Summary of MDI, Polarisation and $\gamma\gamma$-Tools

Karsten Buesser

ECFA Workshop

Warsaw

12. June 2008

Sessions and Talks

09:00->*10:30* **3. MDI** (Convener: Gudrid Moortgat-Pick (*IPPP Durham*) , Sabine Riemann (*Institut fuer Hochenergiephysik Zeuthen*) , Valery Telnov (*Budker INP, Novosibirsk*) , Philip Bambade (*Laboratoire de l"Accelerateur Lineaire (LAL) (IN2P3) (LAL)*) , Grahame Blair (*Royal Holloway*) , Karsten Buesser (*DESY*)) (Location: room B)

09:00	SiD/MDI Interfaces (20')	Marco Oriunno (*SLAC*)
09:20	4th MDI Issues (20')	John Hauptman (*Iowa State*)
09:40	ILD MDI Issues (20') (Slides)	Karsten Buesser (*DESY*)
10:00	Inclusion of Wake Fields via a BDSIM/Placet Interface (20')	Grahame Blair (*Royal Holloway*)
10:20	Position monitoring around the IP (10') (Slides)	David urner (*University of Oxford*)

11:00->*12:30* **3. MDI** (Convener: Gudrid Moortgat-Pick (*IPPP Durham*) , Sabine Riemann (*Institut fuer Hochenergiephysik Zeuthen*) , Valery Telnov (*Budker INP, Novosibirsk*) , Philip Bambade (*Laboratoire de l"Accelerateur Lineaire (LAL) (IN2P3) (LAL)*) , Grahame Blair (*Physics Department*) , Karsten Buesser (*DESY*)) (Location: room B)

11:00	Discussion about the IR Interface Document (1h30')	Thomas Markiewicz (*SLAC*)

14:00->*15:30* **3. Polarisation** (Convener: Gudrid Moortgat-Pick (*IPPP Durham*) , Sabine Riemann (*Institut fuer Hochenergiephysik Zeuthen*) , Valery Telnov (*Budker INP, Novosibirsk*) , Philip Bambade (*Laboratoire de l"Accelerateur Lineaire (LAL) (IN2P3) (LAL)*) , Grahame Blair (*Physics Department*)) (Location: room B) WebEx Instructions

Description:

This will be a webex session!!

14:00	Summary Report on the Workshop on Polarizarion and Energy Measurement (25') (Slides) (Talk will be given by webex)	Jenny List (*DESY*)
14:25	Spin tracking and beam-beam issues (20') (Hartin Polarization Talk) (Talk will be given via webex)	Anthony Hartin (*John Adams Institute*)
14:45	Status of the (polarized) positron source (25') (Slides)	Sabine Riemann (*Institut fuer Hochenergiephysik Zeuthen*)
15:10	Positron target modelling (20')	Stefan Hesselbach (*University of Durham*)

16:00->*18:30* **3. MDI + Gamma-Gamma Technologies** (Convener: Gudrid Moortgat-Pick (*IPPP Durham*) , Sabine Riemann (*Institut fuer Hochenergiephysik Zeuthen*) , Valery Telnov (*Budker INP, Novosibirsk*) , Grahame Blair (*Physics Department*) , Karsten Buesser (*DESY*)) (Location: room B)

16:00	Measurement of the differential luminosity using Bhabha events (20') (Slides)	André Sailer (*DESY*)
16:20	Beam energy measurement by means of Compton backscattering (20') (Slides)	Michele Viti (*DESY*)
16:40	Simulation of pair monitor (20')	Kazutoshi Itoh (*Tohoku*)
17:00	Beam parameters determination using Beamstrahlung photons and incoherent pairs (20') (Slides)	Andrey Sapronov (*DESY*)
17:20	The EM background environment for the IP feedback system (20')	Philip Burrows (*Oxford University*)
17:40	Status of the photon collider (20') (Slides)	Valery Telnov (*Budker INP, Novosibirsk*)
18:00	Status of the high-finesse Fabry Perot R&D at Orsay (20') (Slides)	Zhiqing Zhang (*LAL*) , Fabian Zomer (*LAL*)
18:20	Discussion on the photon collider (10')	all

14:00->*15:30* **3. Polarisation** (Convener: Gudrid Moortgat-Pick (*IPPP Durham*) , Sabine Riemann (*Institut fuer Hochenergiephysik Zeuthen*) , Valery Telnov (*Budker INP, Novosibirsk*) , Grahame Blair (*Physics Department*)) (Location: room D)

14:00	Calibration issues at the ILC (20')	Klaus Moenig (*DESY*)
14:20	Physics with calibration data (20')	Gudrid Moortgat-Pick
14:40	Discussion: use of calibration data for physics (20')	

- 510 mins of talks and discussions
  - 280 mins MDI
  - 180 mins Polarisation
  - 50 mins γγ-Tech
- Excellent talks, much progress
- Impossible to summarise everything in 15 mins
- My very personal selection:
  - IR interface issues
  - Polarisation
  - γγ-Tech

Machine Detector Interface

IR Interface Document

CHALLENGES AND CONCEPTS FOR DESIGN OF AN INTERACTION REGION WITH PUSH-PULL ARRANGEMENT OF DETECTORS – AN INTERFACE DOCUMENT*

B.Parker (BNL), A.Herve, J.Osborne (CERN), A.Mikhailichenko (Cornell Univ.), K.Buesser (DESY), B.Ashmanskas, V.Kuchler, N.Mokhov (Fermilab), A.Enomoto, Y.Sugimoto, T.Tauchi, K.Tsuchiya (KEK), J.Weisend (NSF), P.Burrows (Oxford Univ.), T.Markiewicz, M.Oriunno, A.Seryi, M.Sullivan (SLAC), D.Angal-Kalinin (STFC), T.Sanuki, H.Yamamoto (Tohoku Univ.)

Abstract

Two experimental detectors working in a push-pull mode has been considered for the Interaction Region of the International Linear Collider [1]. The push-pull mode of operation sets specific requirements and challenges for many systems of detector and machine, in particular for the IR magnets, for the cryogenics system, for alignment system, for beamline shielding, for detector design and overall integration, and so on. These challenges and the identified conceptual solutions discussed in the paper intend to form a draft of the Interface Document which will be developed further in the nearest future. The authors of the present paper include the organizers and conveners of working groups of the workshop on engineering design of interaction region IRENG07 [2], the leaders of the IR Integration within Global Design Effort Beam Delivery System, and will also include representatives from each detector concept submitting th… Letters Of Intent.

http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/ir/

INTRODUCTION

The process of finding an acceptable … for Interaction Region involves … between complex and often co… …ents coming from machine or dete… …ocument was thought as a way … …e achieved agreements and ass… …as the way to highlight existing … …ocus the efforts for their resolutio… …s the present Interface Document … …ntity. The first attempt of creatio… …ocument was undertaken at the IR… …he paper presented represents the … …ill be further developed as an integral … …paration.

FUNCTIONAL REQUREMENTS

In this section, the minimal functional requirements, to which all detector concepts are bound, are summarized. These requirements are closely related to fundamental properties of design and less dependent on site location and similar specifics. In contrast, the next section will describe more detailed specification and outline the present working models and likely technical solutions.

The list of minimal functional requirement starts with the need to have two detectors in a single collider hall, able to work in turns, in push-pull mode.

The speed of push-pull operation is the first defining assumption. We set as the goal that hardware des… should allow the moving operation, reconnectio… possible rearrangements of shielding to be perf… few days, or less than a week.

The range of detector sizes consid… include detectors with half size of … …ng optimally if the IP to start… …e (L* parameter) would be in … …5 meters (different L* is allowed … …rs), while the distance from IP t… …upole QF1 is 9.5 meters, which … …eters of the design, including th…

The … …r is shifted in transverse direc… …ition, located 15m from the IP. T… …agnetic environment, suitable for … the off-beamline detector during beam … to be guaranteed by the beamline detector … chosen solution.

… IR and detector design is to satisfy the beam …ameters defined in the RDR [1] including nominal, Low N, Large Y and Low P parameter sets.

INTERFACE SPECIFICATIONS

The superconducting final doublets, consisting from QD0 and QF1 quadrupoles (and associated sextupoles SD0 and SF1) are grouped into two independent cryostats, with QD0 cryostat penetrating almost entirely into the detector. The QD0 cryostat is specific for the detector design and moves together with detector during push-pull operation, while the QF1 cryostat is common and rests in the tunnel.

Radiation shielding is essential with two detectors occupying the same Interaction Region hall. Detector should either be self-shielded or need to assume responsibility for additional local fixed or movable shielding (walls) to provide area accessible for people near the second detector when the first is running with beam. The radiation criteria to be satisfied are for normal operation and for accident case. In the normal operation, the dose anywhere near non-operational second detector should be less than 0.05mrem/hour. In the accident case the dose should be less than 25rem/h for maximum credible beam (simultaneous loss of both e+ and e- beams anywhere near the IP, at maximum beam power), and the

*Work supported in part by US DOE contract DE-AC02-76-SF00515.

