BREEDER BLANKET ENGINEERING DESIGNS FOR HAPL AND IMPACT OF MAGNETIC DIVERSION

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Presentation Outline

- Consistent with the earlier Li and Solid Breeder blanket designs, an incomplete LiPb blanket in ferritic steel is presented. No Be is needed, but the Li has to be enriched.
- As magnetic diversion is contemplated, an evaluation is performed to determine the effect on the blanket and its maintenance
- In magnetic diversion, there are two options:
  - o Mid-plane horizontal splitting of the chamber
  - o Vertical splitting of the chamber through the poles
- An evaluation of both geometries will be made

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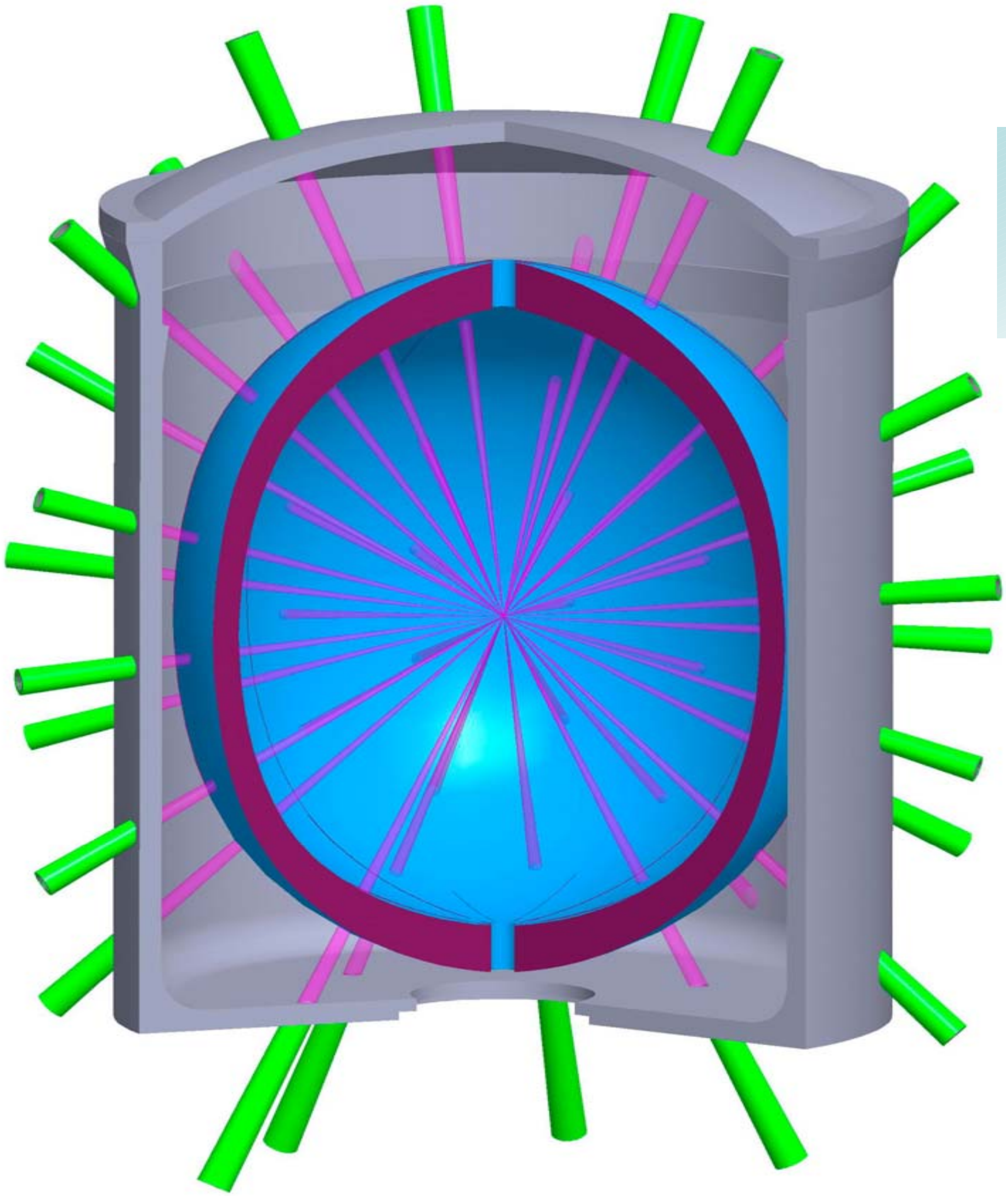
LiPb Blanket w/o Magnetic Diversion.

