

# Status of L\* Studies at ILD

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Karsten Buesser  
ILD Optimisation Meeting  
18.03.2015



# Change Request No 2: Common $L^* \leq 4\text{m}$

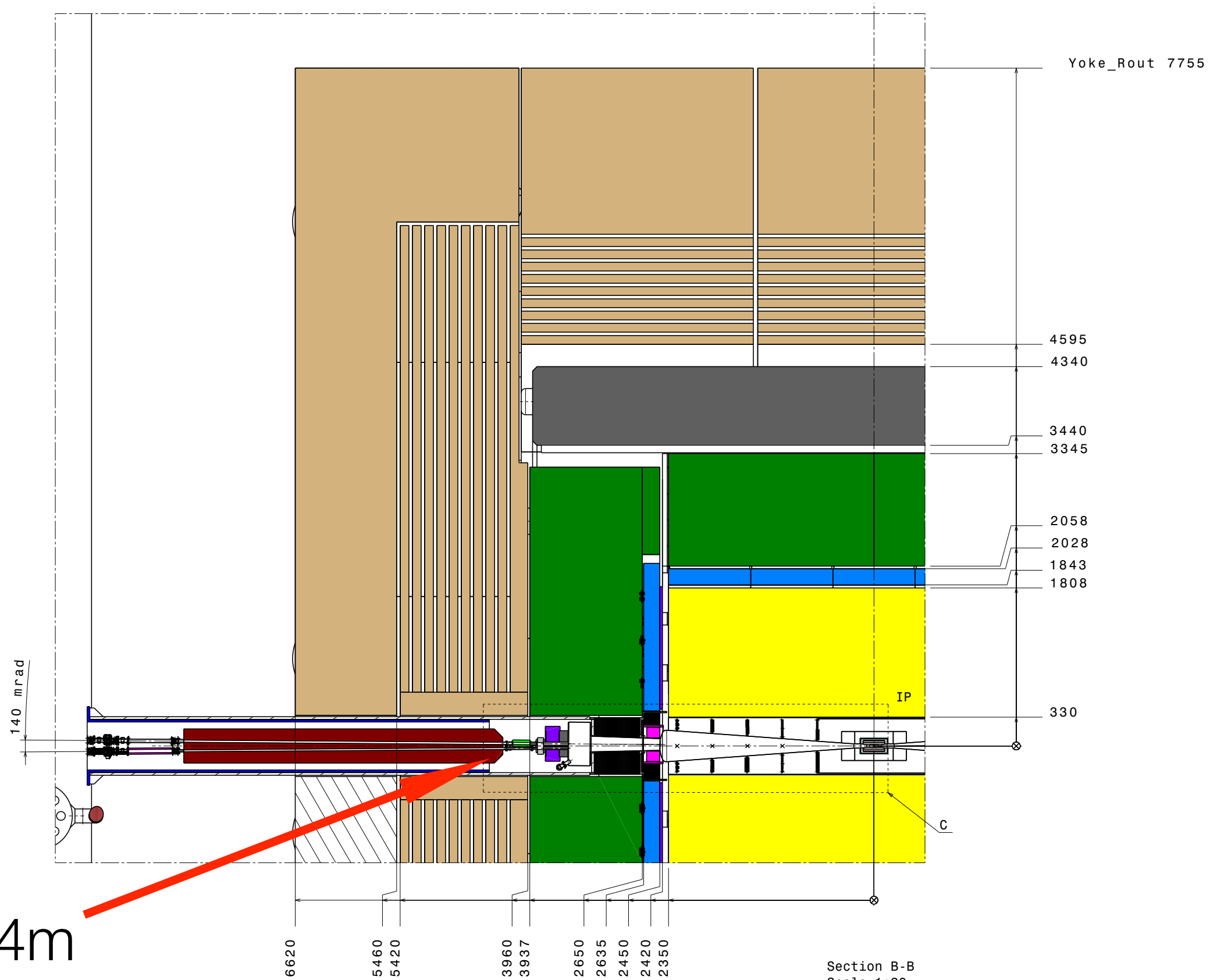
<b>CHANGE REQUEST NO. ILC-CR-0002</b>	EDMS No: <b>D*01082495</b>	Created: <b>02-09-2014</b>
		Last modified: <b>09-09-2014</b>

## **BASELINE OPTICS TO PROVIDE FOR A SINGLE FFS $L^*$ (QD0 EXIT – IP DISTANCE) OPTICS CONFIGURATION**

The final focus system (FFS) and beam dump extraction system (EXT) baseline design is to provide a standard optics with fixed  $L^*$  (yet to be determined, but provisionally assumed to be  $\leq 4\text{m}$ ). This optics solution is to be common to both detectors.

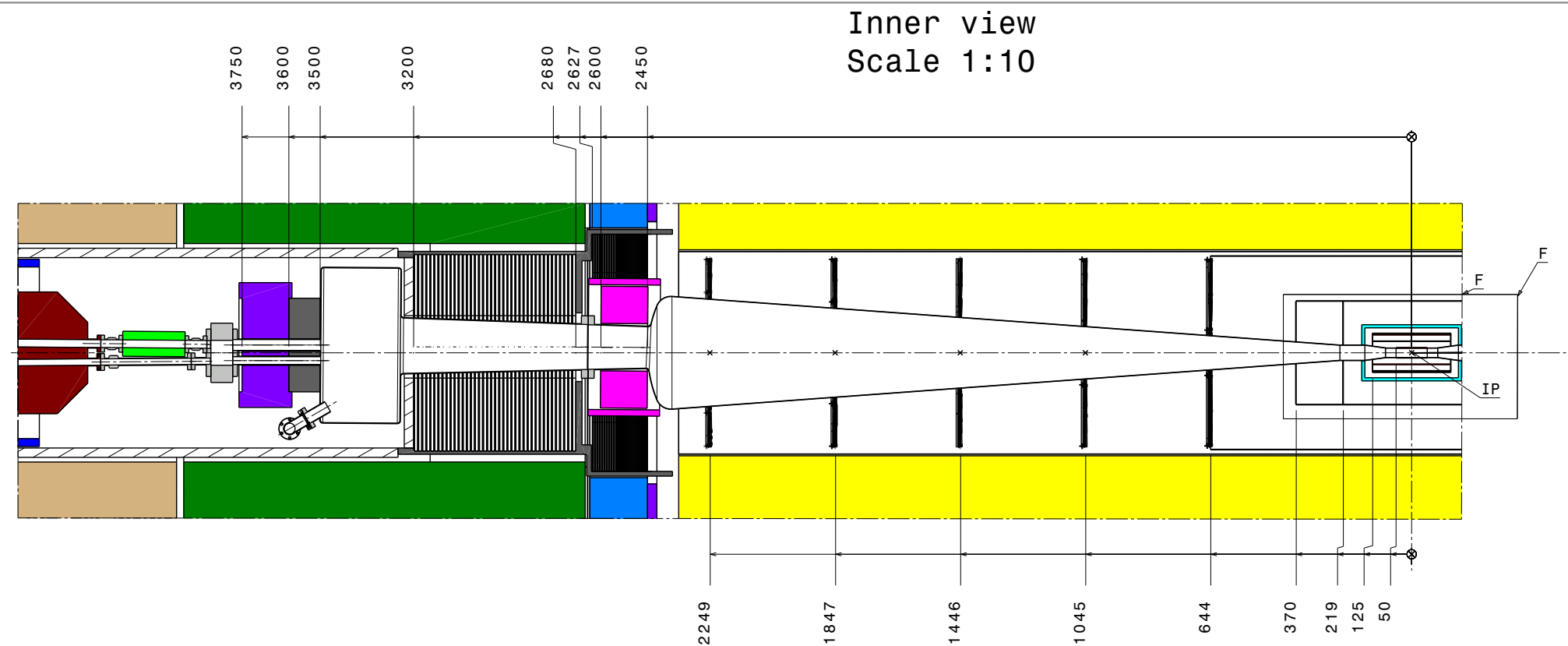
- Submitted by Glen White (BDS WG leader) in September 2014
- Change Management Board has formed a Change Review Panel for this request:
  - T. Markiewicz (SiD), N. Terunuma, N. Walker, G. White, KB (MDI, ILD)
  - CRP has agreed to come to a suggestion at the time scale of the next ILC workshop (April 2015, Tokyo)
  - CMB will decide eventually

