



PIP-II 2nd Technical Workshop – WG3

Coupler Acceptance Criteria and as-shipped configurations

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A Partnership of:

US/DOE

India/DAE

Italy/INFN

UK/STFC-UKRI

France/CEA, CNRS/IN2P3

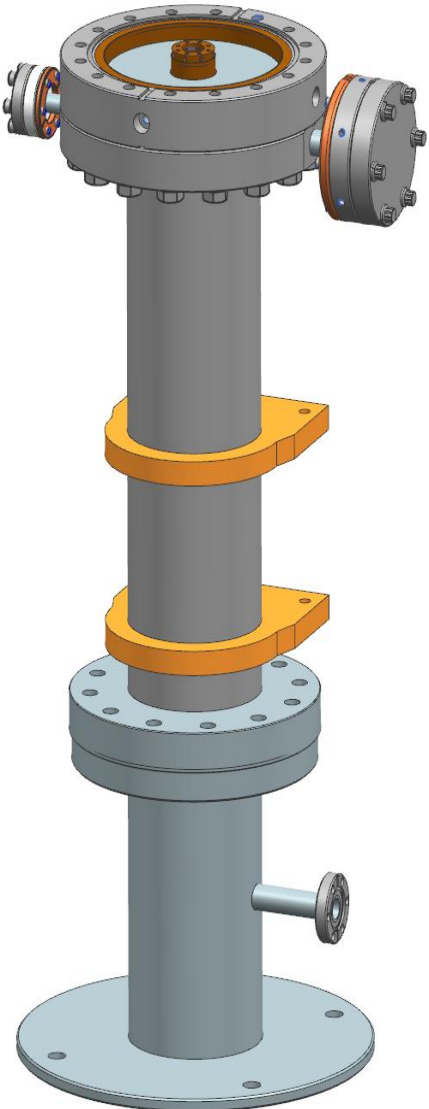
Poland/WUST



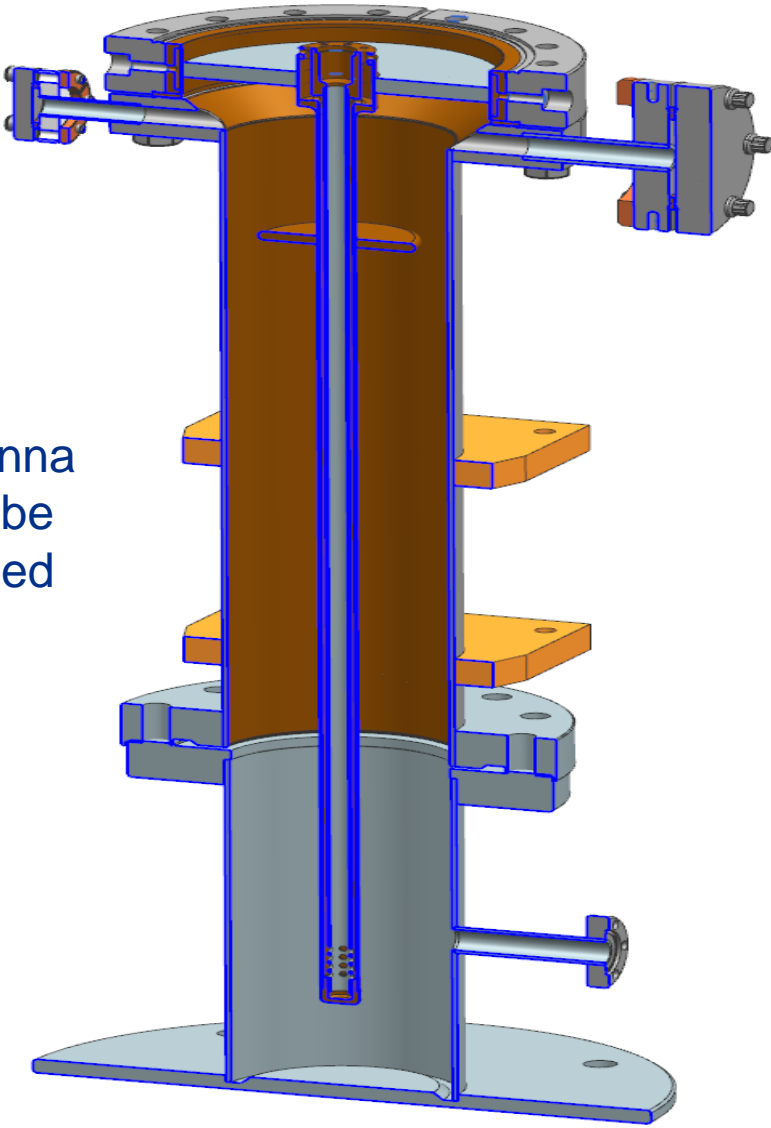
As Shipped Configurations:

