IR Vacuum Systems first thoughts

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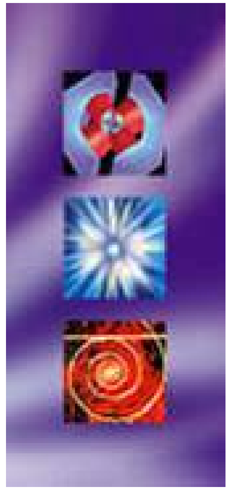
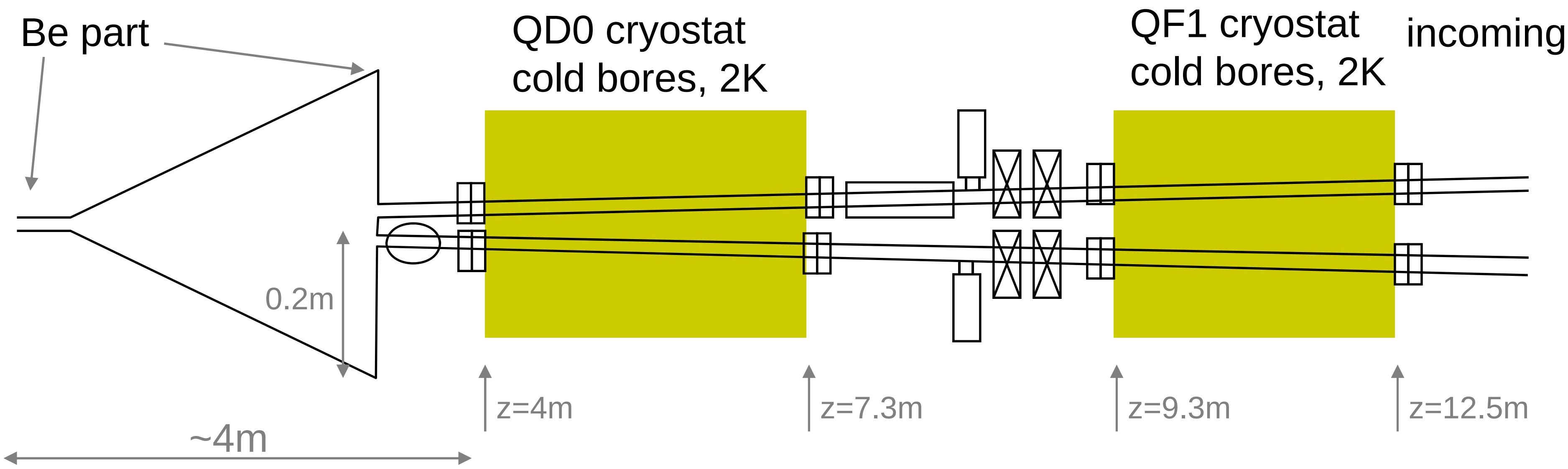
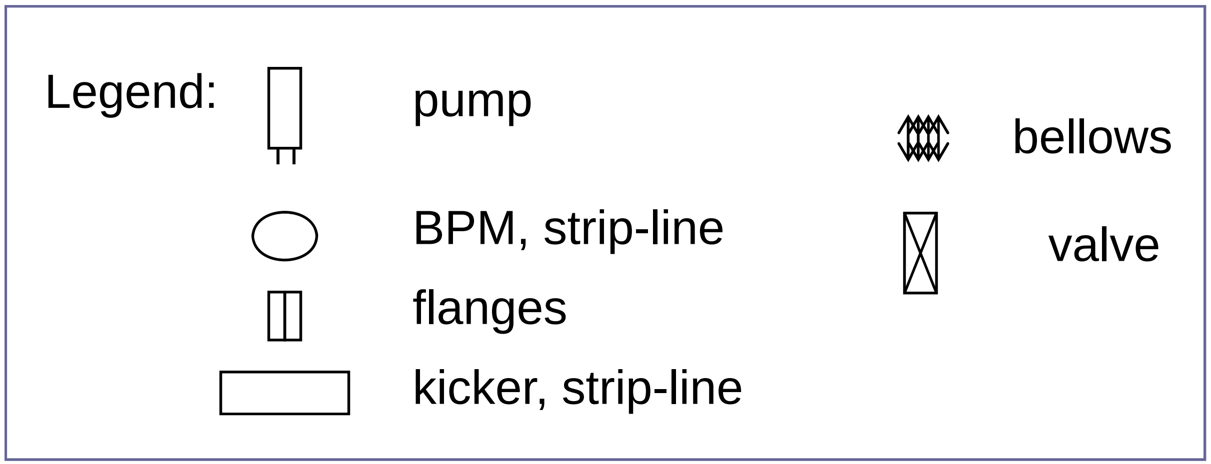