- LiPb is not a very good heat transfer medium. For this reason, the first wall is cooled with He.
- As in the case of the solid breeder blanket, the first wall will have toroidal channels, and the He flow in adjacent channels will alternate.
- To avoid having a separate upper and lower blankets,the radial blanket is designed to cover the entire vertical length of the chamber.
- LiPb is admitted at the bottom of the blanket module, travels vertically upwards in a large channel behind the first wall, then makes a U turn at the top, and travels down exiting the module on the bottom. He coolant connections are also made on the bottom.

Layout of Chamber with LiPb Blanket in Place



Single module extends the full vertical length of the chamber

Several Views of a LiPb Blanket Module (1/12)

Top view

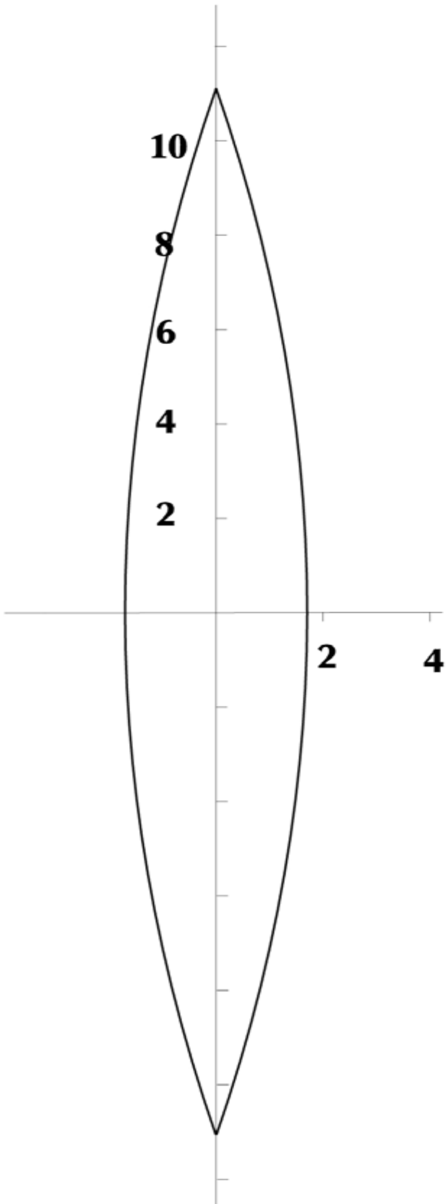
Side view

Front view

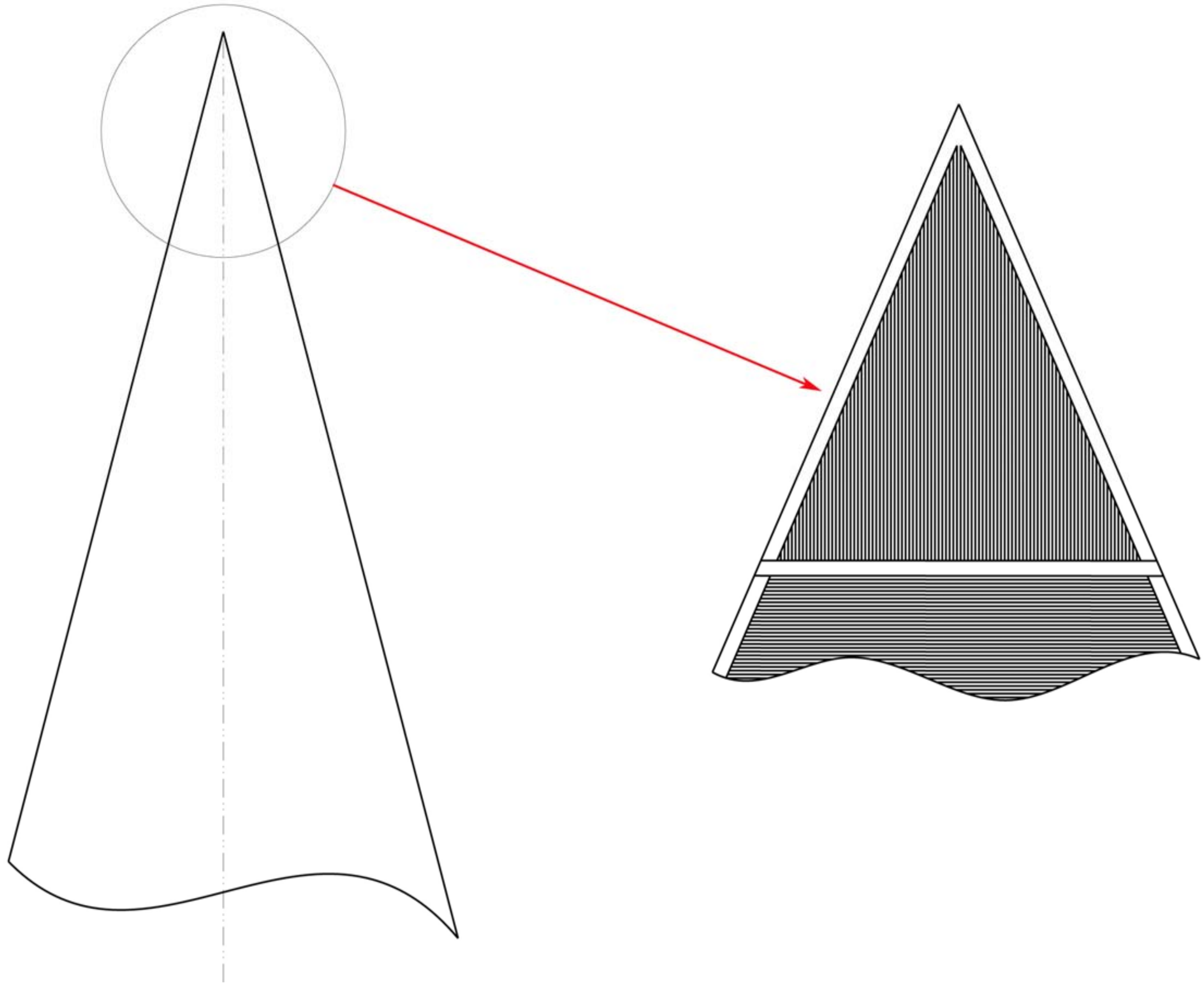
Arrangement of the He Cooling of the First Wall

- Torroidal channels are difficult to implement on the module extremities where it comes to a point .
- At those locations, at a distance of 2m from the ends, the cooling switches to vertical channels.
- A horizontal manifold located near the first wall feeds the vertical channels, which in turn exhaust into collector manifolds located at the sides of the module.
- The LiPb channels are not affected by this change in cooling of the first wall

