Vacuum studies at LAL

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ILD MDI Meeting 24/3/15

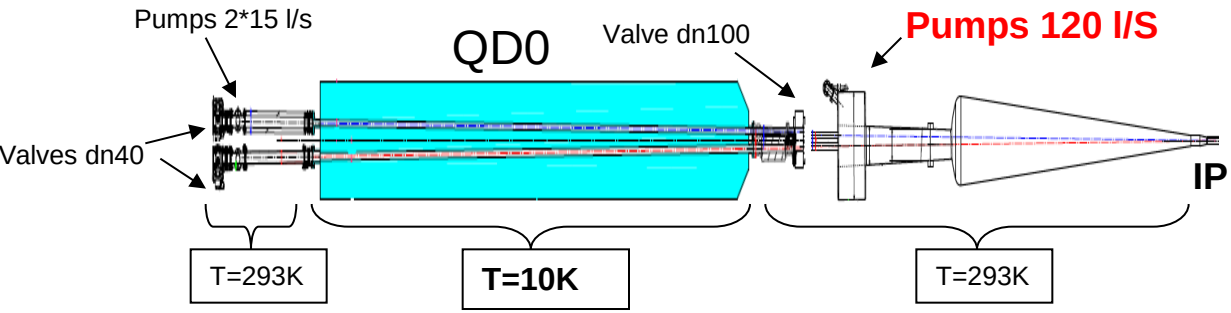
Introduction

- Machine people request to reduce L* of ILD
  - This modification is more or less enacted
- Need to economise ~40cm in ILD forward region
- Primary « suspect » is big vacuum pump downstream of QD0

