Push-pull Operation

T. Tauchi (KEK)

3rd ILD Workshop, Ewha Womans University, Seoul, Korea,

16-18 February,2009

Basic Questions

(1) What is a maximum integrated luminosity for one experimental period/cycle, since "neither detector should be able to get a significant luminosity advantage in a single cycle" ?

Minimum integrated luminosity would be 4 fb^{-1} for Higgs "discovery" at the optimal CM energy which must be true with the LHC result. If not, 10 fb^{-1} would be needed at Ecm=500GeV. Slepton discovery has similar luminosity of 10fb^{-1}. Therefore, the maximum one should be less than 10fb^{-1}.

(2) What is a fraction for the switchover in order to satisfy the ILC physics scope?

Relevant scope is " Luminosity and reliability of the machine should allow the collection of approximately Leq = 500 fb^{-1} in the first four years of running" in "Parameters for the Linear Collider", R.Heuer, Chair of the Parameters Subcommittee (ILCSC), Update, November 20, 2006.

σ(fb)

10^6

10^3

1

10^{-2}

$\sum_{q\neq t} q\bar{q}$

$\mu^+\mu^-$

ZZ
$|\cos\theta|<0.8$

W^+W^-
$|\cos\theta|<0.8$

$t\bar{t}$ 175GeV

Zh
120GeV

$\tilde{\mu}^+_R\tilde{\mu}^-_R$
140GeV

H^+H^-
190GeV

$\tilde{\chi}^+\tilde{\chi}^-$
220GeV

$\tilde{\mu}^+_L\tilde{\mu}^-_L$
230GeV

HA
400GeV

H^+H^-
410GeV

500,00

5,000

50

Event/year for 50fb^{-1}

0 200 400 600 800 1000

$\sqrt{s}$ (GeV)

Switch-over Time

Assume that 500 fb^{-1} /4years is accumulated in each detector for the moment. So, each detector has the half luminosity of 1 x 10^{34} cm^{-2} s^{-1} with the design luminosity = 2 x 10^{34} cm^{-2} s^{-1}.

Relevant integrated luminosities are ;
Integrated L/year -> 129fb^{-1}/150days/y/10^{34} cm^{-2} s^{-1}
-> 0.86fb^{-1}/day/10^{34} cm^{-2} s^{-1},
-> 26fb^{-1}/month

So, the 4 year's integrated luminosity will be 516 fb^{-1} which can be compared to the required one of 500 fb^{-1}. So, the allowed fraction for switchover can be estimated to be 1- 500/516 = 0.031, which corresponds to 4.7 days.

The suggestion of "1 day switchover in every month" could be just in case. However, the monthly integrated luminosity of 26fb^{-1} may exceed the discover value.

ILC-Note-2009-nnn
March 2009
Version 1, 2009-01-26

Functional Requirements on the Design of the Detectors and the Interaction Region of an e^+e^- Linear Collider with a Push-Pull Arrangement of Detectors

B.Parker (BNL), A.Mikhailichenko (Cornell Univ.), K.Buesser (DESY),
J.Hauptman (Iowa State Univ.), T.Tauchi (KEK), P.Burrows (Oxford Univ.),
T.Markiewicz, M.Oriunno, A.Seryi (SLAC)

