ILC MDI

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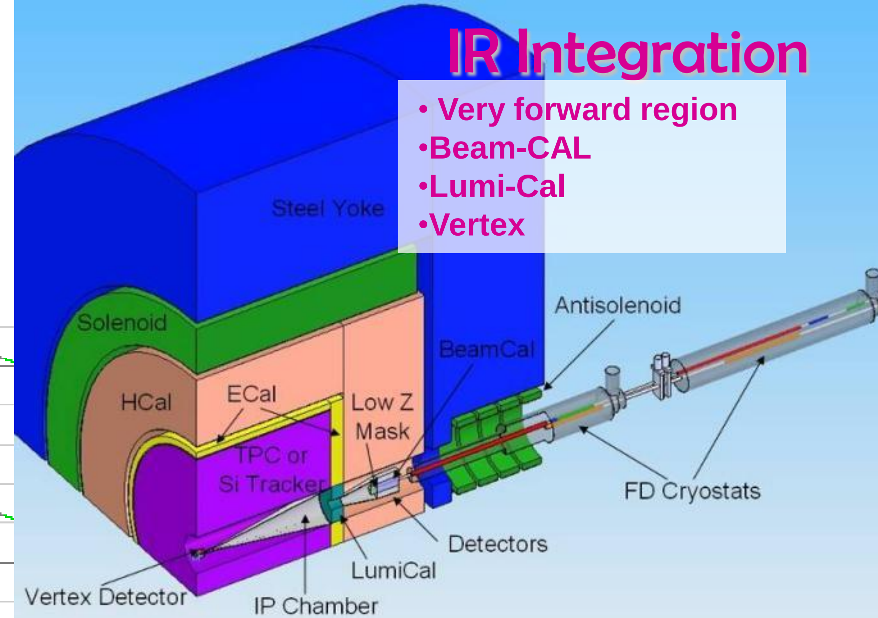
JAI

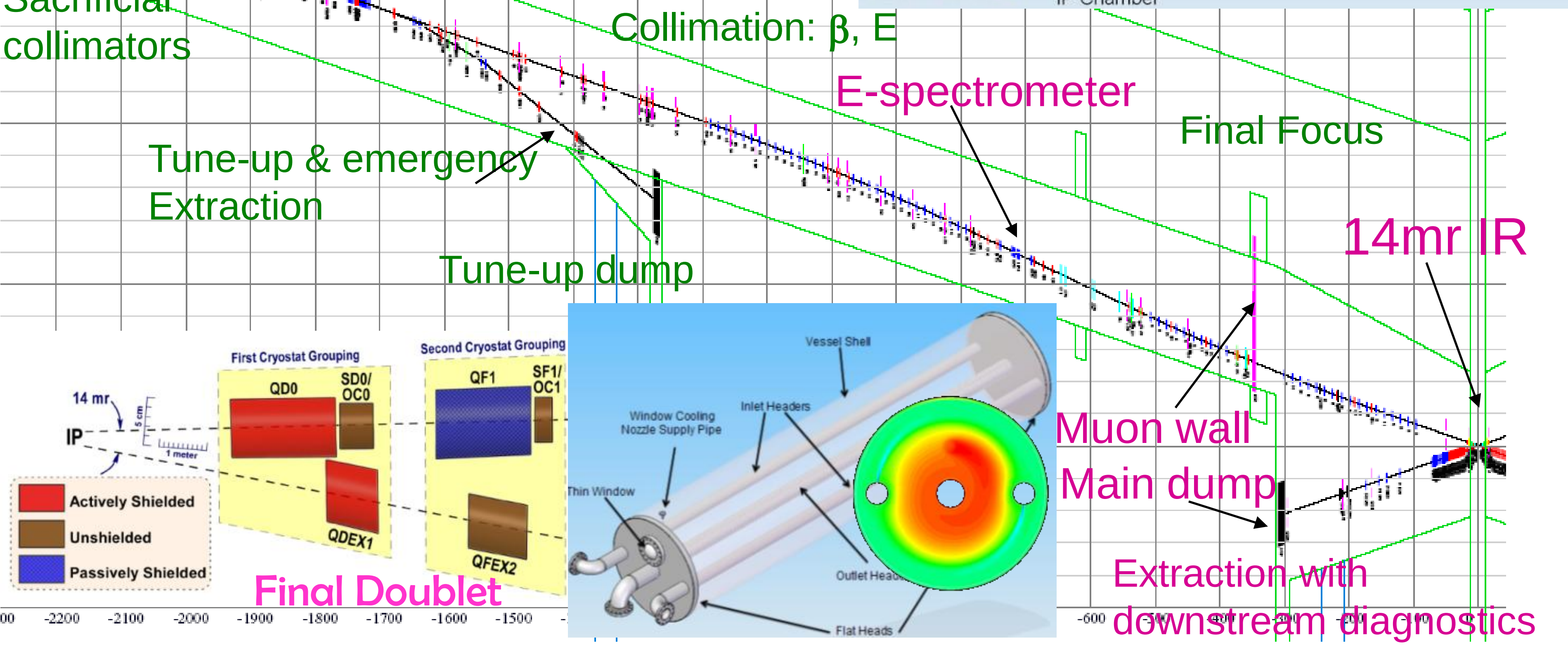
with input from many colleagues working on MDI

IWLC2010
20 -10 - 2010

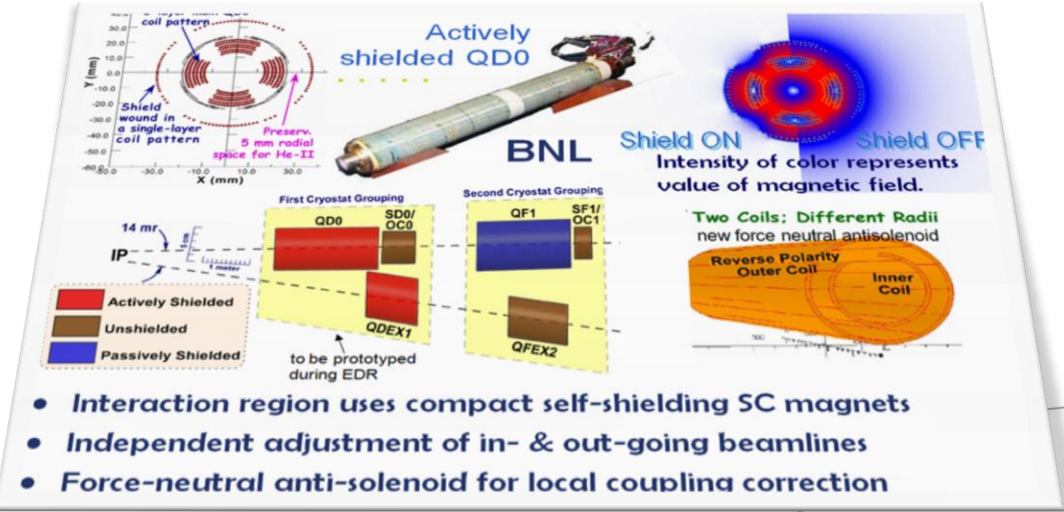
Beam Delivery & MDI elements

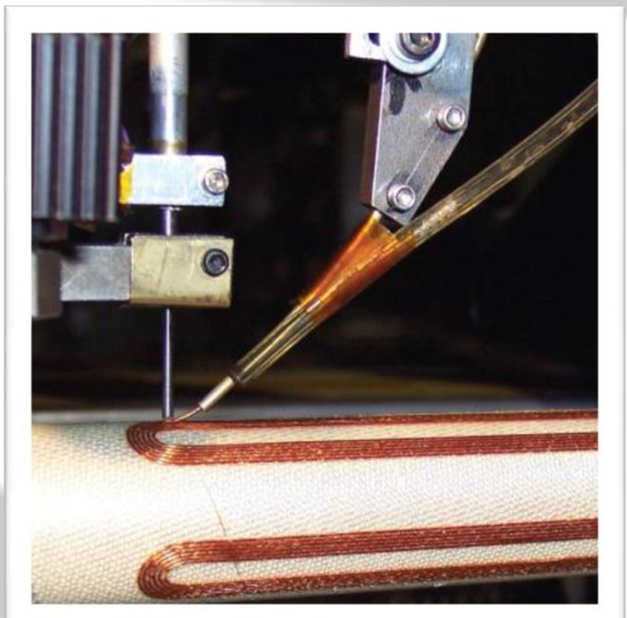
1TeV CM, single IR, two detectors, push-pull