- Coupler air parts will be disconnected from the vacuum parts, and packaged separately, with the Wave Guide transitions, etc.
- Ideally, each pair of vacuum part would be packaged with their testing-conditioning chamber, and shipped under vacuum. But this would require the fabrication of many such chambers, not foreseen. There are two chambers, so far.
- **The proposal from Fermilab is to packaged each vacuum part separately, with the antenna pointing downward, not constrained, and ship them under vacuum.**
- **The container should be shock-proven.**
- Shipped quantities will multiple of 2, i.e. six, eight, as described in the PPDs

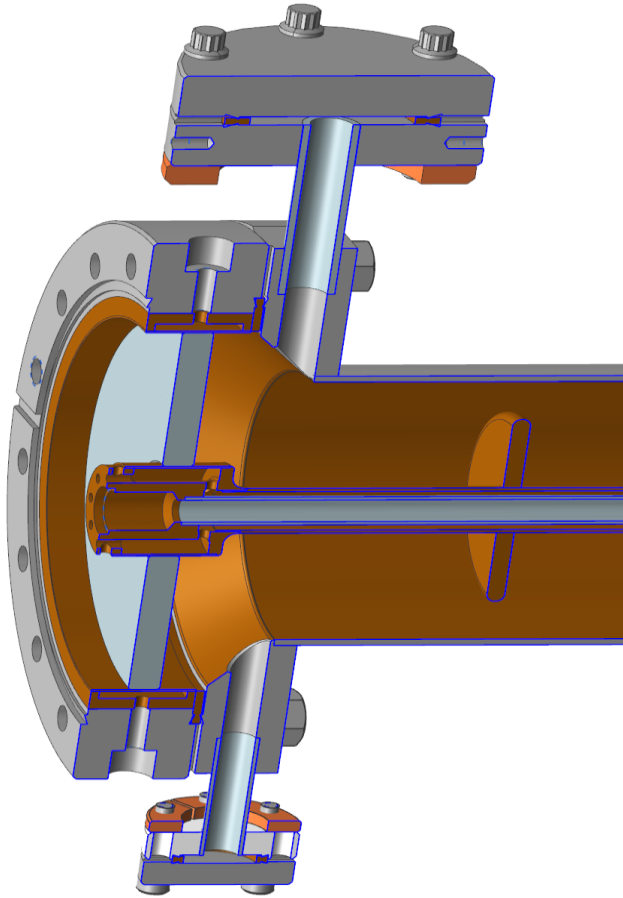
As Shipped Configuration:



