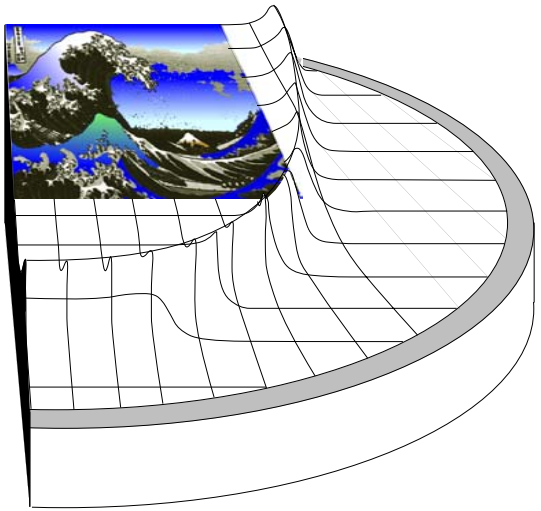
Vortex Extraction



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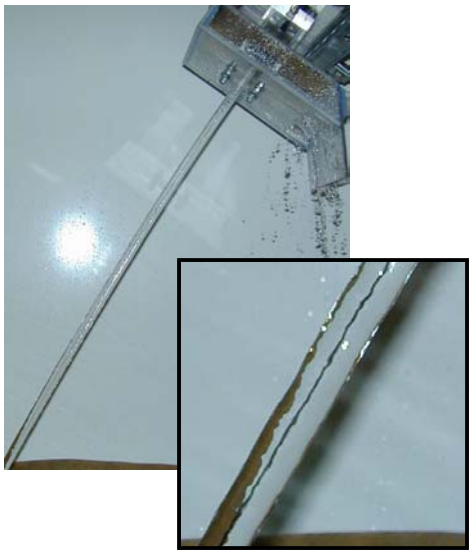
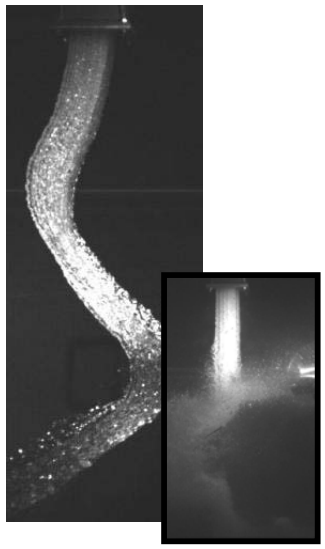
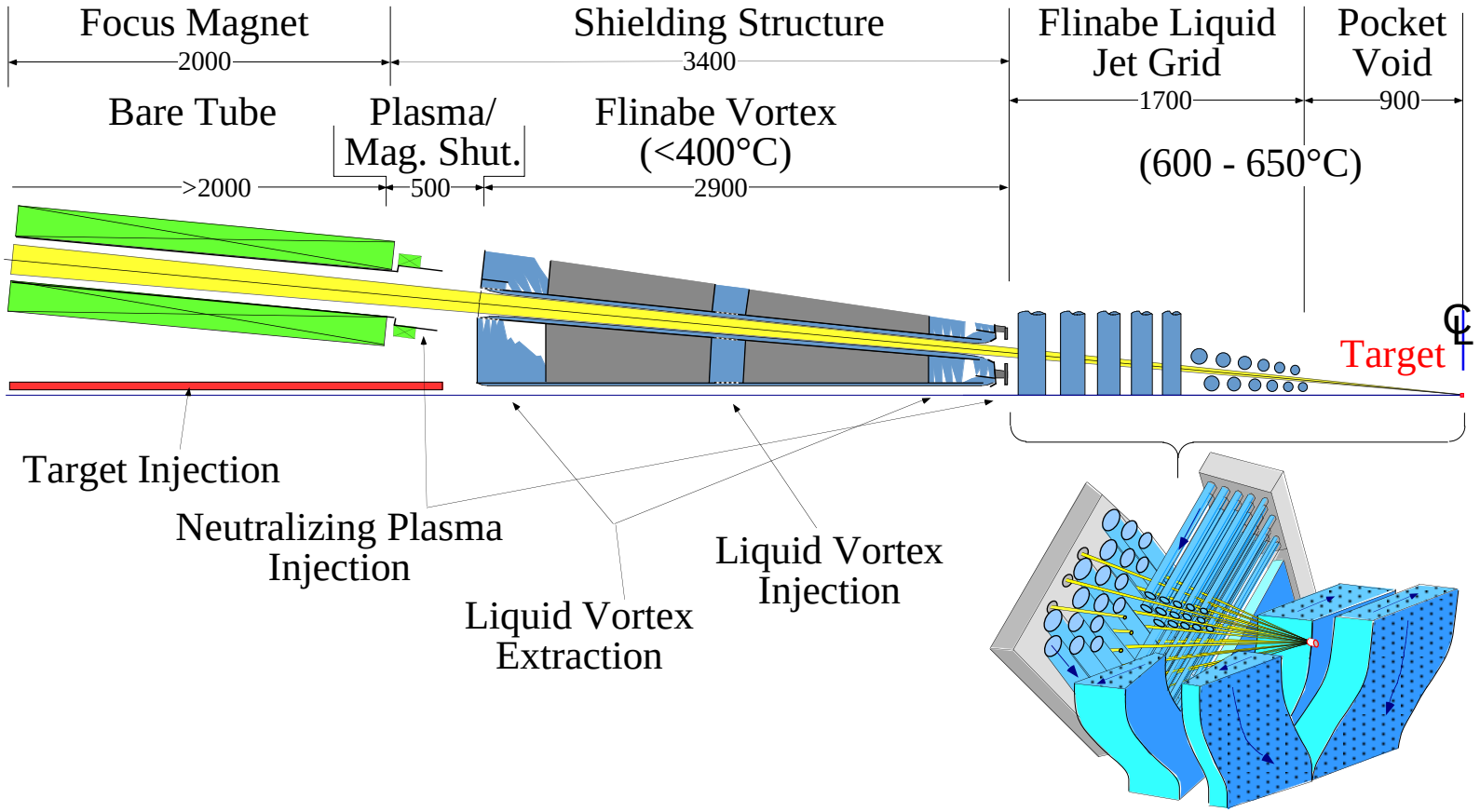




