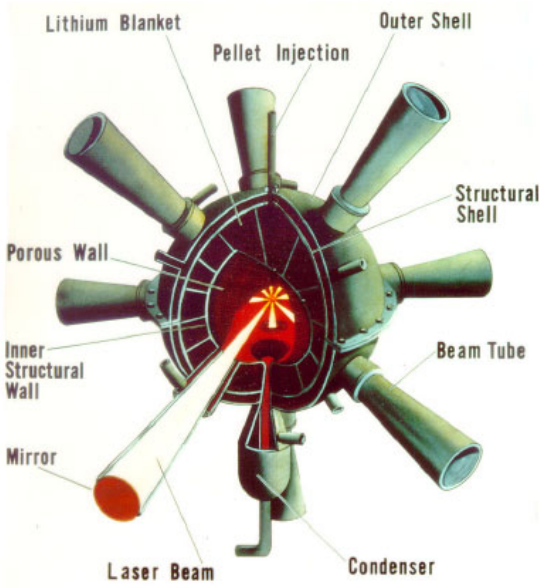
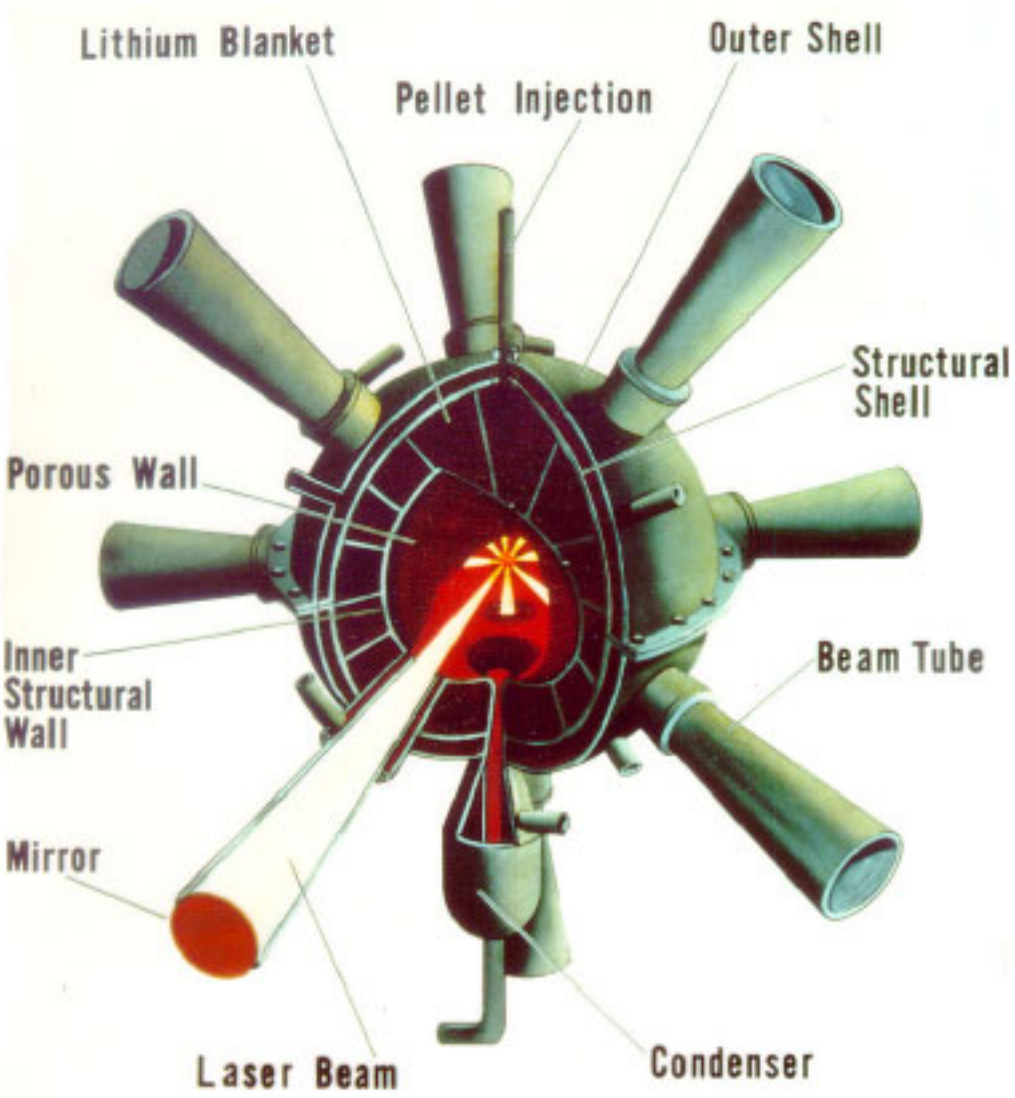
Thin Liquid Wall Protection Concepts for IFE Reactors