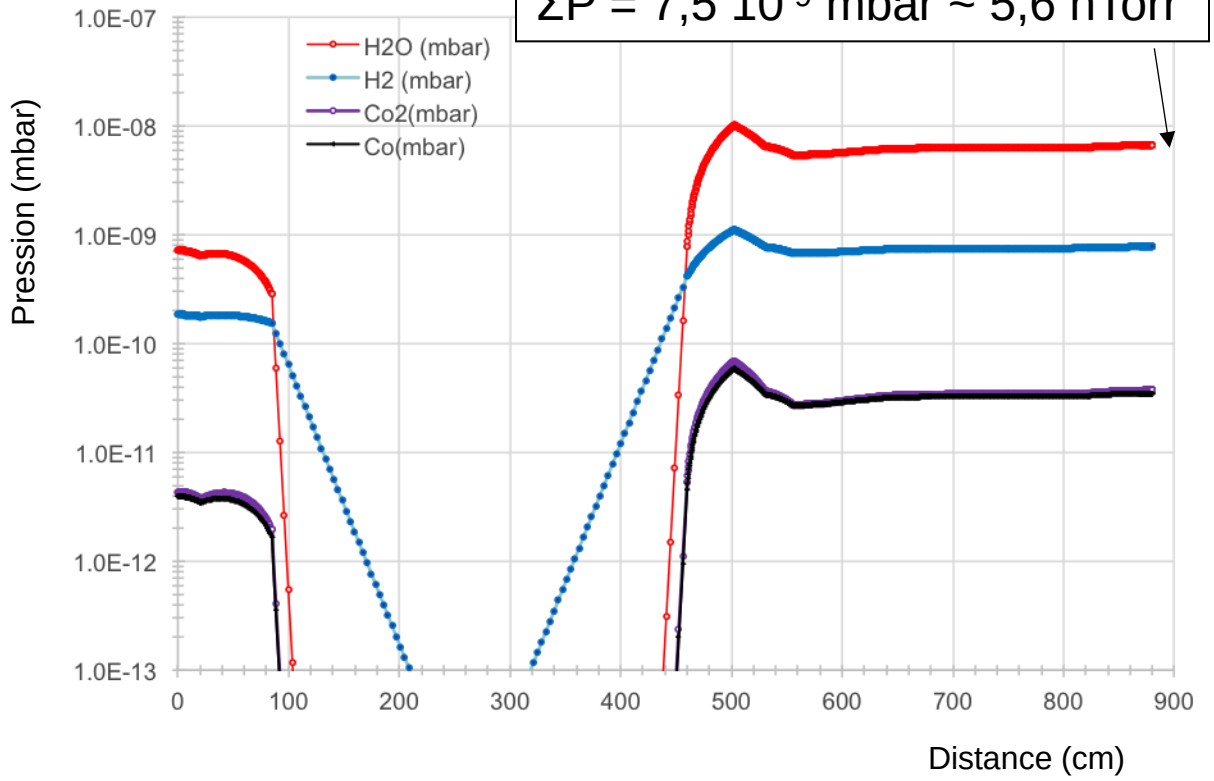
VACUUM DISTRIBUTION ON ILD

UNDER STATIC CONDITION

QD0 + IP region



$\Sigma P = 7{,}5\ 10^{-9}$ mbar ~ 5,6 nTorr



Without baking

T=293K

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

$\tau\ (CO_2) \approx 1.10^{-13}$ 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}

T=10K

σ (sticking coeff CO, CO2, H2O) = 1

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

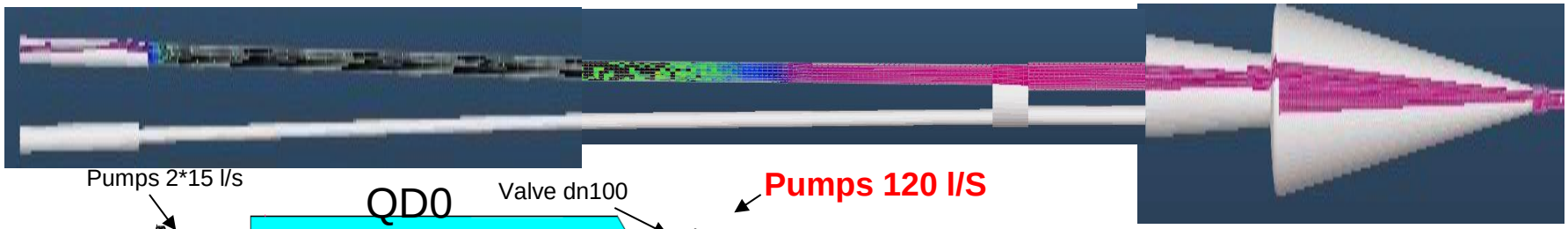
For H_2 pumping by holes in beam screen 2% surface