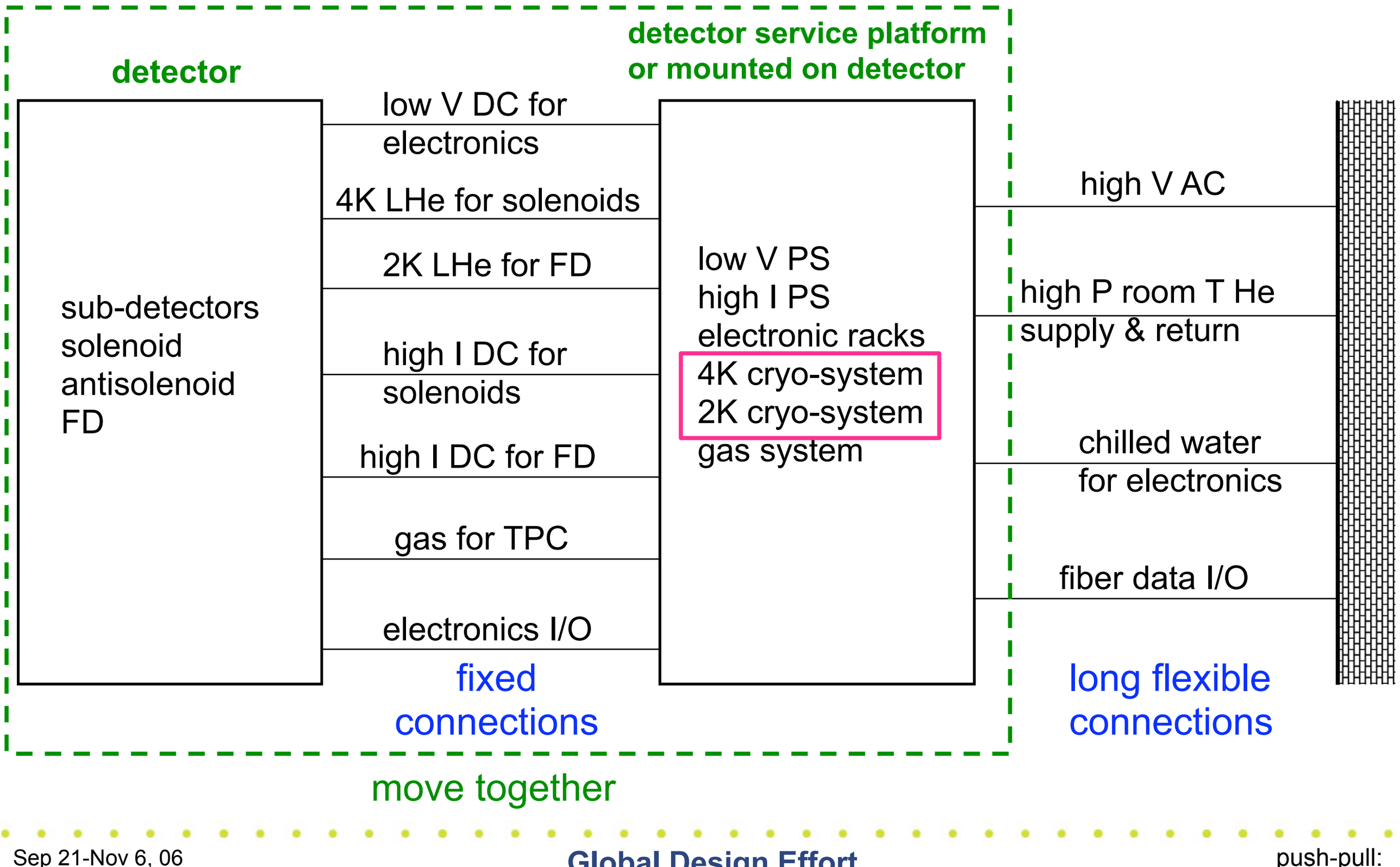
Abstract

The Interaction Region of the International Linear Collider [1] is based on two experimental detectors working in a push-pull mode. A time efficient implementation of this model sets specific requirements and challenges for many detector and machine systems, in particular the IR magnets, the cryogenics and the alignment system, the beamline shielding, the detector design and the overall integration. This paper 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]. As such, we hope that it provides a set of ground rules for interpreting and evaluation the MDI parts of the proposed detector concept's Letters of Intent, due March 2009. 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.

Switch-over time in this document

"A working assumption is that the scheduled "time on beamline" 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. "

