ILC-HiGrade Scientific and Annual Meeting

(CERN, 25 February, 2010)

Mickaël LACROIX (LAL)

ILC HiGrade WP7 couplers

cnrs IN2P3 Les deux infinis
UNIVERSITÉ PARIS-SUD 11
LAL LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE
ilc europe
SEVENTH FRAMEWORK PROGRAMME

ILC HiGrade WP7 couplers

Summary

- ILC HiGrade base line strategy
- XFEL Coupler Design
- XFEL Coupler production
  - Sub-contractor: Fabrication/Cleaning & pre-assembly
  - LAL: Baking/Conditioning/Disassembly
- ILC Higrade schedule scenaries
- ILC Higrade cost scenaries

ILC HiGrade WP7 couplers

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Add the ILC HiGrade coupler order to the XFEL order.

The goal is to get:

-a reliable design (an updated TTF3 design)

-full prepared couplers (cleaned & conditioned)

-the large XFEL production follow up

- a mass production cost!!!

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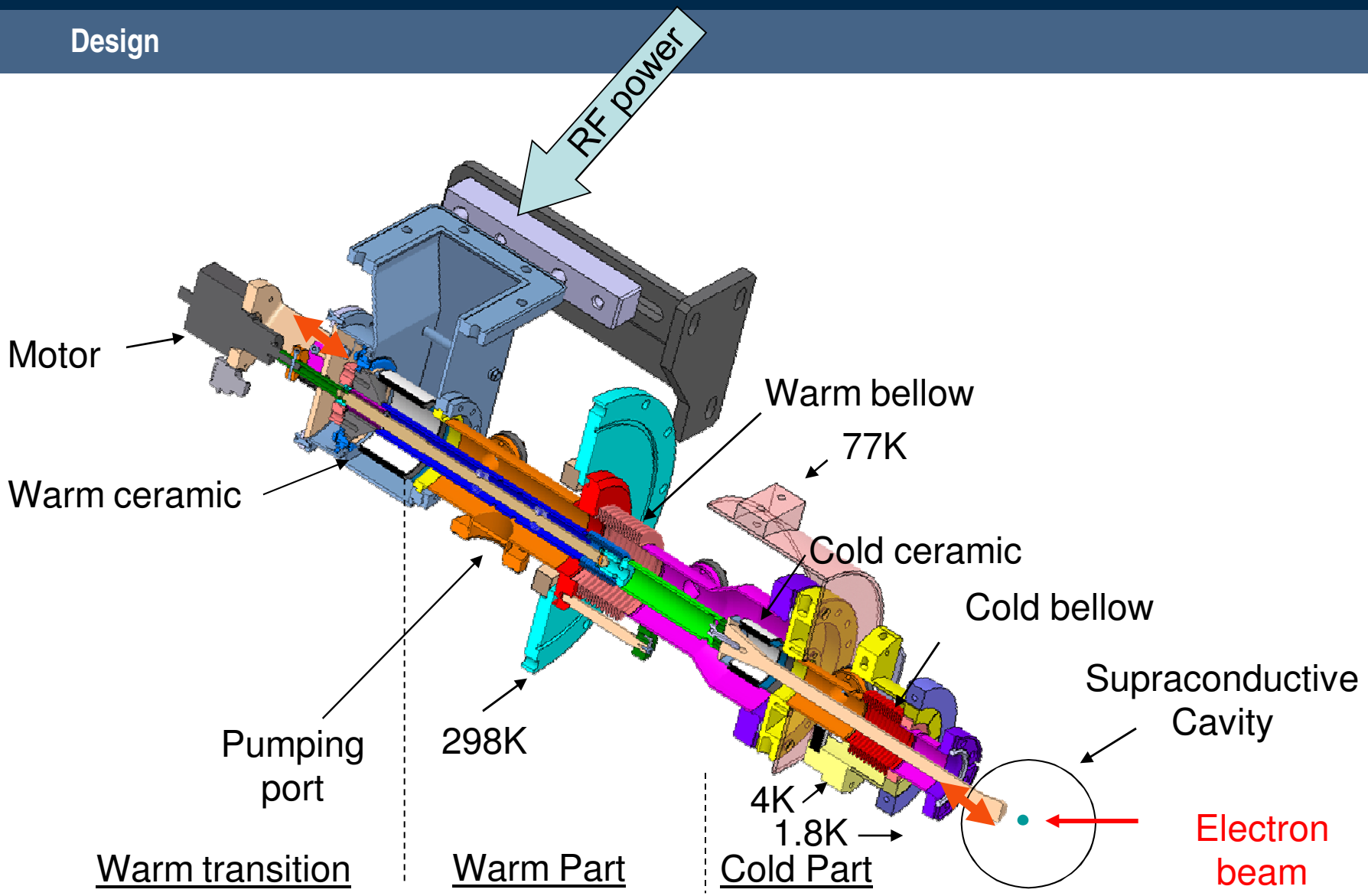
ILC HiGrade WP7 couplers

