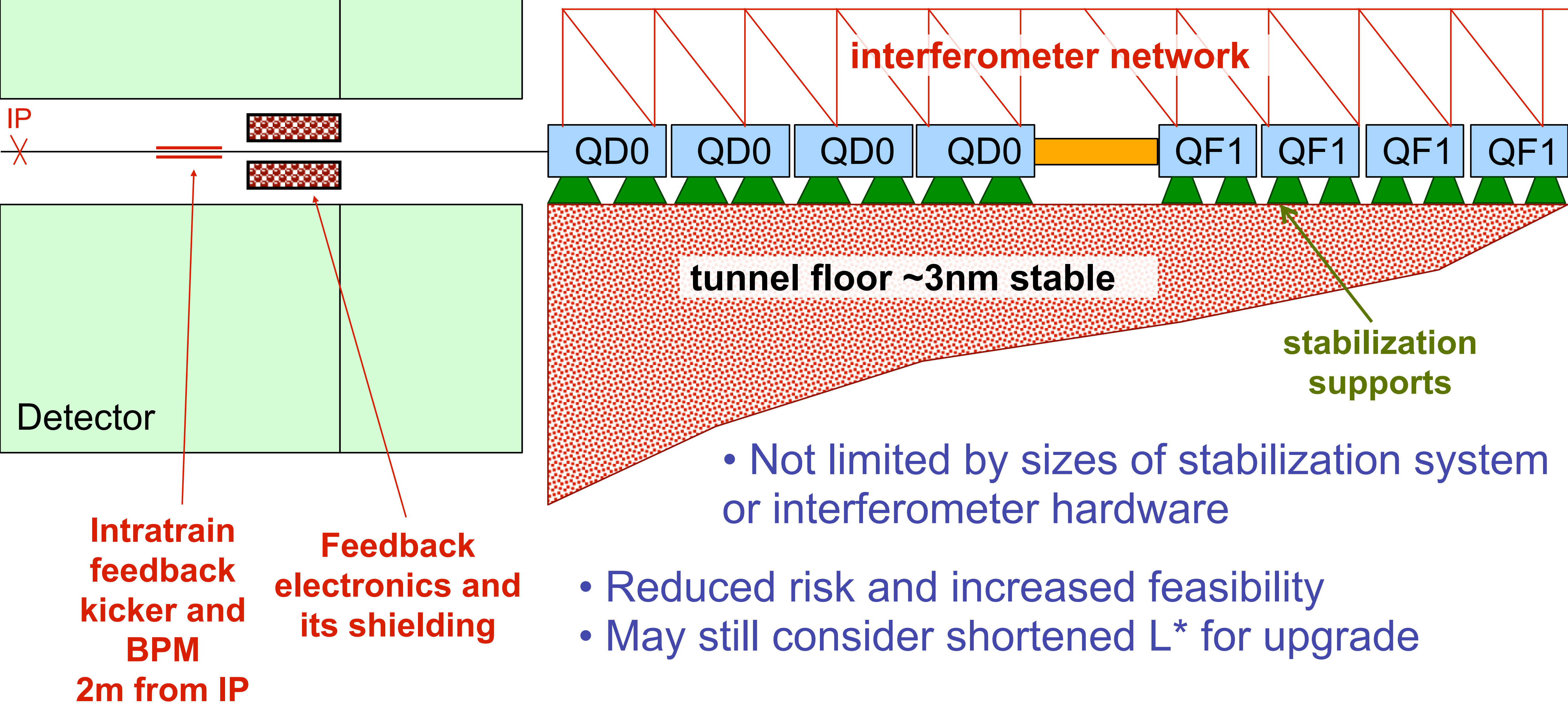
  - C-type magnets to have $D'_y = 0$ at dump

  - huge quadrupoles with $\approx 2 \times 0.7\,\mathrm{m}$ aperture


Theoretical
Simulations
σy/σy_ideal
9
7
5
3
1
0
20
40
60
80
θ [mrad]
σy/σy_ideal
1.6
1.5
1.4
1.3
1.2
1.1
1
0
10
20
30
40
θ [mrad]

New CLIC IR – advantages

- Reduced feedback latency – several iteration of intratrain feedback over 150ns train
- FD placed on tunnel floor, which is ~ten times more stable than detector – easier for stabilization



- Not limited by sizes of stabilization system or interferometer hardware

- Reduced risk and increased feasibility
- May still consider shortened L* for upgrade

Requirements for the Polarimeters

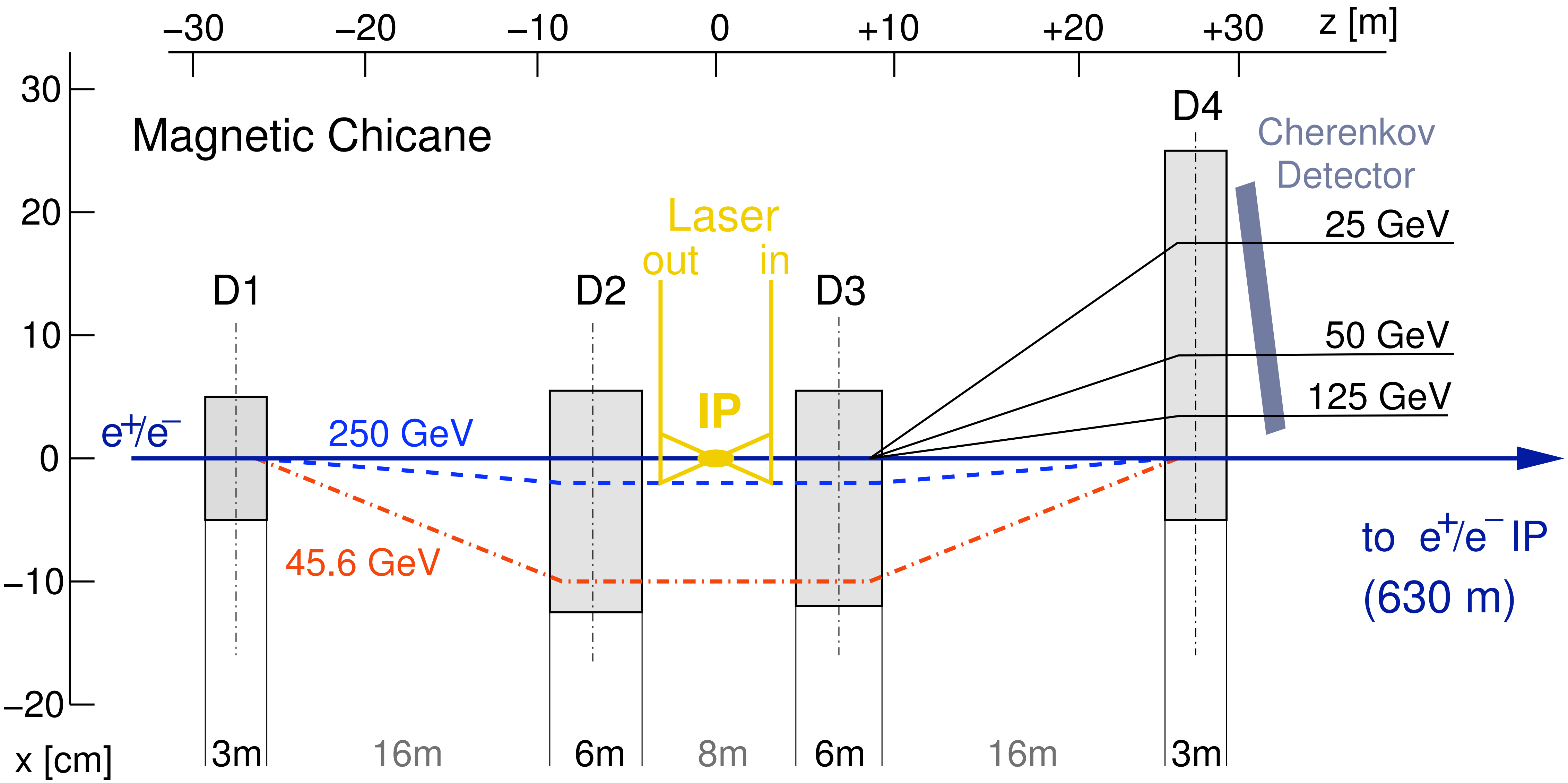
Type of the measurement / precision:

- measurement of the longitudinal beam polarisation
  $\rightarrow$ energy measurement $\leftrightarrow$ position measurement
- necessary precision: $\delta P/P \leqslant 0.2$ %
  2-times more precise than the SLD polarimeter (SLAC, Stanford)

- Compton-IP about 1700 m away from the e^+/e^- IP
- $\Rightarrow$ need a good understanding of the spin transport $\rightarrow$ difficult
  ...that's why we NEED precise measurements of the polarisation!