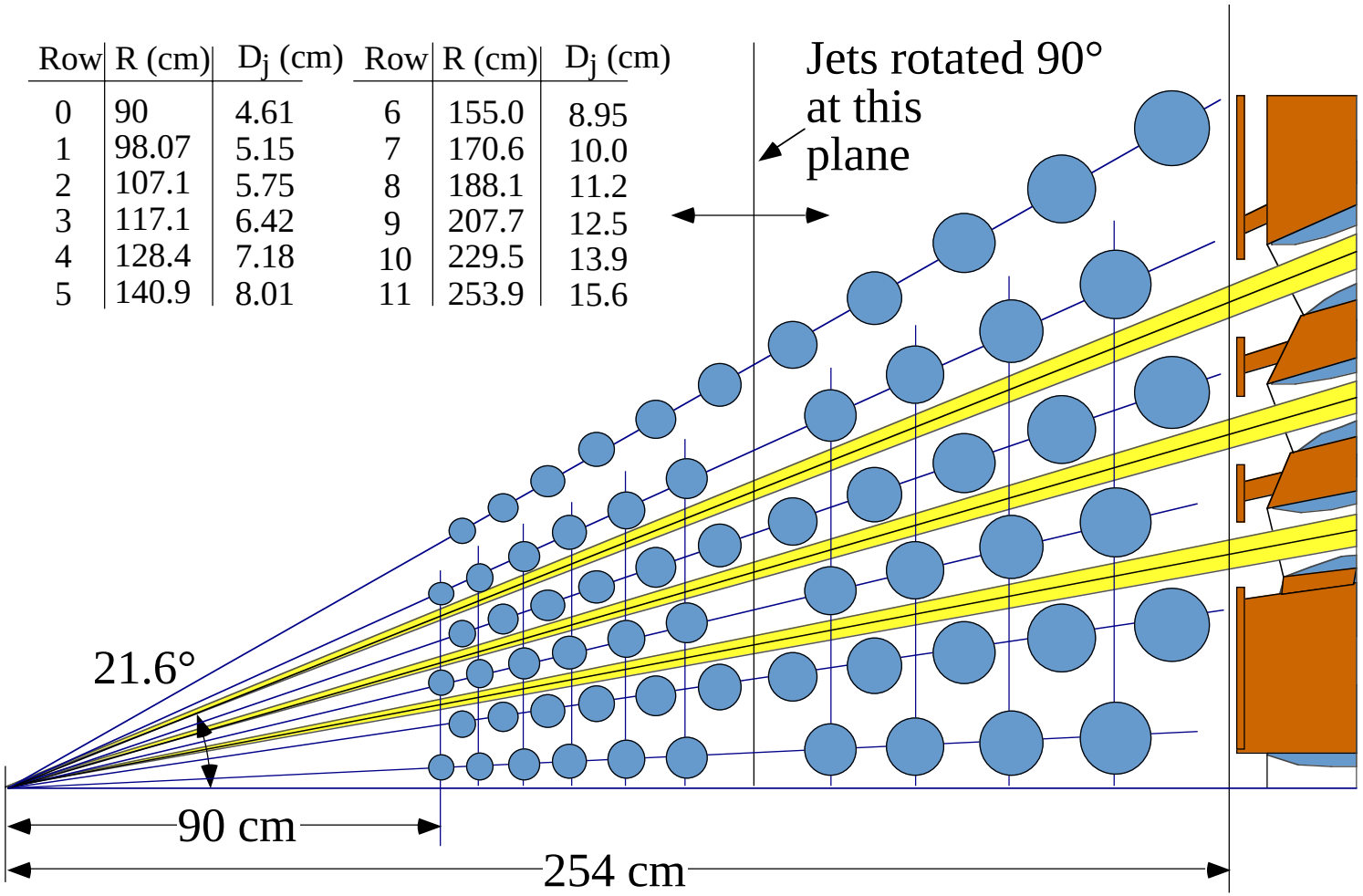
The Robust Point Design (RPD) beam line



Schematic Liquid Jet Geometry