# ILD Dimensions



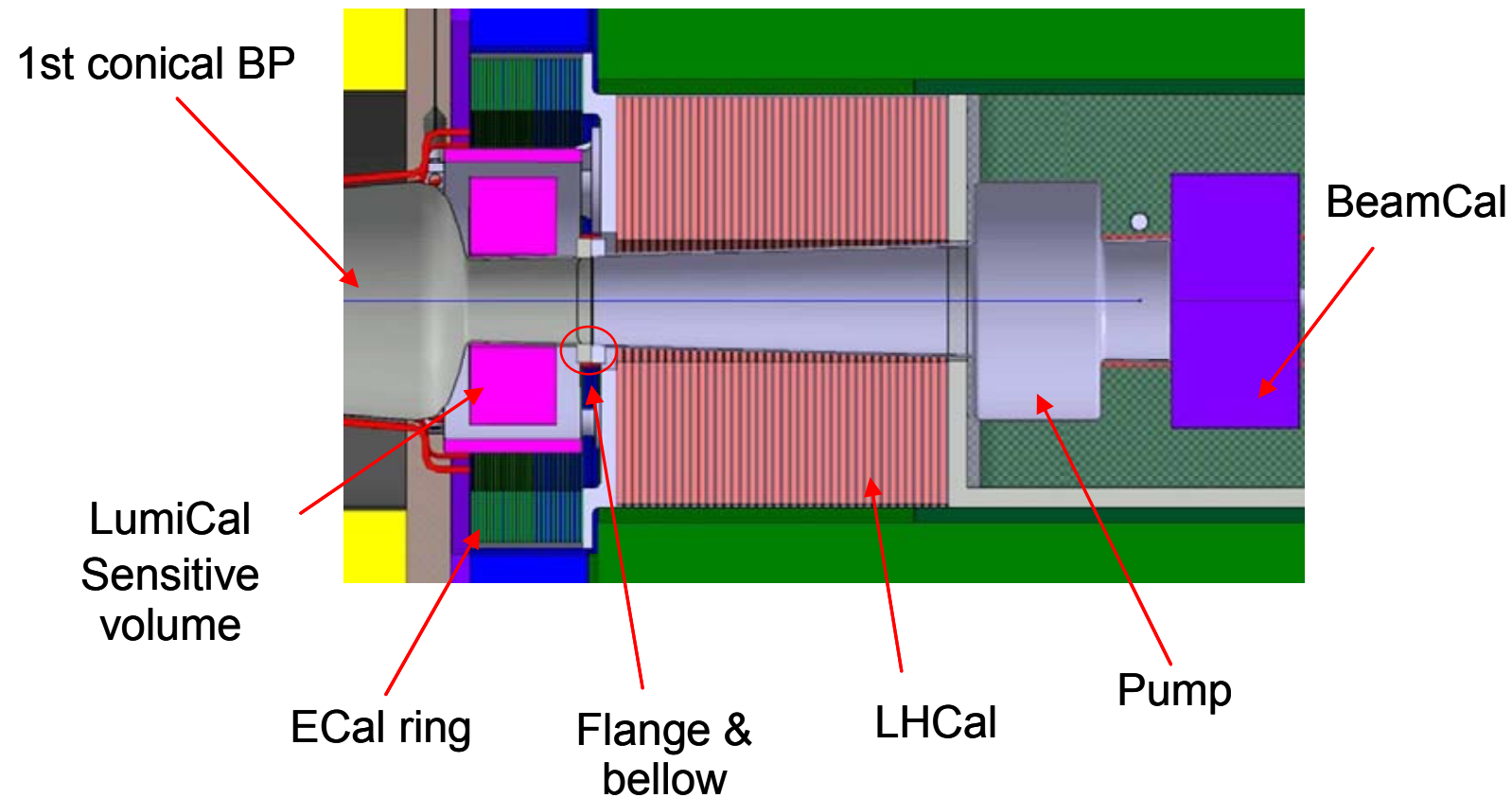
$L^* = 4.4\text{m}$

# 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 $L^*=4\text{m}$

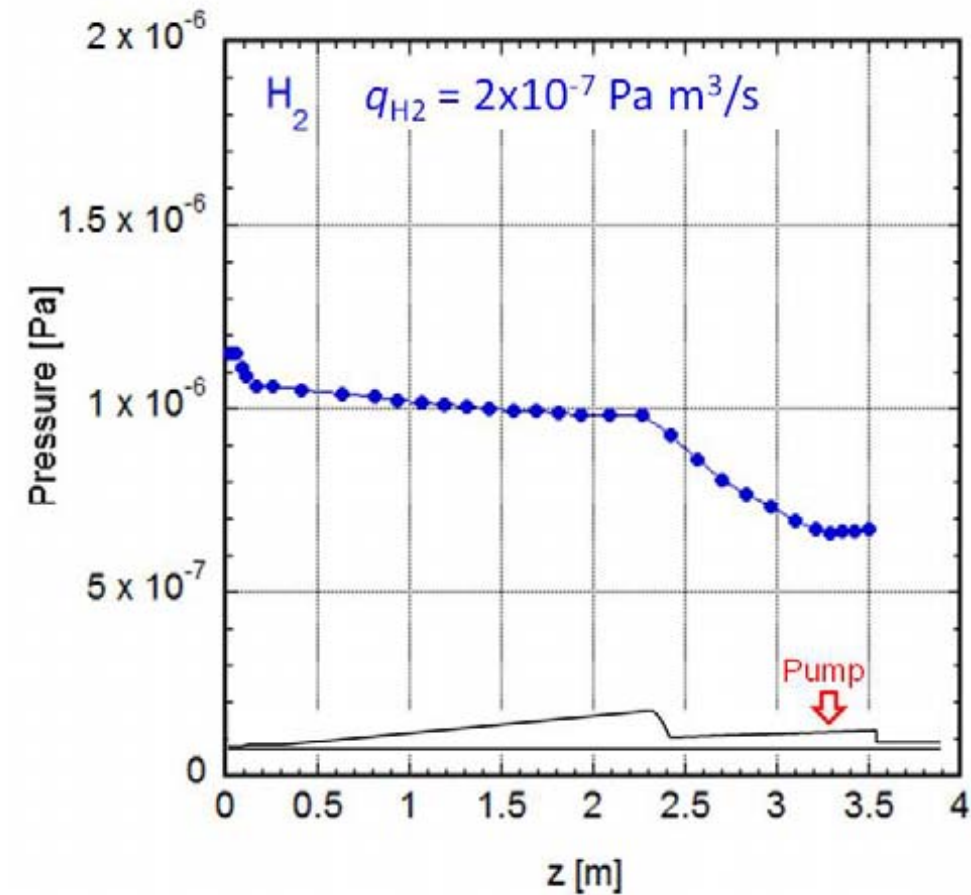
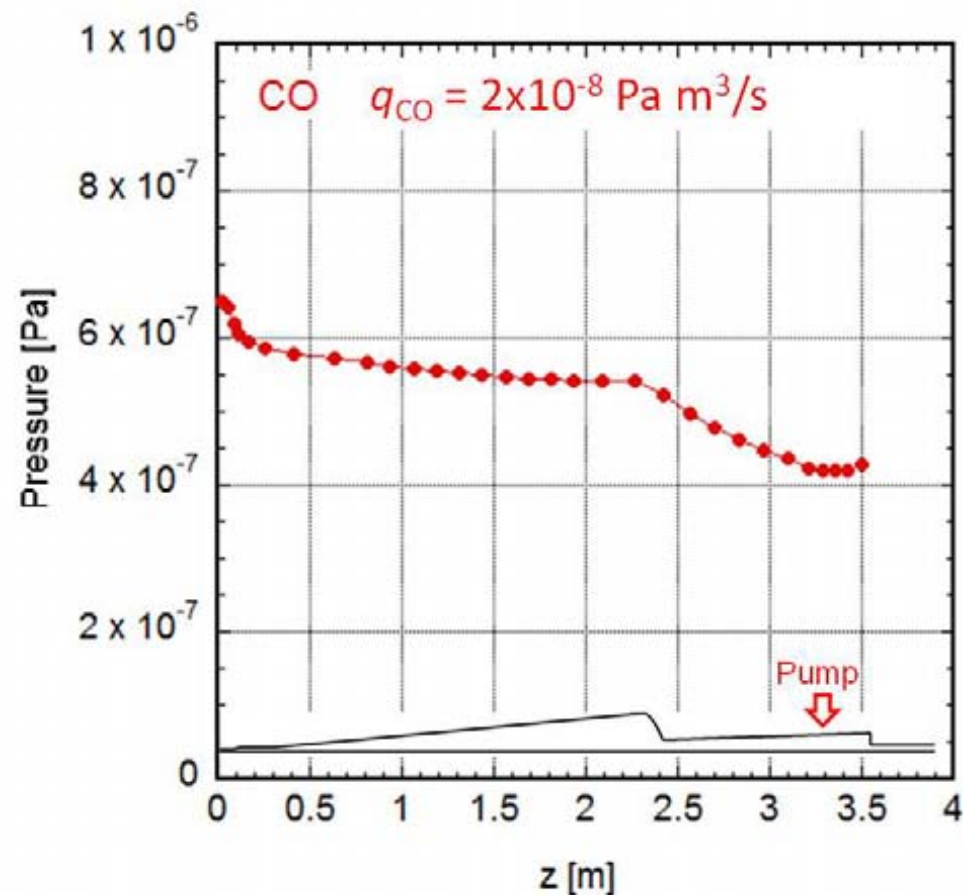
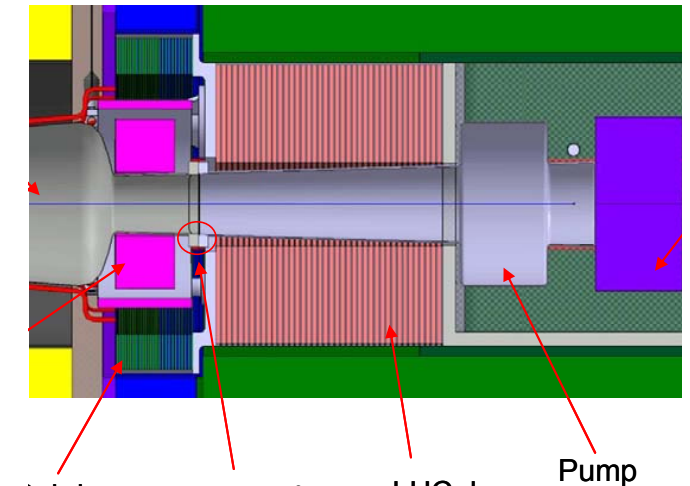


- Need to find ~40cm in current design
- Look into design optimisations of all structures
  - maybe find some 10cm there, but more?
- Biggest devices:
  - Pump in front of BeamCal (30cm)
  - LHCAL (~50cm)