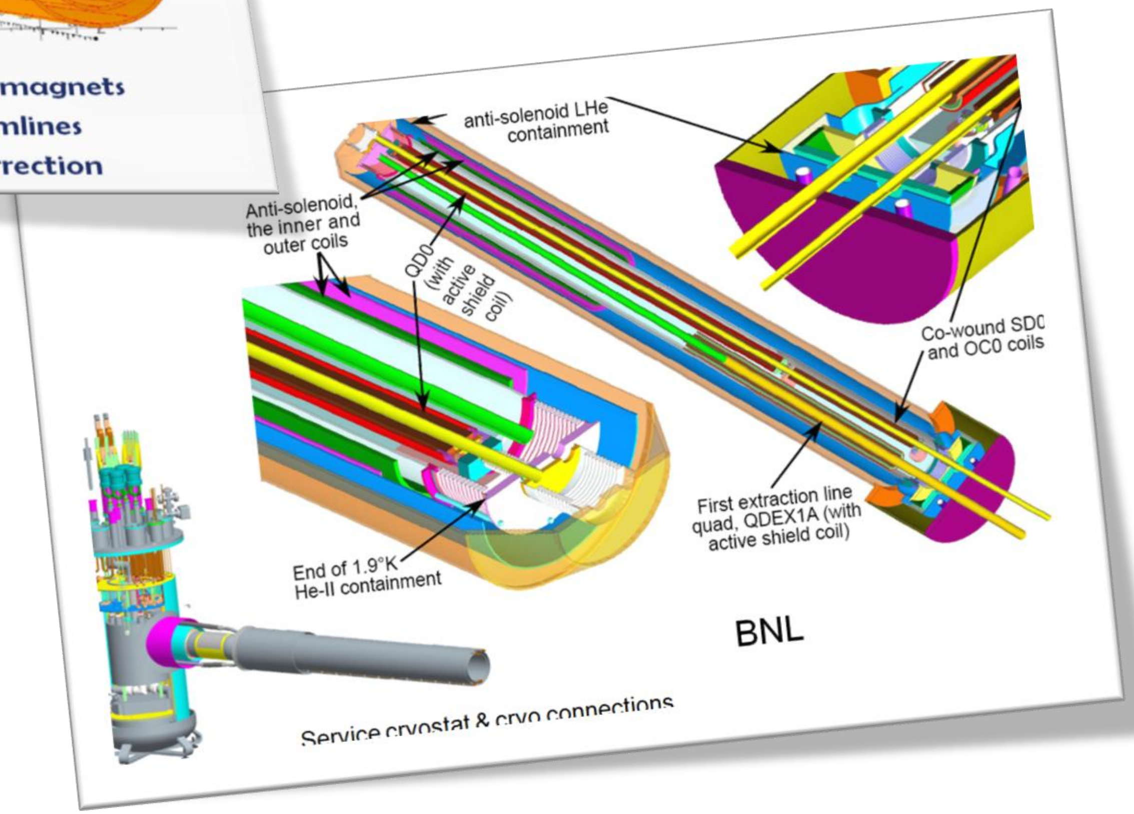




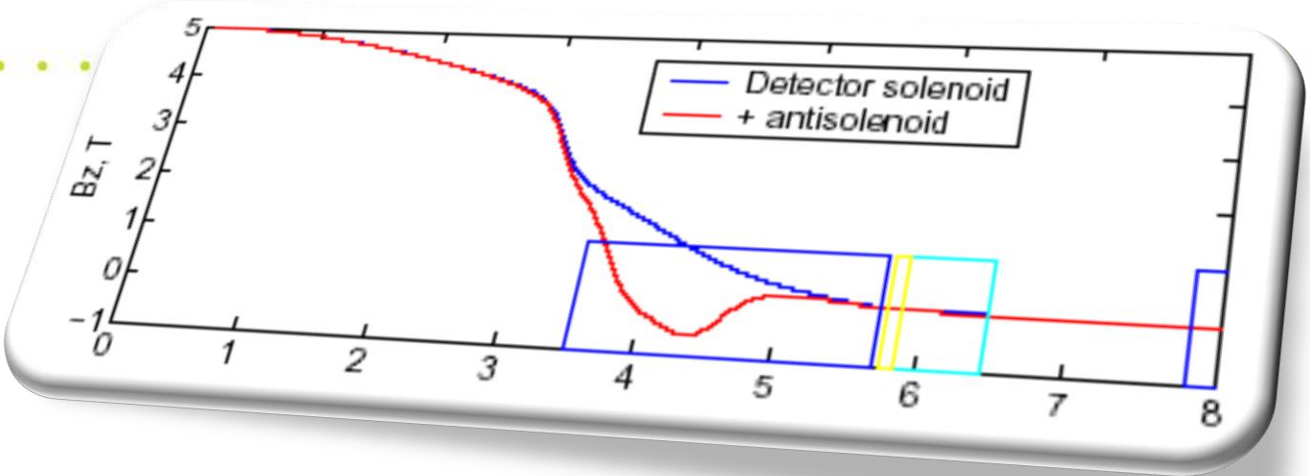
Final Doublet

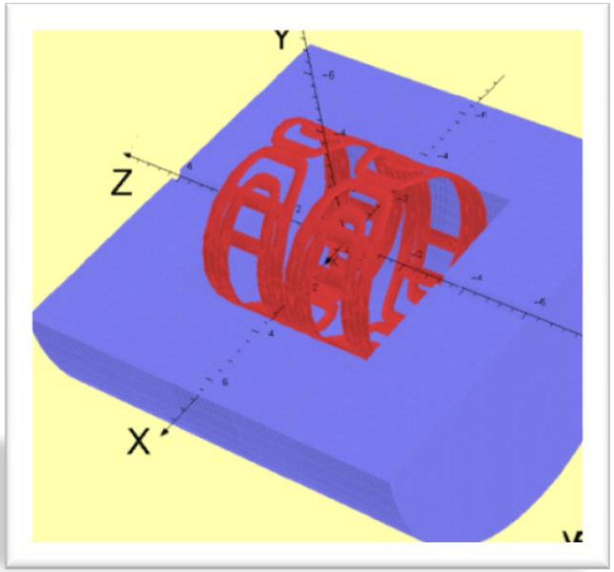


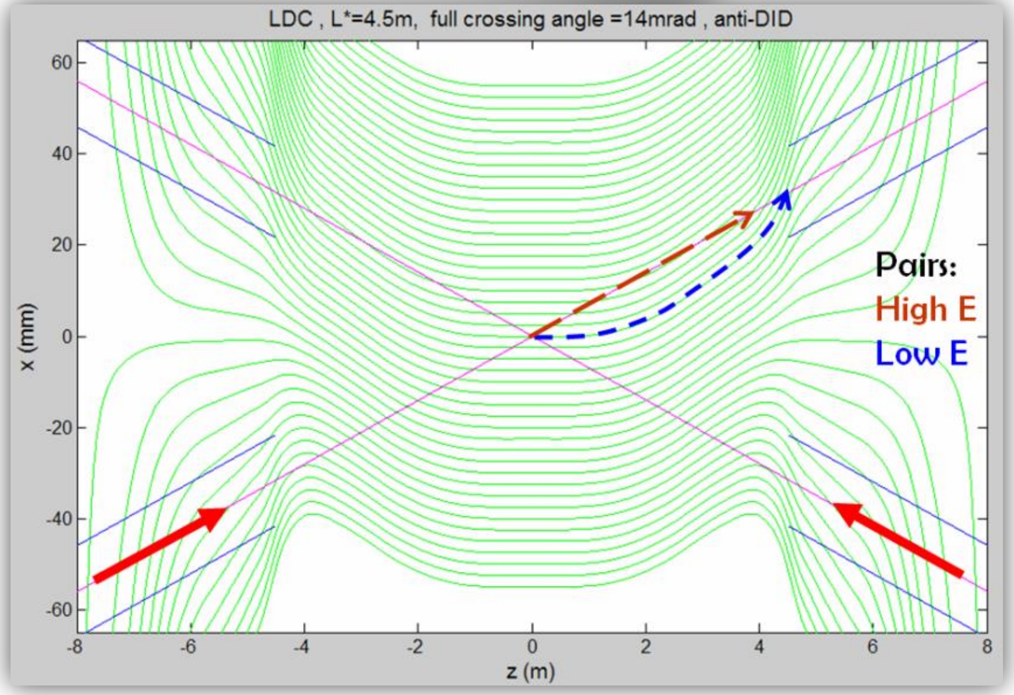




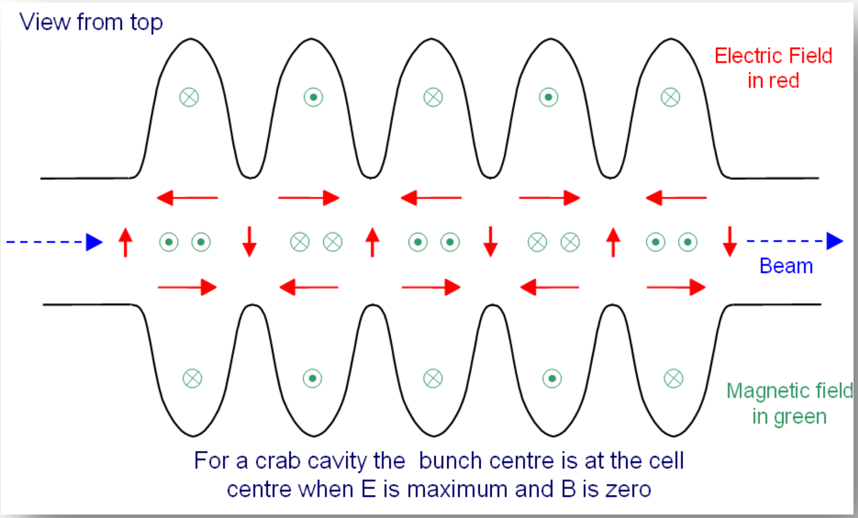
IR orbit & beam manipulation

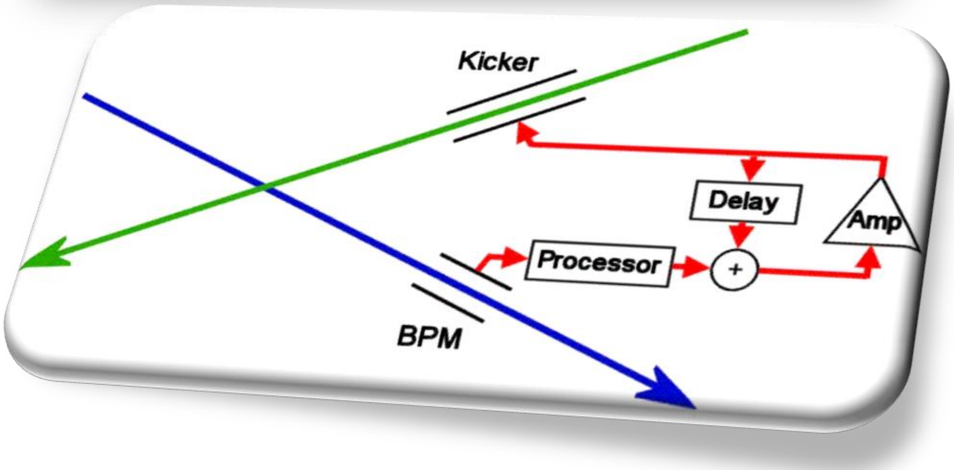


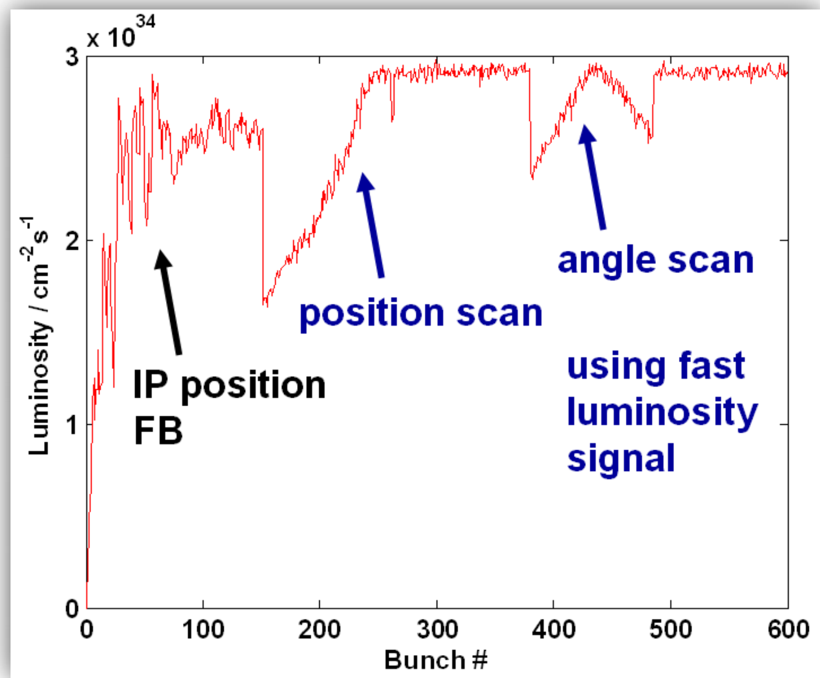




IR feedback & crab-xing

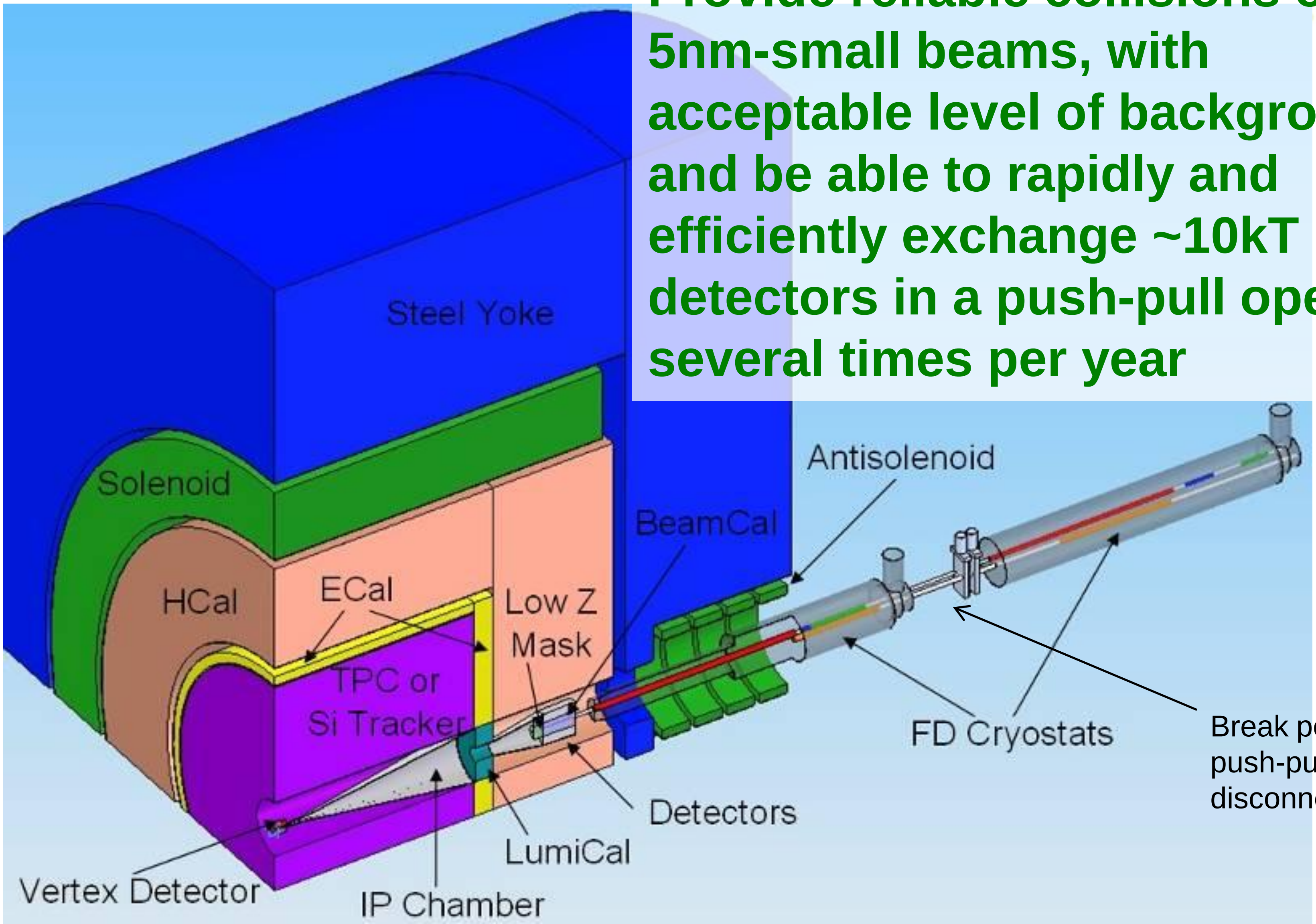






Interaction Region challenge

Provide reliable collisions of 5nm-small beams, with acceptable level of background, and be able to rapidly and efficiently exchange ~10kT detectors in a push-pull operation several times per year

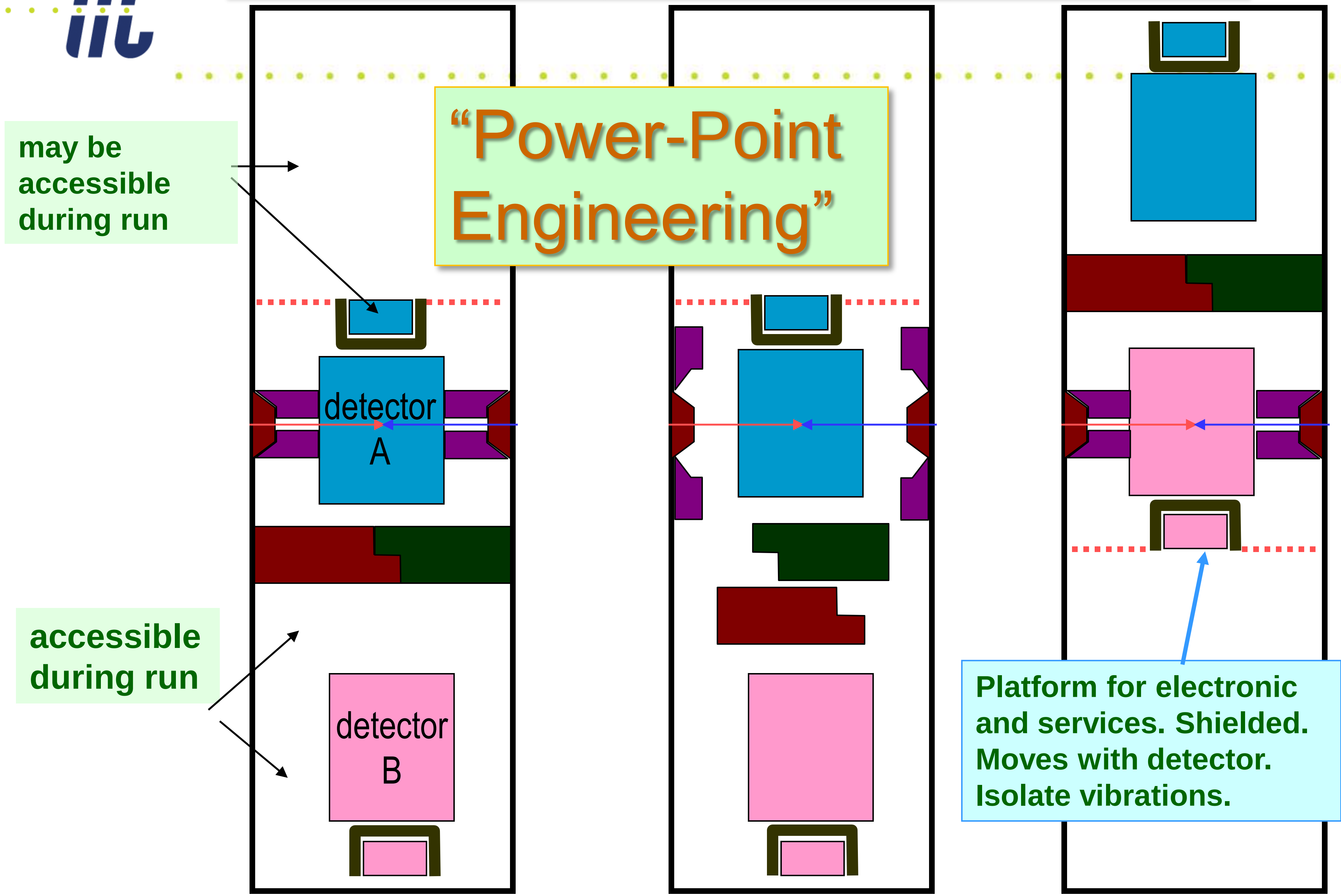


Break point for push-pull disconnect

Push-pull history

- The push-pull arrangement of detectors is not a new idea; however, it was never realised in practice to the extent required for ILC in terms of reliability and efficiency
- For ILC, the push-pull arrangement was evaluated on the conceptual level in 2006, and while it has been determined that the technical issues have conceptual solutions, it was deemed that "careful R&D and engineering studies will be needed during the TDP time to validate and optimize the proposed configuration", as stated in the GDE push-pull Configuration Change Request (CCR) to the ILC baseline approved in early 2007.

Starting point (~2006) push-pull concept

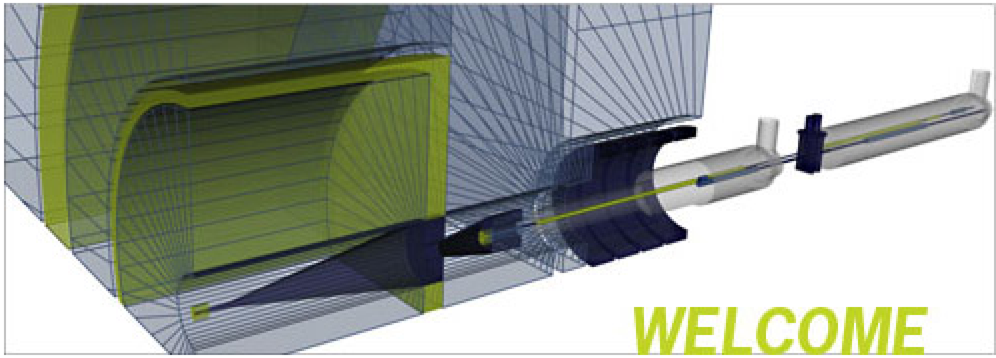


IRENG07 Workshop

ILC INTERACTION REGION ENGINEERING DESIGN WORKSHOP

SLAC

- Home
- Goals
- Registration
- Payment Information
- Agenda
- Organizing Committees
- The Charge to the IPAC
- Accommodations
- Travel and Directions
- Visa Information
- Social Events
- Contact



ILC Interaction Region Engineering Design Workshop

September 17-21, 2007

Stanford Linear Accelerator Center

Menlo Park, California

