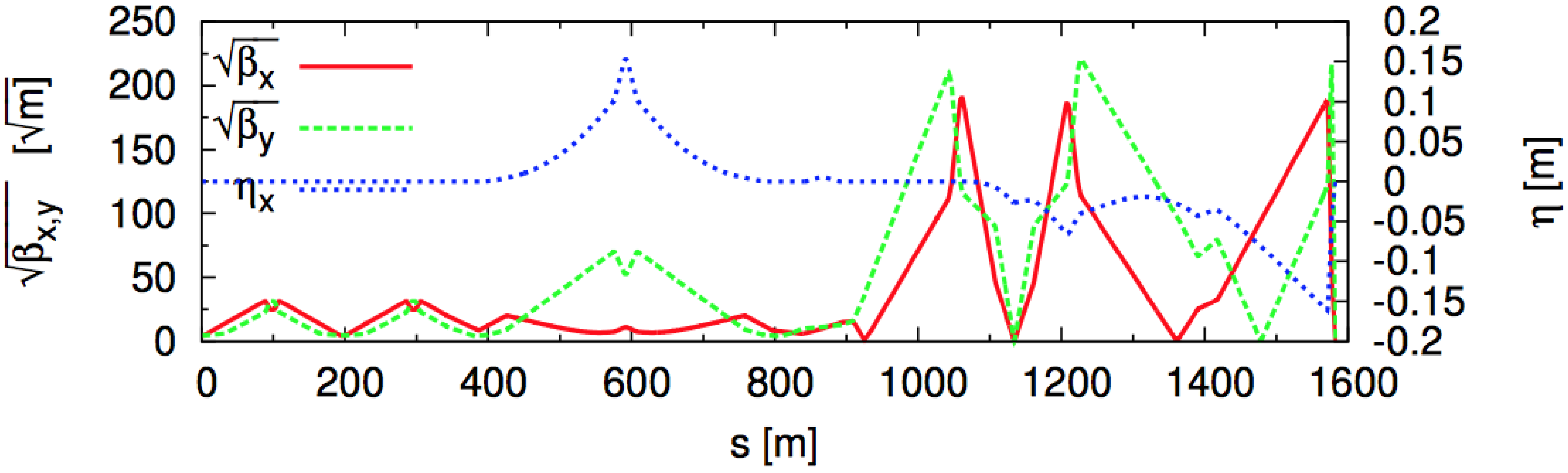
L* Status

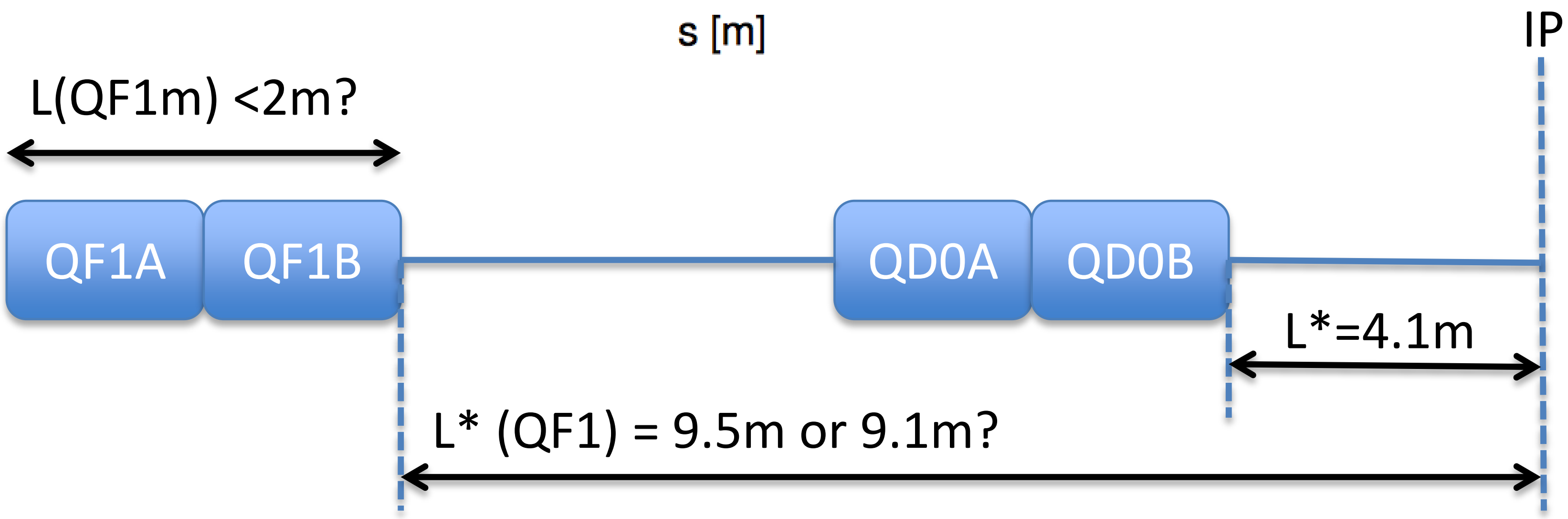
Karsten Buesser
ILC@DESY Project Meeting
23.01.2015

BDS Update (G. White, SiD Workshop)

L*=4.1m Optics

Tools: *MADX, MAPCLASS, SAD, Lucretia*

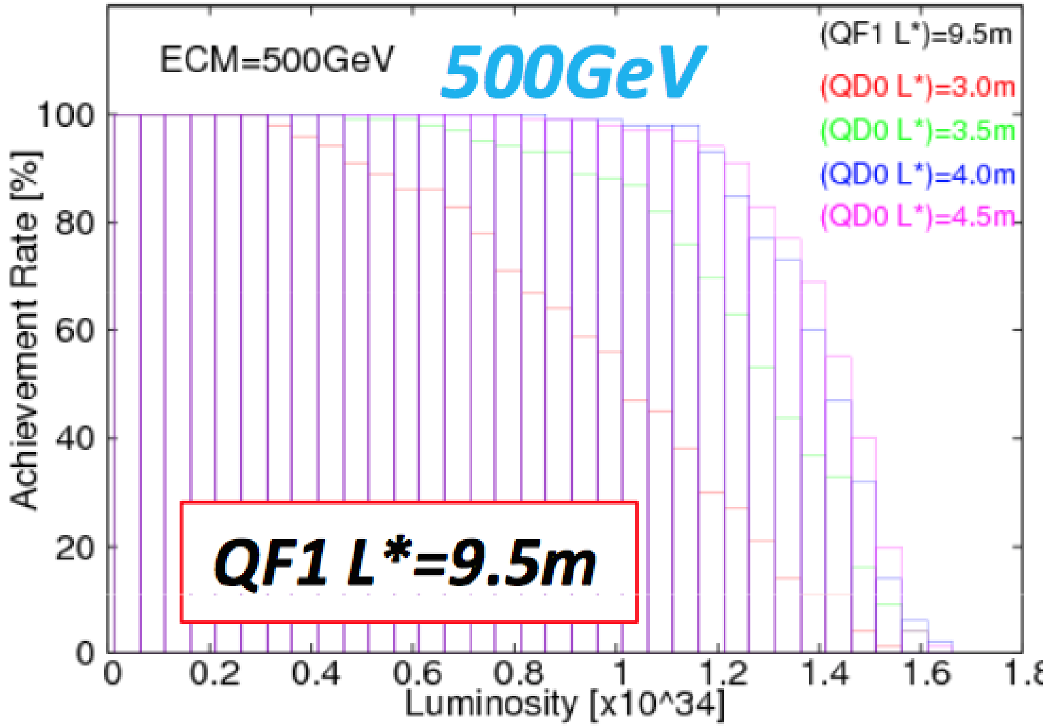


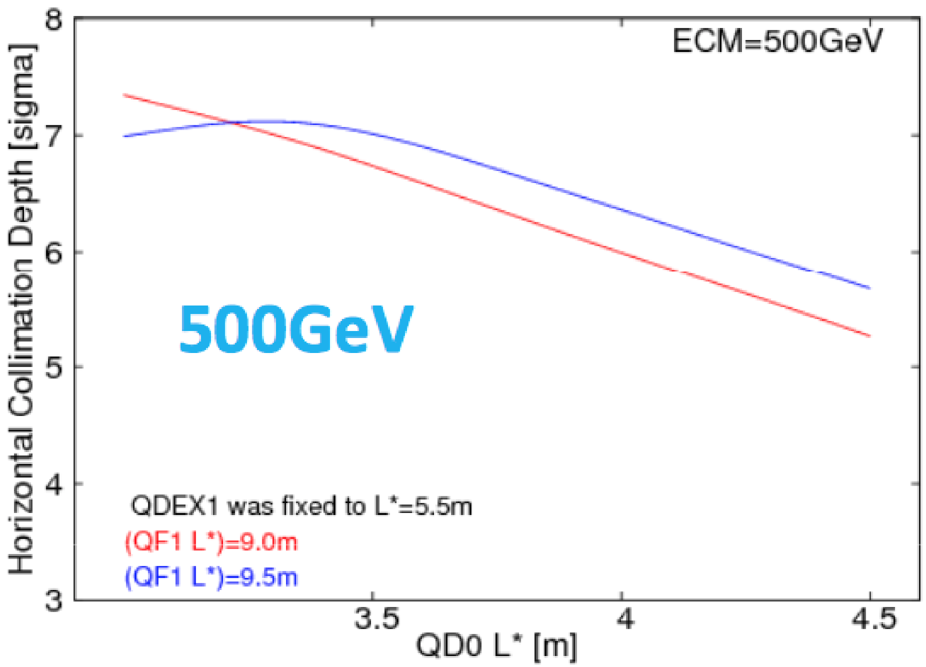


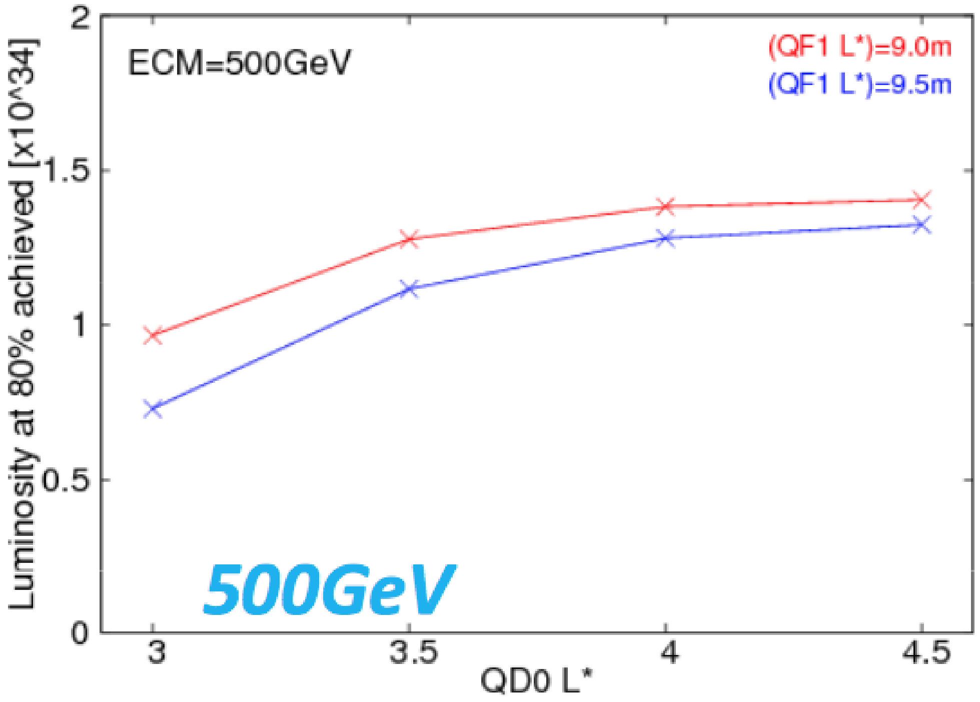
- Have optics solutions for E_{CM} = 250 GeV with improved collimation performance by powering front halves of QF1 & QD0 magnets only.
- Tuning performance driven by QD0->QF1 distance
  - Prefer QF1 closer to QD0, also shorter QF1