# Vacuum Conditions

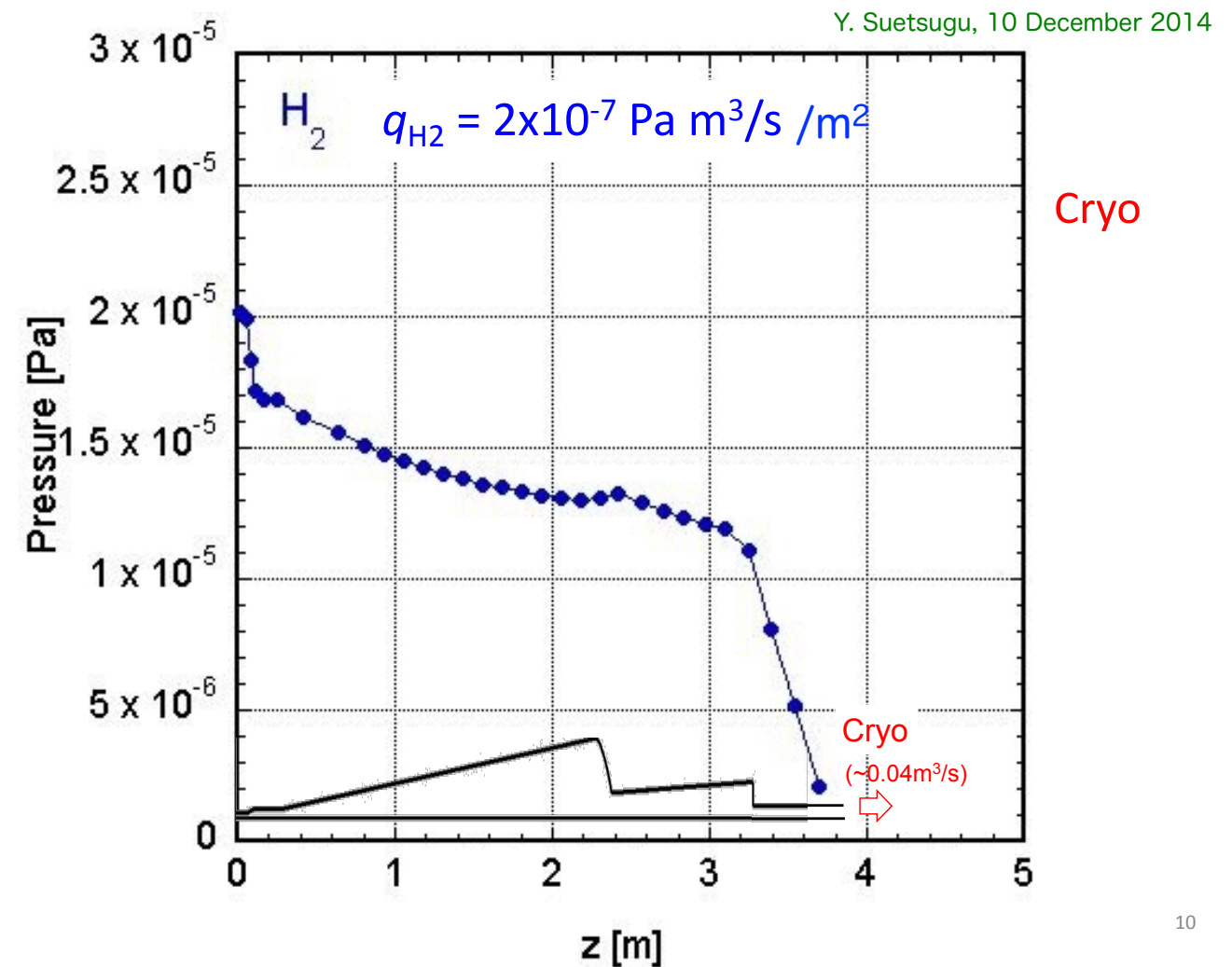
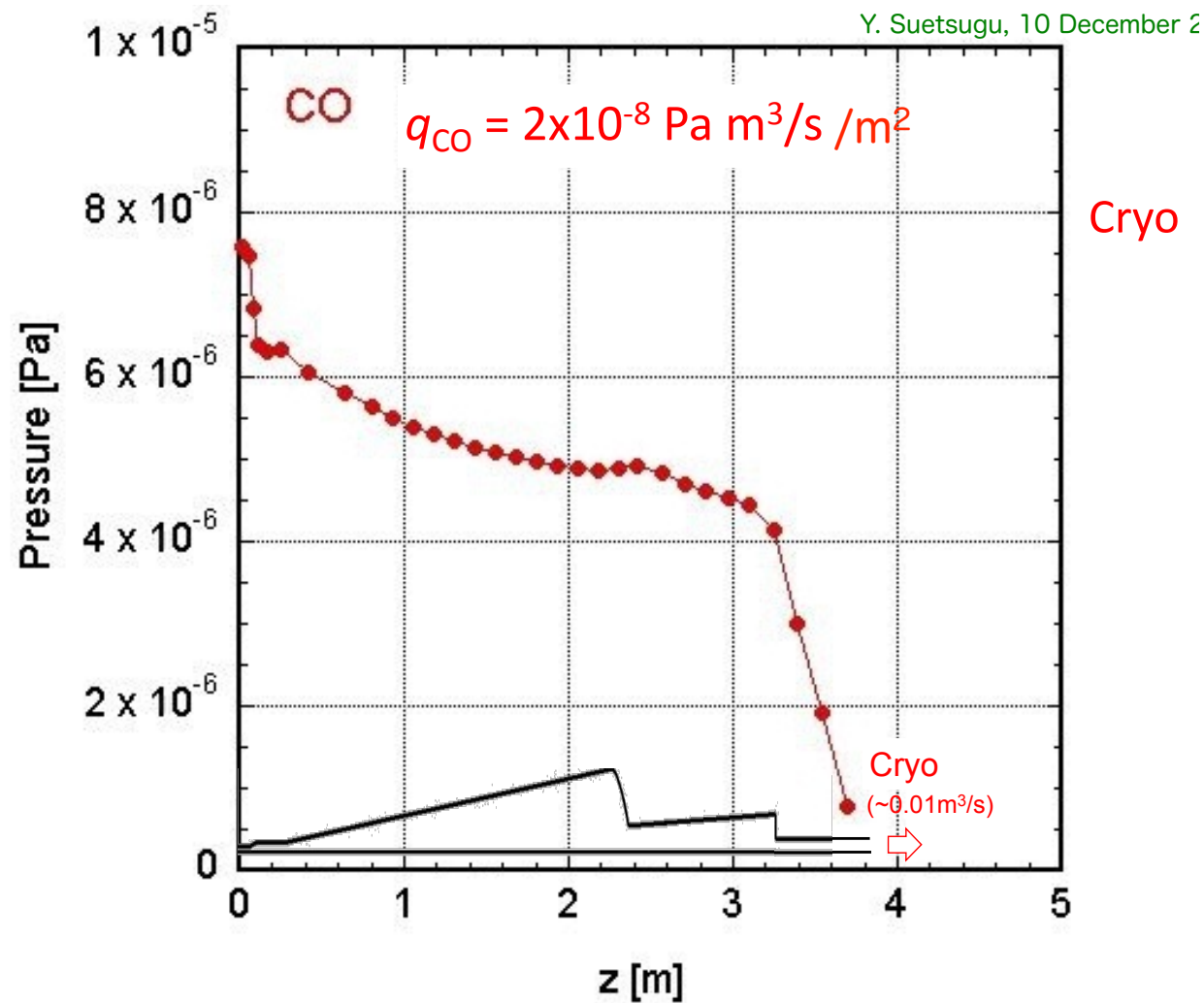
- What about the vacuum pump?
- SiD has no pump in front of QD0, but behind
- ILD vacuum studies done for Lol
  - Y. Suetsugu, “Technical Note for ILD Beam Pipe“:
  - $6\text{E-}7$  Pa ( $6\text{E-}9$  mbar,  $\sim 4.5$  nTorr) for CO
  - $1\text{E-}6$  Pa ( $1\text{E-}8$  mbar,  $\sim 7.5$  nTorr) for  $\text{H}_2$



# Revisited Vacuum Studies at KEK



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



- CO:  $6.8 \times 10^{-6}$  Pa (50 nTorr); factor 10 above DBD value
- H<sub>2</sub>:  $2 \times 10^{-5}$  Pa (150 nTorr); factor 20 above DBD value