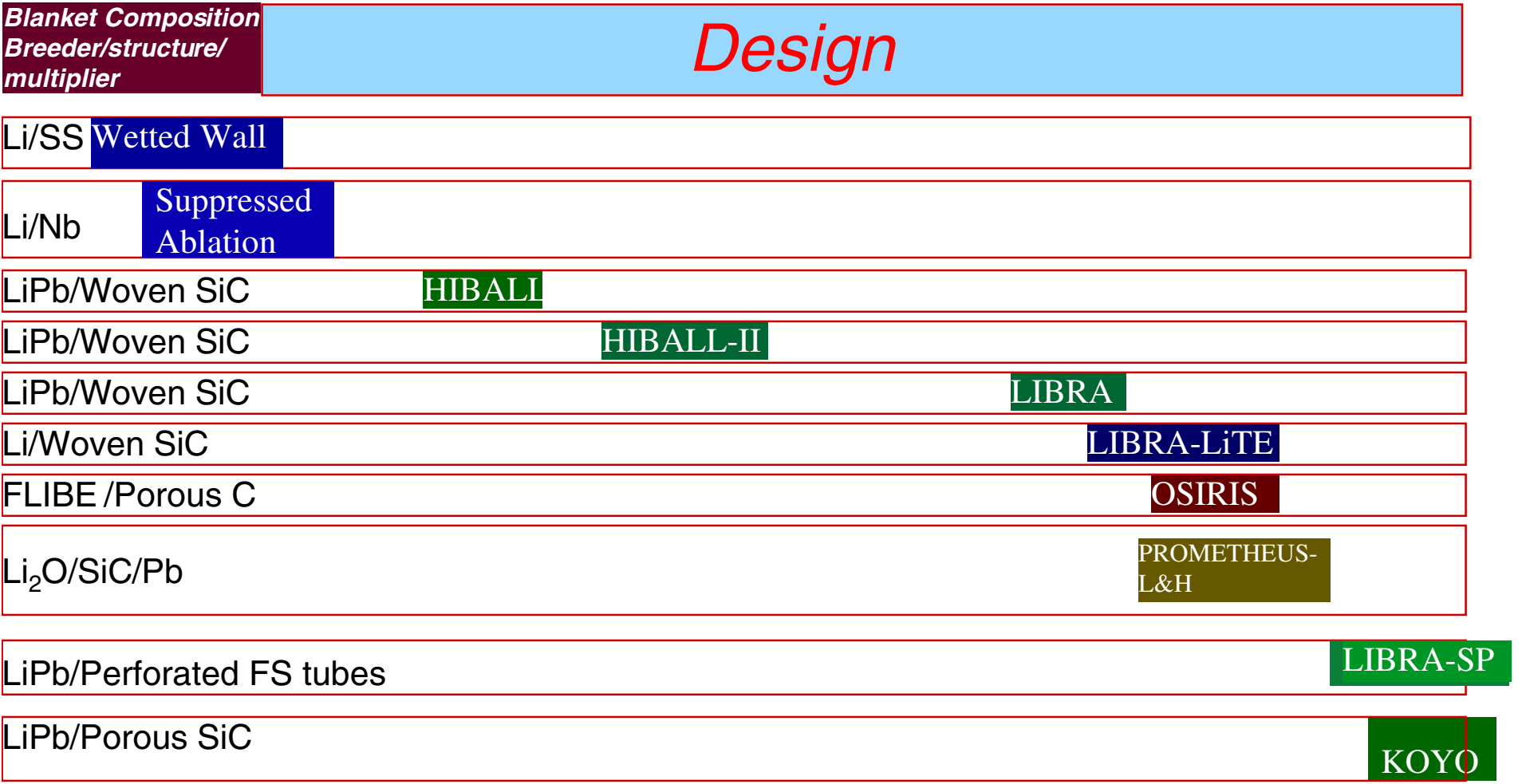
Elsayed A. Mogahed
Fusion Technology Institute
University of Wisconsin-Madison

ARIES Meeting in Madison WI, April 22-23, 2002

The First Thin Liquid Wall Protected Laser Fusion Chamber
L. Booth et al., LASL 4820, 1972



