SiD Collaboration Meeting

2-3 March 2009

SLAC

MDI & Cryo System design

Marco Oriunno, SLAC

Outline

Part 1

The MDI functional requirements document

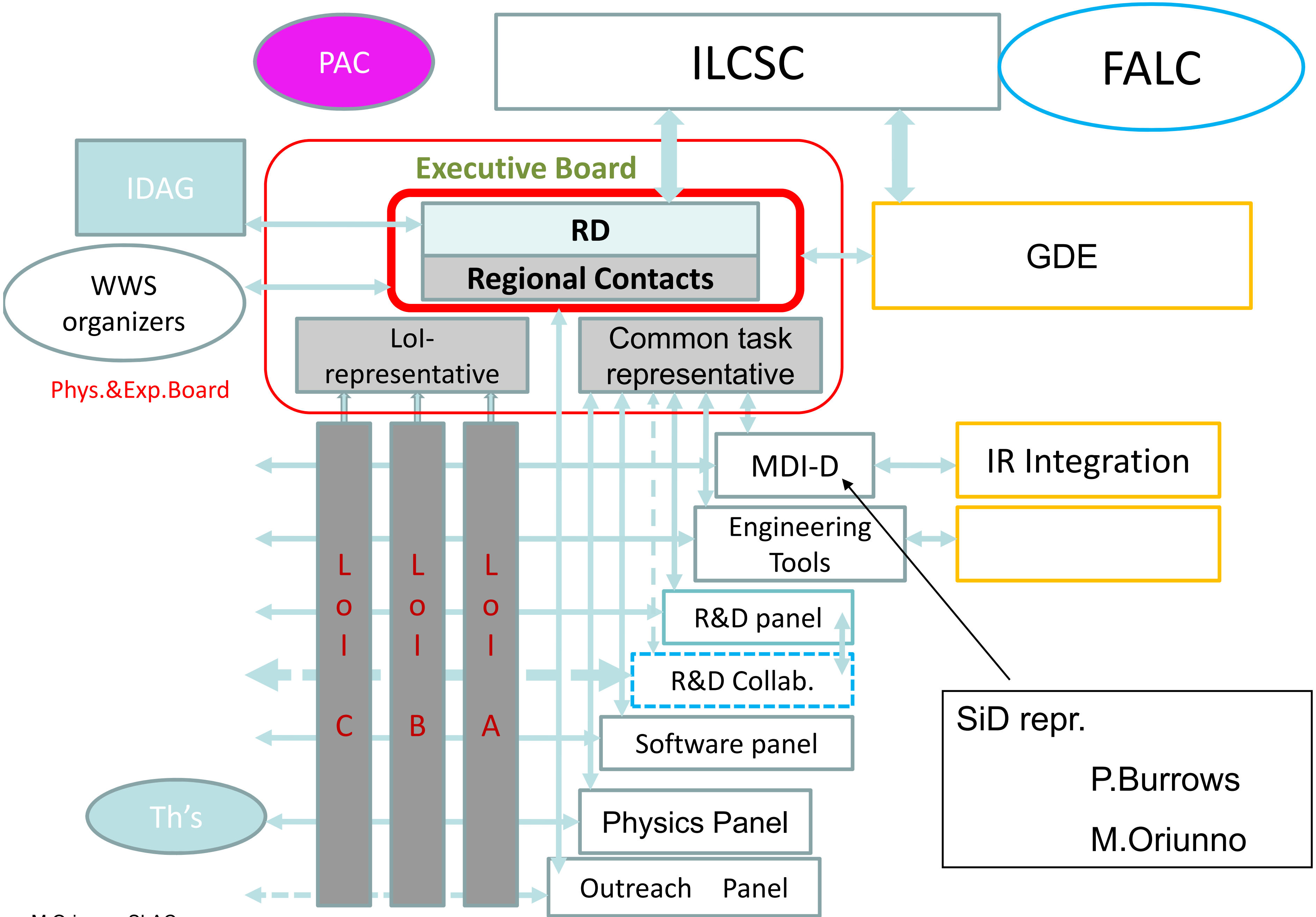
Part 2

Update on MDI activities related to SiD

Part 1

The MDI functional requirements document

Jan.09,2008


PAC
ILCSC
FALC
IDAG
Executive Board
RD
Regional Contacts
GDE
WWS organizers
LoI-representative
Common task representative
Phys.&Exp.Board
MDI-D
IR Integration
Engineering Tools
R&D panel
R&D Collab.
Software panel
Physics Panel
Outreach Panel
Th's
L o I C
L o I B
L o I A
SiD repr.
P.Burrows
M.Oriunno

MDI functional requirements document

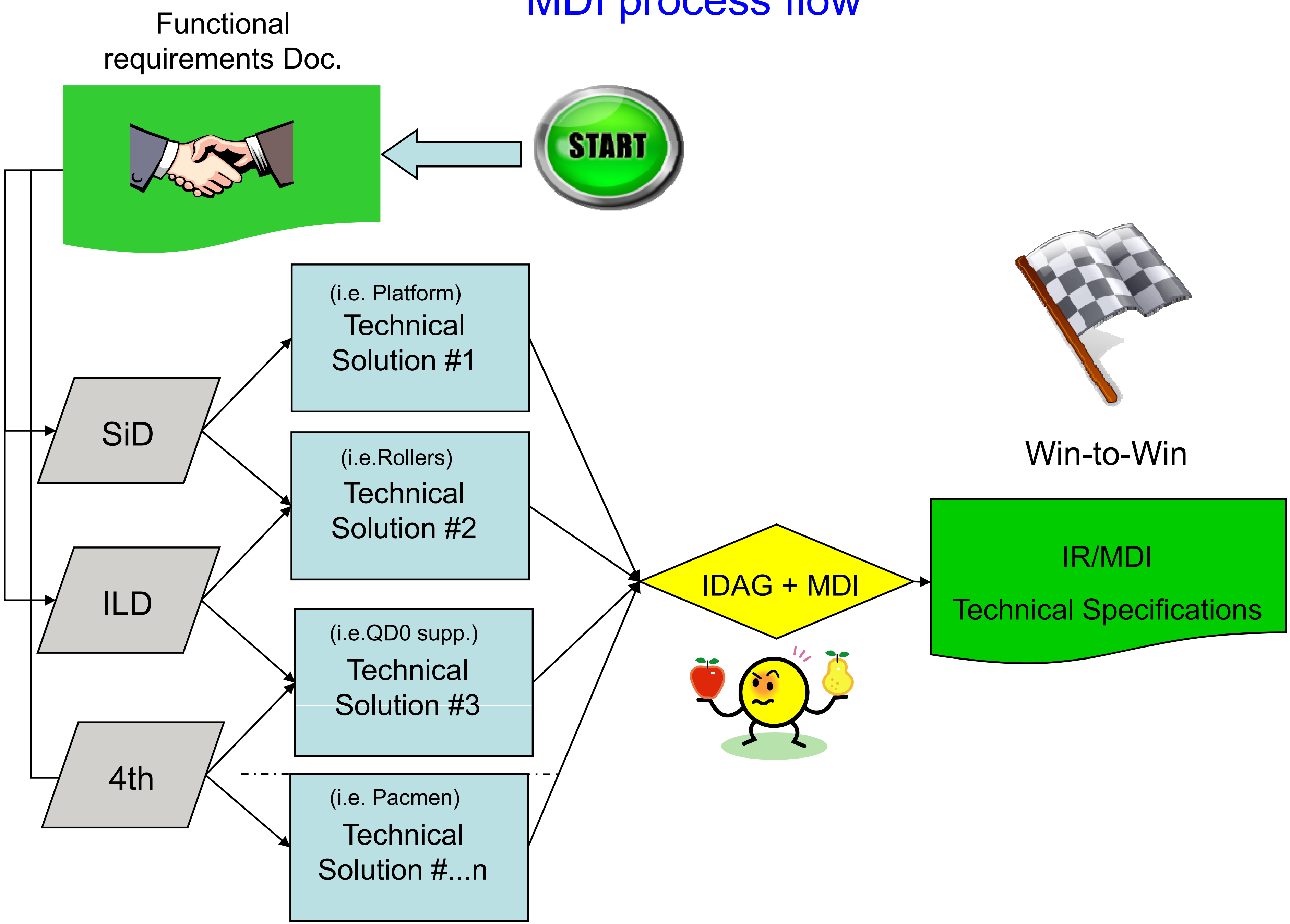
1. The document attempts to separate the functional requirements of a push pull interaction region and Machine Detector Interface from the conceptual and technical solutions being proposed by the ILC Beam Delivery Group and the three detector concepts.

2. It provides a set of ground rules for interpreting and evaluation the MDI parts of the proposed detector concept's Letters of Intent.

3. Each detector concept is expected to endorse it or suggest amendments before the submission to the IDAG Research Director. The due date is March 2009

4. The authors of the present paper are the leaders of the IR Integration Working Group within Global Design Effort Beam Delivery System and the representatives from each detector concept submitting the Letters Of Intent.