Design



ILC HiGrade WP7 couplers

Design

Baseline

TTF3

Laboratory Studies

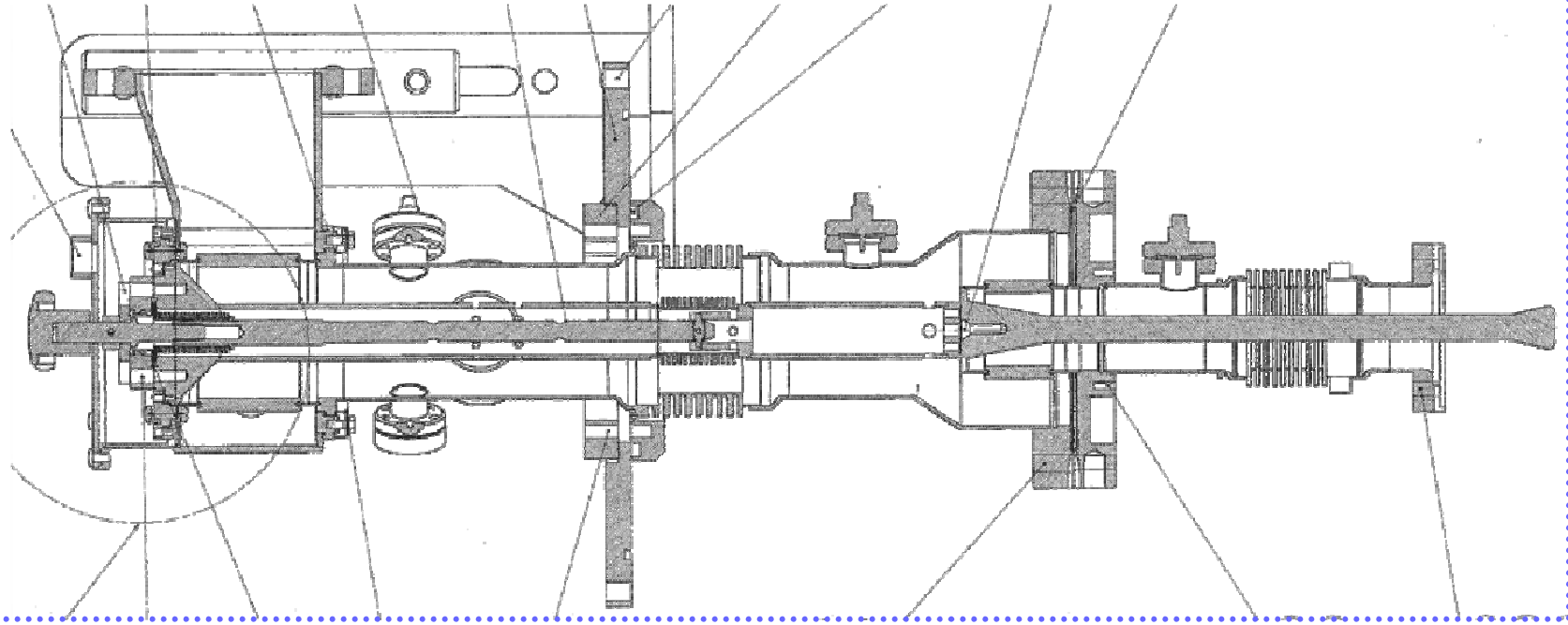
Design & tests

Manufacturer design studies

Accel prototype for XFEL

Toshiba prototype for XFEL

E2V Prototype for XFEL



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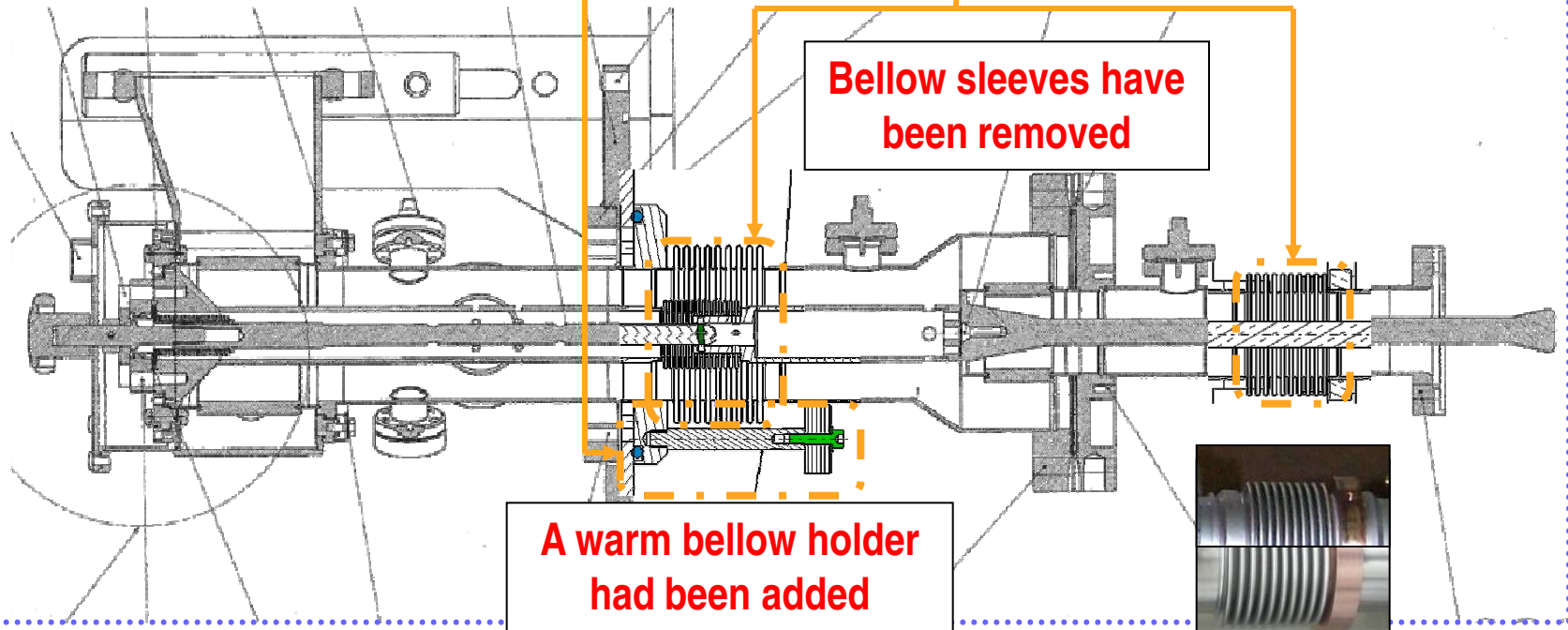

