SPL 3rd Collaboration Meeting
(CERN/ from 11 to 13 November 2009)

Aboud Falou (LAL-Orsay)

XFEL Power Couplers 1.3GHz

Technical Specification & Industrial Strategy

LAL contribution to XFEL linac at DESY

XFEL RF Couplers/ from R&D to Mass Production

SOMMARY

- Power Couplers main components & technical performance
- Interfaces with cryomodule & string cavities
- Industrial studies & coupler prototypes
- RF contact evaluation
- Market Strategy for mass production (Technical Specifications)
- Manufacturing Sequence & Transport/Storage logistic
- Time schedule 2009/2012

XFEL RF Couplers/ from R&D to Mass Production

Functional Parts of XFEL Coupler (M.Lacroix)

Warm Ceramic (TiN in)

Motor

Pick-up e-

Capacitor

Pumping Port

Cold Ceramic (TiN in-out)

Cold Bellows

298K

Warm Bellows

RF Antenna

Cavité Supraconductrice

77K

4K

1.8K

Faisceau d'électrons

+/-10mm

Warm Transition

Warm Part

Cold Part

XFEL RF Couplers/ from R&D to Mass Production

RF & Technical Performance of XFEL coupler

- RF Frequency 1.3GHz
- Repetition rate 10Hz
- RF Power 150kW
- Q_{ext} $2x10^6 – 7x10^7$
- RF Conditioning at ambient T°C
  (cryogenic commissioning with modules at DESY)
- Progressive Pulses 20, 50, 100, 200, 400 µs (Pmax 1.0MW)
- Then 0.8, 1.3ms (Pmax 500kW)

- 2 Ceramic Windows (warm & cold)
- Antenna adjustment ±10mm *(with absolute resolution of 0.1mm)*
- Axial Displacement ± 5 mm
- He leak level $3.5x10^{-10}$ mbar.l/s
- Thermal losses
  - At 1.8K flange ≤ 0.06 W
  - At 4K screen ≤ 0.5 W
  - At 77K flange ≤ 6.0 W

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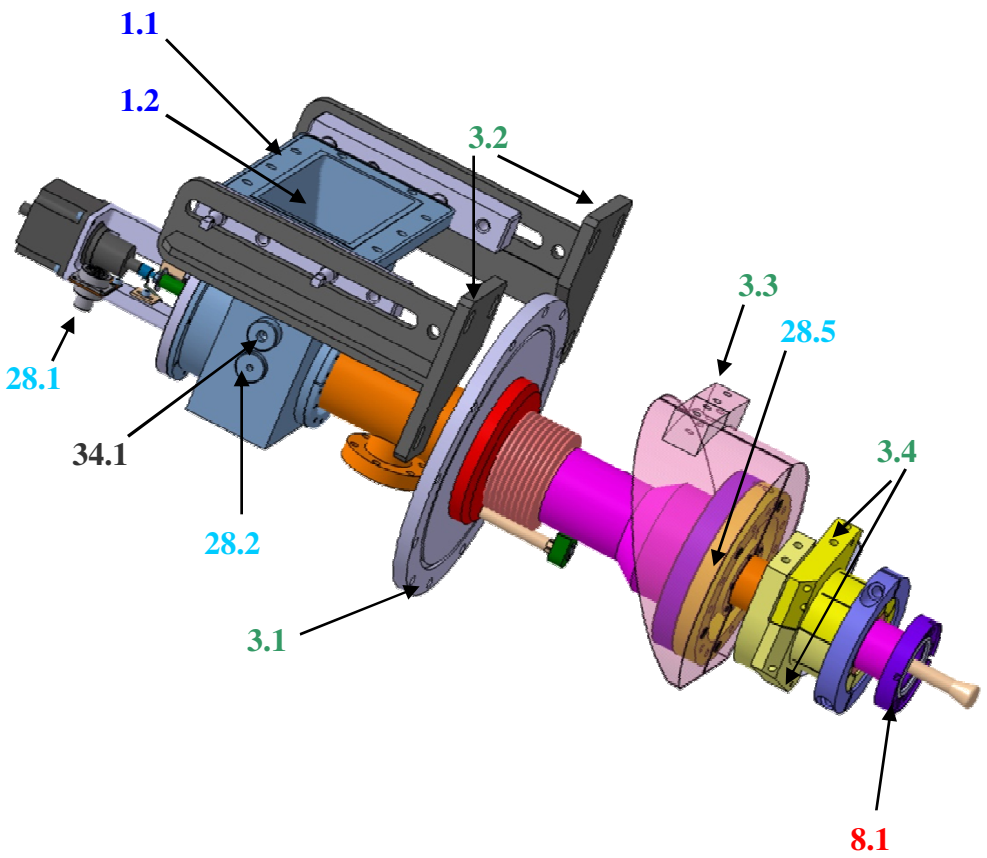
Interfaces with wave guides & cryomodule

WP 1 – Waveguide

1. Waveguide flange, bolts and nuts
2. Kapton window ? seal ?

WP 3 – Cryomodule

1. Flange on vacuum vessel, gasket, bolts
2. Coupler supports (left & right), bolts
3. Connection of Cu braids from 80K thermal shield, bolts
4. Connection of Cu braids from 4K thermal shield, bolts
5. 4 holes in 4K interface for assembly rods
6. Super insulation



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Interfaces with Niobium Cavities, vacuum pumping line & control system