Please join us to review and advance the design of the subsystem of the Interaction Region of ILC, focusing in particular on their integration, engineering design and arrangements for push-pull operation.

RECENT NEWS

- Agenda has been updated.

REGISTRATION

Registration is necessary to participate in the workshop.
Registration fee is $30 and reception fee is $20.

→ Register

ACCOMMODATIONS

A block of 40 rooms is reserved until July 15, 2007 at the **Stanford Guest House**. Please reserve your room early and mention that you are attending this workshop.

→ More Information

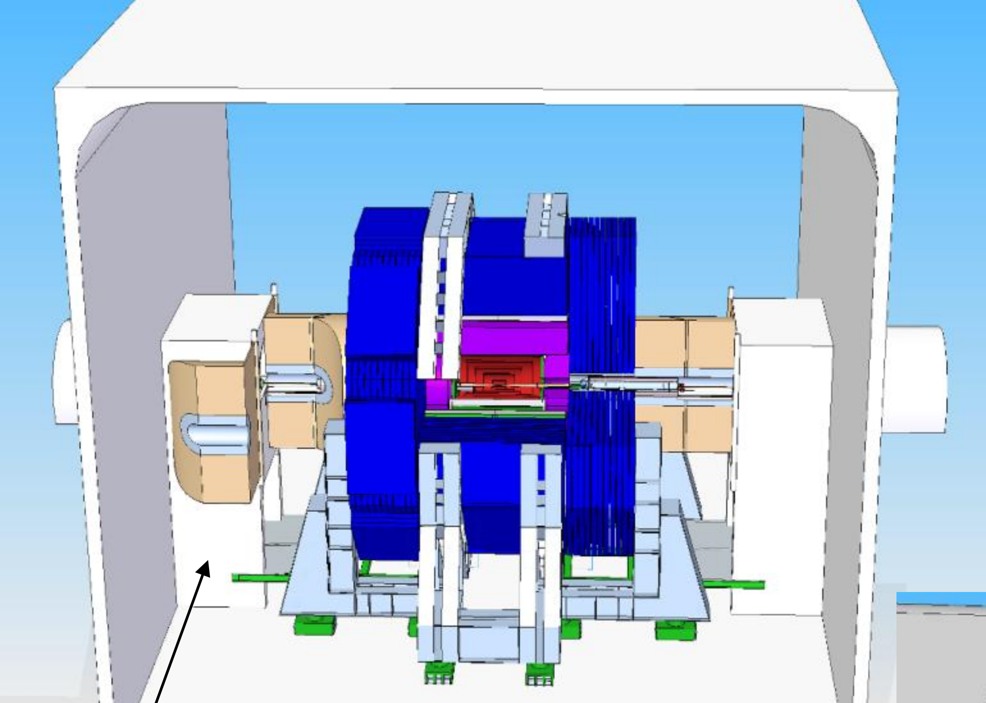
http://www-conf.slac.stanford.edu/ireng07/

Work in preparation for IRENG07

- **WG-A: Overall detector design, assembly, detector moving, shielding.**
  - Including detector design for on-surface assembly and underground assembly procedures. Beamline pacman & detector shielding…
    - Conveners: Alain Herve (CERN), Tom Markiewicz (SLAC), Tomoyuki Sanuki (Tohoku Univ.), Yasuhiro Sugimoto (KEK)
- **WG-B: IR magnets design and cryogenics system design.**
  - Including cryo system, IR magnet engineering design, support, integration with IR, masks, Lumi & Beamcals, IR vacuum chamber...
    - Conveners: Brett Parker (BNL), John Weisend (SLAC/NSF), Kiyosumi Tsuchiya (KEK)
- **WG-C: Conventional construction of IR hall and external systems.**
  - Including lifting equipment, electronics hut, cabling plant, services, shafts, caverns, movable shielding; solutions to meet alignment tolerances...
    - Conveners: Vic Kuchler (FNAL), Atsushi Enomoto (KEK), John Osborne (CERN)
- **WG-D: Accelerator and particle physics requirements.**
  - Including collimation, shielding, RF, background, vibration and stability and other accelerator & detector physics requirements…
    - Conveners: Deepa Angal-Kalinin (STFC), Nikolai Mokhov (FNAL), Mike Sullivan (SLAC), Hitoshi Yamamoto (Tohoku Univ.)

