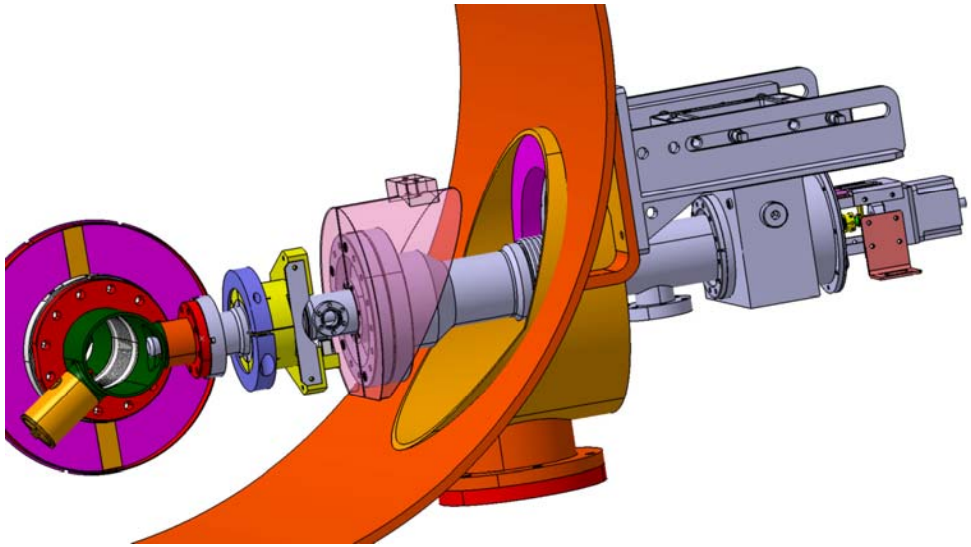
Status report on "Industrialization studies" at LAL
on power couplers for XFEL