- Finally: cross check polarisation measurements, both: up- and downstream, with "real" physics from e^+/e^- IP (e.g. W-helicities) and among each other.

Measurement principle: Compton Polarimetry



The Compton-IP lies within the magnetic spectrometer (4 large dipoles)

→ Scattering of about 10^3 e^+/e^- per beam crossing

→ the Compton edge lies always at the same spot in the detector!

. . . then Detection of the scattered electrons via Cherenkov detectors

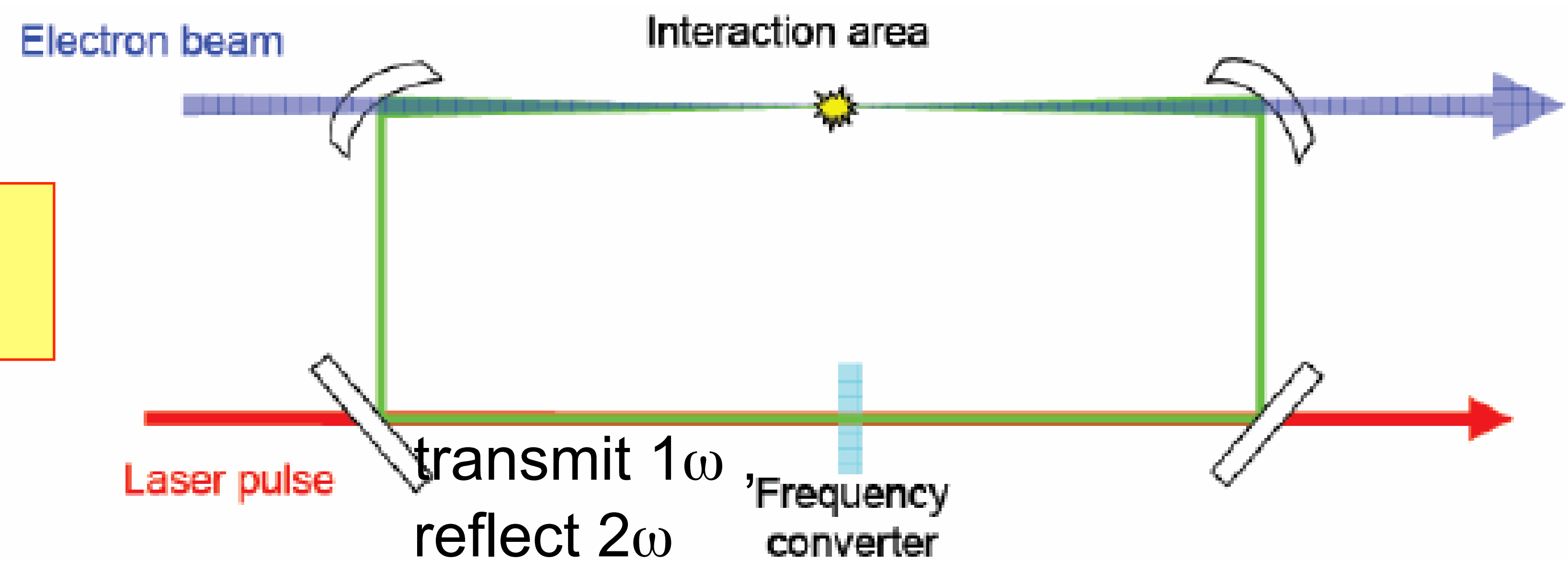
SLD detector setup @ DESY testbeam 21

- detector mounted on moveable stage
- pressure gauge for monitoring purpose
- fast VME electronics for readout

Ideas to reduce laser power

- RING (Recirculation Injection by Nonlinear Gating) Cavity (Gronberg LEI2007)

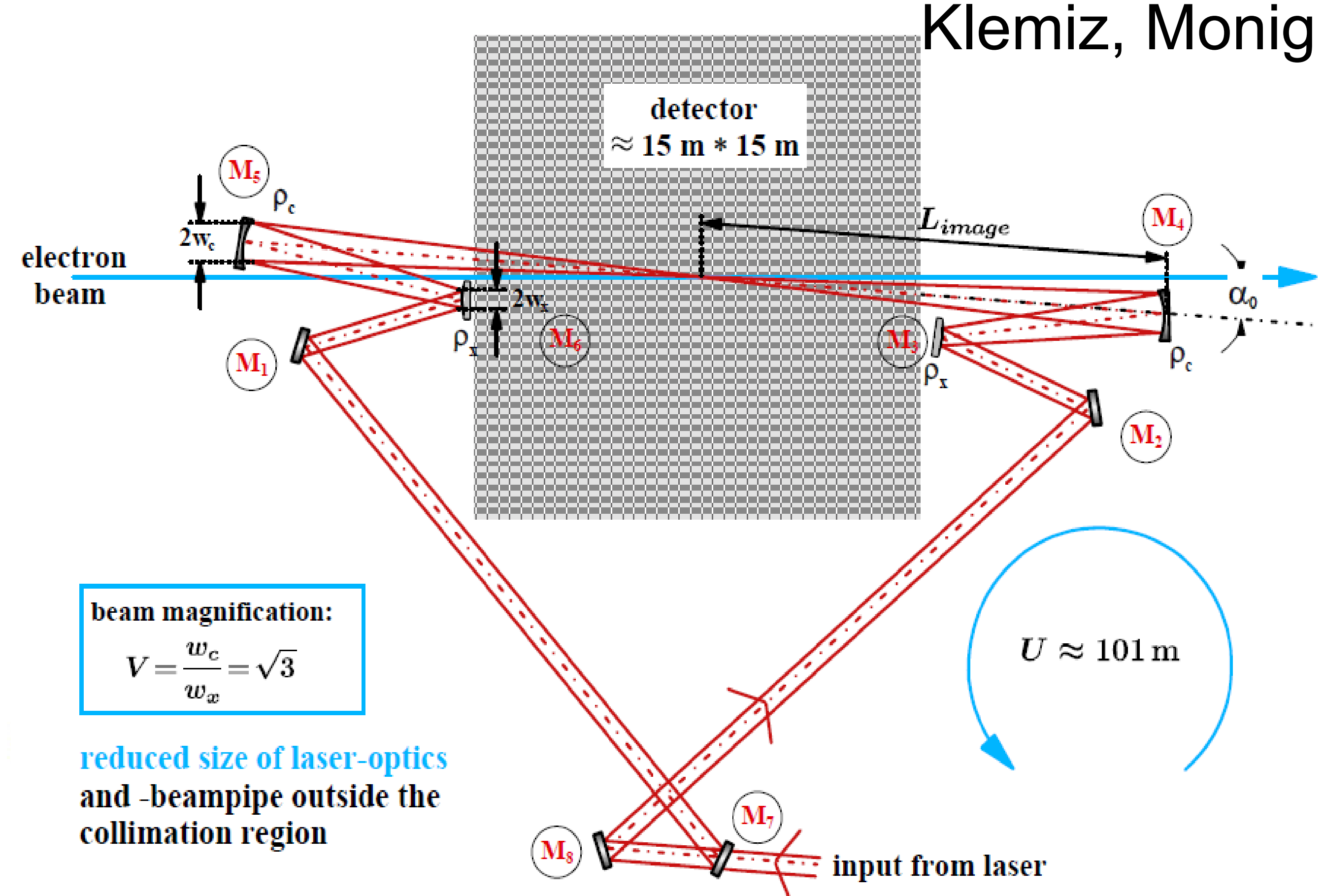
Recirculation of a laser pulse to reduce average laser power