MDI process flow



Functional requirements

List of Contents

Final Doublet

Elapsed time for an exchange of detectors

- *Roll out time*
- *Roll in time*
- *Cryogenic safety assumptions*

Vacuum

Beam feedback system

Beam-Beam parameter space

QD0 support and alignment

Length of IR Hall

Beam height above the reinforced floor of the IR cavern

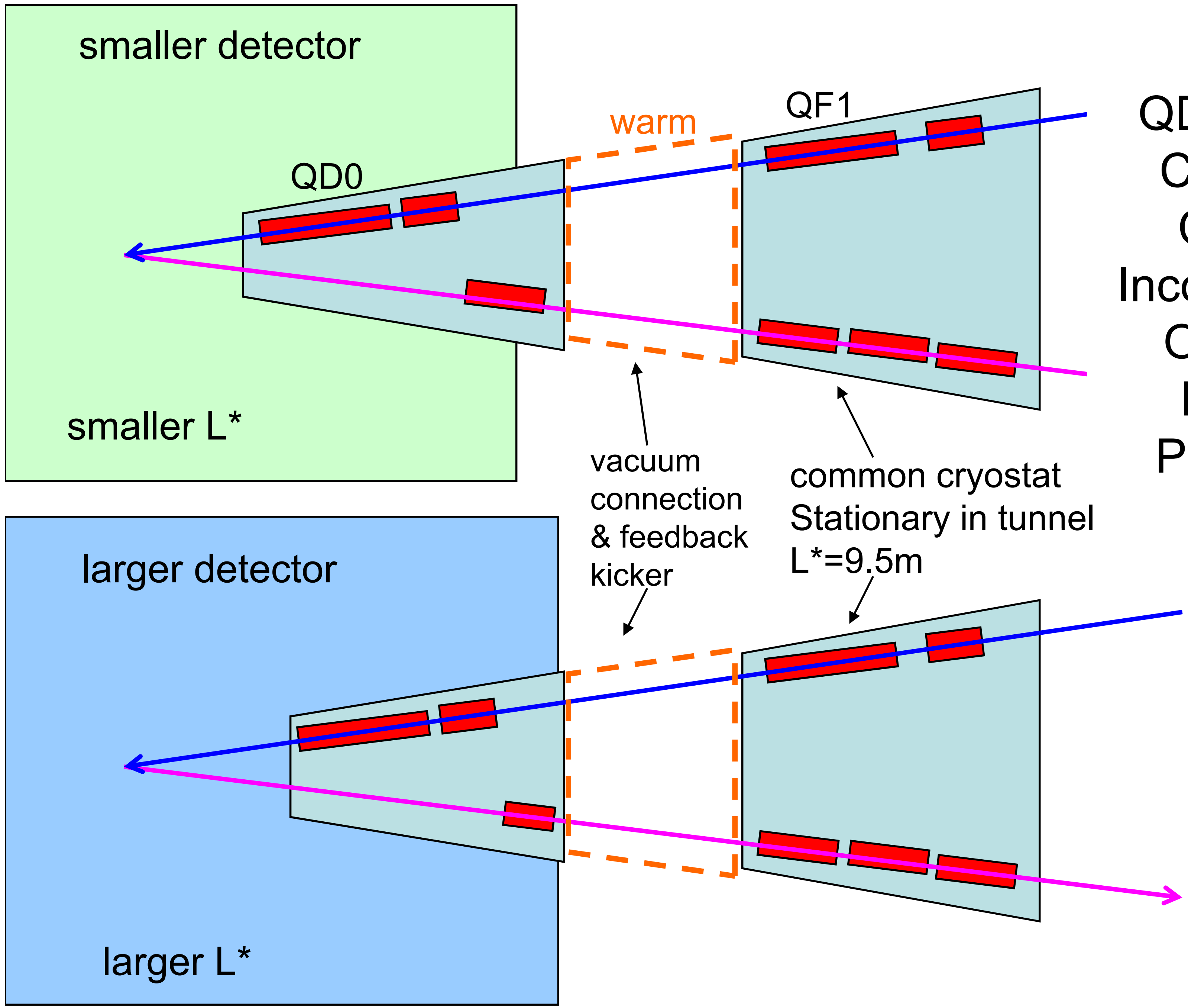
Radiation environment

Magnetic environment

- The garage area housing the off beam line detector
- The beam line
- The area around the on beam line detector

Final Doublet

- A rapid exchange of detectors is possible only if the QD0 final doublet, moves with and is supported by the detector.
- QF1 remains stationary during a detector exchange. It begins magnetically at 9.5m from the IP
- The range of allowable QD0 L*is set to 3.5m < L* < 4.5m for the LOI. Each concept may choose an L* appropriate for their design within this range.
- It is further assumed that QD0 is connected to a service cryostat located within approximately 10m of QD0 and from which it is rarely, if ever, disconnected. The service cryostats for each side of the IP are assumed to move with the detector.
- Proof of principle engineering designs of QD0 and its cryostat exist. It, provides 1.9°K super fluid helium to the QD0 magnet package and can handle 14W of static heat load and 1W dynamic heat load.



QD and QF Cryostats Contain Incoming and Outgoing Magnet Packages

Seryi

Elapsed time for an exchange of detectors

1. It is premature at this stage to specify time requirements for detectors interchange, but it is naturally assumed that the two detectors will share beam time equally.

2. It is preferable to agree on how roll out time and roll in time are to be measured and then to ask the concept groups to supply credible estimates of the required times that can be used as figures of merit in the evaluation of the concept

3. A working assumption is that the scheduled “time on beam line” would be about 25x the length of time required for a detector exchange; thus a 1 day turnaround would allow a detector interchange approximately every month and 1 week turnaround would mean one data run per detector per year.

Definitions of "*Roll Out Time*"

- Roll out time would begin with the preannounced end of ILC operations and would end when the detector leaving the zone could grant safe beneficial occupancy of the agreed on floor area and any shared resources (e.g. crane) to the entering detector.

- It would include any time required to dismantle and store shielding that had been required to keep the off-beam line detector safe in its waiting position ((garage)

Definitions of "*Roll In Time*"

• Roll in time would begin with granting of beneficial occupancy to the on-beam line floor area and would end when the appropriate safety authorities allows personnel access to newly garaged detector independent of the program of the newly installed detector.

• Time required to align the final doublet or detectors and to make the IR safe for beam delivery would eat into the pre-allotted running time as would any special beam requests

• At this point it is assumed that the time required to re-commission the ILC to nominal luminosity is short and has been worked into the allowed time on beamline.

Cryogenic Safety Assumptions

Allowing for push-pull times in the order of one day requires the de-energized magnet systems of the superconducting solenoids and the QD0 magnets to be moved cold.

This could be realized by either using adequately engineered flexible cryogenic low-pressure transfer lines, or by moving the cold boxes together with the detectors.

In the latter case adequately engineered warm helium transfer lines could be used. Both solutions seem to be feasible but more engineering design and evaluation is required before to finalize this very important issue.

Vacuum

• The main vacuum system interface requirement is that each concept provides a pair of valves to isolate the detector-carried beampipe from the two ports from which delivered and extracted beams exit and enter the IP-side of each of the QF1 cryostats and a system to pump down the detector-resident portion of the beamline after it is reconnected to BDS .

• Vacuum in the BDS upstream of the detectors will be provided by the BDS. One analysis of the effect of beam gas interactions on detector backgrounds set the required vacuum level at 1 nTorr in the 200m upstream of the IP and 10 nTorr in the remainder of the BDS system.

• This paper did not attempt to specify the maximum permissible vacuum pressure in the 18m zone of the detector itself.

• It is assumed that each detector concept will investigate this limit and provide a technical means of providing it within the space constraints of their detector design.

Beam Feedback System

Luminosity feedback as described in the RDR is required for luminosity optimization at the ILC.

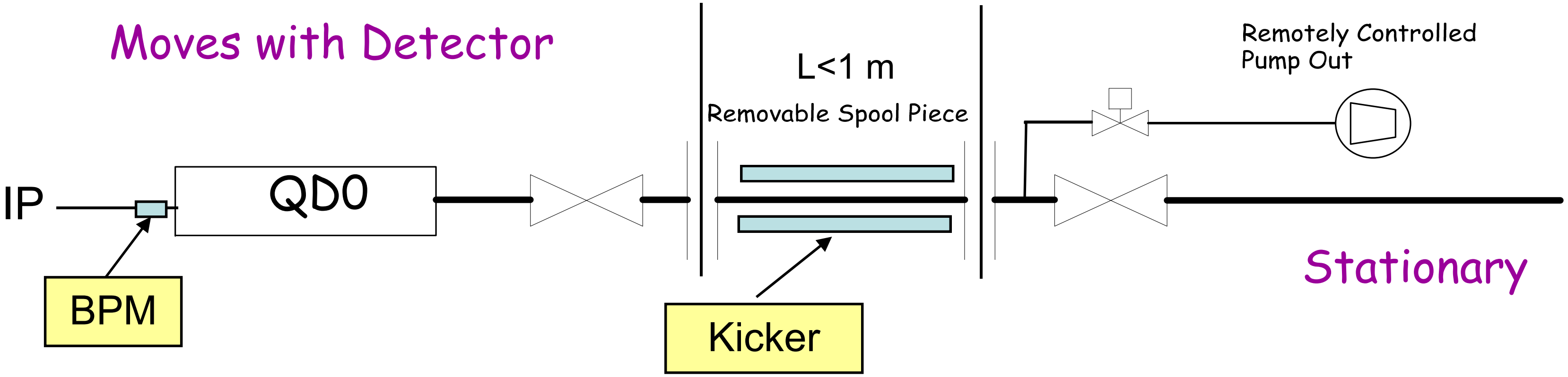
The spool piece mating the back end of the QD0 cryostat to the QF1 cryostat houses a strip-line kicker to correct the beam position.

