ARIES-AT
BLANKET DESIGN AND COOLANT ROUTING

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Subjects Covered

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- **Inboard blanket design and coolant routing**
- **Outboard blanket design and coolant routing**
- **Inboard and outboard blankets integrated coolant routing**

Guiding Principles for Coolant Routing

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- **The diverter elements are cooled first, before the blanket components.**

- **All supply and return headers are to be coaxials, with the inlet cool (650^{o}C) stream in the outer annulus and the hot return stream in the inner tube. This insures that the temperature of the SiC in the return tube stays within prescribed limits.**

- **All internal blanket components which contain the hot return stream are surrounded with channels carrying cooler streams.**

- **All the blanket and diverter components can be drained by gravity. This prevents any heavy LiPb ($\rho \approx$ 9.5 g/cm^3) being trapped in the components and impeding the maintenance procedures.**

Inboard Blanket Design

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- **All the blankets are made of SiC. The IB blanket is divided into 32 modules, each subtending 11.25^{o} of circumference making them 0.66 m wide.**

- **The IB modules have 4 straight coaxial near rectangular shapes (after Malang's design). The four tubes are connected to common manifolds on the top and bottom.**

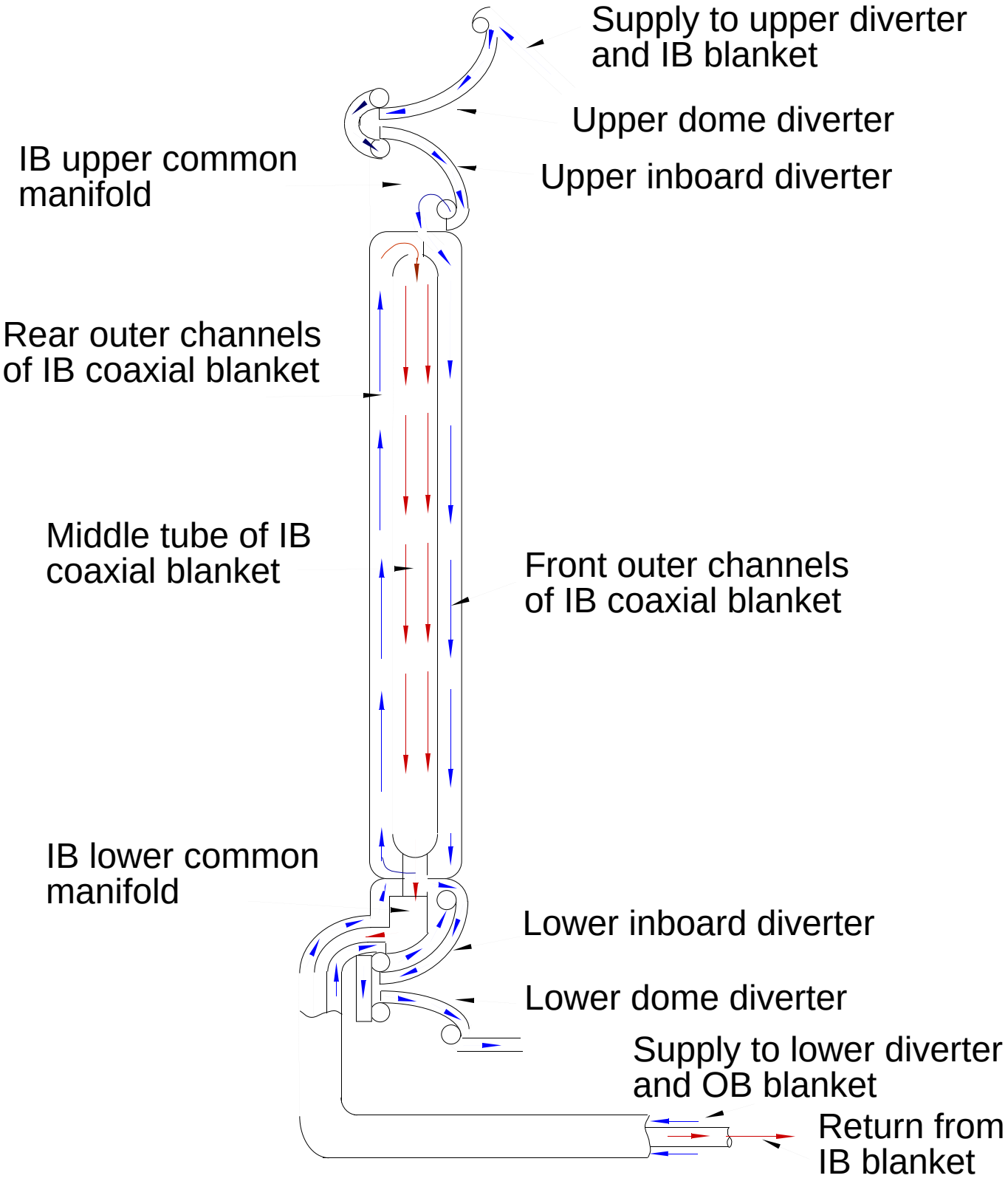
- **These common manifolds provide the base for mounting the inboard upper and lower diverter plates.**