- Discussion of IR Interface Document and especially the minimal functional requirements has just started within the MDI group
- Minimal requirements should set as few boundary conditions as possible but as many as needed to allow a successful development of the push-pull scheme

Minimal Requirements (T. Markiewicz)

- IP parameter range set by ILC Project Mgmt
- Hall width on beamline set my mandated 9.5m L* of QF1
- Garage position begins at a fixed distance from the beamline (15m?)
- Bare reinforced floor and bare walls in ±15m around beamline, all required services enter and exit with detectors
- Radiation and magnetic environment in garage zone to be guaranteed on levels by the beamline detecor using their chosen solution
- Time elapsed for push/pull consistent with chosen solutions
- QD0 support alignment range, accuracy, stability set by BDS
- all other compatibility problems to be solved on inter-concept bi-lateral discussions

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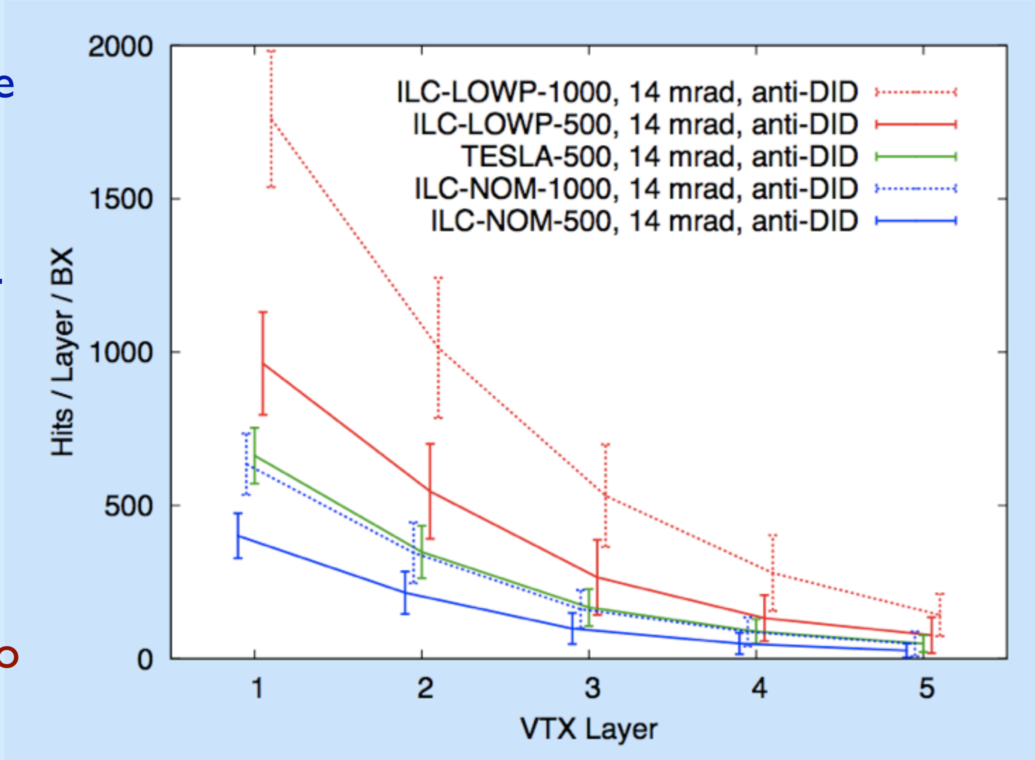
Problem:

- Most concepts optimise their interaction region just for the nominal beam parameter sets
- ILC-RDR describes parameter plane with some example sets, e.g.:
    - Nominal, Large-Y, Low-P
- Some of these sets (especialle Low-P) have nasty consequences for backgrounds

Result of Discussion:

- Concepts should be reminded that in principle they need to optimise to all parameter sets
- ILC PMs will be addressed to verify this assumption

LDC Vertex Backgrounds



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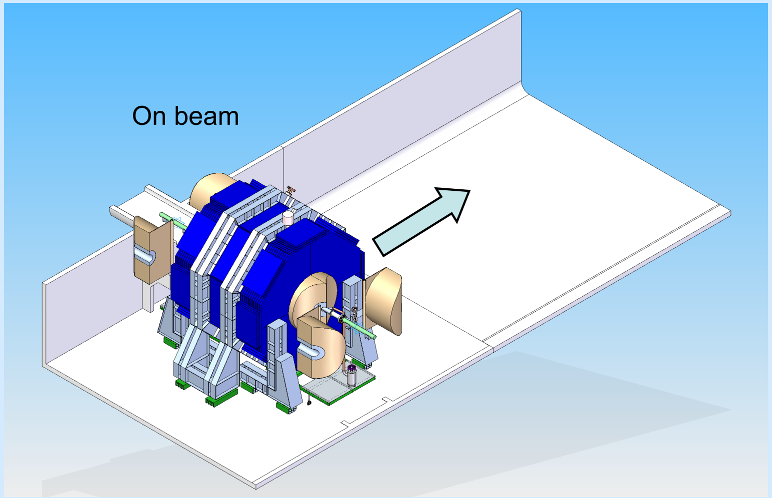
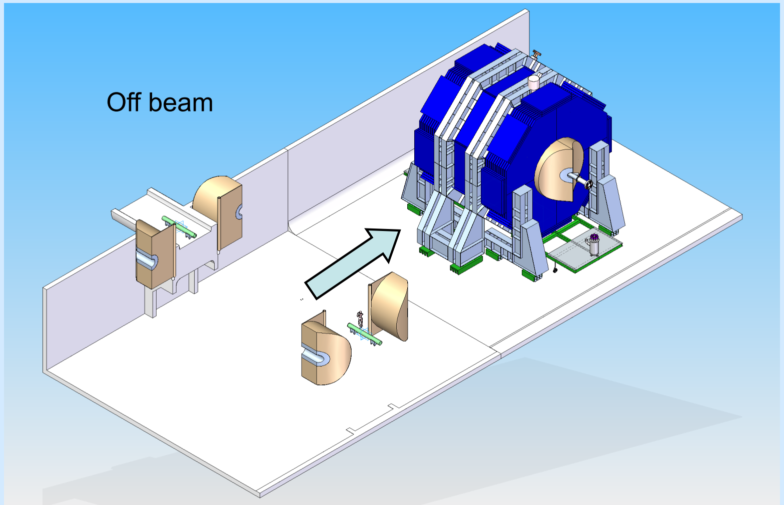
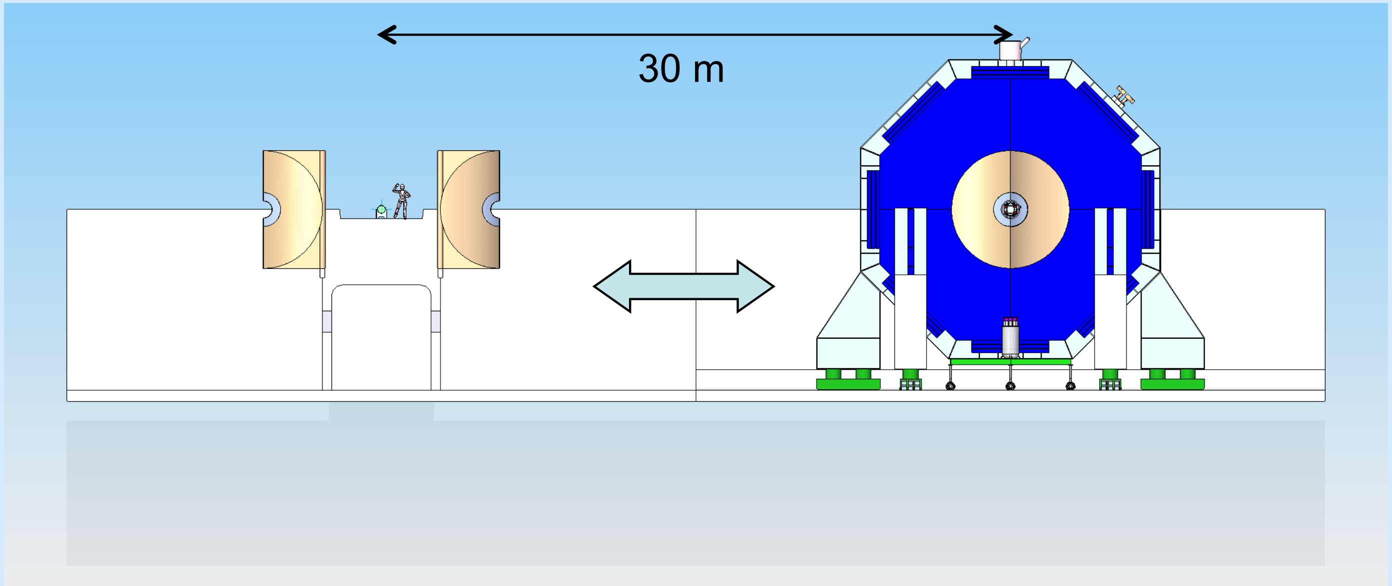
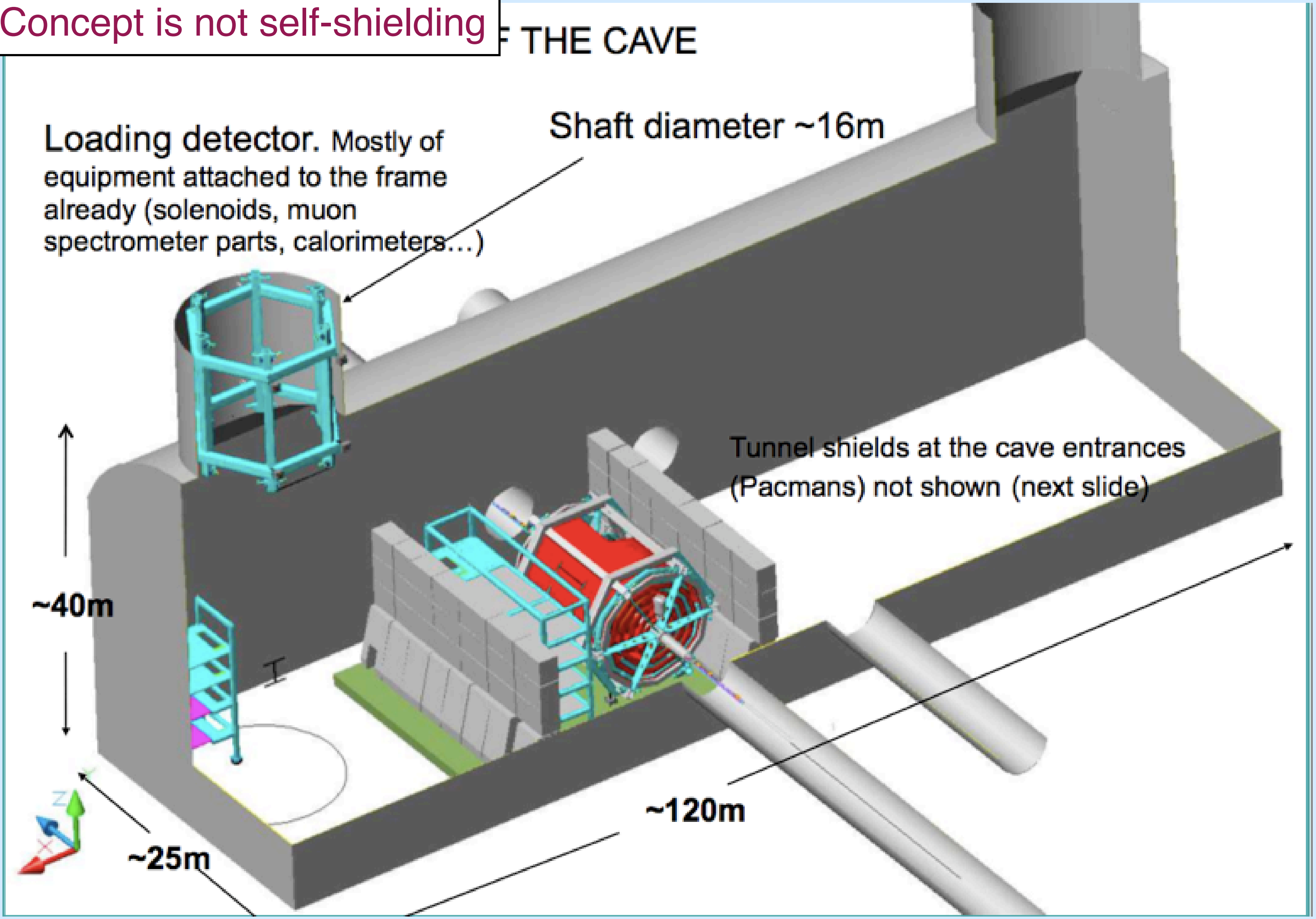