- Pulse Stacking Cavity

Klemiz, Monig

Stack laser pulses on phase to reduce peak as well as average power



Issues and Status

items	Pulse Stacking Cavity	RING Cavity
Performance	~300 enhancement of pulse energy	~recirculation of a pulse ~50 times
Laser requirements	•2820+300 pulses separated by 369ns •5 Joule / 300 = 0.016 J/pulse •5 Hz duty cycle	•2820 / 50 pulses separated by 369 * 50 ns •5J/ pulse •5 Hz duty cycle
Technical issues	•unprecedented for 100m long cavity •tight motion tolerances for interferometric stabilization •quiet environment •sophisticated feed back •adoptive optics ?	•unprecedented for 100m long cavity •No tight motion tolerances for interferometric stabilization •pulse deterioration during cirulation
R&D status	•PosiPol, x/γ sources •not for γγ system yet	•X ray source project at LLNL •not for γγ system yet

Design status 2 mrad IR

Current plan for finalization in 2008

Philip Bambade
LAL-Orsay

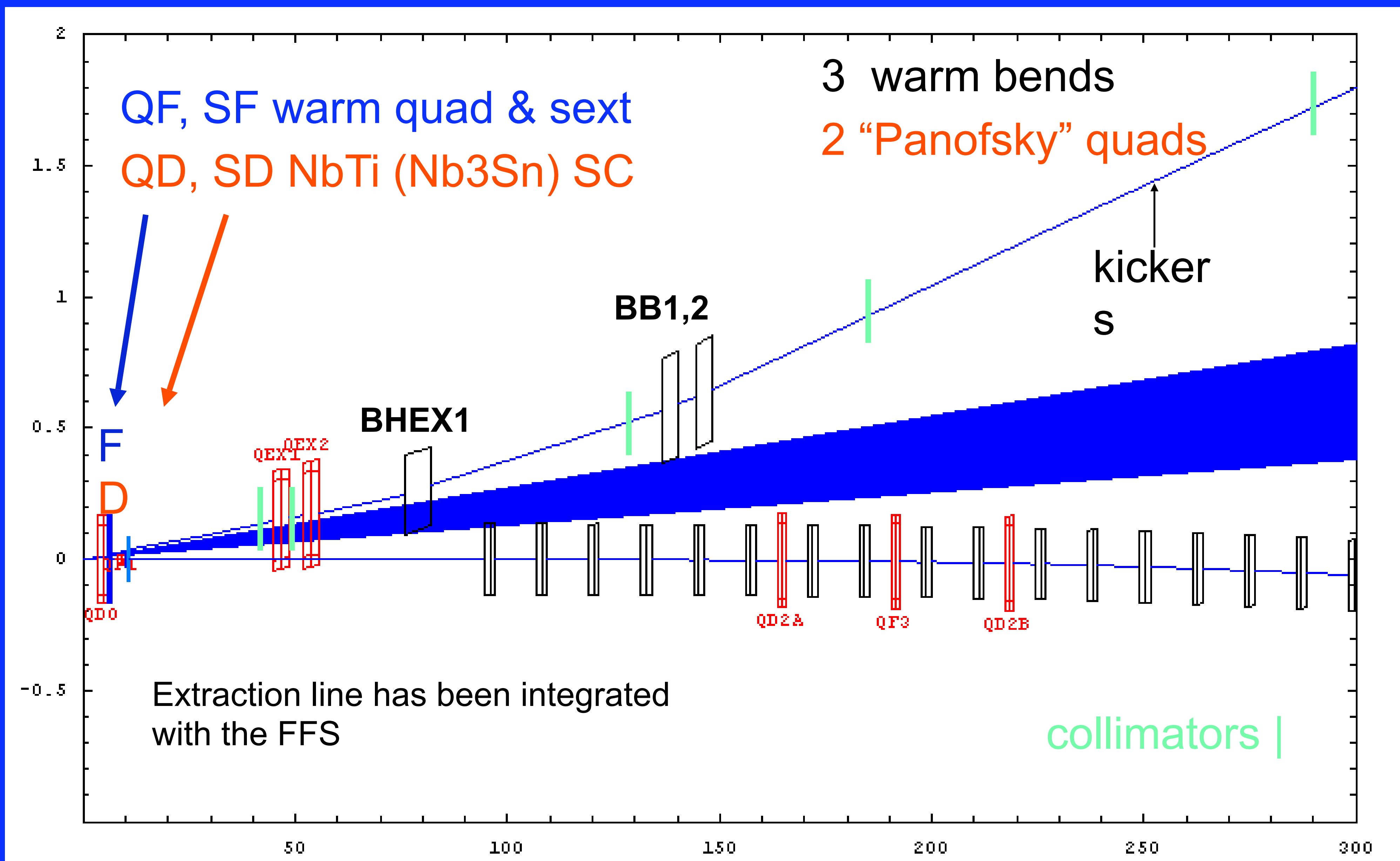
<u>Recent contributors:</u>
D.Angal-Kalinin, R.Appleby, F.Jackson, D.Toprek (Cockcroft)
P.B., S.Cavalier, O.Dadoun, M.Lacroix, F. Touze, G. Le Meur (LAL-Orsay)
Y. Iwashita (Kyoto)

IN2P3-KEK collaboration meeting,
TILC08, Sendai, March 5, 2008

2mr, P. Bambade

New "minimal" extraction line concept

➔ Explicit goals : short & economical, as few and feasible magnets as possible, more tolerant and flexible



dump(s):
0.5 m

flexible

3 m

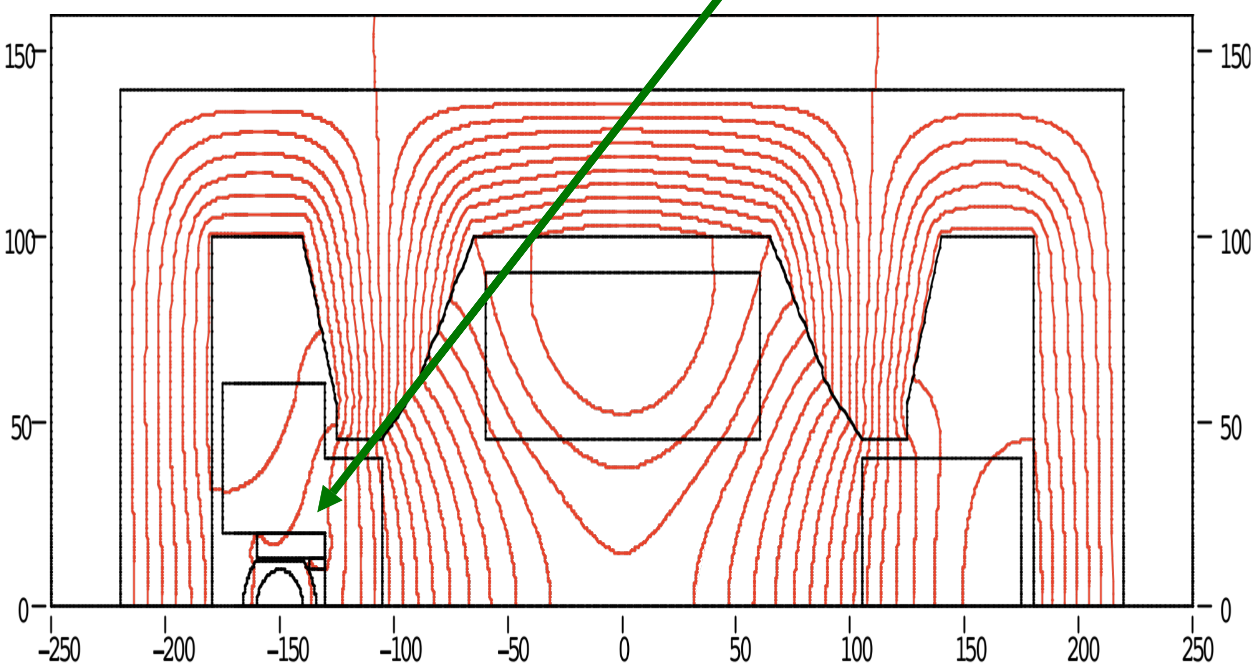
Beam rastering kickers can be placed to prevent water boiling and window damage