TILC08 – Tohoku University
3-6 March 2008
Sendai - Japan

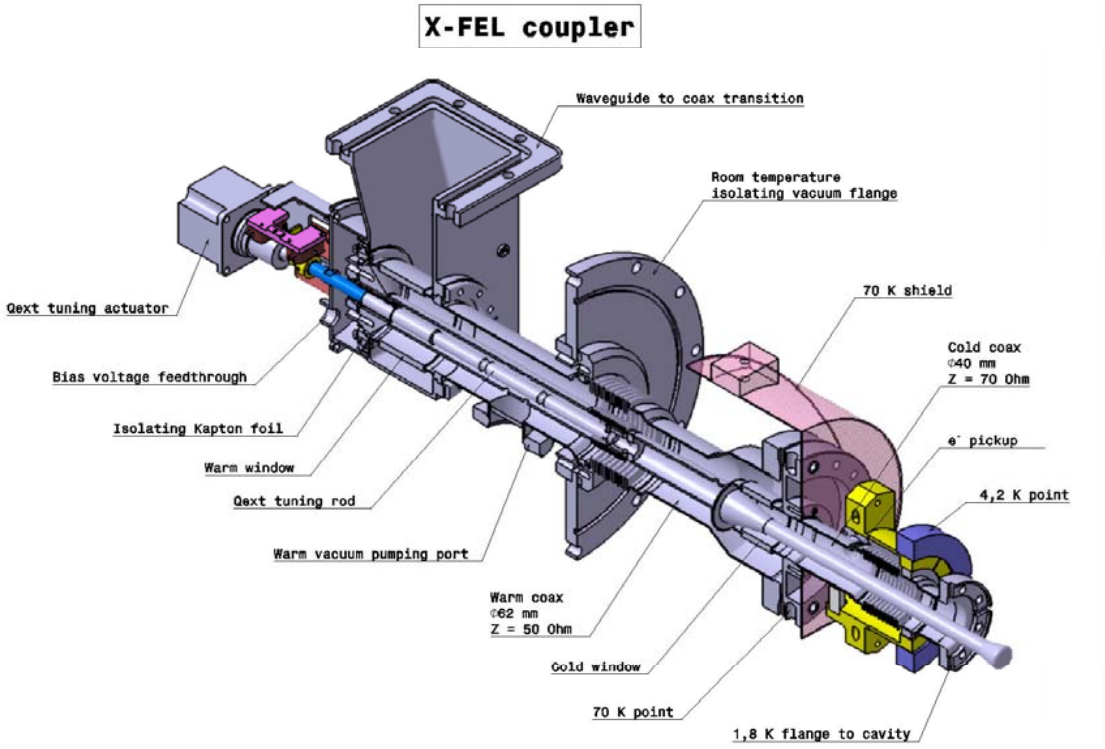


G. Wormser

S. Prat

In the frame of the French contribution to **XFEL** project,

LAL is in charge of "in-kind" delivery of 808 input couplers



3 Main difficulties:

- Mass production of coupler parts
- Assembly in clean room
- RF conditioning

Expertise required from industry in the couplers production

EB welding

Vacuum brazing

TiN coating th. ~ 10nm

Precise geometrical tolerances

Surface finish
and cleanliness

TIG welding

Cu plating: 10 < RRR < 100

Motorized tuning

EN 1.4435

EN 1.4429

Special austenitic stainless steel

+ He leak rate < 10^{-11} Pa.m3/s
+ Careful Handling with gloves
+ Assembly in clean room
+ RF Conditioning

LAL conducted industrialization studies to clarify the mass production of couplers

Award of 3 contracts in March 06: ACCEL, e2v, TOSHIBA

System Design Review:

- functional analysis

SDR

Preliminary Design Review:

- feasibility of the manufacturing processes
- samples for parts and joining

PDR