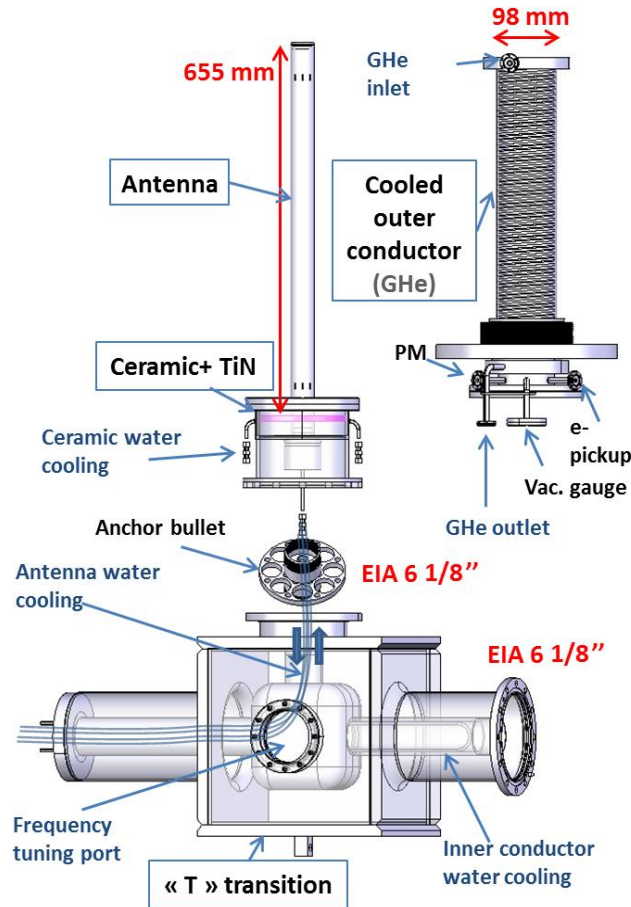
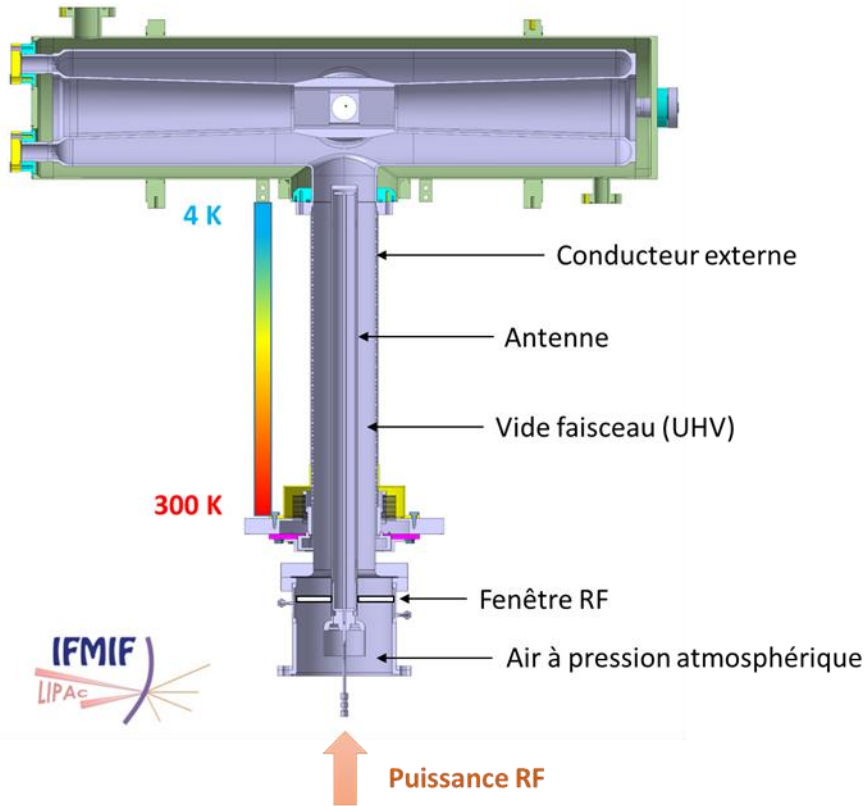
The antenna will NOT be constrained



The ceramics will be capped

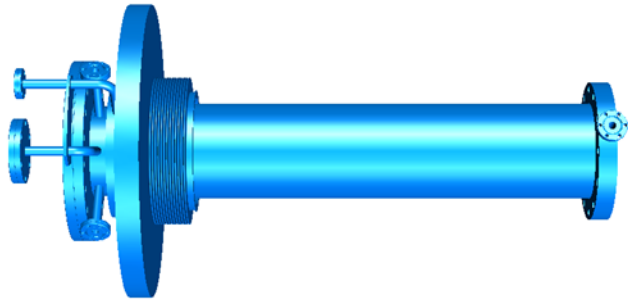


Experience from the IFMIF/EVEDA power coupler: an existence proof ?