Length ~ 300 m

2mr, P. Bambade

QEX1 modified "Panofsky"-style quad design

Permanent magnet plates help reduce field to 10 Gauss for incoming beam



Multipole expansion

(Bx - iBy) = i[sum n*(An + iBn)/r * (z/r)**(n-1)]

n	n(An)/r	n(Bn)/r	Abs(n(Cn)/r)
1	-1.8355E+00	0.0000E+00	1.8355E+00
2	-4.0798E+03	0.0000E+00	4.0798E+03
3	-2.6446E+00	0.0000E+00	2.6446E+00
4	-6.4440E+01	0.0000E+00	6.4440E+01
5	-1.1749E+00	0.0000E+00	1.1749E+00
6	2.1582E+01	0.0000E+00	2.1582E+01
7	-3.4437E-01	0.0000E+00	3.4437E-01
8	-1.8381E+00	0.0000E+00	1.8381E+00
9	-7.6307E-02	0.0000E+00	7.6307E-02
10	-2.0240E+00	0.0000E+00	2.0240E+00

QEX1

Lumped multipole errors

Extra multipole field components modeled in DIMAD

- Disrupted beam tracking (500 GeV) along the extraction line with multipoles:
  - Power loss increase of 1kW at 1 collimator
  - Dump beam size increase of 5%

Summary and conclusion

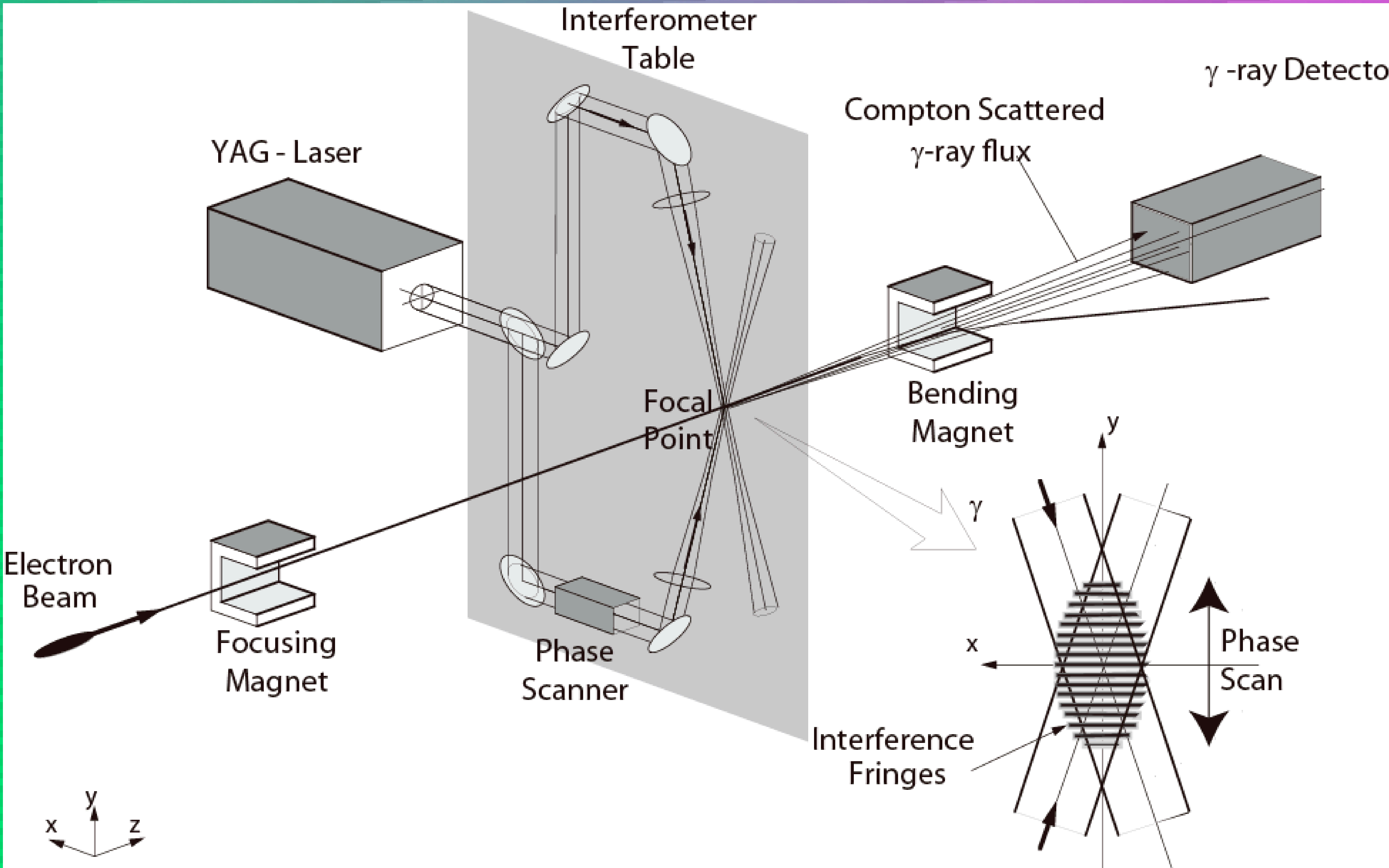
- Progress made → credible small angle alternative for IR
- Documented design including magnet and beam pipe assessment → scheduled within 2008
- main current work planned :