WP 8 – Cavity & vacuum

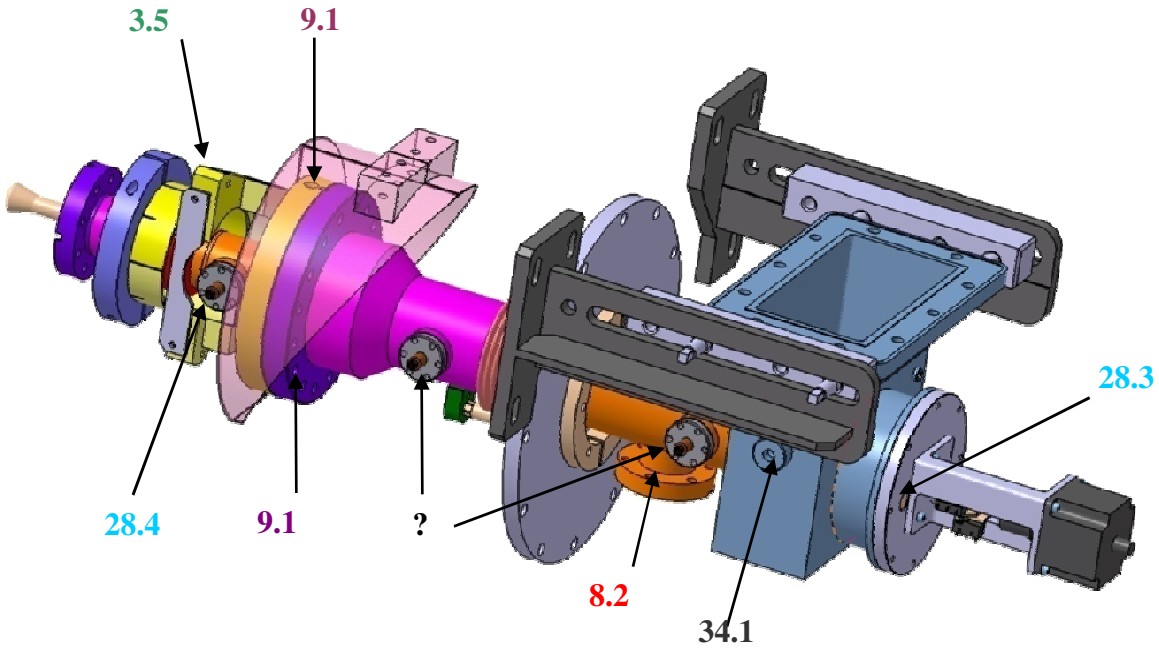
1. Cavity flange, gasket, bolts & nuts
2. Coupler vacuum pumping port, gasket, bolts & nuts

WP 9 – Cavity string assembly

1. Two holes in big cold flange
2. Clamp for cold bellows

WP 28 – Control system

1. Connector for motor, end switches, PT100
2. Arc detector (cancelled)
3. HV connector
4. e- pickup
5. 2 sensors PT100 in 80K zone

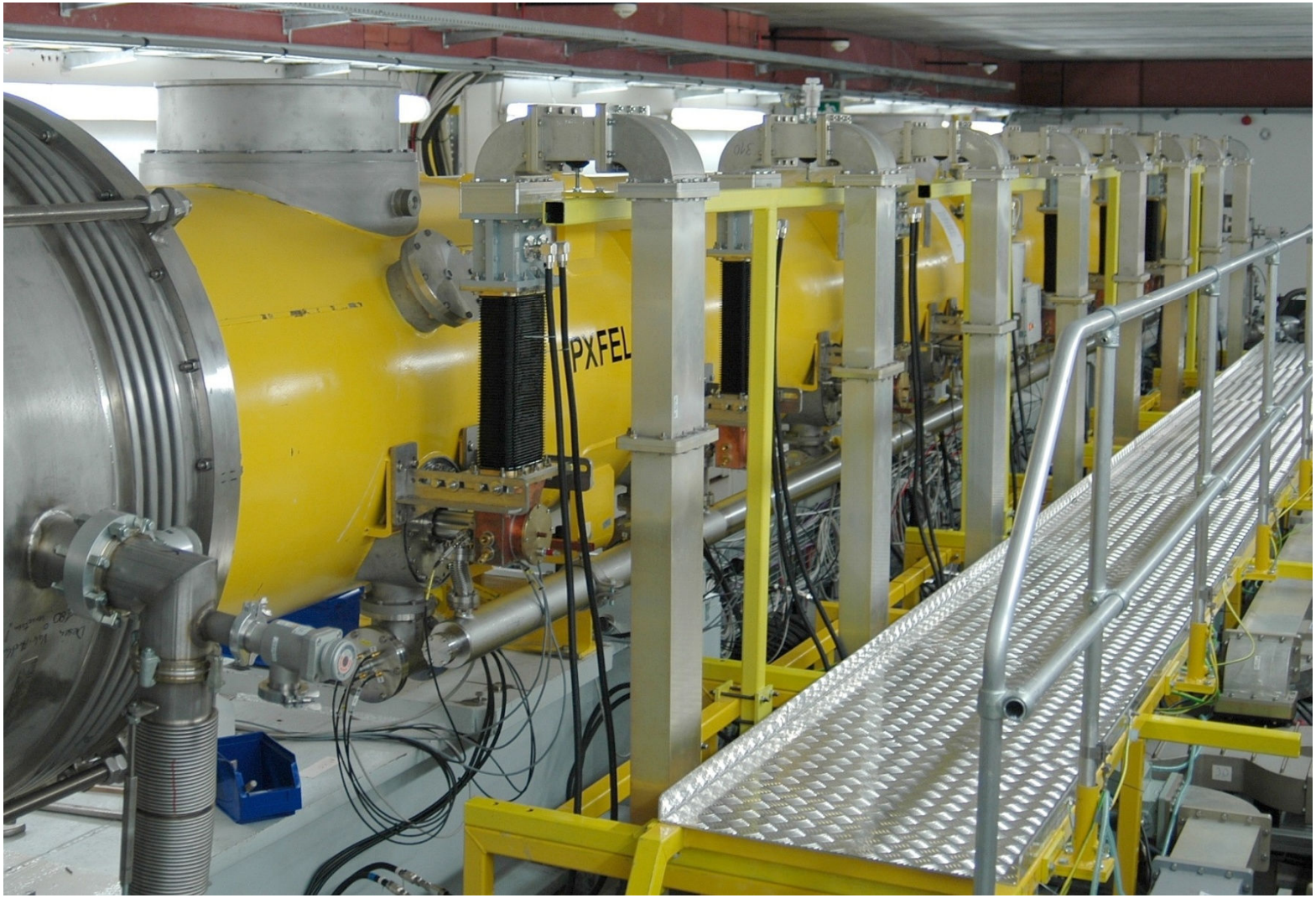


WP 34 – Utilities

1. Two N2 cooling ports
2. Ambiante conditions: T, P, H, radiations ?

XFEL RF Couplers/ from R&D to Mass Production

'FLASH' Commissioning of TTF-3 couplers on cryomodule proto PXFEL1 {D.Kostin/ sept 2009}