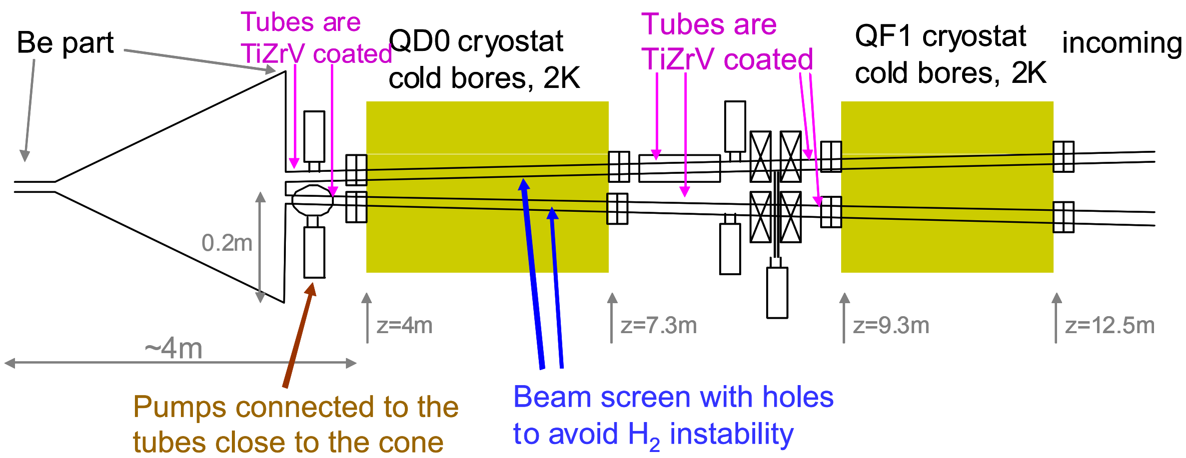
Given the allowed variation in QD0 longitudinal position (L*) and the fixed position of QF1, the length of this spool piece and perhaps of the kicker itself is variable.

It is required a background free BPM signal sensitive to beam centroid position after the beam-beam deflection.

The canonical position for this BPM is after any “Beam-Cal” device and before the QD0 cryostat. Space for this BPM, nominally set at about 10cm length, must be incorporated into the beam line design of each concept.

FB Instrumentation & Vacuum Design and Push Pull





Present vacuum requirements :

P < 1nT in the BDS

P < 100nT in the experimental region

•We may rely on the cryopumping from QD0

•We do not need extra pumps

•We do not need periodic bake out *in situ.*

Open point :

•The beam instrumentation required

•Shut-off valves

Beam-Beam parameter space

Each detector concept must be able to function when the beams are tuned to the nominal IP parameters specified in the RDR.

This requirement effectively defines the minimum beam pipe radius at the IP and the size of the exit apertures in the forward Beam-Cal, given the sensitivity and integration time of the concept's chosen detector technologies to background hits.

Discussions to expand the beam-beam parameter space to include, for example those labeled in the RDR as Low N, Large Y and Low P, as well as to develop parameter sets for other center of mass energies, are ongoing.

For the LOI, it has been agreed that each concept comment on the impact the non-nominal parameter sets might have on detector performance.

QD0 support and alignment

The detector-carried QD0 cryostat must be adequately aligned and stable.

The detector brings the QD0 magnet close enough to the BDS beam line, as defined by a line through the stationary QF1 magnets,

> Detector axis alignment accuracy: ± 1 mm and 100 μrad from a line determined by QF1s
>
> Detector height adjustment range: +/- several cm, tbd after site selection and geologic study

The detector provides a means to finely adjust the QD0 package using the beam to bring it within the capture range of the inter-bunch feedback Number of degrees of freedom: 5

> Range per degree of freedom: ± 2mm
>
> Accuracy per degree of freedom: ± 50 μm

The control of the movers will remain under control of the BDS system during operation. The movers may be periodically adjusted during a run to keep luminosity at its maximum value.

It is assumed that each detector will provide a means of verifying the alignment of the QD0 cryostat to the stated accuracy before low current beam operations begin.

Length of IR Hall belonging to the “on-beam” detector

We assume that once the off-beamline detector has moved so as to clear 15m of floor space from the beamline it is in its safe “garaged” location.

The minimum distance required so that the radiation and magnetic environment in the “garage” can be calculated, is 15m.

Beam height above the reinforced floor of the IR cavern

10-12m for the beam height above the IR caverns’s bare steel-reinforced floor, is assumed as working number.

It is required that the smaller detector provides the support to come up to nominal beam height.

Radiation Environment

Radiation shielding is essential with two detectors occupying the same Interaction Region hall.

The on beamline detector should either be self-shielded or it will need to assume responsibility for additional local fixed or movable shielding (walls).

Whatever the technical choice, the running detector is responsible to provide radiation safety without access control to the personnel maintaining the off beamline detector.

Each detector should include shielding considerations in their analysis of the length of time required to move onto or off of the beamline and to state the expected impact on the IR Hall infrastructure

Radiation environment, continued

The final radiation safety will include criteria for both normal operation and for protection in the event of the worst case beam loss accident.

The criteria of the shielding design for the LoI are the following :
• *Normal operation*: the dose anywhere beyond the 15m zone housing the off-beamline detector should be less than 0.5 μSv/hour.
• *Accidental beam loss*: simultaneous loss of both e+ and e- beams at 250 GeV/beam anywhere, at maximum beam power. In that case, the dose rate for occupational workers in zones with permitted access should be less than 250mSv/h and the integrated dose less than 1mSv per accident.

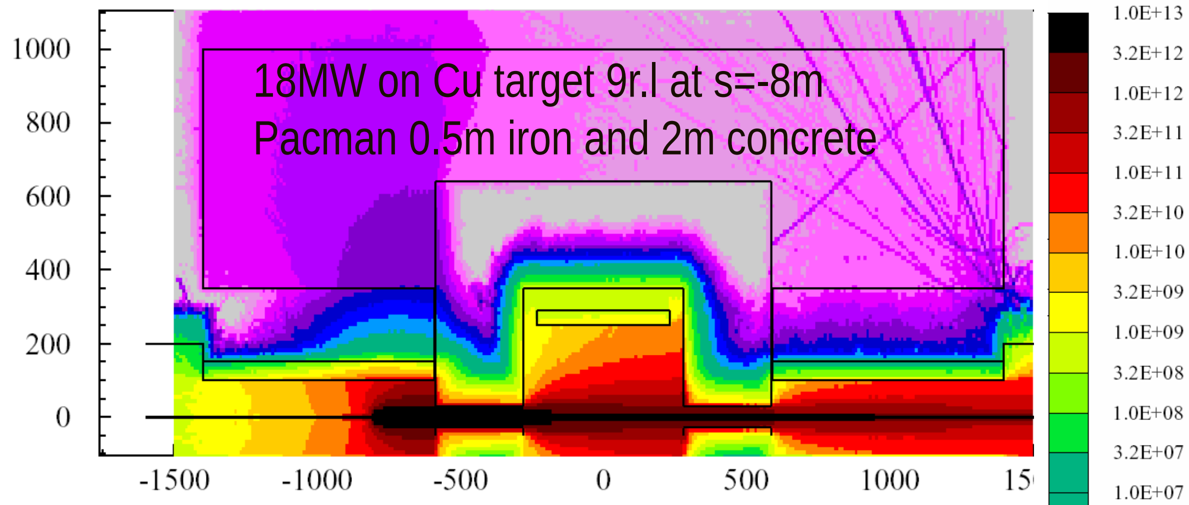
The implied emergency beam shut-off system is assumed to stop beam delivery after 1 beam train.

Each concept will present the results of a credible simulation.