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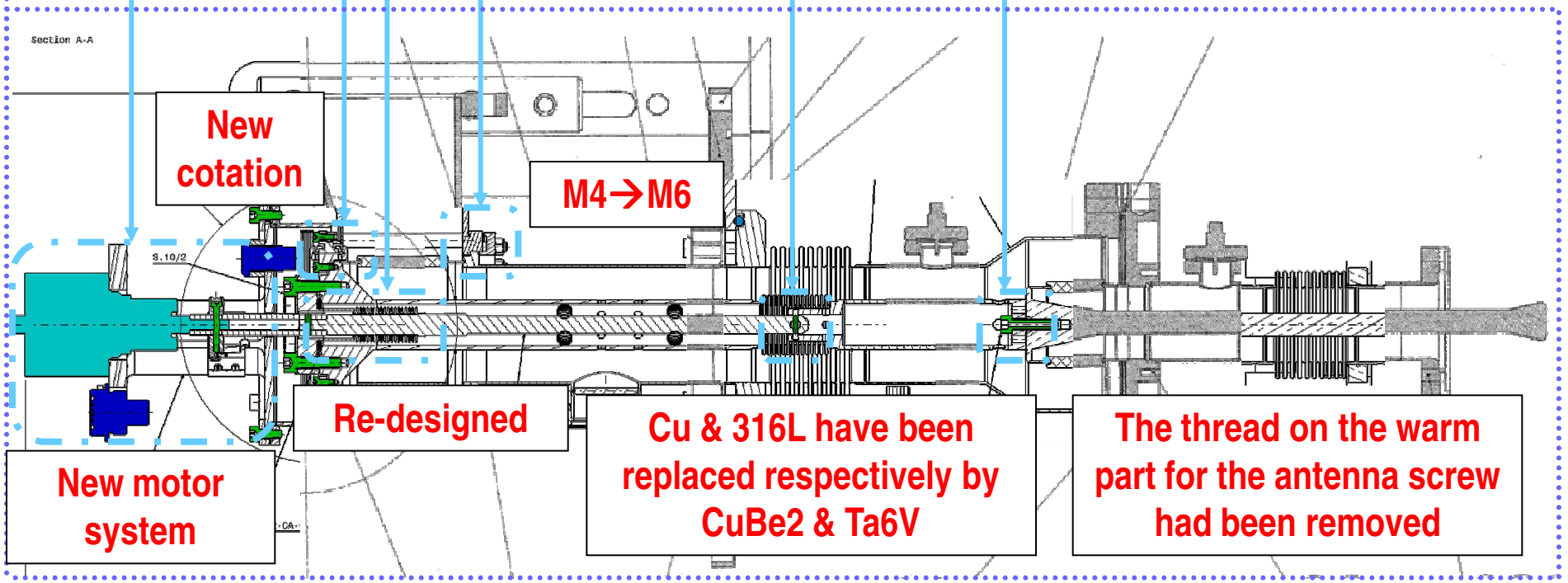
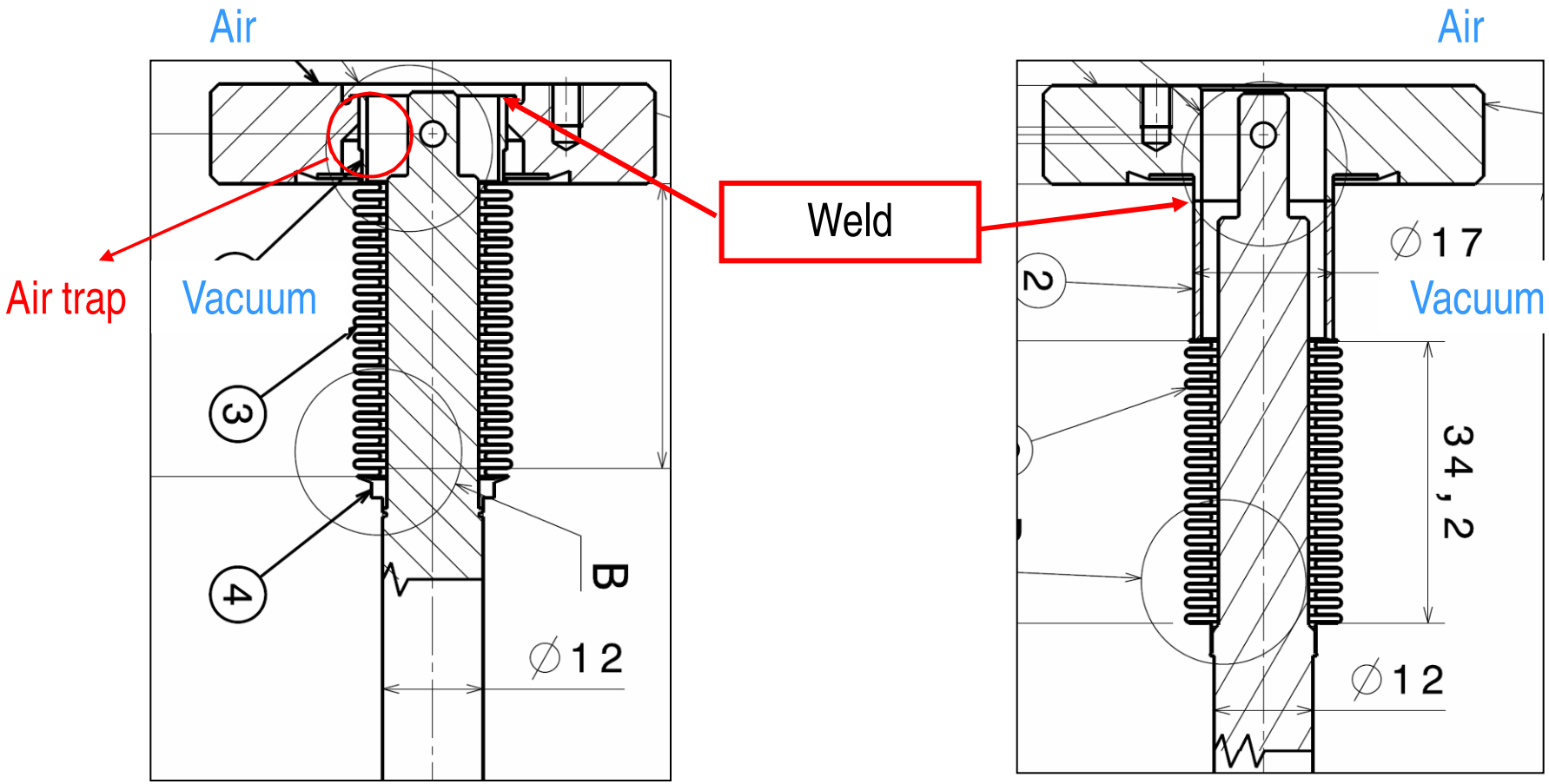