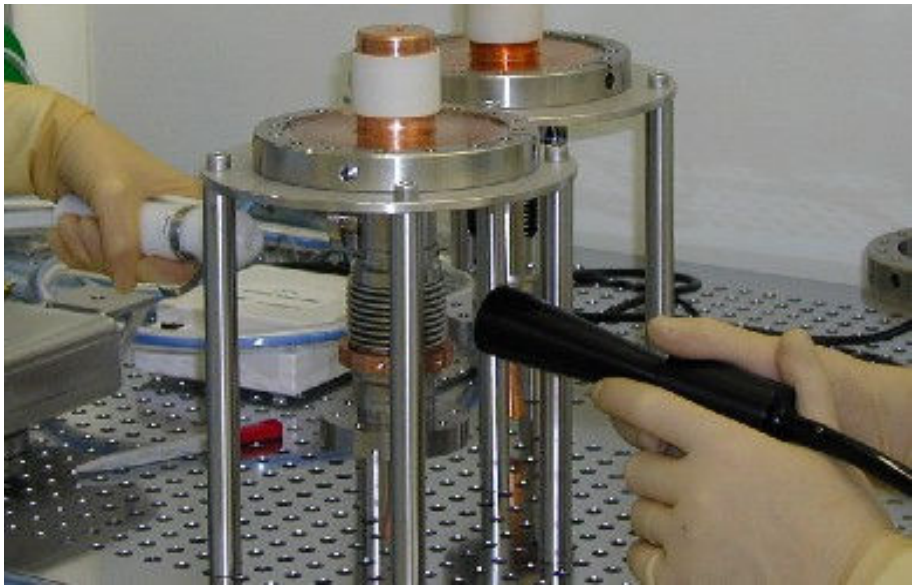
XFEL RF Couplers/ from R&D to Mass Production

Major non conformities (TTF-3 Inspections)

- SS welding performance (full penetration, roughness & seam flatness at RF side).
- Cupper/ceramic brazing (tensile resistance, tightness, metallic projections).
- TiN & Cu surface coating (matrix adhesion, thickness control, roughness, boundary lines).
- Final 'welding' assembly (alignment of in/out conductors, penetration, metallic projections).
- Cleaning procedures, difficult access to residual particles.
- Wave Guide Boxes soldering (lack or excess of metal, acid discoloration).
- RF contact between Wave Guide Box & coupler flanges (misalignment, sparks).
- Translation mechanism of RF antenna (alignment, mechanical constraints).
- Bolting dysfunction under UHV environment (grippage).

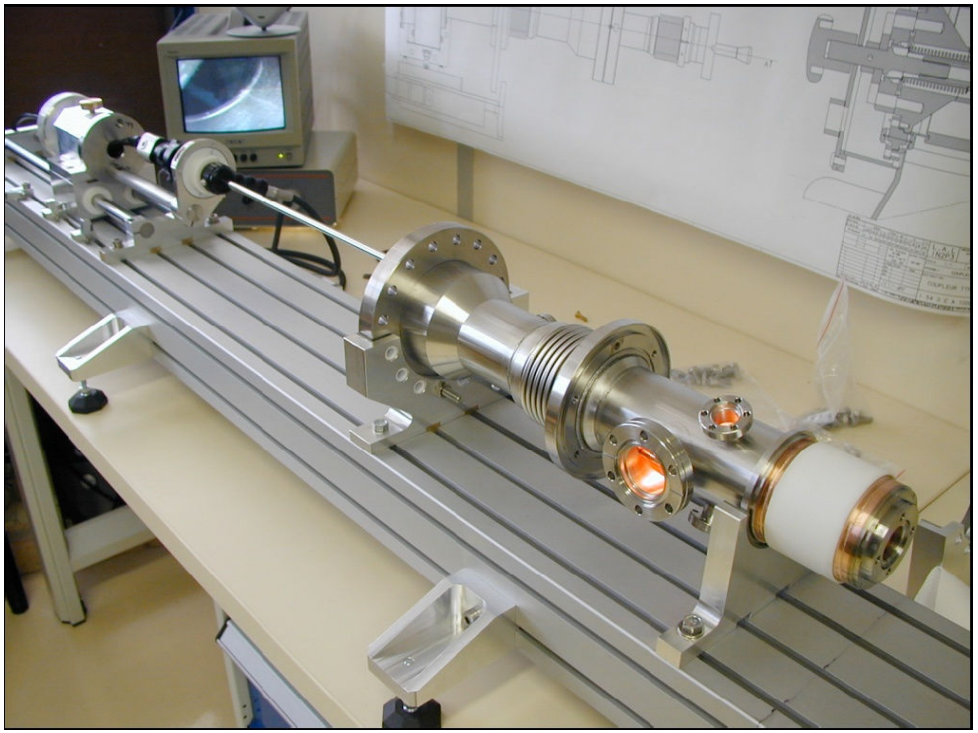
XFEL RF Couplers/ from R&D to Mass Production

LAL Inspection of one TTF-3 coupler



Comptage de particules sur les parties froides des coupleurs TTF-3

Inspection visuelle par endoscope des surfaces HF sur la partie chaude d'un coupleur TTF-3



. Brazing final assembly, 2 proto Feb 2008 from Toshiba

- Cleaning non conformity, couplers complete dismounting at LAL, fully cleaning up, drying and remounting.
- Automatic RF processing failed, many vacuum interlocks. RF manual processing was successful.
- Possible failure reasons: High T°C TiN cycles, Hollow antenna.

. EB weld final assembly, 2 proto March 2008 from Accel

- Cleaning non conformity, back to the company and fully cleaned up.
- Automatic RF processing successful, few interlocks.
- RF contact failed during sweeps (capacitor springs assembly).

Industrial Studies & Coupler Prototypes

. EB weld final assembly, 2 from Thales (Tin & Cr2O3)

- Automatic RF processing successful, few interlocks.
- RF contact identical to TTF-3 design.