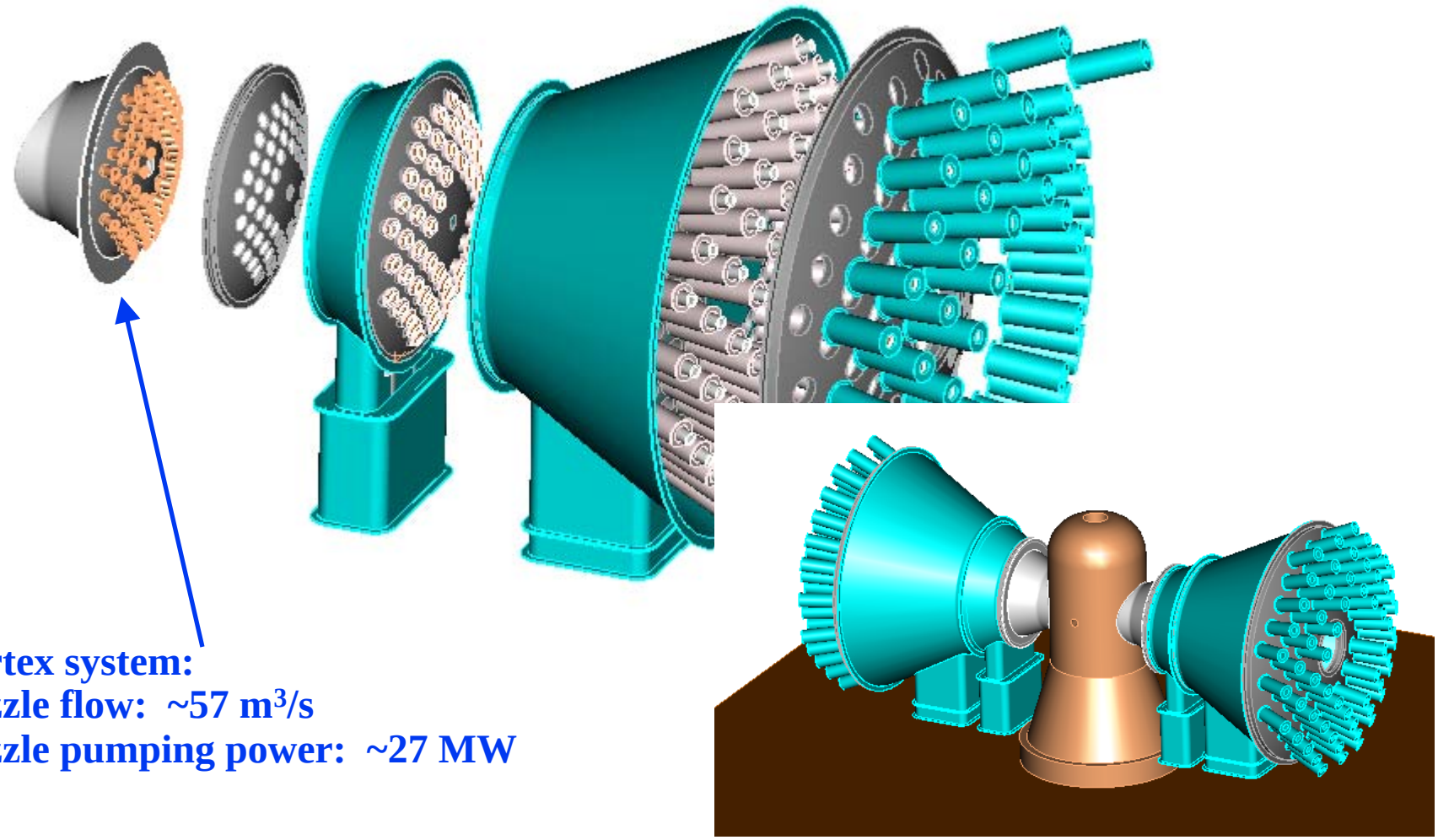
RPD-2002 cylindrical configuration is optimized to maximize liquid density in the crossed-jet region