ILC HiGrade WP7 couplers

Design example

Improvement of the push-rod design



TTF3 design

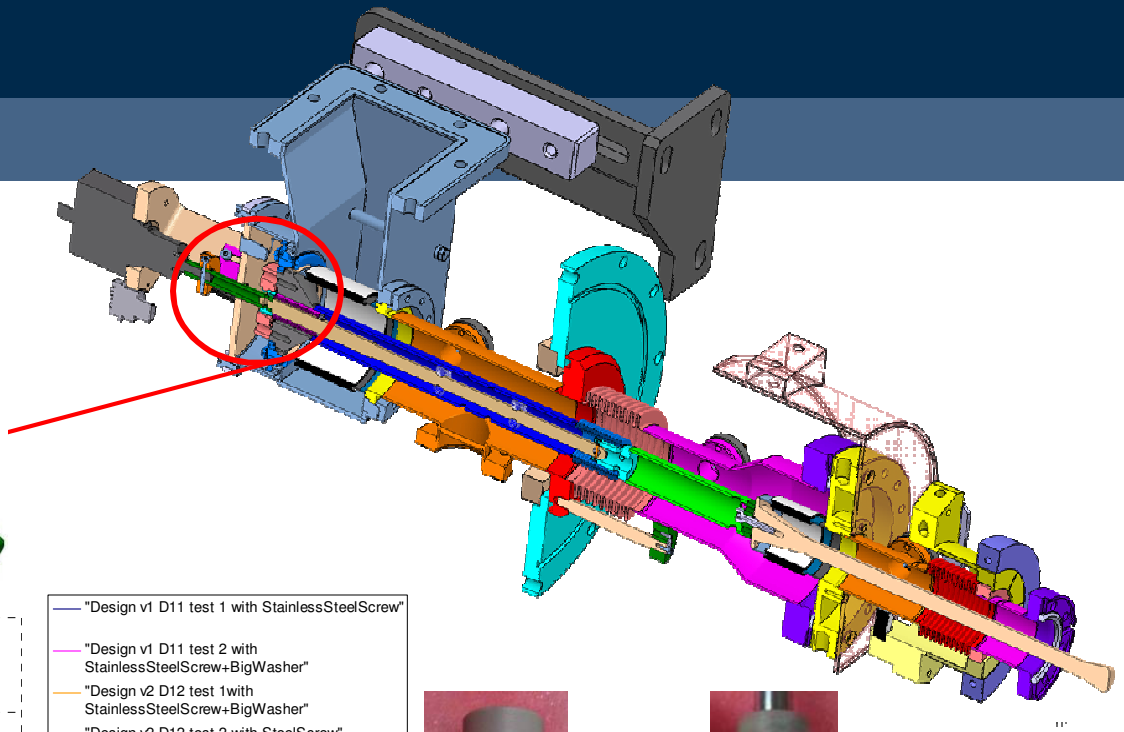
XFEL design

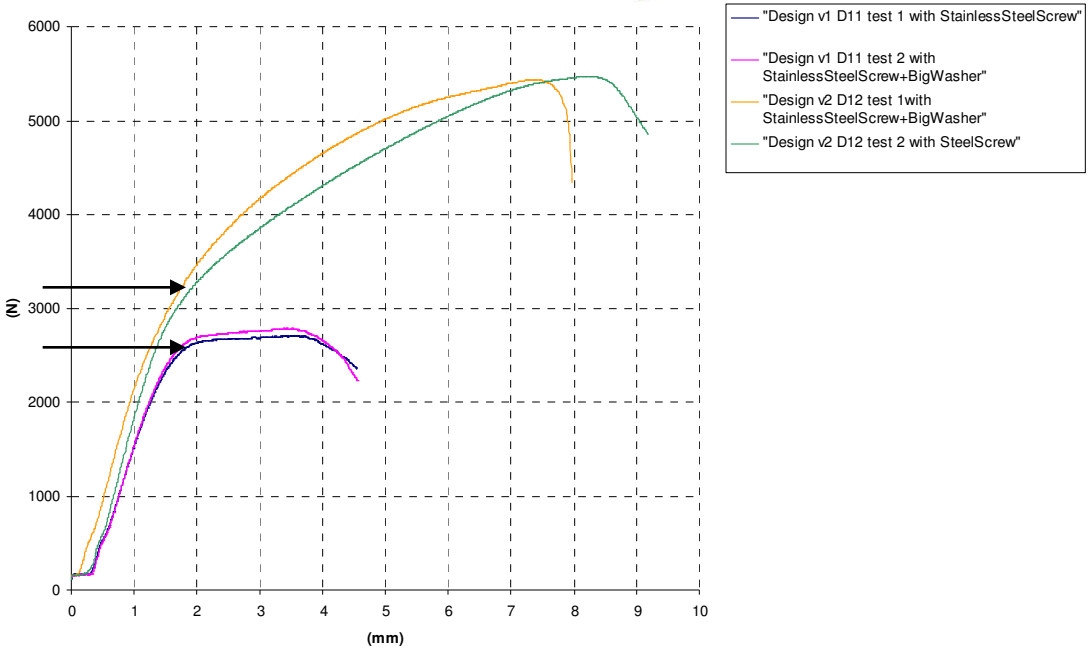
ILC HiGrade WP7 couplers

Design example

Insulator axle (+/- 800N)