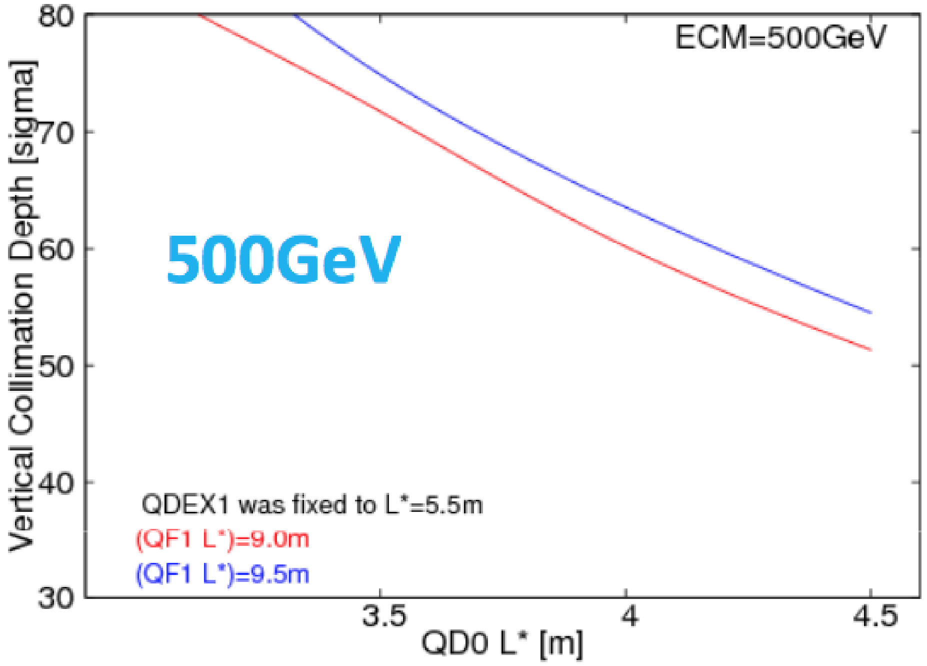
Collimation Depths and Beam Tuning

Collimation depth & beam tuning simulation
For different L* *(T. Okugi, KEK)*



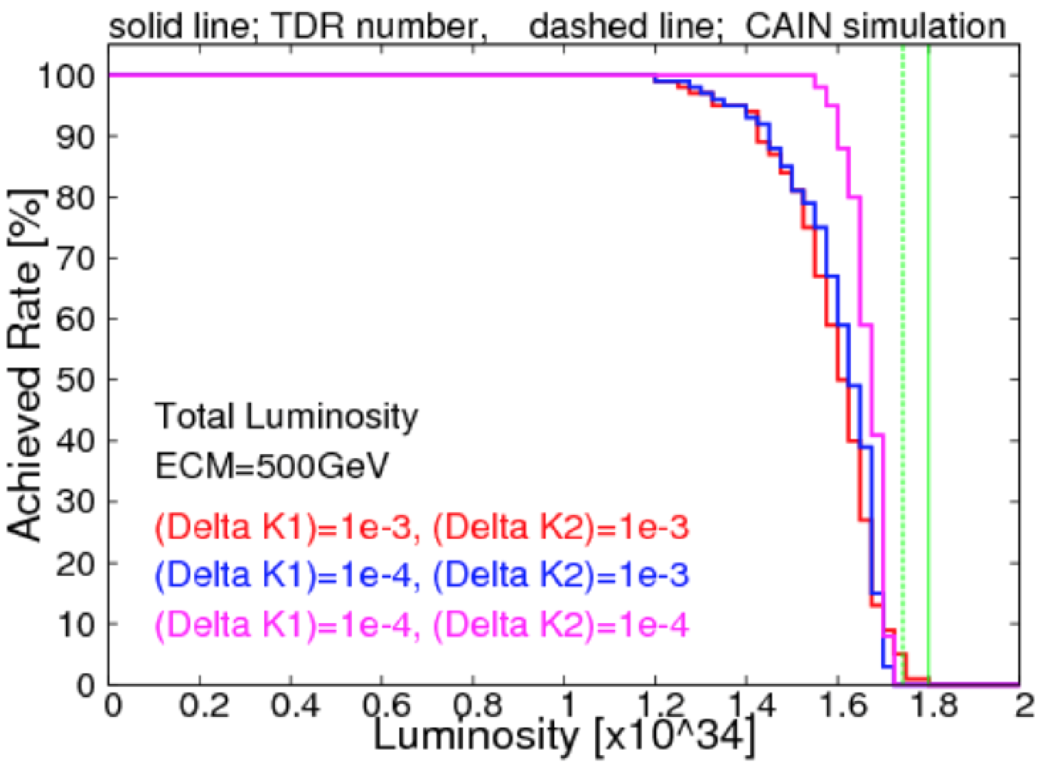


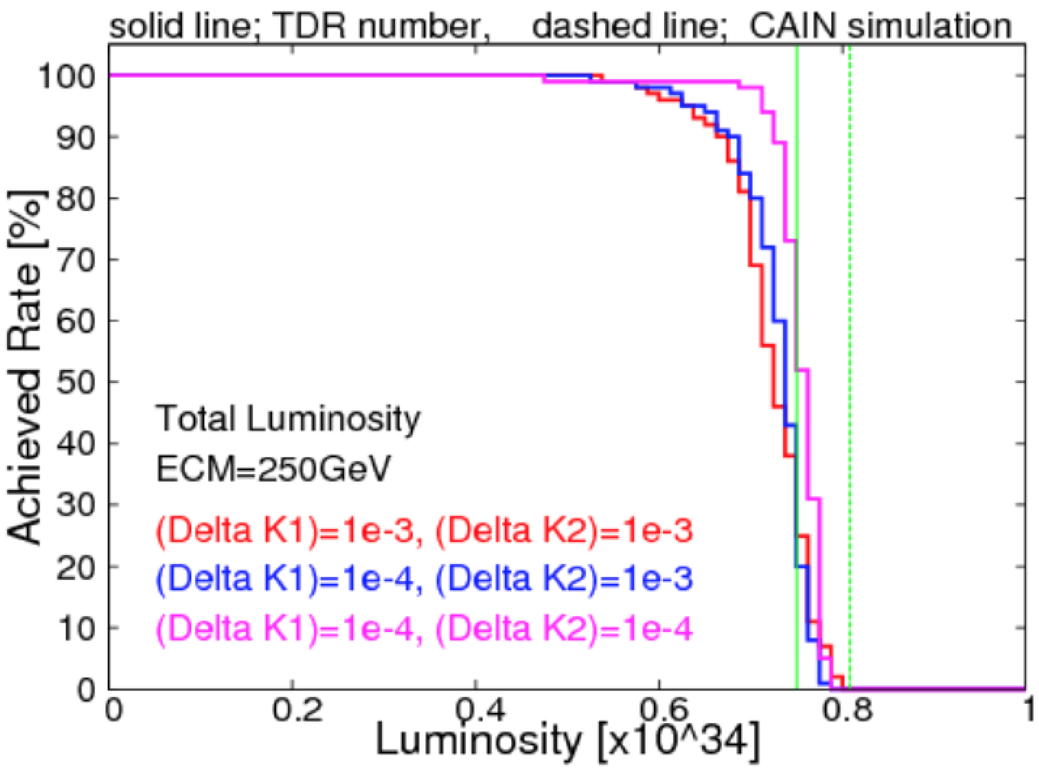




BDS Tuning Simulations

MC Tuning Simulations
(T. Okugi, KEK) – SAD + CAIN



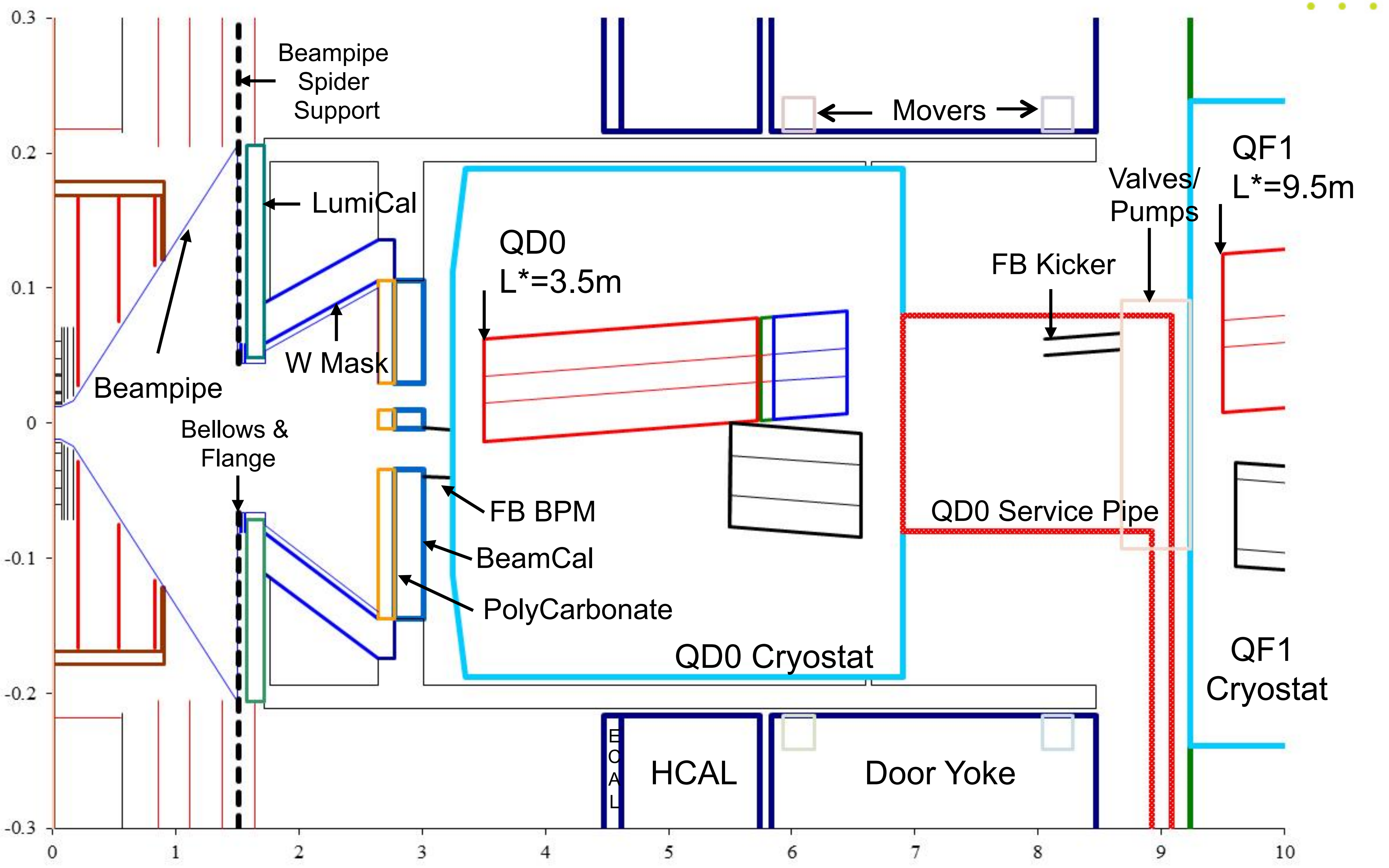


- Tuning simulation results for E_{CM}=250,500 GeV
  - *Compare magenta lines to outer green lines depicting design lumi*
- 4.1, 9.1m QD0, QF1 L* configuration
- Standard tuning algorithms no longer sufficient to deliver design luminosirty, more work required in the future to specify a tuning system and/or improved assumption of BDS delivered beam quality.

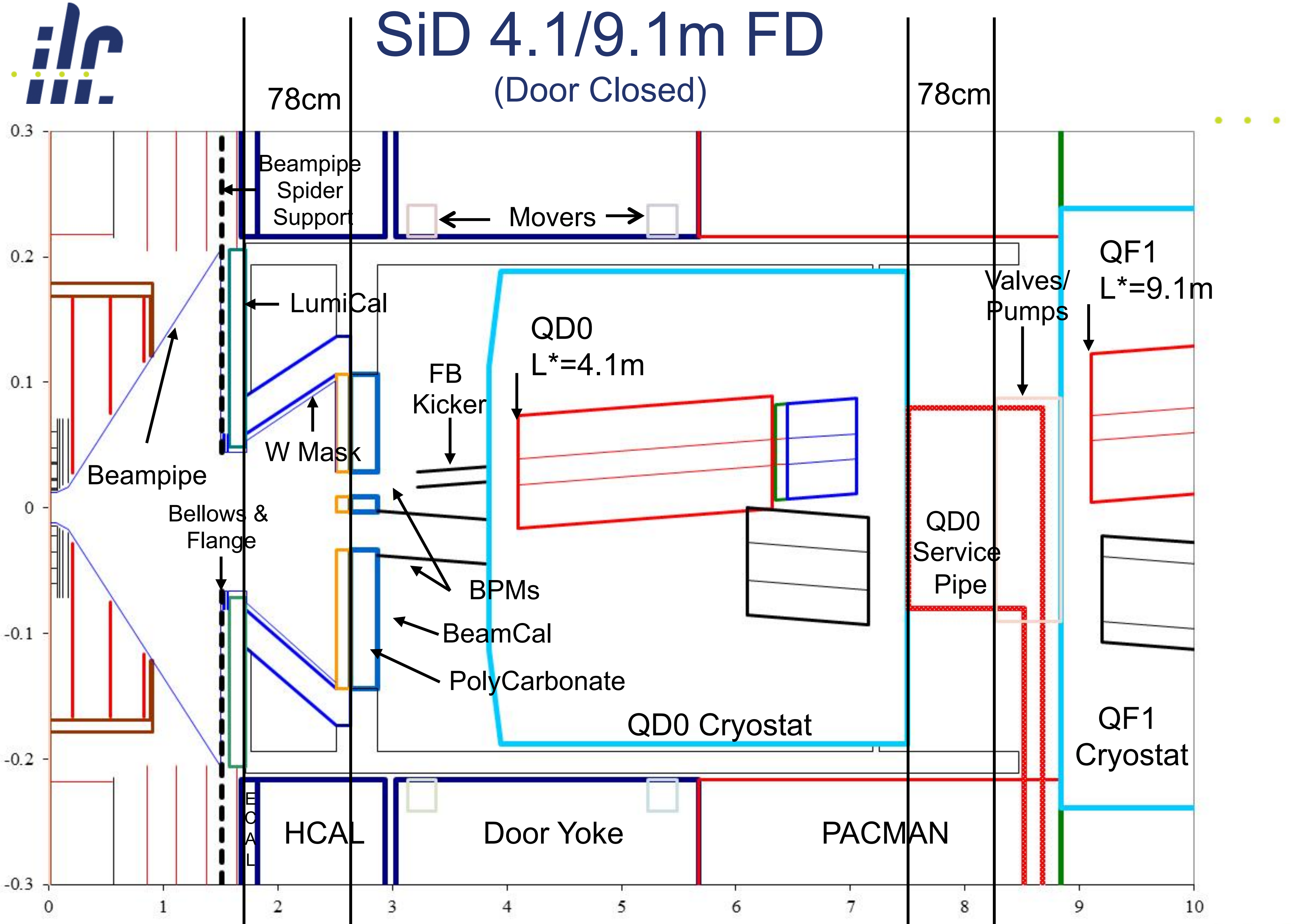
SiD and L*

SiD 3.5/9.5m FD

(Door Open 2.8m)



SiD and L*

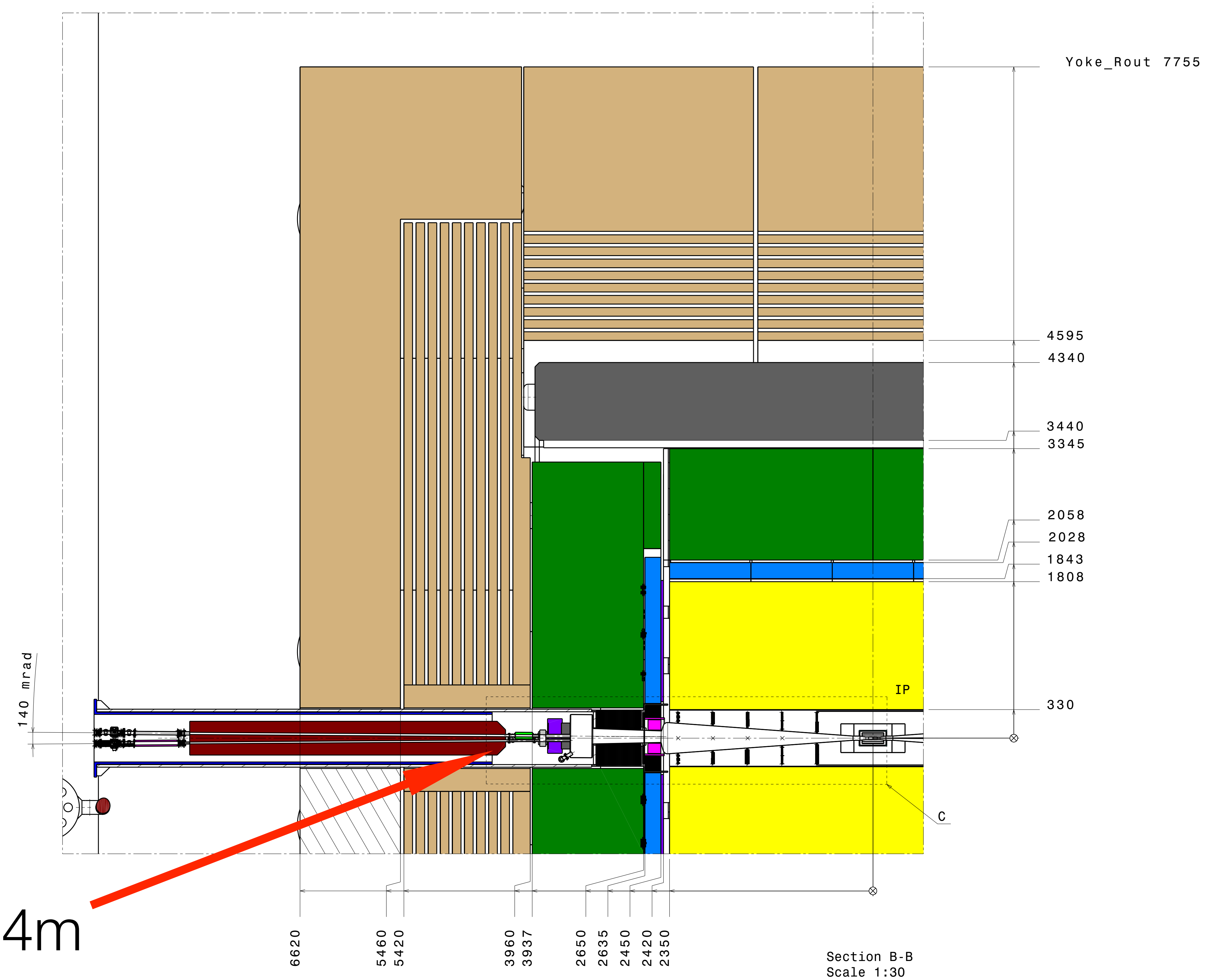

SiD 4.1/9.1m FD
(Door Closed)
78cm
78cm
Beampipe
Spider
Support
Movers
LumiCal
W Mask
Beampipe
Bellows &
Flange
FB
Kicker
BPMs
BeamCal
PolyCarbonate
QD0
L*=4.1m
QD0 Cryostat
QD0
Service
Pipe
Valves/
Pumps
QF1
L*=9.1m
QF1
Cryostat
ECAL
HCAL
Door Yoke
PACMAN
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
0
1
2
3
4
5
6
7
8
9
10