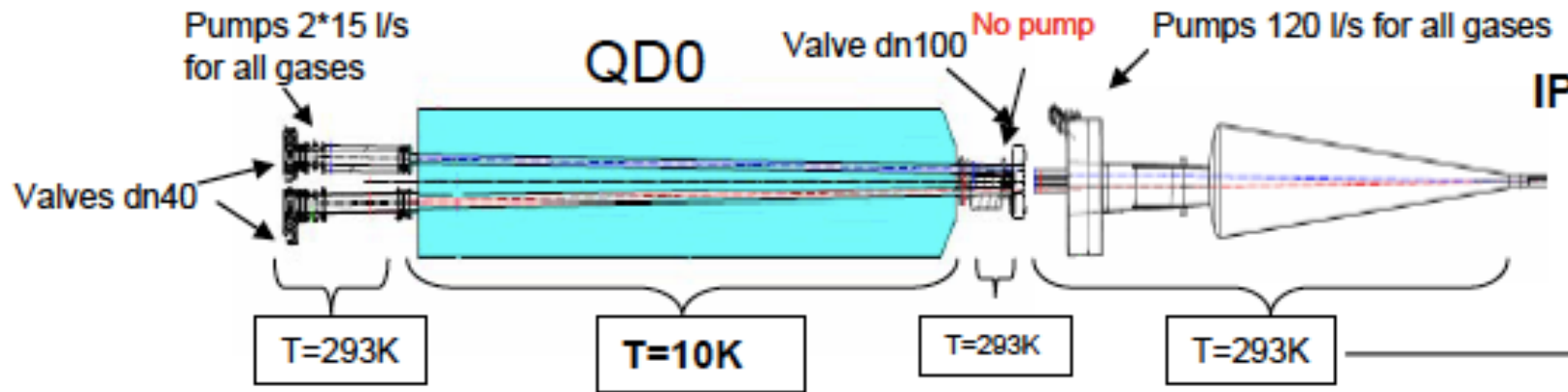


# Vacuum Studies at LAL (TDR Setup)



UNDER STATIC CONDITION

QD0 + IP region



B. Mercier

IP region with baking

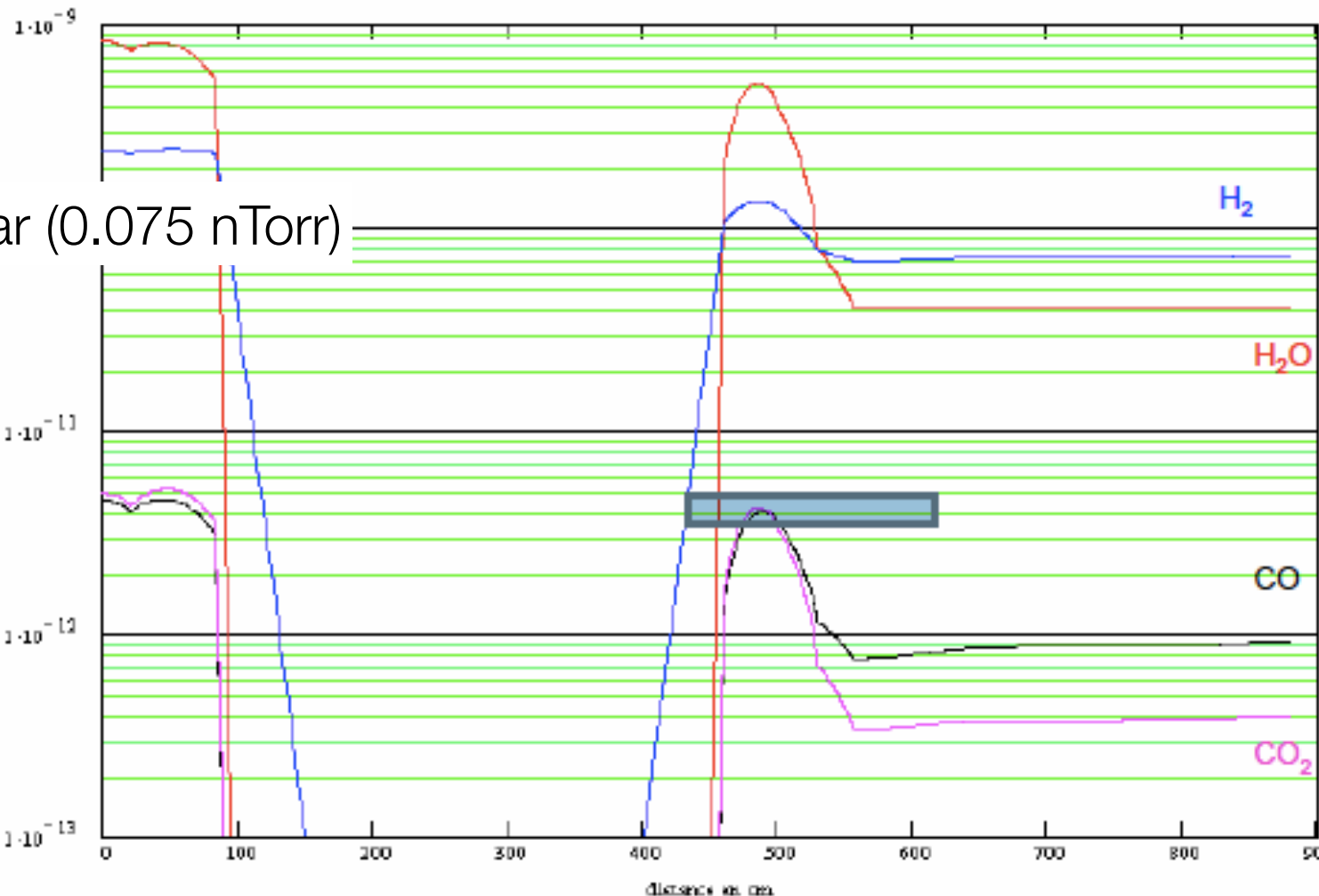
Alu or Cu or SS after 100h pumping

$$\begin{aligned} \tau (\text{H}_2) &\approx 2 \cdot 10^{-13} \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \\ \tau (\text{H}_2\text{O}) &\approx 0 \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \\ \tau (\text{CO}) &\approx 2 \cdot 10^{-15} \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \\ \tau (\text{CO}_2) &\approx 5 \cdot 10^{-16} \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \end{aligned}$$

Between valves dn40 and dn100  
Without baking

$$\begin{aligned} \text{T=293K} \quad \tau (\text{H}_2) &\approx 5 \cdot 10^{-12} \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \\ \tau (\text{H}_2\text{O}) &\approx 2 \cdot 10^{-11} \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \\ \tau (\text{CO}) &\approx 1 \cdot 10^{-13} \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \\ \tau (\text{CO}_2) &\approx 1 \cdot 10^{-13} \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \end{aligned}$$

$$\begin{aligned} \text{T=10K} \quad \tau (\text{all gases}) &\approx 0 \text{ mbar.l.s}^{-1}.\text{cm}^{-2} \\ \sigma (\text{all gases}) &= 1 \text{ few monolayers} \\ &\text{For H}_2 \text{ beam screen } 2\% \text{ surface} \end{aligned}$$



$10^{-10}$  mbar (0.075 nTorr)



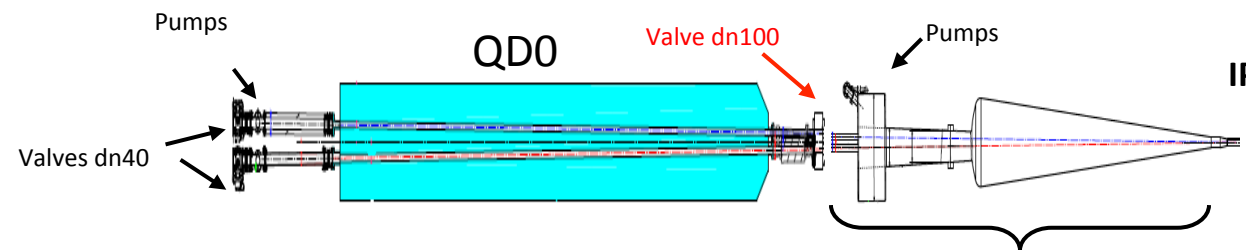
# Vacuum Studies at LAL (Revisited)

ILC

IP vacuum

15/12/2014

possible changes towards  $L^*=4\text{m}$



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

• Preliminary results:

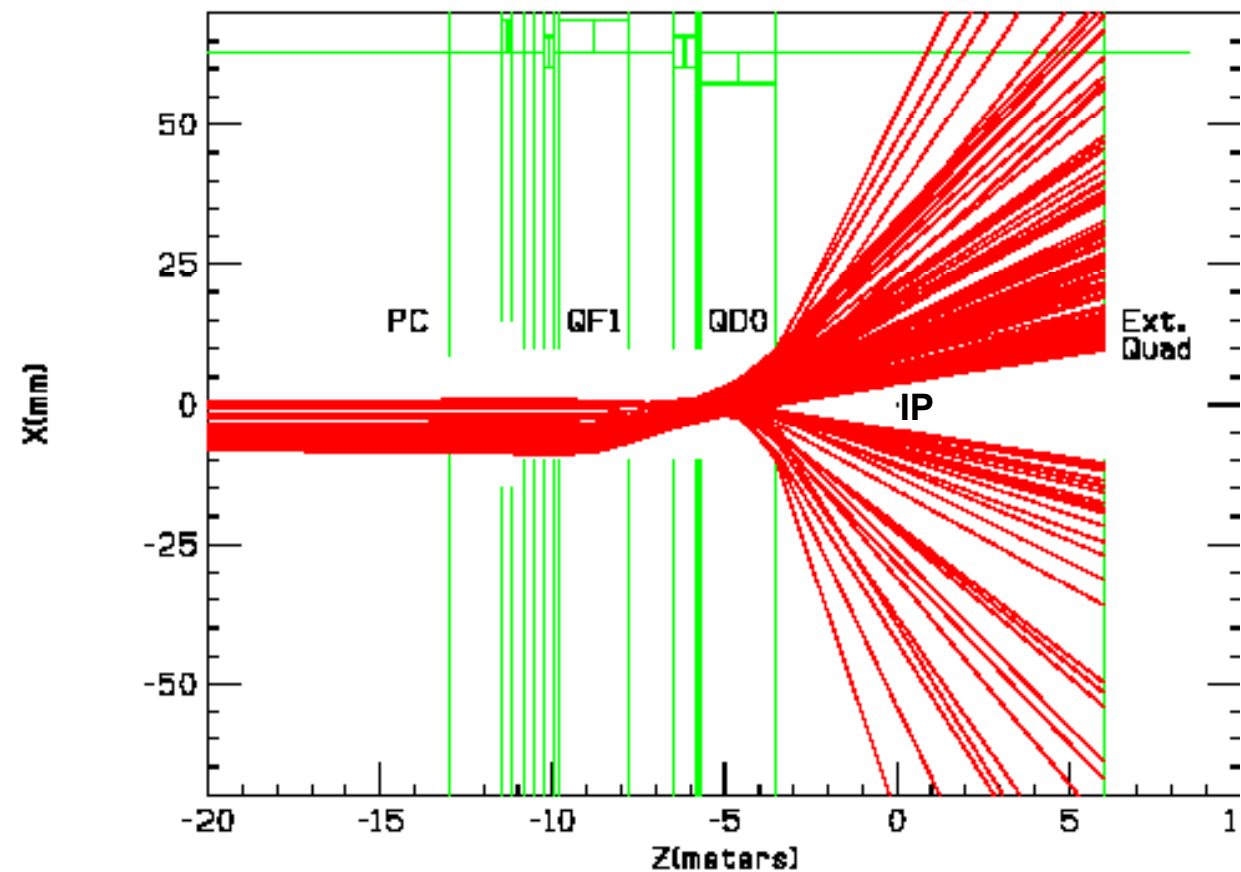
- only remove the pump: ~150 nTorr vacuum level
- remove pump and add distributed system (NEG): ~1-2 nTorr reachable
- more details on next MDI/Integration meeting (24.03.)

B. Mercier



# How relevant is the Vacuum inside the detector?

- Beam-Gas scattering in the BDS upstream is relevant for detector backgrounds
- $O(10 \text{ nTorr})$  is the required vacuum level up to  $\pm 200\text{m}$
- 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!