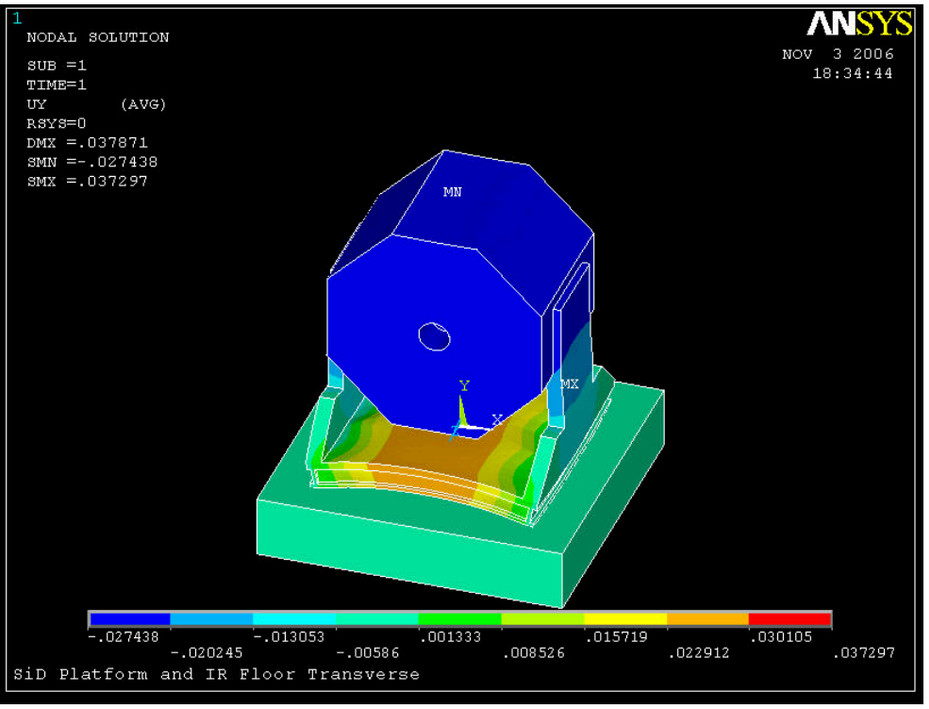
Detector systems connections

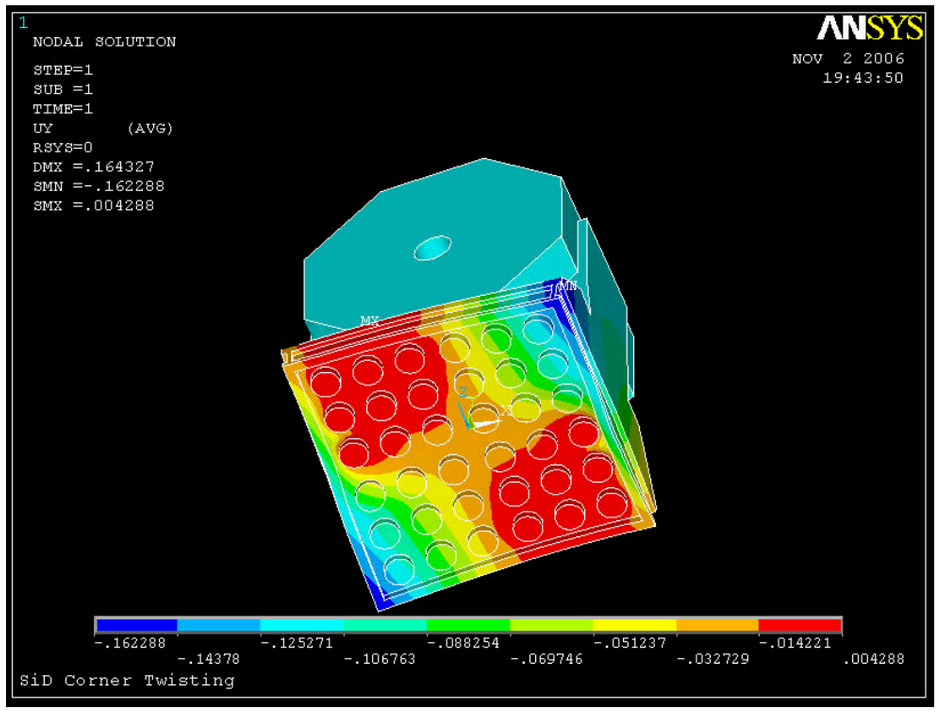


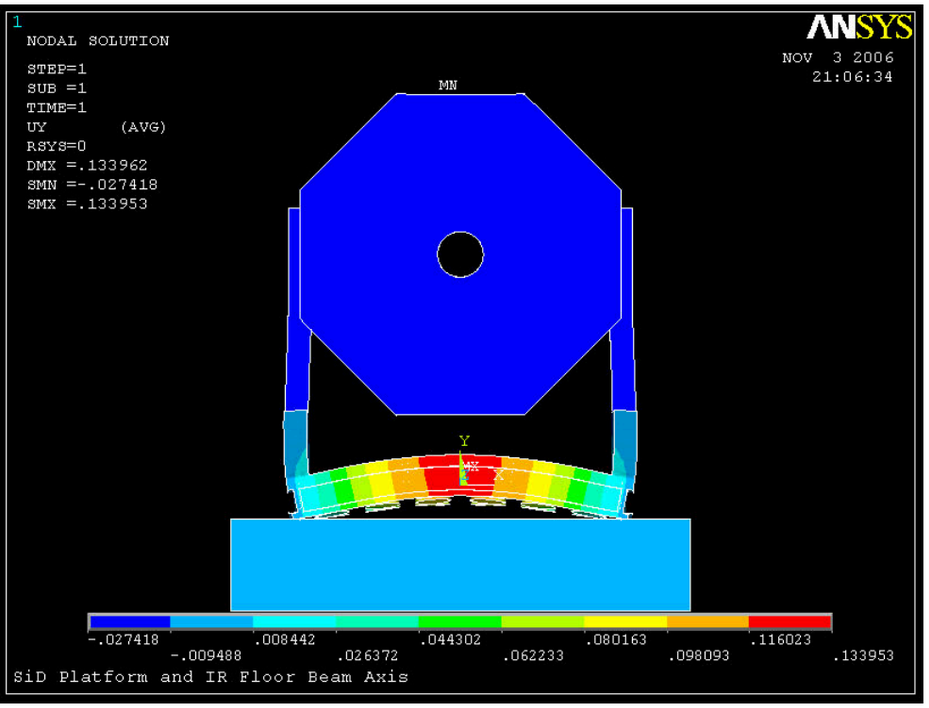
plat form :22m x 22m x 2m
closed in 30min. (descendant UA1)

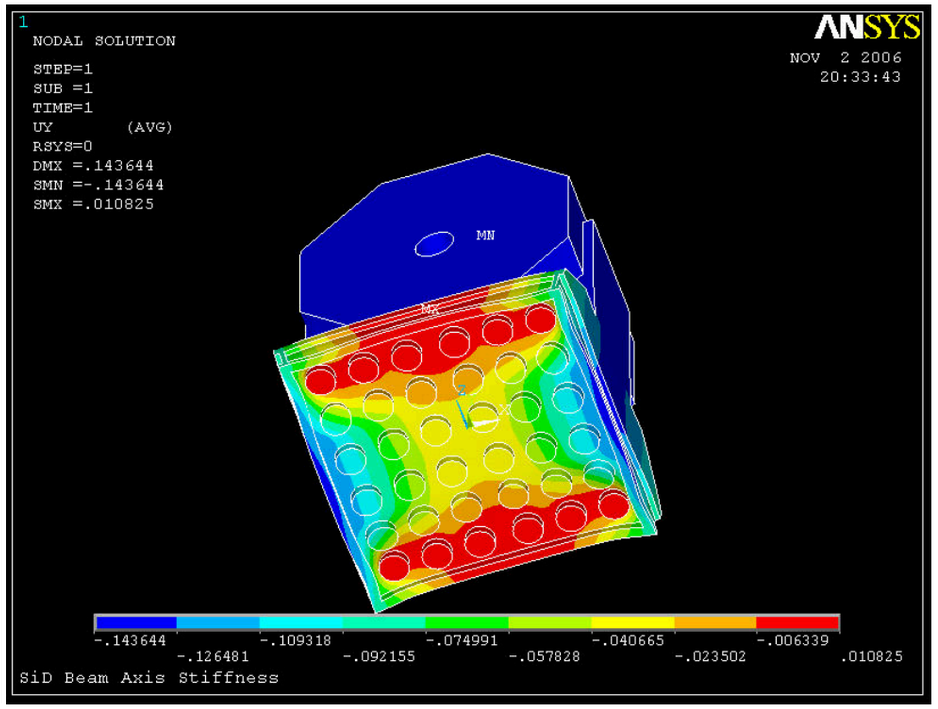
142 tons of high
tensile steel in plug

Study of a platform under detector









Working progress of platform modeling. Pictures show deformations of the platform in transverse or twisting modes when applied pressure is not-uniform. Deflections (may be exaggerated as did not assume a limit on the air-pad capacity) are in the range of 0.5-2mm. Some stiffening of the platform needed (presently use 1.5m tall I-beams).
J.Amann