10 IFE Wetted Wall Protection Concepts Over the Past 30 Years

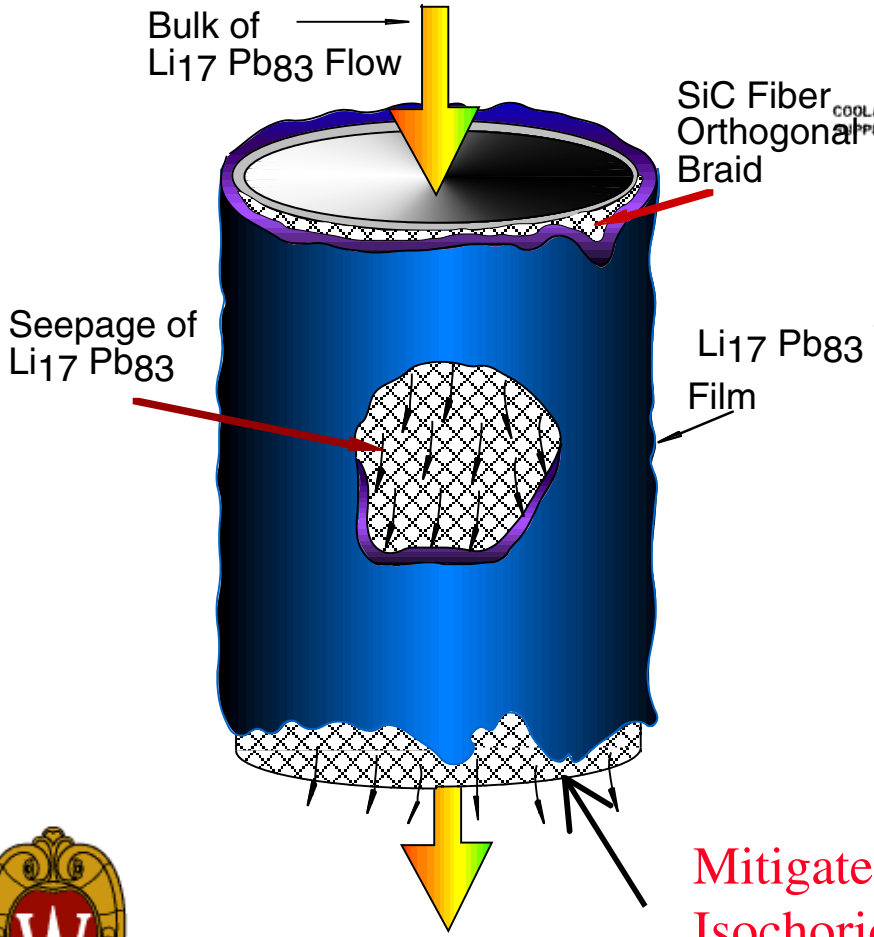


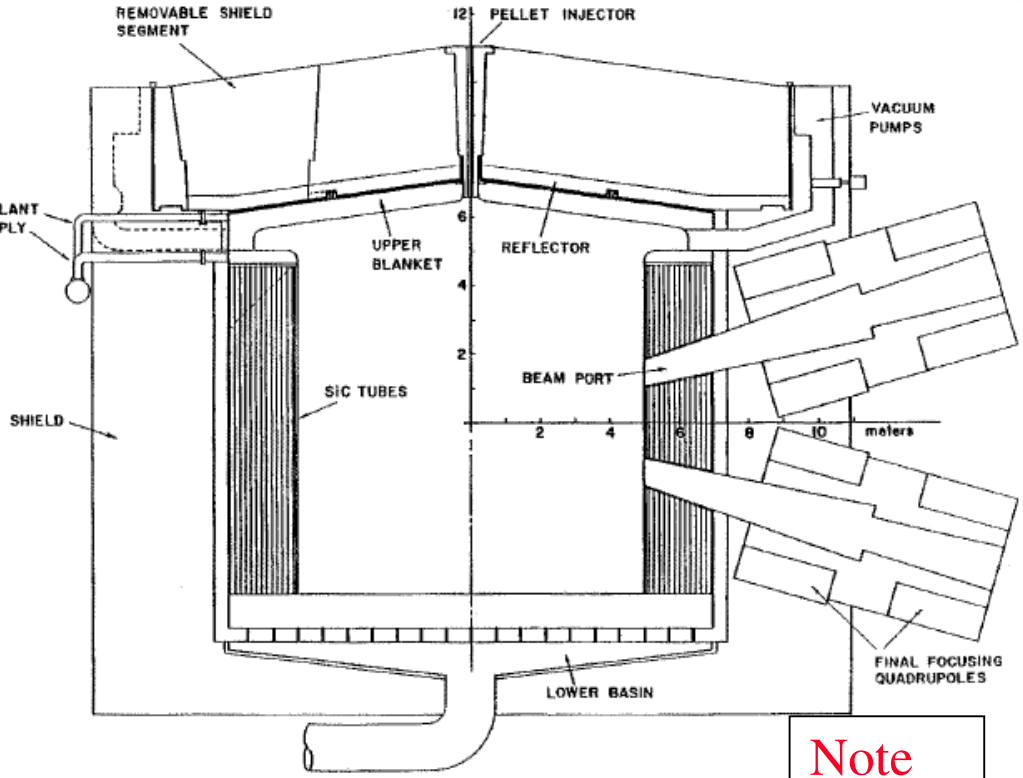
HIBALL (1984)

Coolant/PbLi
Structure/Woven SiC

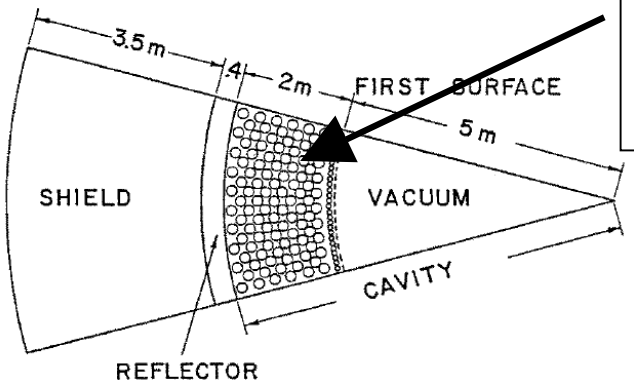
HIBALL INPORT

(**In**hibited flow in **Por**ous **T**ubes) (1981)





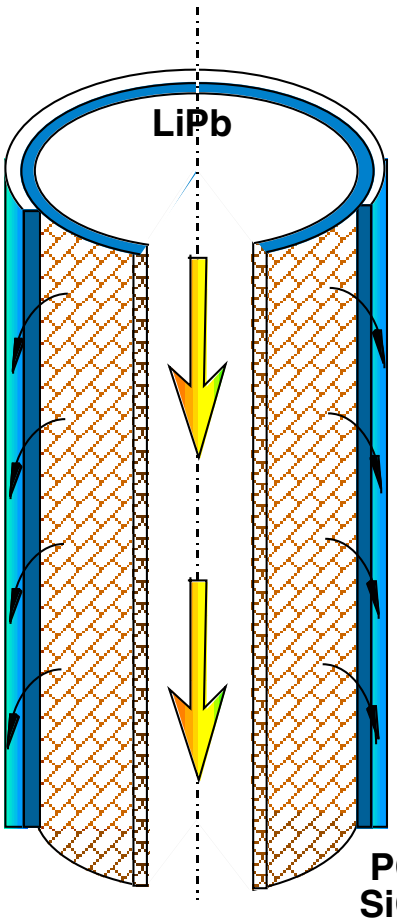
Note surface area



Mitigates Isochoric Heating

LIBRA (1991)