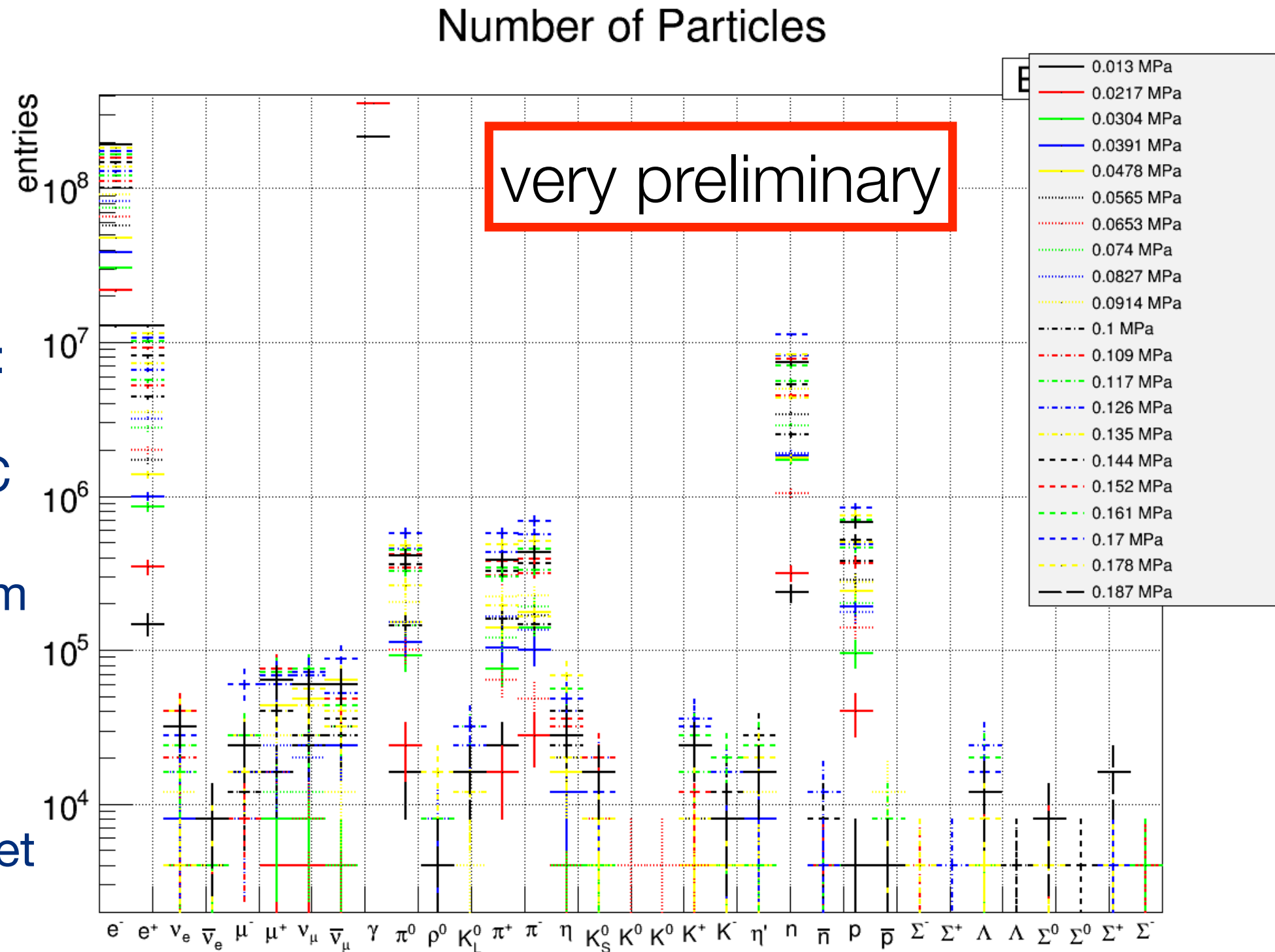


L. Keller et al., ILC-Note-2007-016



# Beam-Gas Background Studies in ILD

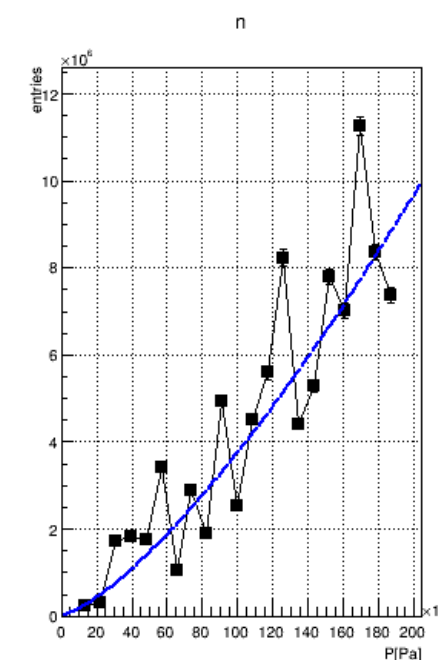
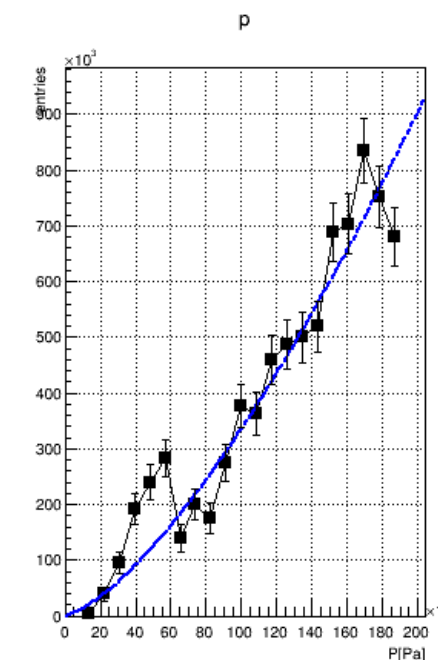
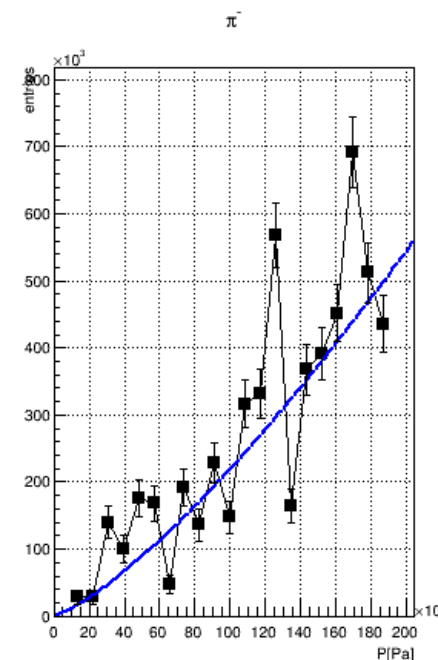
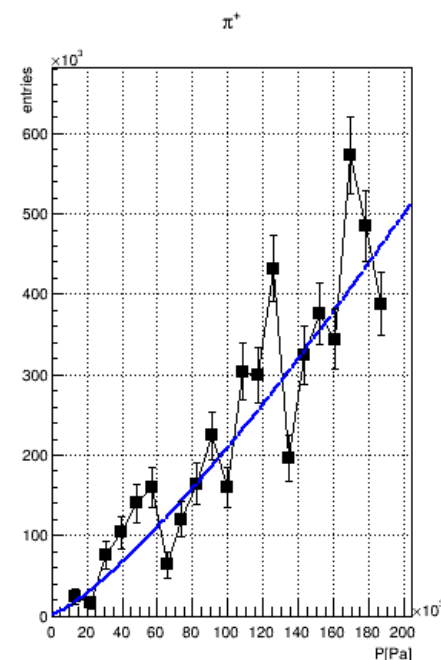
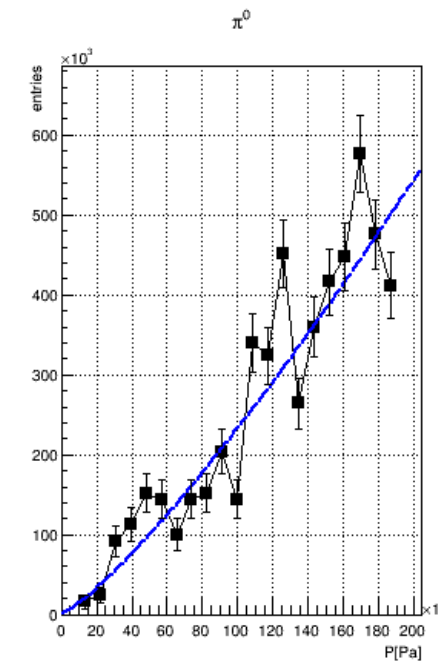
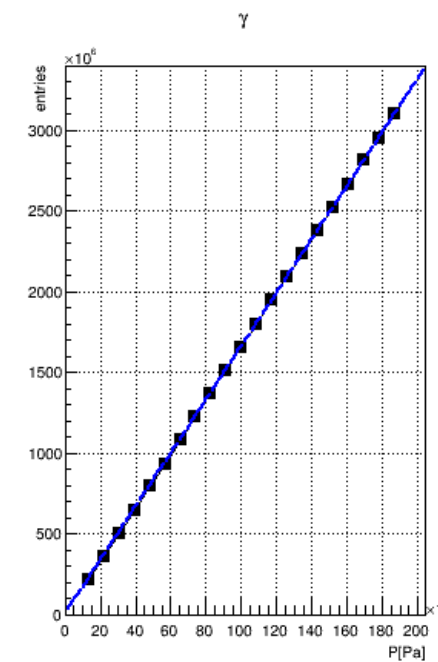
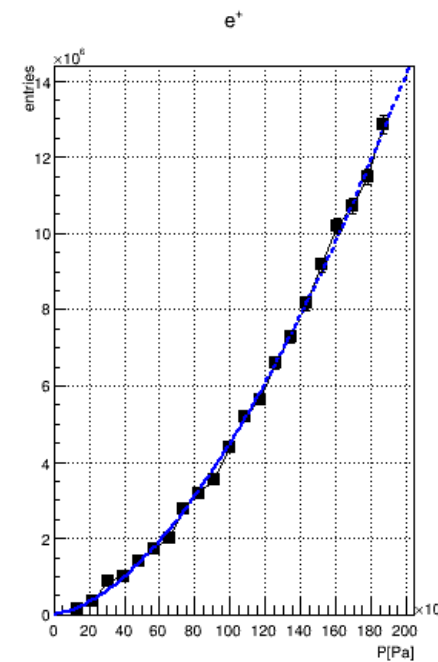
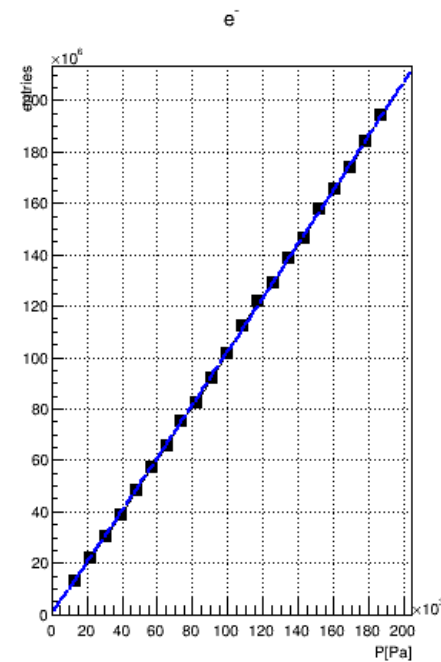
- Robert Karl has started to do Beam-Gas simulations with Geant4
- First impression: secondaries produced by ILC bunches (500 GeV) in ILD beam pipe
  - note: highly increased pressure to get statistics