. EB weld final assembly, many TTF-3 couplers from CPI

- Automatic RF processing successful, few interlocks.
- Engineering non conformance during visual inspections.
- Couplers under operation at FLASH experiment.

XFEL RF Couplers/ from R&D to Mass Production

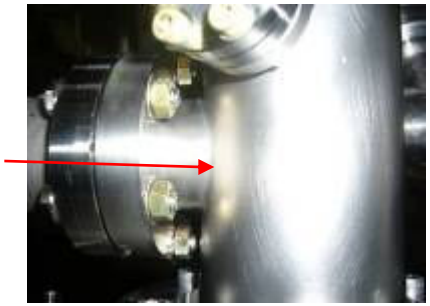
Industrial Studies/ Accepted & rejected proposals {manufacturing techniques}

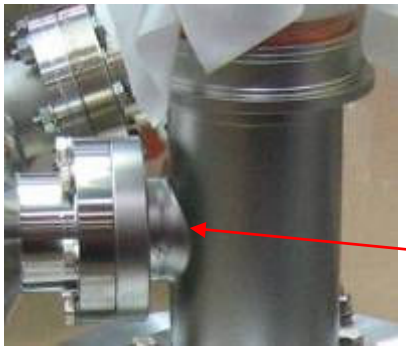
Single Block Machining,

Non optimized cost

Forming by Deep drawing, recommended

Saddle weld, not recommended





Pull out + circular weld

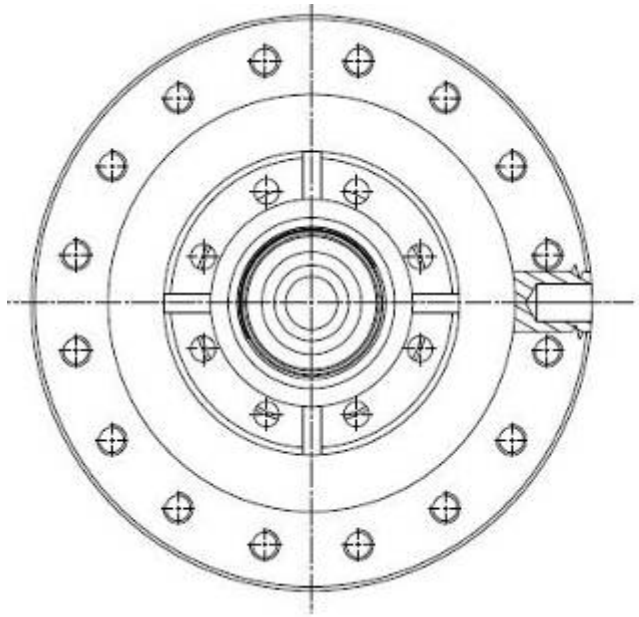
Smooth RF surface

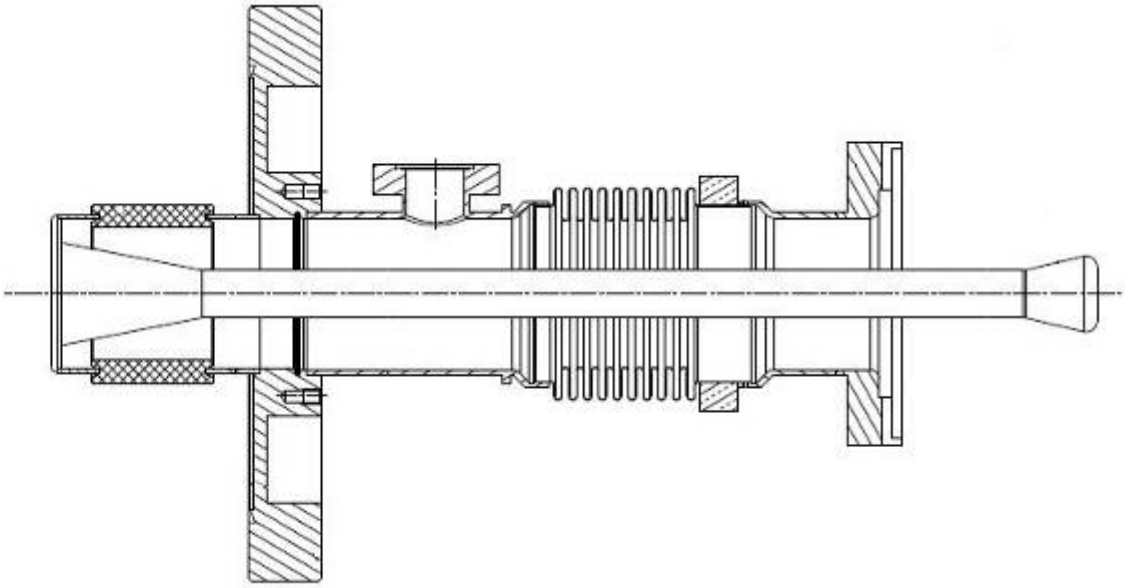
Final brazed assembly, not accepted to prevent TiN coating

Final EB or TIG weld, recommended.

XFEL RF Couplers/ from R&D to Mass Production

Industrial Studies/ Accepted & rejected proposals {hollow antenna from SS+Cu brazing}





Partie froide: l'antenne de la conception d'origine TTF-3 est usinée dans du cuivre OFHC massif.