Coolant/PbLi
Structure/Woven SiC

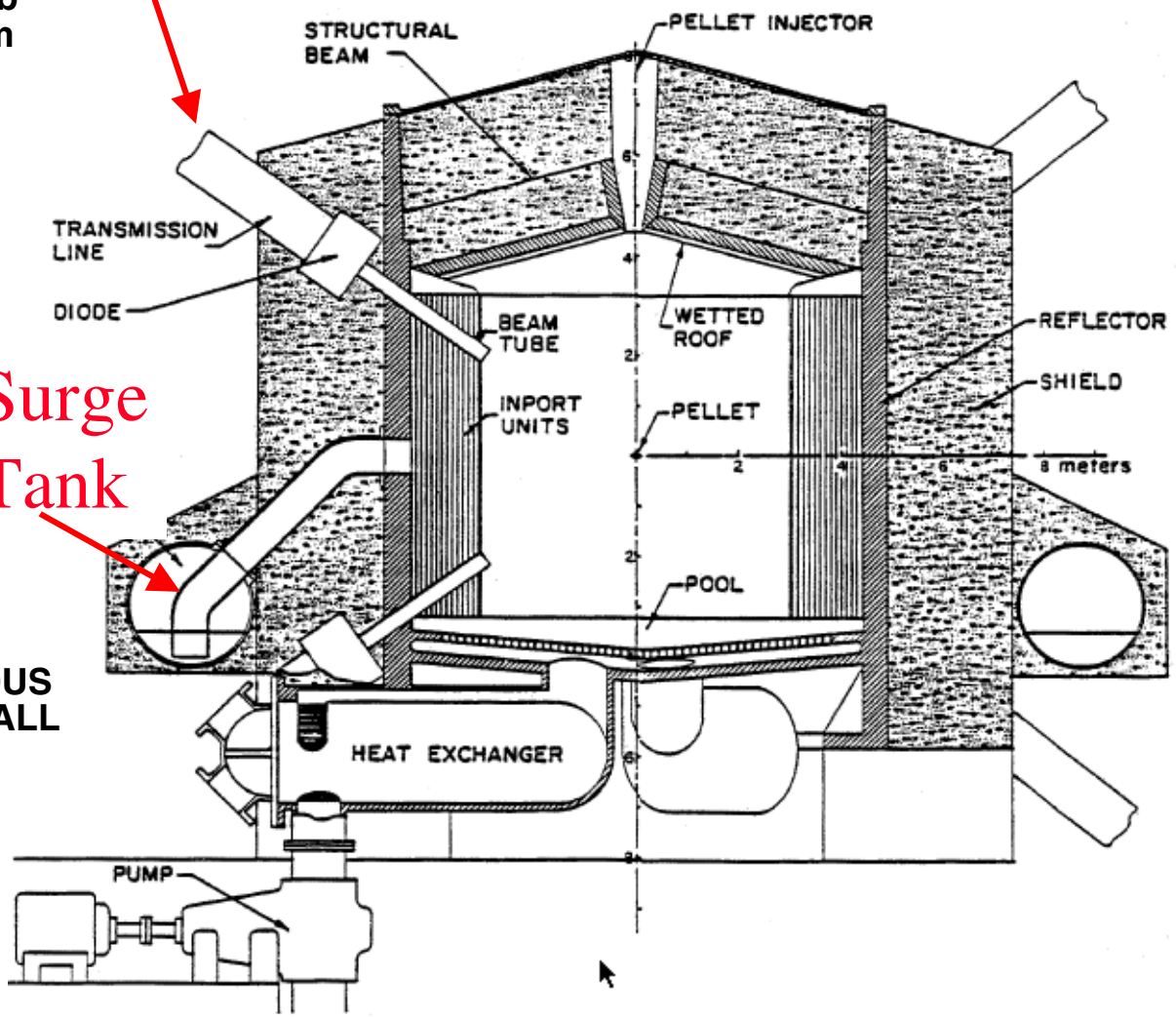


Sectioned INPORT Unit

Inhibited flow in Porous Tubes

Channel Transport Through
≈10 Torr of He

Surge
Tank

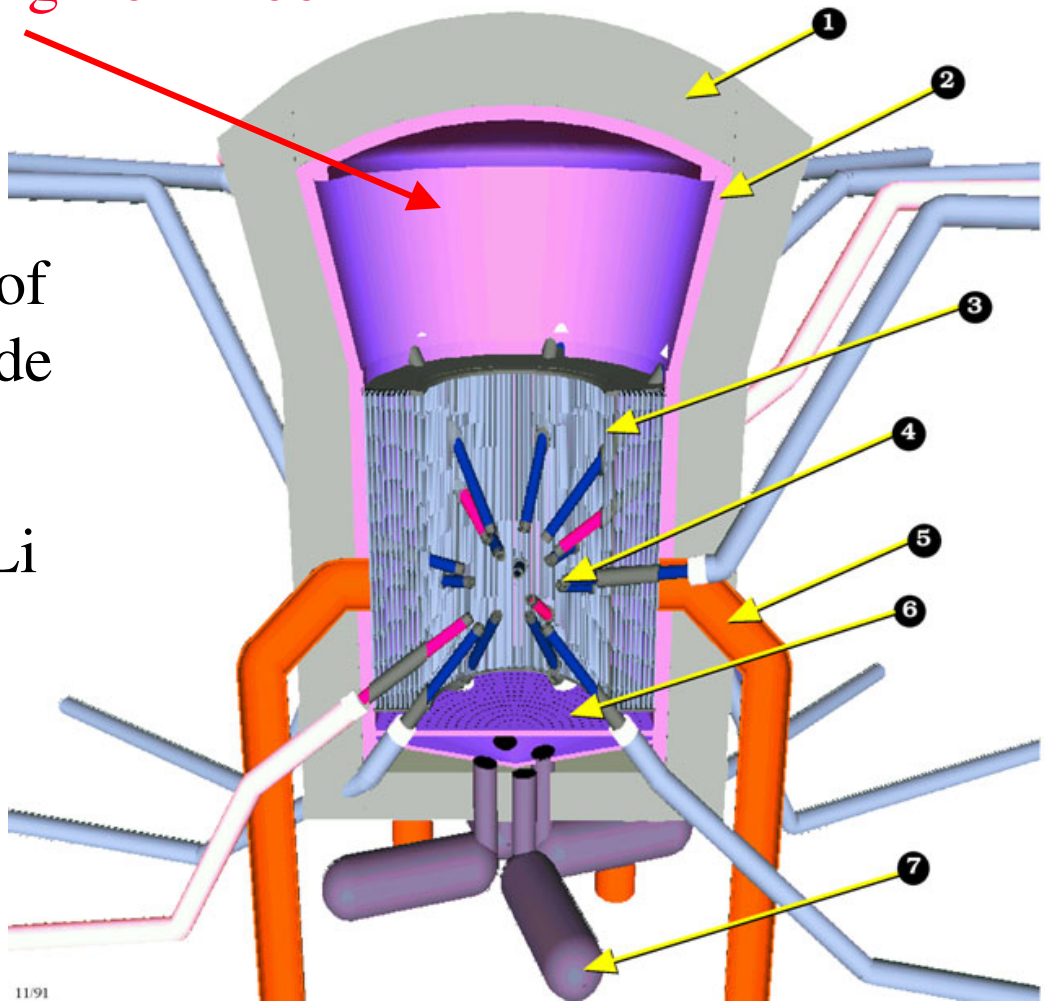


LIBRA-LiTE {Light Ion}(1992)

Coolant/Li
Structure/Woven FS

Upper Expansion Chamber
Ameliorates Dripping from Roof

- LIBRA-LiTE relies on ballistic transport of lithium ions to implode the target
- LIBRA-LiTE uses Li as coolant/breeder fluid