IR layout





Layout sketched by A. Seryi

IR cone vacuum chamber

- Be cone vacuum chamber (half):
  - A=~2 m^2
  - Reachable thermal desorption rate **after 24 hrs bakeout at 250°C and weeks of pumping:**
    - η (H_2) = 10^{-11} Torr·l/(s·cm^2)
    - η (CO) = 10^{-12} Torr·l/(s·cm^2)
  - Total thermal desorption:
    - Q(H_2) = 2·10^{-7} Torr·l/s; Q(CO) = 2·10^{-8} Torr·l/s
  - Required pumping speed for P=10^{-9} Torr:
    - S(H_2) = 200 l/s; S(CO) = 20 l/s
  - Available tube conductance (2 tubes: R=1 cm, L=0.5 m) is very low:
    - U(H_2) = 15 l/s; S(CO) = 4 l/s

IR cone vacuum chamber

- Reachable pressure without a beam:
  - $P = Q / S_{eff},\quad S_{eff} < U$
  - $P(H_2) > 10^{-8}$ Torr; $P(CO) > 5 \cdot 10^{-9}$ Torr
- Lower desorption can be reached by longer bakeout
- Larger pumping speed S_{eff}, requires a pump connected directly to a Be vessel
  - In-build SIP in a magnetic field of a detector
- Present layout does not allow reaching the required pressure without long bakeout at 250°C and weeks of pumping by using conventional technology even for thermal outgassing only, i.e. with no beam.

A vacuum chamber in presence of the beam

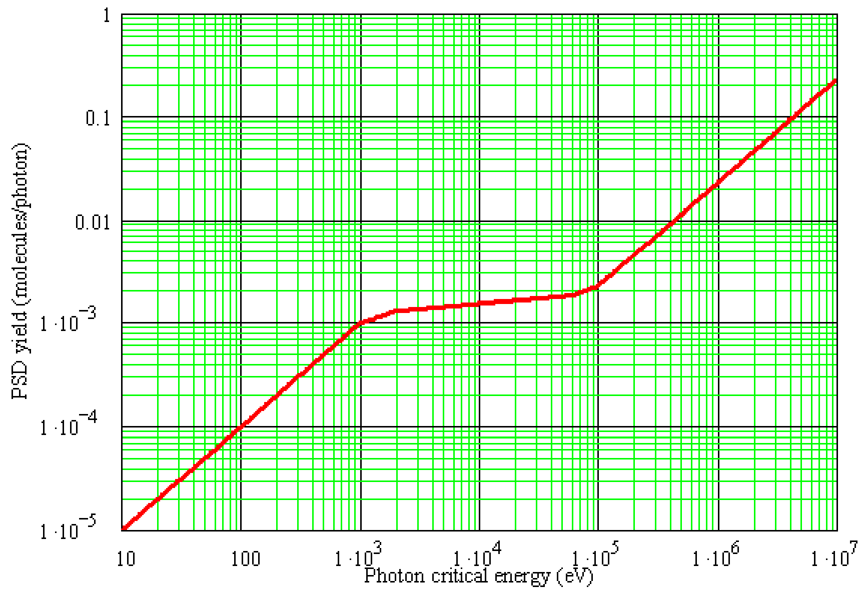
- Photon, electron, ions, lost positron and electron stimulated desorption