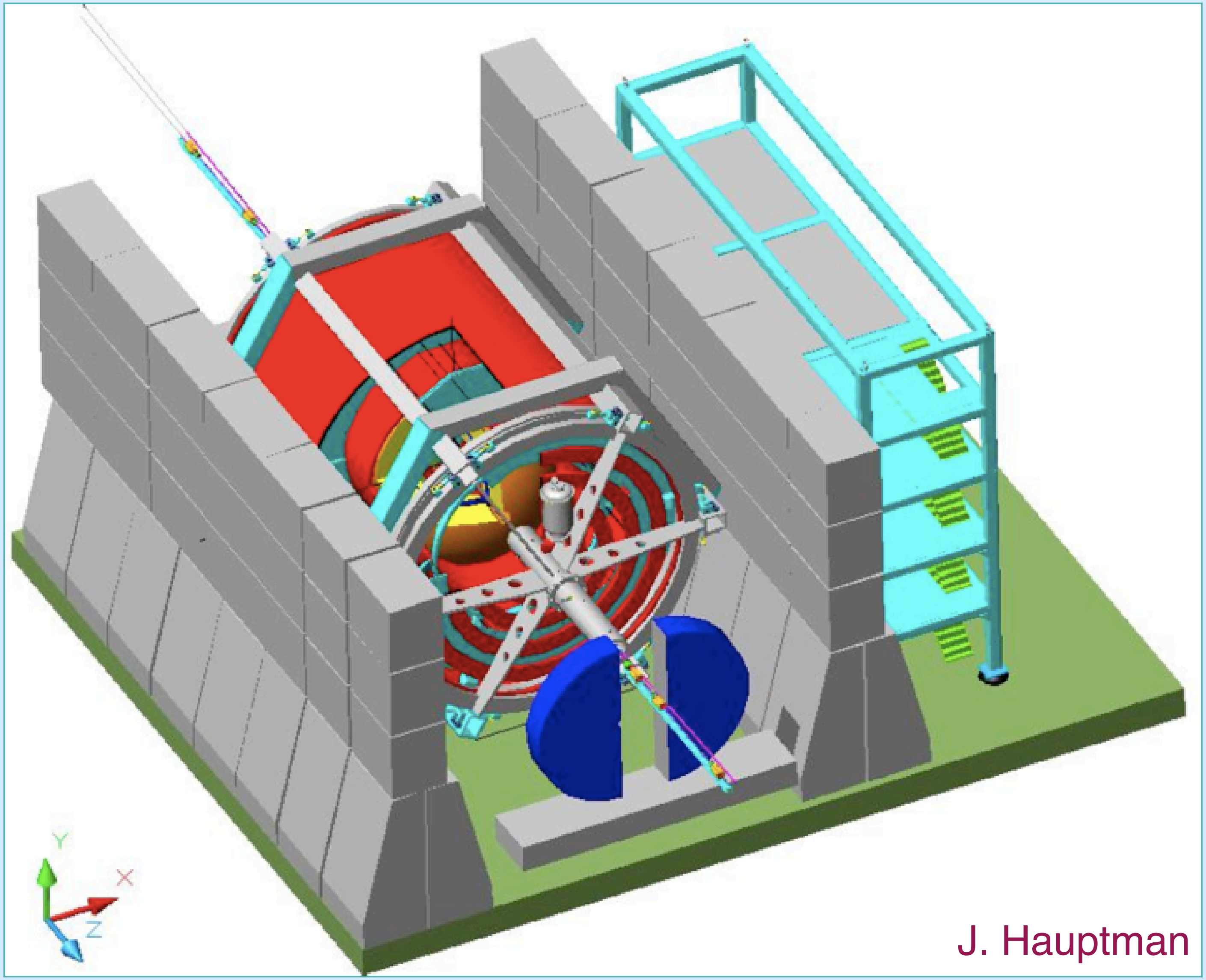
M. Oriunno

4th Concept is not self-shielding

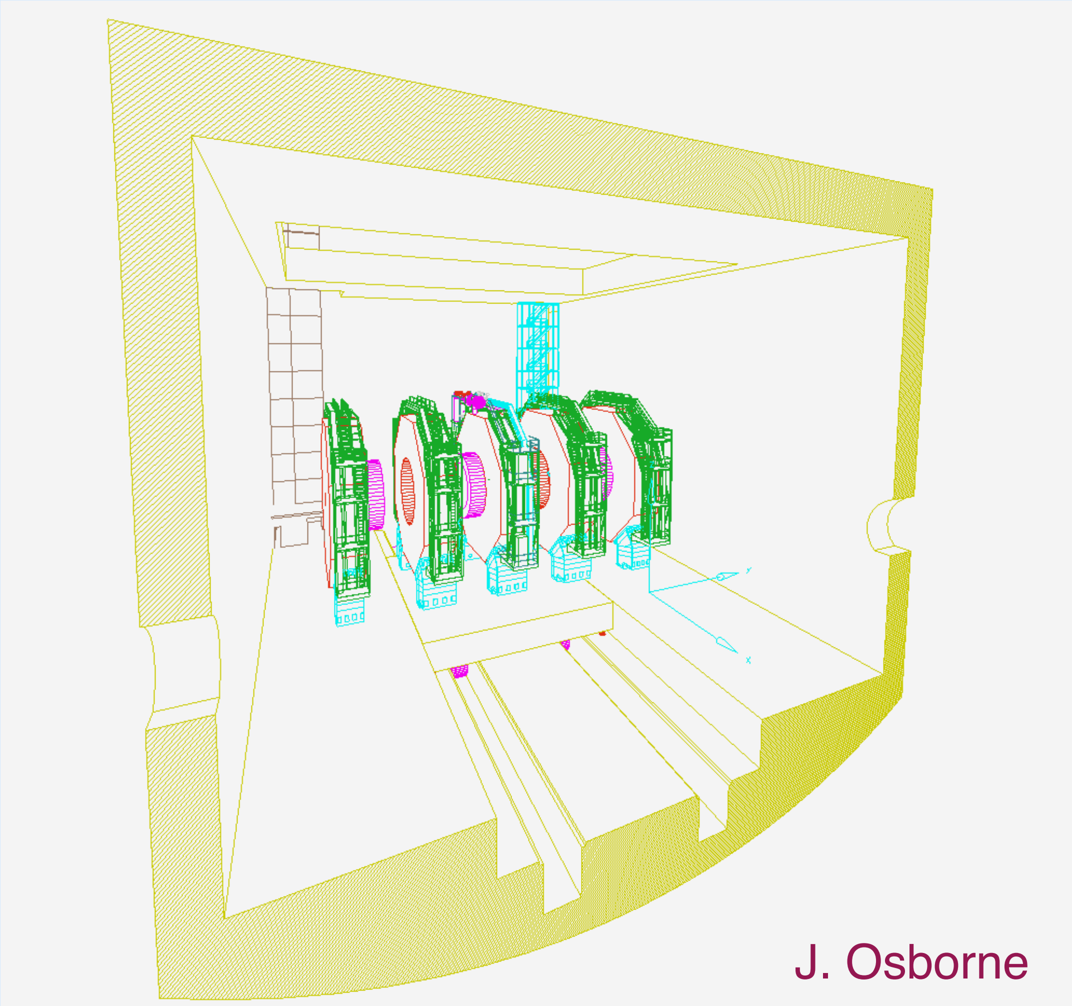


J. Hauptman

4th Shielding and Platform



Push-pull: Platform or not?