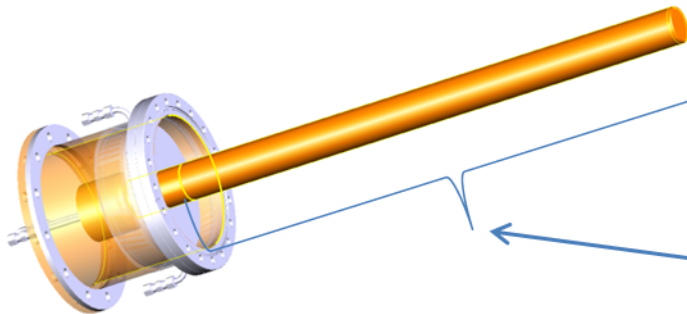
175 MHz, 200 kW CW

The IFMIF/EVEDA power coupler: materials



Cooled outer conductor:

- Stainless steel
- High purity copper plating of all the RF surfaces



Window :

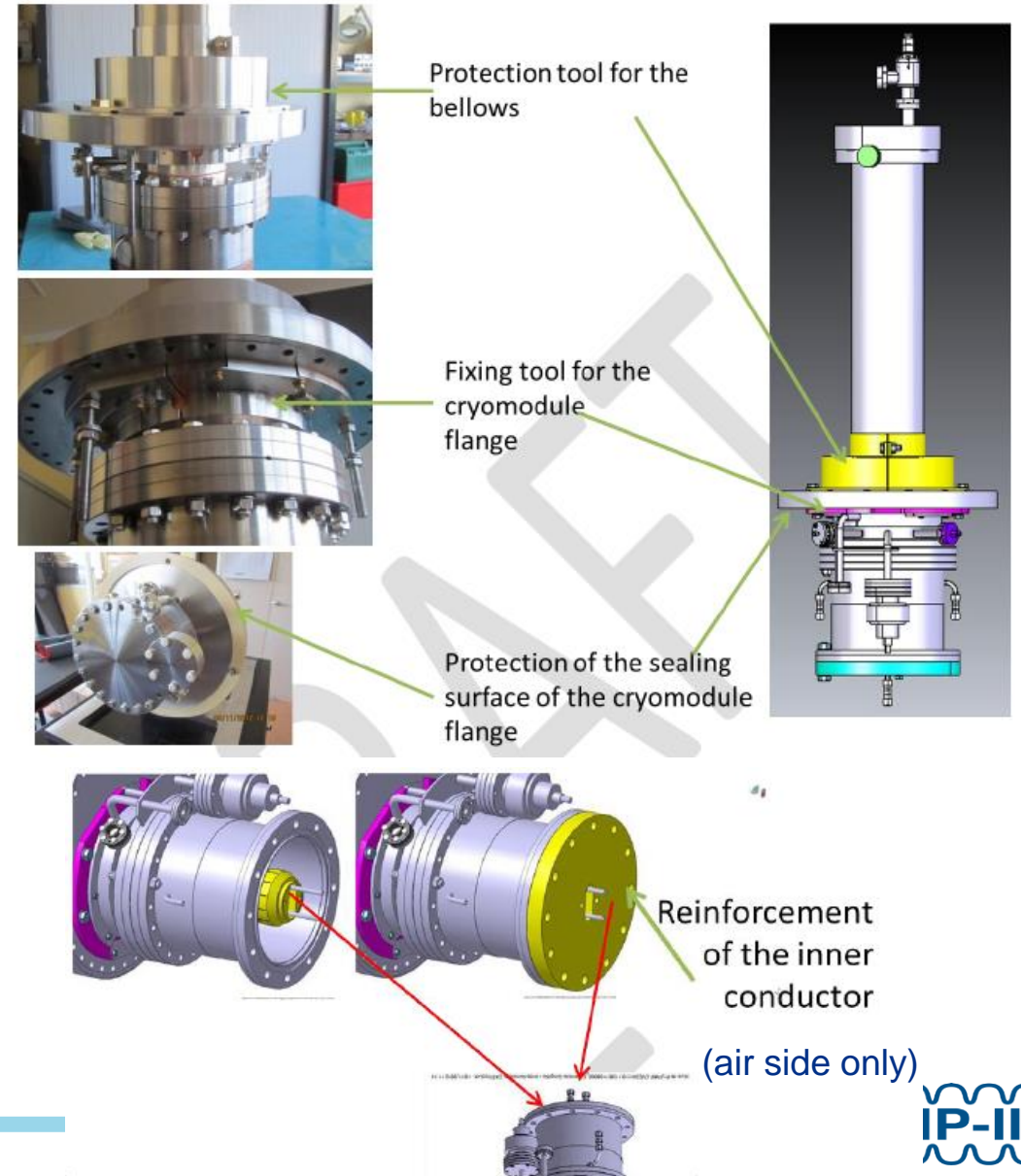
- Ceramic: AL995
- External conductor & inner conductor: OFHC Copper
- Antenna: Stainless steel with high purity copper plating