- $Q = \Sigma(\eta_i \Gamma_i)$, where
  - η is desorption yield, number of desorbed gas molecules per impact photon or particle
  - i is an index associated with each kind of impact particle
  - Γ is a number of photon or particle hitting a surface per second

Photon stimulated desorption:

The 'critical' energy of photon near IR is ε_c ~ 0.5 MeV.
Photon flux $\Gamma=10^9$ γ/s (calculated by Dr. Takashi Maruyama)

- PSD yield at ε_c ~1 MeV is not well studied (LEP data only, for Al and SS)
- Beam conditioning studied at DCI at ε_c up to ~20 keV
- Initial desorption yield for Be at ε_c = 500 eV (Foerster et al, JVSTA 10(1992),p. 2077):
  - $\eta = 4{\cdot}10^{-3}$ H_2/γ, $\eta = 1{\cdot}10^{-3}$ CO/γ, $\eta = 8{\cdot}10^{-4}$ CO_2/γ, $\eta = 2{\cdot}10^{-4}$ CH_4/γ
  - Coefficient due to photon energy = 100
  - Total photon stimulated desorption is less than thermal:
    - $Q(H_2) = 1.2{\cdot}10^{-11}$ Torr·l/s;
    - $Q(CO) = 2{\cdot}10^{-12}$ Torr·l/s



e^+/e^- stimulated desorption:

The 'peak' energy of e^+/e^- near IR is ε_c ~ 1-2 MeV.
Flux of e+/e- I=$8.5 \cdot 10^8$ e^{+-}/s (calculated by Dr. Takashi Maruyama)

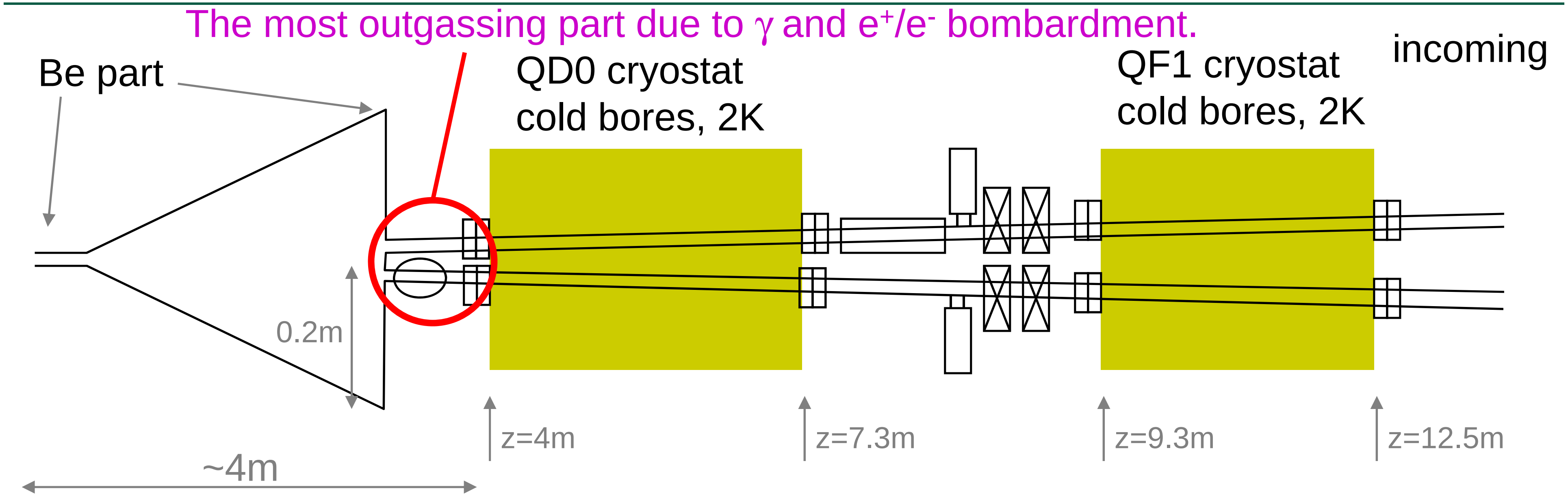
- ESD yield at ε_c ~1 MeV is not studied
- Initial desorption yield for Ti at E = 3 keV after bakeout at 300°C for 24 hrs (M.-H. Achard, private communication):
  - $\eta = 0.1$ H_2/e, $\eta = 0.02$ CO/e, $\eta = 0.02$ CO_2/e, $\eta = 0.01$ CH_4/e.
  - Coefficient due to e^+/e^- energy is unknown, probably the same as for photons (~100)
  - Total e^+/e^- stimulated desorption is also less than thermal:
    - $Q(H_2) = 3 \cdot 10^{-10}$ Torr·l/s;
    - $Q(CO) = 5 \cdot 10^{-11}$ Torr·l/s