- A platform might be a good but expensive idea
- Maybe the detector could be stable enough to be moved on air pads w/o the need for a platform
- Concepts follow different approaches

Mechanical Boundaries

T. Markiewicz's Proposal:

- Hall width on beamline set my mandated 9.5m L* of QF1
- Garage position begins at a fixed distance from the beamline (15m?)
- Bare reinforced floor and bare walls in ±15m around beamline, all required services enter and exit with detectors

Result of Discussion:

- IR hall extent along the beamline
  - The statement should be modified to say that the design should be COMPATIBLE with an L* of 9.5m for the QF magnets.
- Delineation of garage position
  - ILD and SiD were comfortable with a working boundary at 15m transverse to the beamline.
  - 4th Concept is to consider how much space they need and provide the number.
- The transverse extent of the garage area will not be considered (for now) in the interface document.
- Bare floor ... walls within +-15m transverse to beamline
  - The word' reinforced' will be removed, as the whole floor will likely need to be reinforced.

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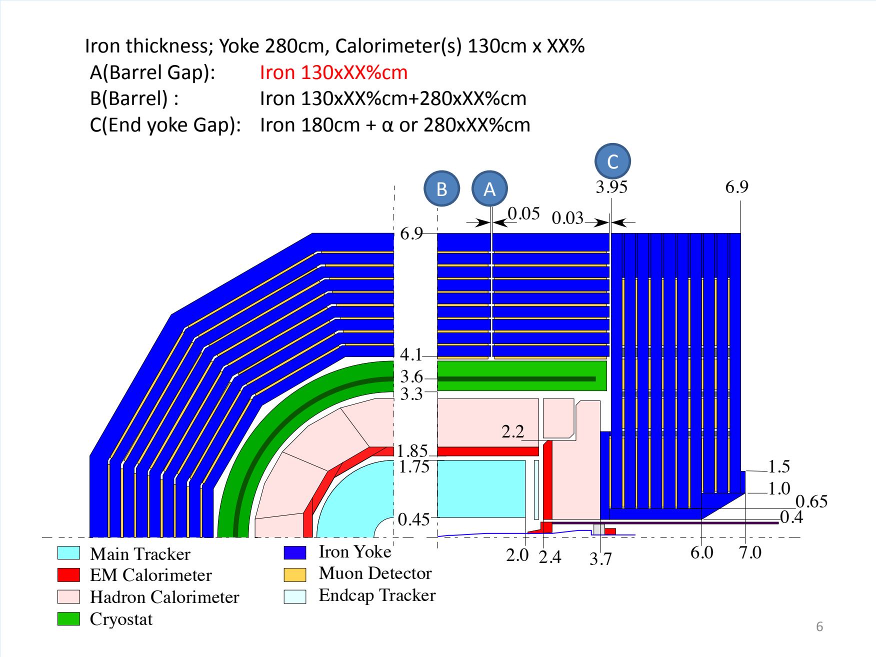
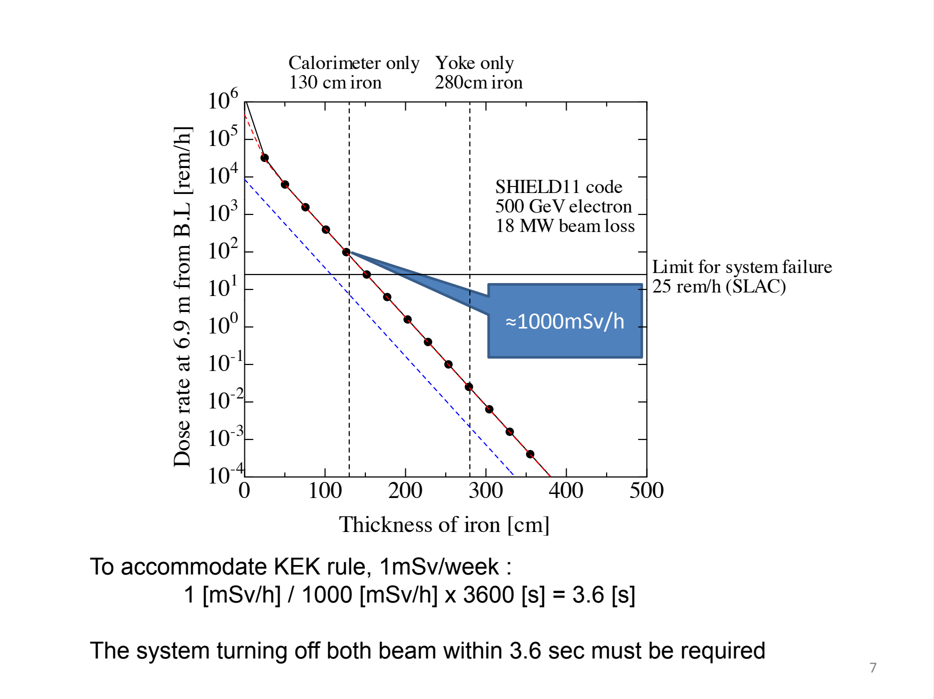
Radiation Protection

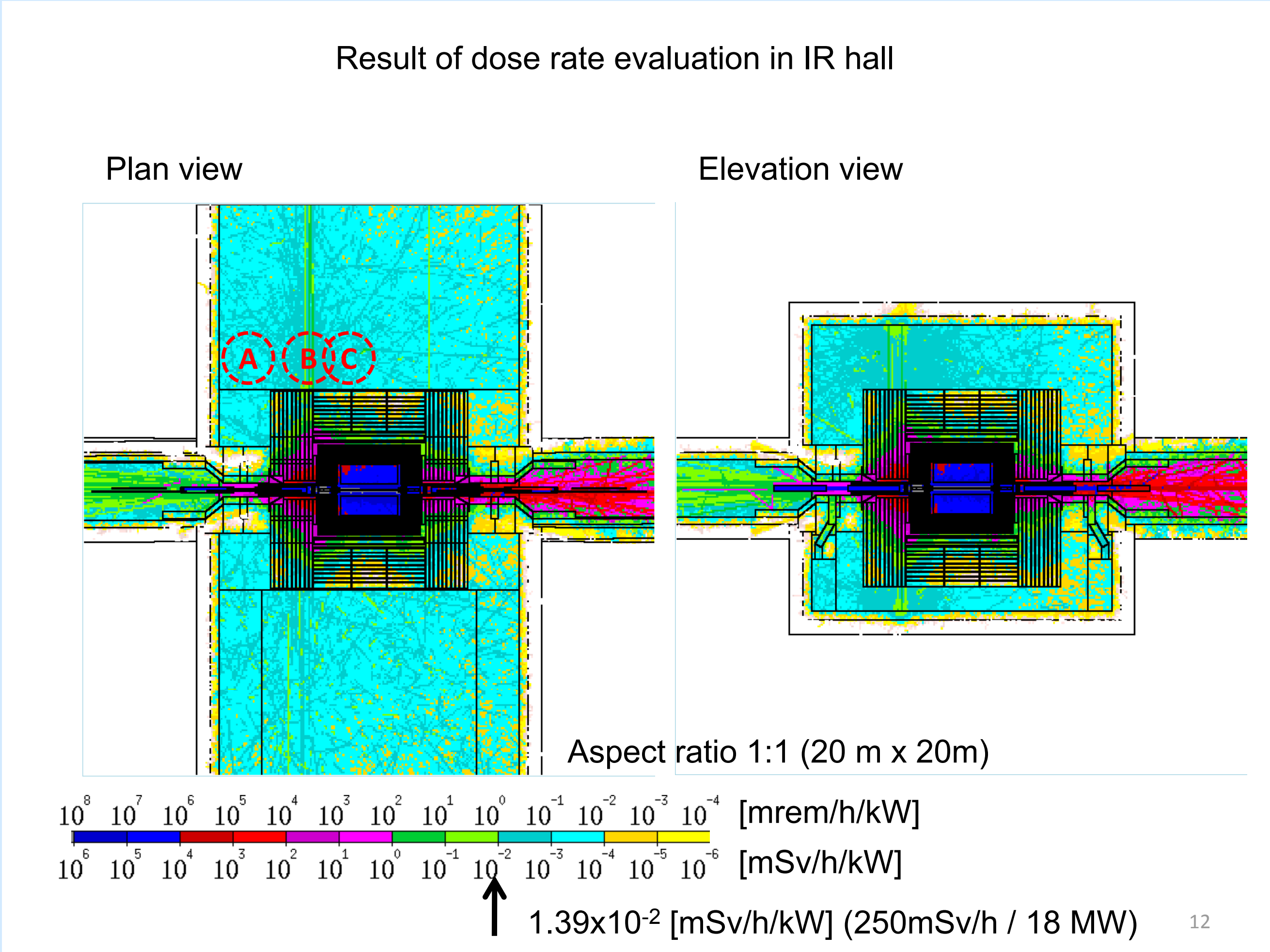
- Simulations done at KEK
- Limit at KEK (mis-steering beam loss): 1 mSv/week
- Limit at SLAC (system failure): 250 mSv/h, 30 mSv/event
- Limit at LHC (total beam loss): 50 mSv/h