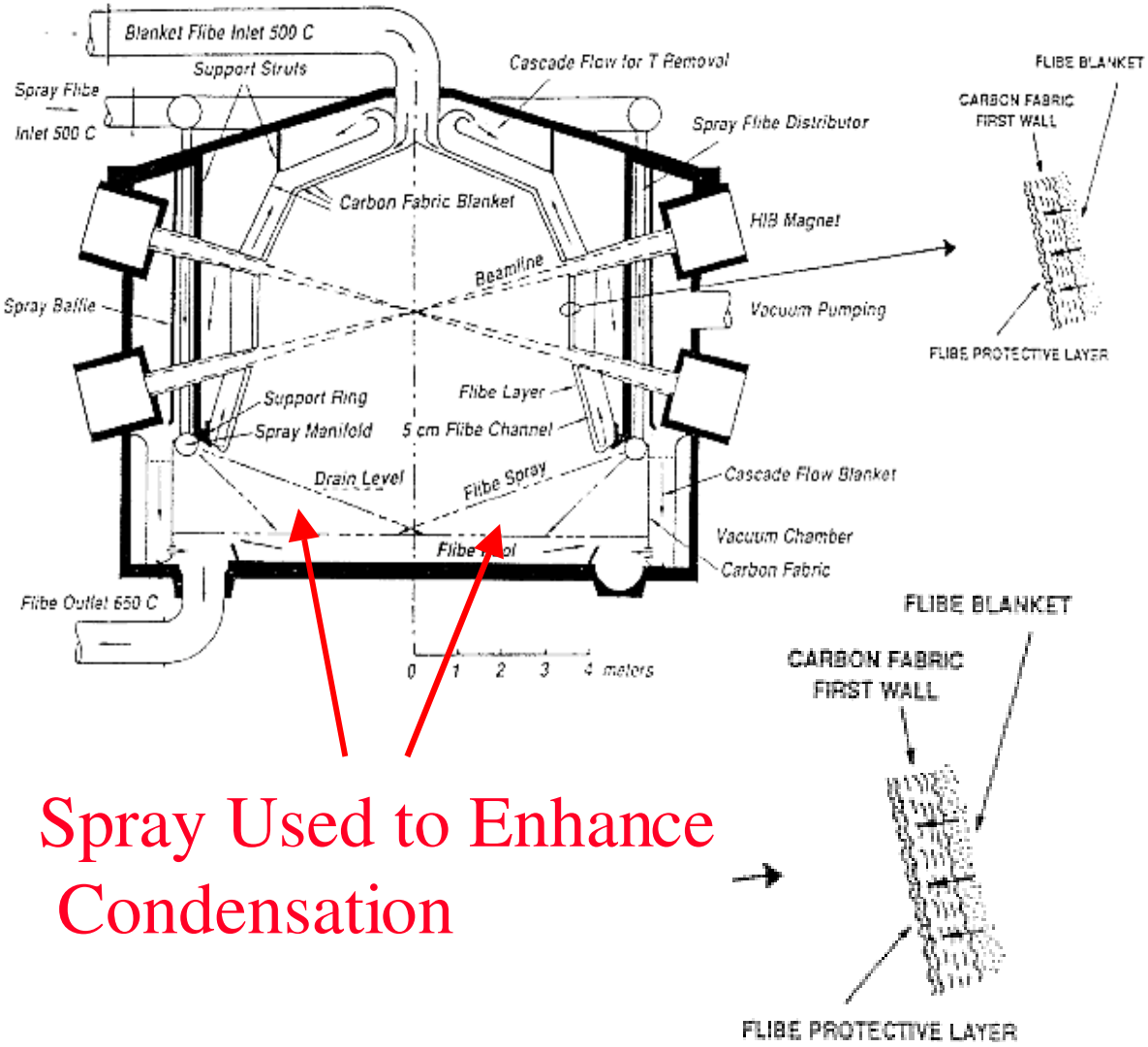
OSIRIS {HIB} 1992

Coolant/FLIBE
Structure/C fabric

OSIRIS Chamber --

First Wall: Flexible, porous carbon fabric that contains the molten salt, FLIBE.

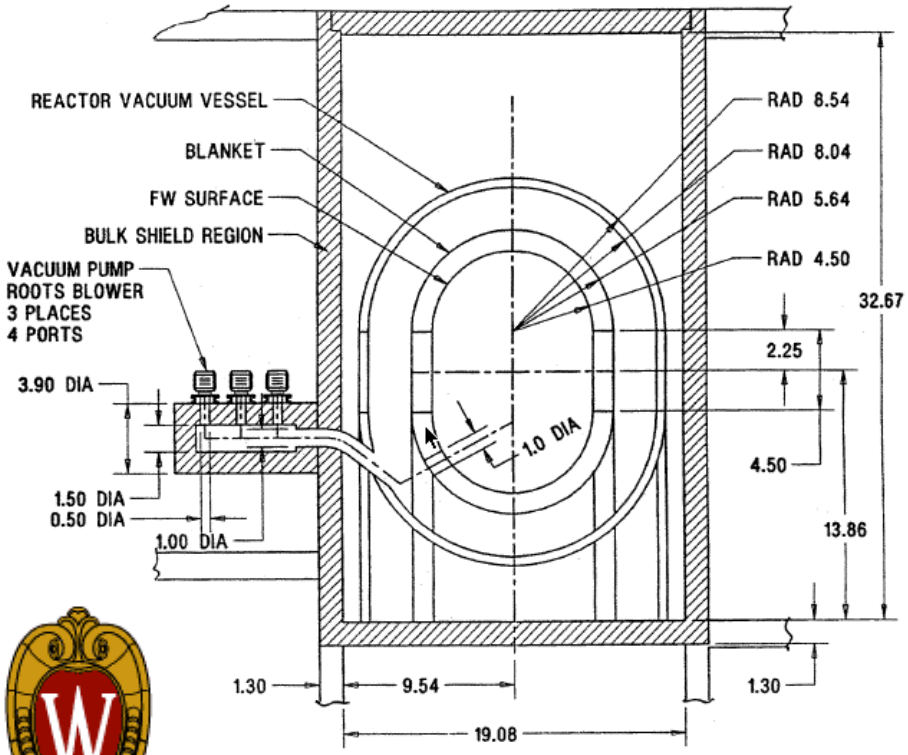
A thin layer of FLIBE coats the first wall to protect it from x-ray and debris damage.