A Notes on a Push-Pull Superconducting Magnet and Cryogenics System for ILC Detectors

Summary

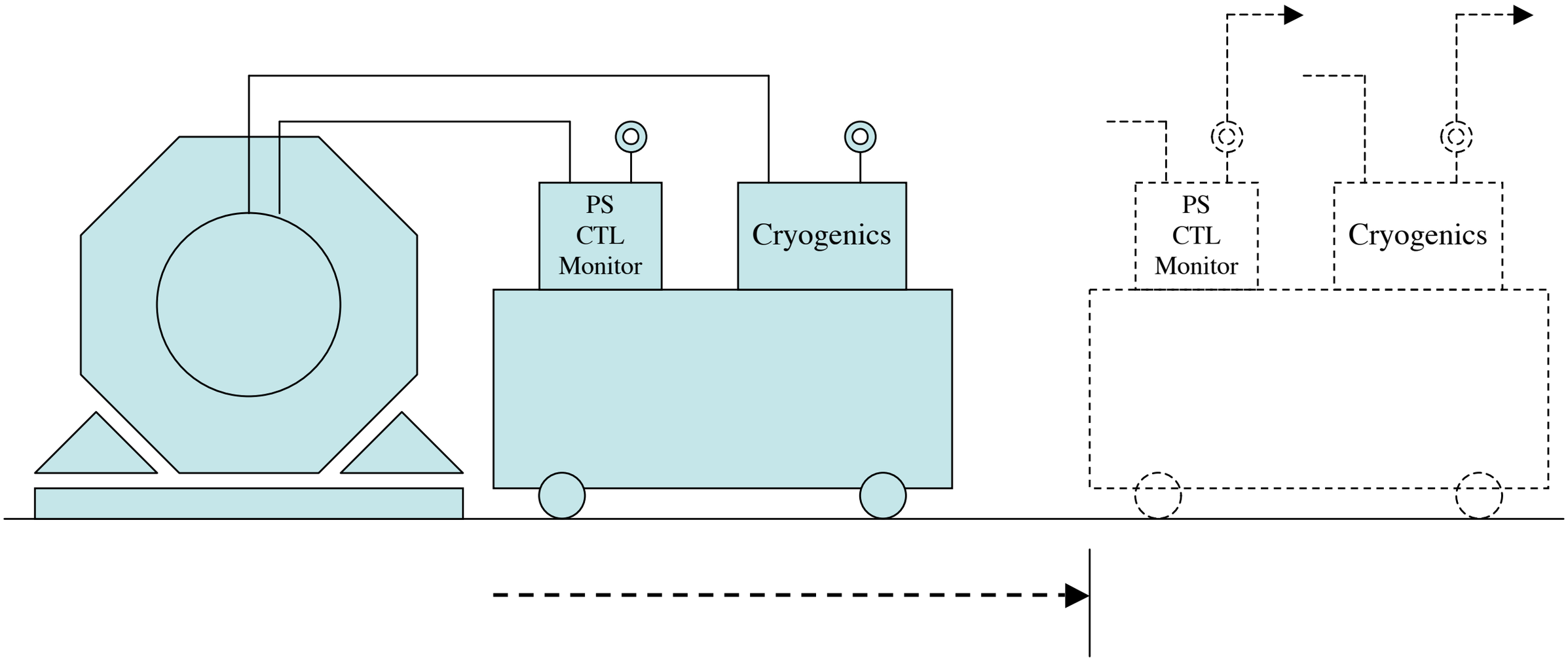
by A. Yamamoto, Dec.12, 2006

- Push-pull magnet and cryogenics system should be feasible under boundary conditions of:
  - Magnet power supply and cryogenics facility is placed on the plat-form movable together with the main detector system
  - The Move-in/-out time duration to be ~ 1 week.
    - One day operation should not be practical without much extra effort for the fully flexible high pressure pipe line with extra space.

- Magnet can be kept cold with sealing-off the line,

- Cryogenics (cold-box) warm-up is highly recommended for safety, and for reliable cryogenics operation.

Concept of Pushpull Detector System with SC Magnet and Cryogenics



Connection/Reconnection work required

	PS	Cryogenics Vacuum pumps,	Control, monitor, safety, etc
Electrical cables	Primary AC (400 V, 100V)	Primary AC (200 V, 100V)	Primary AC DC (emergency)
Control cables	< 50 cables	~ 100 cabls	~ 100 cables
Pipes	Cooling waters (2)	He gas line, (~20) Control Air (100) (LN2, GN2 line)	