- **The IB modules' 4 coaxial tubes have the outer channels designed such that the coolant first comes down the front channels facing the plasma, then goes back up the rear channels before entering the inner coaxial tube.**

- **The lower common manifold is jacketed on the outer perimeter by a volume of cool fluid.**

- **The coaxial header attached to the IB lower common manifold supplies coolant to the lower diverter and the OB blanket modules. The return tube in that header is the drain for the IB module coolant.**

INBOARD BLANKET



Outboard Blanket Design

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- **The SiC OB blanket is divided into 32 modules, each 1.13 m wide at midplane and 0.74 m wide at the ends.**

- **Each module consists of six curved coaxial near rectangular shapes varying in width from the midplane to the ends to accommodate the change in circumference.**

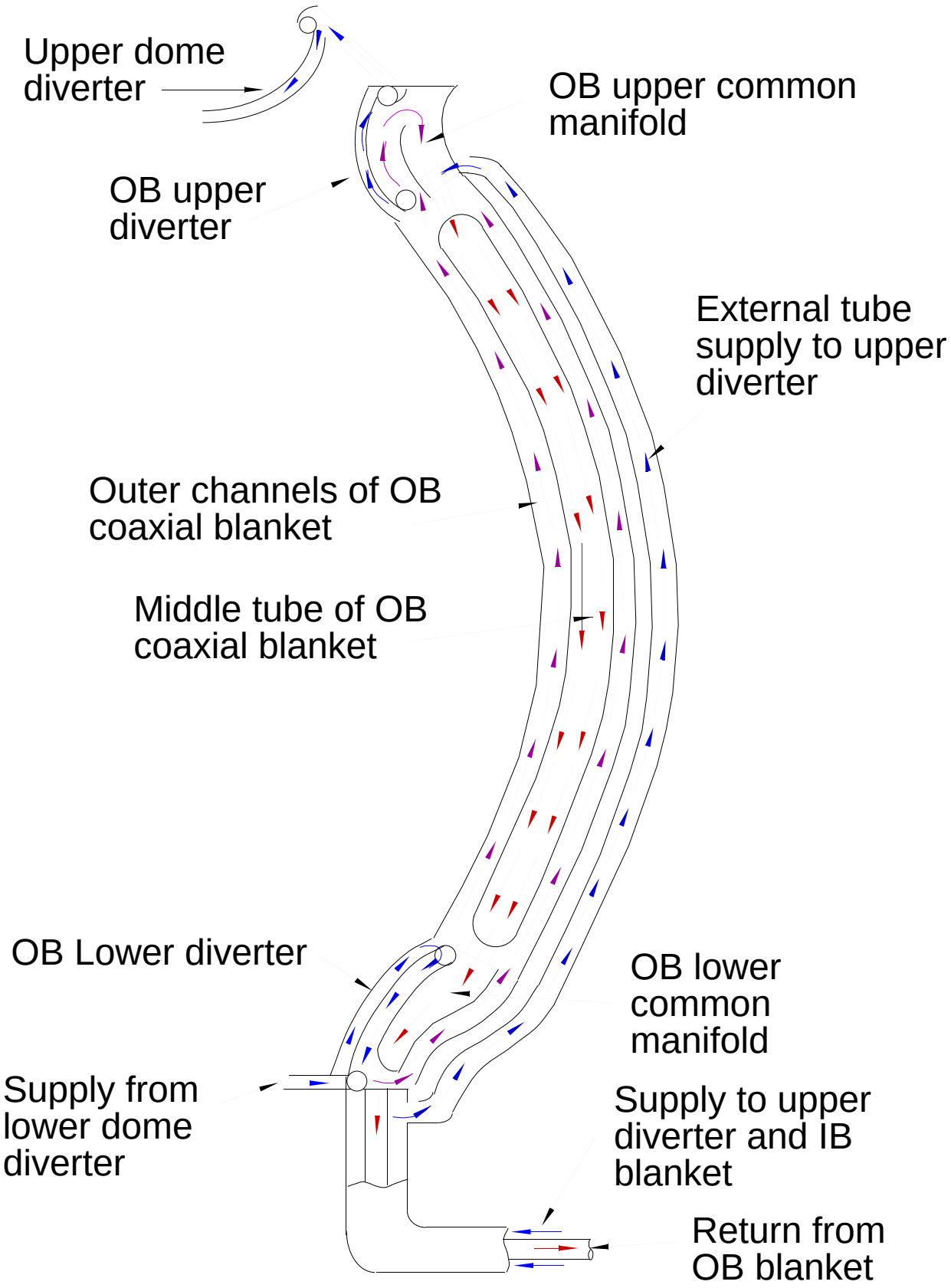
- **The six tubes are connected to common manifolds on top and bottom, and the bottom manifold is jacketed on the outer perimeter by a volume of cool fluid.**