- Pull tests





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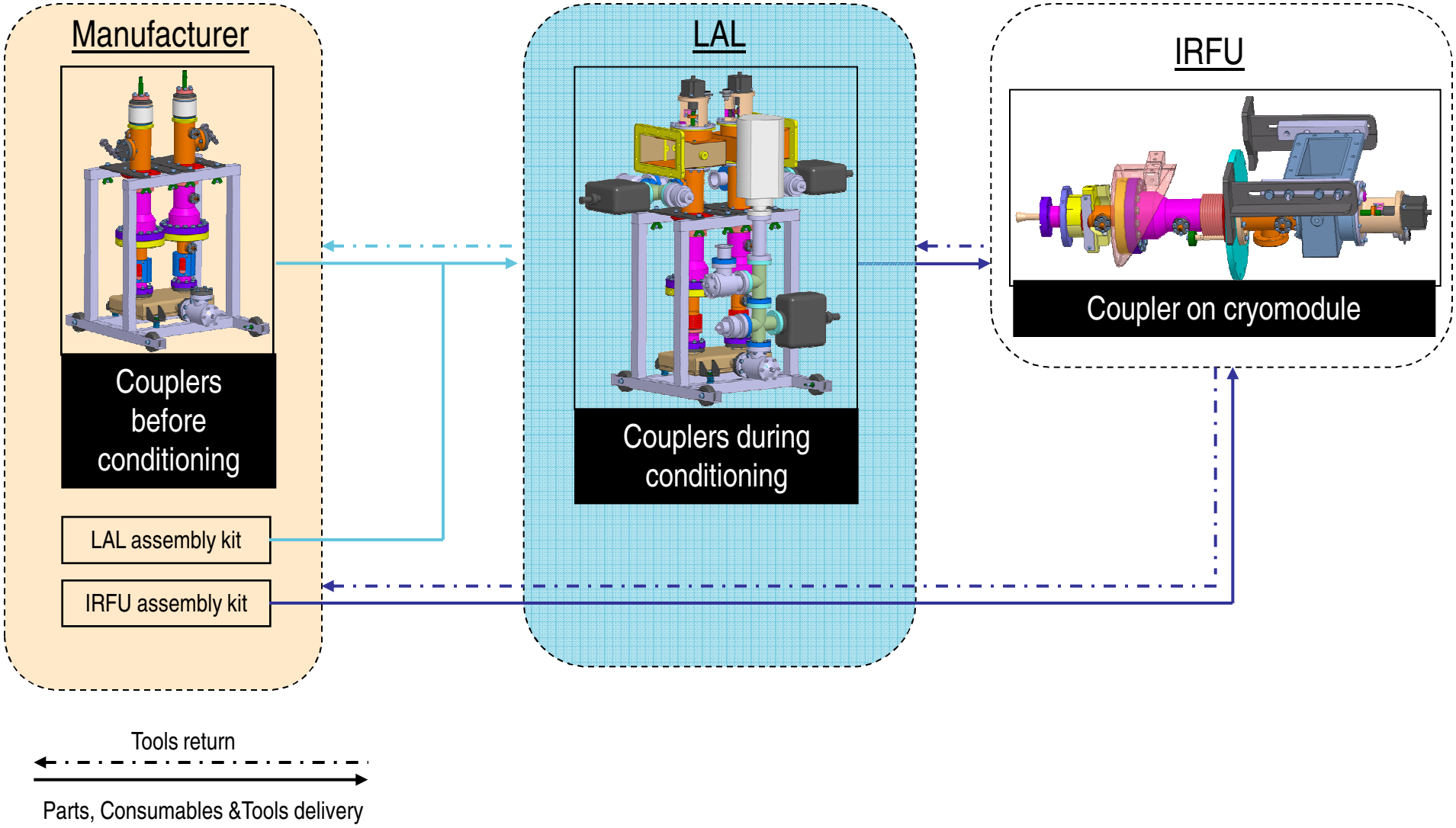
ILC HiGrade WP7 couplers