Critical Design Review:

- detailed drawings
- organization of the mass production
- risks analysis
- samples of Cu plating and TiN coating

CDR

Final Project Review:

- deliver 2 prototypes
- volume manufacturing plan
- costs estimate for XFEL couplers

FPR

2 full days for each review at each contractor

Cost reduction was one of the main objectives :

Phase 1: **functional analysis of existing design**

Functions & requirements for each sub-assembly, each part
Analysis of requirements for each interface
Functionality of global breakdown:
- analyze limits of each sub-assembly
- what are the purposes of this design ?

Phase 2: **systems engineering**

- reduce number of parts
- reduce number of junctions
- reduce number of different junctions, types of junctions

Phase 3: **design for manufacturability**

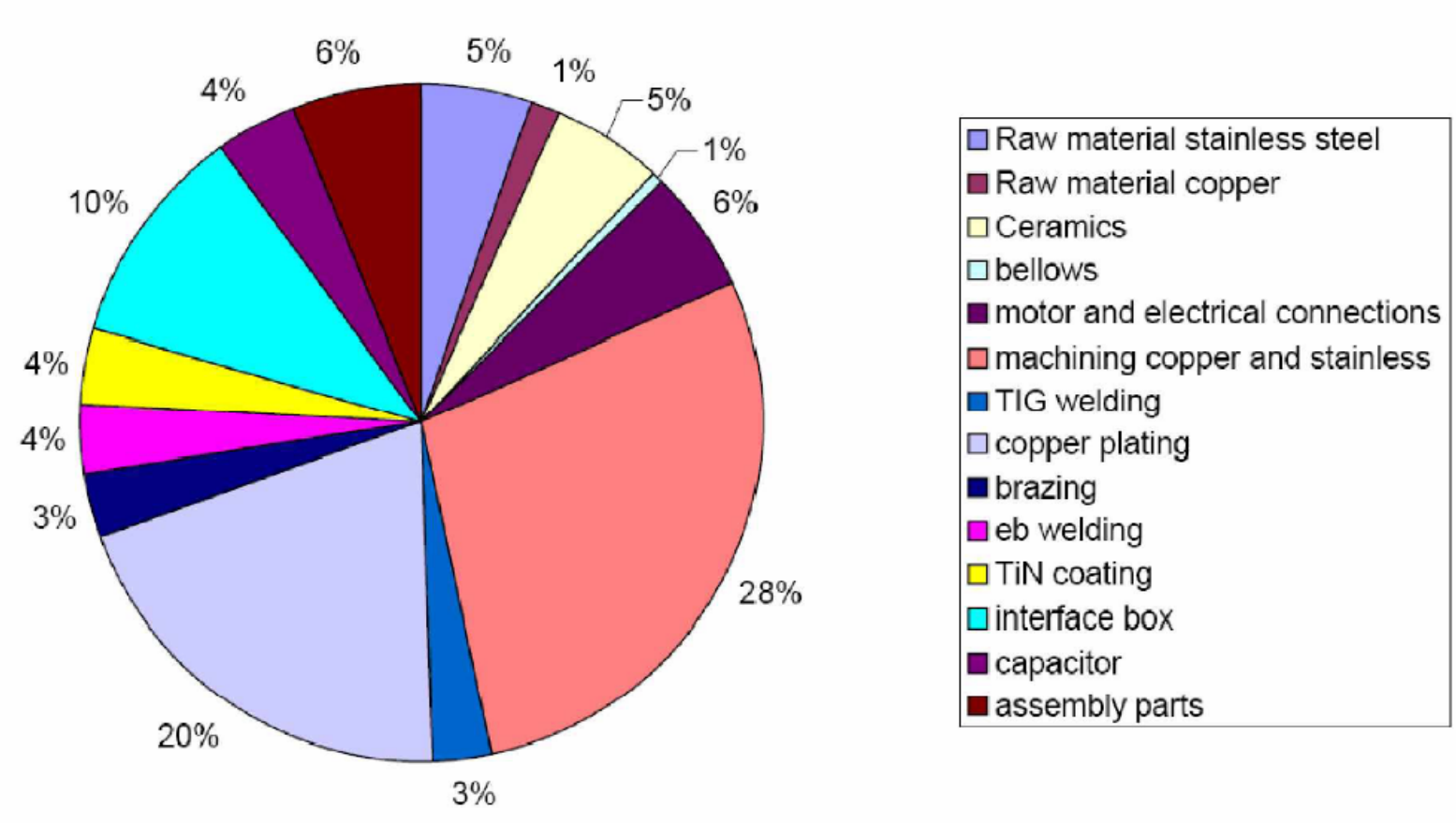
analysis of manufacturing method for each part:
- prefer deformation process instead of material removal process
- optimize design of parts connected to interfaces (functional analysis results)