SiD and L*

Larger L* Issues

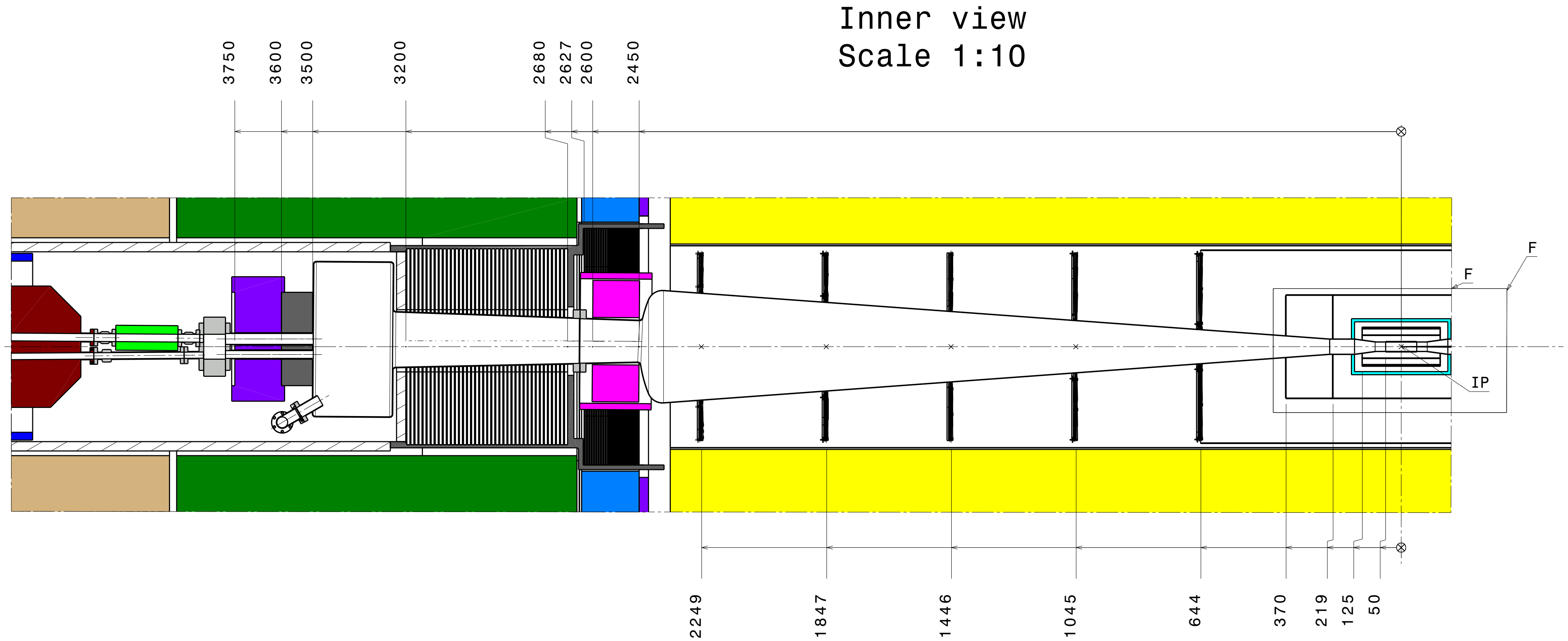
- More deflection of pairs from dipole component of solenoid
  - **Nominally compensated by “anti-DID”**
- Less backsplash from BeamCal to VXD & Tracker
- Length and weight of W mask (currently 1.23m long) increase
- Diameter of BeamCal likely increases
- More space for LumiCal & BeamCal readout
- More load on support tube from W and BeamCal
- Probably more stress and vertical displacement of tip of support tube when door opened to maximum of 2.8m (needs analysis)
- More cantilever of QD0 when door in closed position (1.26m + increase in L*)

ILD Dimensions



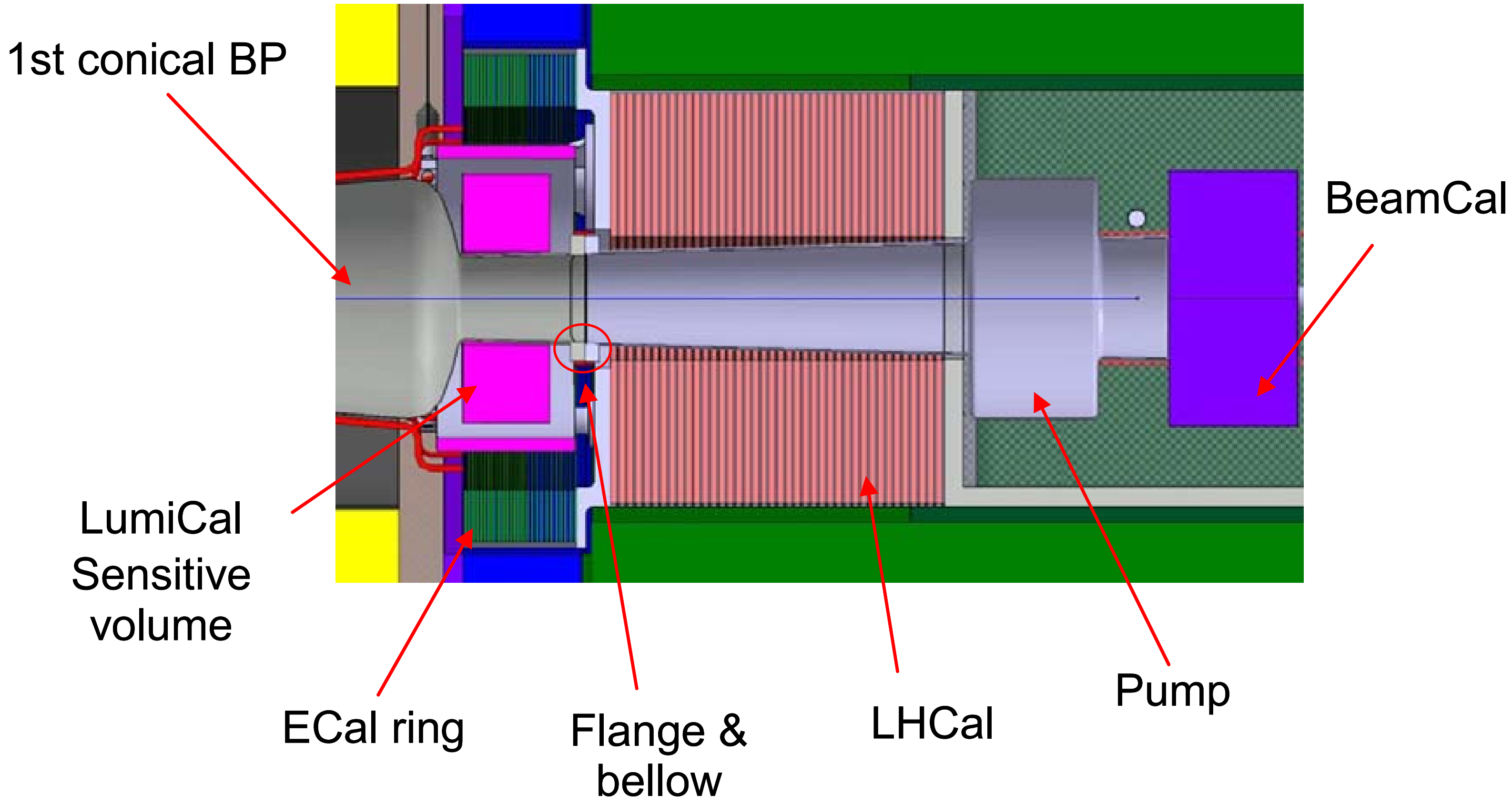
L*=4.4m

ILD: Current Lower Constraints on L*



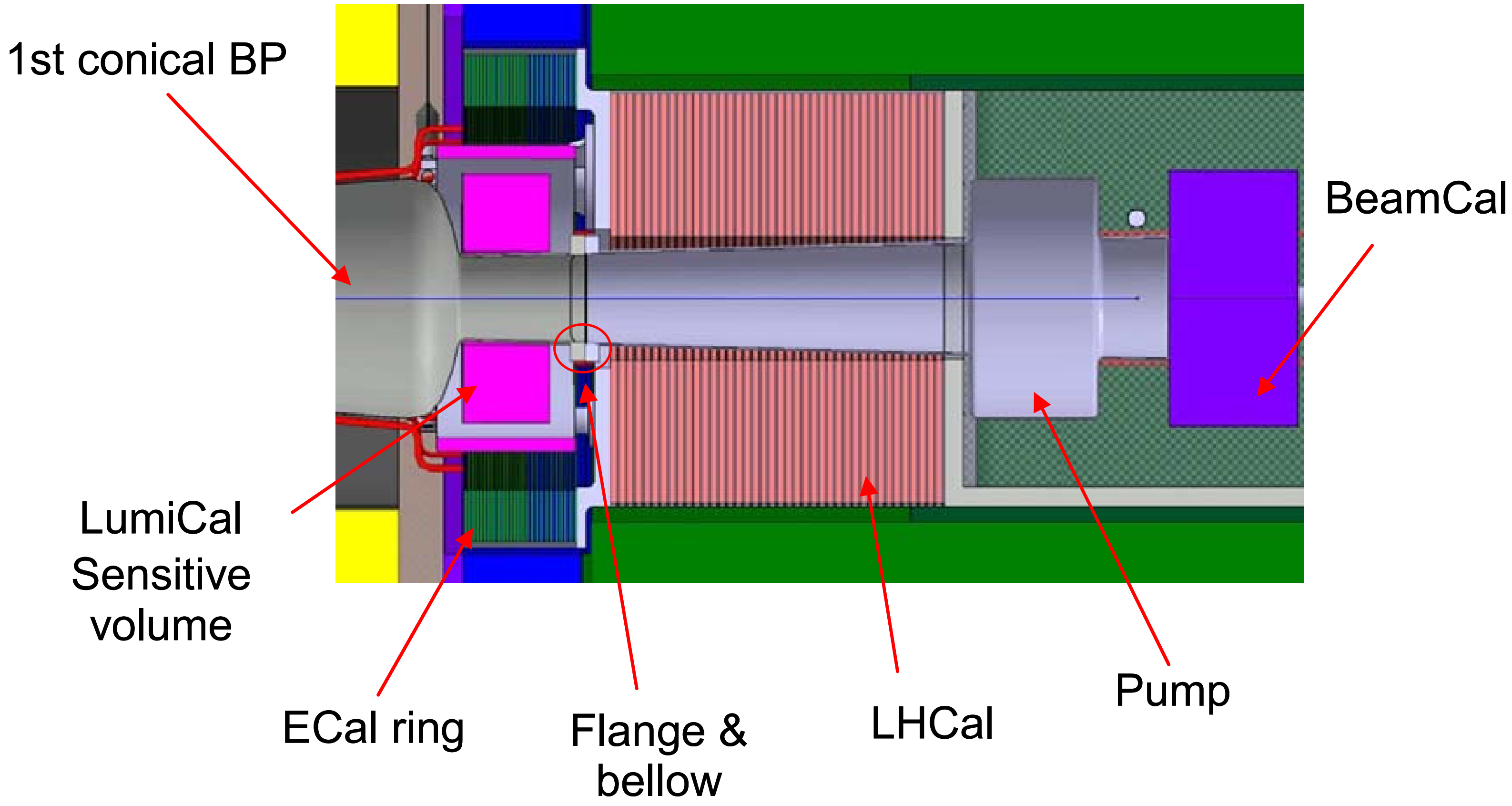
- Detailed design of forward region:
  - LumiCal, LHCAL, BeamCal
  - Beam Pipe, Bellows, Flanges, Vacuum Pumps
  - Optimised (many FTEs in the last ~10y) for
    - operations: no FCAL or masks inside the tracking volume
    - assembly and maintenance
    - physics: VTX (occupancies and layer radii), FCAL performance, hermeticity

Forward Region - possible changes towards L*=4m



- Need to find ~40cm in current design
- Look into design optimisations of all structures
    - maybe find some 10cm there, but more?
- Biggest devices:
    - Pump in front of BeamCal (30cm)
    - LHCAL (~50cm)