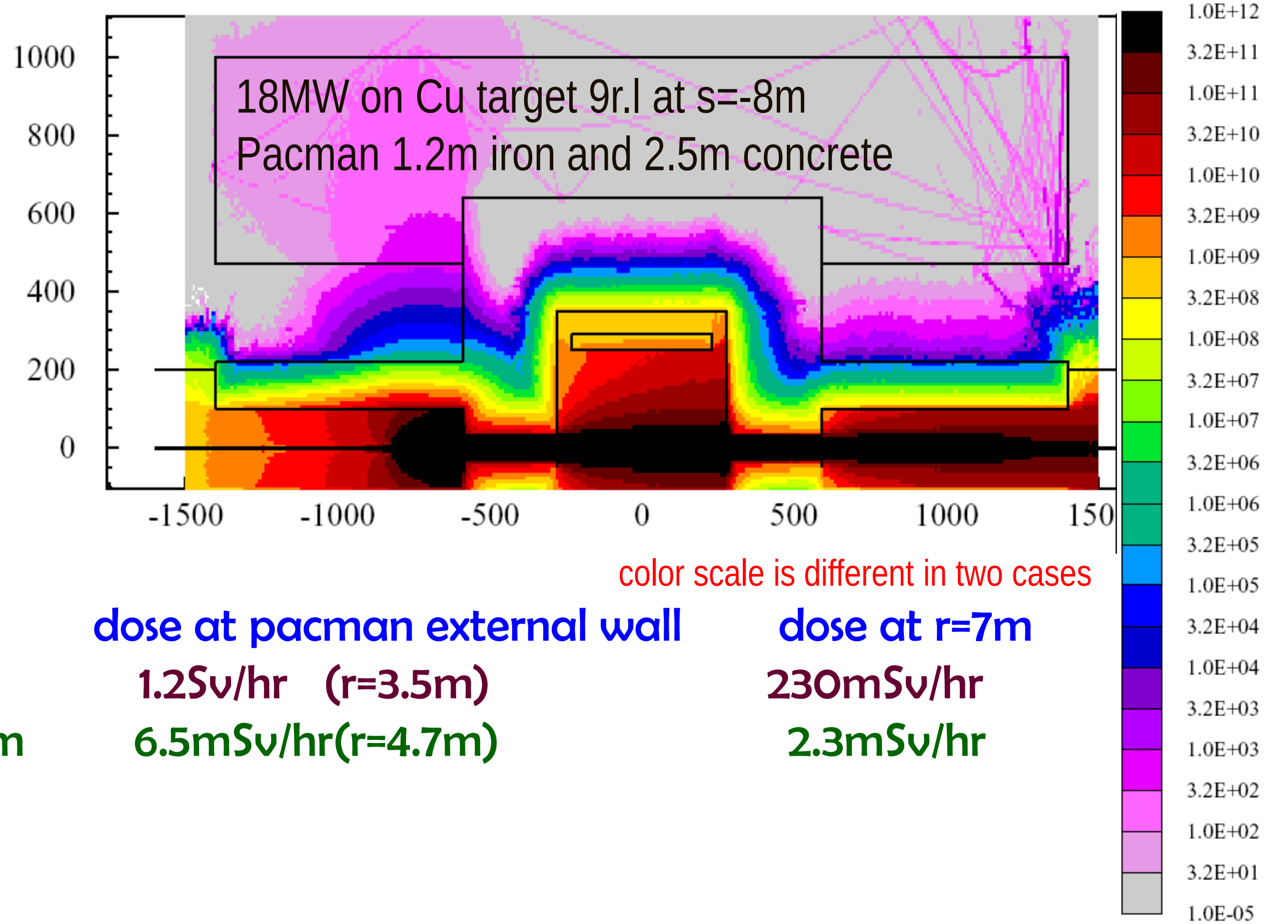
The on-beamline detector may chose to satisfy the criteria through some use of administrative access control and/or engineering control, depending on the level of access they feel is desirable or required while the detector is running.

Self-shielding Example

Adjusting pacman to reduce dose below 250mSv/hr



Desired thickness is in between of these two cases



color scale is different in two cases

18MW at s=-8m: Packman	dose at pacman external wall	dose at r=7m
Fe: 0.5m, Concrete:2m	1.2Sv/hr (r=3.5m)	230mSv/hr
Fe: 1.2m, Concrete: 2.5m	6.5mSv/hr(r=4.7m)	2.3mSv/hr

Magnetic environment

The requirements on the magnetic field outside of detector operating on the beamline will define the amount of iron in the detector

We agree to base our working numbers for the upper limits for personal safety on the values in force at CERN:

- 5 Gauss (0.5 mTesla) for people wearing pacemakers
- 100 Gauss (10 mTesla) for the general public
- 2000 Gauss (200 mTesla) for occupational exposure.

The magnetic environment in the *garage area* housing the off beamline *detector* must be limited to 50 Gauss and individuals wearing pacemakers will be excluded.

We assume that effects of any static field outside of detector on the *beamline* can be corrected.

The area around the on-beamline detector

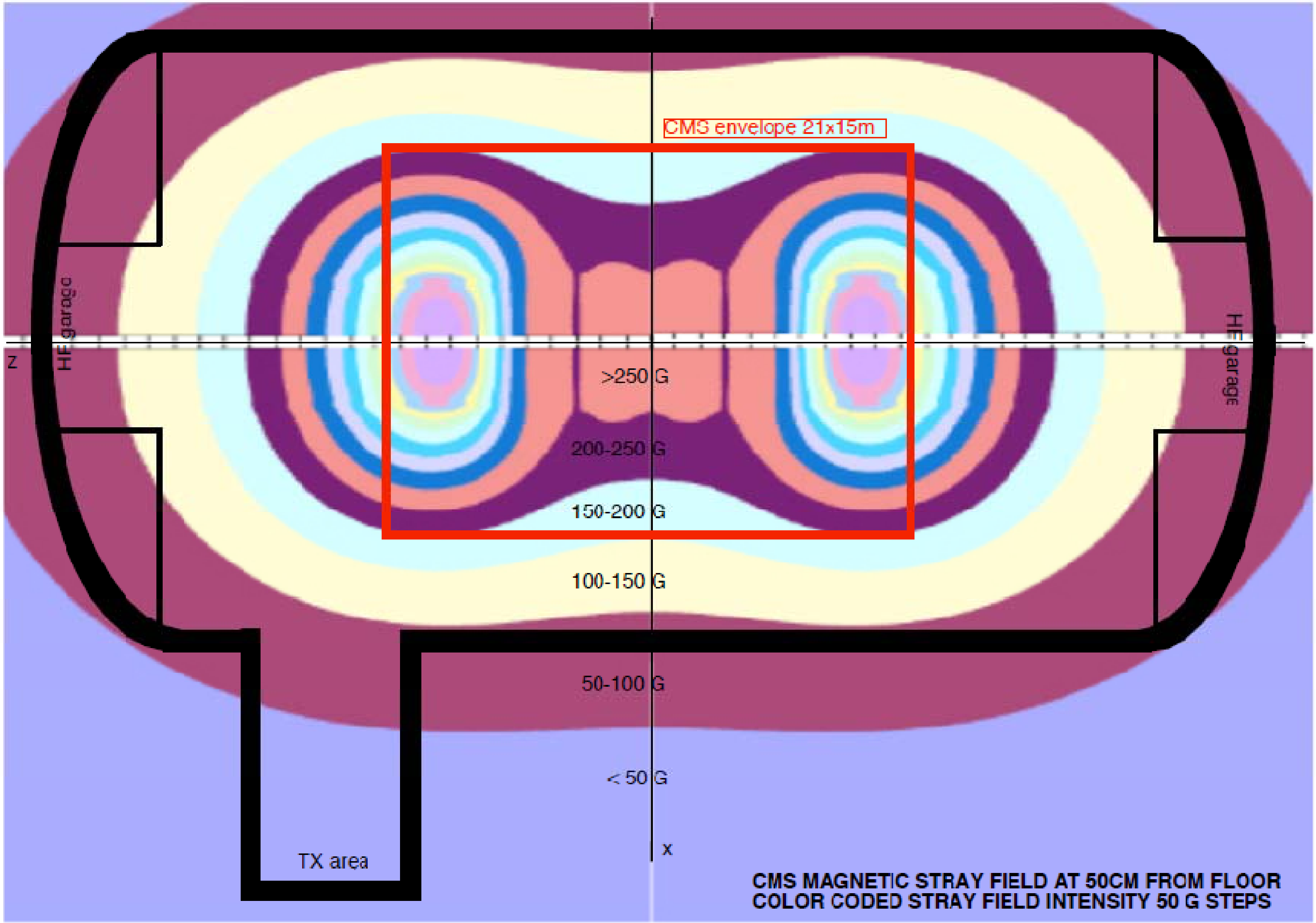
- Human Safety: 2000 Gauss, with denial of access for people with pacemakers and the
general public
- Operation of magnetically sensitive equipment: at the complete discretion of the detector group

Magnetic environment, continued

When the off-beamline detector may wish to operate its solenoid while in its garage, the distortion of the magnetic field map of the on-beamline detector due to such operation must be less than 0.01% of the field anywhere inside the on-beamline detector's tracking volume, both for steady state operation and transitory event, such as ramp-up or an unforeseen quench of a superconducting solenoid.

It is incumbent on that detector (normally the on-beamline detector) to guarantee the safety of personnel working in the zone of the second detector (normally the off-beamline detector) against any transitory event that could conceivably provoke an accident.

CMS Magnetic Stray field at 50cm from the floor



DISCUSSION

To progress in many of these areas a degree of mutual cooperation and discussion between pairs of detectors who propose to share the IR is required.