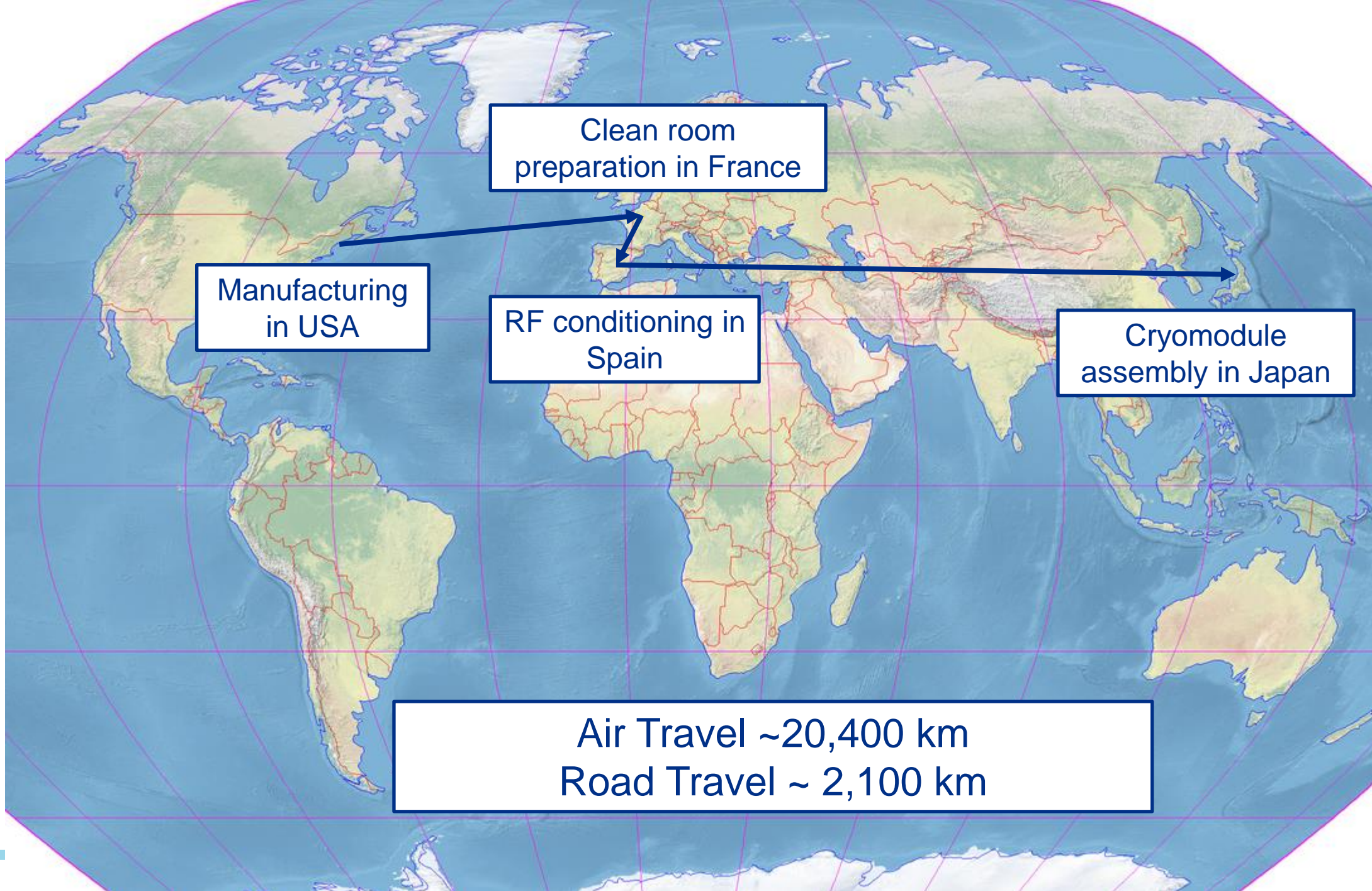
All
brazed

Packaging



- The coupler vacuum internal parts are tightly closed and filled with nitrogen for transportation.
- Each coupler is equipped with four holding rods. This allows to extract vertically the couplers from the transportation box.
- Protection devices installed to protect the sensitive parts: bellows, sealing surface of the cryomodule flange, reinforcement of the inner conductor (air side only)





Coupler Acceptance Criteria

- 650 MHz couplers will be RF tested, or RF conditioned, at Fermilab, and shipped to Partner Labs after their successful test.
- Shipment from Fermilab is gate by a set of 'acceptance' criteria verified by Fermilab, under Fermilab responsibility, and communicated to the Partner.
- Each Partner submit the couplers to their own acceptance criteria, currently under discussion and definition through the active Working Groups.

- Shipment acceptance criteria from Fermilab are tabulated as follows

Fermilab Shipment Acceptance Criteria: Vacuum Side

Number	Requirement Definition	Performance Criteria or Quantity	Units	Verification Method	Location Performed	Procedure Summary	Reference Document
	Shipping Container (External)	Free of damage		Visual	Receiving Area	Visual inspection. Document any damage	FNAL Traveler xxxxxx or TRS
	Shipping Container (Internal)	Free of damage, Cleanliness, Appropriate packing		Visual	Receiving Area	Visual inspection. Document any damage	FNAL Traveler xxxxxx or TRS
	Validation of Vendor Documentation	Vendor provided travelers and documentation conform to requirements.		Visual	Receiving Area	Visual inspection, note anything which is missing and contact the vendor to receive documents. A short list of the most critical dimensions and manufacturing QC steps should be the primary concern.	FNAL Traveler xxxxxx or TRS
	Antenna / Outer Conductor Isolation Check	Resistance between antenna and outer conductor verified to be >xxxG Ohm	Ohm	Electrical	Receiving Area / Iso 6 CR	Measure resistance from IC to OC using ohm-meter.	FNAL Traveler xxxxxx or TRS