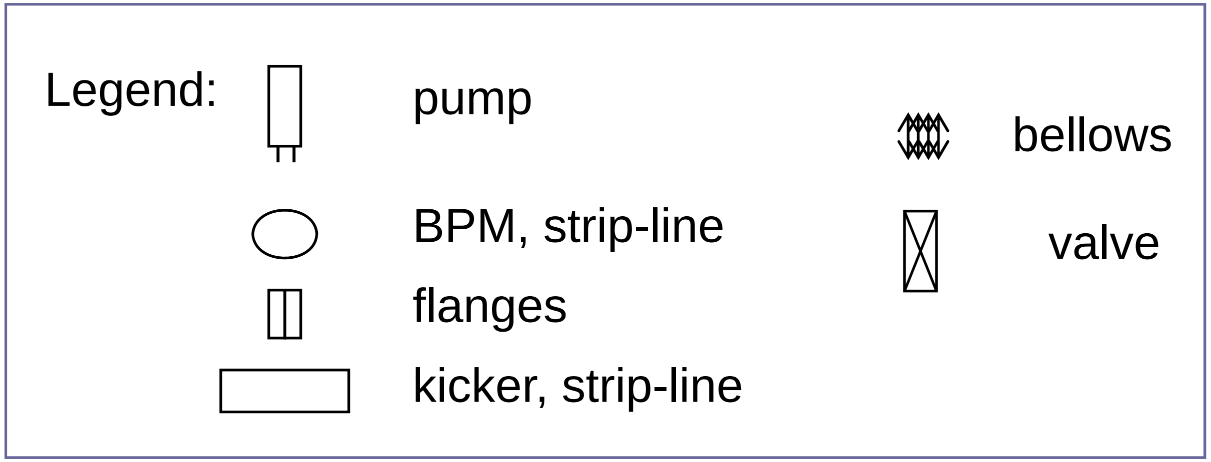
IR cone vacuum chamber

Solution is the NEG coated vacuum chamber:

- 1-µm TiZrV coating
- Activated by bakeout for 24 hrs at 180°C
  - Even bakeout for 24 hrs at 160°C is very beneficial
  - Inductive heating of thin Be wall (tbd)
- Pressure without a beam is below 10^{-13} Torr
- Low photon, electron and other particles induced gas desorption
- Low secondary electron emission
- Pumping speed:
  - $S(H_2)$ = 0.5 l/(s·cm^2), S(CO) = 5 l/(s·cm^2)
  - Does not pump C_xH_y and noble gases

Tube between cone and QD0





Photon and e^+/e^- stimulated desorption:

The 'critical' energy of photon near IR is εc ~ 0.5 MeV.

Photon flux Γ=~7·1010 γ/(s·m) **(calculated by Dr. Takashi Maruyama)**

- Estimated pressure raise due to photon stimulated desorption is much larger than thermal:
  - $P(H_2) = 1.5 \cdot 10^{-8}$ Torr; $P(CO) = 3 \cdot 10^{-9}$ Torr
- e^+/e^- stimulated desorption may lead to an order of magnitude larger pressure raise.