It seems likely at this point that both the eventual detectors will need to agree on a common technology for locomotion; a moveable platform does not appear to be compatible with a detector which rolls on a bare floor on either rollers or air pads.

The ILD and SiD concepts which present themselves as “self-shielded” need to discuss which elements of their shielding mate.

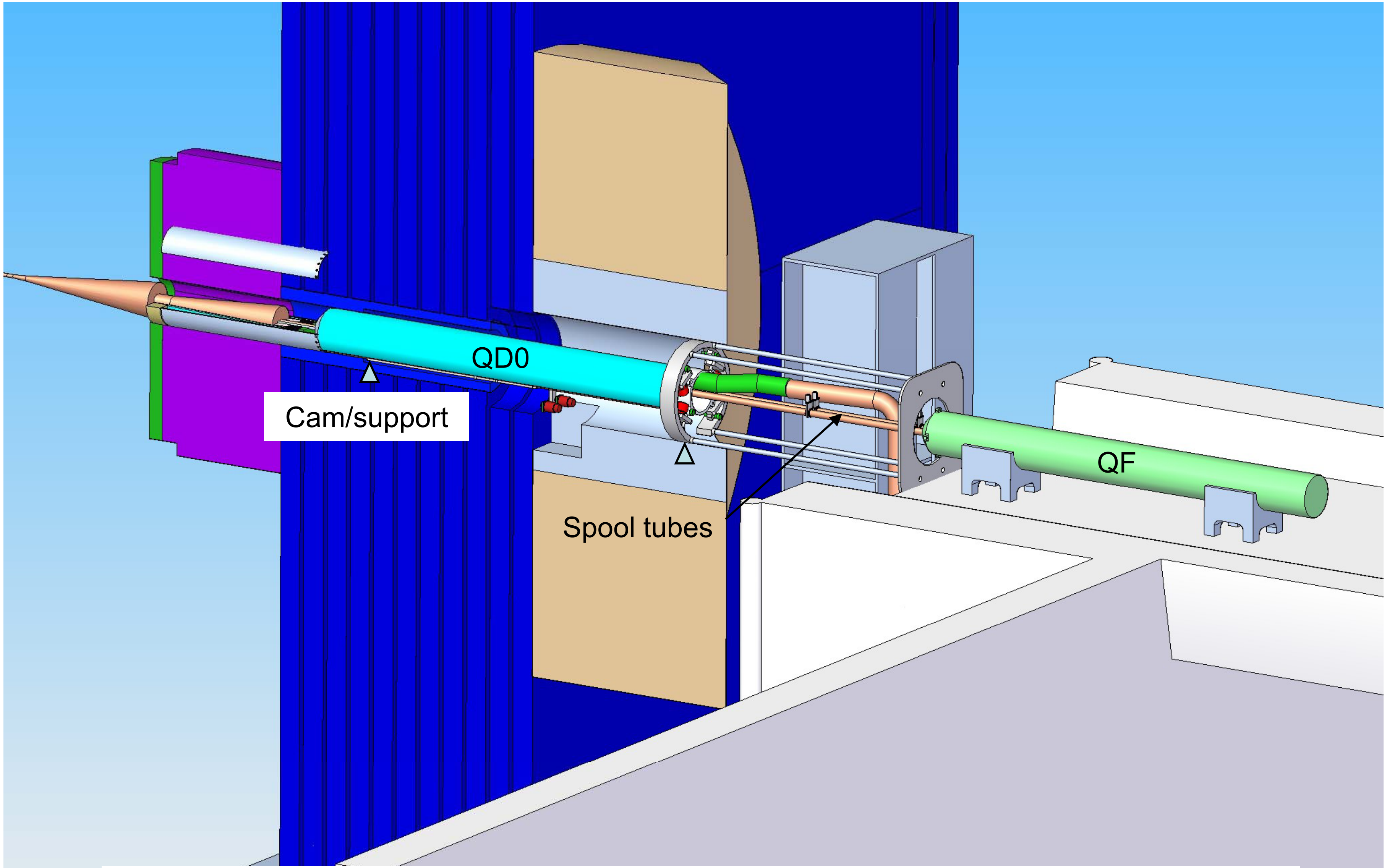
Each of these two concepts need to seriously engage the advocates of the iron-free 4th Concept to understand the impact of shielding blocks on hall size and crane capacity and coverage.

While these discussions may occur after the delivery of the LOI, the evaluation of the concepts would be certainly aided by any agreed technical solutions that could be described.

Part 2

Update on MDI activities related to SiD

MDI Snapshot (compliant with all items in the MDI document)



See most recent talk “SiD MDI status LCWS08, Chicago

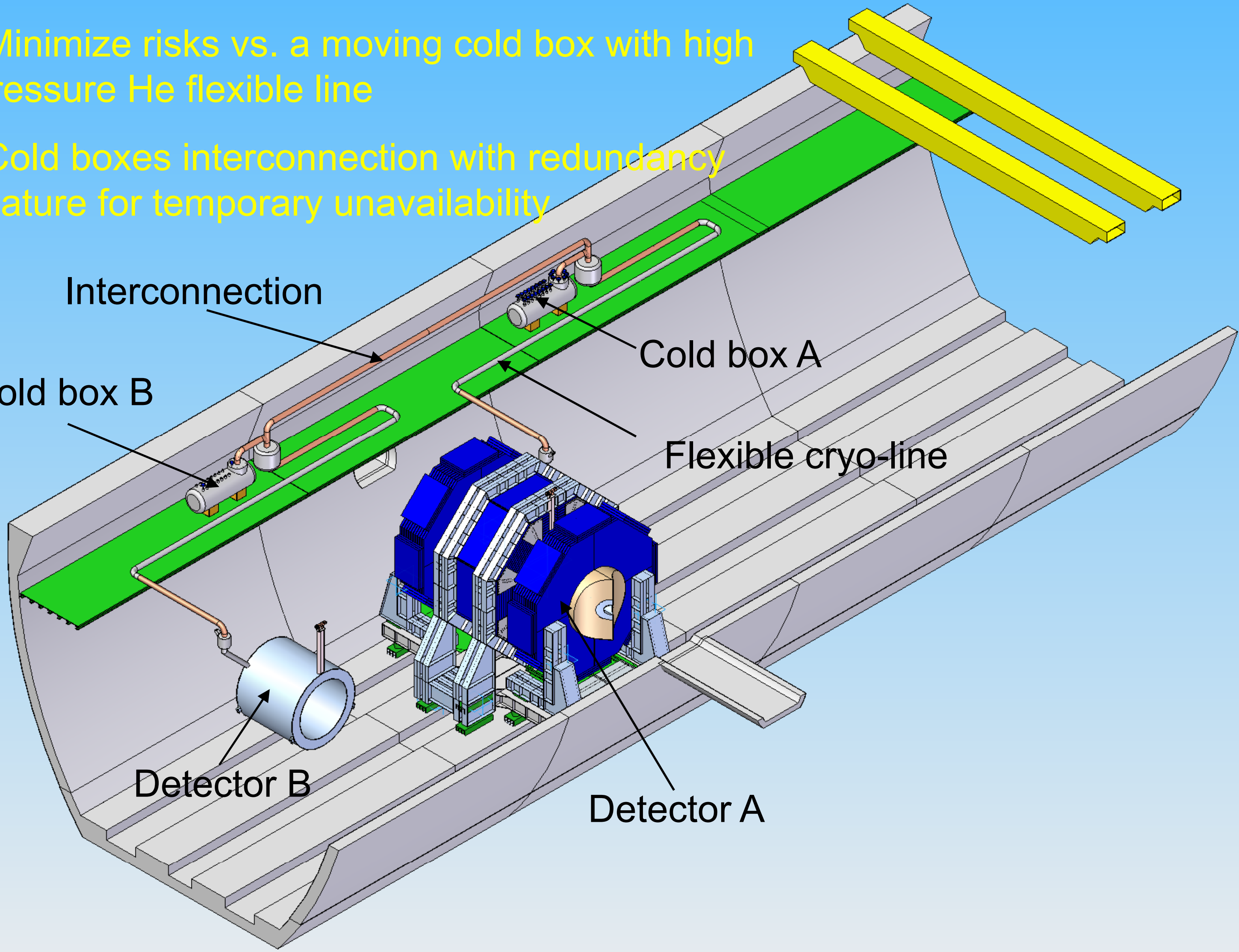
http://ilcagenda.linearcollider.org/getFile.py/access?contribId=255&sessionId=13&resId=0&materialId=slides&confId=2628