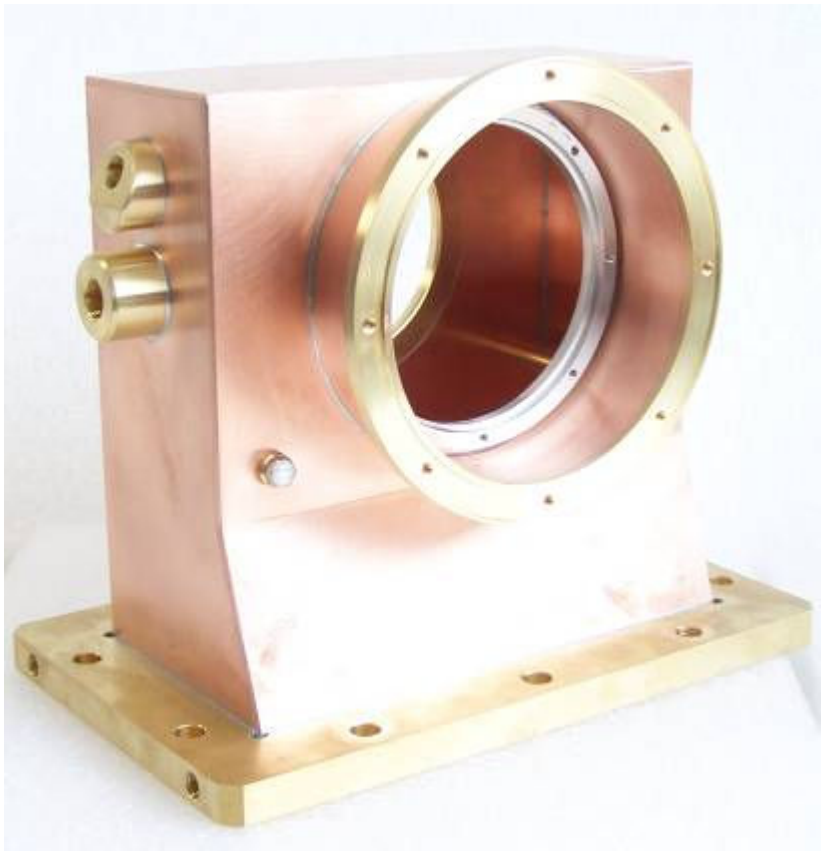
Cette solution est retenue pour les coupleurs XFEL de série avec un mode de production exempt de cycles de température > 250°C.

Partie froide: la proposition Toshiba contient une antenne creuse en acier inox avec dépôt de cuivre et brasure aux extrémités d'embouts Cu OFHC.

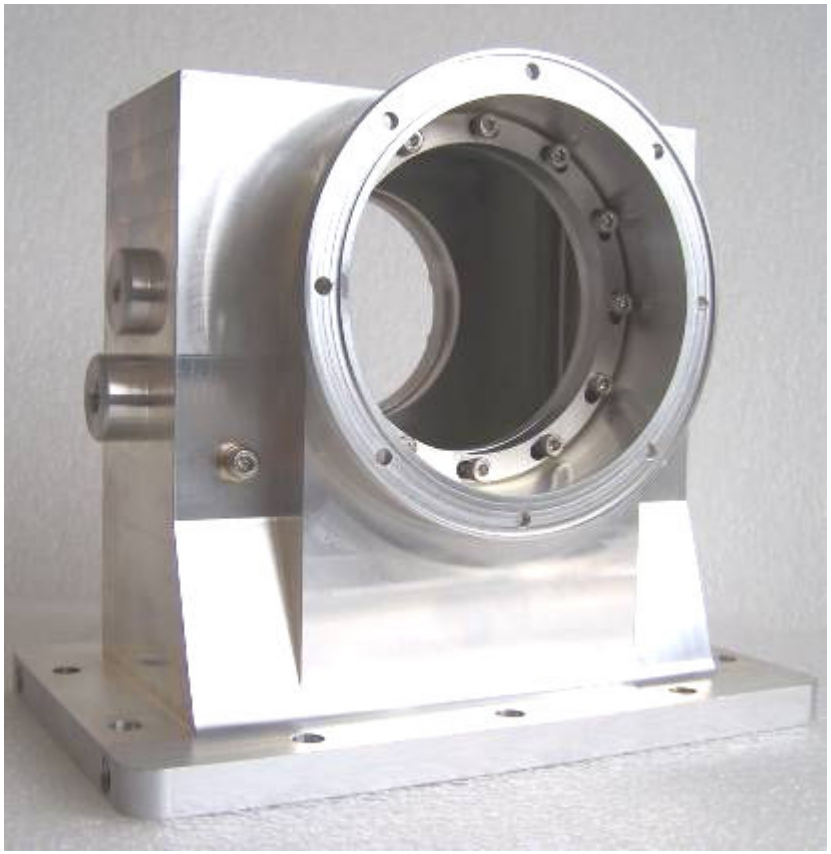
Le cycle thermique de brasure est rejeté (dégradation du dépôt TiN) et l'antenne creuse est incompatible avec les opérations de nettoyage, rinçage, étuvage et pompage vide.

XFEL RF Couplers/ from R&D to Mass Production

Industrial Studies/ Accepted & rejected proposals {Wave Guide Box}



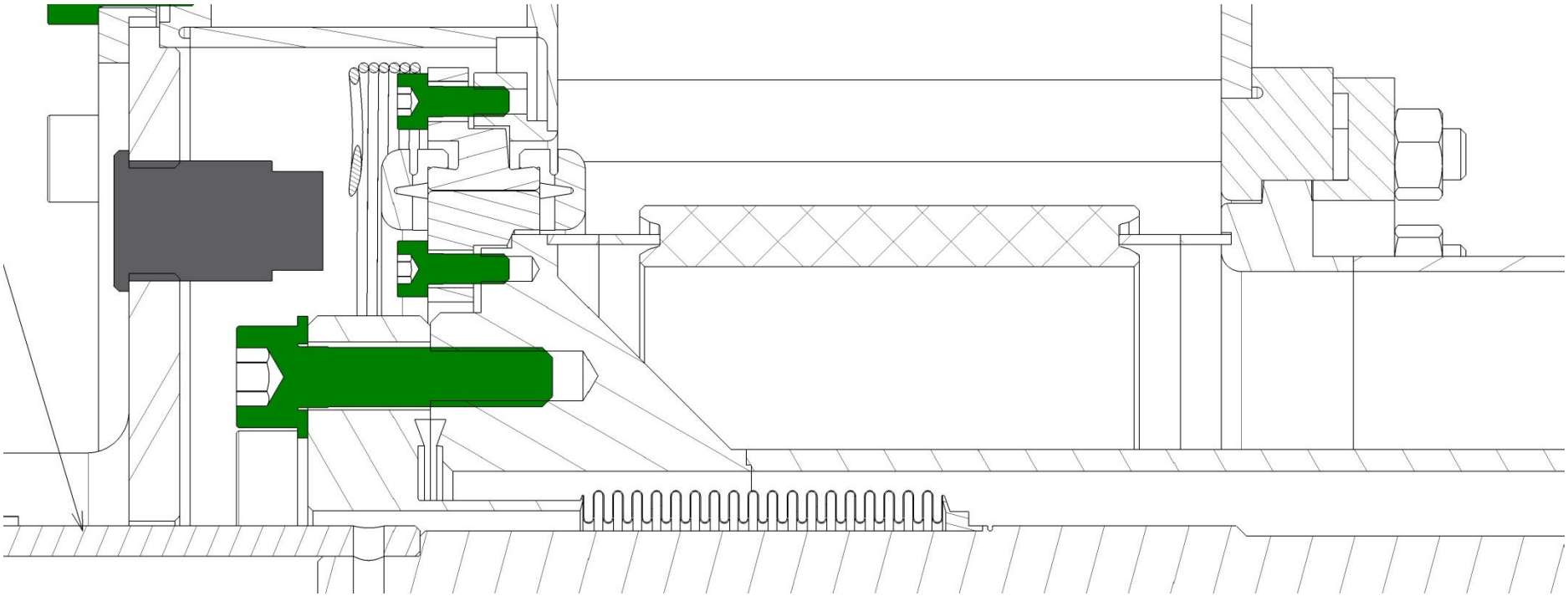
Boîtier guide d'ondes: la conception d'origine TTF-3 est un assemblage brasé de pièces cuivre, laiton et acier inoxydable. La membrane Cu donne la flexibilité pour le contact RF.