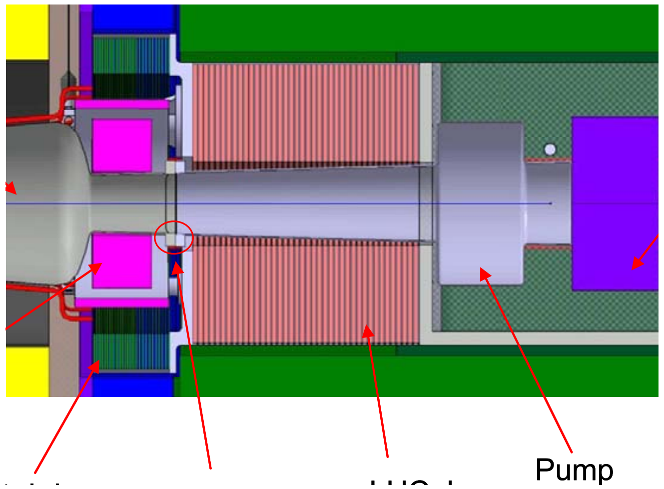
FCAL

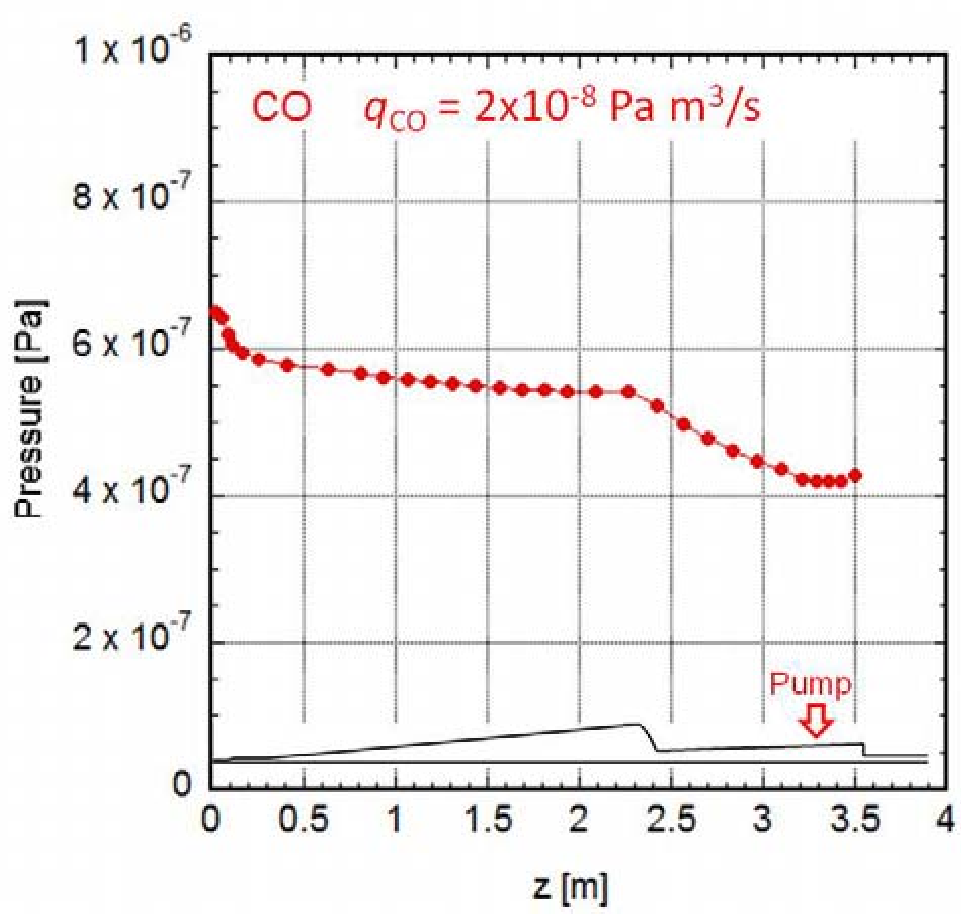


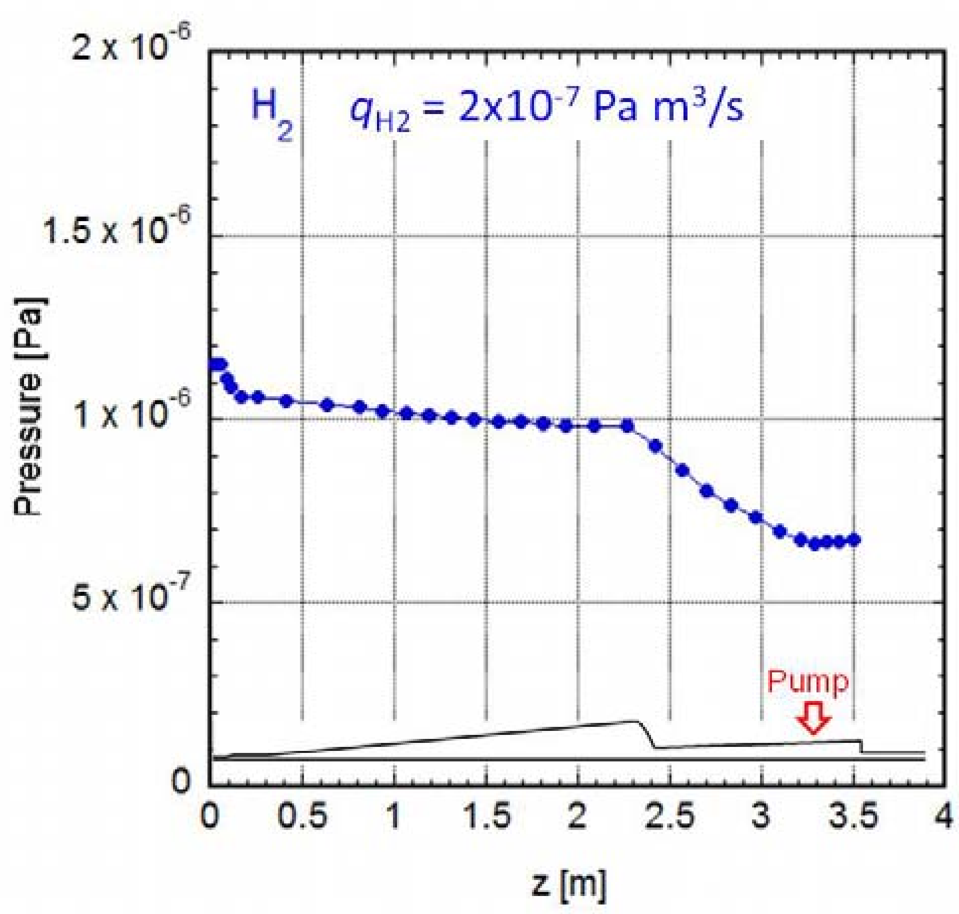
- FCAL collaboration will look into optimisation of existing BeamCal and LumiCal design
    - not sooo eager to start activities on LHCAL
- Lucia Bortko (Zeuthen) has started background simulation on pair background with new BeamCal location

Vacuum Conditions

- What about the vacuum pump?
- SiD has no pump in front of QD0, but behind
- ILD vacuum studies done for LoI
  - Y. Suetsugu,“Technical Note for ILD Beam Pipe“:
  - 6E-7 Pa (6E-9 mbar, ~4.5 nTorr) for CO
  - 1E-6 Pa (1E-8 mbar, ~7.5 nTorr) for H_2



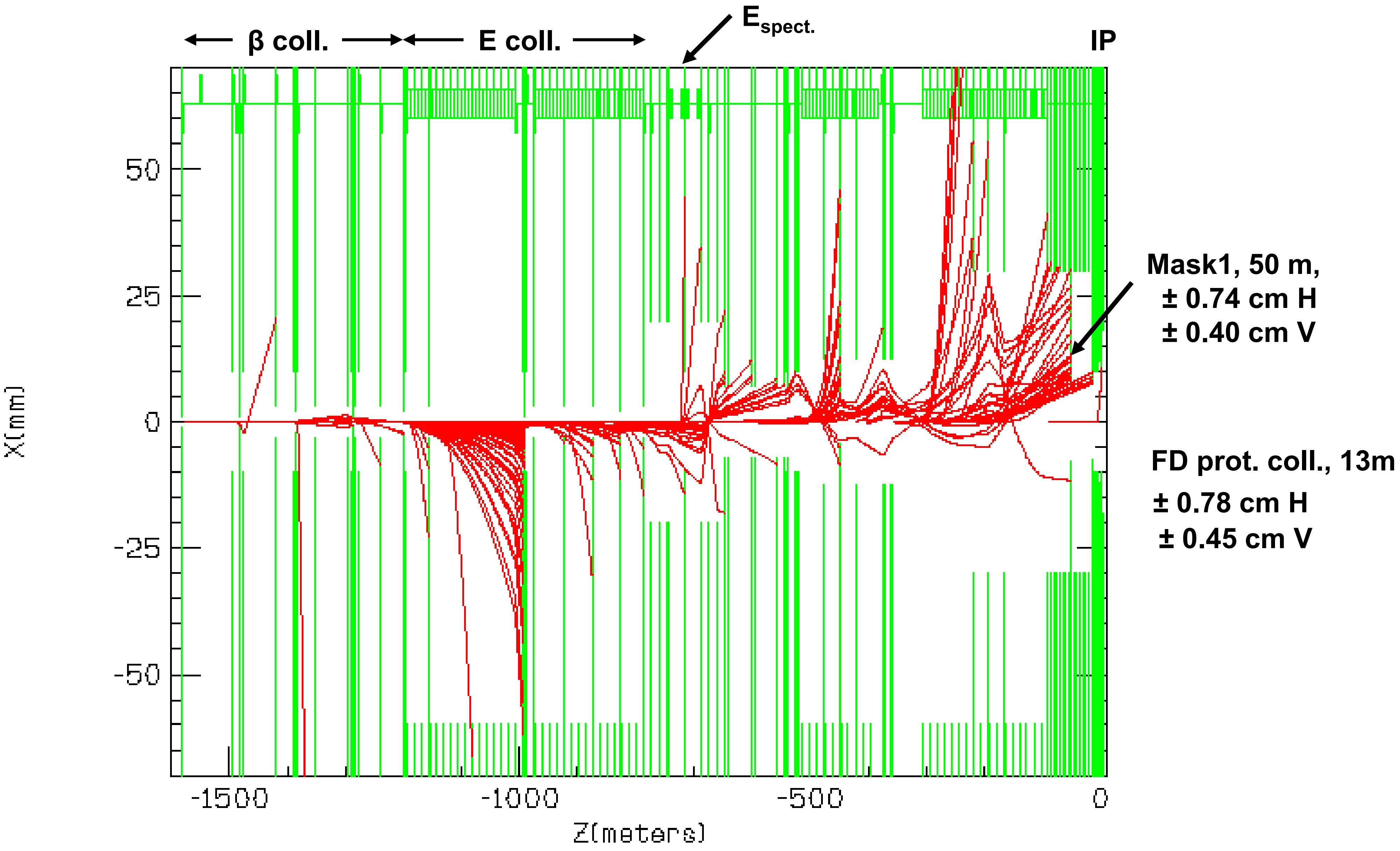




Vacuum Requirements

- L. Keller, T. Maruyama, T. Markiewicz - ILC-Note-2007-016

Loss pts. of 150 random beam-gas brem. trajectories in the BDS using LP TURTLE



Mask1, 50 m,
± 0.74 cm H
± 0.40 cm V

FD prot. coll., 13m
± 0.78 cm H
± 0.45 cm V

Vacuum Requirements

- L. Keller, T. Maruyama, T. Markiewicz - ILC-Note-2007-016

Summary of Hits/bunch and Hits/160 bunches (TPC) – both beams, 10 nTorr

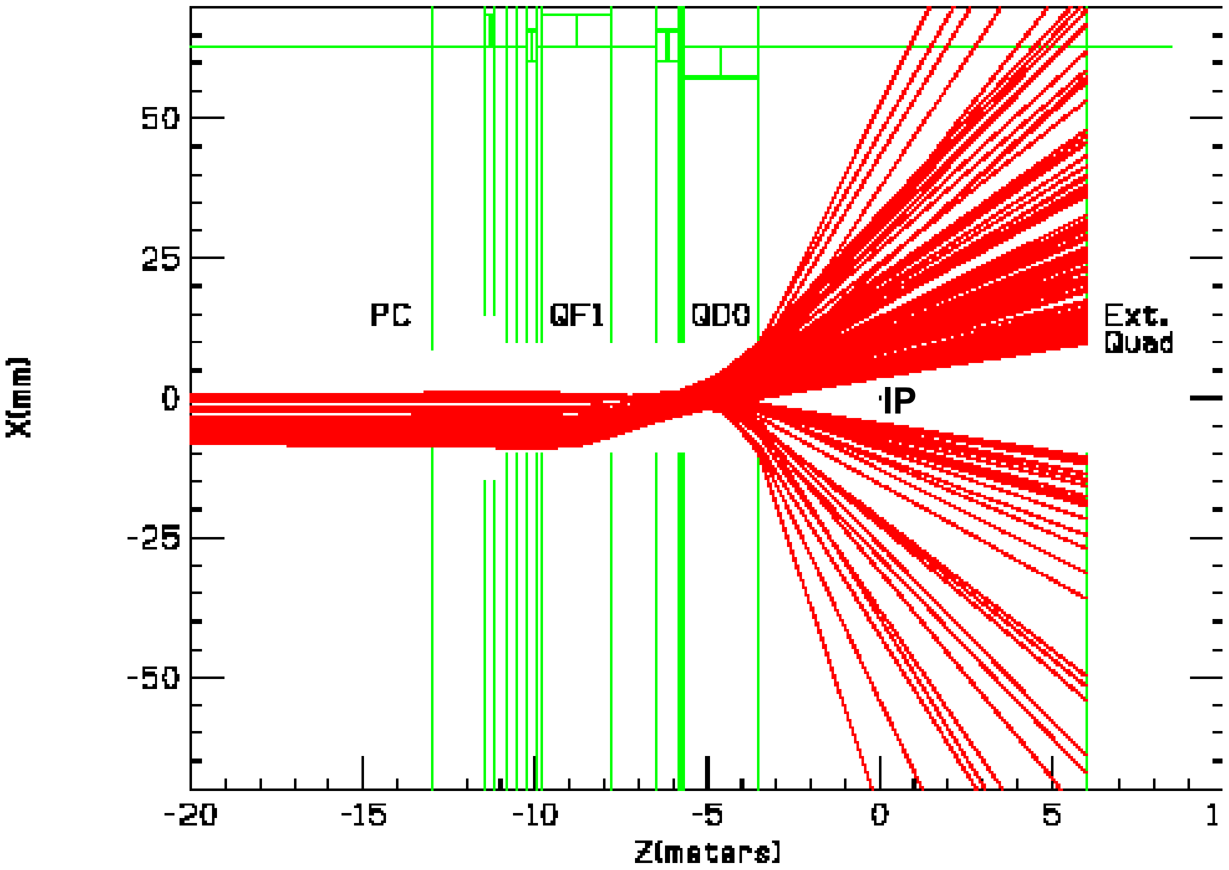
▬ Hits/bunch ▬ Hits/160 bunches (TPC)

Hit Location	GEANT3 Beam-gas brem (charged)	TURTLE Beam-gas brem (charged)		TURTLE Beam-gas brem (photons)		TURTLE Coulomb (charged)	
	Hits	Hits	<E>	Hits	<E>	Hits	<E>
FD Prot. Coll. (13 m) |x| > 0.74 cm |y| > 0.45 cm Origin 0-800m from IP	0.22 35	0.17 27	235 GeV	0.056 9.0	~50 GeV	0.009 1.4	250 GeV
Inside F.D. (10 – 3.5 m) (QF1 to QD0) Origin 0-100m from IP	0.014 2.2	0.006 1.0	~100 GeV	0	-	0	-
IP region (± 3.5 m) (R > 1 cm at Z = 6.0 m) Origin 0-200m from IP	0.04 6.4	0.02 3.2	~100 GeV	0	-	0	-

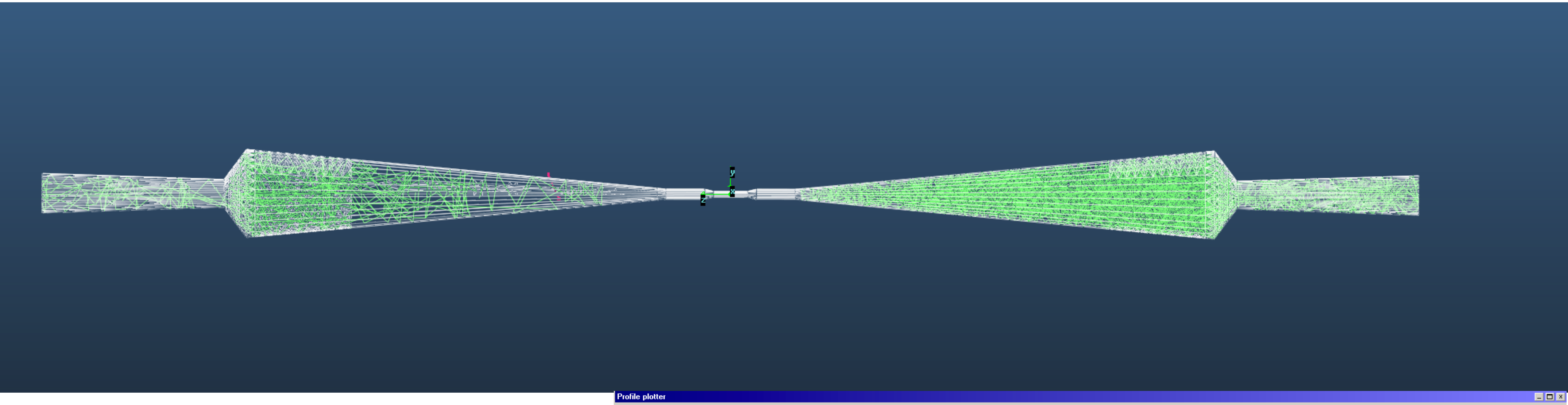
GEANT3 simulations show that only hits in the IP region (± 3.5 m) cause problems for the vertex detector

How relevant is the Vacuum inside the detector?