Phase 4: **lean manufacturing methods**

- optimise the design in terms of functions
- analyse bar chart of components costs:
  concentrate efforts of cost reduction on most expensive components
- think about production with less of everything:
  . less human resources, less specific competences
  . less manufacturing equipments and space
  . less raw material, less tooling & jigs
  . less stock, less spares, less energy, less waste

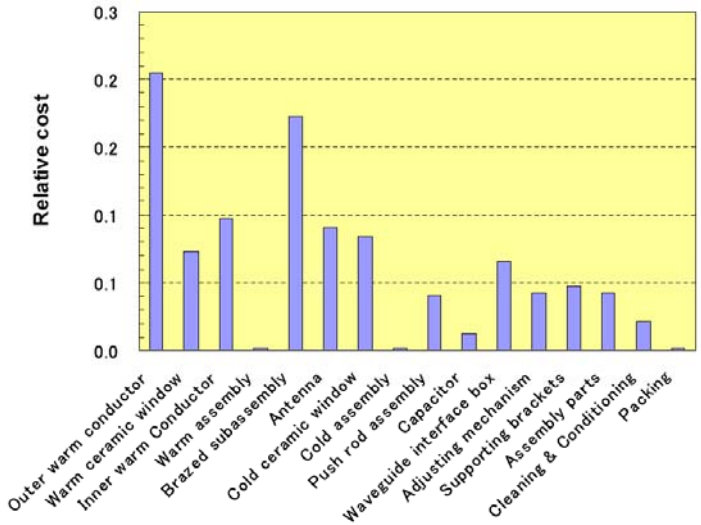
Phase 5: **analysis of final assembly**

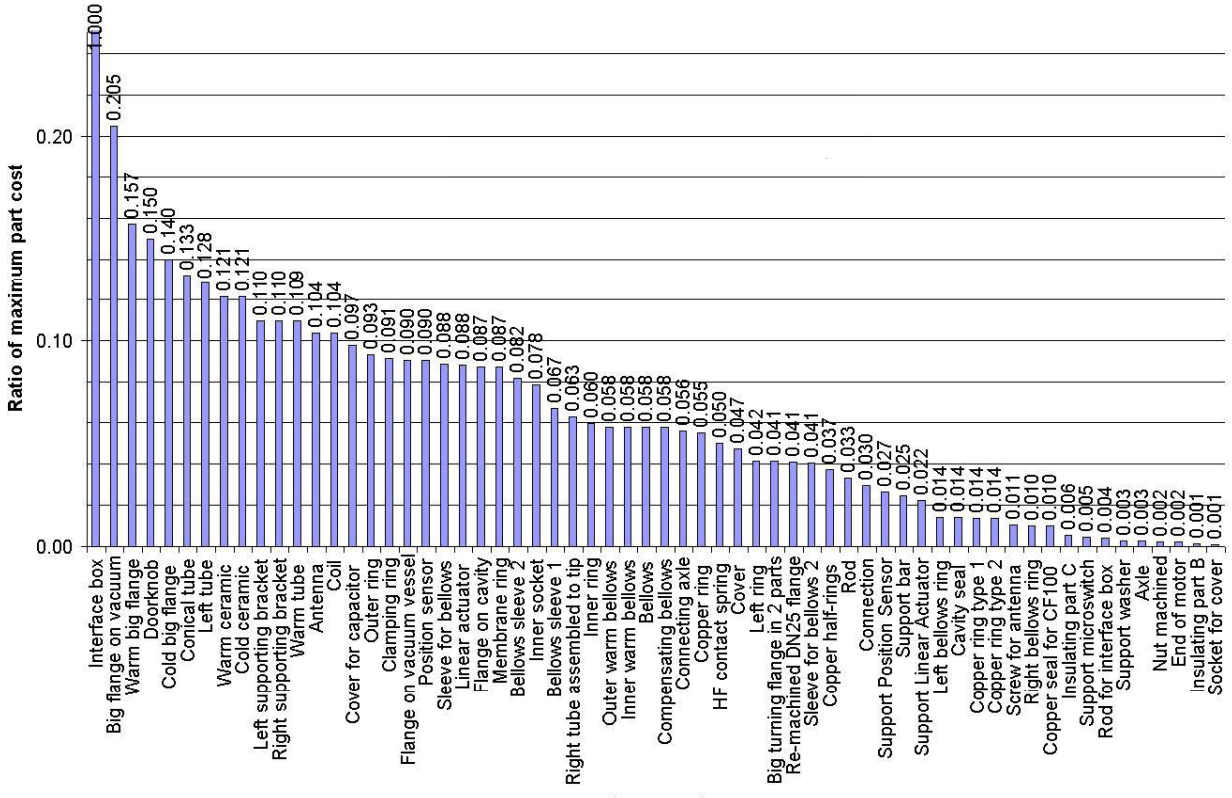
- decompose assembly operations in successive sequences
- what are the consequences of assembly on each component ?
- what parts could be simplified ?
- how to save manpower and assembly time ?



Cost breakdown chart

Bar chart cost for sub-assemblies →





Bar chart for each part

Status for prototypes

1 pair received Feb 28th

Others to be received 1st week of March

Next Actions on prototypes

- RF condition prototype pairs: → analyze results
- dismount couplers and inspect inside/outside → quality evaluation and ranking

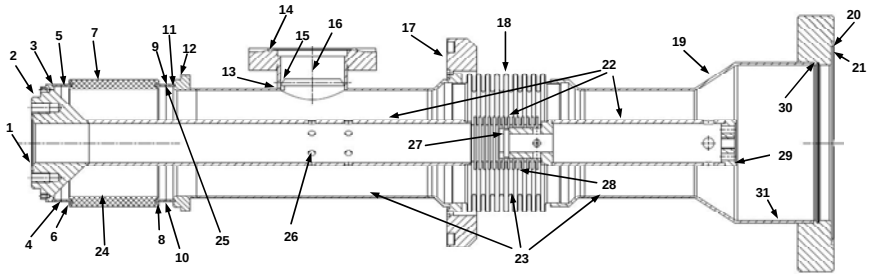
Next Actions for XFEL

- initiate call for tenders
- award contract(s) for production of 808 couplers

Example: Visual inspection to be made on warm and cold assemblies

Outside

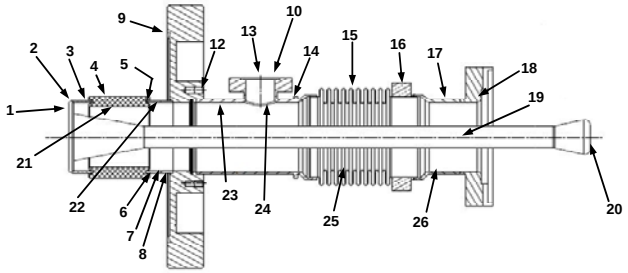
- identification
- conformance of geometry
- cleanliness
- surface finish
- ceramic aspect (absence of scratches, broken edge, stain)
- brazes aspect (good filling, no spill)
- welds aspect (absence of holes, corrosion)
- centering
- bellows (no excessive deformation, no dents)
- CF flanges (no damage)
- edges (good chamfers or rounded edges, sharp edge when needed)