1) finish QEX1,2 Panofsky quads

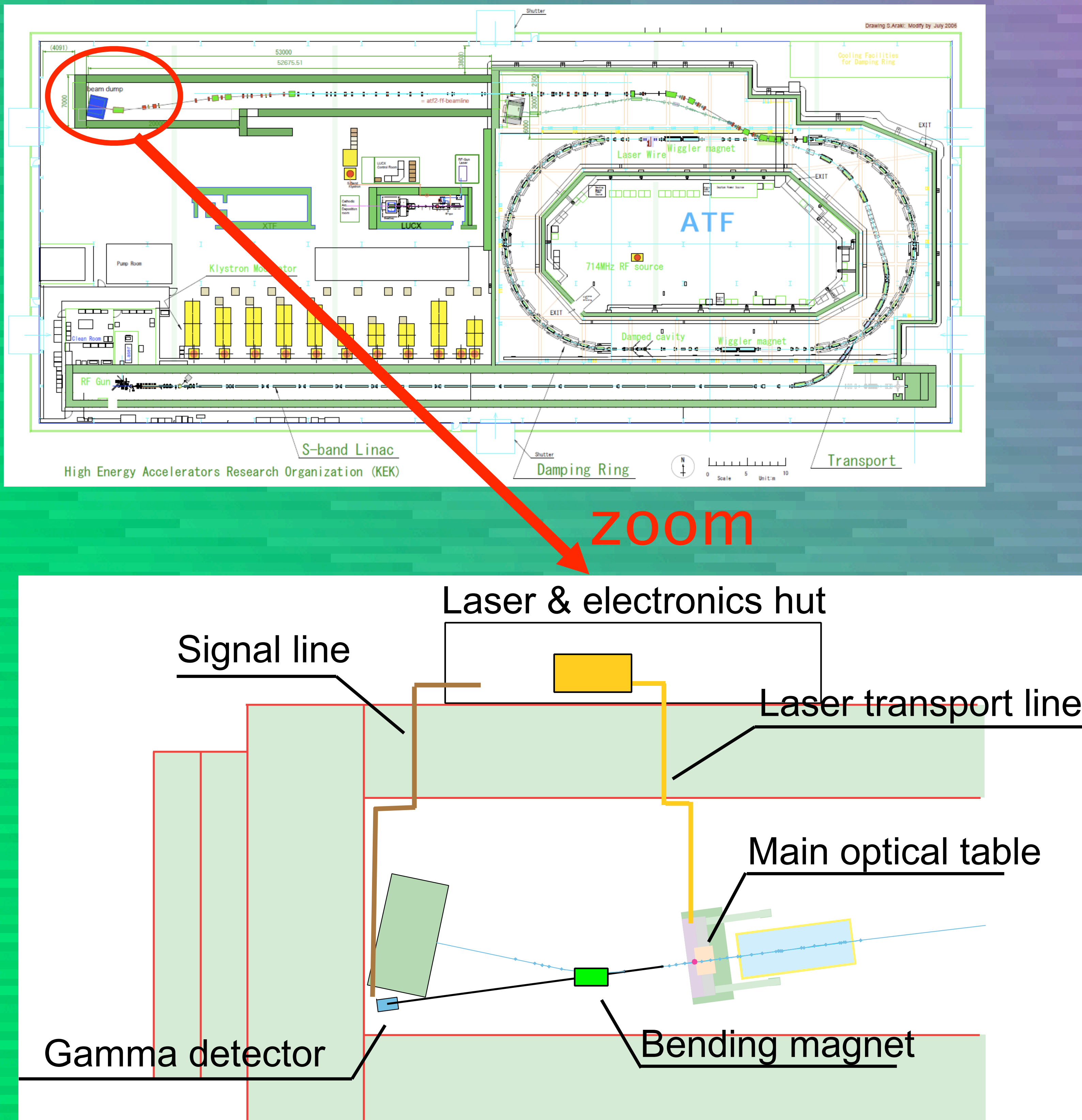
2) design QF and SF to revisit pocket field impact and assess beam pipe shape in shared region

3) Check design of super-conductive SD & QD

Schematic of Shintake Monitor



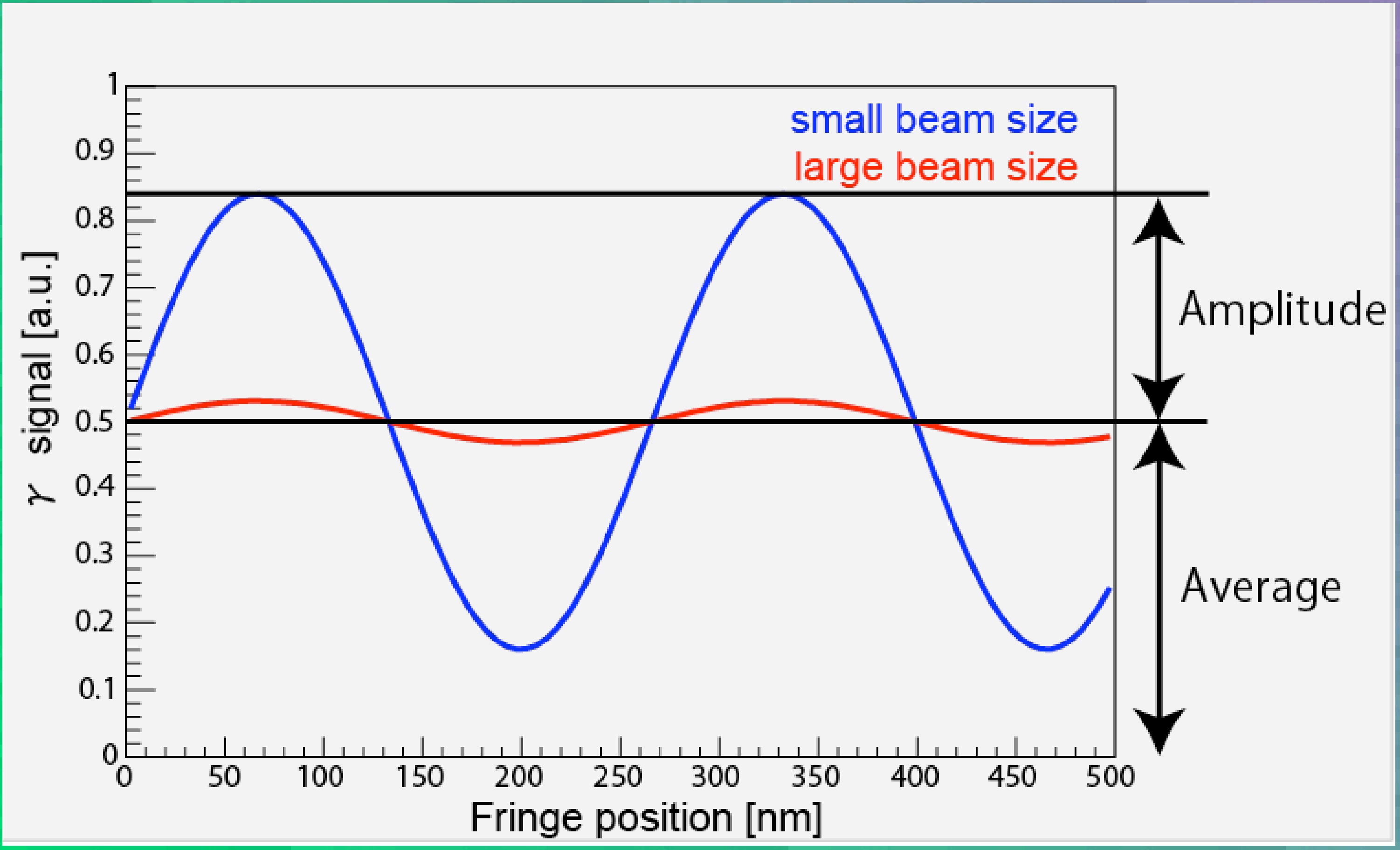
Layout and Components



Components:

- Laser
  - 532 nm wavelength
  - 40 MW, 8 ns FWHM
  - Single mode (90 MHz line width)
  - 10 Hz max.
- Laser transport line
  - About 15 m
- Optical table
  - 1.6 by 1.7 m
  - Independent support frame
- Gamma detector
  - CsI(Tl) multi layers
  - Gamma collimators
- Electronics