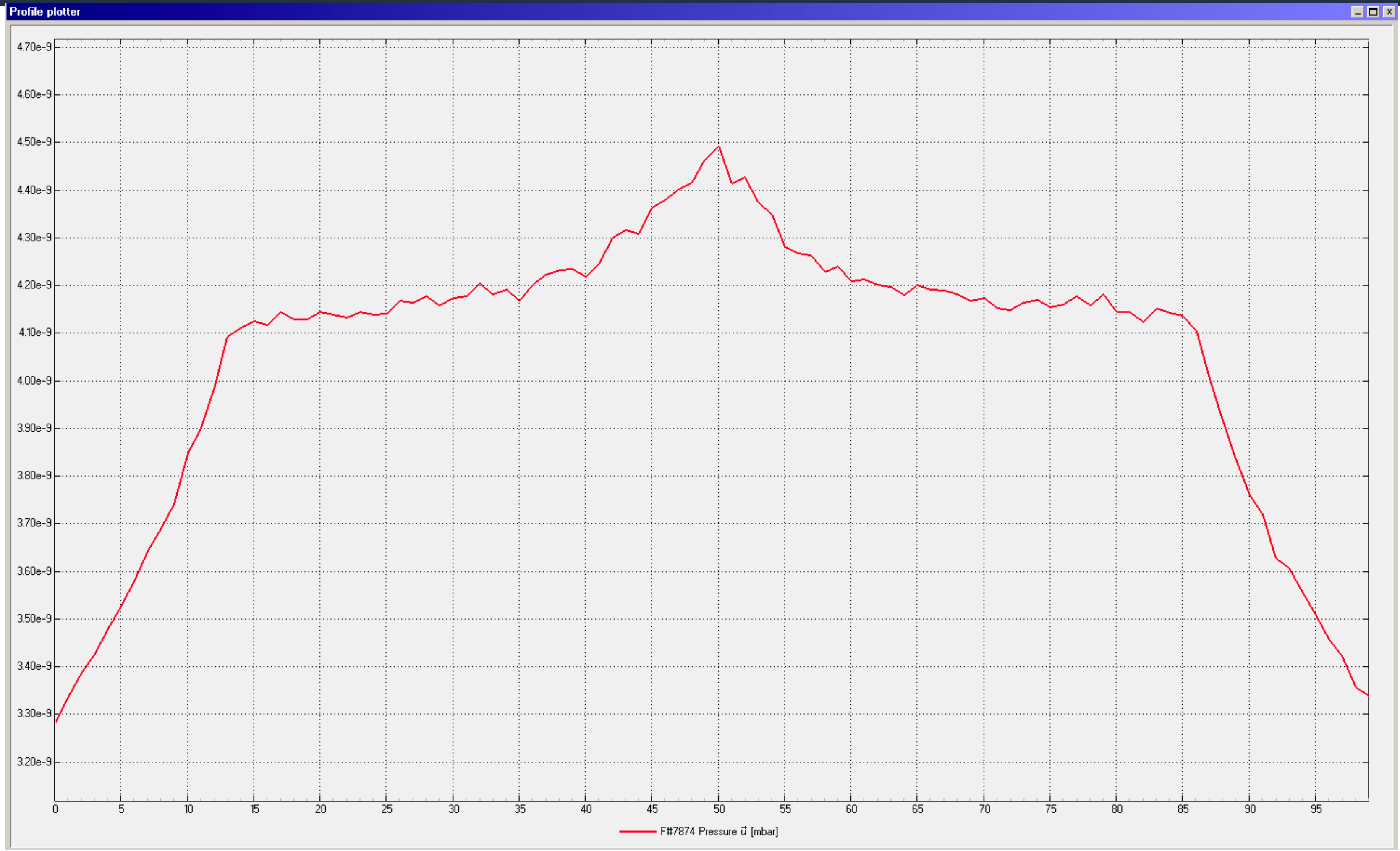
- Beam-Gas scattering in the BDS upstream is relevant for detector backgrounds
- O(10 nTorr) is the required vacuum level up to +- 200m
- Beam-Gas background produced inside the detector is mostly forward peaked - leaves the detector through the beam pipe
- So in theory, vacuum level inside the detector could be much higher
- To be checked with full detector simulations!



Check Vacuum Conditions

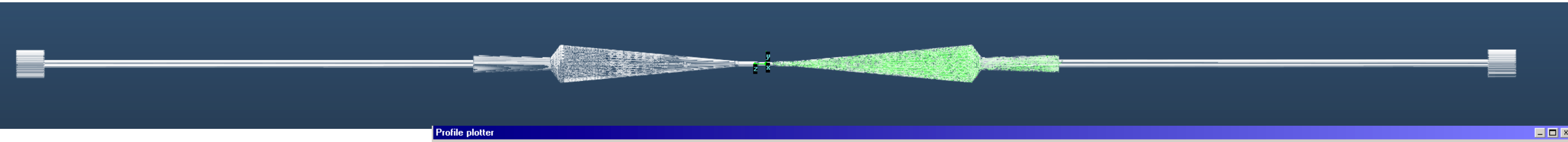


- MolFlow+ (CERN)
- Molecule tracker for given gases, materials and geometries
- For CO: 4.5E-9 mbar
  - Suetsugu: 6E-9 mbar

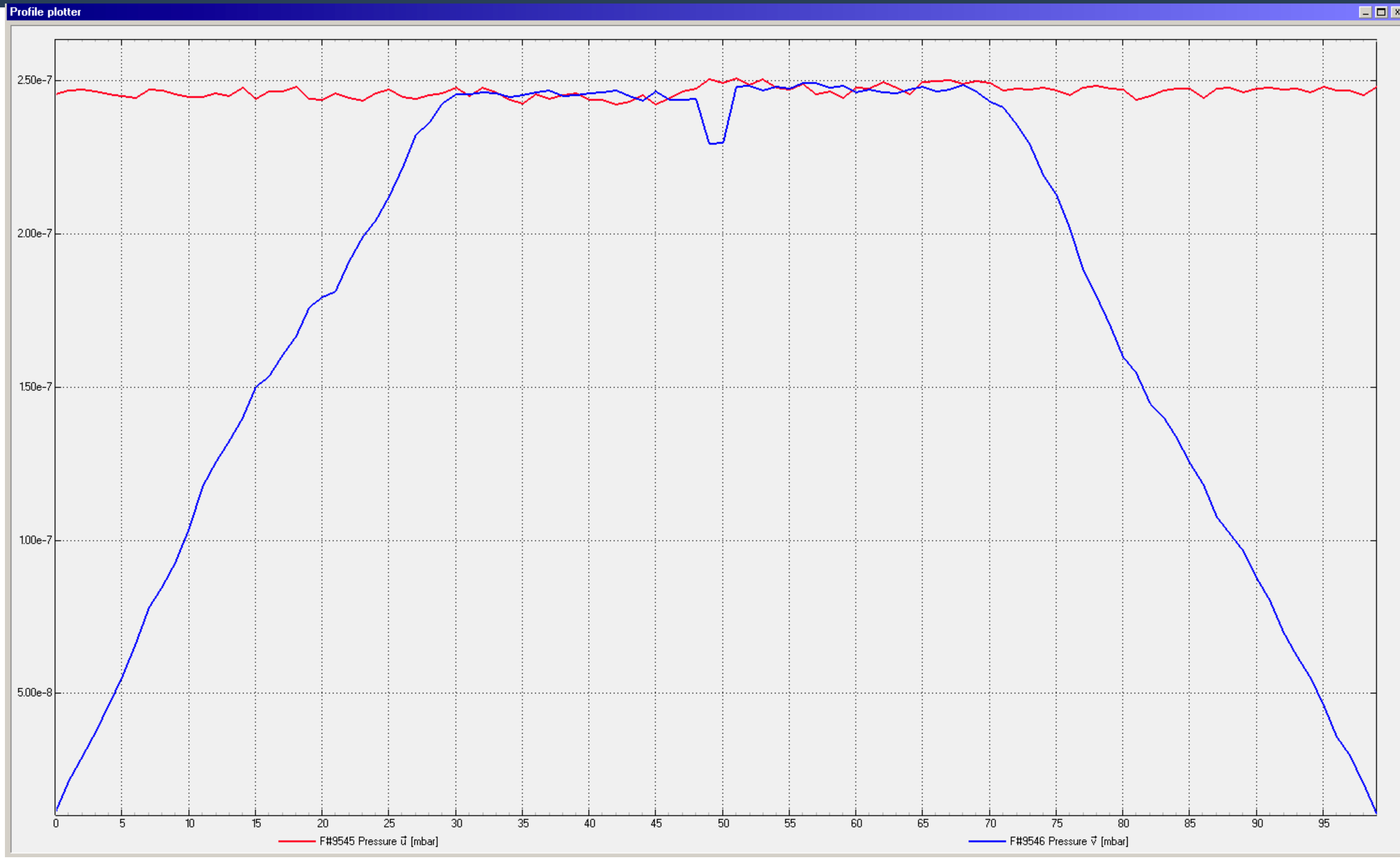


New Vacuum Geometry

- Moved the pumps to the upstream sides of both QD0s
  - increases pumping lever arm by ~5m on both sides…

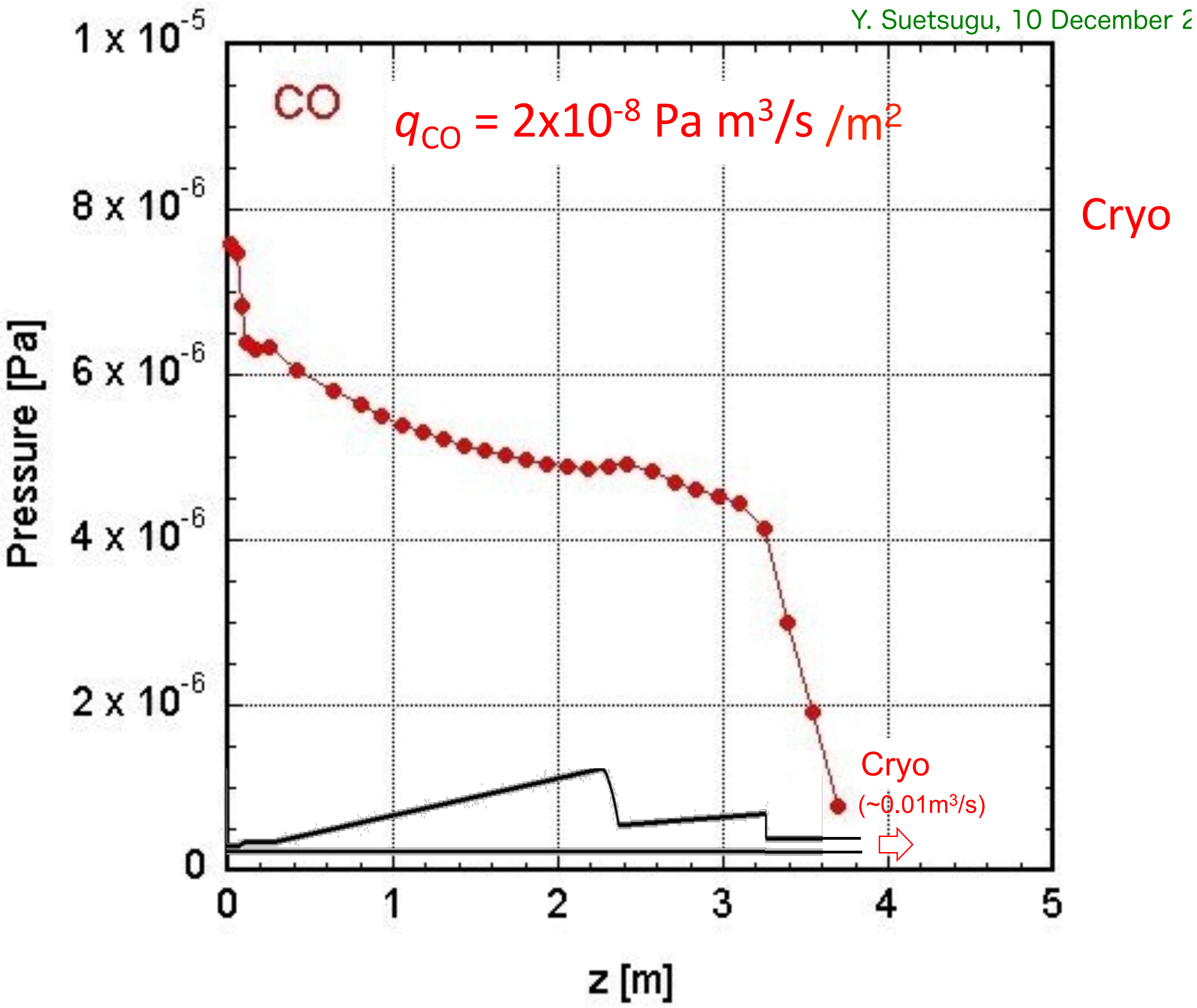


- Increases level to 2.5E-7 mbar
  - for CO
- ~200 nTorr
- ~50 times higher than with old pump location



Revisited Vacuum Studies at KEK

- Y. Suetsugu checked impact of cryogenic QD0
  - Vacuum levels without pump but with cold QD0:

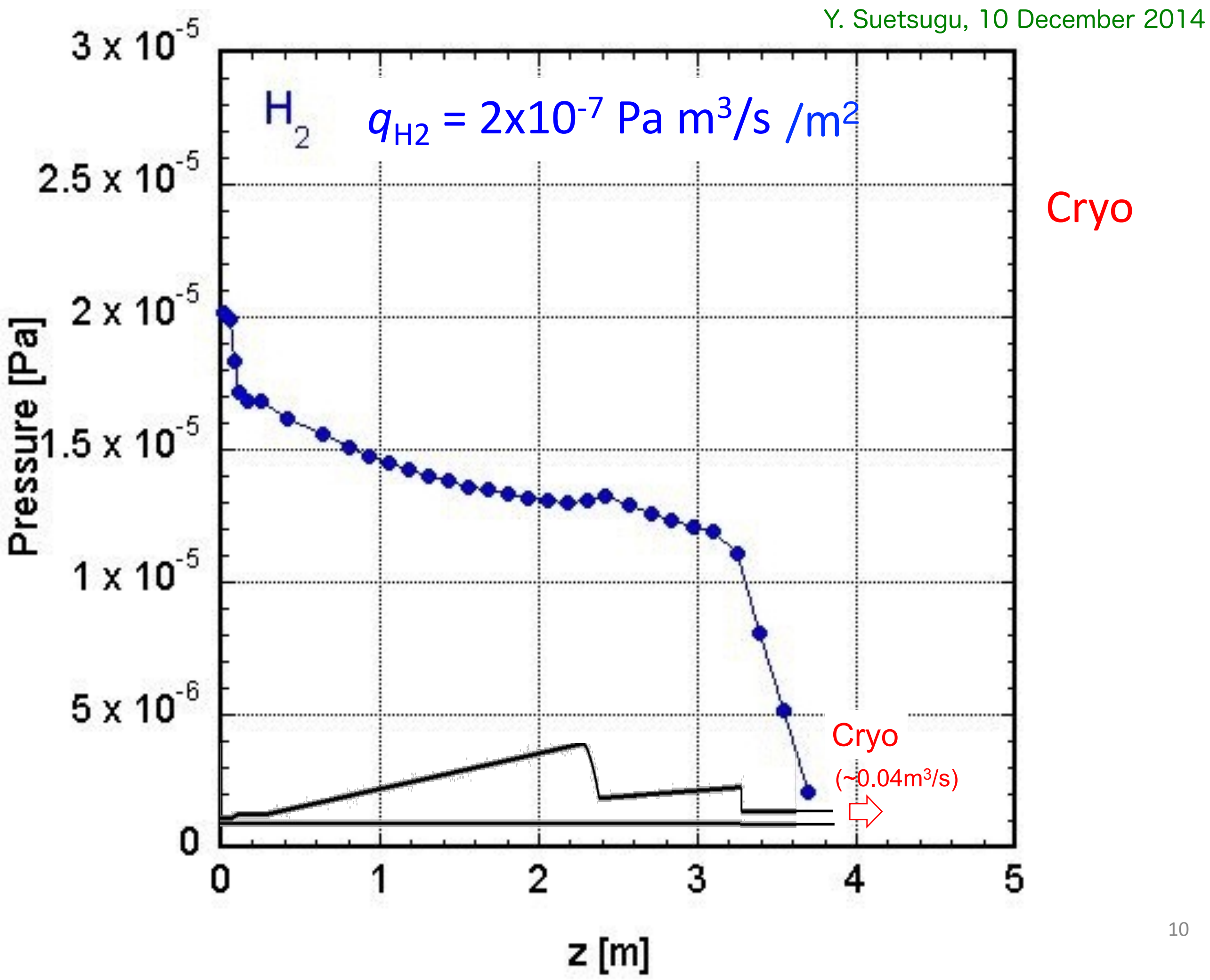


Y. Suetsugu, 10 December 2

q_{CO} = 2x10^{-8} Pa m^3/s /m^2

Cryo

Cryo (~0.01m^3/s)



Y. Suetsugu, 10 December 2014

q_{H2} = 2x10^{-7} Pa m^3/s /m^2

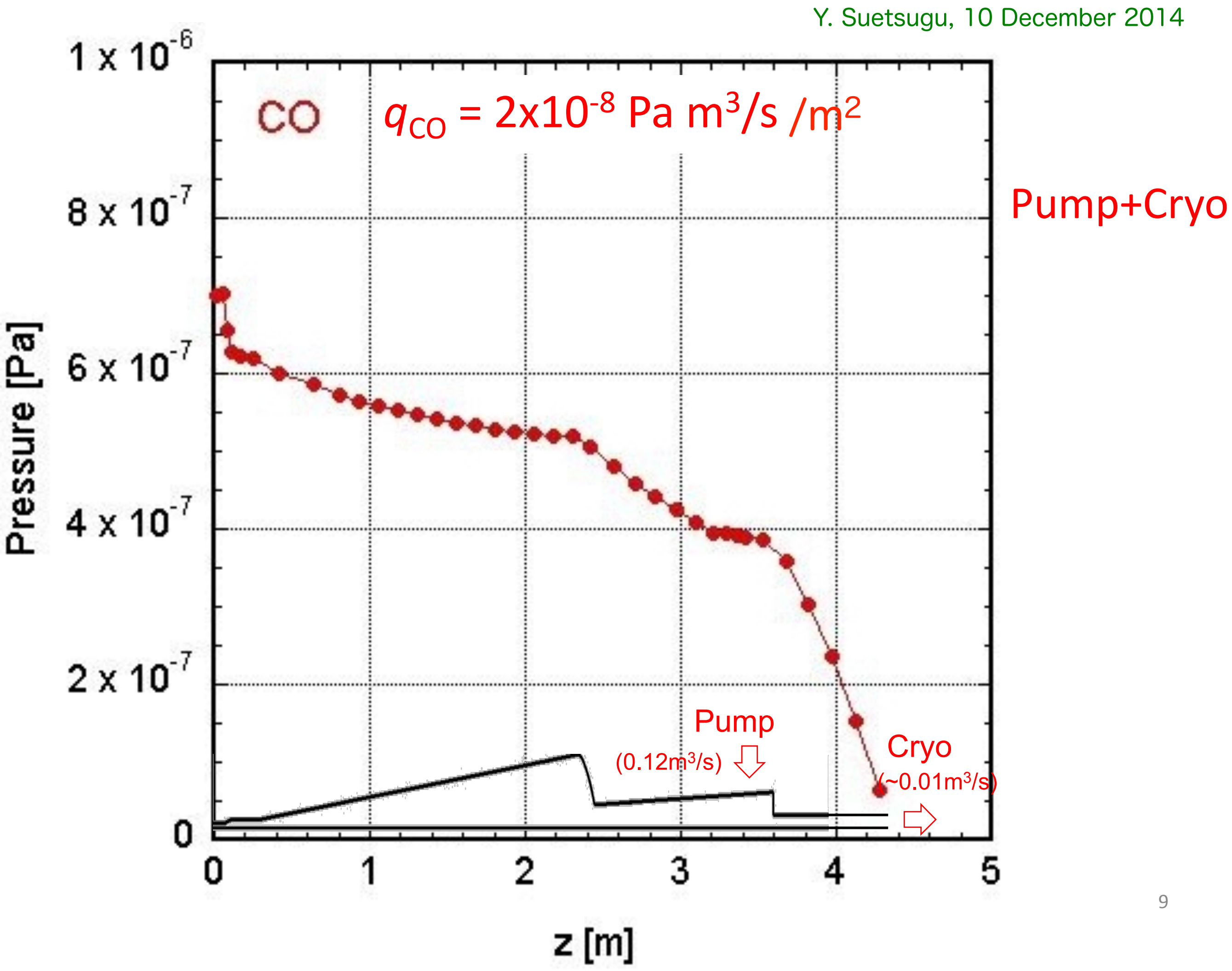
Cryo

Cryo (~0.04m^3/s)

  - CO: 6.8E-6 Pa (50 nTorr); factor 10 above DBD value
  - H_2: 2E-5 Pa (150 nTorr); factor 20 above DBD value

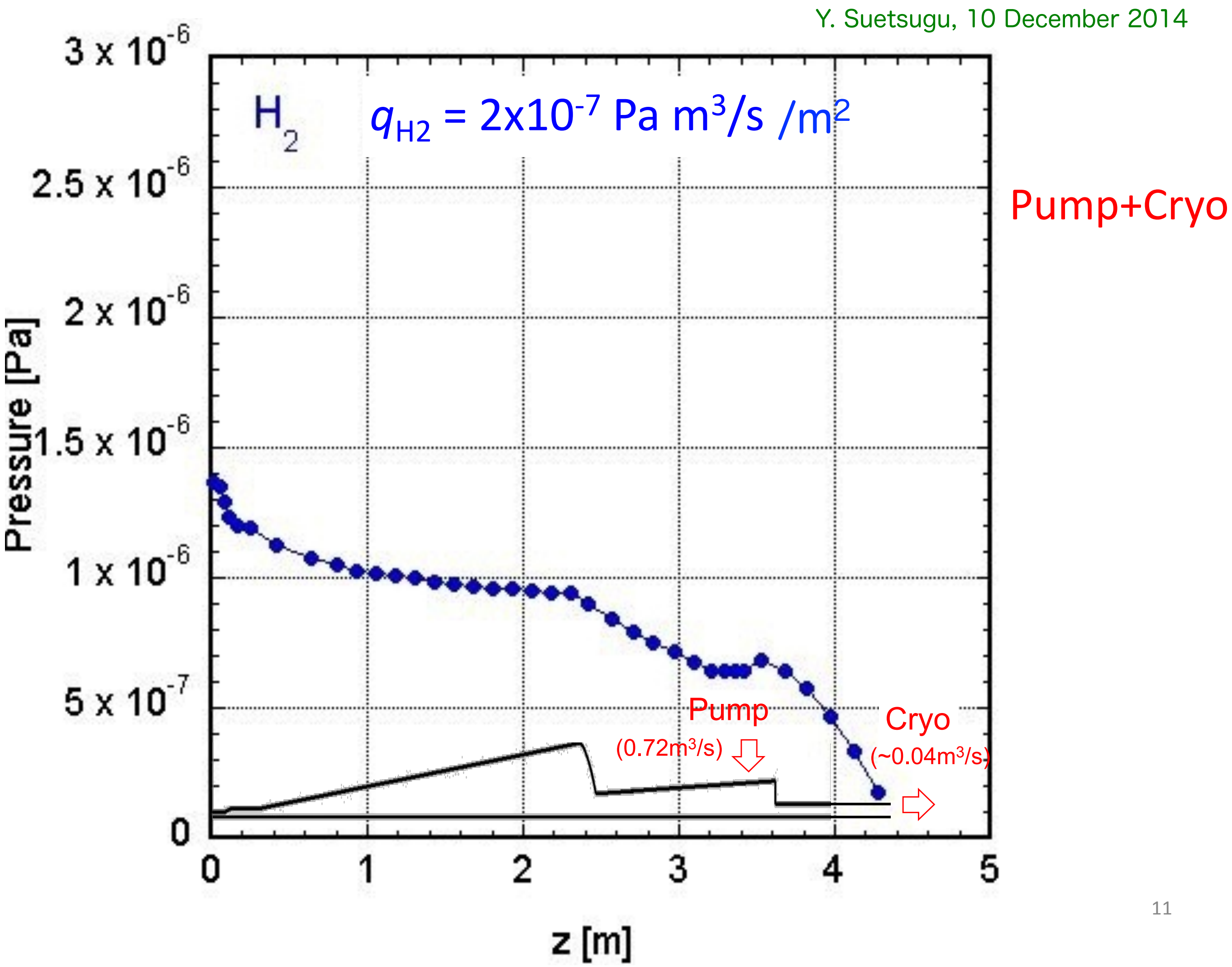
Revisited Vacuum Studies at KEK

- Vacuum levels with pump and cold QD0:



Y. Suetsugu, 10 December 2014

Pump+Cryo



Y. Suetsugu, 10 December 2014

Pump+Cryo

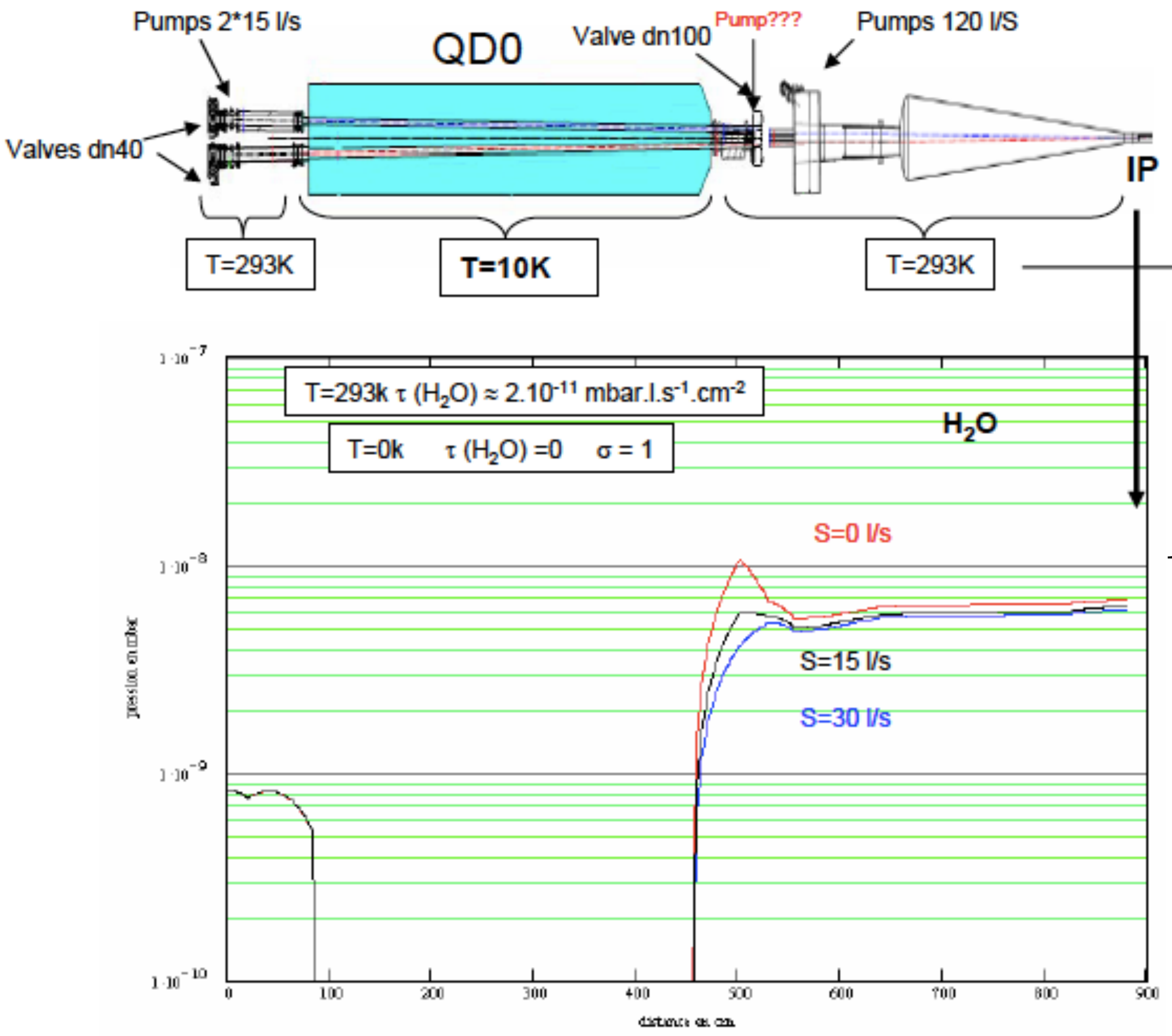
- CO: 6.5E-7 Pa (4.8 nTorr); similar as DBD numbers
- H2: 1.4E-6 Pa (10 nTorr); similar as DBD numbers