Boîtier guide d'ondes: Usinage sur CN d'un bloc massif d'aluminium exempt de soudures et brasures. Variante possible pour la production de série si le contact RF ne nécessite pas de flexibilité.

XFEL RF Couplers/ from R&D to Mass Production

Industrial Studies/ Accepted & rejected proposals {TTF-3 RF contact}

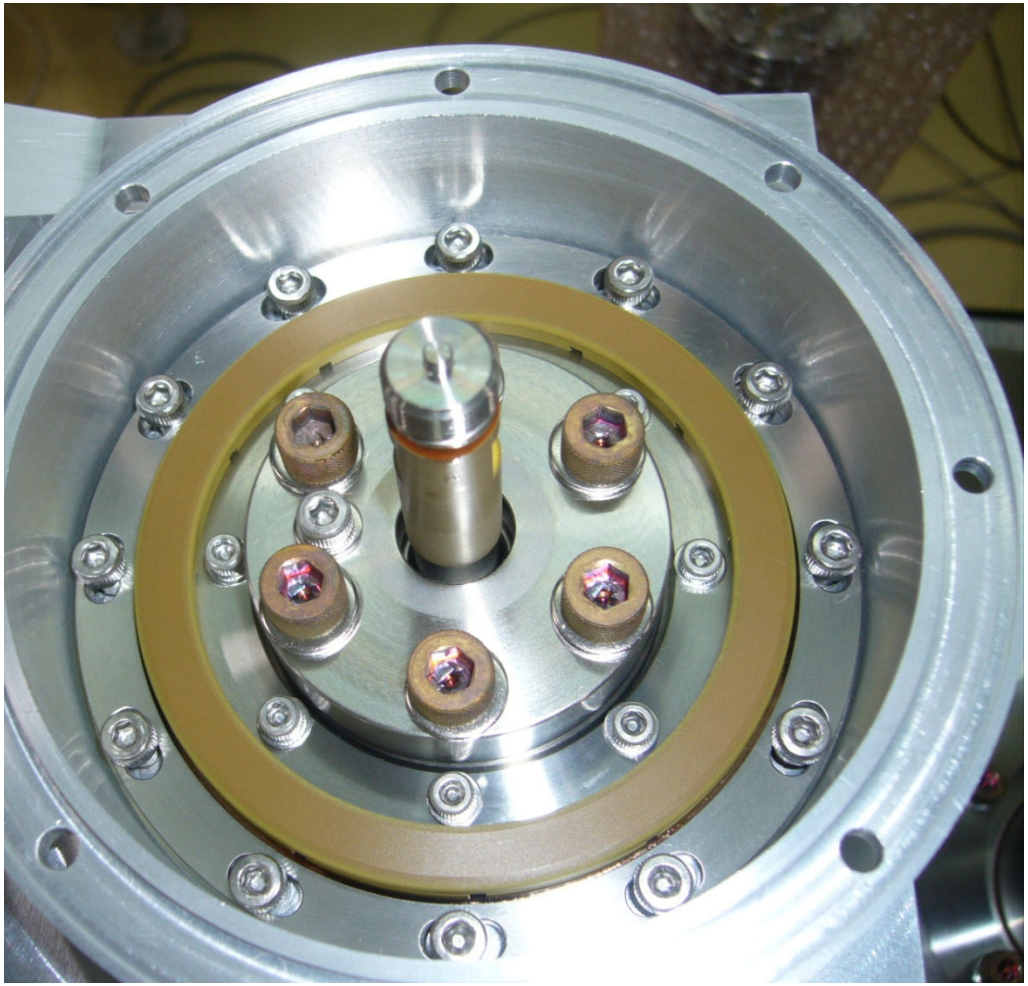


- M5 screws to WGB & Coupler assembly
- M3 screws to capacitor assembly on coupler & WGB
- SS to SS RF contact (Alu foil to fill in gaps)

- 'Soft' membrane at WGB to absorb manufacturing misalignments
- Improvements should be expected during call for tender and/or pre-series stage.

XFEL RF Couplers/ from R&D to Mass Production

Industrial Studies/ Accepted & rejected proposals {TTF-3 RF contact}



XFEL RF Couplers/ from R&D to Mass Production

Industrial Studies/ Accepted & rejected proposals {RF contact/capacitor}

•Condensateur avec contacts RF élastiques, solution prototype non retenue par manque de temps en R&D.

•Ce composant est sur le chemin critique puisque le projet n'a toujours pas de solution appropriée à quelques mois de l'appel d'offre. Des variantes seront demandées aux industriels (joints RF, anneaux fins en alliage Cu ou Al…).