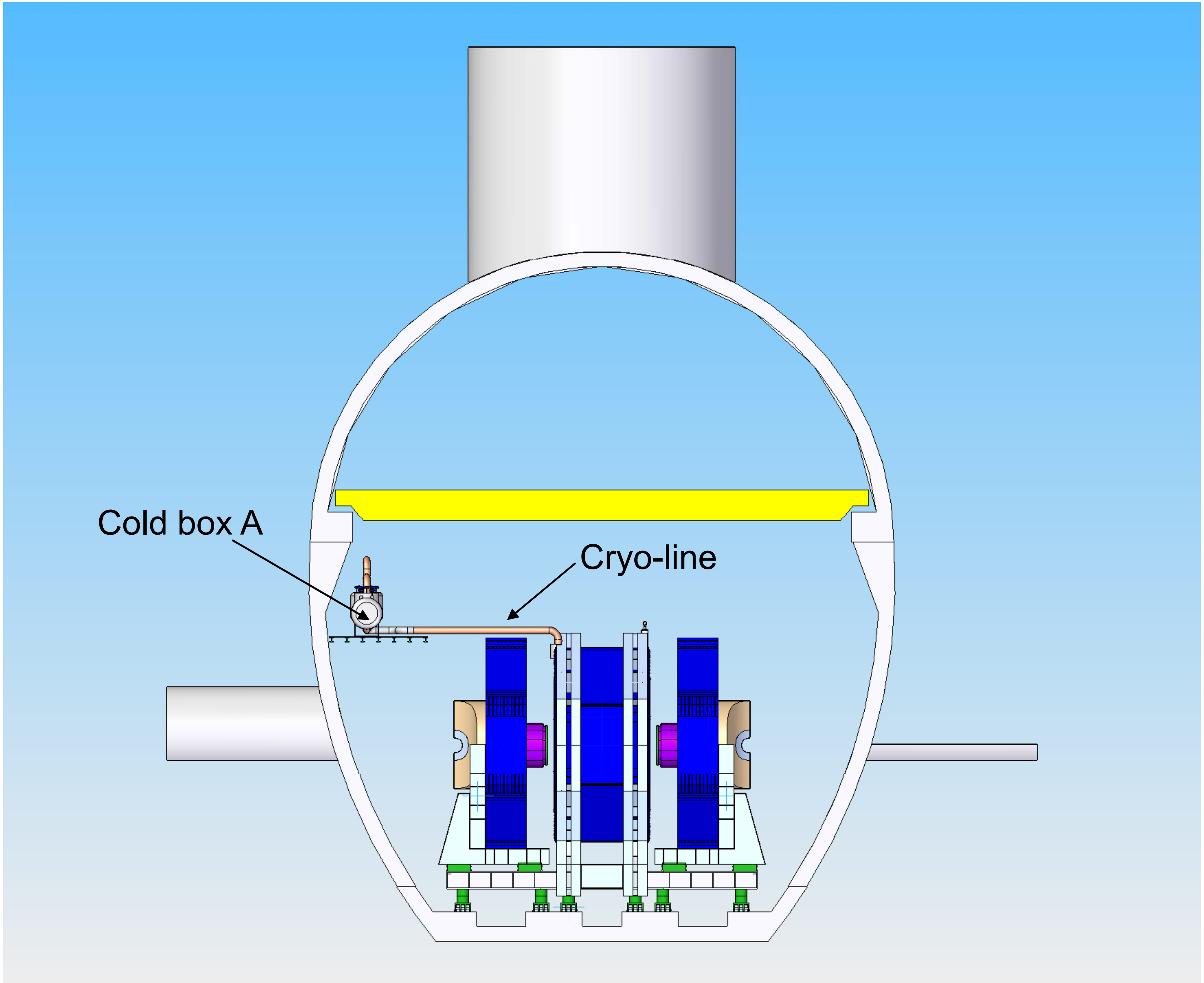
Cryogenics system design for push-pull

•Stationary cold box with flexible cryo-transfer line

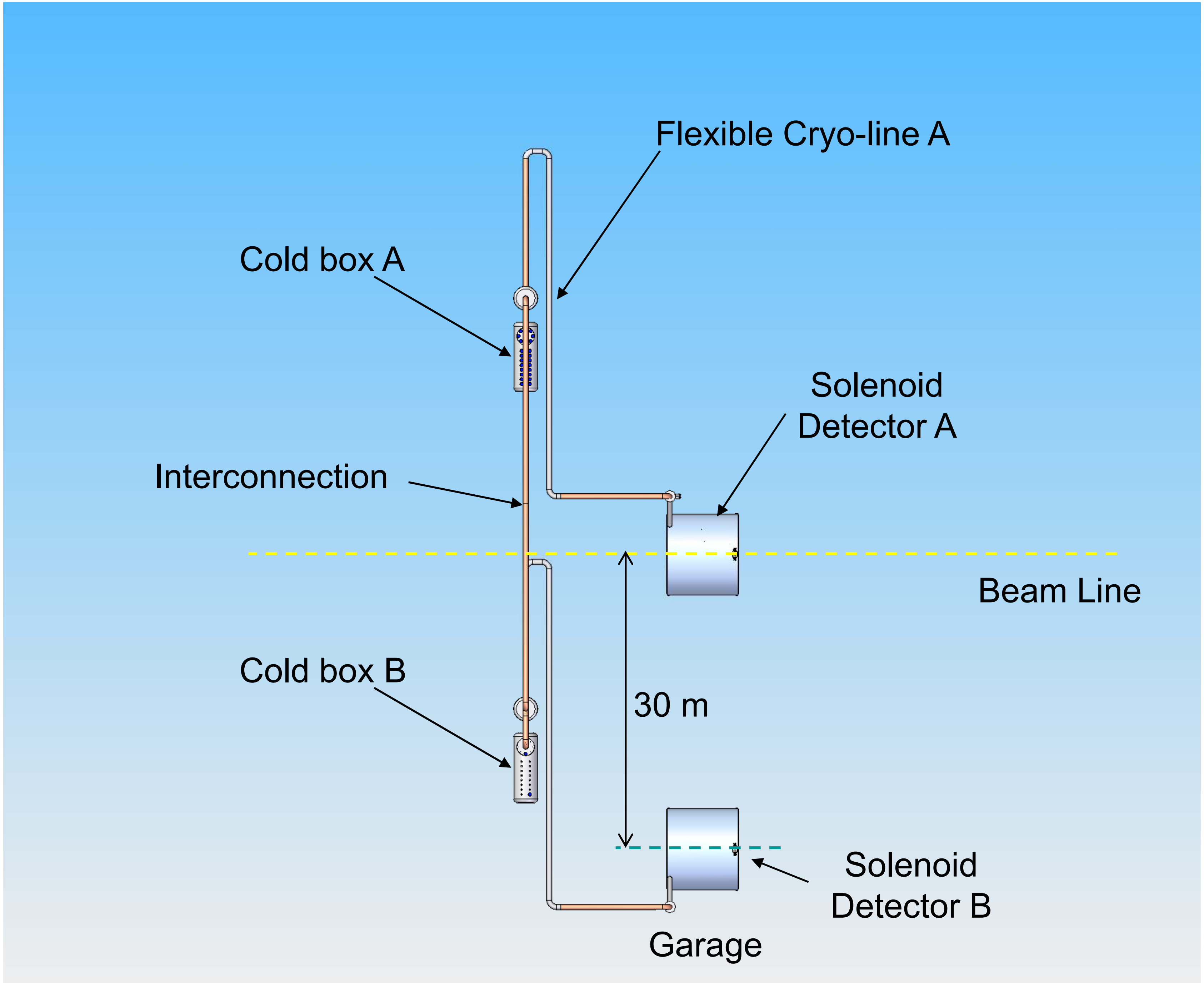
•Minimize risks vs. a moving cold box with high pressure He flexible line