Row	R (cm)	D_j (cm)	Row	R (cm)	D_j (cm)
0	90	4.61	6	155.0	8.95
1	98.07	5.15	7	170.6	10.0
2	107.1	5.75	8	188.1	11.2
3	117.1	6.42	9	207.7	12.5
4	128.4	7.18	10	229.5	13.9
5	140.9	8.01	11	253.9	15.6



RPD-2002 uses a large maximum beam entry angle (24°) to maximize space for magnets and neutron shielding

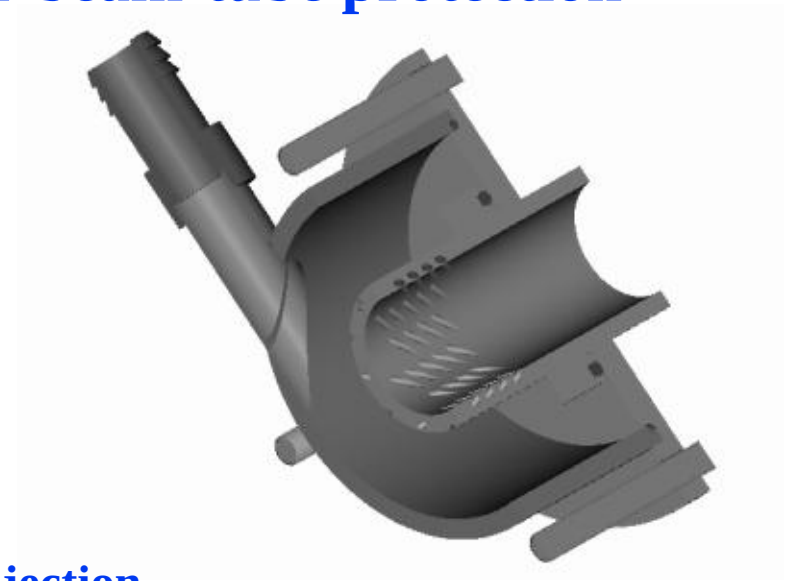
Credit: T. Brown, PPPL



Vortex system:
Nozzle flow: ~57 m^3/s
Nozzle pumping power: ~27 MW

UCB vortex test stand has studied vortex injection and extraction methods for beam-tube protection