=> these tubes must be also NEG coated and activated

QD0 cold bore

- Required vacuum:
  - 10^{-9} Torr at RT => $3.2 \cdot 10^{13}$ molecules/m^3
- d=21-36 mm, L=3 m
- Gas density with no beam is negligible at T=2 K (except for He).
- Gas density with a beam increase due do:
  - Photon, electron, ions, lost positron and electron stimulated desorption inside the cold bore.
  - Gas from the cone and connecting tube!
  - Desorbed gas cryosorbed and accumulated on the cryogenic walls
  - Accumulated molecules will be desorbed by photon, electron, ions, lost positron and electron.
  - => Gas density is growing with time

Cold bore – behaviour under SR

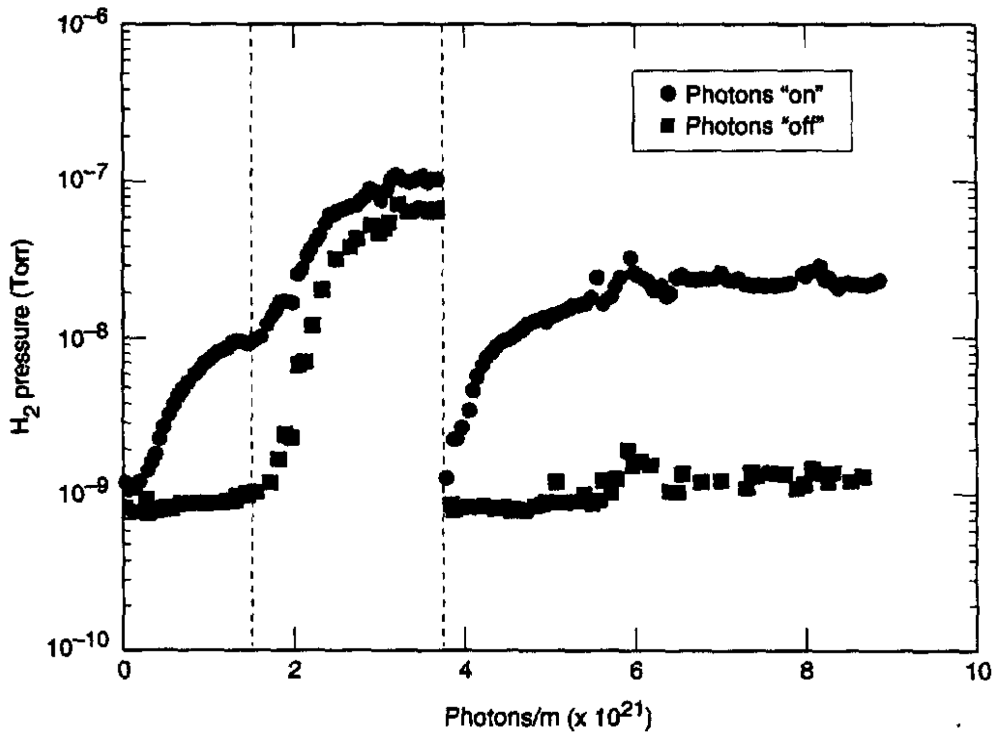


FIG. 1. Room-temperature RGA H_2 pressure measured at the center of the 4.2-K beam tube vs integrated photon flux with photons on and photons off. The raw pressure difference "on" minus "off" has been normalized to 1×10^{16} photons/m/s. The vertical dashed lines correspond to features discussed in the text.

- Experiment was performed with photons with ε_c = 300 eV

Investigation of synchrotron radiation-induced photodesorption in cryosorbing quasiclosed geometry