- **The common manifolds provide the base for mounting the inboard upper and lower diverter plates.**

- **The coaxial header attached to the bottom common manifold supplies coolant through an external tube to the top of the OB manifold and connects with the outboard upper diverter plate. After cooling the upper diverter, the coolant enters the IB blanket modules.**

- **The coolant from the bottom diverter enters the OB modules, rises to the top through the outer channels, then comes down through the middle coaxial tube and exits through the coaxial header.**

OUTBOARD BLANKET



Coolant Flow Routing (IB Blanket)

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1) Coaxial header connected to OB lower common manifold.

2) External tube goes to top of OB blanket and connects to OB upper diverter plate.

3) Coolant goes through the OB upper diverter plate, the upper dome diverter plate and the IB upper diverter plate in series.

4) From the IB upper diverter plate it enters the IB upper common manifold.

5) The upper common manifold feeds the front outer channels of the IB coaxial blanket.

6) At the bottom the coolant makes a U turn and travels back up through the outer rear and side channels of the IB coaxial blanket.

7) The coolant enters the middle tube of the IB coaxial blanket and travels down.

8) From there it enters the IB lower common manifold (jacketed with cool fluid).

9) It exits through the inner tube of coaxial header attached to the bottom of the IB lower common manifold.

Coolant Flow Routing (OB Blanket)

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1) Coaxial header connected to the IB lower common manifold.

2) It cools the outer jacket of the IB lower common manifold and then enters the IB lower diverter plate.

3) It cools the IB lower diverter plate, the lower dome diverter plate and the OB lower diverter plate.

4) From there it cools the outer jacket of the OB lower common manifold.