XFEL RF Couplers/ from R&D to Mass Production

Market Strategy for Mass Production

Tendering dossier:

•French public market {2 contracts, possible single consortium}

•Companies are invited to propose variants (welding, brazing, capacitor)

•Detailed description of production means (CAD, workshops, UHV)

•Qualified operators & operations (welding, brazing, Cu & TiN coating)

•*Specific samples, before open market procedure (one concerned firm)*

During mass production:

•Quality Control Plan (material certificate 3-1-B, equipment calibration)

•Follow up at production site (LAL inspector, monthly progress reports)

•Full traceability, XFEL-EDMS used for firms documentation

•Statistic inspection (witness production samples, audits)

•Performance tests & controls (He leak checks, cleaning control, RGA)

End deliveries (coupler acceptance)

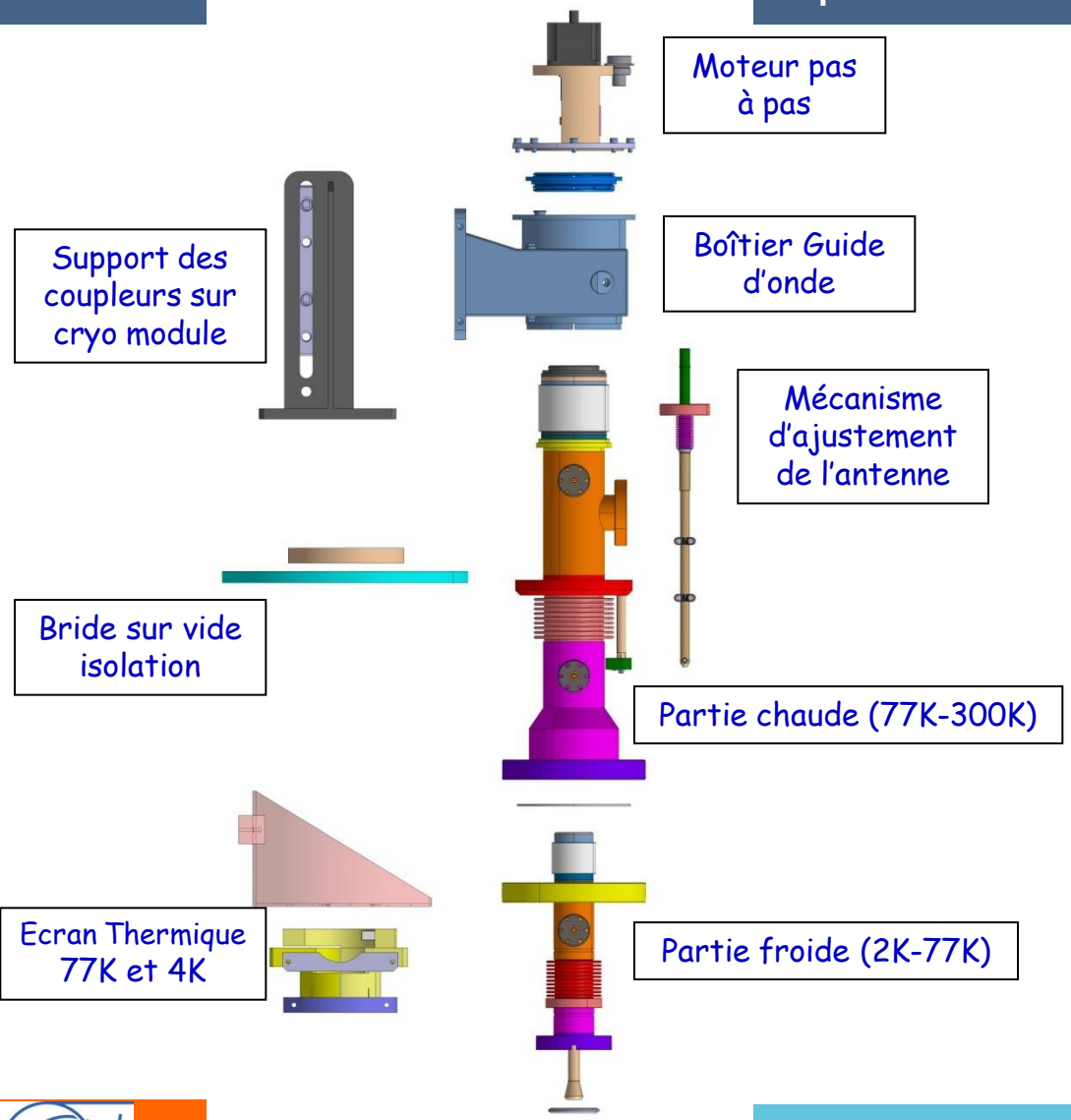
•Engineering documents (prod dwg, welding/brazing/coating parameters)

•Test reports (out gazing, vacuum leak checks, baking records, RGA)

•RF processing at LAL-Orsay (Frequency tuning, RF performance)

XFEL RF Couplers/ from R&D to Mass Production

Séquences de Fabrication



- Spécification Matière et Approvisionnement
- Mise en forme, usinages, soudages, brazages
- Dégraissage, Nettoyage
- Fenêtres Céramique + TiN
- Soudage sous-ensembles
- Contrôle Qualité, Test He et mesures géométriques
- Nettoyage final, étuvage comptage des particules
- Assemblage final parties chaude, froide et cavité
- Emballage, transport LAL
  CP sous vide, WP sous N2

XFEL RF Couplers/ from R&D to Mass Production

Couplers Transport & Logistics/ Industrial ↔ LAL ↔ IRFU

Transfer of Responsibility from Industry to LAL:
Engineering Acceptance Criteria (Follow up & Quality Control Dossier)
RF Performance Criteria (1.3GHz Tuning, Conditioning, Long Term Tests)

Transfer of Responsibility from LAL to IRFU:
Partial Disassembly, Packing & Transport (PV + Quality Control Dossier)
Reception Criteria (Visual Inspection, Digital Pictures, complete set)