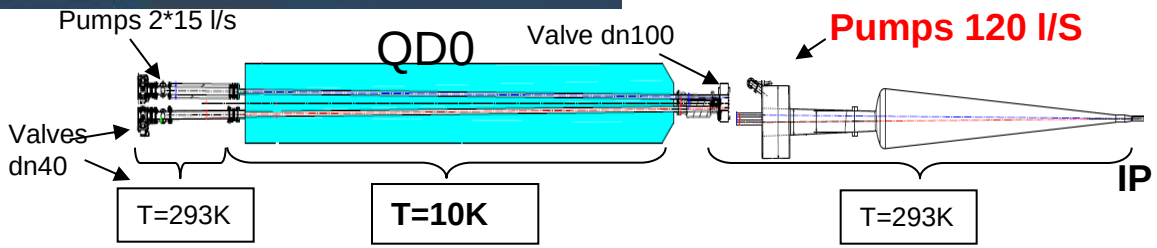
Without outgassing valves dn40

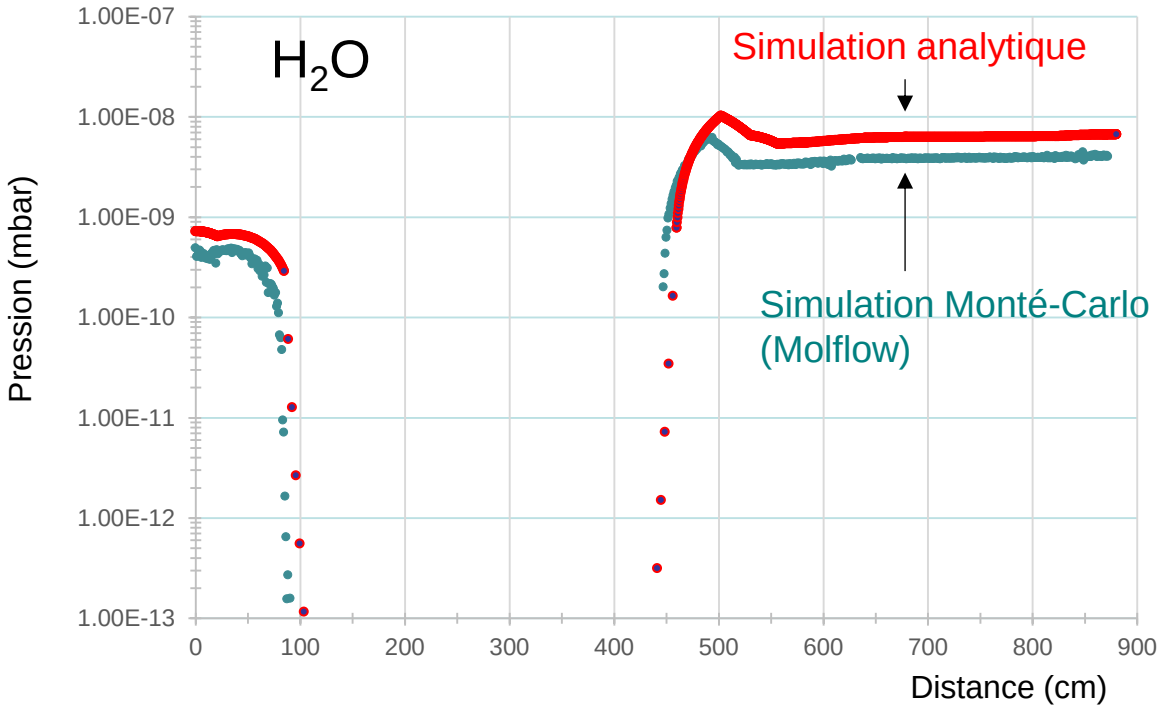
VACUUM DISTRIBUTION ON ILD

UNDER STATIC CONDITION — QD0 + IP region

Comparison of a Monté-Carlo simulation and analytical simulation for H_2O







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

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

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

After 100h pumping

T=10K

σ (sticking coeff CO, CO2, H2O) = 1

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

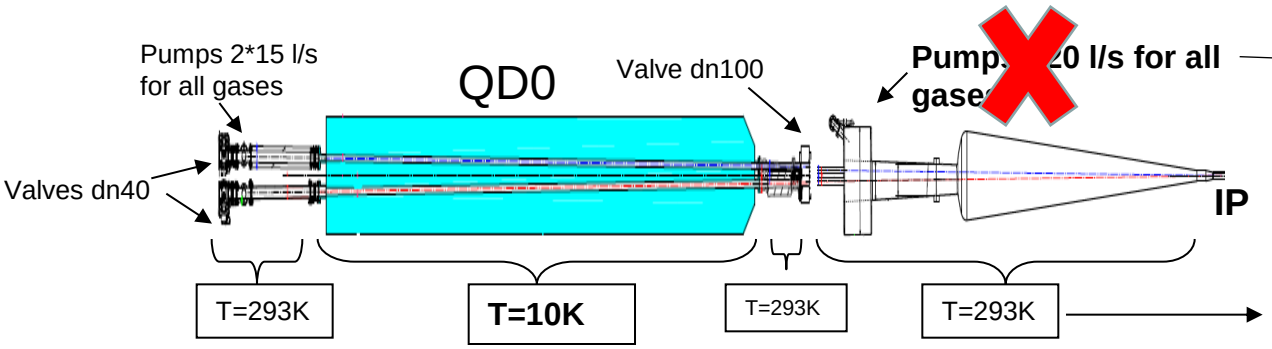
For H_2 pumping by holes in beam screen 2% surface