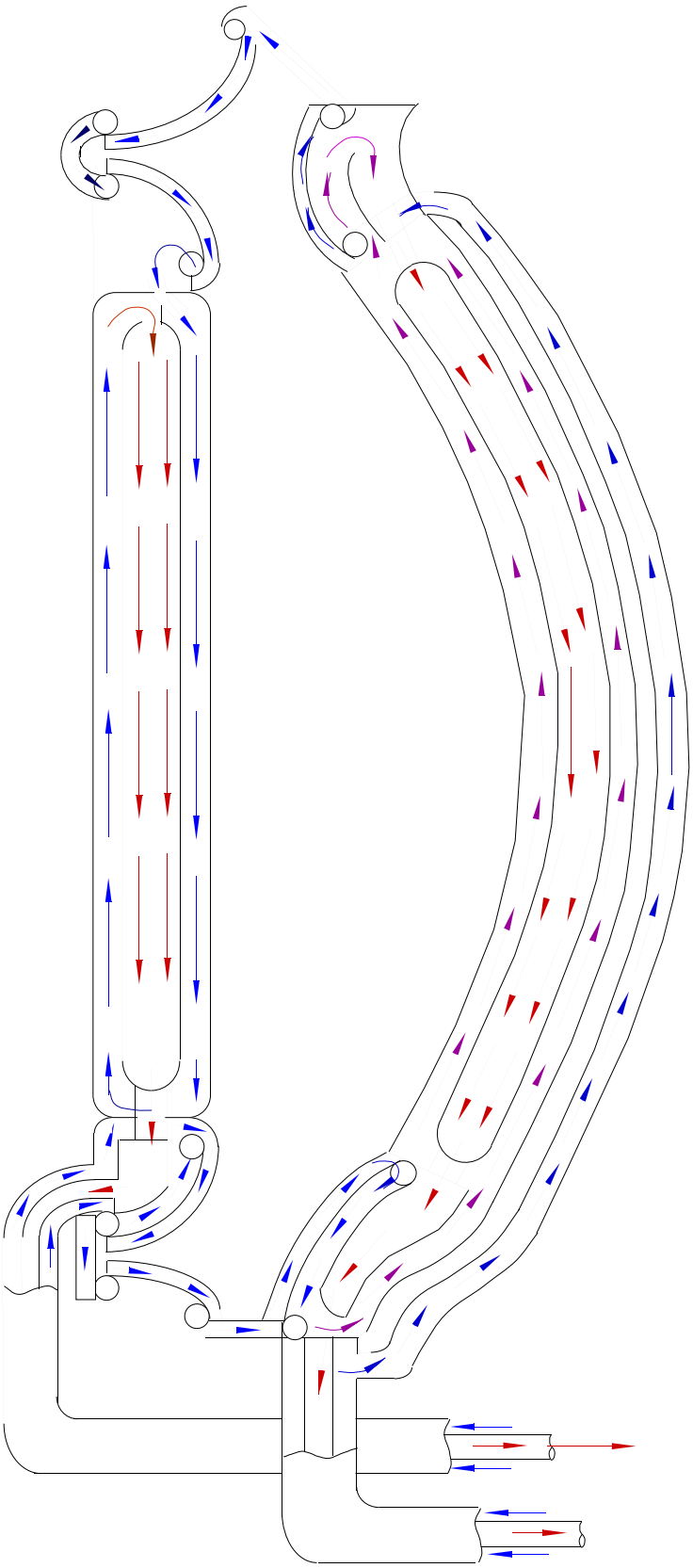
5) It then enters the outer channels of the OB coaxial blanket and travels up.

6) At the top it enters one side of the OB upper common manifold, makes a U turn and exits into the middle tube of the OB coaxial blanket.

7) At the bottom it enters into the OB lower common manifold (jacketed with cool fluid).

8) Then it exits through the inner tube of the coaxial header attached to the bottom of the OB lower common manifold.

INTEGRATED BLANKET



Effect of Coolant Flow Distribution Between IB and OB Blankets

The flow in the OB blanket is 12700 kg/s and in the IB blanket it is 6500 kg/s.

In order to balance the flow in the diverters, the flow in the lower diverter must be reduced to 6500 kg/s to be comparable to the upper diverter.

This can be accomplished by splitting the supply stream to the OB blanket such that only 6500 kg/s goes to the lower diverter and the remaining 6200 kg/s enters the base of the OB lower common manifold where it is joined by the coolant from the lower diverter before going through the rest of the OB blanket.

Summary and Conclusions

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- **A blanket design using the proposed Malang coaxial blanket concept has been achieved.**
- **The diverters are the first components to be cooled.**
- **Supply and return headers are coaxial.**
- **All internal blanket components which contain the hot stream are jacketed with cool stream.**
- **Most of the IB and OB blanket components can be drained by gravity except the outer channels of the IB coaxial blanket. Small bleed holes in the base will drain them without affecting the proper routing during normal operation.**