- Empirical formula (top) and 3d simulations

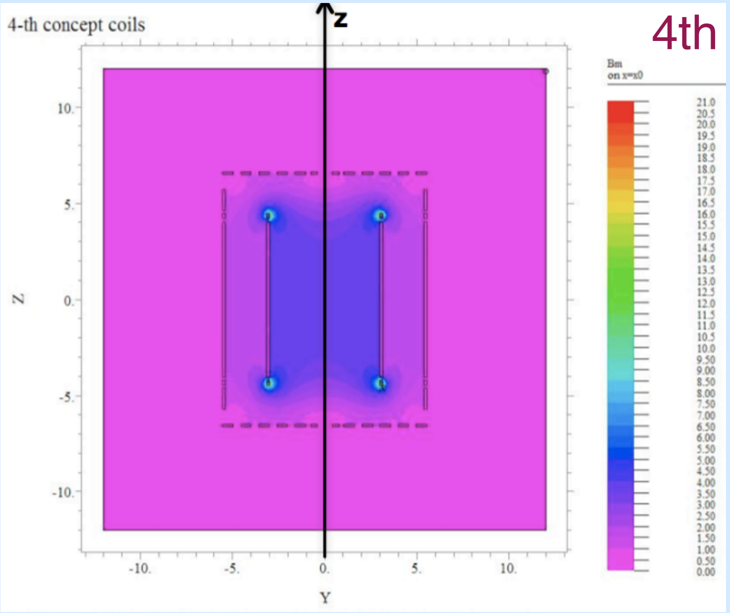
3d Simulations



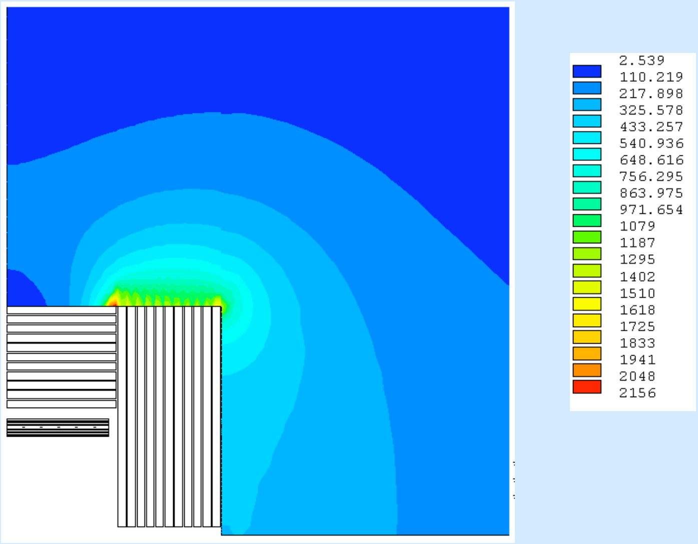
- Self-shielding detector should be possible
- add concrete layer if necessary

Magnetic Stray Fields

4th

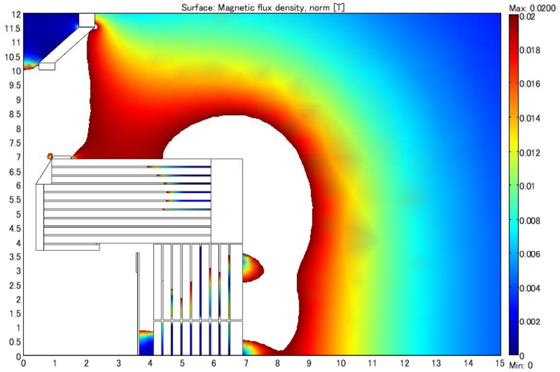


SiD

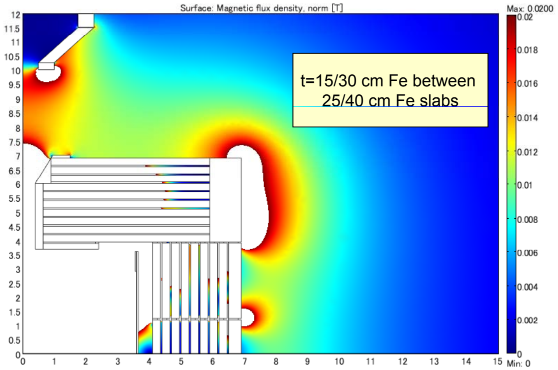


ILD

GLDc



Gap partially filled with Fe



T. Markiewicz's Proposal:

- Radiation and magnetic environment in garage zone to be guaranteed on levels by the beamline detecor using their chosen solution

Result of Discussion:

- To be guaranteed by each concept to be below the agreed levels, to be specified. The range of values is under discussion.

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Push/Pull Time

- What time should be allowed for the push/pull operation?
  - Needs to be defined otherwise people will design the system for the safest but slowest possible solution
- Times need to be defined:
  - just mechanical movement, hook-up to cryo, etc?
  - include times for position survey?
  - include beam commissioning time?
  - include calibration time?
- Discussion converged to $\mathcal{O}$(3d) for the mechanical parts (movement, survey)

- NB: this is linked to the overall push-pull strategies
  - measurement mode
  - discovery mode

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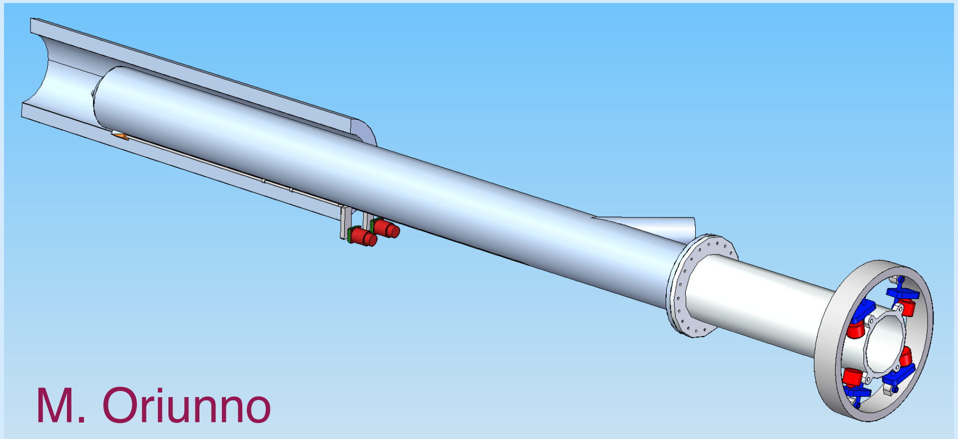
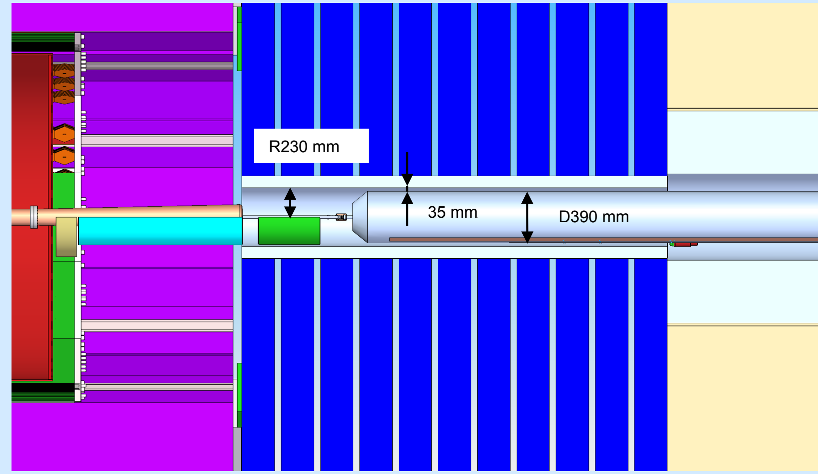
QD0 Support and Stabilisation

QD0 Support at SiD:

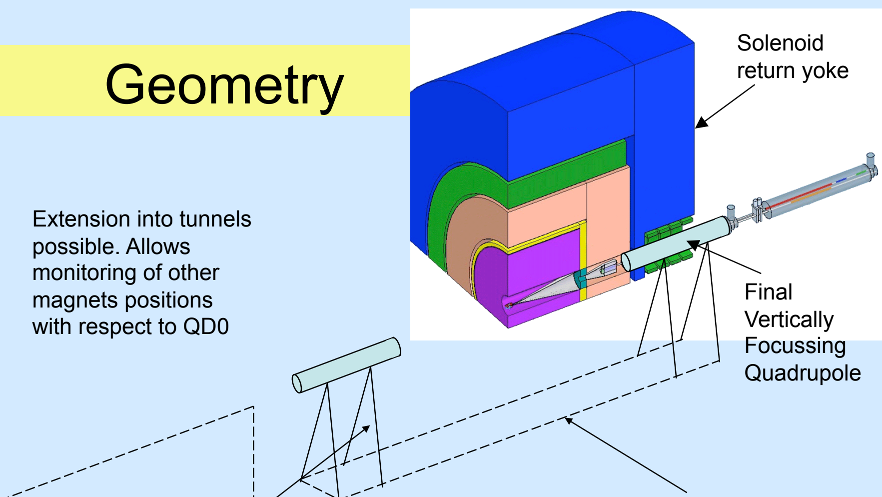


M. Oriunno



Position monitoring with MONALISA:

Geometry

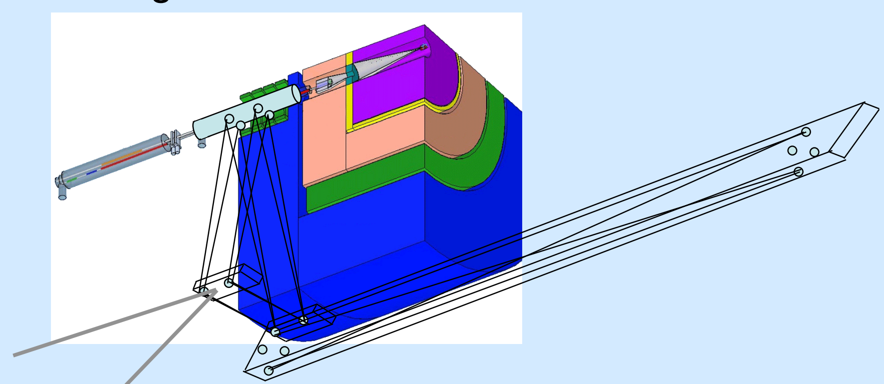


Extension into tunnels possible. Allows monitoring of other magnets positions with respect to QD0