	E-Pick Up Isolation Check	Resistance between IC and OC of E-Pick Up verified to be >xxxG Ohm	Ohm	Electrical	Receiving Area / Iso 6 CR	Measure resistance from IC to OC using ohm-meter.	FNAL Traveler xxxxxx or TRS
	Incoming Leak check	Passes Leak check with < xxx leak rate while assembled to the shipping manifold.	leak rate units	Leak check	Iso 4 CR	Use B6 leak check method where entire component is bagged with helium.	FNAL Traveler xxxxxx or TRS
	Incoming RGA	RGA pass while coupler is assembled to the shipping manifold.	Amu sum	RGA	Iso 4 CR	Connect to vacuum cart, after leak check perform RGA scan.	FNAL Traveler xxxxxx or TRS
	Vacuum Gauge Operational	Vacuum gauge is working and reading is within xx% of pumping cart	% difference	Visual	Iso 4 CR	While connected to vacuum cart, connect vacuum gauge and turn on, verify reading of gauge is accurate relative to cart.	FNAL Traveler xxxxxx or TRS
	Particle Count	All beamline volume surfaces blow with 0 particles counted. External surfaces blow with minimal particles counted (define external surfaces based on spec)		Particle Counter	Iso 4 CR	After removal from the shipping manifold, blow clean with dry N2.	FNAL Traveler xxxxxx or TRS
	Sealing Surfaces	Sealing surfaces are free of damage.		Visual with magnification	Iso 4 CR	Diamond sealing surface and conflat are inspected at 10x magnification. No radial scratched on diamond, no damage to knife edge on conflat.	FNAL Traveler xxxxxx or TRS
	Visual Inspection and Critical Point Inspection	Free of visual defects.		Visual - Take pictures of critical surfaces - in the event there is degradation - also to have some history	Iso 4 CR	No obvious damage. No significant oxidation. Copper plating intact and ends at specified locations. Overall craftsmanship. Proper fill of brazings. Accurate rotational orientation of flanges / antenna tip. Ceramic is free of discoloration. Antenna checked for approximate straightness. All components are present and in the correct quantities and configuration. Need to check drawings/spec for other critical points - but this is most the critical points	FNAL Traveler xxxxxx or TRS