Vacuum Studies at LAL

UNDER STATIC CONDITION

QD0 + IP region

B. Mercier



Without baking

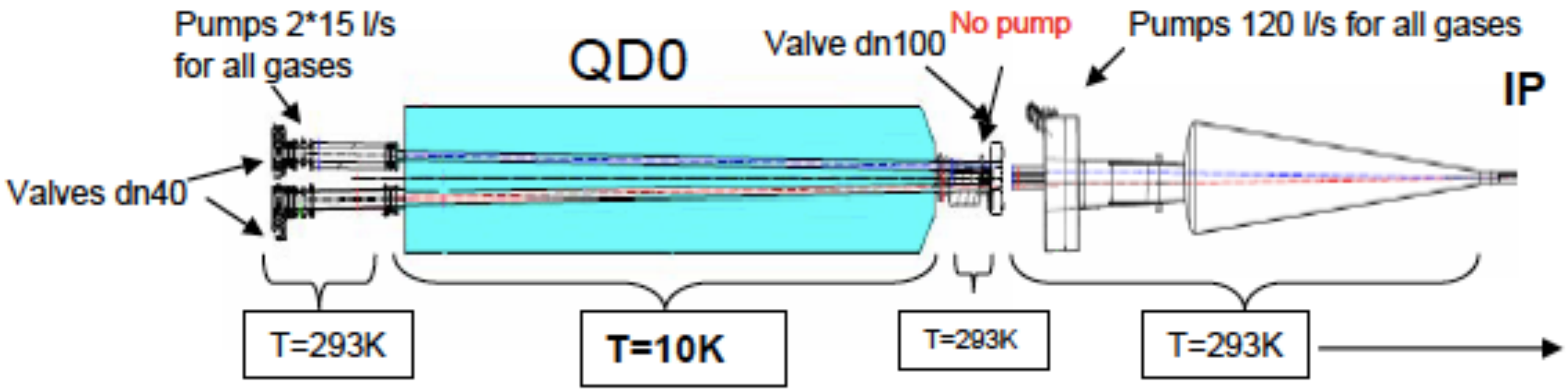
10^{-8} mbar (7.5 nTorr)

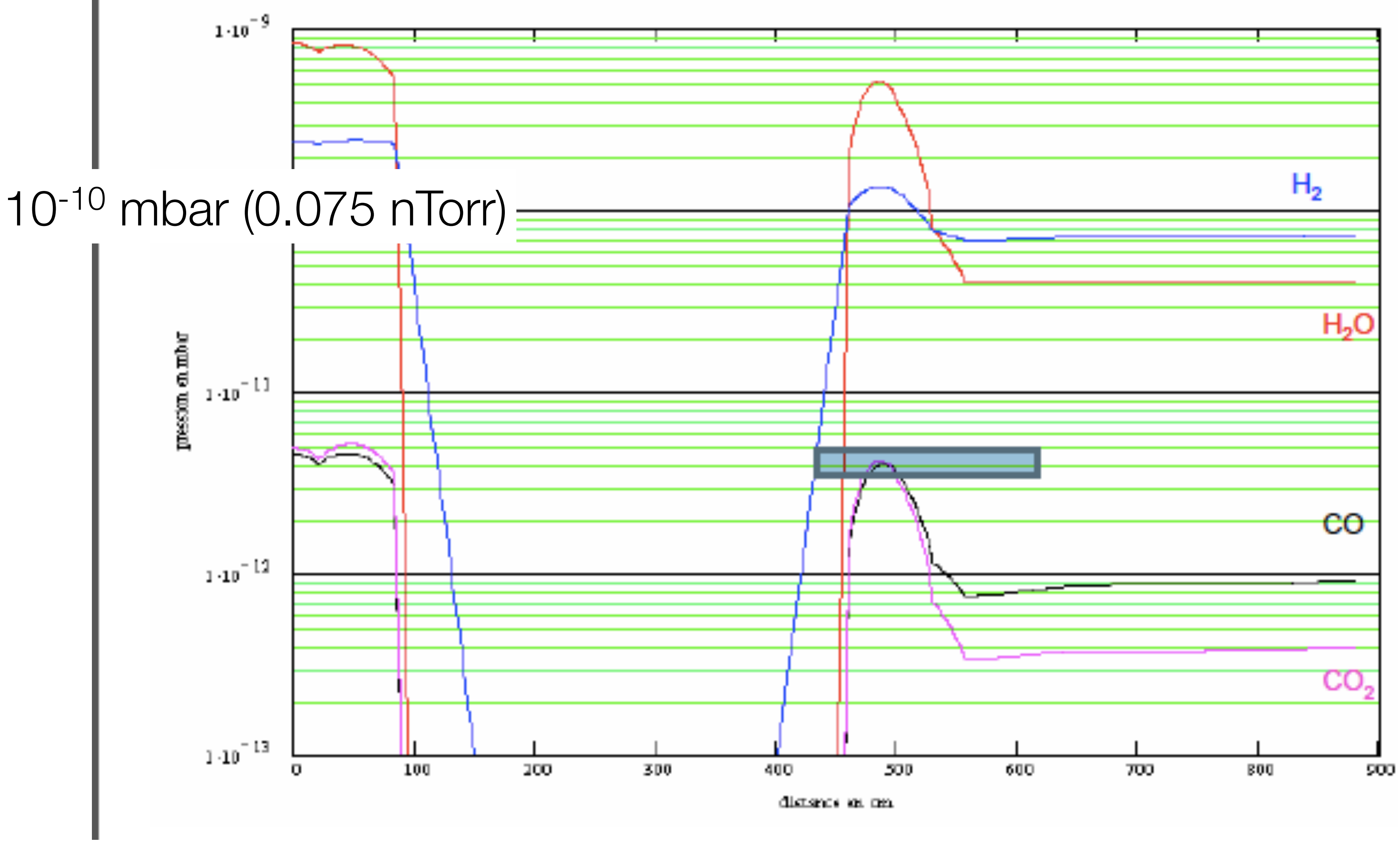
Vacuum Studies at LAL

UNDER STATIC CONDITION

QD0 + IP region

B. Mercier





IP region with baking

Alu or Cu or SS after 100h pumping

$\tau\ (H_2) \approx 2.10^{-13}$ $mbar.l.s^{-1}.cm^{-2}$

$\tau\ (H_2O) \approx 0$ $mbar.l.s^{-1}.cm^{-2}$

$\tau\ (CO) \approx 2.10^{-15}$ $mbar.l.s^{-1}.cm^{-2}$

$\tau\ (CO_2) \approx 5.10^{-16}$ $mbar.l.s^{-1}.cm^{-2}$

Between valves dn40 and dn100

Without baking

T=293K

$\tau\ (H_2) \approx 5.10^{-12}$ $mbar.l.s^{-1}.cm^{-2}$

$\tau\ (H_2O) \approx 2.10^{-11}$ $mbar.l.s^{-1}.cm^{-2}$

$\tau\ (CO) \approx 1.10^{-13}$ $mbar.l.s^{-1}.cm^{-2}$

$\tau\ (CO_2) \approx 1.10^{-13}$ $mbar.l.s^{-1}.cm^{-2}$

T=10K

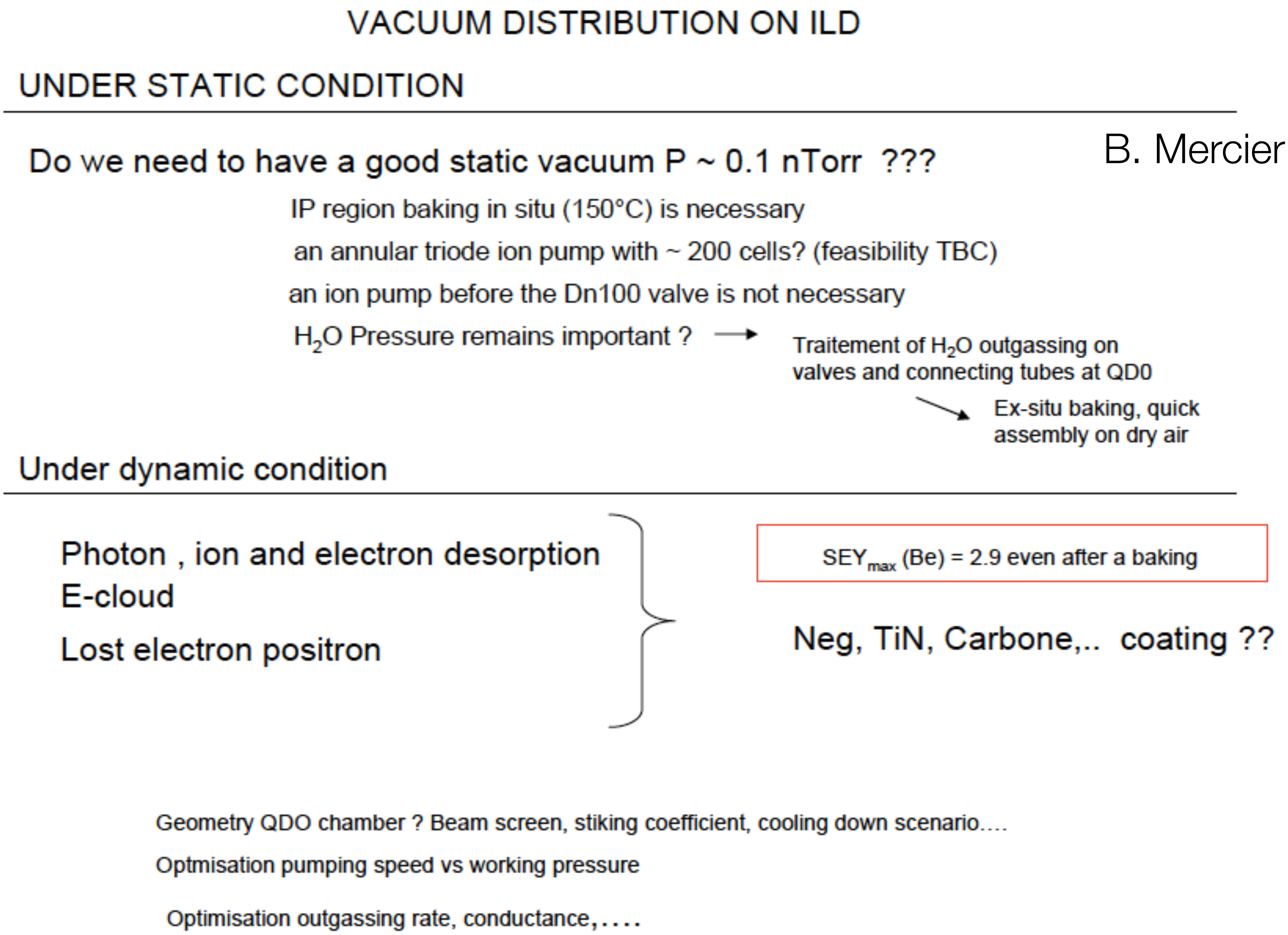
τ (all gases) ≈ 0 $mbar.l.s^{-1}.cm^{-2}$

σ (all gases) = 1 few monolayers

For H_2 beam screen 2% surface

Vacuum Studies at LAL

B. Mercier



VACUUM DISTRIBUTION ON ILD

UNDER STATIC CONDITION

Do we need to have a good static vacuum P ~ 0.1 nTorr ???

IP region baking in situ (150°C) is necessary

an annular triode ion pump with ~ 200 cells? (feasibility TBC)

an ion pump before the Dn100 valve is not necessary

H_2O Pressure remains important ? → Traitement of H_2O outgassing on valves and connecting tubes at QD0 → Ex-situ baking, quick assembly on dry air

Under dynamic condition

Photon , ion and electron desorption
E-cloud
Lost electron positron

SEY_{max} (Be) = 2.9 even after a baking

Neg, TiN, Carbone,.. coating ??

Geometry QDO chamber ? Beam screen, stiking coefficient, cooling down scenario....

Optmisation pumping speed vs working pressure

Optimisation outgassing rate, conductance,....

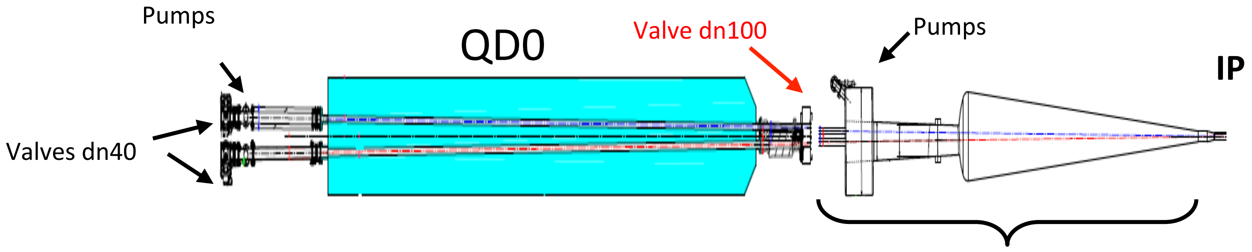
Vacuum Studies at LAL

ILC

IP vacuum

15/12/2014

possible changes towards L*=4m



Need a pumping system between the two DN 100 valves (hot part of the IP chamber)

Proposal for a distributed pumping: coating NEG (Non evaporate Getter)

→ Length reduction

→ Improved vacuum level (to quantify)

→ Need to in situ baking of beam pipe

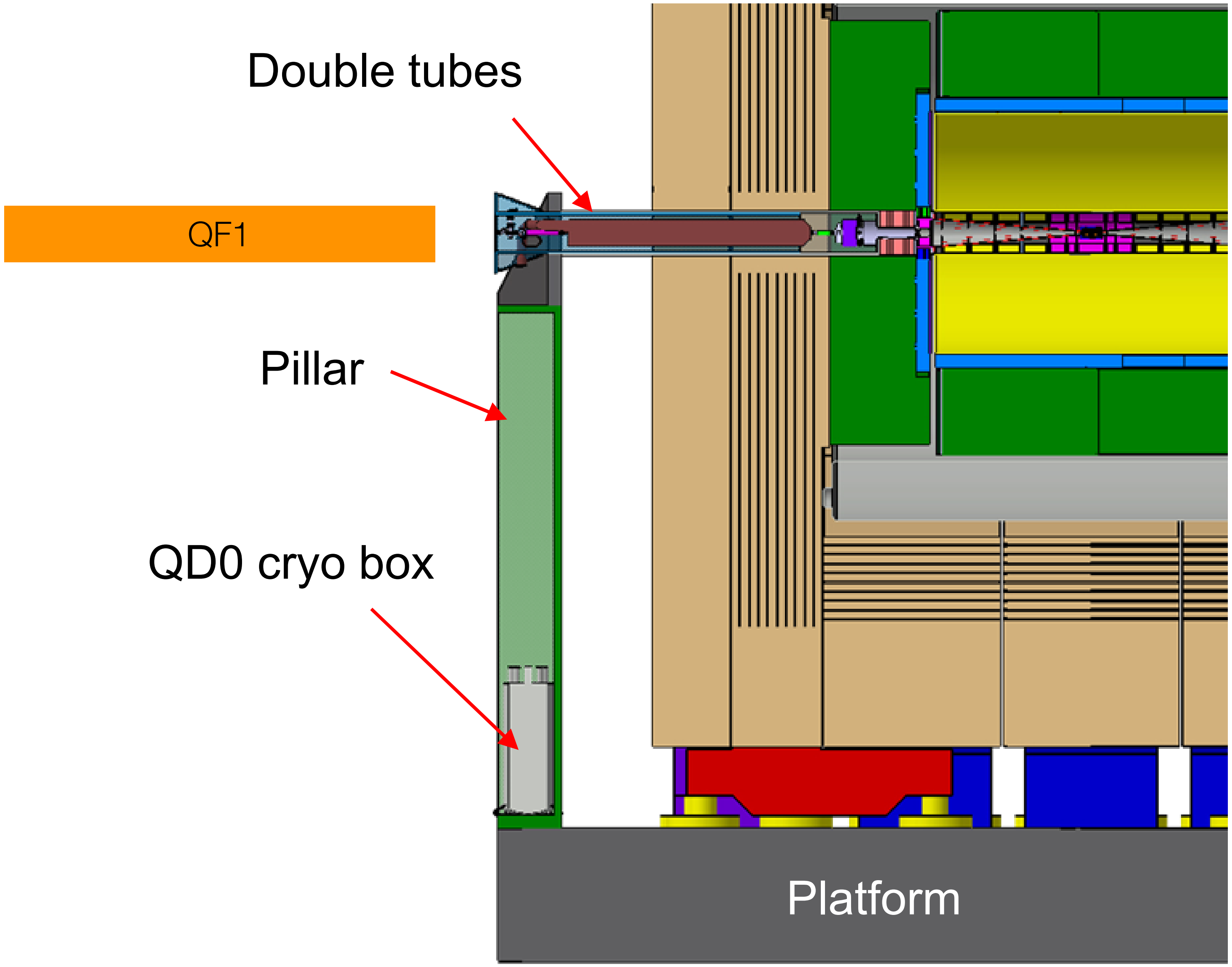
B. Mercier

Vacuum Studies Summary

- Vacuum studies indicate that
  - Cryo effect by QD0 is relevant
  - If we remove any pump in front of QD0:
    - the vacuum conditions deteriorate by factors of ~O(10)
      - KEK: from 5 nTorr levels to 50 nTorr levels
      - detailed studies at LAL even predict 0.1 nTorr level for DBD geometry
  - LAL proposal to look into distributed pumping system (NEG coating) in the beam pipe to possibly recover nTorr levels
- Still need to do work on background tolerances in ILD
  - about to identify persons in ILD analysis group who could do detailed Geant-type studies on beam-gas studies
- Probably need to put emphasis on dynamic vacuum conditions
  - photon desorption, etc.