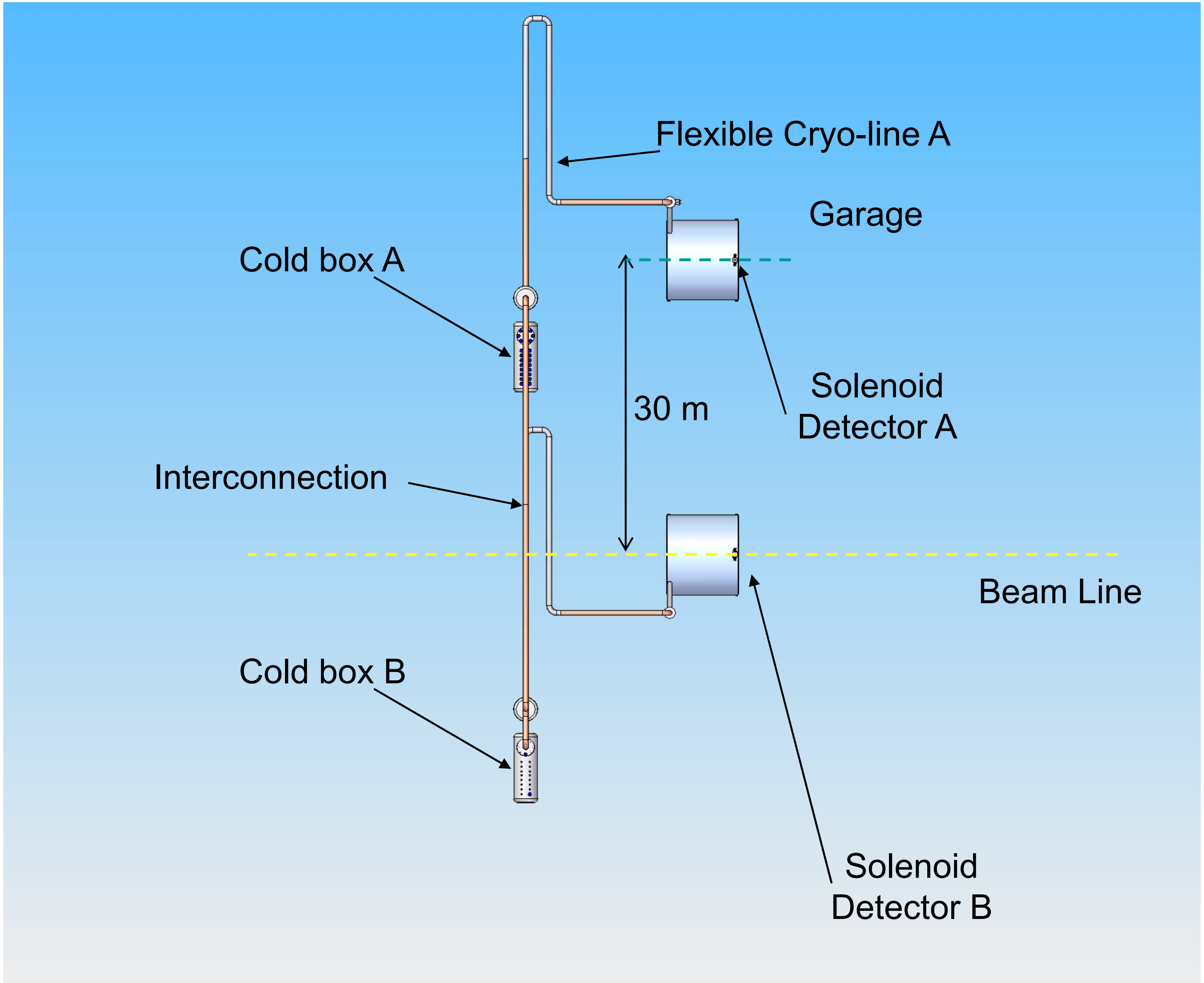
•Cold boxes interconnection with redundancy feature for temporary unavailability





Detector open on the beam line

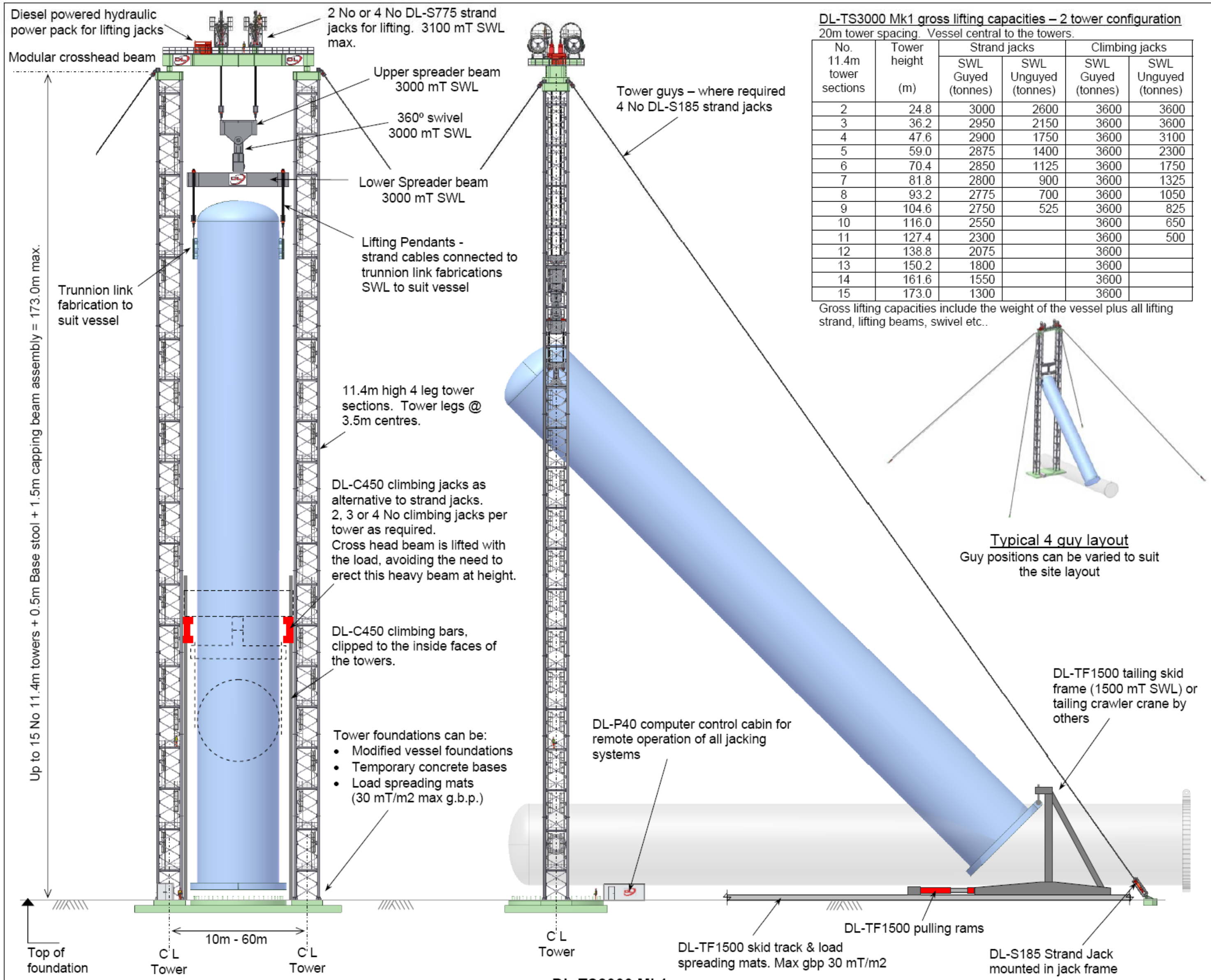

Flexible Cryo-line A
Cold box A
Solenoid Detector A
Interconnection
Beam Line
Cold box B
30 m
Solenoid Detector B
Garage


Flexible Cryo-line A
Garage
Cold box A
30 m
Solenoid
Detector A
Interconnection
Beam Line
Cold box B
Solenoid
Detector B

Assembly Scenarios

- There appears to be a debate between surface and below ground assembly.
- However:
  - The major detector modules will be assembled elsewhere. This obviously includes the VXD, Tracker, EMCal, and HCal.
  - The muon detectors can be loaded into the iron elsewhere.
  - The solenoid will be wound elsewhere.
  - The amount of cabling and services on SiD is tiny compared to the LHC detectors.
- Therefore, we can choose among:
  - Assemble the barrel and doors above ground and lower the ~4Ktonne barrel and two ~2Ktonne doors.
  - Final assembly of the major steel components below ground. Depending on steel design, components might weigh 100-500 tonnes. The solenoid with calorimeters weighs ~700 tonnes, but calorimeters could be inserted later.
- Actual strategy depends on details of site and schedules

Gantry Crane for the surface assembly option



DL-TS3000 Mk1
(2 tower guyed configuration shown)

DL-TS3000 Mk1 gross lifting capacities – 2 tower configuration

20m tower spacing. Vessel central to the towers.

No. 11.4m tower sections	Tower height (m)	Strand jacks		Climbing jacks	
		SWL Guyed (tonnes)	SWL Unguyed (tonnes)	SWL Guyed (tonnes)	SWL Unguyed (tonnes)
2	24.8	3000	2600	3600	3600
3	36.2	2950	2150	3600	3600
4	47.6	2900	1750	3600	3100
5	59.0	2875	1400	3600	2300
6	70.4	2850	1125	3600	1750
7	81.8	2800	900	3600	1325
8	93.2	2775	700	3600	1050
9	104.6	2750	525	3600	825
10	116.0	2550		3600	650
11	127.4	2300		3600	500
12	138.8	2075		3600	
13	150.2	1800		3600	
14	161.6	1550		3600	
15	173.0	1300		3600	

Gross lifting capacities include the weight of the vessel plus all lifting strand, lifting beams, swivel etc..

Typical 4 guy layout
Guy positions can be varied to suit the site layout

Notes:

General

The DL-TS3000 Mk1 can be used in 2 tower or 4 tower configuration, guyed or unguyed, and using either strand jacks or climbing jacks for lifting. The system can self erect and self dismantle to avoid the need for a large tower erection crane. Vessels can be lifted, skidded laterally and rotated as required to suit delivery position. All jacking systems are monitored and controlled from ground level by a single operator using the DL-P40 computer control system. All items are transported in standard shipping containers.

Specification

Lifting capacity:	See table
Lifting speed:	10-30 m/hr
Max tower spacing:	60m
Max lifting wind speed:	20 m/sec
Max storm wind:	40 m/sec @ 10m
Operating temp:	-20 to +50 deg
Foundation options:	see drawing
Guys:	4 x 185 mT SWL

Unguyed towers can only resist 40 m/sec storm winds up to 6 towers high with cross beam at top for strand jacks and 7 towers high where no top cross beam used, i.e. in climbing jack configuration.