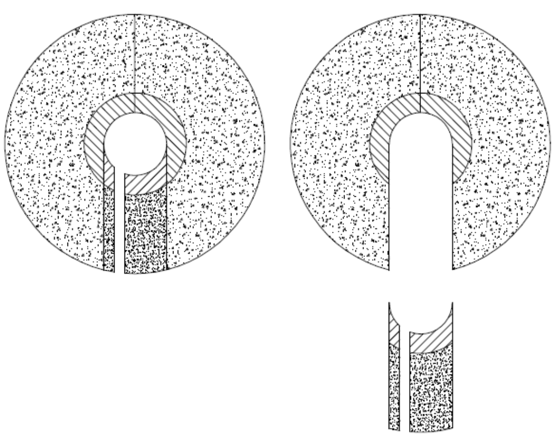
- WG-A, conveners meeting, July 5
- WG-D, conveners meeting, July 11
- WG-A, group meeting, July 12
- WG-B, conveners meeting, July 13
- WG-C, group meeting, July 17
- WG-B, group meeting, July 23
- WG-C, group meeting, July 24
- WG-A, group meeting, July 30
- WG-C, group meeting, July 31
- WG-D, group meeting, August 1
- WG-B, group meeting, August 2
- WG-A, group meeting, August 6
- WG-C, group meeting, August 7
- WG-A, group meeting, August 13
- WG-D, group meeting, August 15
- WG-B, group meeting, August 16
- WG-A, group meeting, August 20
- WG-C, group meeting, August 21
- WG-A, group meeting, August 27
- WG-C, group meeting, August 28
- Conveners and IPAC mtg, August 29
- WG-B, group meeting, August 30
- WG-B, group meeting, September 13

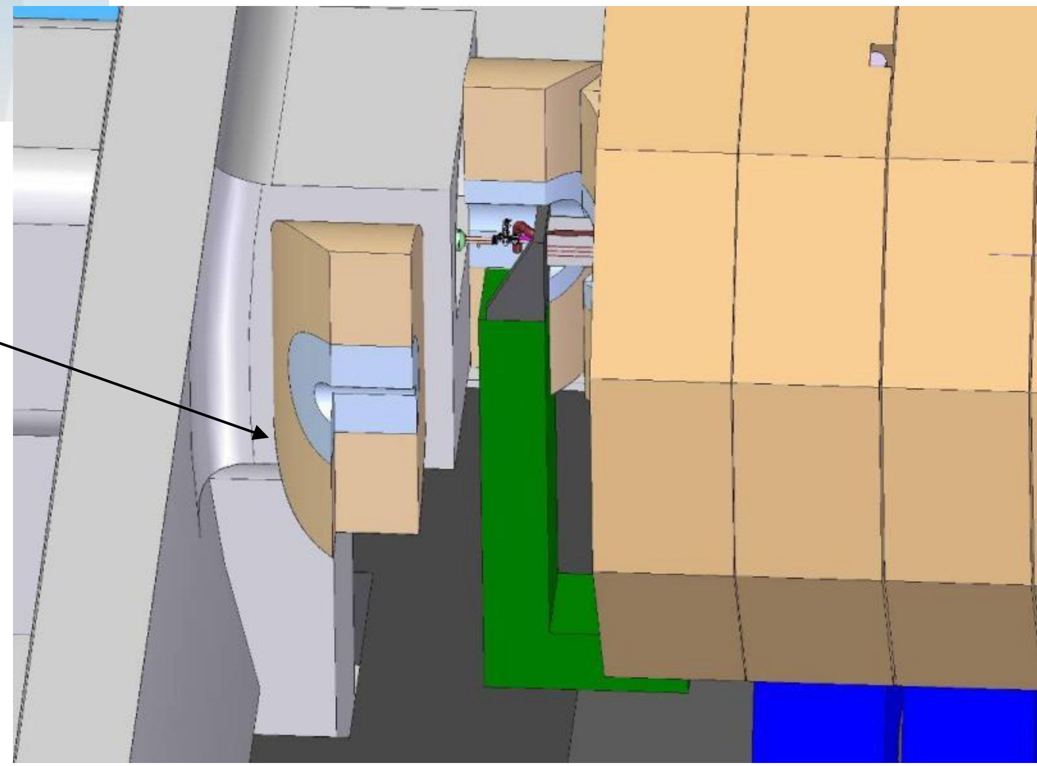
http://www-conf.slac.stanford.edu/ireng07/agenda.htm



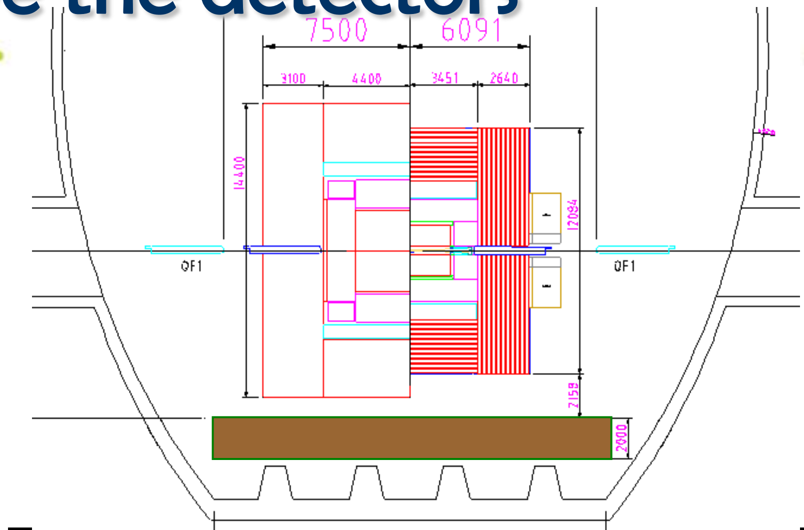
Example of design progress to date, showing in particular the radiation shielding systems (so called “pacman”)

SiD ILD

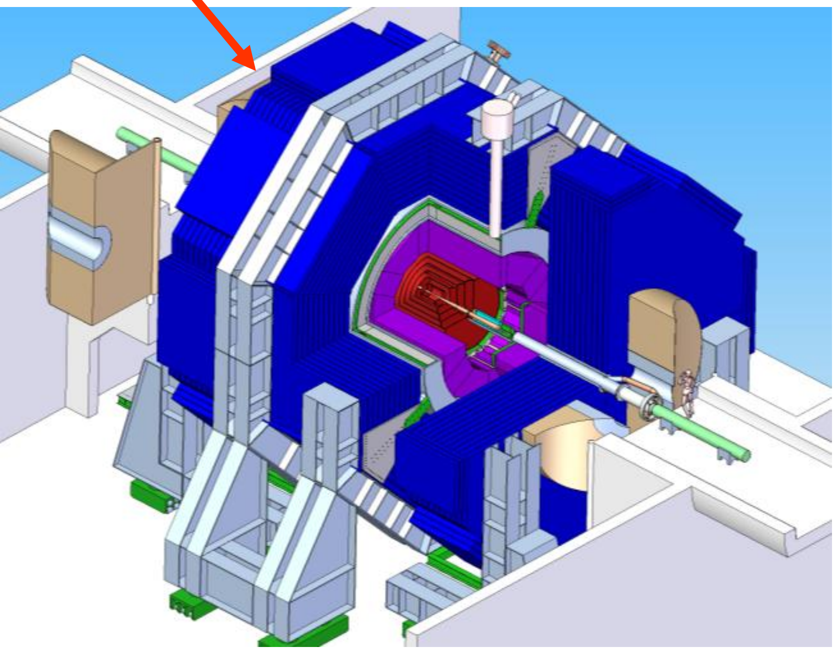




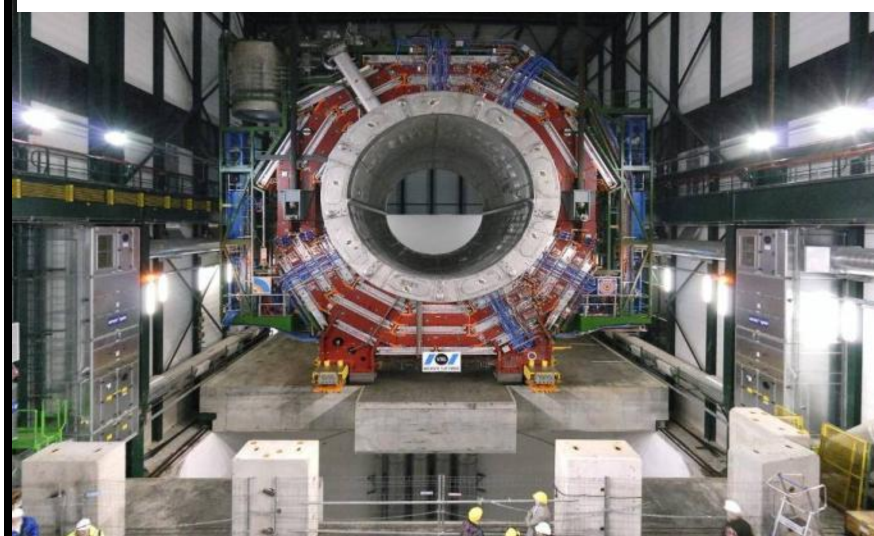
Example of design progress to date: how to move the detectors



Detector motion system with or without an intermediate platform

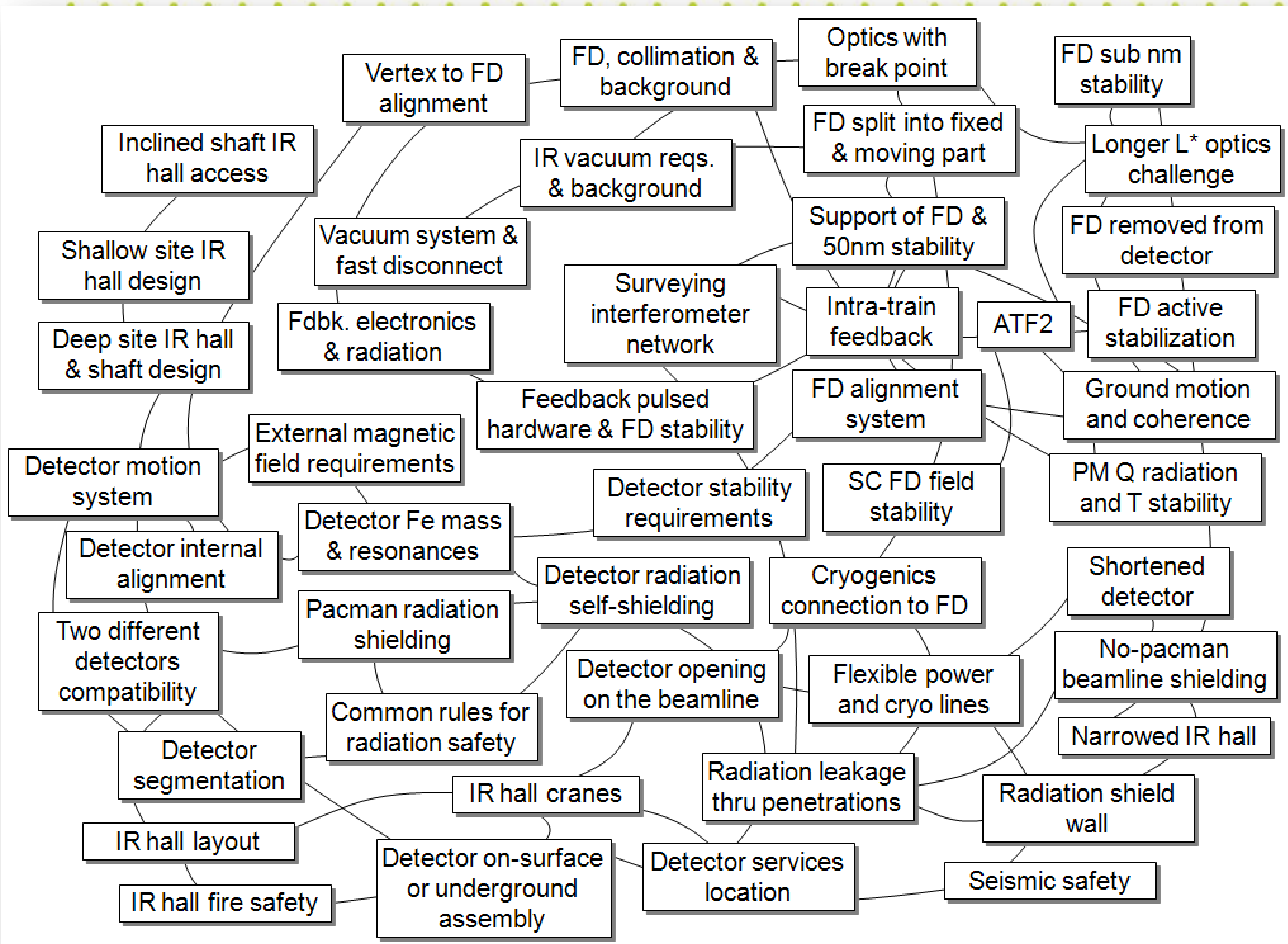


CMS platform – proof of principle for ILC



Two different approached for detector motion are considered: with and without a platform