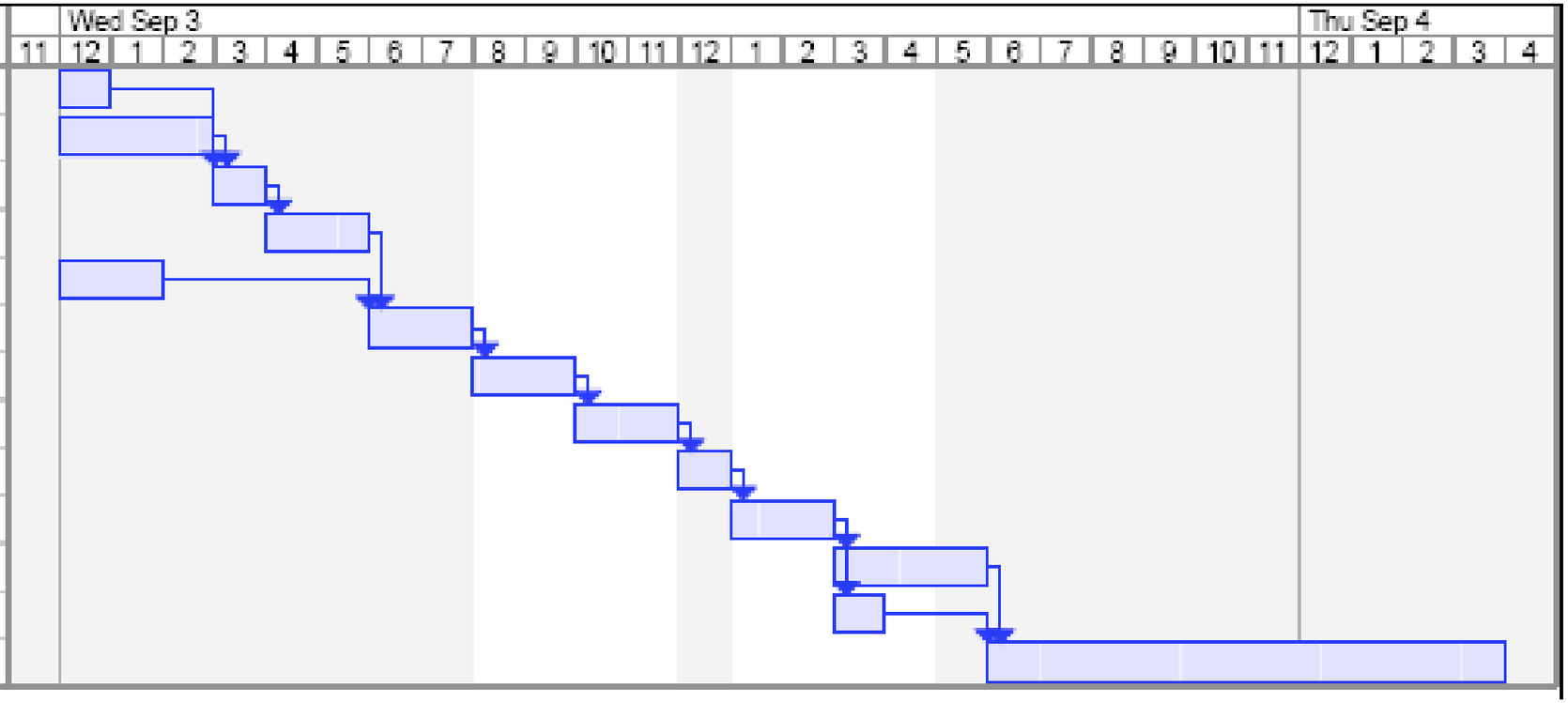
Possible Move-in/out Time

	Day 1	2	3	4	5	6	7	8	9	10
Stop steady op.,B-off, Cryo. cold-box warm-up,										
Seal-off & disconnect pipe and cables										
Move-in/-out										
Reconnect pipes and cables										
Check safety (leak tight, interock)										
Cryogenics re-start cool-down,										
Check safety at cold, & pre-excitation test										
Re-start detector run										

One week would be a reasonable time for
such critical operation for high-pressure gas system

Detectors Swap Time Estimate

ID	Task Name	Duration
1	Secure ILC Beams	1 hr
2	De-energize magnets	3 hrs
3	Open Beamline Shielding	1 hr
4	Disconnect Beamlines	2 hrs
5	Checkout Detetctor Transport s	2 hrs
6	Transport Detector 20 m	2 hrs
7	Transport other detector on bea	2 hrs
8	Connect beamline	2 hrs
9	Close Beamline shielding	1 hr
10	Check gross detector alignment	2 hrs
11	Energize magnets	3 hrs
12	Safety Checks before beams	1 hr
13	Begin Beam Based alignment	10 hrs



With careful engineering and an experienced, well rehearsed crew, it seems plausible to make the push-pull cycle, not including the beam based alignment and re-tuning of the machine, in less than a day.