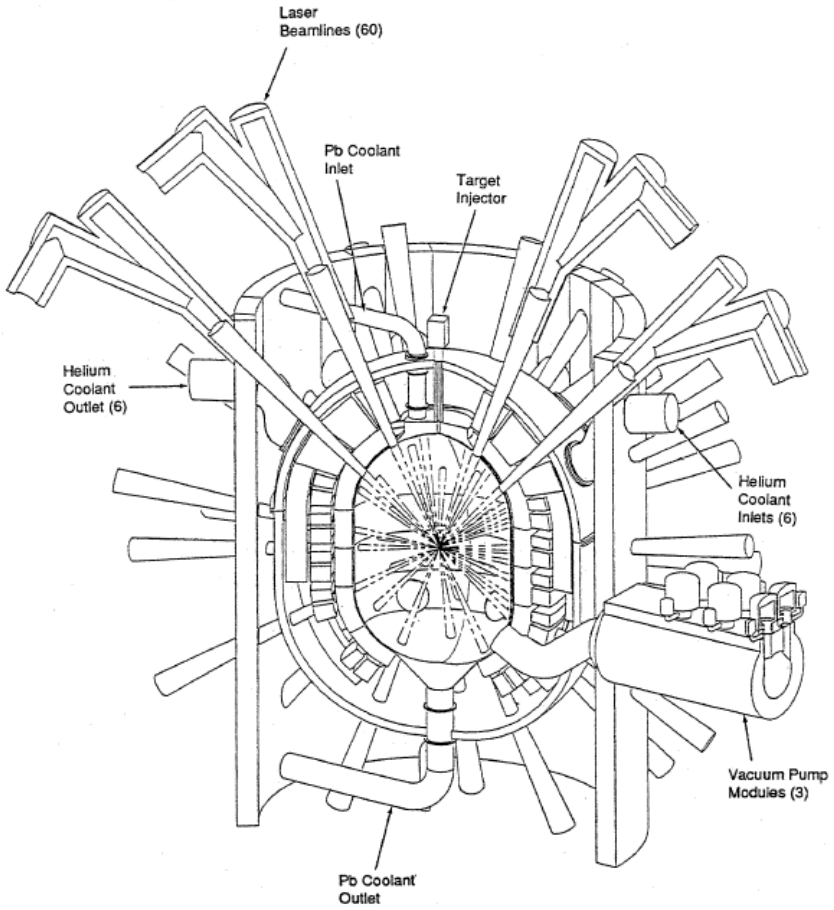
Prometheus-L (1992)

Coolant/Pb
Structure/Porous SiC

In the same time frame there was another design,
Prometheus-H (heavy Ion)