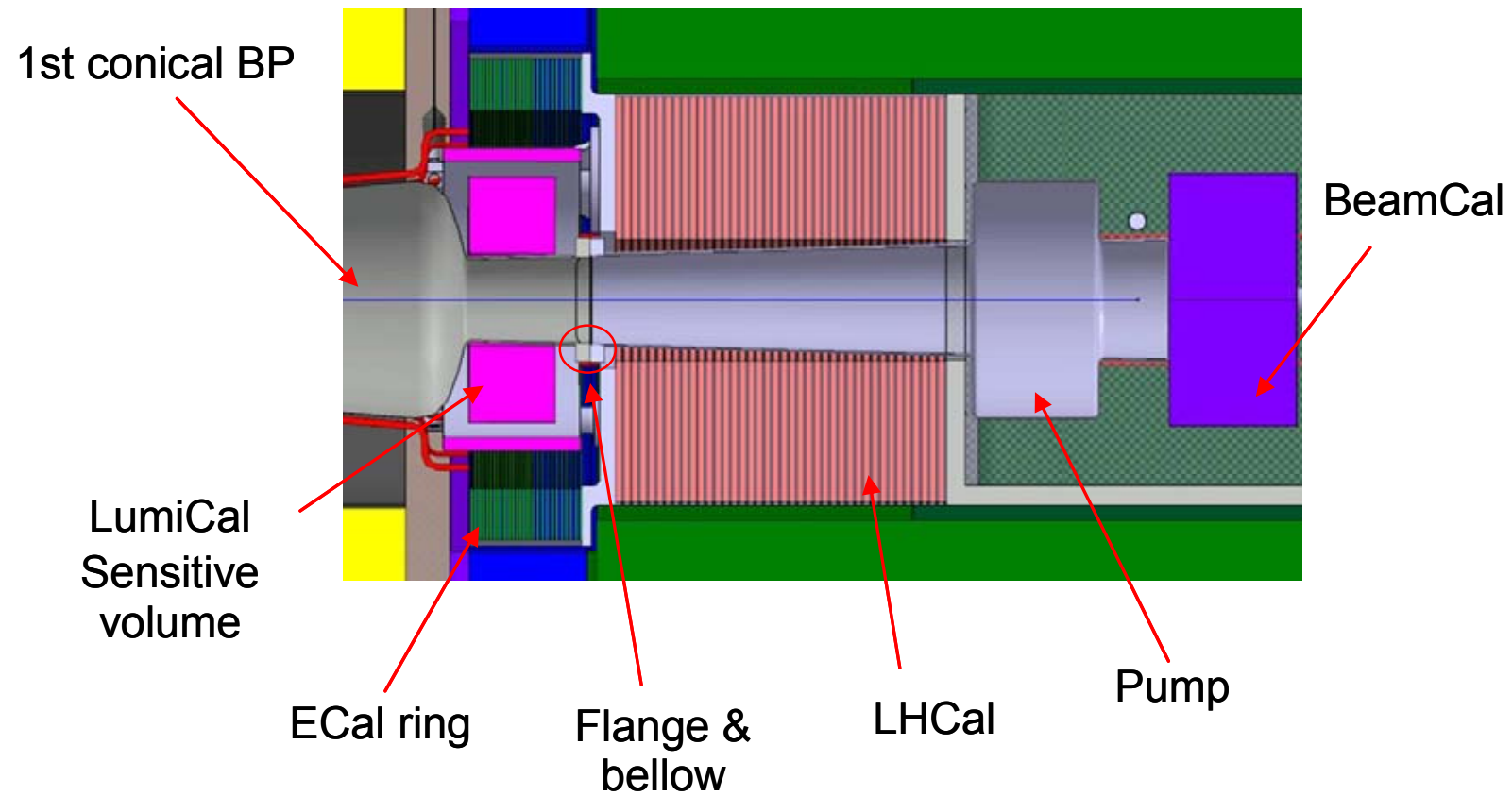


# Secondaries Production

- Extrapolation of production rates vs gas pressure
  - still at high levels (unit is kPa)
- Next step: track secondaries into detector
- Rescale to realistic pressure values
- NB: most particles leave detector through beam pipe



very preliminary

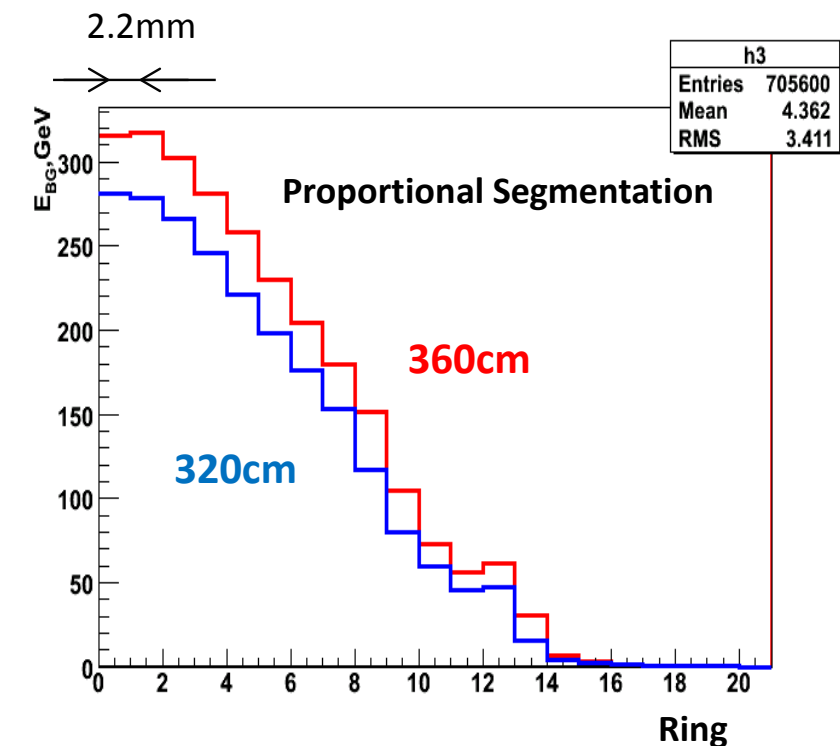
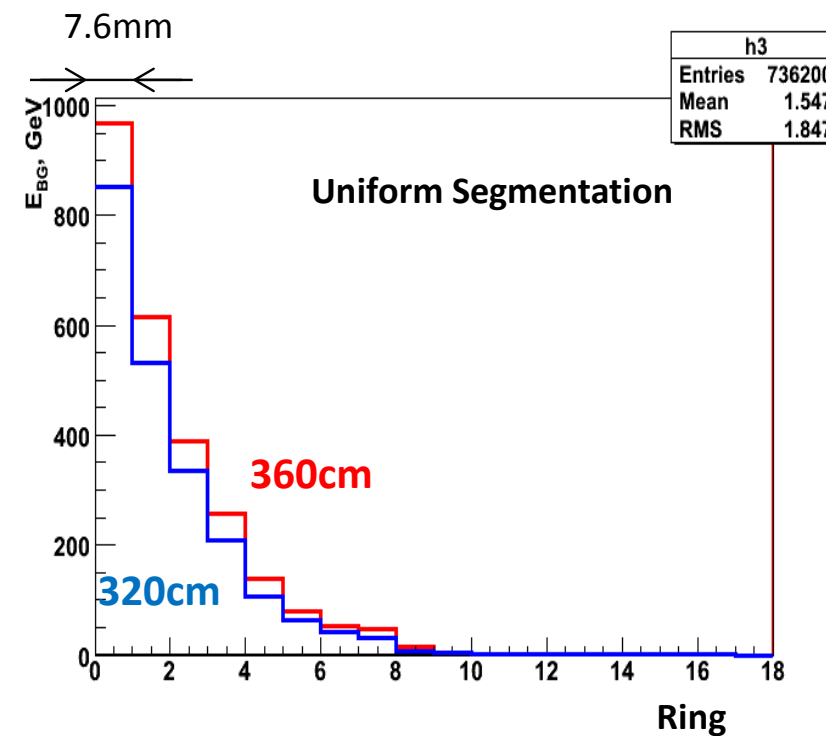
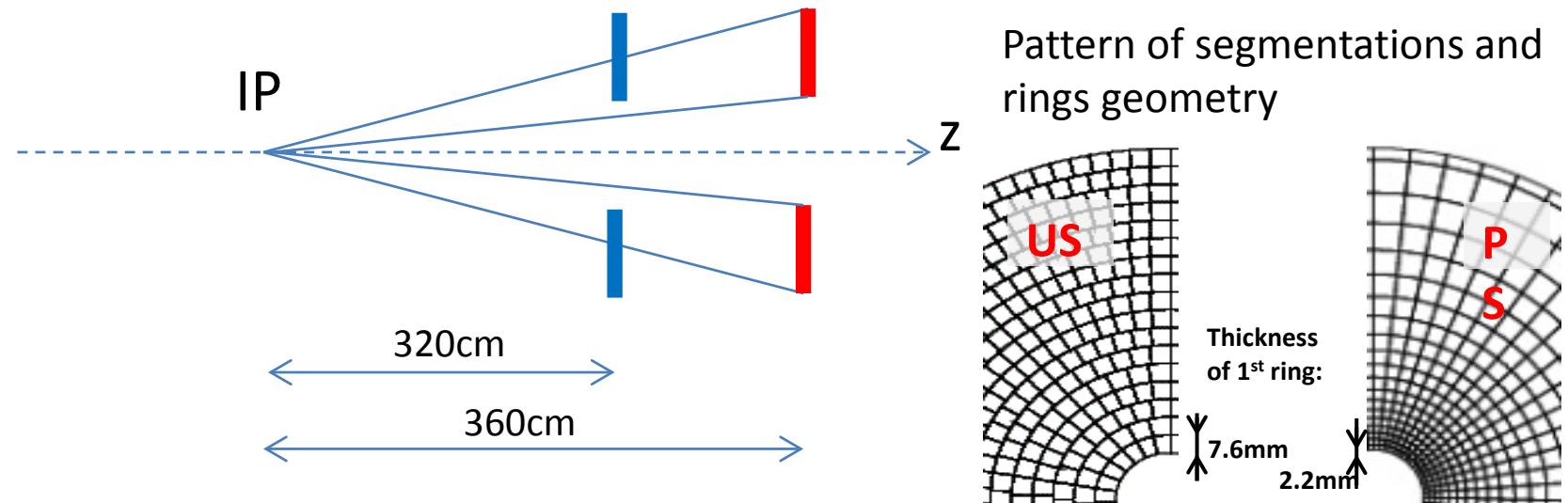