Fermilab Shipment Acceptance Criteria: Air Side

Number	Requirement Definition	Performance Criteria or Quantity	Units	Verification Method	Location Performed	Procedure Summary	Reference Document
	Shipping Container (External)	Free of damage		Visual	Receiving Area	Visual inspection, Document any damage	FNAL Traveler xxxxxx or TRS
	Shipping Container (Internal)	Free of damage, Cleanliness, Appropriate packing. N2 bagging not punctured.		Visual	Receiving Area	Visual inspection, Document any damage	FNAL Traveler xxxxxx or TRS
	Validation of Vendor Documentation and Critical Dimensions	Vendor provided travelers and documentation conform to requirements		Visual	Receiving Area	Visual inspection, note anything which is missing and contact the vendor to receive documents. A short list of the most critical dimensions and manufacturing QC steps should be the primary concern.	FNAL Traveler xxxxxx or TRS
	Visual Inspection and Critical Point Inspection	Free of visual defects.		Visual	ISO 6 portable or open air	No obvious damage. No damage to bellows. No significant oxidation. Copper plating intact and ends at specified locations. Overall craftsmanship and cleanliness. Proper fill of brazings. Accurate rotational orientation of flange. Alodine present on Alum parts. All components are present and in the correct quantities and configuration. Verify fitment of innerconductor to waveguide w/ 5 layers kapton. Check all RF surfaces for surface quality. Need to check drawings/spec for other critical points - but this is most	FNAL Traveler xxxxxx or TRS
	Sealing Surfaces	Sealing surfaces are free of damage.		Visual	ISO 6 portable or open air	Conflats are inspected at 10x magnification. no damage to knife edge on conflat.	FNAL Traveler xxxxxx or TRS



Fermilab Shipment Acceptance Criteria: RF Qualification

Number	Requirement Definition	Performance Criteria or Quantity	Units	Verification Method	Location Performed	Procedure Summary	Reference Document
	RF Power Level Reached	Coupler is able to reach 35 kW power at arbitrary reflection phase		Testing	Meson Detector Building	Tested in Pulse and CW regime at Full Power at 8 different phases for reflection. Tested to 35kW input with full reflection and arbitrary reflection phase. With bias on, there should be no Multipacting, and Temps remain below limits. At CEA, couplers are conditioned with traveling wave. . Need to agree on e-pick up behavior	FNAL Traveler xxxxxx or TRS
	RF Transmission	RF Transmission verified to be < -20 dB	dB	Testing	Meson Detector Building		FNAL Traveler xxxxxx or TRS
	Vacuum level when operating at full power	Coupler test chamber vacuum remains < x.x e-x torr when the coupler is at full power AFTER all the phases have been tested		Vacuum gauge	Meson Detector Building	Once coupler has been RF conditioned, the outgassing rate at 35kW with arbitrary phase must be below the specified value. Need to agree on outgassing rate at 35 kW.	FNAL Traveler xxxxxx or TRS