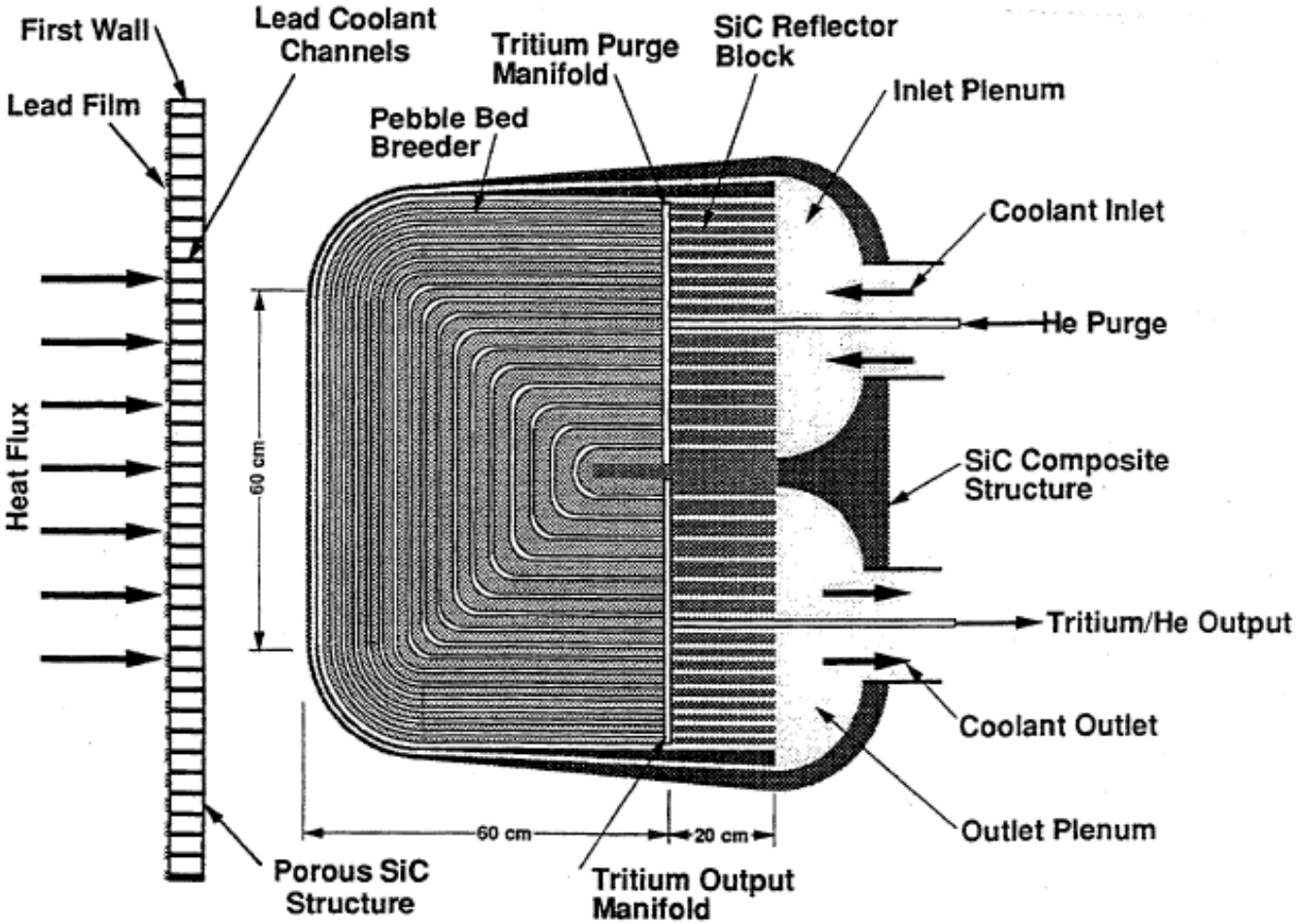


General view of
Prometheus-L reactor



Prometheus-L blanket module

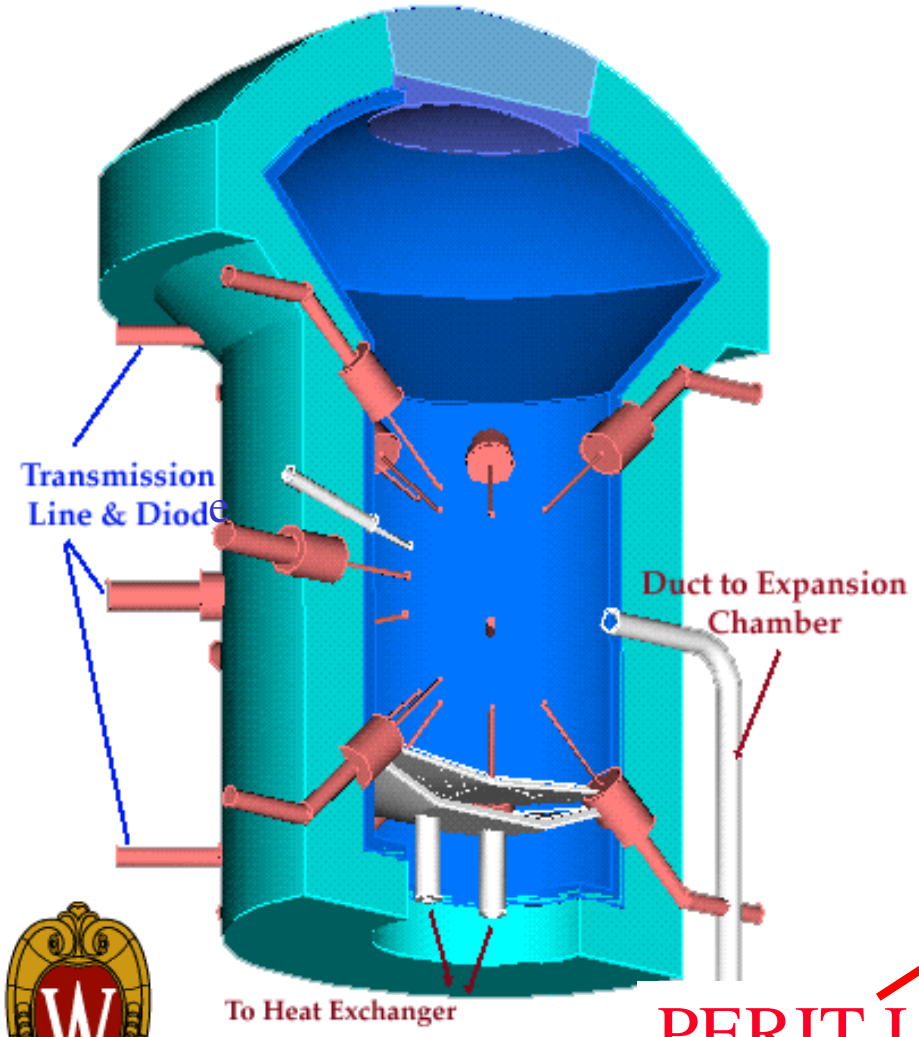
- A wetted wall with a layer of liquid lead on the surface.
- The first surface facing the plasma is porous SiC while the back of the F/W coolant channel is graded to fully dense SiC.