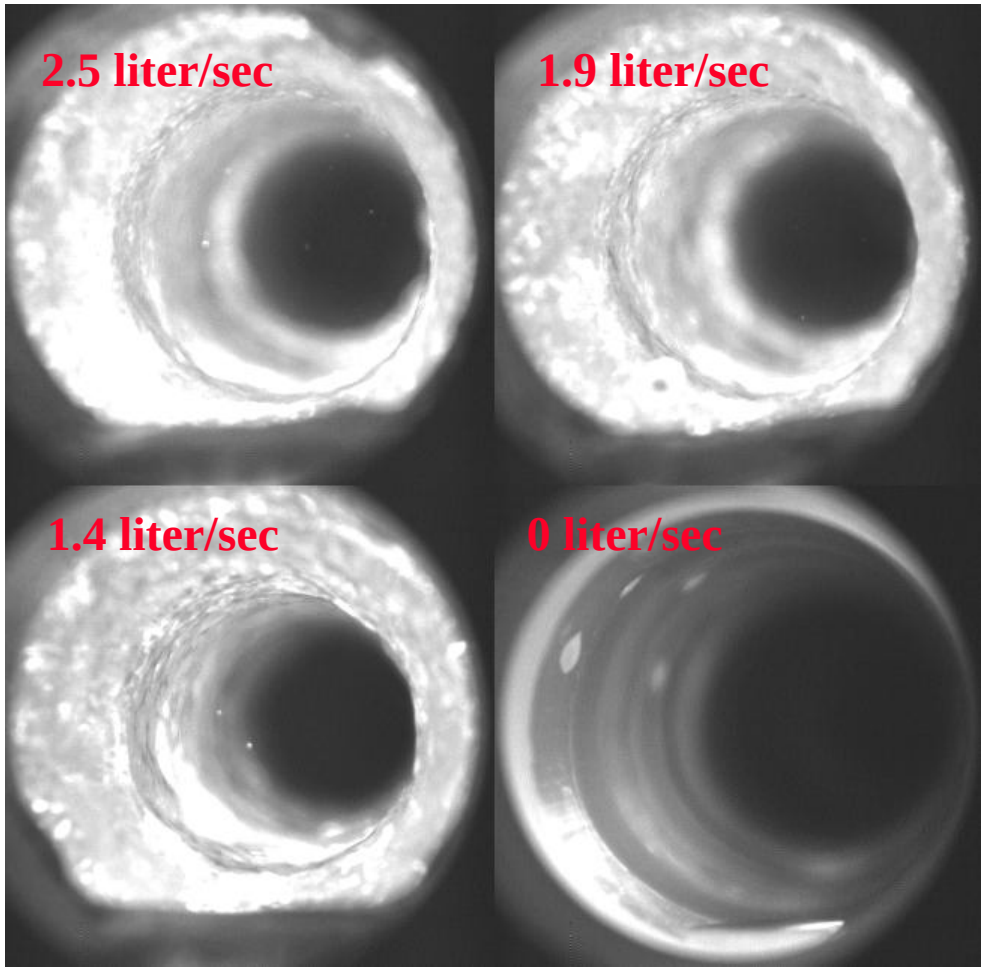
Side view showing operation at 30° angle (extraction nozzle used on right, vortex fan on left)



Injection nozzle

End view

Theory and experiments show that the vortex layer thickness is independent of flow rate

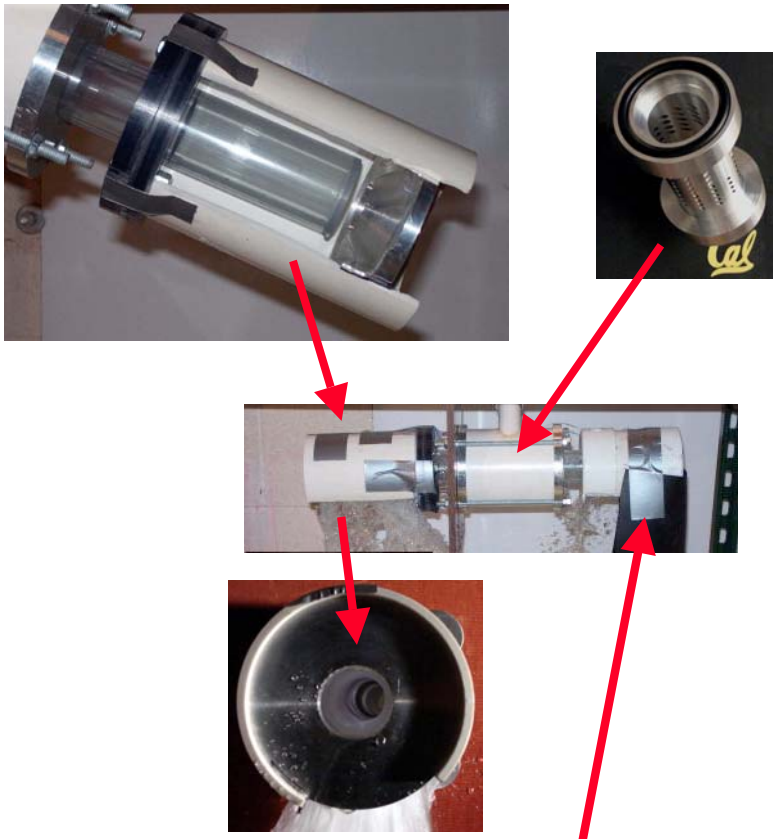


Modular solenoid HIF chamber could potentially use a large-scale vortex flow

- **Issues:**

No extraction

Perforated tube extraction



Fan Extraction Method

Perforated tube extraction

Conclusions

- **Fan extraction method is quite clean**
  - **Issue is developing compact extraction collector to allow close packing of beams**
  - **More compact geometry may be possible if layer thickness is first reduced by perforated extraction**
- **Perforated extraction may have dripping**
  - **Distribution of extraction holes can be weighted toward the bottom of the tube**
  - **Allows compact vortex tube packing**
- **Sufficient area must be provided to collect extracted liquid and drain it through duct to bottom of vortex tube array**