Without outgassing valves dn40

VACUUM DISTRIBUTION ON ILD

UNDER STATIC CONDITION

QD0 + IP region



NEG coating

L=30 cm Ø = 179 mm

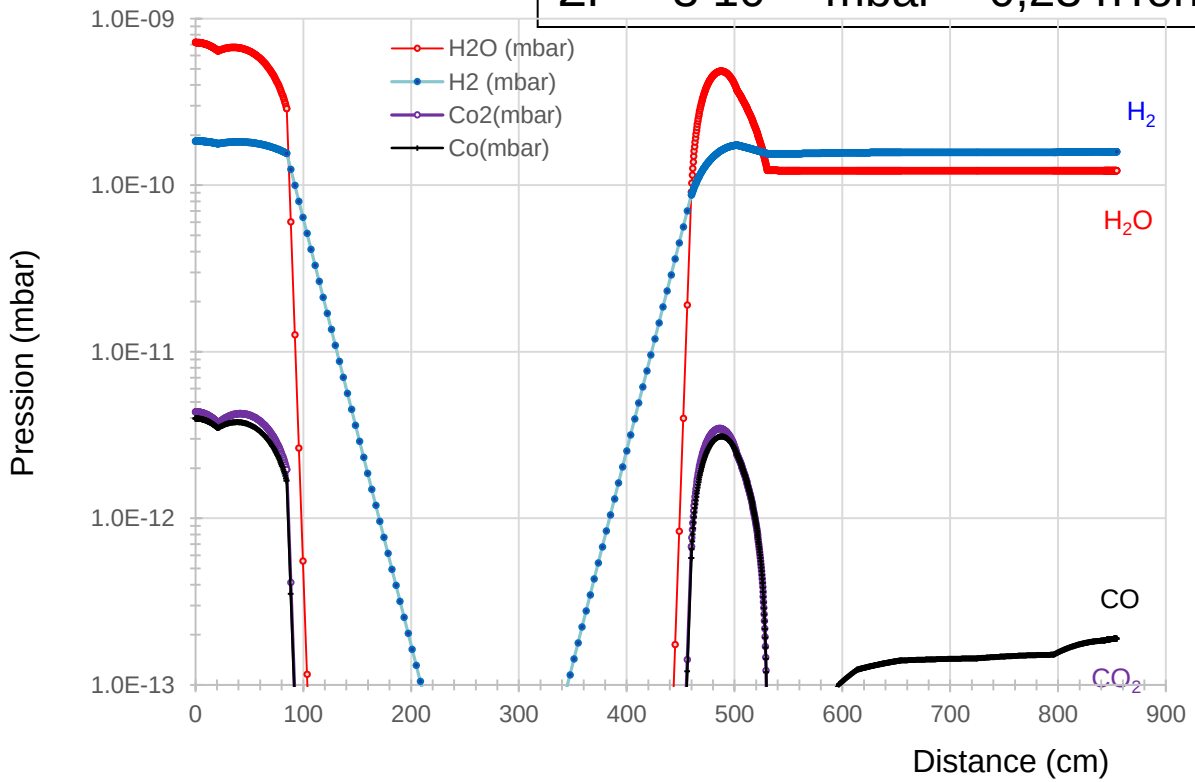
sticking coeff σ(CO;CO2)=0,1
σ(H2)=0,0005
σ(H2O)=0,0005 ??