The information provided on this drawing is intended for initial evaluation purposes only. DLT will provide a detailed proposal for each project giving more specific information.

Rev	Date	Status	Description	By
A	20/03/07	INF	First issue	TB

Dorman Long Technology

www.dormanlongtechnology.com

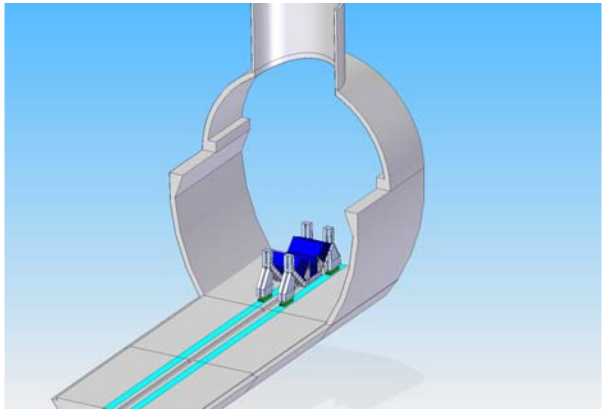
Project: DL-TS3000 Mk1

Drawing Title: DL-TS3000 Mk1 General arrangement and duty charts for guyed and unguyed configurations

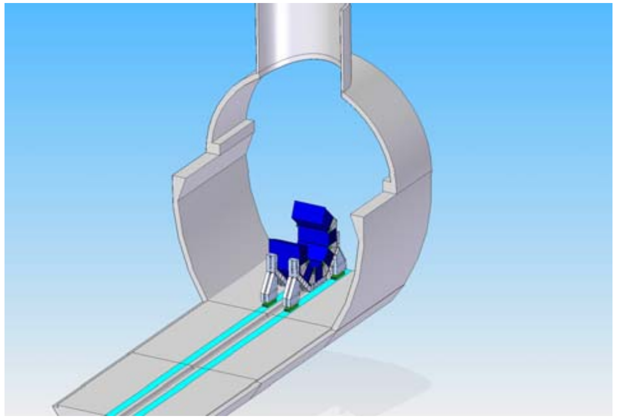
Design Eng:	GG	Checking Eng:	PW
Drawn By:	DD	Project Eng:	MO

Drawing Status: INFORMATION

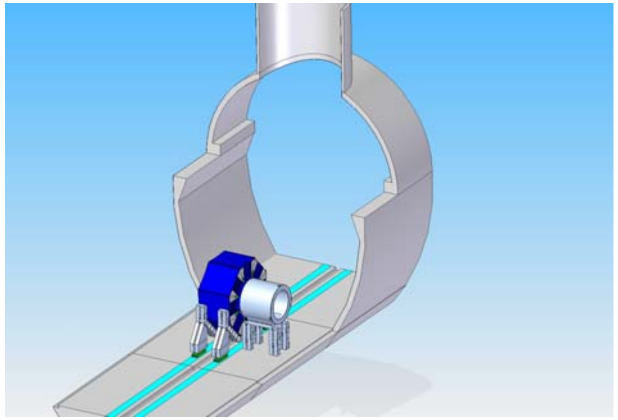
Drawing No.	Sheet.	Rev.
DL-TS3000/001		A



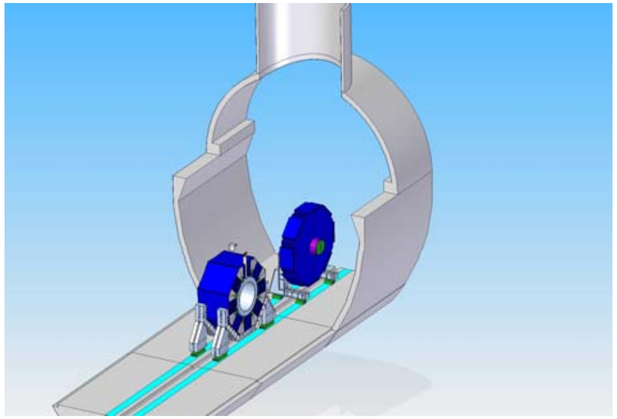
1



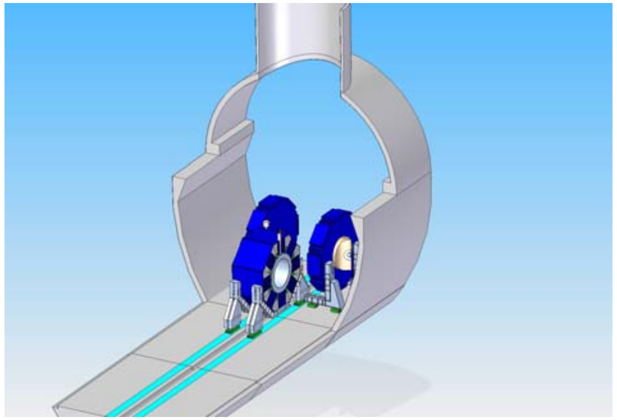
2



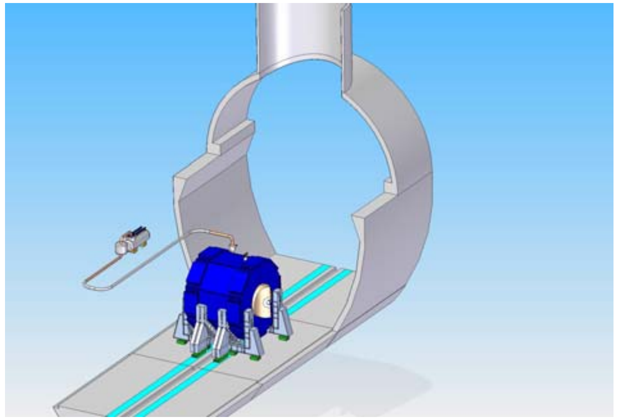
3



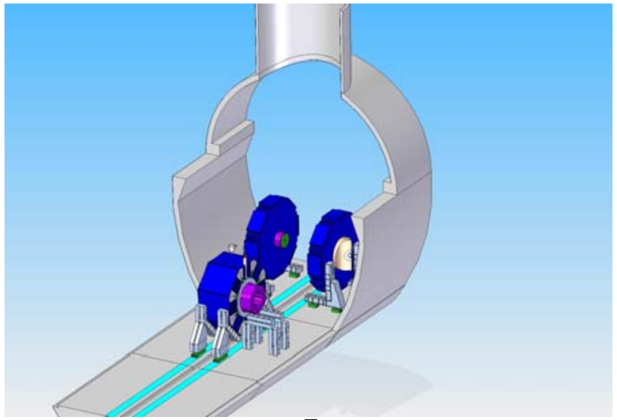
4



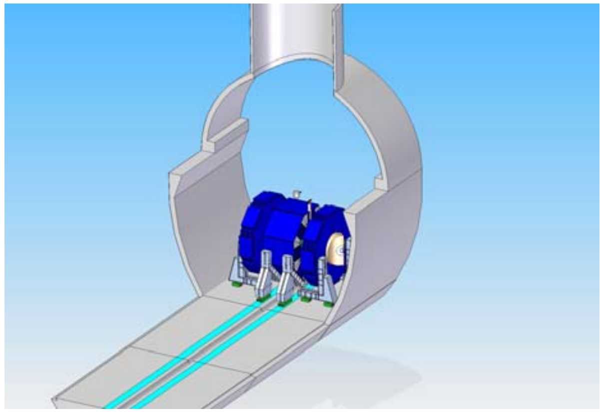
5



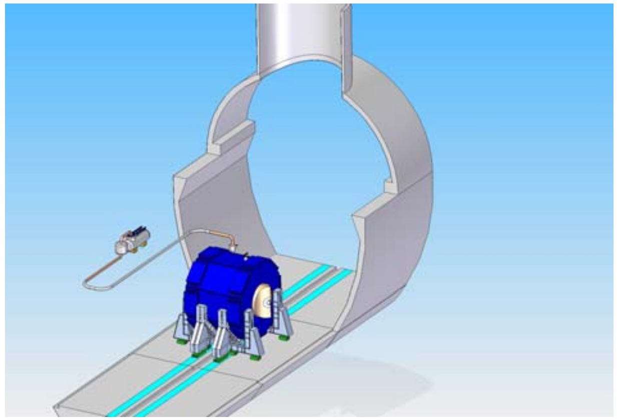
6



7



8



9

IDAG questions

IDAG wishes the proponents of the 3 LOI's to address the following points in their LOI document:

(1) Sensitivity of different detector components to machine background as characterized in the MDI panel.

(2) Calibration and alignment schemes.

(3) Status of an engineering model describing the support structures and the dead zones in the detector simulation

(4) Plans for getting the necessary R&D results to transform the design concept into a well-defined detector proposal.

(5) Push-pull ability with respect to technical aspects (assembly areas needed, detector transport and connections) and maintaining the detector performance for a stable and time-efficient operation.

(6) A short statement about the energy coverage, identifying the deterioration of the performances when going to energies higher than 500 GeV and the considered possible detector upgrades.

(7) How was the detector optimized: for example the identification of the major parameters which drive the total detector cost and its sensitivity to variations of these parameters.