Interrelation of technical challenges for the push-pull system



Illustrations of interrelations

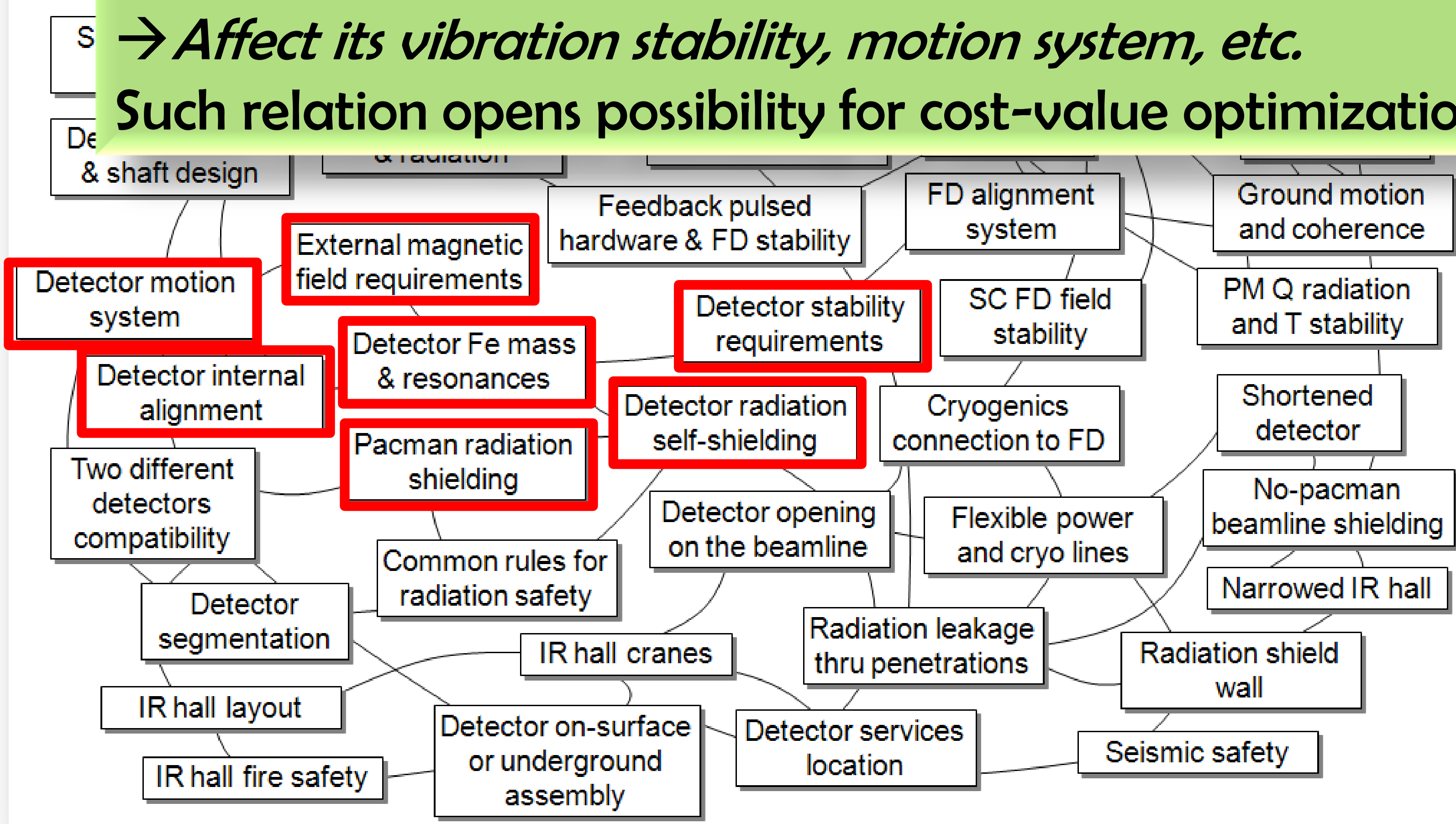
Iron in the muon system also provides:

- *radiation shielding*
- *magnetic field shielding*

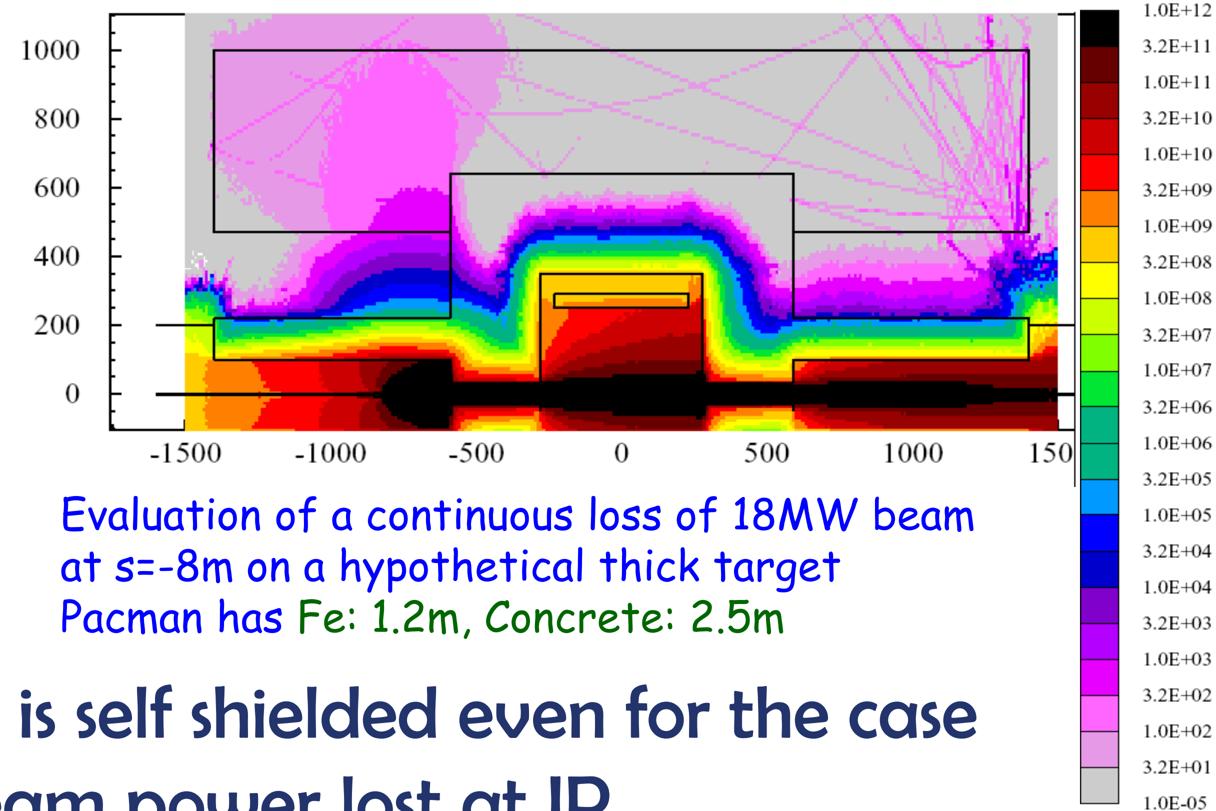
The shielding requirements may affect the detector mass

→ *Affect its vibration stability, motion system, etc.*

Such relation opens possibility for cost-value optimization



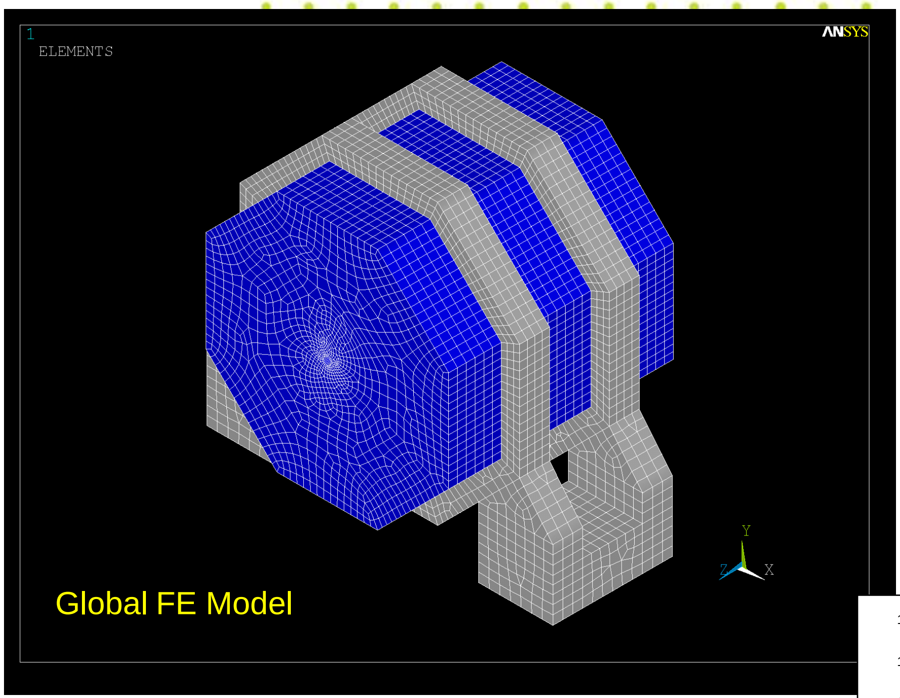
Shielding the IR hall

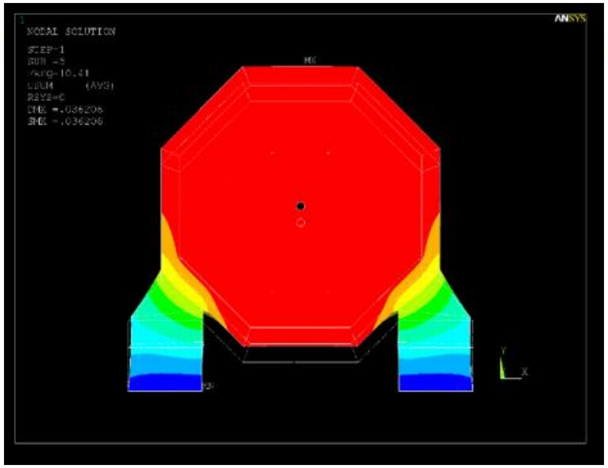


Evaluation of a continuous loss of 18MW beam at s=-8m on a hypothetical thick target
Pacman has Fe: 1.2m, Concrete: 2.5m