One Blanket Module Rolled out Flat



Top End of Module Expanded to Show Cooling Scheme



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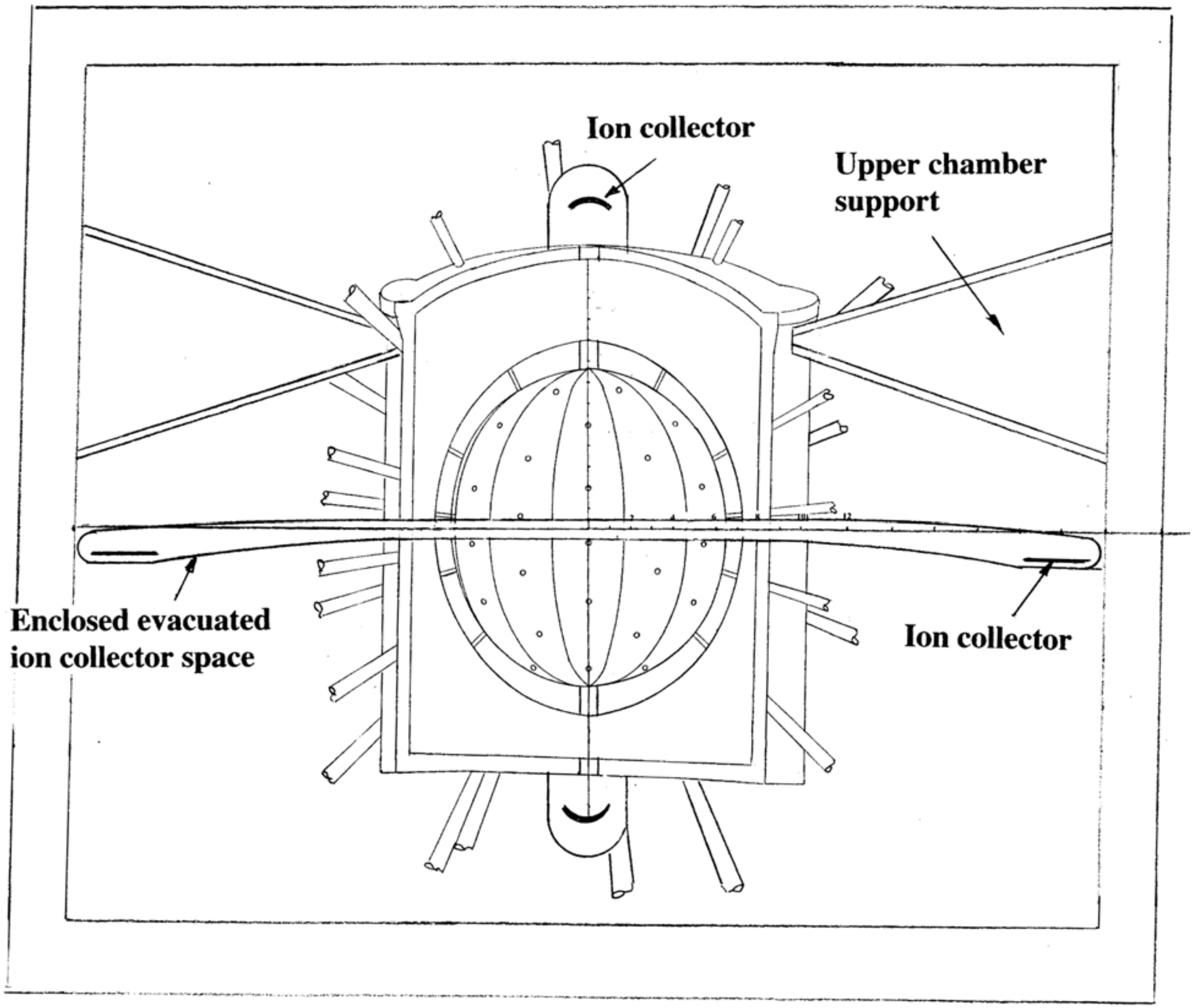
Impact of Magnetic Diversion on the Blanket and its Maintenance

- As covered in preceding talks, magnetic diversion has a major impact on the geometry of the chamber and blanket.
- The cusp coils create within the chamber magnetic field lines which exit through a mid-plane belt and through polar holes.
- The mid-plane belt splits the chamber into two halves, an upper and a lower half.
- The ions exiting through the mid-plane belt are diverted to impact a collector surface where their energy is recovered in the power cycle. The radius at which this collector is located depends on the heat flux from the ions at that point.
- This is important because it determines the span over which the support of the upper chamber must be built.

Magnetic Diversion Using a Mid-plane Horizontal Split

The cusp coils, the diversion coil and the pick-up coils are not shown



Impact on Blanket of Horizontal Split

- The available vertical space for a mid-plane split is < 1.0 m
- A mid-plane horizontal split divides the chamber into two halves, an upper and a lower half, leaving the upper half unsupported.
- A special support structure is needed for the upper half of the chamber. This support structure shares space with the beams in an already crowded area.
- An evacuated enclosure is provided for the trajectory of the ions to the ion collectors. The extent of the enclosure depends on the area needed for the collector and could be 20-25m from the center of the chamber. Obviously this impacts the size of the building.
- MHD effects have to be considered in liquid metals