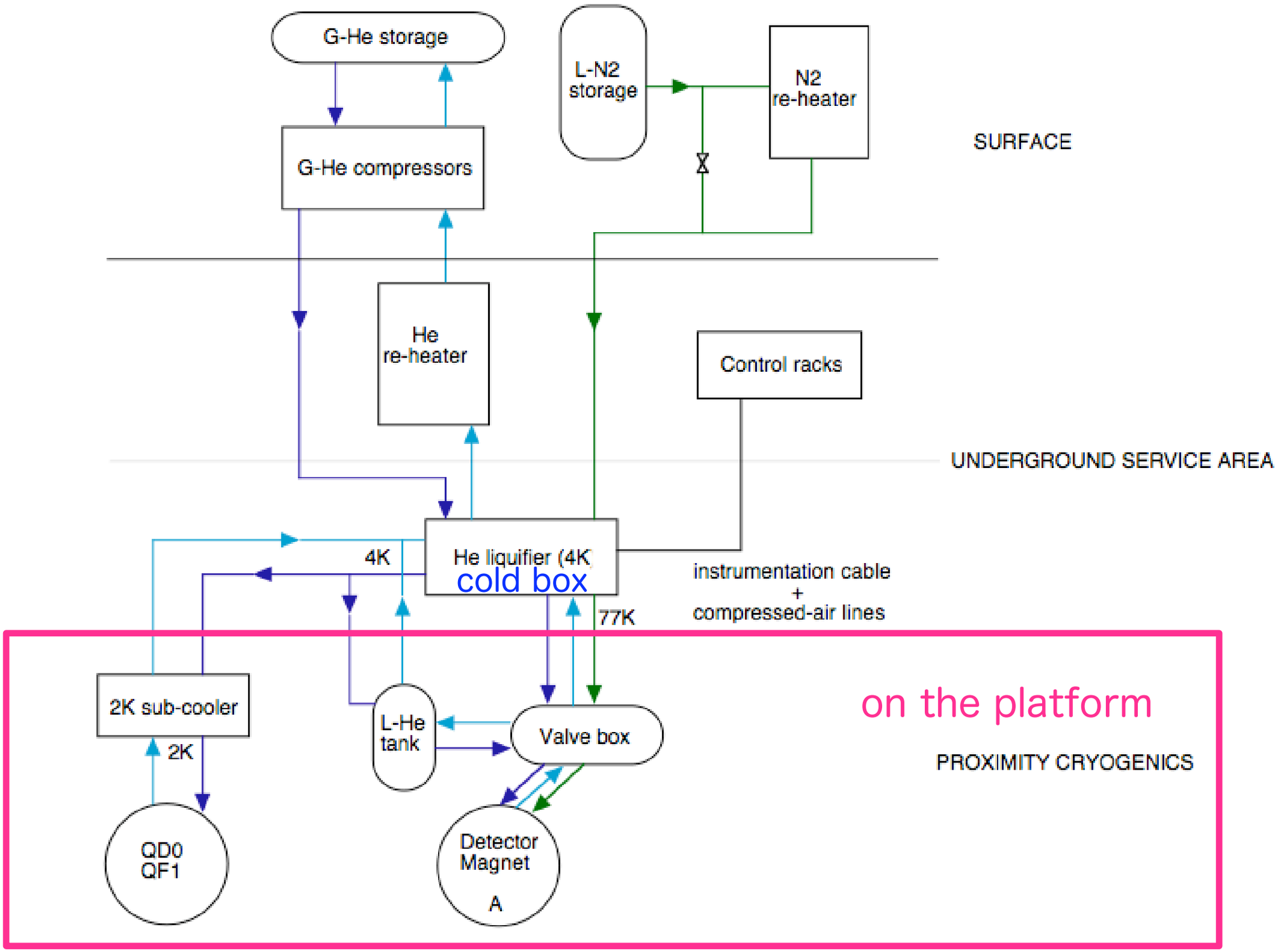
In order to have the shortest and most reliable push-pull procedure , we envisage for SiD to have always the magnet connected to the PS and the cryogenics. At this purpose we prefer to have flexibility at the level of the cryogenic “low-pressure“ transfer line instead of the Helium high pressure gas. With this scheme the cold-box is stationary and power supplies, breakers and dump resistor are mounted on the detector.

In this case there is need to neither disconnect the cryogenics nor warm up the cold box.

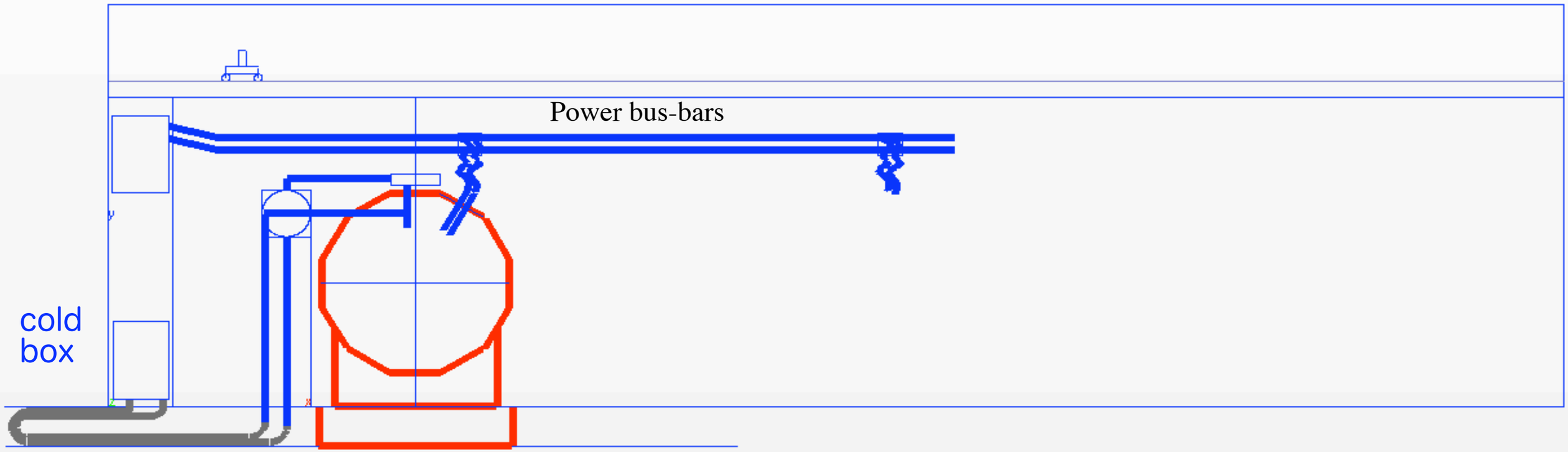
need discussion among the experts in the world

