$C_l(t)$

$J_{lt}(10s) = \blacksquare$

to be continued...

Azriel noted that the above assumes mixing in the vessel, and that once cleaned, gas can be released into the chamber from the reclamation vessel directly. One can even fill with new but dirty gas directly through the purifier. However the EXe is likely to be very clean already <1ppb) so this is not an issue.

D. Shuman 8-31-11

Gas velocity in drift region

Circulation pump has a flow capacity given in SLPM (std. L/min), which is a molar flow rate

$Q_{pump} := 200SLPM$ $\qquad SLPM = 7.44\times 10^{-4}\,\frac{mol}{s}$ $\qquad R = 8.314\,\frac{kg\,m^2}{s^2 K\,mol}$ $\qquad T = 293\,K$

$\frac{Q_{pump}\cdot R\cdot T}{15bar} = 0.512\,cfm$

At our maximum operating pressure (MOP) of

$MOP := 15bar$

Volumetric flow rate is:

$V_{pump} := \frac{Q_{pump}\cdot R\cdot T}{MOP} \qquad V_{pump} = 0.242\,\frac{L}{s}$

Assume axial flow through vessel, of radius:

$r_{Xe} := 53cm$

Average velocity through drift region is then:

$v_{drift} := \frac{V_{pump}}{\pi r_{Xe}^2} \qquad v_{drift} = 0.274\,\frac{mm}{s}$

Kinematic viscosity of Xenon

Dynamic visc. from Wakeham, Kestin, Ro:) $\qquad$ density from Wikipedia, Xenon at STP

$\mu_{Xe\_STP} := 230\cdot 10^{-6}poise$ $\qquad \rho_{Xe\_STP} := 5.89\,\frac{gm}{L}$

$\nu_{Xe} := \frac{\mu_{Xe\_STP}}{\rho_{Xe\_STP}\cdot 15} \qquad \nu_{Xe} = 2.603\times 10^{-7}\,\frac{m^2}{s}$

Reynolds number

$Re_{drift} := \frac{v_{drift}\cdot 2r_{Xe}}{\nu_{Xe}} \qquad Re_{drift} = 1.115\times 10^3$ $\qquad$ laminar flow, but close to transition region

Velocity in PMT carrier plate gas holes; for radius:

$r_{gh} := 1.5cm$

$v_{gh} := v_{drift}\cdot\left(\frac{r_{Xe}}{r_{gh}}\right)^2 \qquad v_{gh} = 34\,\frac{cm}{s}$

Reynolds number

$Re_{gh} := \frac{v_{gh}\cdot 2r_{gh}}{\nu_{Xe}} \qquad Re_{gh} = 3.94\times 10^4$

flow is fully turbulent, and may act as jets to break up main drift flow

Gas velocity and pressure drop though SiPM plate $\qquad$ D. Shuman 2/29/12

Gas flow is constricted primarily as it flows between the dice boards. The pressure drop associated with this flow is the primary load transmitted to the support structure, as the support structure has far more open area. Dice boards are assumed here 48mm square, with a 2mm gap between them (spacing = 50mm), and they are ~5mm thick

$w_{db} := 48mm \quad s_{db} := 50mm \quad g_{db} := s_{db} - w_{db} \quad g_{db} = 2\,mm \quad t_{db} := 5mm$

$r_{Xe} = 0.53\,m \quad A_{tp} := \pi r_{Xe}^2 \quad A_{tp} = 0.882\,m^2$

Area ratio is: $R_a := \left(\frac{g_{db}}{s_{db}}\right)^2 \quad R_a = 1.6 \times 10^{-3}$

Gas flow area through dice board gaps:

$A_{dbg} := A_{tp} \cdot R_a \quad A_{dbg} = 14.12\,cm^2$

Gas velocity, through dice board gaps

$v_{dbg} := \frac{v_{drift}}{R_a} \quad v_{dbg} = 0.171\,\frac{m}{s}$

Hydraulic diameter of dice board gap = 2x gap

$D_{h\_dbg} := 2 \cdot g_{db} \quad D_{h\_dbg} = 4\,mm$

Reynolds number:

$Re_{dbg} := \frac{v_{dbg} \cdot D_{h\_dbg}}{\nu_{Xe}} \quad Re_{dbg} = 2.63 \times 10^3$ flow is maybe still laminar, as duct is short, use Hagen-Poisseulle flow formula

$\Delta P := 8 \cdot \frac{\mu \cdot L \cdot Q}{\pi r^4} \quad M_{a\_Xe} = 0.136\,\frac{kg}{mol}$

$q_{Xe} := 200SLPM \quad q_{Xe} \cdot M_{a\_Xe} = 0.02\,\frac{kg}{s}$

$dVdt_{Xe} := q_{Xe} \cdot \frac{R \cdot 293K}{15bar} \quad dVdt_{Xe} = 2.417 \times 10^{-4}\,\frac{m^3}{s}$

$\mu_{Xe} := \nu_{Xe} \cdot \rho_{Xe} \quad \mu_{Xe} = 2.369 \times 10^{-5}\,\frac{kg}{m\,s}$

$\Delta P_{dbg} := \frac{8 \cdot \mu_{Xe} \cdot t_{db} \cdot dVdt_{Xe}}{\pi g_{db}^4} \quad \Delta P_{dbg} = 4.556\,Pa$

This is pressure drop across the flow area, which is only a small portion of the total plate area, however, it represents a necessary boundary condition needed to maintain the required flow, and so must be applied to the plate as a whole. If there are leaks around the edges, gas will not flow trough the plate as needed, and stagnation conditions may be develeloped, or perhaps a radial dependent flow profile, which would not be desirable

Tracking Plane should not deflect more than 0.5mm under this condition, to maintain uniform distance between EL mesh and SiPMs. We may have various pressures and flow rates so we would like to avoid

For **emergency vent condition** (to vacuum chamber) , vent flow (choked flow condition) through vent valve is sized to be:

$m_{emg} := 25\,\frac{kg}{s}$ = 10x the max flow through a broken 41 pin feedthrough (this is greater than through a broken PMT window/conduit assembly)

Assume this flow is through a valve on the energy head, and we do not use a secondary vent valve on the