Fermilab Shipment Acceptance Criteria: Shipment Readiness / Vacuum Side

Number	Requirement Definition	Performance Criteria or Quantity	Units	Verification Method	Location Performed	Procedure Summary	Reference Document
	Visual Inspection and Critical Point Inspection	Free of visual defects.		Visual - Take pictures of critical surfaces - in the event there is degradation - also to have some history	Iso 4 CR	No obvious damage. No significant oxidation. Copper plating intact. Ceramic is free of discoloration. components are present and in the correct quantities and configuration. Need to check drawings/spec for other critical points - but this is most the critical points.	FNAL Traveler xxxxxx or TRS
	Particle Count	All beamline volume surfaces blow with 0 particles counted. External surfaces blow with minimal particles counted (define external surfaces based on spec)		Particle Counter	Iso 4 CR	After removal from the shipping manifold, blow clean with dry N2.	FNAL Traveler xxxxxx or TRS
	Outgoing Leak check	Passes Leak check with < xxx leak rate while assembled to the shipping manifold.	leak rate units	Leak check	Iso 4 CR	Use B6 leak check method where entire component is bagged with helium. Question of wether to leave undervacuum or backfill with N2. Current decision is leaning to vacuum.	FNAL Traveler xxxxxx or TRS
	Outgoing RGA	RGA pass while coupler is assembled to the shipping manifold.	Amu sum	RGA	Iso 4 CR	Connect to vacuum cart, after leak check perform RGA scan.	FNAL Traveler xxxxxx or TRS
	Packaging Complete	Vaccum Side + Manifold are double bagged in N2, packed in double layer crate, tip / shock dectors installed.		Visual	Iso 6 CR / Packing area	Verify coupler packing meets necessary requirements - assembly is double bagged in clean room, then packaged in crate.	FNAL Traveler xxxxxx or TRS
	Documentation Complete	All required documentation is packed with Vacuum Side		Visual	Any	Verify list of documentation being sent with couplers is complete.	FNAL Traveler xxxxxx or TRS

Fermilab Shipment Acceptance Criteria: Shipment Readiness / Air Side

Number	Requirement Definition	Performance Criteria or Quantity	Units	Verification Method	Location Performed	Procedure Summary	Reference Document
	Visual Inspection and Critical Point Inspection	Free of visual defects.		Visual - Take pictures of critical surfaces - in the event there is degradation - also to have some history	Iso 6 / any.	No obvious damage. No significant oxidation. Copper plating intact. Bellows free of damage. components are present and in the correct quantities and configuration. Need to check drawings/spec for other critical points - but this is most the critical points.	FNAL Traveler xxxxxx or TRS
	Packaging Complete.	Bellows Components have shipping restraints installed, are separated into sub-assemblies, double bagged in N2, and crated, tip / shock detectors installed.		Visual	Iso 6 / any	Verify coupler packing meets necessary requirements - assembly is double bagged with N2, then packaged in crate.	FNAL Traveler xxxxxx or TRS
	Documentation Complete	All required documentation is packed with Air Side		Visual	Any	Verify list of documentation being sent with couplers is complete.	FNAL Traveler xxxxxx or TRS

Fermilab Shipment Acceptance Criteria: Deliverable documentation and records validation

Number	Requirement Definition	Performance Criteria or Quantity	Units	Verification Method	Location Performed	Procedure Summary	Reference Document
	Engineering note of coupler pressure safety	Including weld certification, Material Certification		Visual	Shipping area	Pending work at Fermilab	FNAL Traveler xxxxxx or TRS
	Vendor Documentation	Includes traveler set, CMM Reports, RGA scans.		Visual	Shipping area	Verify list of documentation being sent with couplers is complete.	FNAL Traveler xxxxxx or TRS
	Fermilab Travelers	All travelers for the coupler are completed and closed. Must include all attached images and RGA reports. partners may not have access to vector - so they can't download		Visual	Shipping area	Verify list of documentation being sent with couplers is complete.	FNAL Traveler xxxxxx or TRS