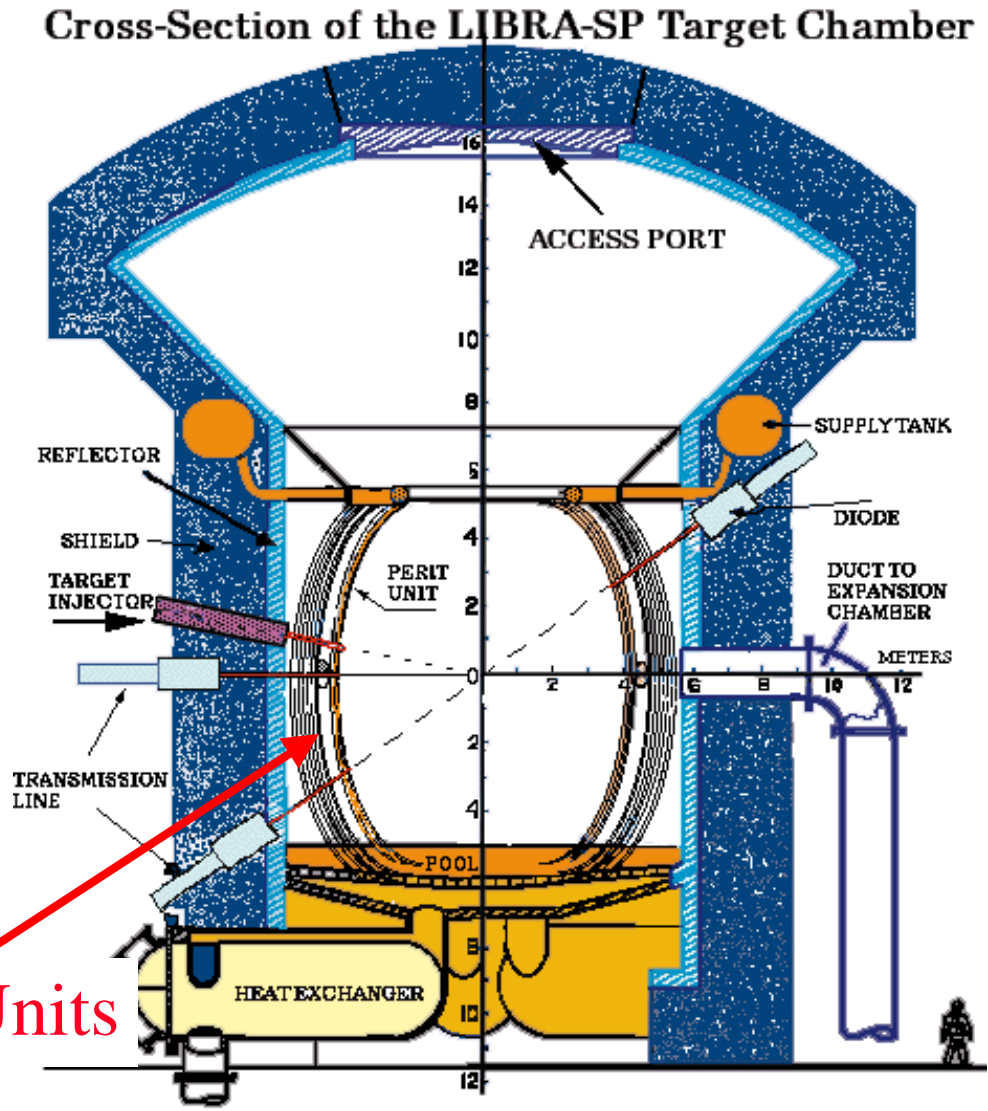
LIBRA-SP Uses Rigid Tubes

(1996)

Coolant/PbLi
Structure/Perforated FS



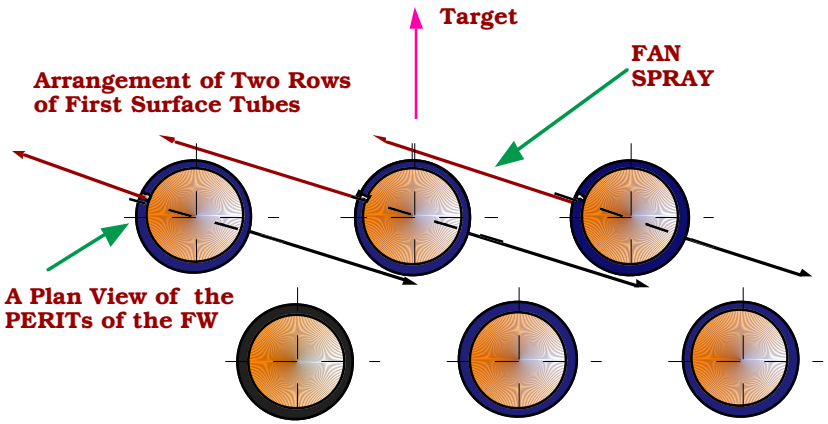
LIBRA-SP Target Chamber

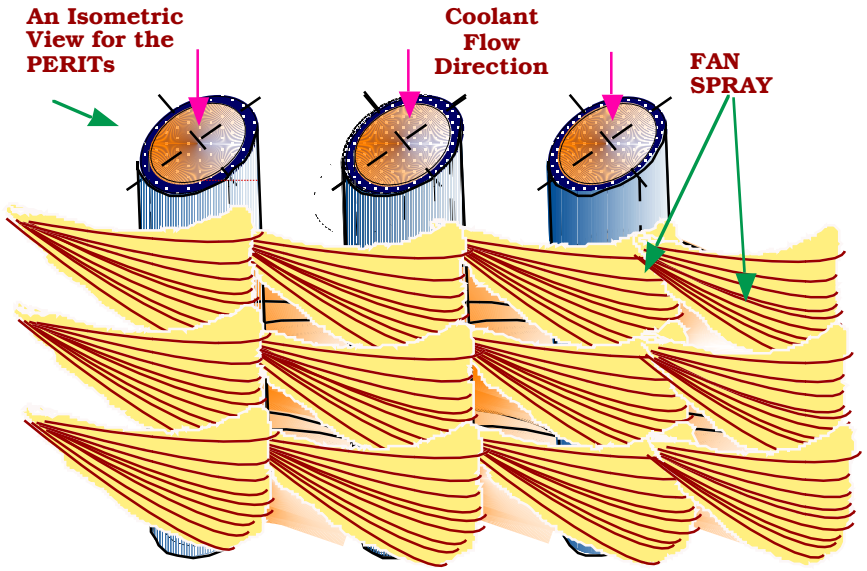


PERIT Units

LIBRA-SP First Wall Thin Film Spray-Fan Protection

In LIBRA-SP the thin LiPb film spray-fan is overlapped to completely shadow the first surface (FS Perforated Rigid Tubes {PERIT})





First Surface Protection by Fan Spray

Wetted Wall Designs Have Attempted to Address Many Issues

Design	Breeder/ Structure	Year	First Solid Surface	FW Coating Liquid	Condensation Area
Wetted Wall	Li/SiC	1972	Porous-Rigid	Light	2D flat wall
Suppressed Ablation	Li/Nb	1974	Porous-Rigid?	Light	2D flat wall
HIBALL	PbLi/SiC	1981	Woven	Heavy	3D-tubes
HIBALL-II	PbLi/SiC	1984	Woven	Heavy	3D-tubes
LIBRA	PbLi/SiC	1990	Woven	Heavy	3D-tubes
LIBRA-LiTE	Li/FS	1992	Woven	Light	3D-tubes
OSIRIS	FLIBE/C	1992	Porous-semi rigid	Interm ediate	2D flat wall -plus spray
Prometheus	Li_2O/SiC/Pb	1992	Porous-rigid	Heavy	2D flat wall
LIBRA-SP	PbLi/FS	1996	Perforated-rigid	Heavy	3D-tubes
KOYO	PbLi/SiC	1996	Porous-rigid	Heavy	3D-tubes

Future Wetted Wall Designs Must Address the Following Issues Simultaneously

- Cavity Clearing:
  - Condensation surface area
  - Thermal velocity (i.e., Pb vs Li)
- Wetability/Dry Out
- Aerosol Formation:
  - Dust
  - Nucleation sites
- Accommodation of Penetrations