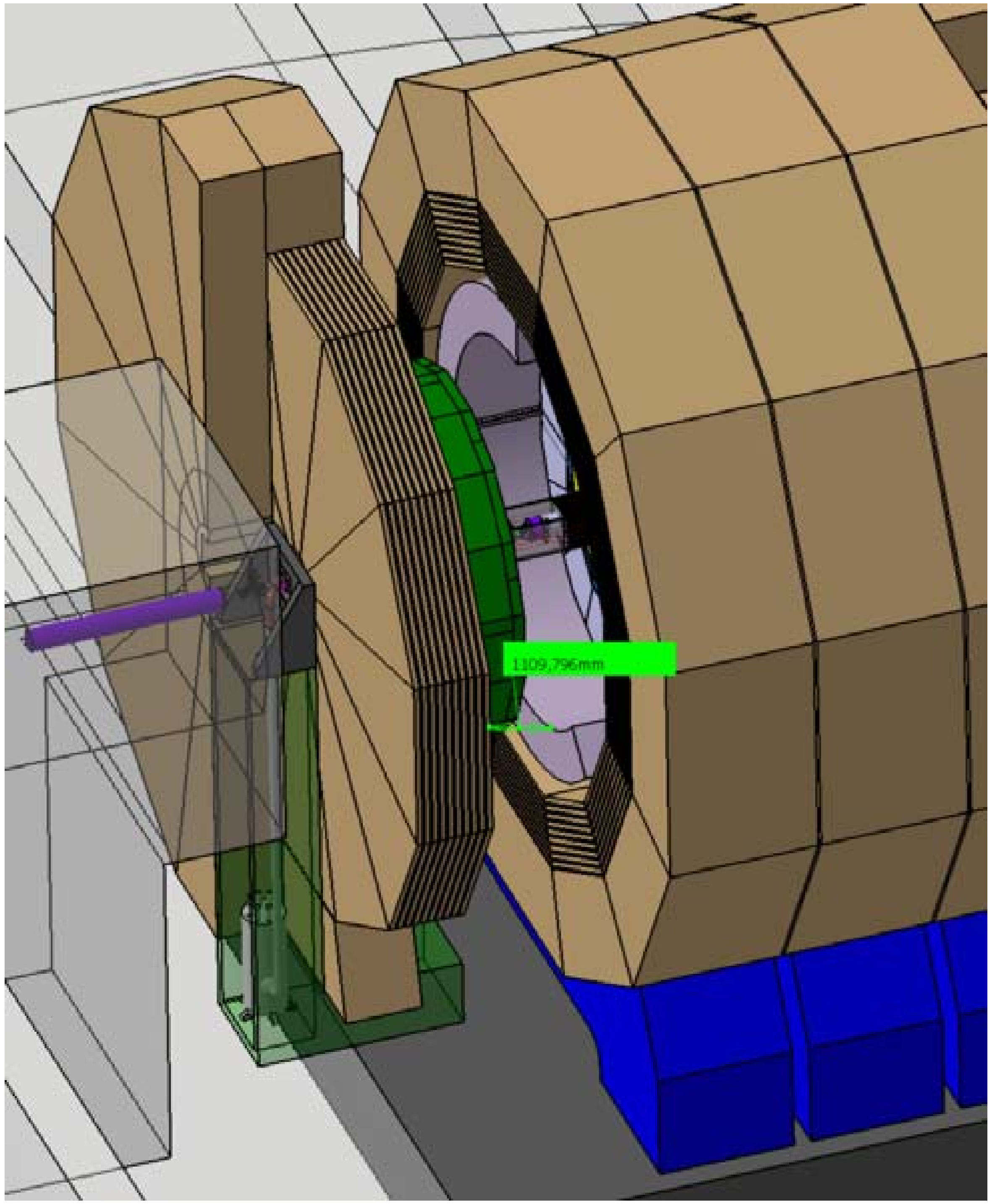
What about QF1?

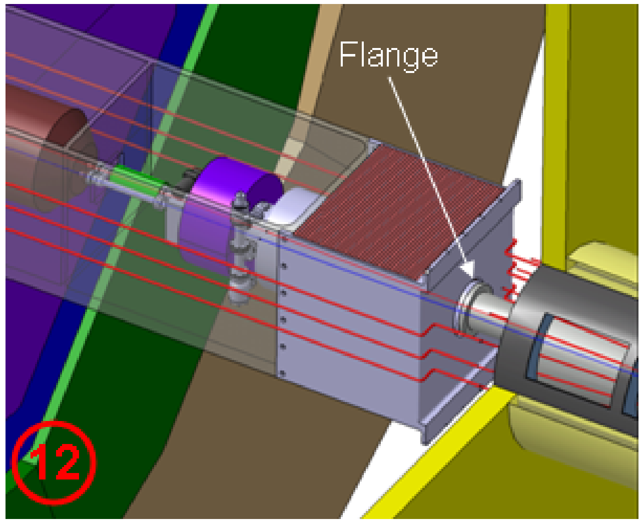
- BDS studies indicate that a smaller L* for QD0 might require also a smaller L* for QF1
- This might also have an impact on ILD:

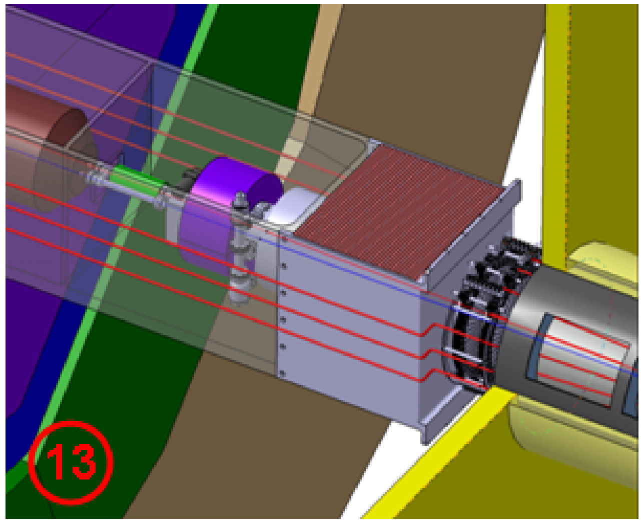


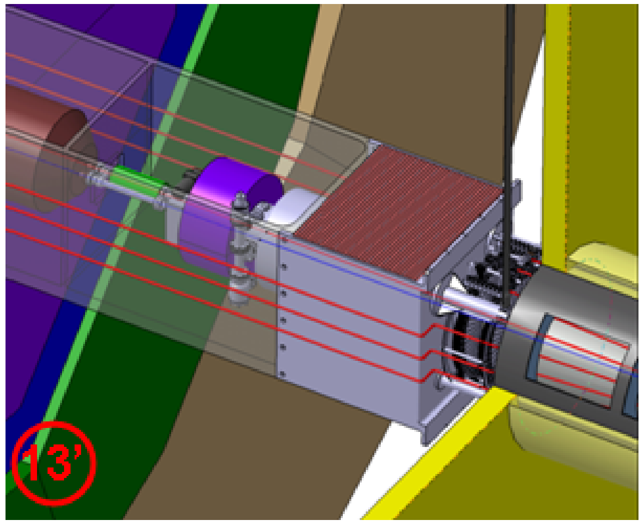
Current ILD Opening Procedure

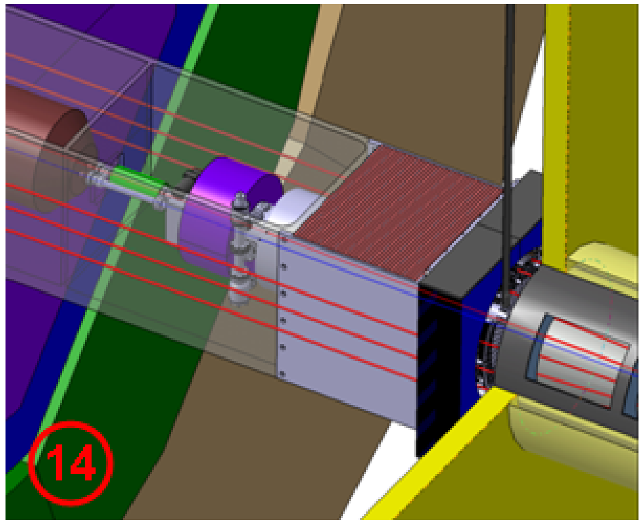
- Need to move endcap far enough out to have access to inner detector to open flanges





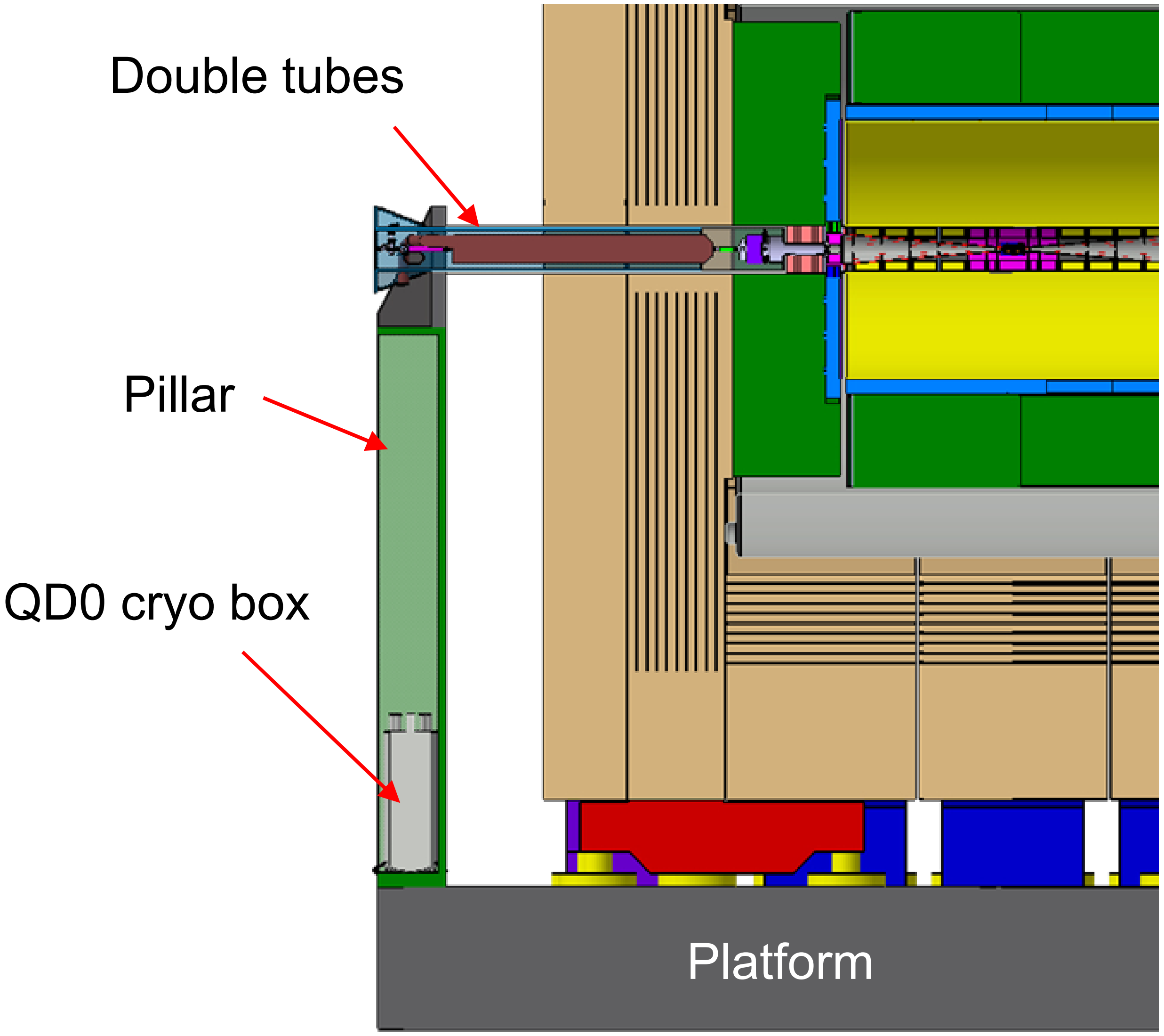






ILD and QF1 L*

- If QF1 comes closer and the QD0 support pillar eventually moves closer to the endcap, the current opening scheme needs to be modified
- Need to re-think the QD0 support using a pillar
- Maybe a temporary QD0 support in the garage position is needed
  - has impact on cryo supplies…
- Would abandon the possibility to open the detector on the beam line
  - anyhow rarely needed in push-pull scenario



Summary and Outlook

- ILD has started an effort to adapt to a reduction of QD0 L*
- Removal of the vacuum pump in front of QD0 seems a possible way to gain ~40 cm of space
- Vacuum studies under way at LAL, KEK, DESY
- Vacuum levels could increase by factors of ~10-20
  - LAL group has started a study on a distributed vacuum system that could recover the previous levels
  - all vacuum experts are concerned more by dynamic conditions
    - though, their main experience comes from storage rings, not linear colliders
  - ILD is about to start a beam-gas background study - collaboration with SiD has been agreed (J. Strube, PNNL)
- QF1 L* has also implications on ILD engineering design
- Time line: have informations at hand for a conceptual decision by April