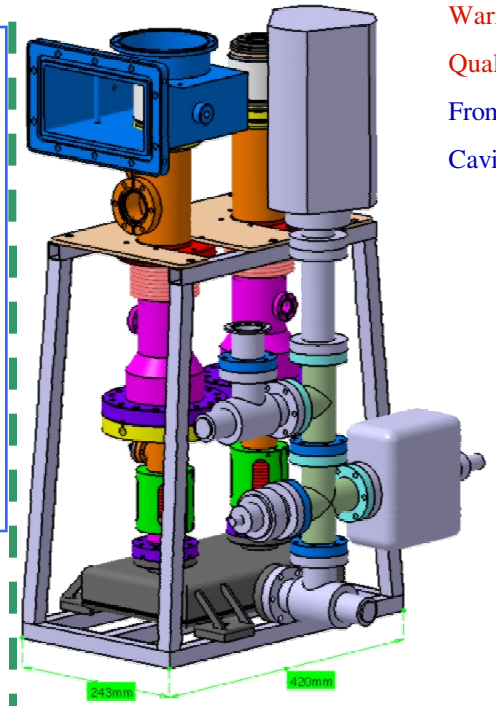
Transfer from Industry to LAL/ 2x2 pairs of couplers kits per week

Industrial site A

Transfer from LAL to Industry/ 2x2cavities + chassis per week

- Management & Quality Control Plan
- Follow up @ production site, LAL inspector
- Qualified operators & operations
- Full traceability, XFEL-EDMS database
- Statistic inspection & audits
- Quality/control tests & reports
- Engineering documents (prod dwg,…)
- In situ backing, RGA, Frequency tuning & RF processing at LAL

Industrial site B



From LAL to IRFU:
Warm & cold parts + cavities, 4 pairs/week
Quality Control Dossier
From IRFU to LAL:
Cavities & boxes, 4 units/week

IRFU-Saclay
Modules Assembly

LAL-Orsay
RF-Station

Final Acceptance
- Vacuum leak tests,
- Baking, RGA spectrum
- RF conditioning, long term tests
- Disassembly (WG box & Warm part (cold part connected to cavity)

Storage Buffering (under study):
- *32? pairs of couplers with cavities & chassis (before/after RF processing)*

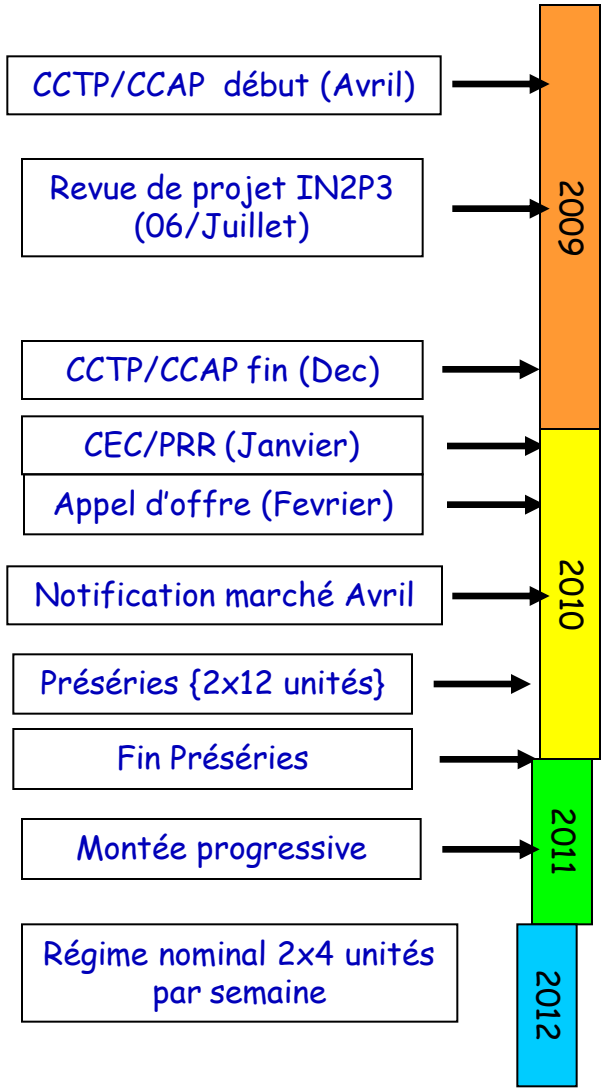
Transfer from IRFU to DESY
One module per week

XFEL-DESY
AMTF

XFEL RF Couplers/ from R&D to Mass Production

Planning 2009-2012

Item	Resources
Rédaction du CCTP et des documents associés {Nomenclature + dossier de plans, Spécifications de Controle/Qualité, conditionnement HF}	Equipe Technique
Rédaction du CCAP et des documents administratifs relatifs au marché	LAL & DDA du CNRS
Traduction français→anglais des documents du marché	**Externe**
PRR {Revue de lancement de l'appel d'offre}	**ET & groupe de revue**
Lancement de l'appel d'offre/ Reception des offres techniques-commerciales	DDA du CNRS
Analyse des offres, consultation et audit des candidats, selection des deux firmes A & B (ou du consortium)	Commission du marché
Revue de contrat avec le partenaire XFEL-DESY	ET & groupe de revue
Derniers examens administratifs et fiscaux, notification des contrats	**DDA du CNRS**
Réception/Analyse du dossier de management & de production des firmes (organigramme, plan qualité, LOFC, planning de fabrication et de livraison...)	Contractants A & B Equipe Technique.
Spécification & Appro matière, outil industriel (salle blanches, postes de soudage, de brasage, dépôts Cu et TiN, nettoyage, étuvage, pompage UHV}	Contractants A & B
Production présérie de 2x12 unités {amélioration de l'outil industriel, inspection par le représentant LAL} livraison par paire & dossier qualité	**Contractants A & B, {représentant LAL}**
Montée progressive de la production, ~2x3x8 coupleurs {8/ mois/ contractant} Approbation de l'outil industriel et de l'inspection + recette technique	Contractants A & B, {représentant LAL}
Livraison régulière de 2x16 coupleurs par mois. Conditionnement HF au LAL et préparation livraison à l'IRFU de 2x4 coupleurs par semaine	Equipe Technique LAL



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