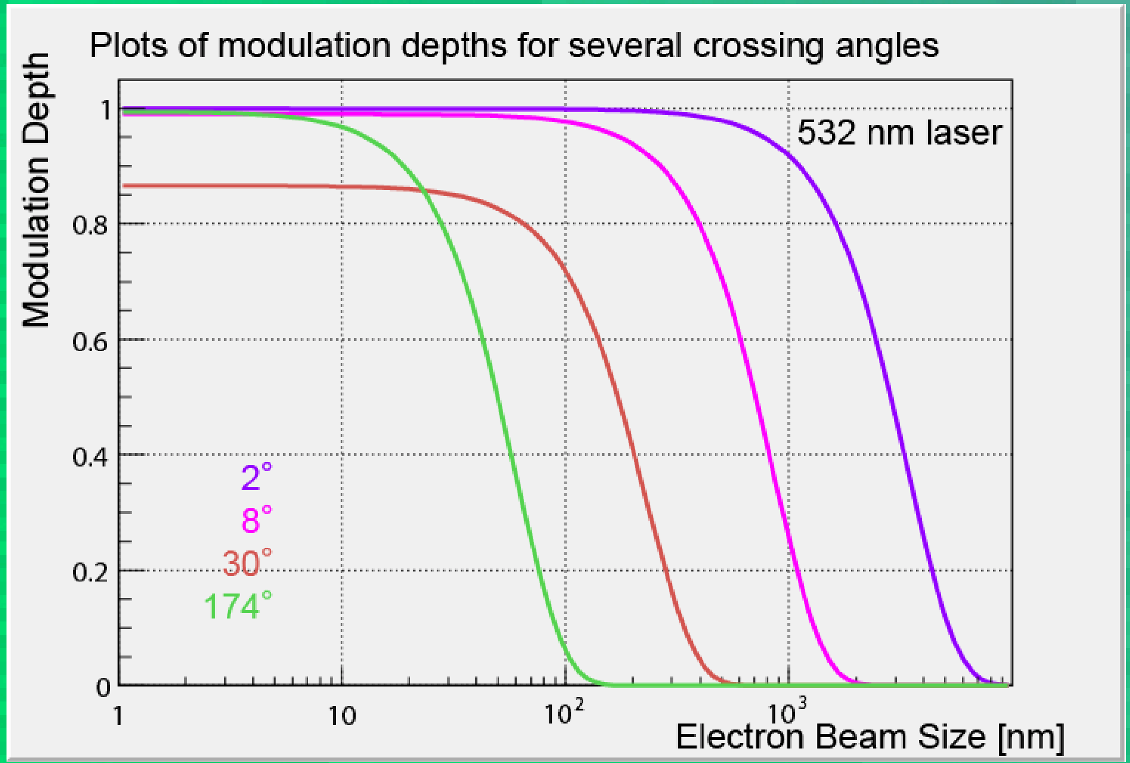
Modulation depth and Crossing angles



$$M = |\cos 2\phi| \exp\left[-2(k_y\sigma_y)^2\right]$$
$$(k_y = k\sin\phi)$$

M: modulation depth (amplitude / average)

φ: crossing angle



Crossing angles	Fringe pitch	Observable beam size
174°	266nm	25 – 100nm
30°	1.0μm	100 – 400nm
8°	3.8μm	0.4 – 1.5μm
2°	15.2μm	1.5 – 6.0μm

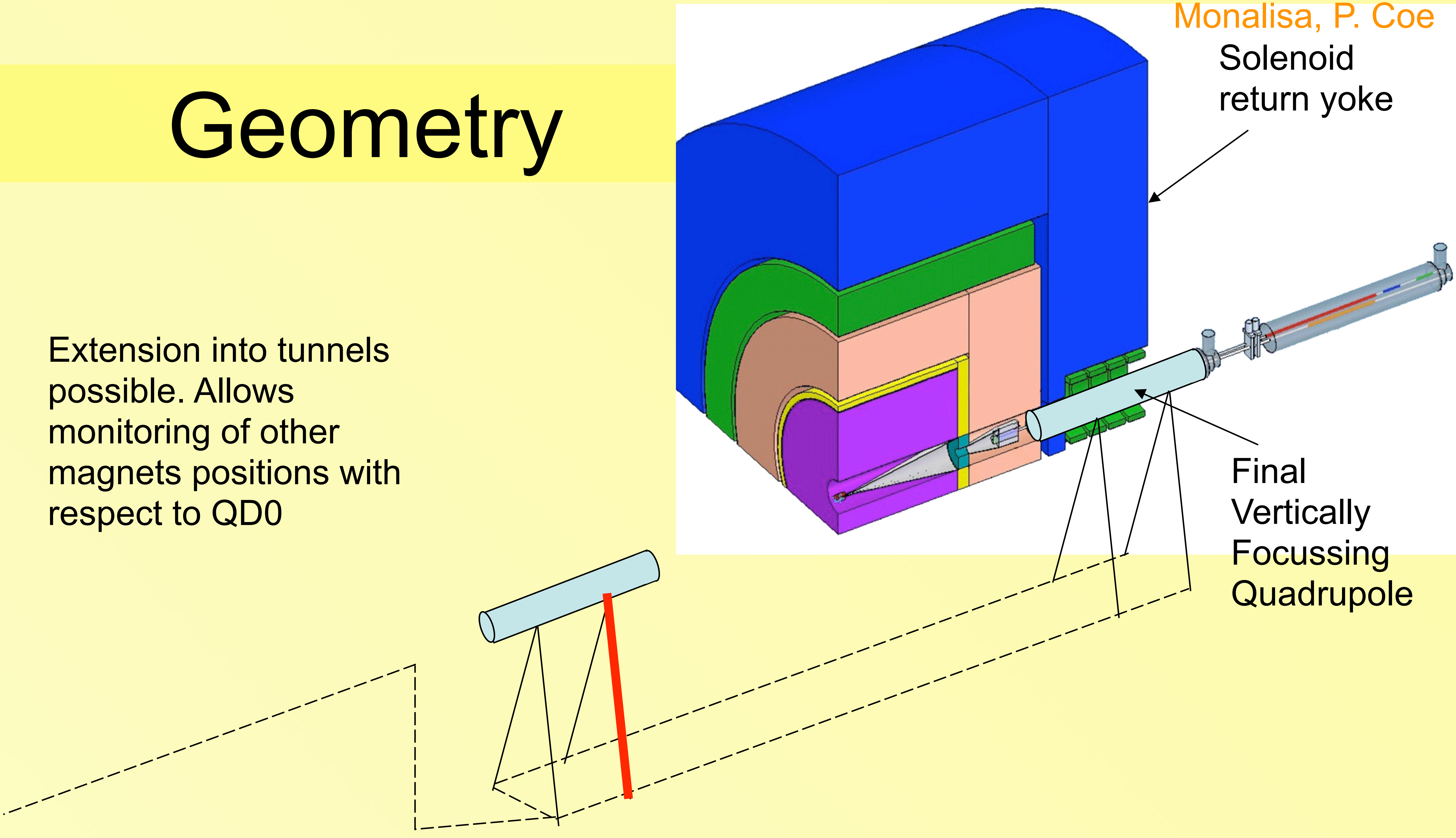
2, 8, 30, and 174 degrees are chosen to observe 25 to 6000 nm