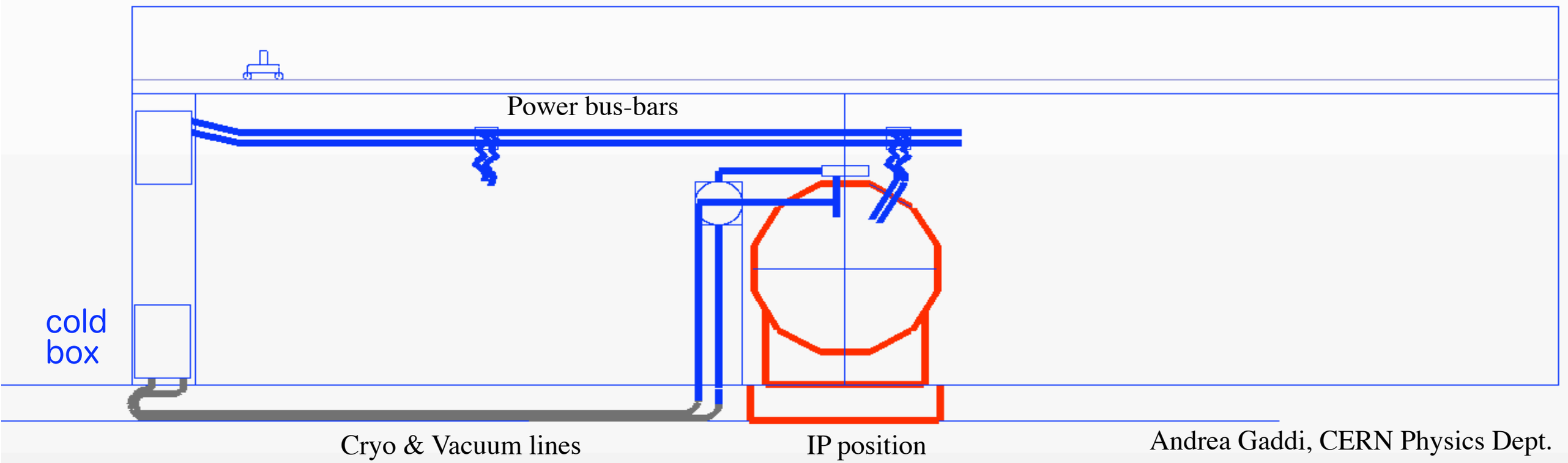
Coil Ancillaries & Detector General Services

Cryogenics block diagram (concept)



Cable-chains and power bus-bars





Primary services

usually on surface

Facility	Output	Users
Water chillers	Water at 6 - 10 deg C	HVAC Electronics racks cooling Detector specific cooling (chilled fluids in range -30 / +25 deg C)
High to medium voltage power transformers	18 kV / 400V AC tri-phase	Lifts, cranes, general services Cooling & HVAC stations Primary power to detector electronics
Diesel & UPS facility	Secured power for valuable systems	
He storage & compressor plants	High pressure He at room temperature	He liquifier
Gas & compressed-air plants	Gas mixtures Compressed-air	Detectors chambers Process control valves, moving systems, …

Plants providing these services are usually located on surface, due to their dimensions and related risks.

Secondary services
suggested in alcove at the main cavern ends

- Temperature-stable cooling water for sensitive detectors
- Low Voltage/High Voltage supply for front-end electronics
- Gas mixtures for drift-chambers
- UPS power for valuable electronics
- AC-DC power converters for superconducting coil(s)
- Cryogenics (Cold Box, He liquefier) & Vacuum services

Secondary service plants need often to be close to the detector (low-voltage/high-current lines, cryogenics lines, etc…) and they are located in the underground areas. Due to the push-pull design of the Interaction Region, these services are permanently connected and run into cable-chains toward the detector, regardless of their position in the Hall. To keep flexible pipes and cables in the chains within a reasonable length (< 50m), a service alcove for each detector is proposed at the main cavern ends.

On-board services
i.e. on the platform

Some secondary services must be situated close to the detector as well, if the connection lines through the cable-chains is technically difficult or too expensive. However this makes the size of the moving detector bigger with risks of inducing vibrations and electrical noise and should be limited to a few special utilities, in a push-pull scenario, where detectors move every month or so.

i.e. Liquid He tank and valve box

Re-commission the ILC to nominal luminosity assuming that it is short (?);

Re-commissioning for the push-pull scheme

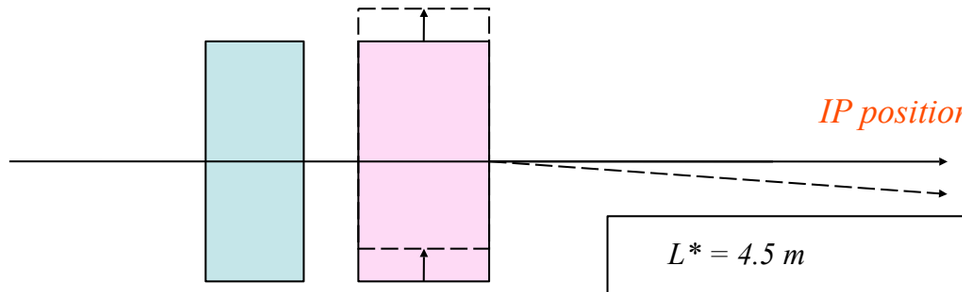
Re-positioning within +/- 1mm

1) Initial transverse alignment should be less than 1mm (within mover dynamic range).
2) BBA of QD0 (Rough Transverse Position Scan)
3) IP position scan with the QD0 mover (Two Dimensional Scan)
   The re-commissioning time depends on the time to establish the first collision.
4) Luminosity scan by changing the SD0 transverse position.
   (The single scan for both horizontal and vertical directions)
5) Nominal beam size tuning with sextupole tuning knobs.