XFEL Coupler production



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ILC HiGrade WP7 couplers

Fabrication

Process

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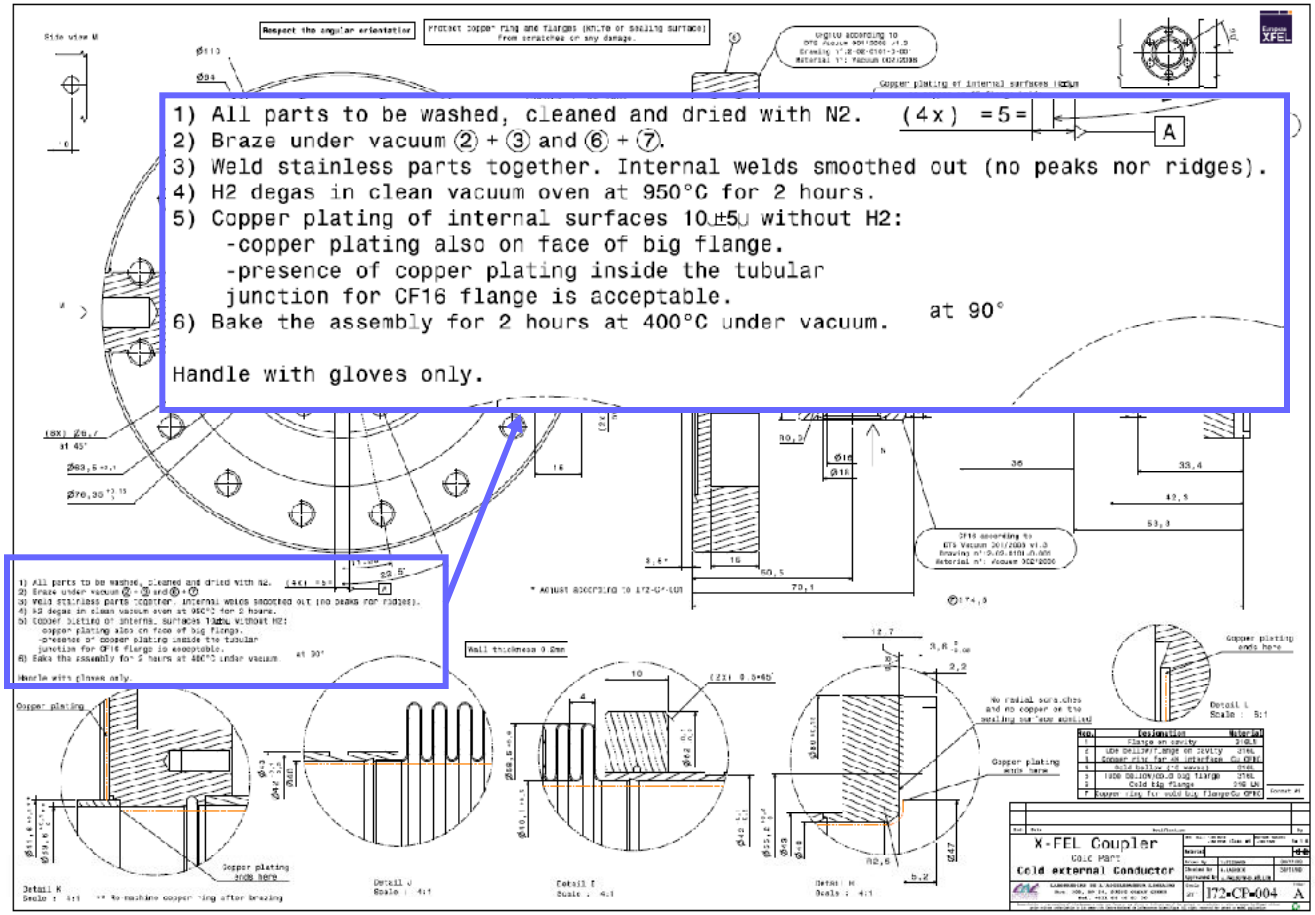

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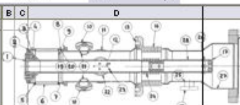
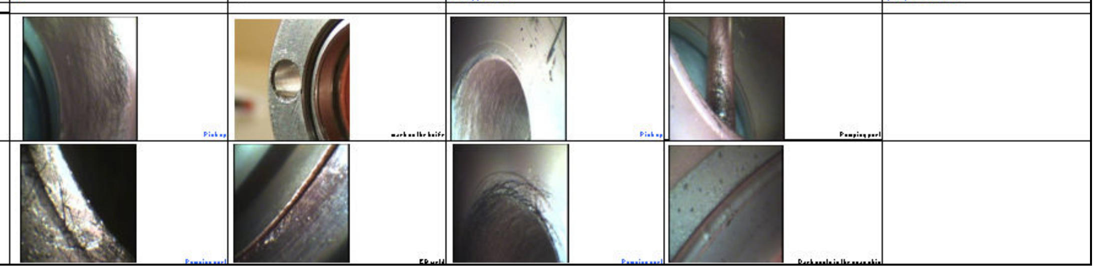
J38