MONALISA : Requirements

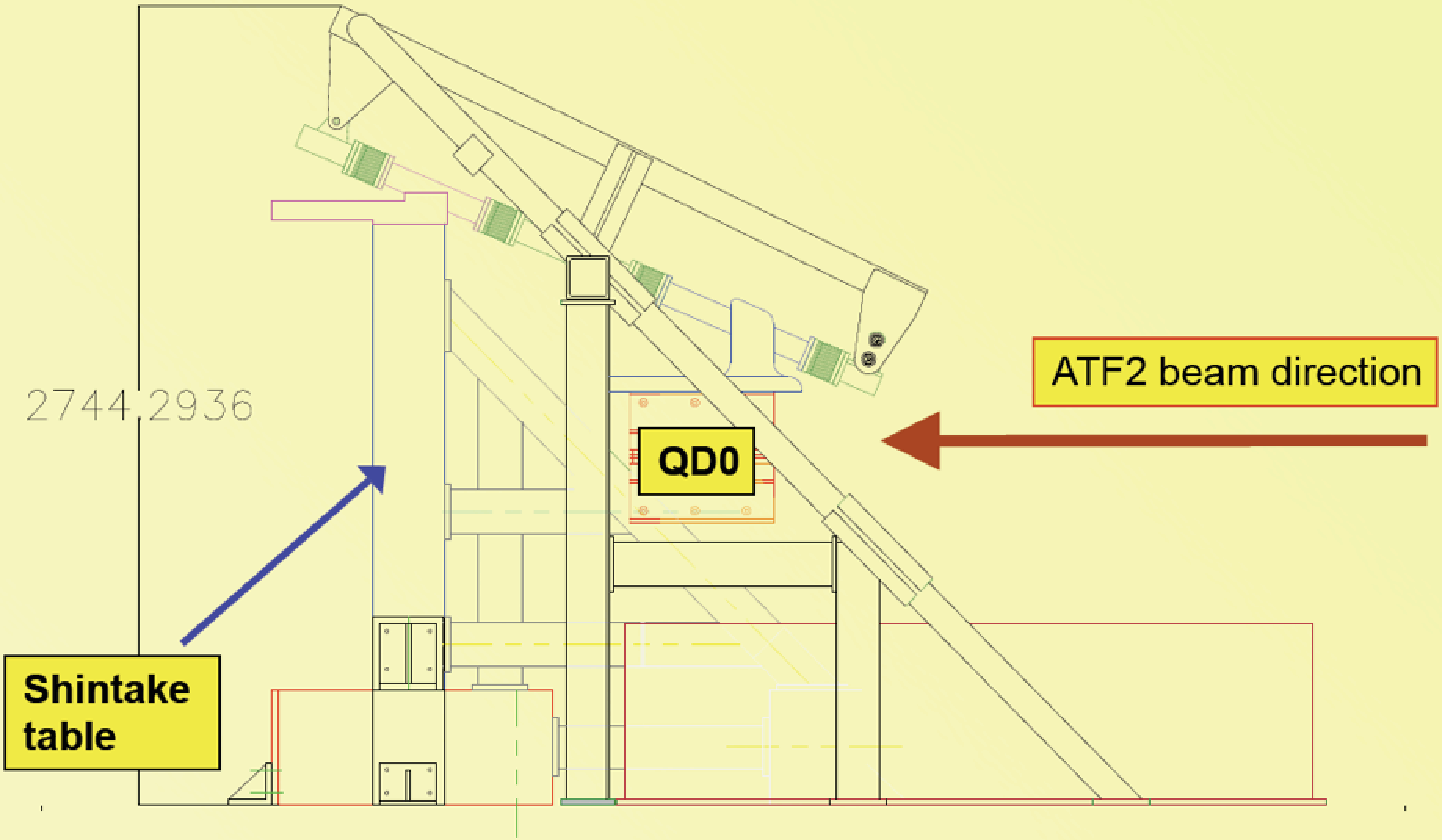
- The ideal for any survey/monitor system
  - measure distances along clear lines of sight
  - use evacuated narrow tubes
- MDI issues for detector LoI
  - issues broadly as discussed here at SENDAI in Tuesday MDI session
  - e.g. push pull vacuum connections

Geometry

Extension into tunnels possible. Allows monitoring of other magnets positions with respect to QD0