- Lucia Bortko (Zeuthen) has started background simulation on pair background with new BeamCal location

# Beamstrahlung Pairs on BeamCal (L. Bortko)



- If QD0 moves by 40cm, BeamCal would also move
- If BeamCal geometry stays unchanged, deposited energy is lower
- Would consider to change inner radius of BeamCal proportionally
  - physics reach
  - total deposited energy would get larger
- Need to understand the backscattering of secondary particles into the tracking system
  - needs full detector MC studies
  - hope to have preliminary results before KEK workshop





# QD0 L\* Summary

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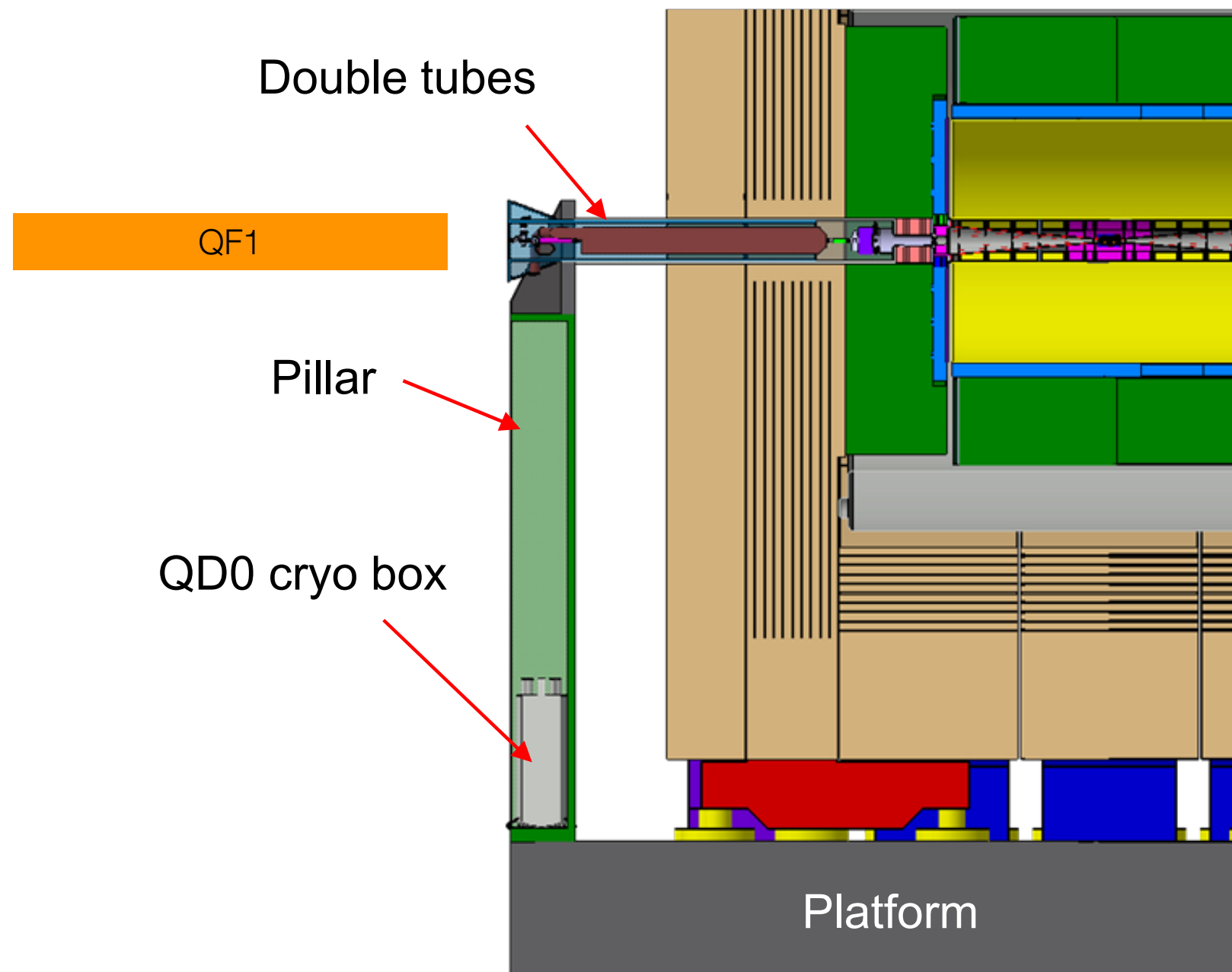
- Vacuum studies indicate that
  - If we remove the pump in front of QD0:
    - the vacuum conditions deteriorate by factors of  $\sim O(20)$ 
      - from  $\sim 7$  nTorr to  $\sim 150$  nTorr
      - detailed studies at LAL started for a distributed pumping system using NEG coatings
      - preliminary results show that  $\sim 1-2$  nTorr can be reached
- Studies to understand the vacuum level requirements from the detector point of view have started
  - first results from Geant-type studies on beam-gas studies
- Vacuum experts are concerned about dynamic vacuum conditions
  - photon desorption, etc.
- FCAL collaboration has started to investigate backscattering from beamstrahlung pairs hitting the BeamCal at its new position





# What about QF1?

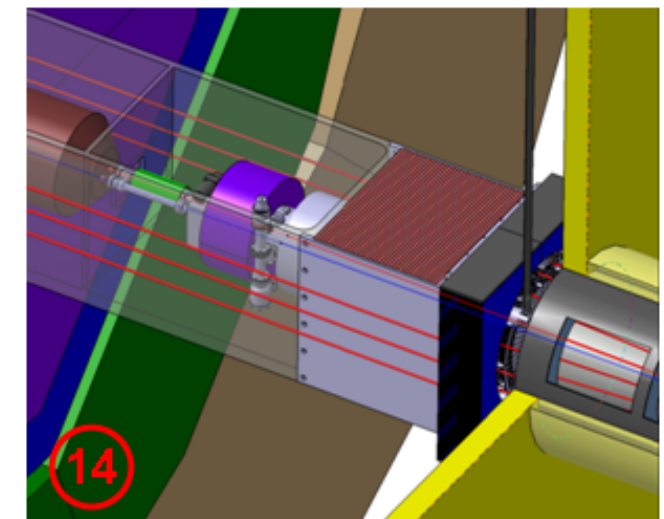
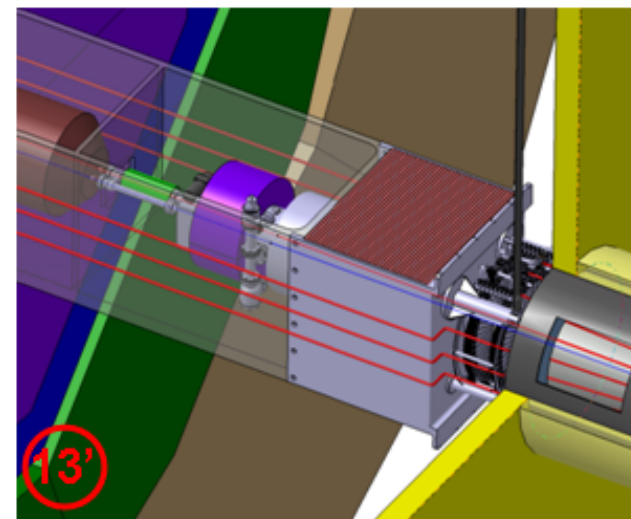
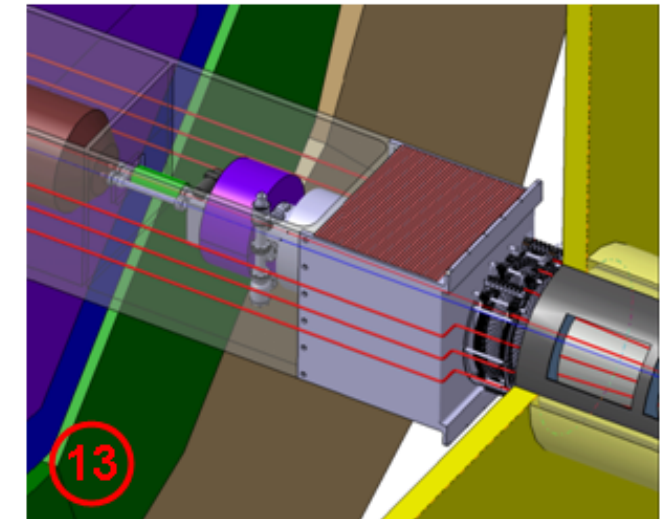
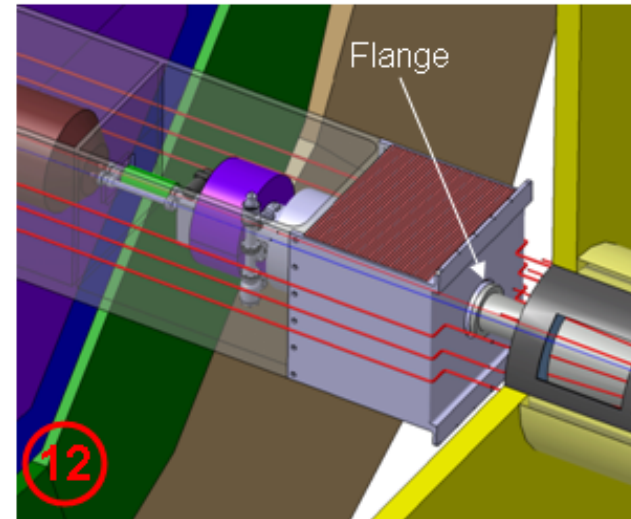
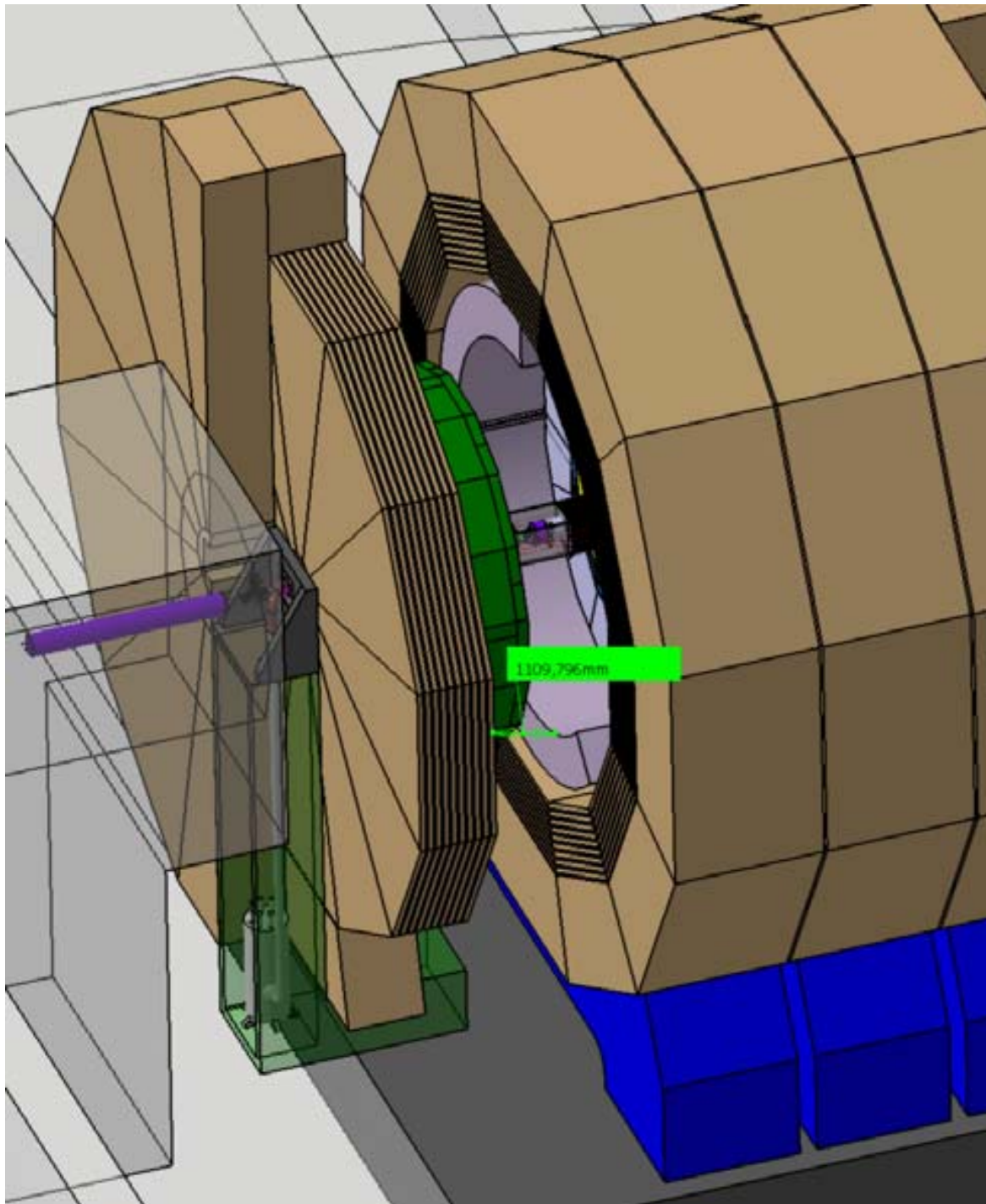
- BDS studies indicate that a smaller  $L^*$  for QD0 might require also a smaller  $L^*$  for QF1
- This might also have an impact on ILD:





# Current ILD Opening Procedure

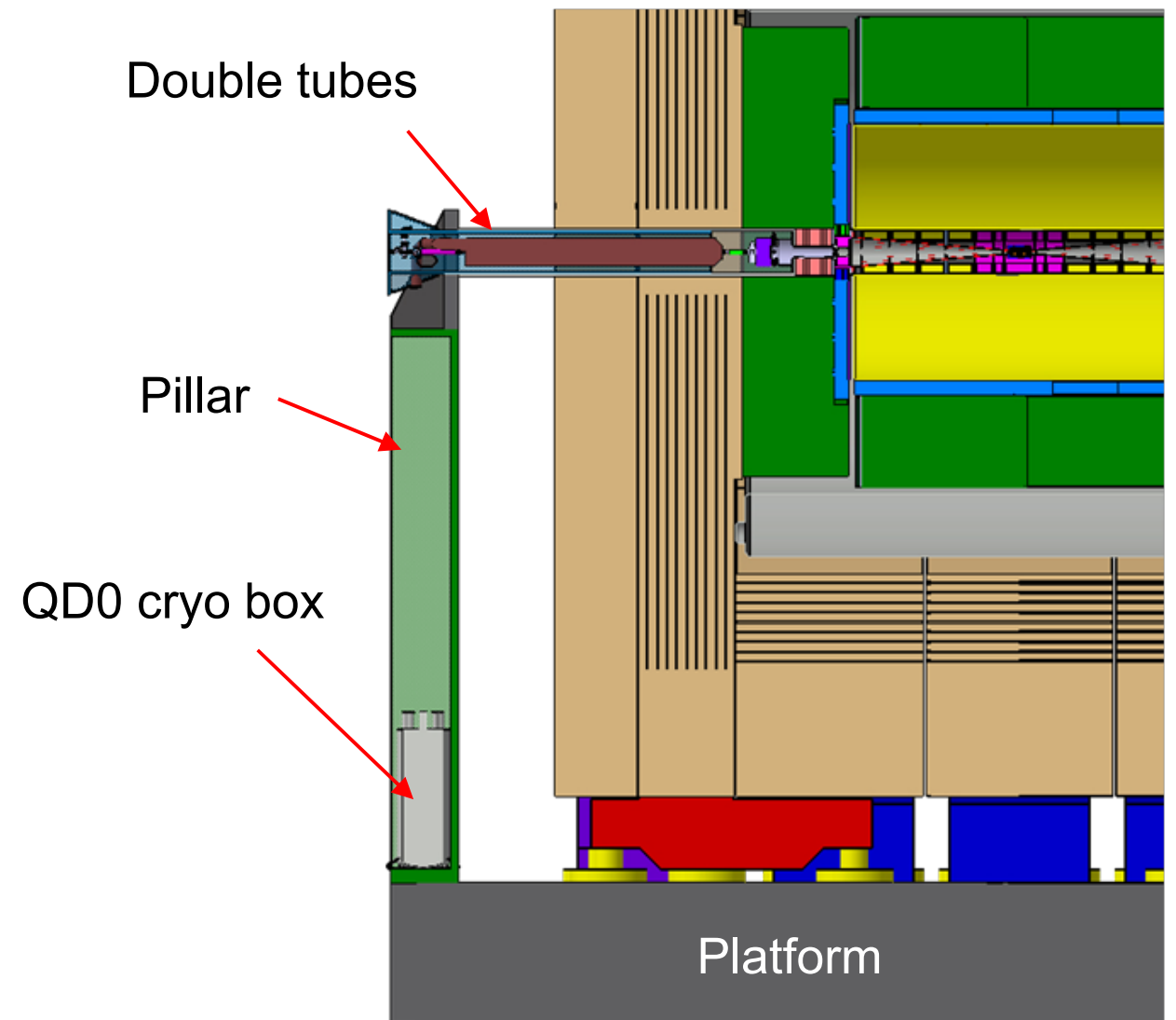
- Need to move endcap far enough out to have access to inner detector to open flanges





# 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

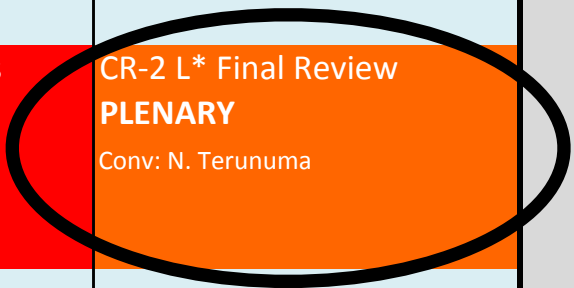
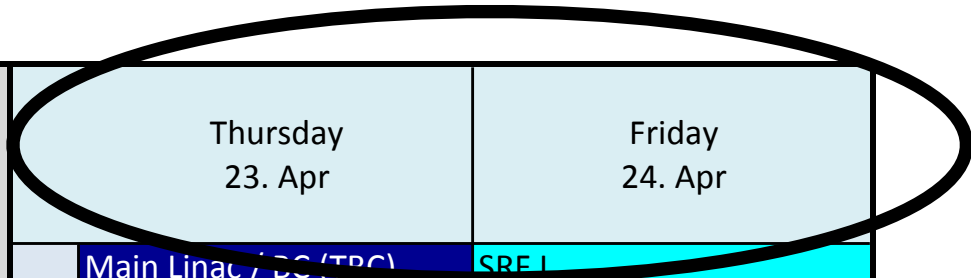


# Timeline



- Final review of change request at ALCW15: ILD Workshop parallel

	Monday 20. Apr	Tuesday 21. Apr	Tokyo Event Wednesday 22. Apr	Thursday 23. Apr	Friday 24. Apr
09:00	Registration	BDS-II: optics		Main Linac / DC (TBC) conveners N. Solyak K. Kubo A. Latina	SRF I
09:30	Opening joint plenary	Conveners G. White T. Okugi			Conveners H. Hayano ?
10:00					
10:30	Coffee			Coffee	
11:00	Machine overviews <b>PLENARY</b> Conv. M. Harrison	CR-2 L* Final Review <b>PLENARY</b> Conv: N. Terunuma		Sources (TBC) conveners Wei Gai M. Kuriki	SRF II
12:30	Lunch			Lunch	
14:00	BDS I/MDI I Conveners G. White T. Okugi	CR-4 Tunnel Extension <b>PLENARY</b> Conv. V Kuchler		Central Region <b>PLENARY</b> conv: N. Walker TDR lattice release status	SRF III
15:30	Coffee			Change Register Review conv. N Walker	
16:00	CR-3 CIT report <b>PLENARY</b> Conv. N Walker			Coffee	
16:30	MDI-II: Surface & Infr. With CFS Conv: Büser, Tauchi	Joint Plenary ?? (undefined)		Joint Plenary ?? (undefined)	Joint Closing Plenary
18:00					



14:45



# Summary and Outlook

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- 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 has started a beam-gas background study (Robert Karl) - collaboration with SiD envisaged (J. Strube, M. Stanitzki)
- QF1 L\* has also implications on ILD engineering design
- Time line: have informations at hand for a conceptual decision by April