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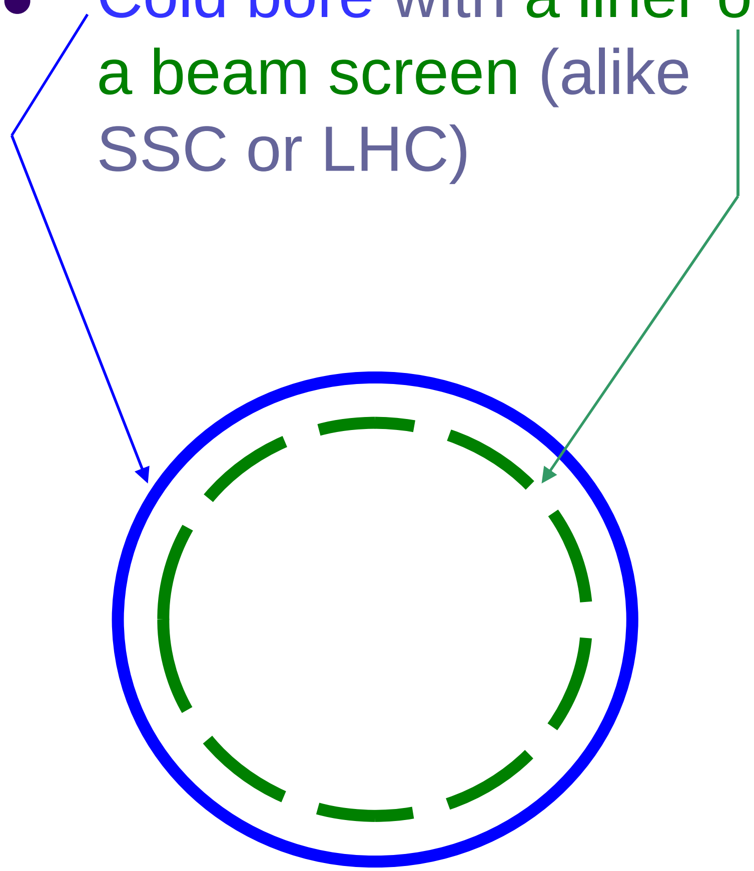
Possible solution:

- Cold bore with a liner or a beam screen (alike SSC or LHC)