Lines situated in return yoke of detector

Compact Straightness monitors buried in floor

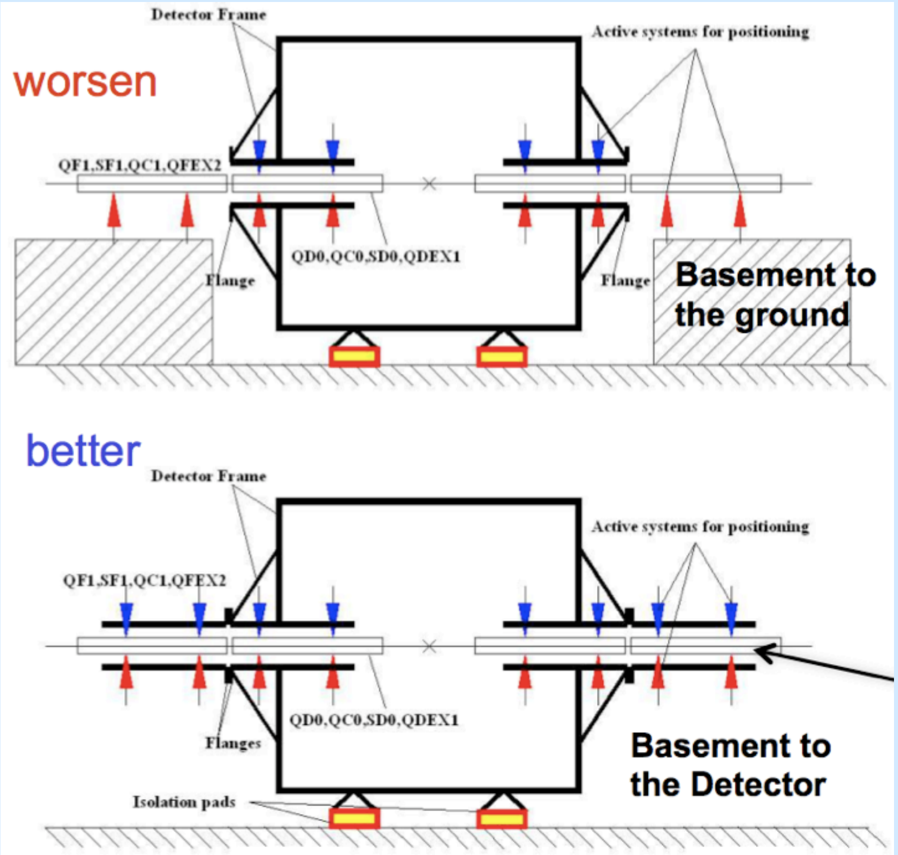
Straightness Monitors Attached to Detector

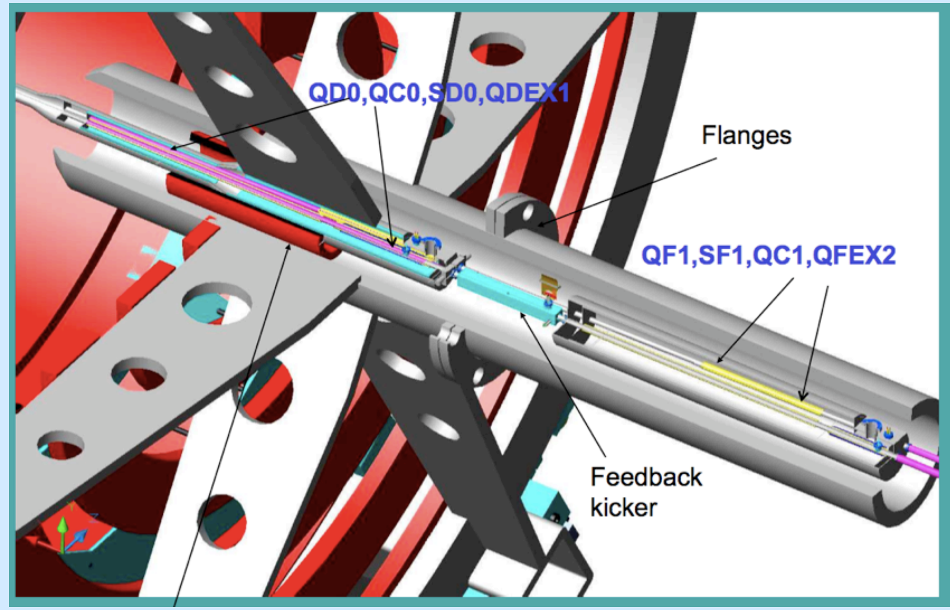


MONALISA lines to floor/wall
- Through air
- Order 1 micron absolute resolution good enough for repositioning detector

D. Urner

QD0/QF1 support: 4th approach





- ILC Baseline: QD0 supported by detector, QF1 is in the tunnel
- 4th proposal: support both quadrupoles from detector
    - Discussion with ILC-BDS group is needed

T. Markiewicz‘s Proposal:

- QD0 support alignment range, accuracy, stability set by BDS

Result of Discussion:

- Each concept to provide a QD0 alignment system, and take responsibility for providing the machine with alignment information for QD0 in a common format/interface (to be determined).

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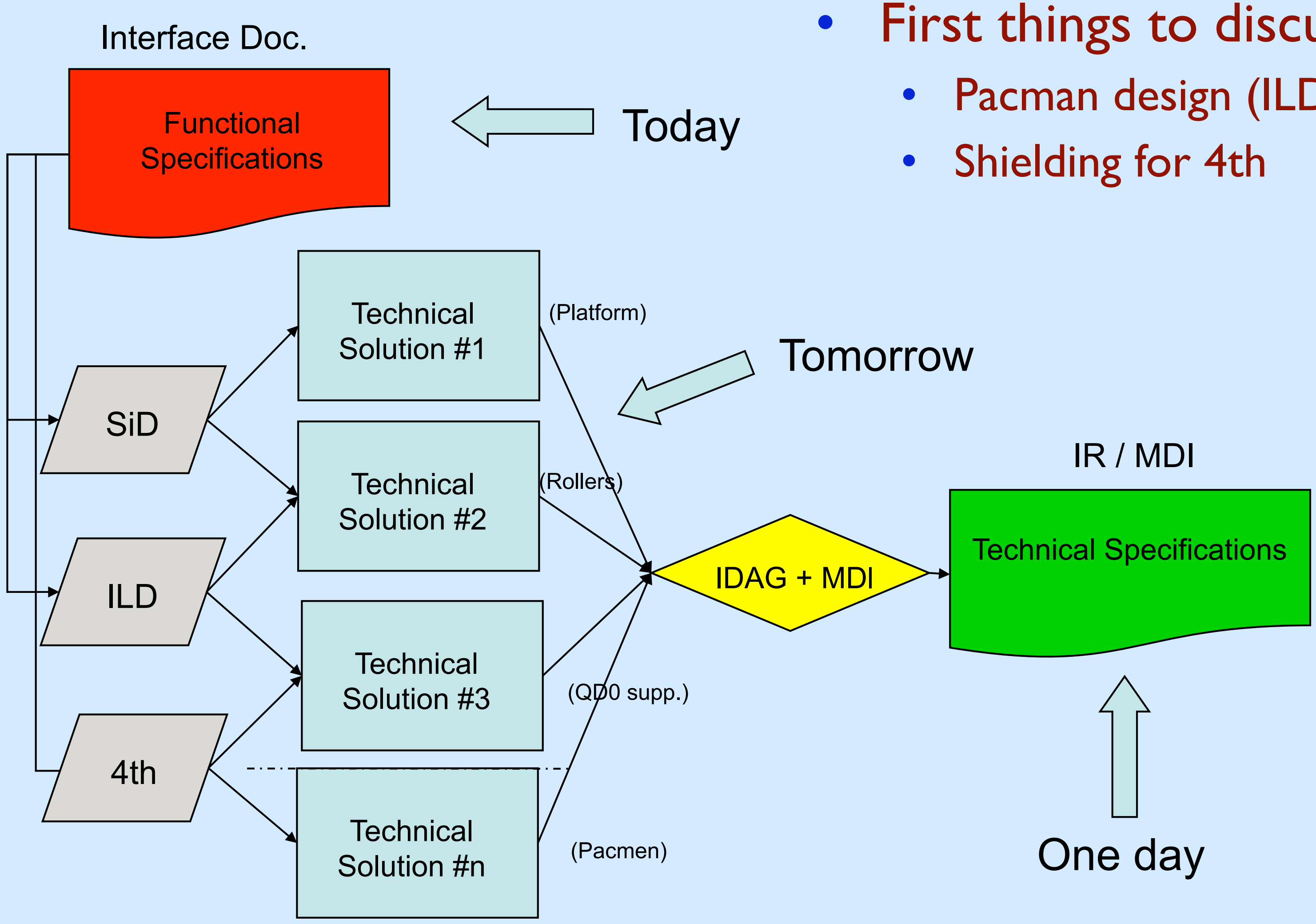