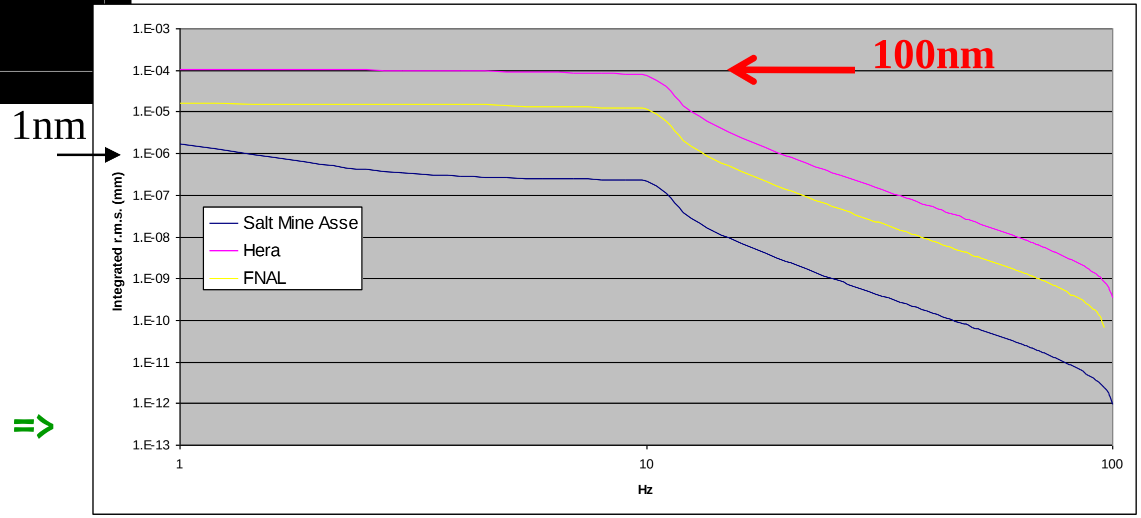
- Detector is self shielded even for the case of full beam power lost at IP
- Real geometry, with cable and cryo penetrations is presently being studied

Detector stability analysis





SiD first vertical motion mode, 10.42 Hz



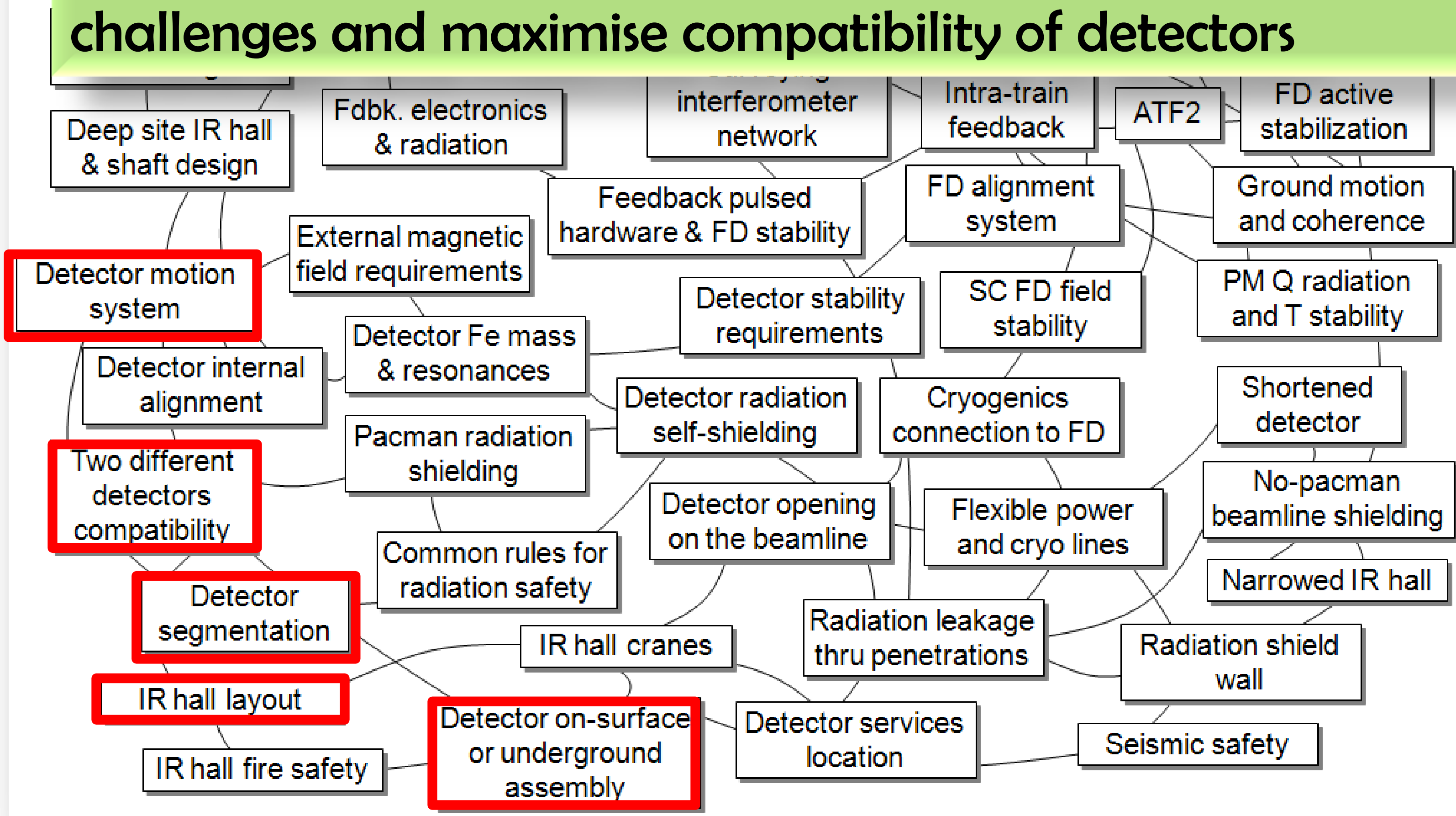
- First analysis shows possibilities for further optimization
  - e.g. tolerance to fringe field => detector mass => resonance frequency

Plot shows the absolute motion. The relevant relative motion may be smaller (is being studied).

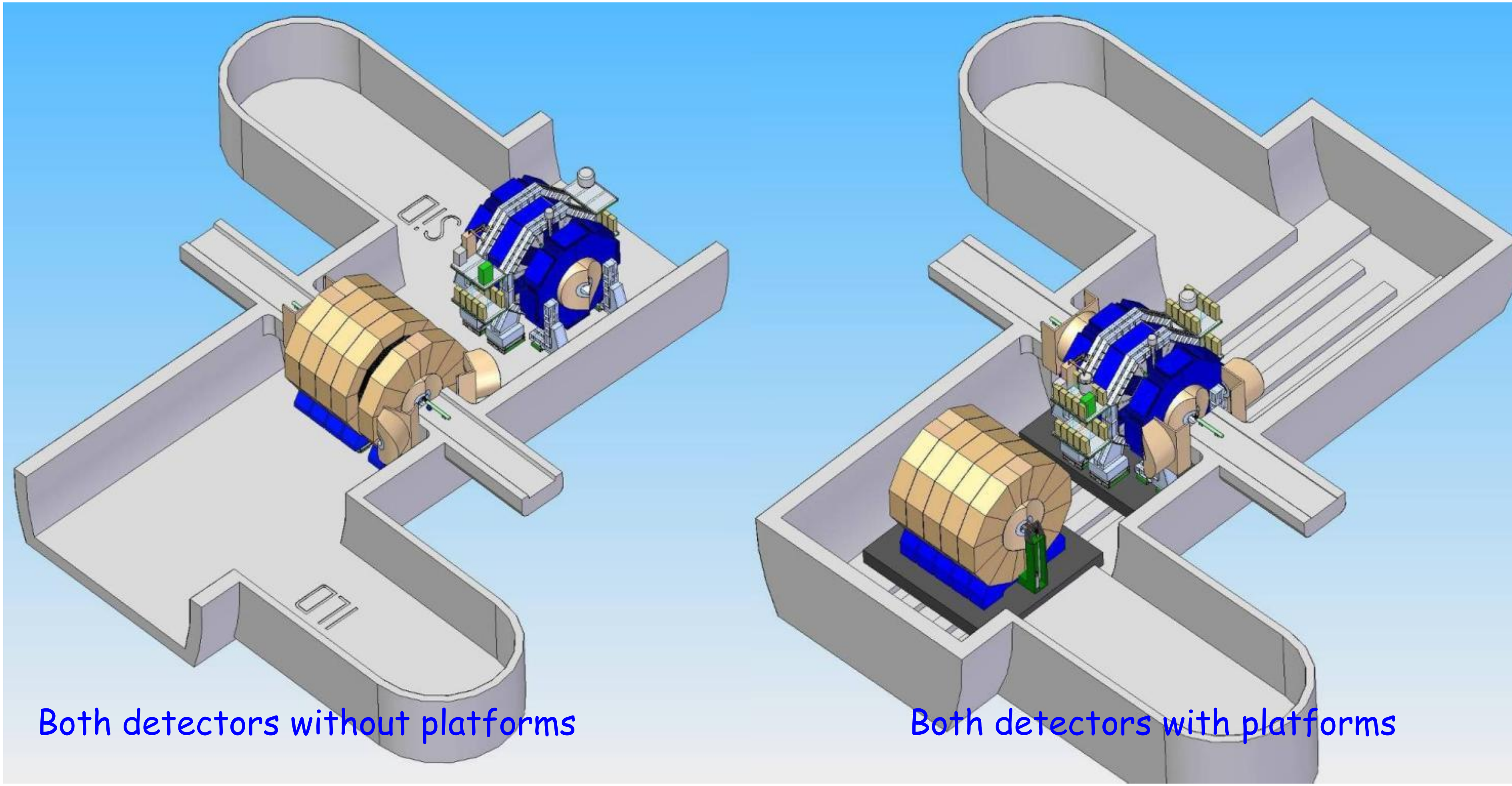
Illustrations of interrelations

• Differences of approaches for detector assembly lead to differences in segmentation and rigidity, resulting in different assumptions on requirements for a detector platform

• The motion system and IR hall design need to mitigate the challenges and maximise compatibility of detectors