Inspection points on warm assembly

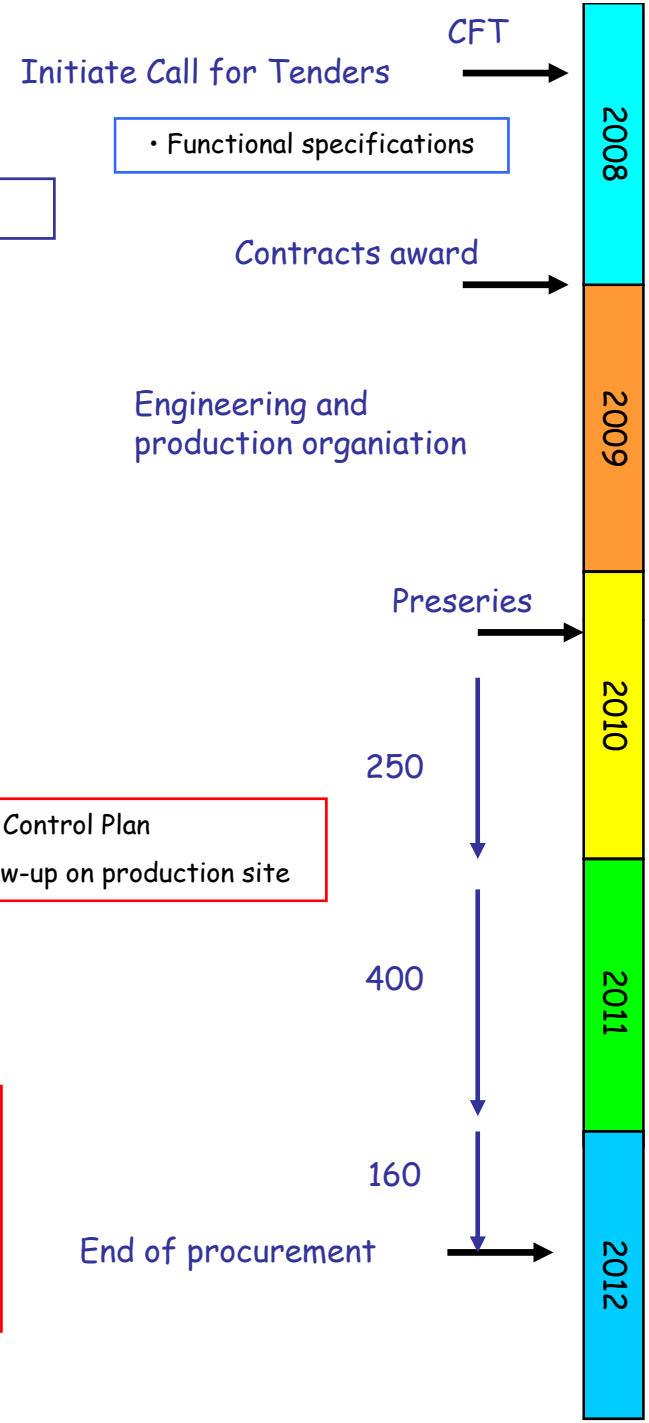
Inside

- cleanliness
- end of inner conductor (sharp edge)
- inner bellows (no excessive deformation, no dents)
- pumping holes (rounded edges)
- RF surface finish (roughness value, absence of scratches, stains)
- Ceramic aspect (absence of scratches, broken edge, stain)
- joints aspect (full penetration, smoothness, no peaks)
- Cu coating aspect (smoothness, color, coating limit, no flakes, stains, corrosion)
- rounded edges (for RF needs)



Inspection points on cold assembly

Preliminary schedule for XFEL couplers procurement



Requirements:

- Certified materials
- Industrial processes
- Written procedures
- Standard competences
- Qualified operators
- Adequate means size
- Optimized costs

- Precise Quality Control Plan
- permanent follow-up on production site

End requirements:

- Traceability
- Constant Quality
- Reliability
- Plug-compatibility