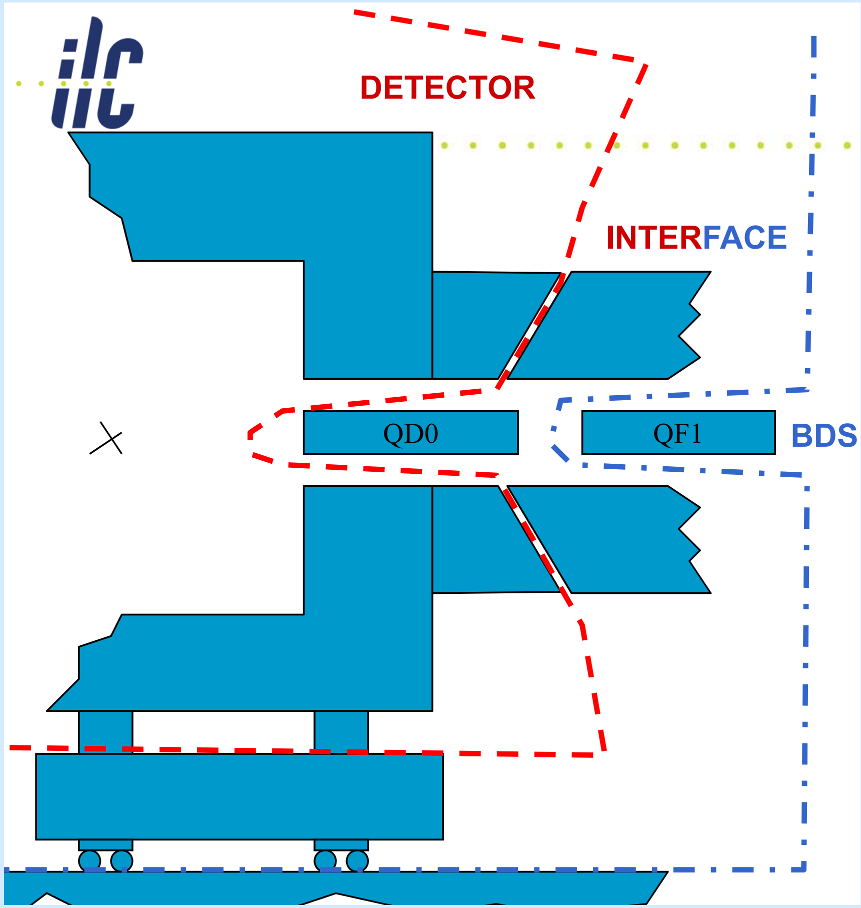
- First things to discuss:
  - Pacman design (ILD + SiD)
  - Shielding for 4th

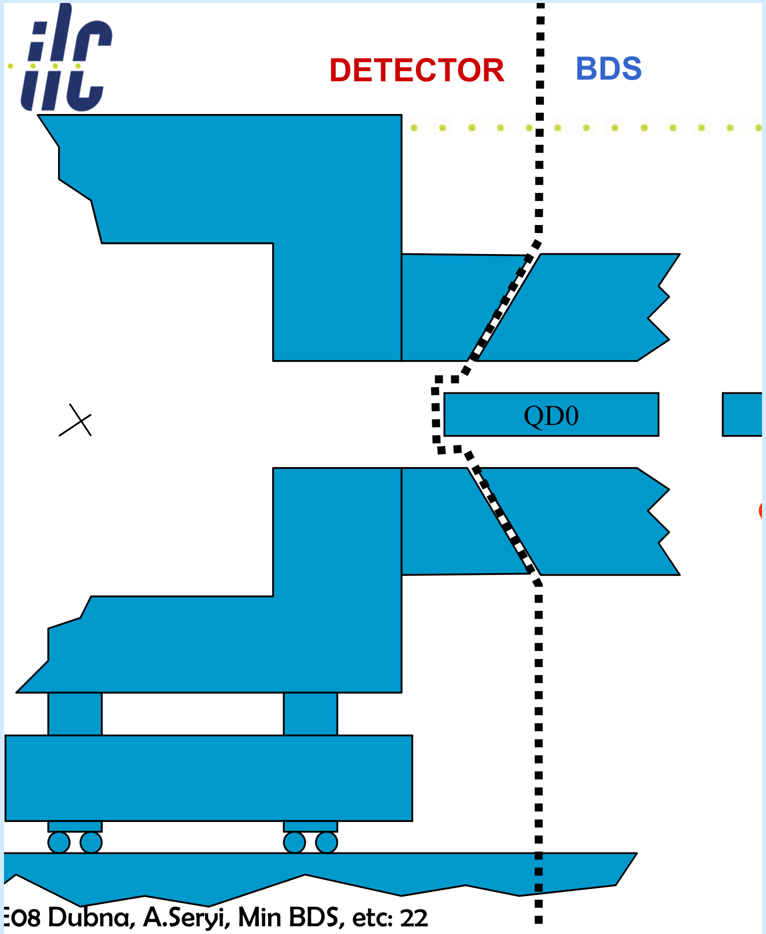
M. Oriunno

General Comments to the Interface Document

It was discussed and agreed that:

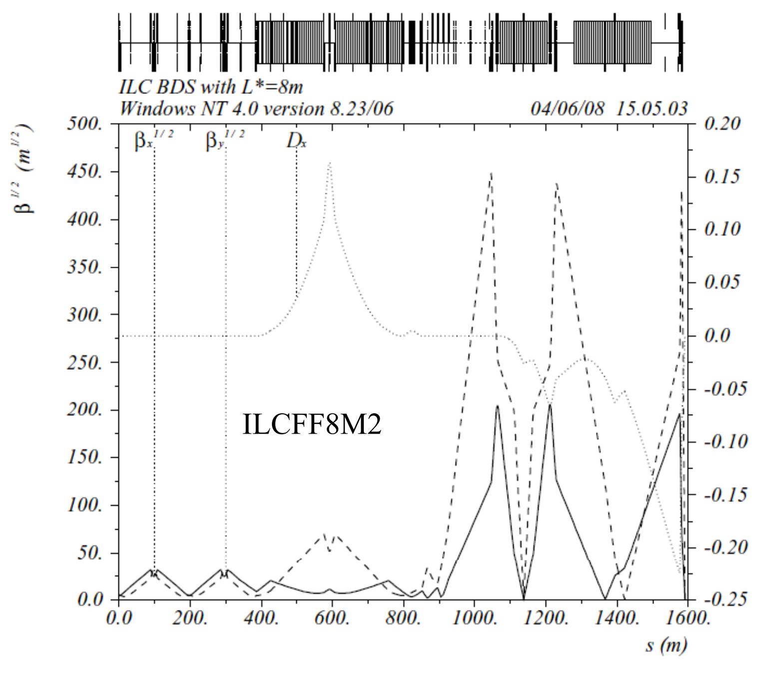
- The interface document should specify a minimal set of BOUNDARY CONDITIONS, not technical solutions.
- Technical specifications should be minimised.
- Evolutionary changes should be possible, via a mechanism (the MDI panel?) yet to be specified.
- The current EPAC paper is fine for EPAC but can and should be sharpened to satisfy the above format.

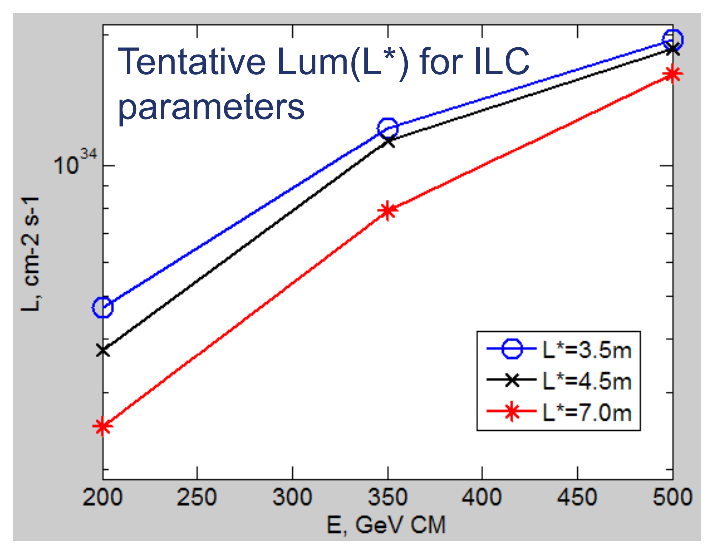




- Shown by A. Seryi in Dubna
- Requires L* ~ 7-8m
- Needs a lof of more work before any decision could be taken

Enlarging L*





- Instananeous Luminosity would be reduced by 20-30%
- Much easier MD Interface
- Better stabilisation of the QD0/QF1 magnets
- Shorter round-trip time for feedback systems
- Integrated Luminosity loss might be small!
- A lot of work needs to be done to show feasibility!