Stability and detector motion system

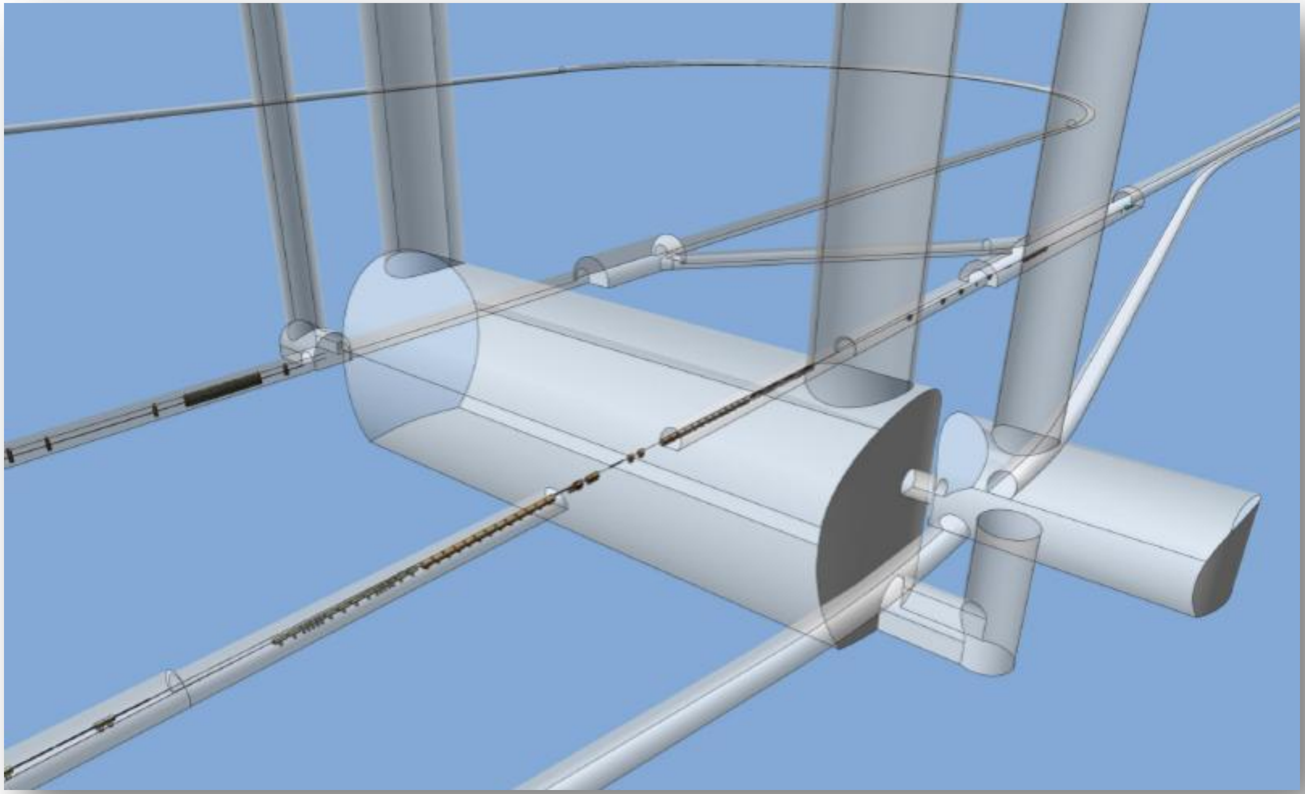


Both detectors without platforms

Both detectors with platforms

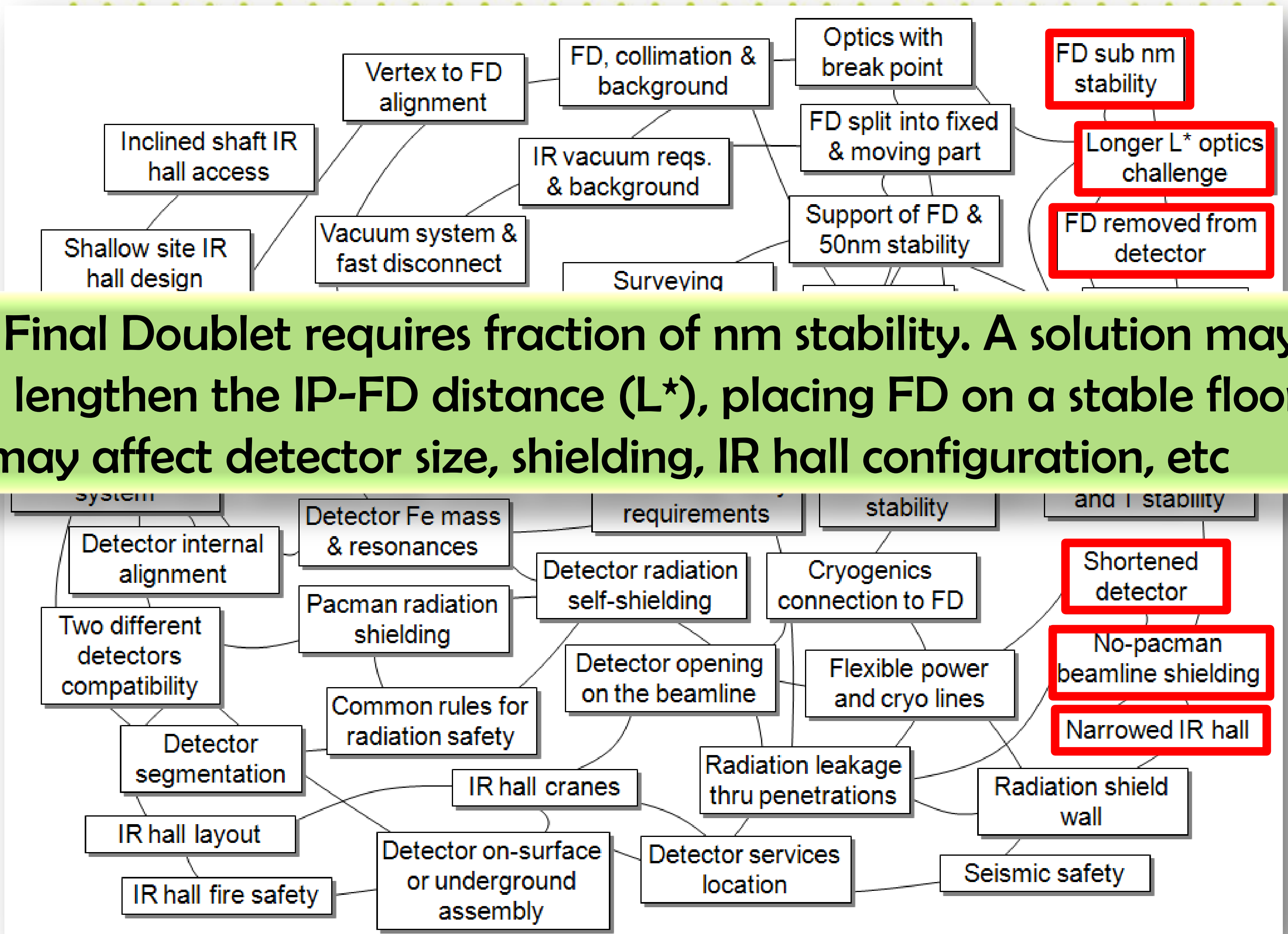
- Vibration stability will be one of the major criteria in eventual selection of a motion system design

IR hall design



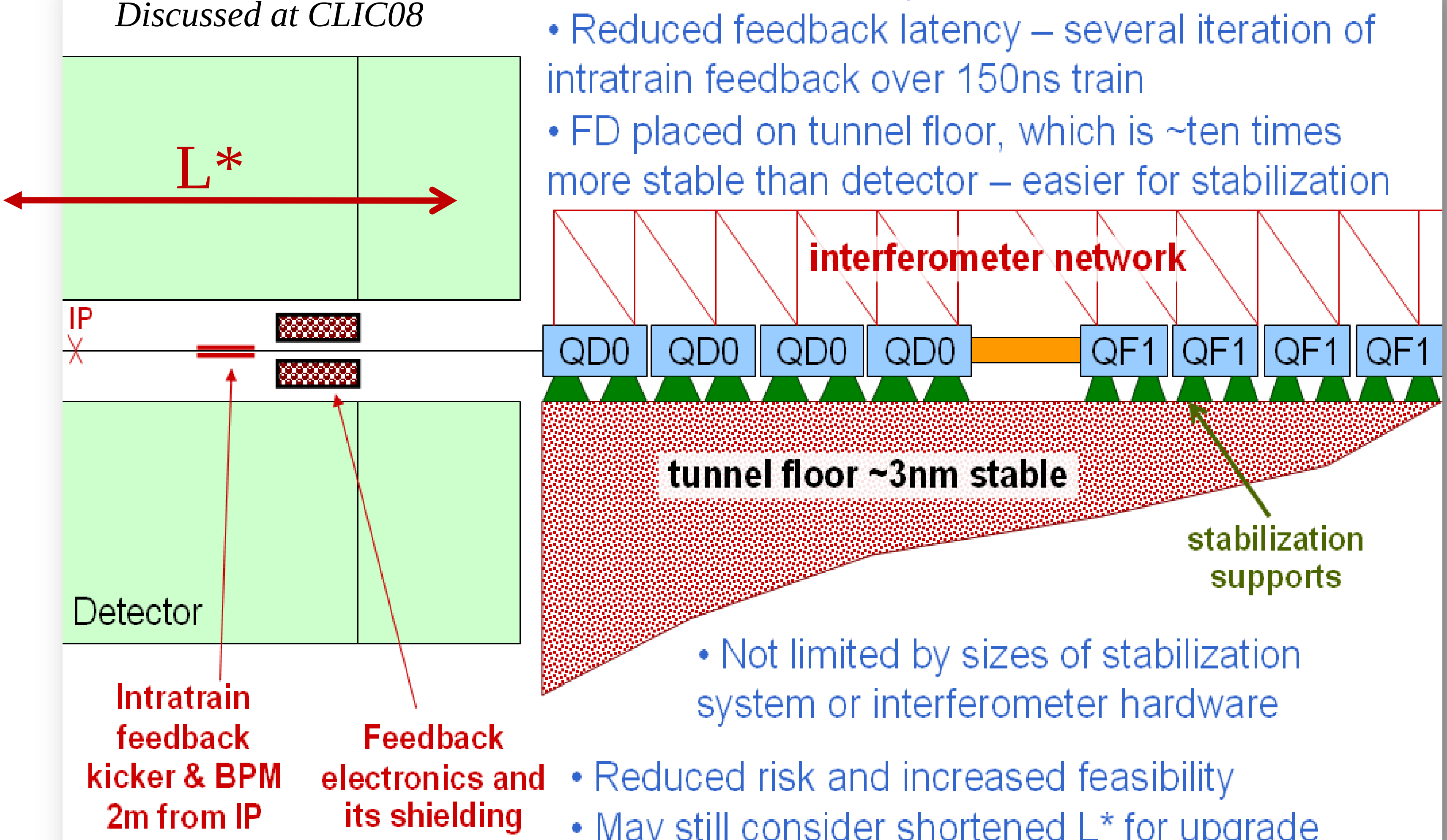
- IR hall dimensions, strength of the floor, size of shafts and service alcoves depend on the detector assembly approach, its motion system, geology, depth, etc.

Illustrations of interrelations



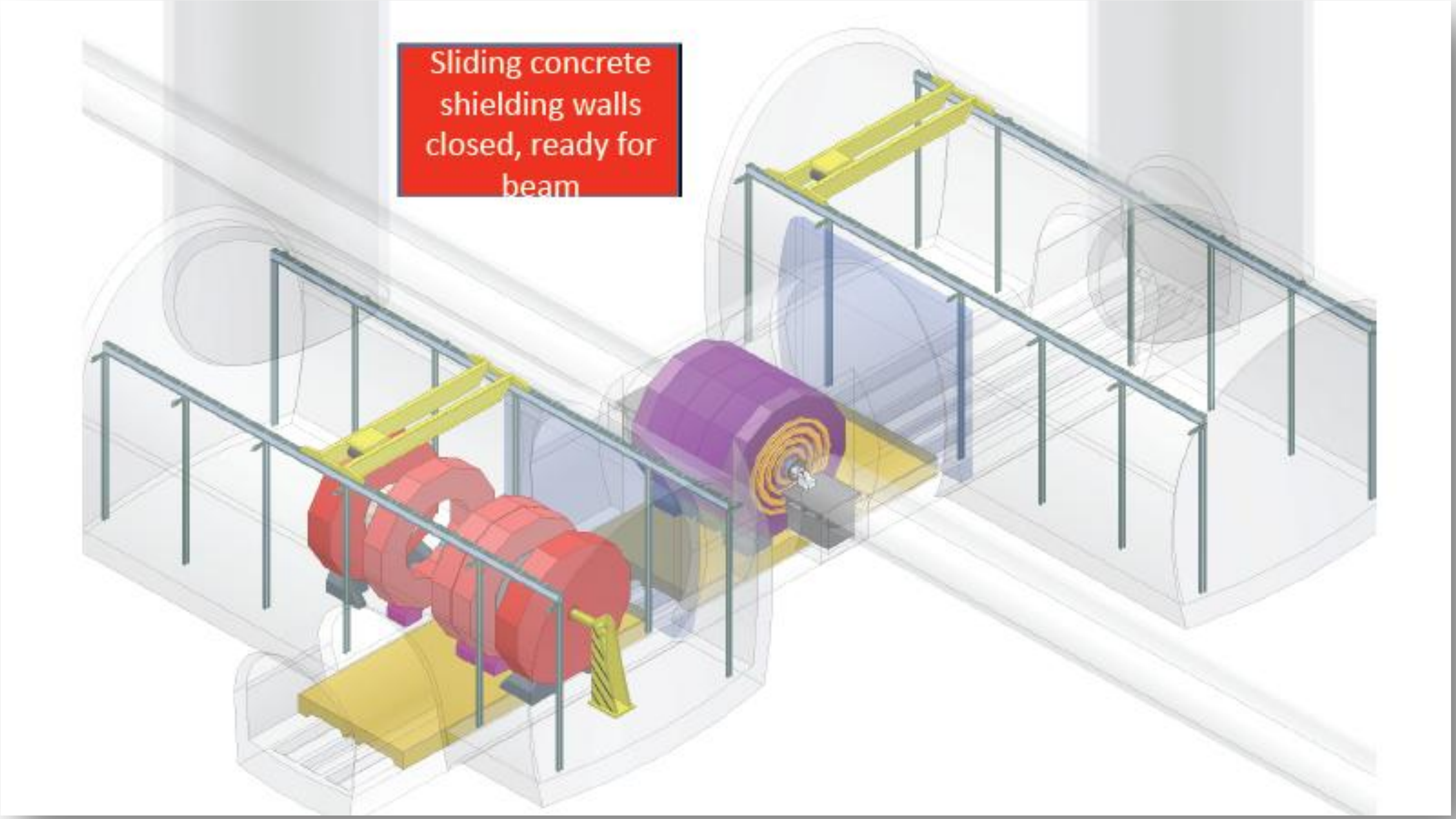
CLIC Final Doublet requires fraction of nm stability. A solution may be to lengthen the IP-FD distance (L*), placing FD on a stable floor. This may affect detector size, shielding, IR hall configuration, etc