Toshiyuki Okugi, KEK, 2007 / 12 / 5

The Effect of the position shift of QD0 and SD0 in the push-pull scheme

The transverse position (x, y) shift of QD0



QD0 Mover in transverse

L = 4.5 m*

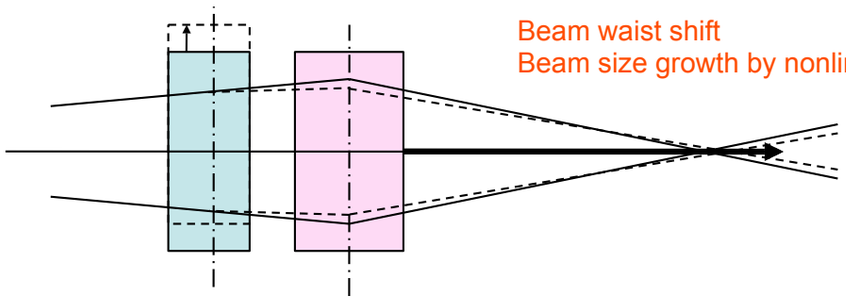
K1 = -0.34 [1/m]

Abs ($\Delta x, y_{IP}$) = 1.5 $\Delta x, y_{QD0}$

If the QD0 will be shifted by 1mm, the beam position at IP will also be changed by 1.5mm.
We cannot correct such a large amount of position displacement without QD0 mover.

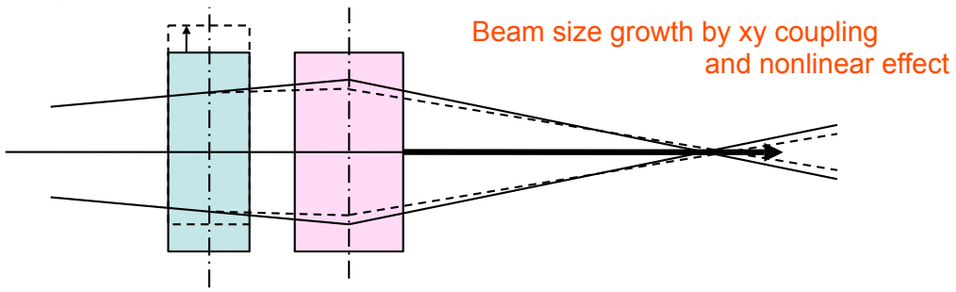
QD0 transverse mover is important for the IP position adjustment.
We must realign the QD0 within the dynamic range of the QD0 mover (~ 1mm).

The horizontal position shift of SD0



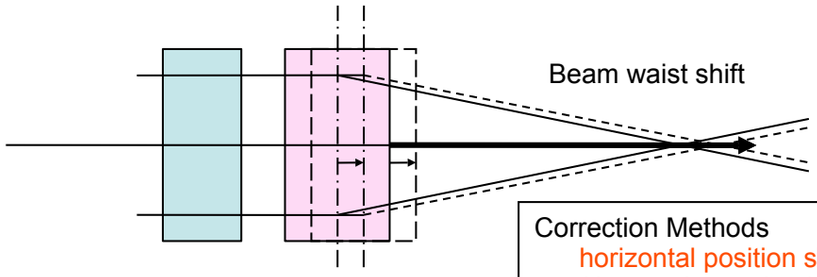
SD0 Mover in transverse

The vertical position shift of SD0



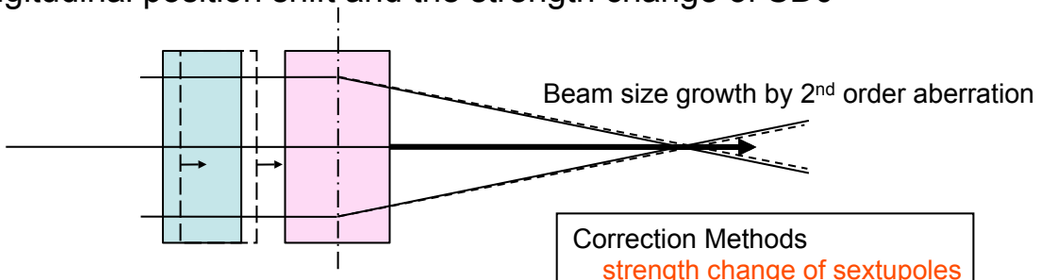
SD0 transverse mover is important for the IP beam size tuning.
We must realign the SD0 within the dynamic range of the SD0 mover (~ 1mm).

The longitudinal position shift and the strength change of QD0



Correction Methods
horizontal position shift of sextupoles
(beam size tuning knobs)

The longitudinal position shift and the strength change of SD0



Correction Methods
strength change of sextupoles

We don't have to put the QD0, SD0 longitudinal movers.

Realization of Push-pull Operation

1. Time for Roll-out and Roll-in

   1 day without dis-connection of all cables and pipes

   or

   1 week with dis-connection of high pressure line
   and the cold box on the platform

2. Re-commission the ILC at the nominal luminosity

   It should take short time.

3. Alignment of sub-detectors

   Their relative positions should be kept.

   At least, they should be monitors.

4. Calibration of sub-detectors

   We should identify specific calibrations in each sub-detectors.