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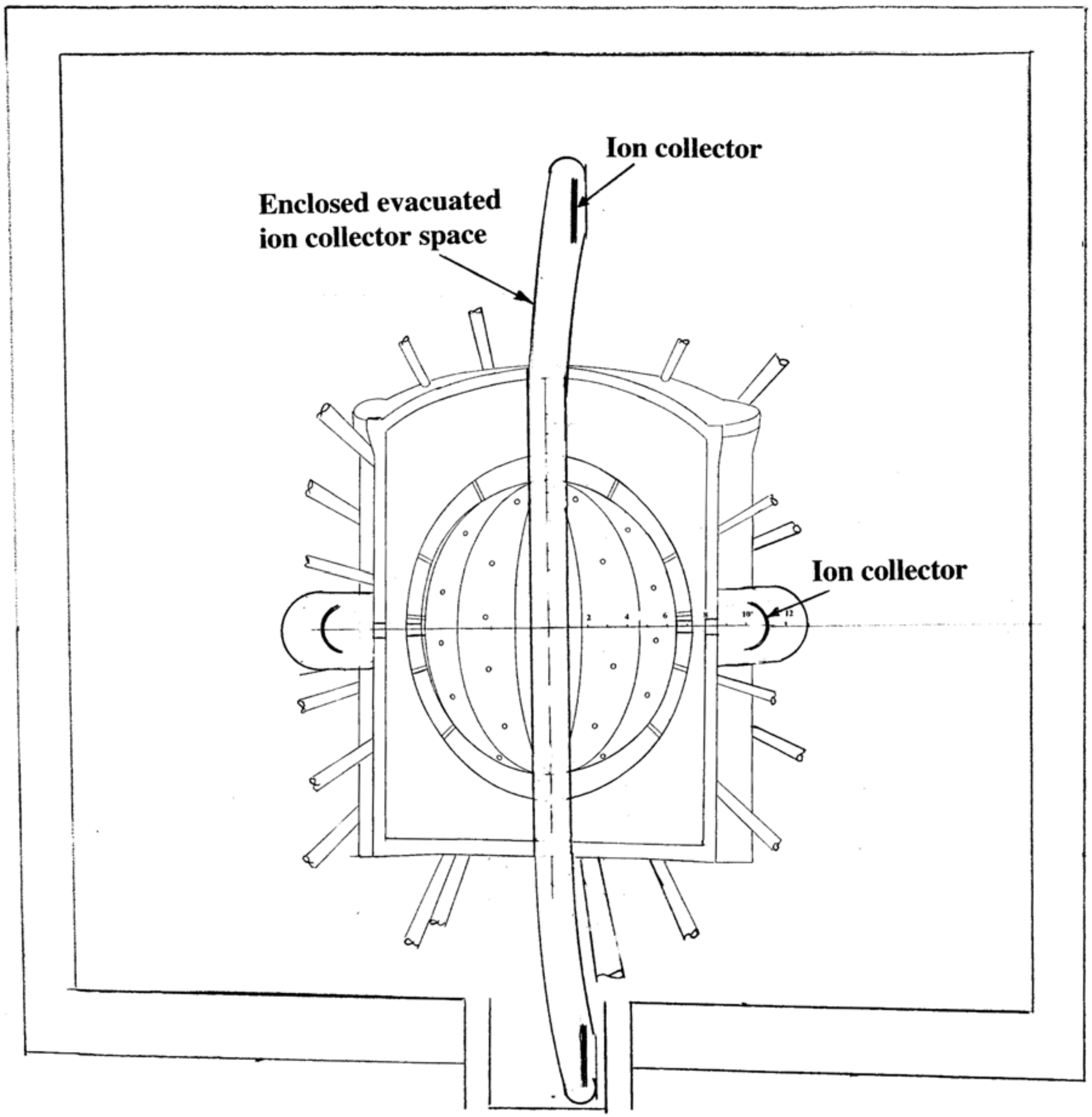
Magnetic Diversion Using a Vertical Split

The cusp coils, the diversion coil and the pick-up coils are not shown



Impact on Blanket of Using a Vertical Split

- Cusp coils must be rotated to a vertical position
- The chamber design will be modified for accommodating the cusp coils in the vertical attitude.
- The available space between beams increases to ~ 1.5 m
- A vertical evacuated enclosure is provided for the ions.
- The interface of this enclosure with the upper maintenance flange is complicated. The upper flange will have to be segmented to permit maintenance of the blanket between the cusp coils. The blanket modules, however, can be maintained as whole units.
- Support of the chamber and blanket is not impacted.
- The radial size of the building is the same as in the case of the horizontal split, but its height is larger.
- MHD effects have to be considered

Summary and Conclusions

- Magnetic diversion alleviates the problems of protecting the first wall but creates major complications in the rest of the reactor.
- The major issues with a horizontal split of the chamber are:
  - Support of the upper half of the chamber and blanket.
  - Splitting of the blanket into two parts complicates its cooling and maintenance.
- The major issues of a vertical split of the chamber are:
  - Complicates the design of the upper maintenance flange.
  - Maintenance of the blanket is harder due to interference with the cusp coils