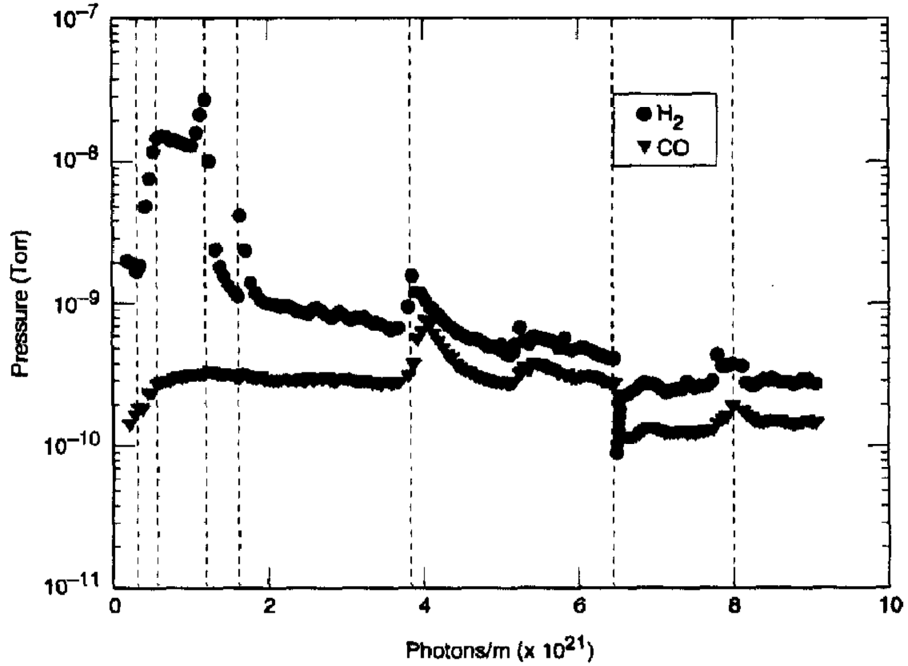
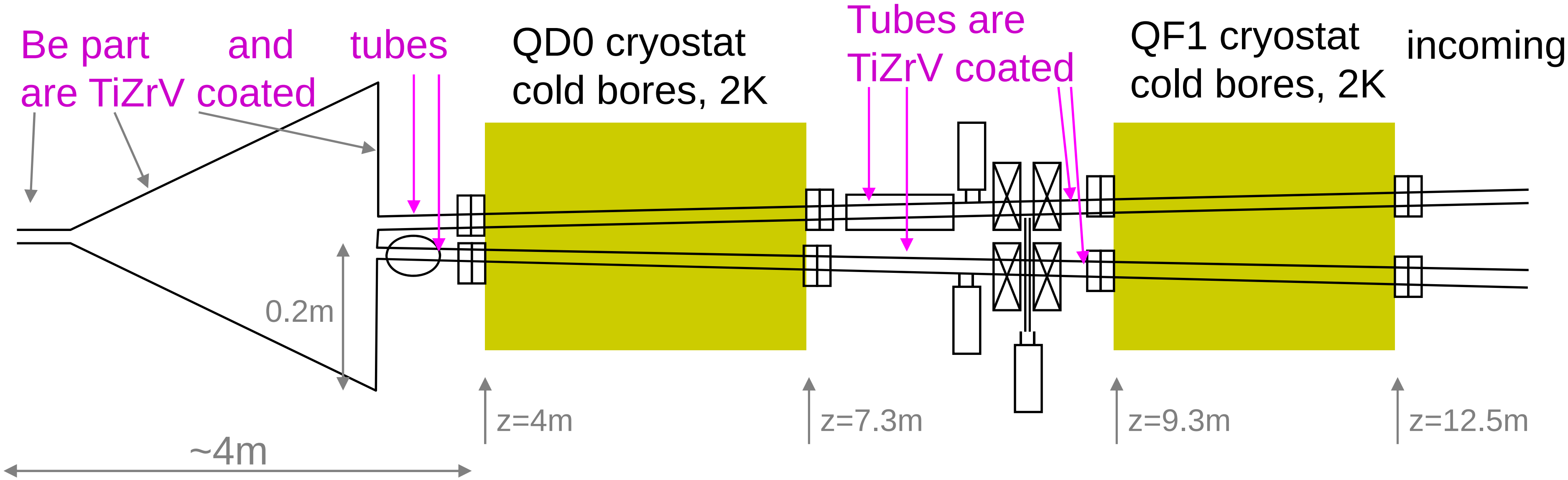
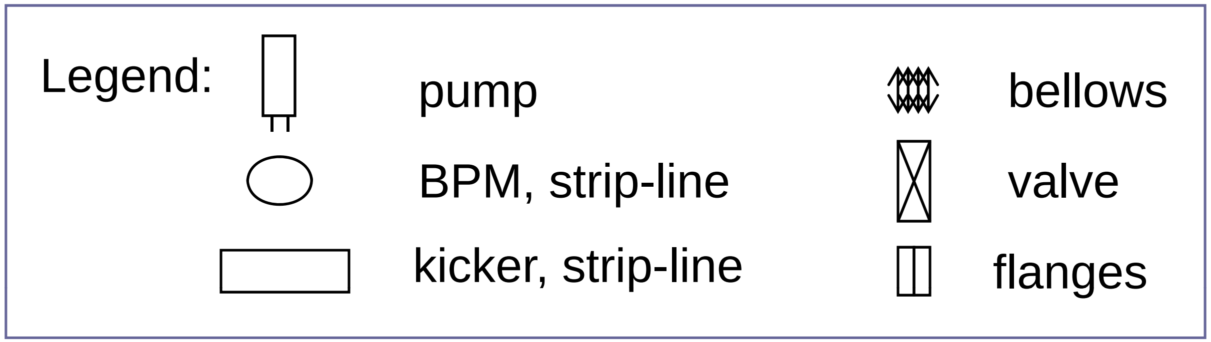


FIG. 2. Room-temperature RGA H_2 and CO dynamic pressures measured at the center of the liner configuration. Dynamic pressure is normalized to 1×10^{16} photons/m/s.

Two possible solutions: solution 1





Two possible solutions: solution 2