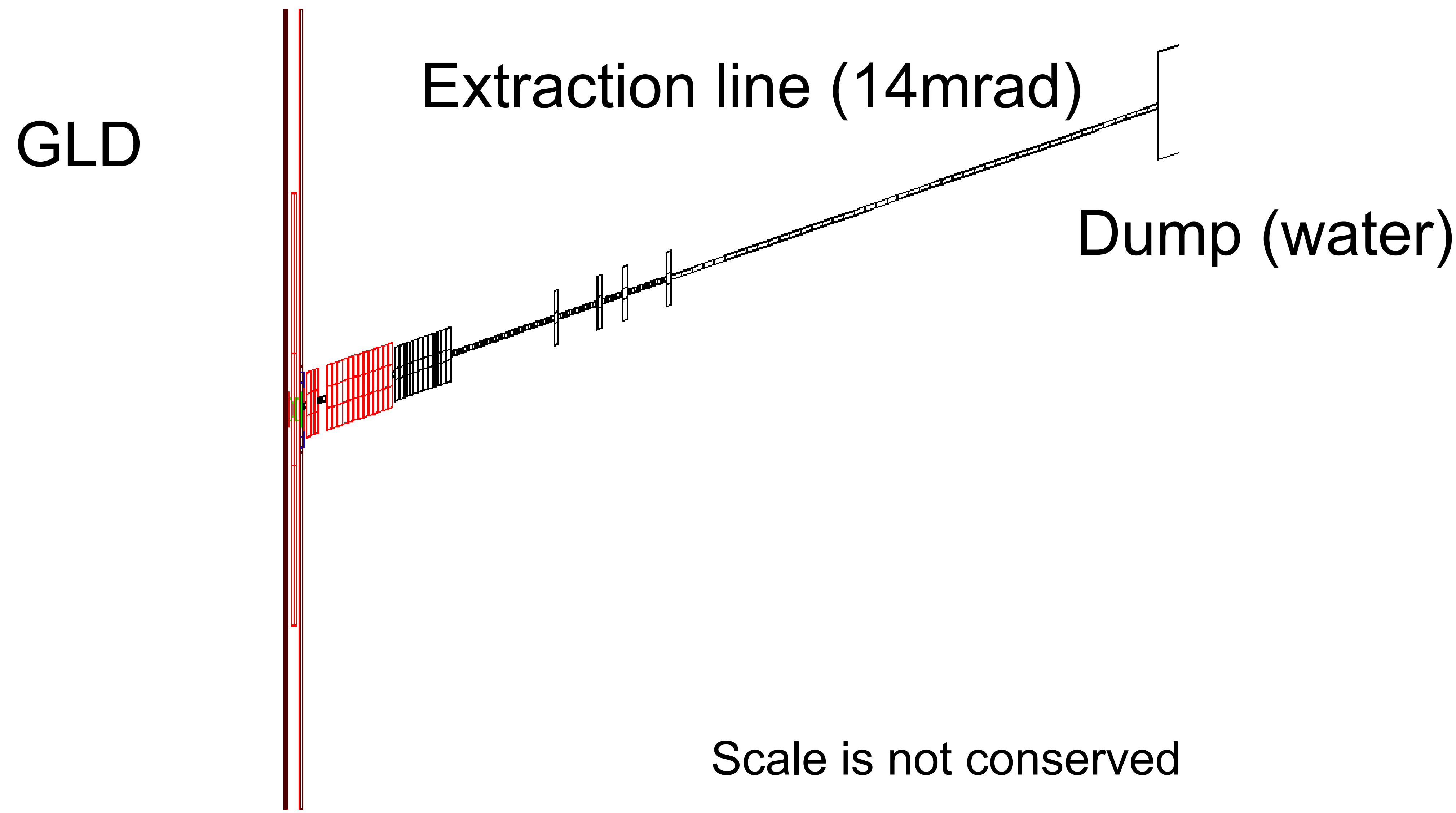


ATF2: Monitor relative vertical motion



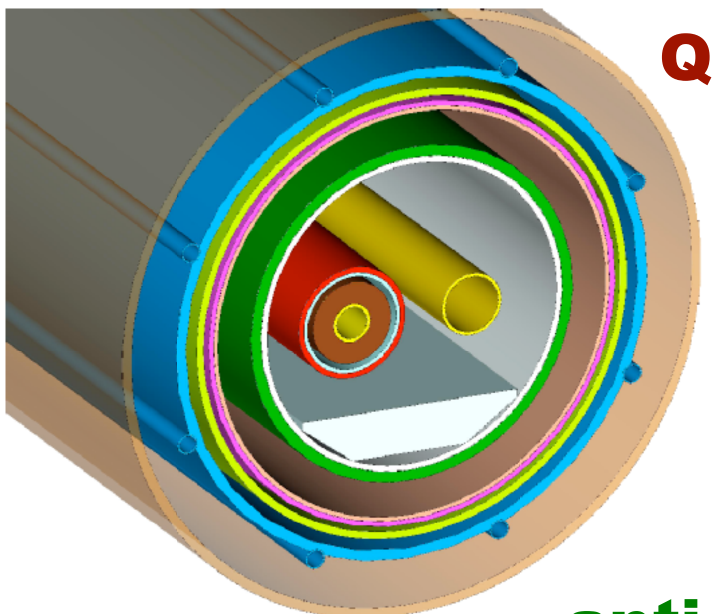
ATF2 extraction line: 08 Feb 2008

GLD + Extraction beam line



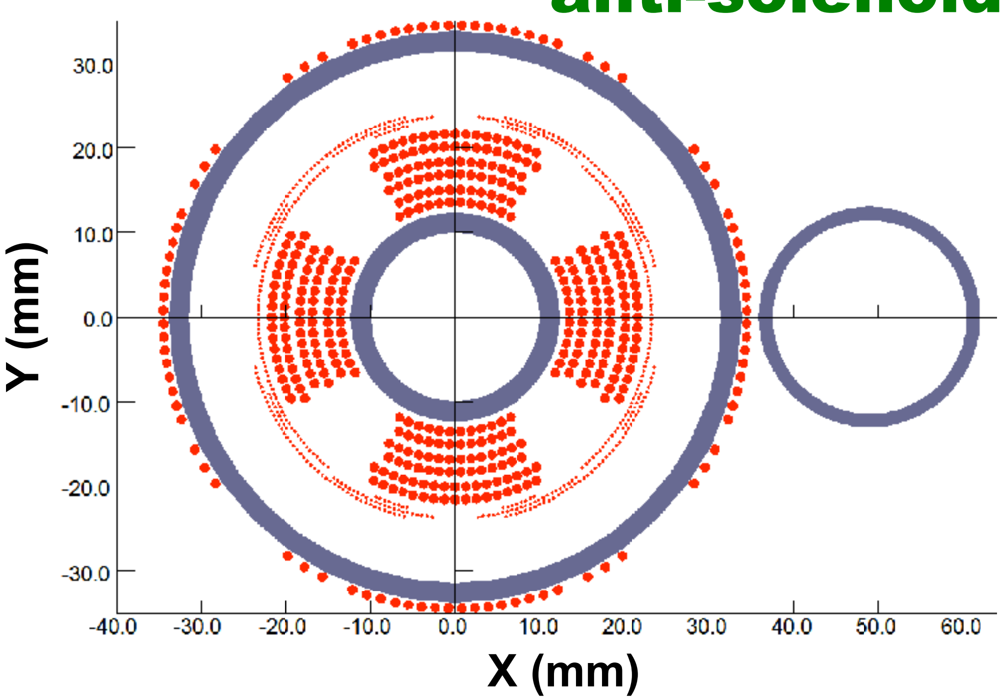
Scale is not conserved

Superconducting Final Focus for ATF2

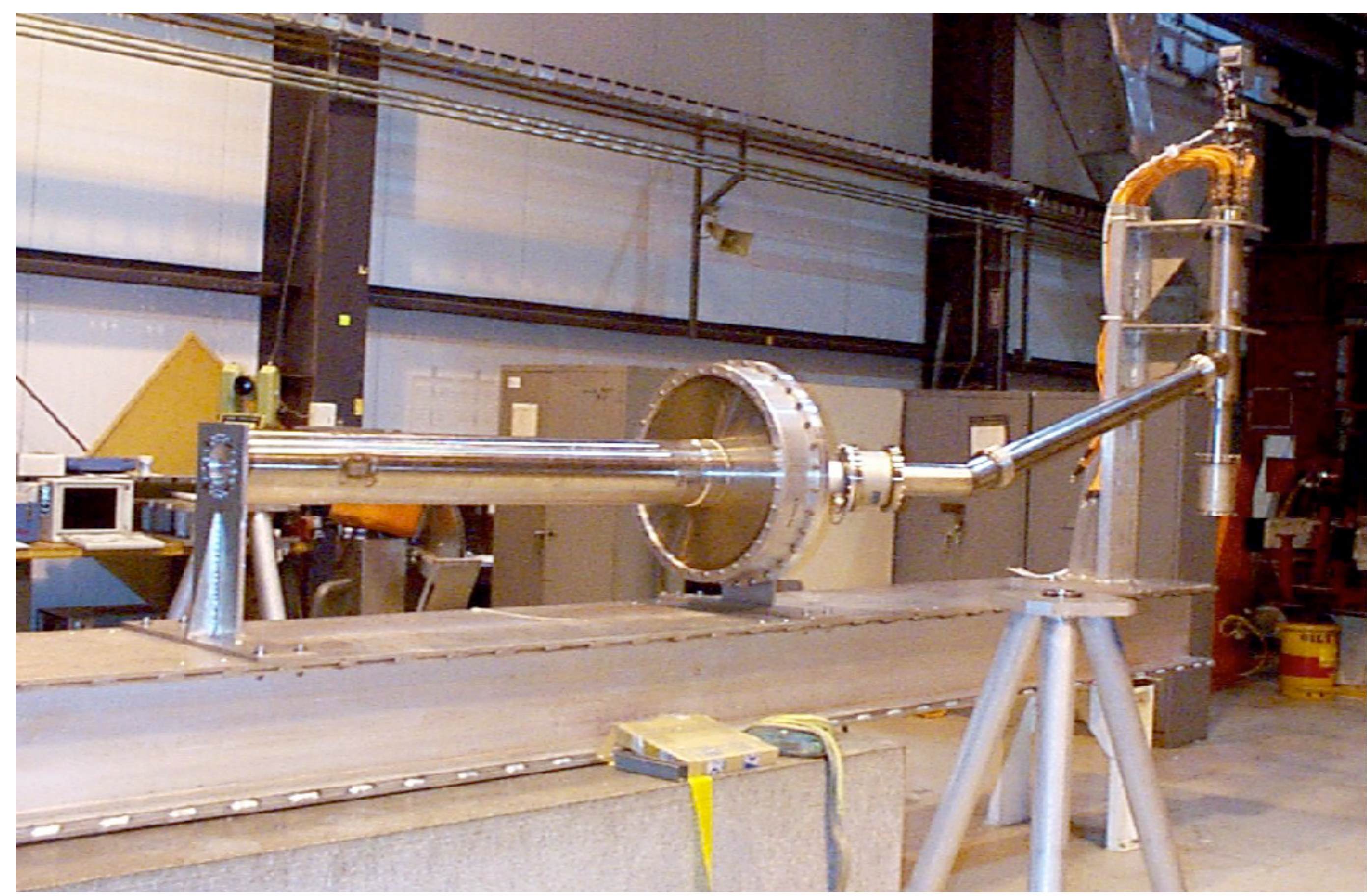


QD0 is self shielded.

Cryostat includes a force neutral anti-solenoid.



Brett Parker for the Superconducting Magnet Division at BNL



GG Style, HERA-II Upgrade Magnet

IR integration times scale

May 2008

GDE meeting, Dubna

June 2008

ECFA workshop

EPAC workshop

LCWS 2008, November. 2008

- Interface document, draft

LoI, April 2009

- Interface document

April 2009 to May 2010 (TDP-I)

- design according to interface doc.

May 2010: LHC and start of TDP-II

- design according to interface doc and adjust to specific configuration of ILC

1. Items which interface each concept to the BDS

push-pull time constraints
baseline IR hall model (dimension, crane, shafts etc) ILC CFS
QF1 support model
QD0 alignment specification
where is detector v.s. BDS dividing line
Pair monitor input to luminosity feedback system
Machine/detector DAQ compatibility
DID or Anti-DID or nothing?

2. Items which are unique to each detector concept and which must be mutually compatible for push pull

QD0 magnetic system (cryostat & feed boxes) for each L*
Shielding schemes : walls, PACMAN ILC/ILD team, Dubna
Motion system; platform versus rollers/air pads on floor Dubna
Cryogen distribution system Emmanuel Tsesmelis
Vacuum requirements and solutions Emmanuel Tsesmelis