BDS Vacuum and Backgrounds

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Some Background Issues

- A lot of work has gone into studying detector backgrounds
  - Upstream sources and masking
    - SR from bends
    - SR from the Final Doublet
    - BGB hitting the IP and nearby masks and magnets
  - Downstream sources
    - Beam disruption –SR from wide energy beam
    - Beam bremsstrahlung
    - Bending the outgoing beam – backscatter SR from bend
    - Backscatter photons from beam losses
    - Neutrons

Vacuum

- Vacuum level assumed upstream of the detector
  - 1 nT dynamic pressure

- Vacuum level assumed inside the detector
  - 100 nT dynamic pressure

- What level of vacuum is needed downstream of the detector?
  - Present working assumption? 100 nT? 1000 nT?

Sources of gas

- **Thermal outgassing (molecules/(cm^2 s))**
  - depends on material, its treatment, conditioning, history, coatings, surface area, wall temperature, etc.
- **Photon stimulated desorption (molecules/photon)**
  - SR photons, Bremsstrahlung radiation
  - Depends on the same as above plus photon energy, number of photons per second per unit of beam pipe length, integrated photon dose.

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Sources of gas (2)

- Ion stimulated desorption
  - Molecules of residual gas can be ionised by the beam and be repelled to the walls by the positron beam charge
  - Has the same dependence as thermal desorption plus ion energy (function of beam charge and size), pressure in the beam pipe, integrated photon, electron and ion dose.

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Sources of gas (3)

- Desorption stimulated by any other energetic particles
  - Lost beam particles, new particles
  - Same as thermal desorption plus the particle energy, intensity, integrated photon, electron and ion dose.
  - Have we put the beam dump far enough away from the incoming beam line?

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Sources of gas (4)

- Locally, view-factor effect:
  - In a straight pipe the local gas density can depend on the gas density of remote regions and this can be a limiting factor when the required local gas density must be much lower (order of magnitude or more) than other parts of the straight pipe.
- Either the entire straight needs to be at the same pressure or else gas dynamic modelling is required
  - Oleg or any other vacuum expert familiar with TPMC or angular coefficient methods can look at this

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Possible problems

- Cryogenic beam pipe (Oleg's experience):
  - Secondary desorption of cryo-condensed gases
    - Even a fraction of a H_2 monolayer can cause a significant gas density increase if bombarded with photons, electrons or other particles
    - A monolayer of H_2 at 4.2 K cause dramatic gas density increase (equilibrium gas density)
    - Temperature instability can cause significant gas density fluctuations
  - Ideal solution:
    - Minimise the gas molecules entering the cryogenic pipe
    - Minimise the possibility of energetic particles or photons hitting the cryogenic pipe
  - Vacuum specification should be in **gas density**, not pressure

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Possible problems (2)

- Narrow beam pipe and limited access for pumping port may define limitation for lowest reachable pressure.
- Distributed pumping could be a good solution
  - SIP inside the detector magnetic field
  - NEG coatings
  - NEG strips or cartridges
- A vacuum scientist should be in the design loop

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Possible problems (3)

- Ion induced pressure instability in the positron beam pipe
  - This problem relates the ion stimulated desorption, which depends on beam parameters and available pumping.
  - Solution is sufficient pumping
    - It requires some modelling
    - Oleg recently made such a study for ILC DR, and now can do the same for BDS.

Courtesy of Oleg Malyshev

Summary

- We think we know what the vacuum pressure should be in each area

- The primary issue is whether or not we have modeled the gas sources completely enough to be able to design adequate pumping

- Beam scrubbing is another aspect of this issue as it sets the dynamic pressure