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}

$\Sigma P = 3\ 10^{-10}$ mbar ~ 0,23 nTorr



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

σ (sticking coeff CO, CO2, H2O) = 1

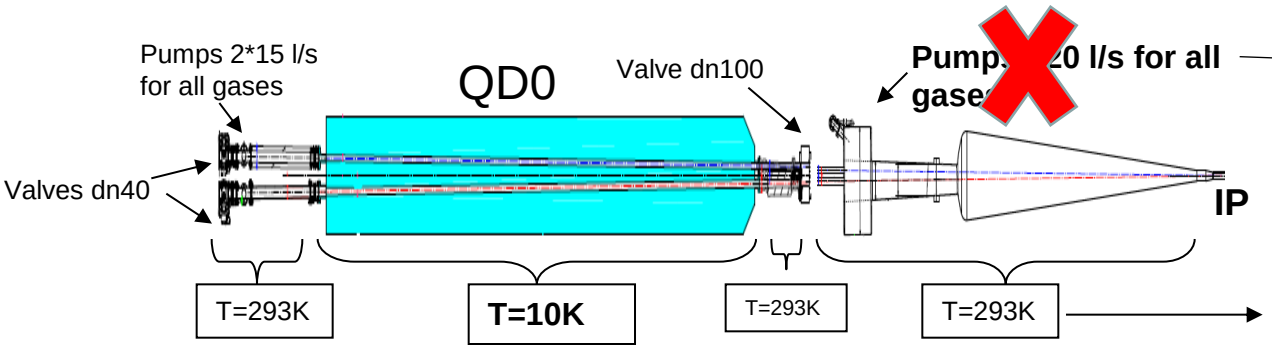
τ (all gases) ≈ 0 mbar.l.s^{-1}.cm^{-2}

For H_2 pumping by holes in beam screen 2% surface

VACUUM DISTRIBUTION ON ILD

UNDER STATIC CONDITION

QD0 + IP region



NEG coating **satured**

L=30 cm Ø = 179 mm

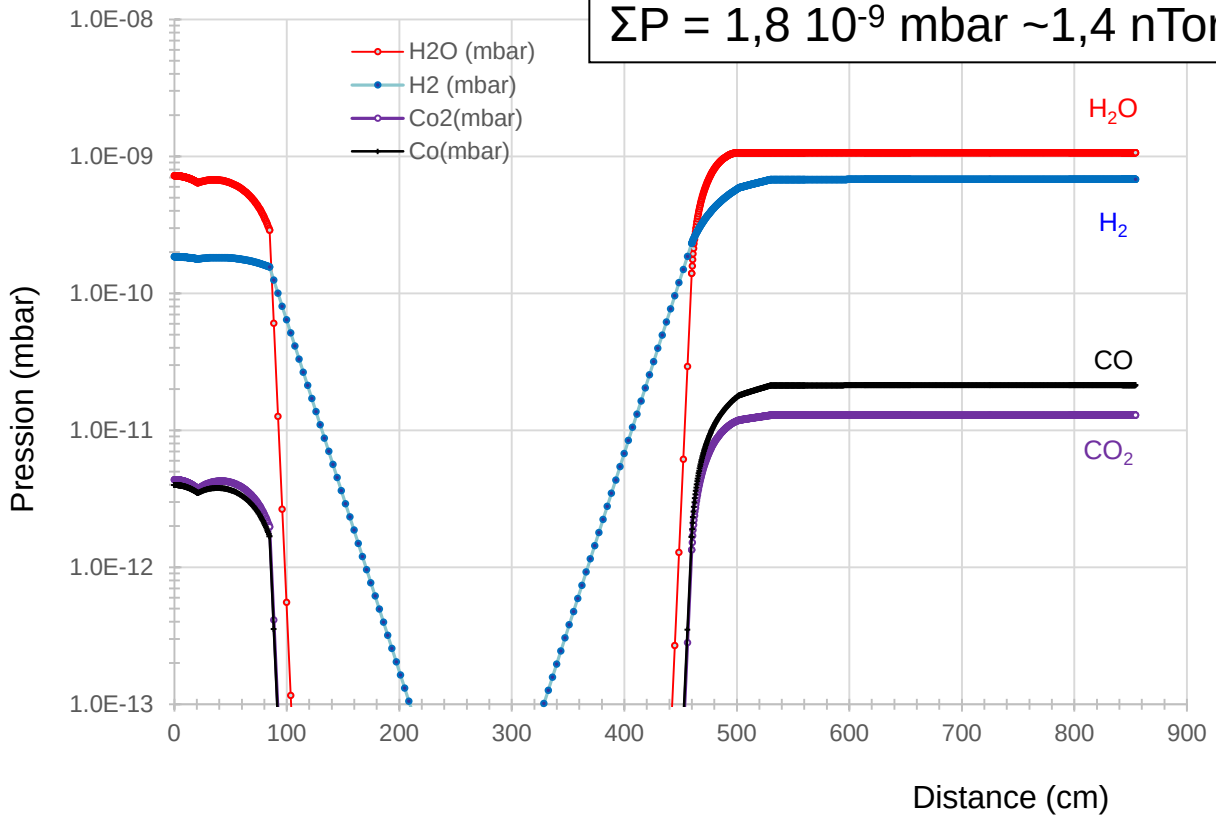
sticking coeff σ(CO;CO2)=0
σ(H2)=0
σ(H2O)=0

IP region with baking

Alu or Cu or SS after 100h pumping

τ (H_2) ≈ 2.10^{-13} mbar.l.s^{-1}.cm^{-2}
τ (H_2O) ≈ 0 mbar.l.s^{-1}.cm^{-2}
τ (CO) ≈ 2.10^{-15} mbar.l.s^{-1}.cm^{-2}
τ (CO_2) ≈ 5.10^{-16} mbar.l.s^{-1}.cm^{-2}

$\Sigma P = 1{,}8\ 10^{-9}$ mbar ~1,4 nTorr



Between valves dn40 and dn100
Without baking

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τ (CO) ≈ 1.10^{-13} mbar.l.s^{-1}.cm^{-2}
τ (CO_2) ≈ 1.10^{-13} mbar.l.s^{-1}.cm^{-2}

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For H_2 pumping by holes in beam screen 2% surface

