

Issues for a small vapour volume (relative to the liquid volume) above the liquid level

1. Level fluctuation
 - a. Liquid filling spay
 - b. Gas bubble departure
 - c. Sensor error
 - d. Supply pressure fluctuation
2. LHe droplets entrainment
 - a. Formed by expansion of inlet and the departure of gas bubbles
 - b. Carried by gas flow
3. LHe quality
4. LHe valve control

Mitigations:

1. Liquid line feeds into bath
 - a. Droplets by expansion eliminated
 - b. Nominal quality (80%) effectively compliment the heater
 - c. Very low quality will deplete/disturb the level: interlock?
2. A surrounding tube to reduce the level sensor error due to gas cooling (dumping of liquid vapor interface oscillation)

- *Liquid/vapour space in the range for level control*

- A height of 250mm and in a cone from 500mm base diameter to 250mm top diameter
 - Level control within $\pm 125\text{mm}$
 - 125mm deep LHe in the cone is 12.3 litres
- At a continuous liquid He filling rate of 42ml/s for a nominal SC-Link GHe mass flow rate of 5g/s
 - 5min depletion time

- *GHe flow near the phase interface*

- Steady state gas flow for 5g/s is 228ml/s
- The interface surface area $\frac{\pi(D^2-d^2)}{4} = \frac{\pi(30^2-20^2)}{4} = 400\text{cm}^2$
- Overall gas departure speed $228\text{ml s}^{-1}/400\text{cm}^2 = 0.57\text{cm s}^{-1}$
- Not strong life for liquid droplets entrainment
- Assuming bubble density at 10% of surface area, bubble departure speed at 6cm/s