Polarisation

Summary: Polarization session (1)

Advantage ILC: clean initial states with known helicity

Positron source

- e+ source status report (talk by S. Riemann)
  - group is active – although budget cuts in US and UK good progress, generic work will be continued (UK)
  - UK helical undulator prototype tested → fulfils baseline requirements
  - positron source will provide ≥30% polarization from beginning
    - Spin rotation
    - e+ Polarimetry at IP
    - helicity reversal as for e- (not foreseen in RDR but essential for physics)
- critical issue: positron production target (talk by S. Hesselbach)
  - thermal, mech., radiation stress
  - shock wave studies to model target damage

Modeling of polarization transport (electrons and positrons)

- Important to understand e+, e- spin tracking at the ILC (talk by A. Hartin)
  - all depolarization effects have to be understood and evaluated, precise spin tracking required to meet envisaged accuracy @ IP
    - Theoretical studies to describe spin precession in strong fields.
    - Inclusion of second order depolarization processes

Summary: Polarization session (2)

Polarimetry at the IP (talk by D. Kaefer)

- polarimetry is essential, may be THE precision limiting part in some measurements
- big challenge to reach $\Delta P/P$ ~0.25% but no fundamental show stoppers
- only the combination of upstream and downstream and using annihilation data will allow to reach the precision goal:
  - **Upstream polarimeter**
    - cleanest measurement with best time granularity;
    - gives main input for correlationas and differences in left-right polarizations
  - **Downstream polarimeter:**
    - measures depolarization effects from collisions, providing access to the luminosity weighted polarization
  - **Annihilation data:**
    - provide absolute calibration (Z-peak) when correlations are known from polarimeter measurements

Summary: Polarization session (3)

Calibration with Z-pole data – use them for physics

(talks by K. Moenig, R. Settles, C. Damerell and G. Moortgat-Pick + discussion)

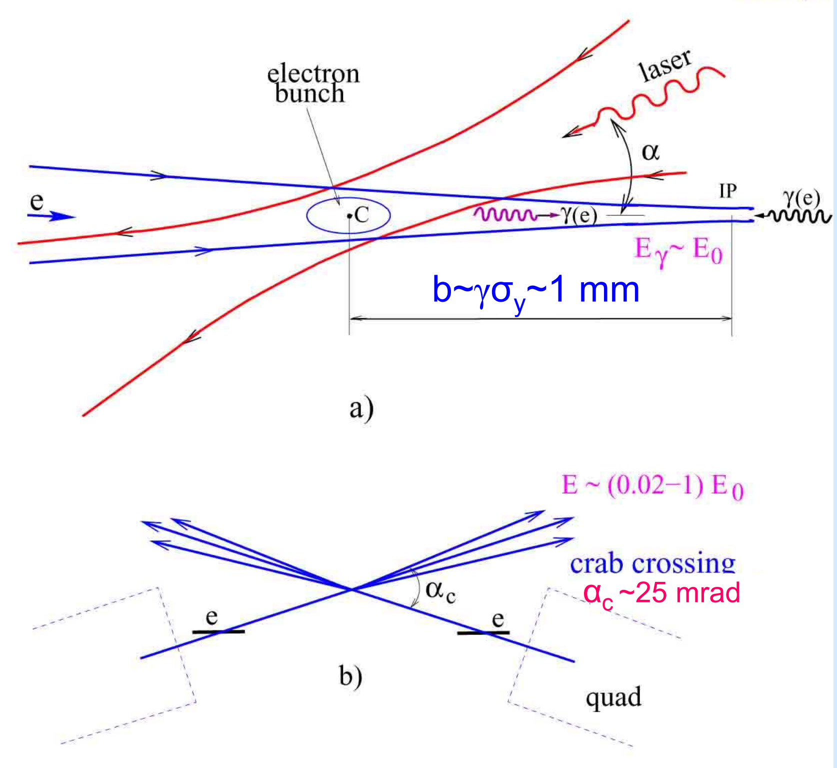
- detectors need calibration on the Z pole ($L \sim 7 \cdot 10^{32}/cm^2s$)
- corresponds to $1.8 \cdot 10^6$ hadronic Z decays per day(~3 times SLD physics)!!

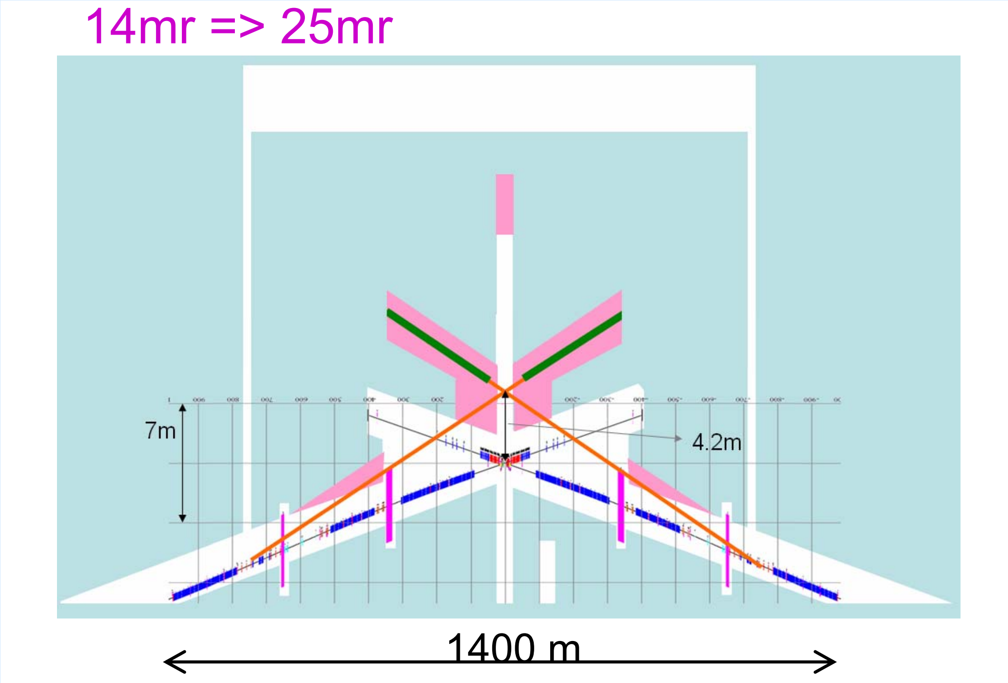
  → would offer the world's best measurement of $\sin^2\theta_{eff}$
- Need:
  - **Polarimetry at the Z-pole**
  - **Fast helicity reversal**
  - **Frequency of push-pull**
    - Fast → required for discoveries
    - Slow → ok for precision measurements
    - Z calibration needed for each push/pull cycle?
  - **Energy spread of positron beam**
    - Check the scheme of e+ production at the Z –pole

YY-Technologies

Gamma-Gamma Collider

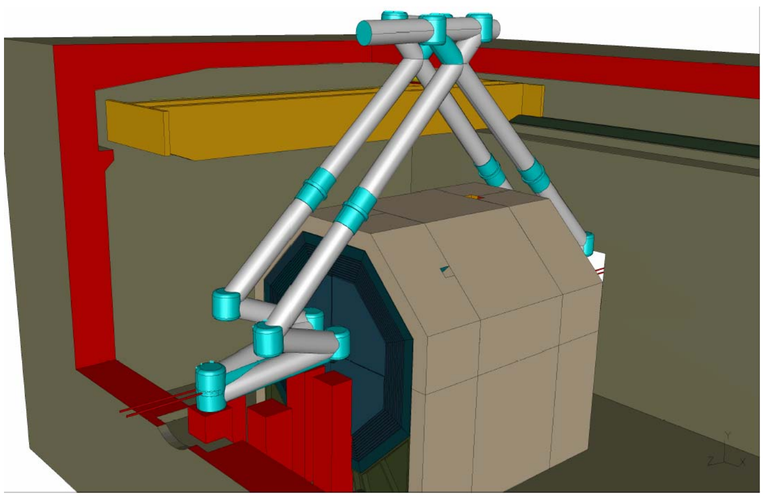
V. Telnov

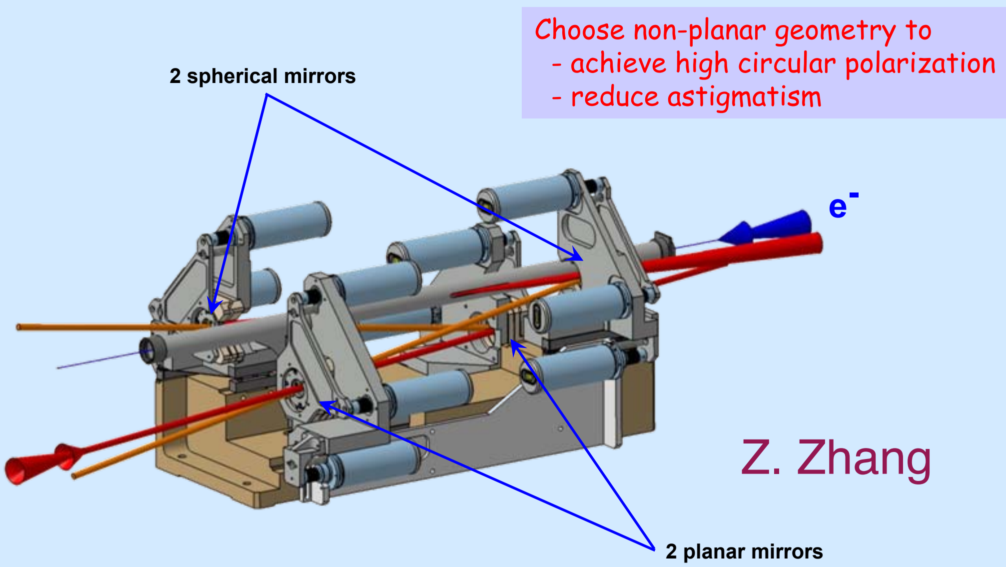




- Gamma-Collider needs larger crossing angle
- Transition of 14 mrad baseline IR to 25 mrad would be part of a substantial upgrade program for the ILC

Laser Cavity


The above scheme does not fit the ILC experimental hall



- Gamma collider needs laser cavity
- Present conceptual design does not fit in ILC detector hall
- Synergies in developments of cavities for other applications (e.g. positron production, polarimetry, etc.)

Summary

- The definition of the minimal requirements are an essential pre-requisite for the successful development of the push-pull system in a worldwide collaboration
- Worldwide collaboration in the framework of the new MDI structures has just started

- Polarisation
  - Polarisation is an attractive ingredient of the ILC physics programme
  - Z-pole calibration data could be used for physics

- The Gamma-Gamma collider is an interesting option for the ILC