UNDER STATIC CONDITION

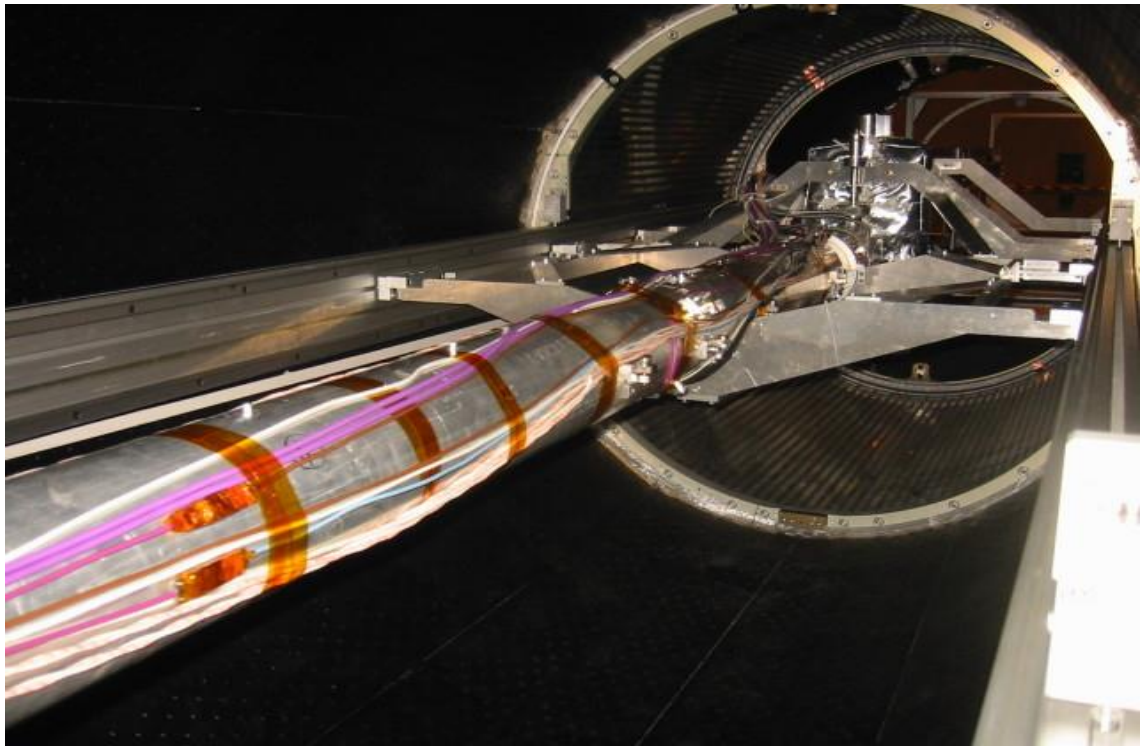
QD0 + IP region

DP0 + IP	Pumps IP 120 l/s	Without baking	5,6 nTorr	H2O	initial
DP0 + IP	No pumps IP	Without baking	120 nTorr	H2O	DP0 and IP volume not separated / Lenght reduction
DP0 + IP	Neg coating	Baking IP	0,23 nTorr	H2/ H2O	Length reduction
DP0 + IP	Neg satured	Baking IP	1,4 nTorr	H2O / H2	Length red uction

UNDER STATIC CONDITION

QD0 + IP region

some references



One end of the vacuum sector during the bakeout and pure gas refill of ALICE's central beryllium beam pipe and absorber beam pipe.

http://cds.cern.ch/record/1033952?ln=fr

Design of beampipes for LHC experiments (LHC Project Report 664)

THE ATLAS BEAM VACUUM SYSTEM (R. Veness, PAC09)

DEVELOPMENT OF BERYLLIUM VACUUM CHAMBER TECHNOLOGY FOR THE LHC (R. Veness and all, IPAC2011)

Conclusions

- Pumping is needed to assure good vacuum conditions in IP region
- The mechanical pump can be replaced by a NEG pump system
  - Need maybe to check for rare gases but pumping at QD0 level should be fine
- Adds material along the beam pipe
  - NEG coating niveau LHCAL ok
  - Heating fibres until IP, to be studied
- Would have consequences for assembly and (re)start of of ILD after shutdowns
- Large experience for LHC experiments (remark: a small system will be also installed at LAL Accelerator THOMX)