Doubled L* concept for CLIC, aimed to ease reaching the ~0.1 nm stability requirement

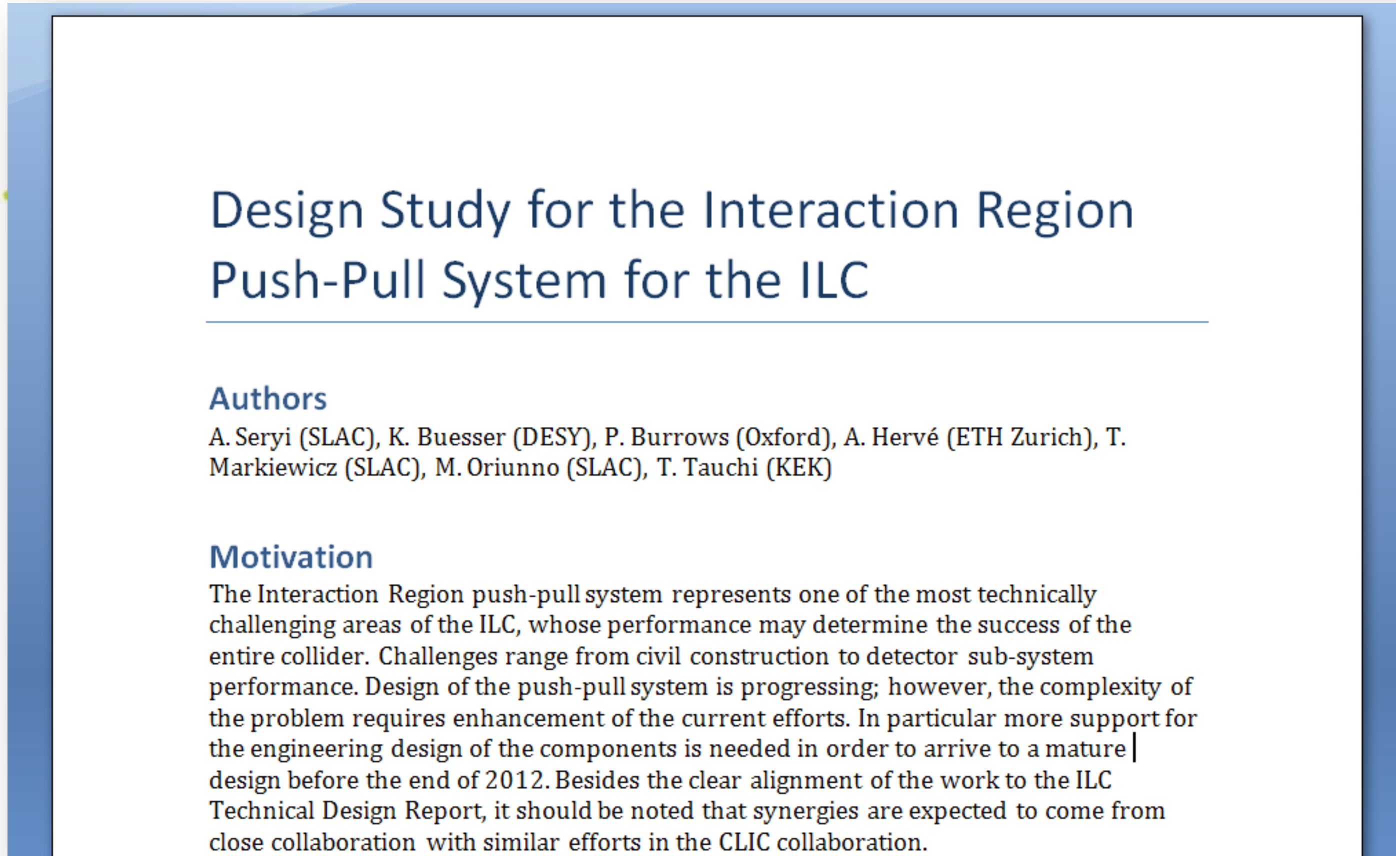


- Slower than 1/L* dependence of Lum => ↑L*
- Reduced feedback latency – several iteration of intratrain feedback over 150ns train
- FD placed on tunnel floor, which is ~ten times more stable than detector – easier for stabilization
- Not limited by sizes of stabilization system or interferometer hardware
- Reduced risk and increased feasibility
- May still consider shortened L* for upgrade

New concept of CLIC push-pull IR hall



- New concept brings the stable tunnel closer to FD, helping to achieve its better stability



Design Study for the Interaction Region Push-Pull System for the ILC

Authors

A. Seryi (SLAC), K. Buesser (DESY), P. Burrows (Oxford), A. Hervé (ETH Zurich), T. Markiewicz (SLAC), M. Oriunno (SLAC), T. Tauchi (KEK)

Motivation

The Interaction Region push-pull system represents one of the most technically challenging areas of the ILC, whose performance may determine the success of the entire collider. Challenges range from civil construction to detector sub-system performance. Design of the push-pull system is progressing; however, the complexity of the problem requires enhancement of the current efforts. In particular more support for the engineering design of the components is needed in order to arrive to a mature design before the end of 2012. Besides the clear alignment of the work to the ILC Technical Design Report, it should be noted that synergies are expected to come from close collaboration with similar efforts in the CLIC collaboration.

- A plan for enhanced engineering efforts on push-pull design has been developed by MDI team in early 2010
- This plan requires additional engineering resources
- The ways to realize the plan are being now developed

Details of the plan

- The Push-pull plan defines the tasks that need to be performed to arrive to a robust design
- A possible distribution of tasks among the participants (present and future) has been developed
- Detailed plan with intermediate milestones will be developed taking into account available resources

Elements of the plan…

1. Design an IR hall for three distinct configurations:
    a. Deep site as at FNAL or CERN; b. Deep site with inclined access shafts as in Japan; c. Shallow site with open IR hall as in Dubna.
2. For the considered detectors, optimize the detector layout, sizes, and segmentation iterating on radiation, external magnetic field, mechanical resonances, and other requirements.
3. For the considered three versions of the IR hall location and layouts, determine the optimal detector assembly procedure.
4. Study detector and its motion system vibration and stability characteristics, in Finite Element Analysis and experimentally, reaching sufficient predicting capabilities of the analysis for the entire system performance.
5. Evaluate and specify the sets of radiation, fire safety, seismic and other safety rules applicable for the IR designs.
6. Design and prototype the Final Doublet and verify its stability with appropriate set of measurements.

...Elements of the plan

7. Design IR vacuum system allowing sufficiently quick disconnection and providing suitable, from the background point of view, vacuum level.
8. Design and prototype the intra-train feedback system, taking into account its possible interference with FD stability and radiation effects on its electronics.
9. Design and prototype the FD-surveying interferometer network.
10. Design the alignment systems for the Final Doublet, vertex, and internals of the detector, so that they are capable of working in unison.
11. Design suitable cryogenics system allowing flexible vibration-free connections to the Final Doublet.
12. Design an appropriate radiation shield, taking into account relevant radiation, seismic safety, and other rules.

Parameters

- SB 2009 parameter development (end 2009 – early 2010)
  - Optimization of cost / performance
    - Central region integration
    - Lower current with tighter & travelling focussing
    - Same Luminosity at nominal energy
    - Challenge at lower E due to reduced collision rate
- LCWS10 – discussion of the parameter set and tentative evaluation of double rep rate at low E
  - A solution to restore Luminosity at low E was found
- Mid 2010 – development of the new parameters and finalization of a tentative set
- BAW-2 – January 2011

New parameters based on the following assumptions

- Starting point: parameters developed by the Physics Questions Committee (B. Foster, A. Seryi, J. Clarke, M. Harrison, D. Schulte, T. Tauchi) in December 2009.
- Take into account progress on 10Hz rep rate for low E achieved after LCWS10
  - There are issues with DR duty cycle that are being studied, however assume that they will be solved
- Assume that we will develop and use new universal FD that gives additional luminosity improvement (only) for 200 and 250 GeV energies
- Consider the following energies: 200, 250, 350, 500 GeV CM
- Assume single stage bunch compressor (min sigma_z=230um – will use 300um and consider 230 as an overhead or safety margin)
- Assume 10Hz and 1300 bunches
- Consider separately the cases with and without Travelling Focus
- Energy and rep rate:

E=	200	250	350	500	GeV CM
IP rep rate	5	5	5	5	Hz
Linac rate	10	10	5	5	Hz
	(double pulsing)				

BAW-2 Themes

								upgrade
Centre-of-mass energy	E_{cm}	**GeV**	**200**	**230**	**250**	**350**	**500**	**1000**
Luminosity	L	$\times 10^{34}$ cm^{-2}s^{-2}	**0.5**	**0.5**	**0.7**	**0.8**	**1.5**	**2.8**
Luminosity (Travelling Focus)	L_{TF}	$\times 10^{34}$ cm^{-2}s^{-2}	**0.5**		**0.8**	**1.0**	**2.0**	
Number of bunches	n_b		1312	1312	1312	1312	1312	2625
Collision rate	f_{rep}	Hz	5	5	5	5	5	4
Electron linac rate	f_{linac}	Hz	10	10	10	5	5	4
Positron bunch population	N_+	$\times 10^{10}$	2	2	2	2	2	2

Formally agreed parameter sets across energy range
ILC-EDMS document ID 925325

http://ilc-edmsdirect.desy.de/ilc-edmsdirect/document.jsp?edmsid=*925325

BAW-2 Issues

Travelling Focus	• More detailed simulations required • Stability issues → impact on feedback and tolerances • considered higher-risk option • Inclusion not a cost issue
10Hz Operation (Low E_{cm})	• Positron damping ring 50% duty cycle • RF solution still required (this workshop) • Understanding cost impact (1.9% TPC) • Other emerging options (high-field undulator)
Upgrade / Risk-Mitigation	• Understand scenarios for re-establishing RDR bunch number • Cost impact (mostly CFS) • Considered either as possible luminosity upgrade or risk-mitigation (GDE PAC)

Physics impact ⟷ Working with Physics & Detector groups as part of the TLCC process

Obvious Conclusions

- MDI aspects to focus on
  - Push-pull, Final Doublet, Parameters, …
- Essential to connect accelerator and detector physics and engineering
- Most efficient would be to have frequent (~bi-weekly) events for tracking and coordination