			D	CP3H43	CP3H44	CP3H45	CP3H46	CP3H47
3			Delivery date:	23/11/2007	23/11/2007	23/11/2007	26/11/2007	26/11/2007
4			Inspector:	Alice Manu Yann	Alice Manu Yann	Alice Manu Yann	Alice Manu Yann	Alice Manu Yann
5	P3H5	Select / All	Inspection date:	05/11/2007	05/11/2007	05/11/2007	05/11/2007	11/12/2007
6			Packaging:	Not under vacuum				under pressure
7	Visual	1	Scratches, flange knife edge damage, chamfer	OK	OK	unknown material on a small area of the knife	some copper on the knife + dust/fibbers	OK
8	Visual	2	Edge profiles broken/smooth	OK	OK	OK	OK	OK
9	Visual	3	Copper Sleeves: screw mark locations	large screw marks	marks not so deep	OK	screw marks	8 screw marks
10	Visual	4	Weldment: form, irregularities, concentricity of mating shoulders	Copper sleeve seems to be bigger	Copper sleeve seems to be bigger but centered	slightly uncentered	slighty uncentered and not uniform	uncentered
11	Visual	5	Brazing: braze ceramic: metallization borderline, chamfer, lines	OK	OK	OK	OK	OK
12	Visual	6	Braze ceramic: discoloring, lines, chips	ligh marks	OK	slight yellow color	yellow edges	OK
13	Visual	7	Brazing: irregularities, scattering of groove, Braze buildup Braze ceramic: metallization	OK	bad concentricity, slight screw marks	OK	OK	OK
14	Visual	8	Weldment: form, irregularities, concentricity of mating shoulders	Screw marks + slight oxide	OK	slightly uncentered	uncentered and not uniform, screw marks	Screw marks
15	Visual	9	Form of the angles	Spot of braze material	OK	OK	OK	OK
16	Visual	10	Scratches, knife edge damage, chamfer	OK	OK	OK	OK	OK (1 mark)
17	Visual	11	Scratches, knife edge damage, chamfer	OK	Knife not very nice	Knife angle seems to be different + start of scratche on	OK	OK
18	Visual	12	Brazed lips of main body rounded off	OK	OK	OK	OK	OK
19	Visual	13	Condition of the mating surface	OK	OK	Red small fibber of tissues?	slightly brushed and dust/fibber	OK
20	Visual	14	Bellow: checks, black lines, welding residues	Bent	OK	OK	OK	small spots
21	Visual	15	Scratches, ridge damaged, chamfer	OK	very slight dump	OK	OK	OK
22	Visual	16	Surface of joint: scratches, ridge damaged, chamfer	OK	OK	OK	OK	OK
23	Visual	17	Control of ridge	OK	OK	OK	OK	OK
24	Visual	18	Other			push rod not correctly assembled + bellow compressed		One screw seized screw in a nut
25	Boroscope	19	Internal surface of ceramic: irregularity, lines, chips	OK	OK	slight marks	Marks from circonuim covers (see picture)	Marks from circonuim covers
26	Boroscope	20	Weldment: internal form, irregularities, penetration	OK	Small gap between the both sleeves	OK	small holes + marks	OK
27	Boroscope	21	Round off of the internal ridge DN25	OK	Scratches	One Pick-up is very brushed	OK	OK
28	Boroscope	22	Round off of the internal ridge DN35	OK	Scratches	large scratches	Dark scratches in the pumping part, oxide?	OK
29	Boroscope	23	Round off ridges of the internal conductor cavities	OK	Scratches on the antenna	OK	OK	OK
30	Boroscope	24	Internal bellows: uniformity, black lines, welding residues	OK	OK	Braze material drops?	scratches and marks	OK
31	Boroscope	25	Round off of the internal ridge DN25	OK	OK	OK	OK	OK
32	Boroscope	26	Round off ridges of the internal conductor cavities	Not smooth, a lot of scraches, massive brushing	OK	OK	OK	OK
33	Boroscope	27	Form of the external conductor copper, lines, scratches, color	Scratches, Ra=0,51µm Rmax=4,64µm	OK	Copper color not regular, Brushed with scratches and t	Fully brushed + scratches, marks, oxide spot	OK
34	Boroscope	28	Form of the internal conductor copper, lines, scratches, color	OK	OK	strongly brushed		glassy and brushed
35			reasons to send it back					

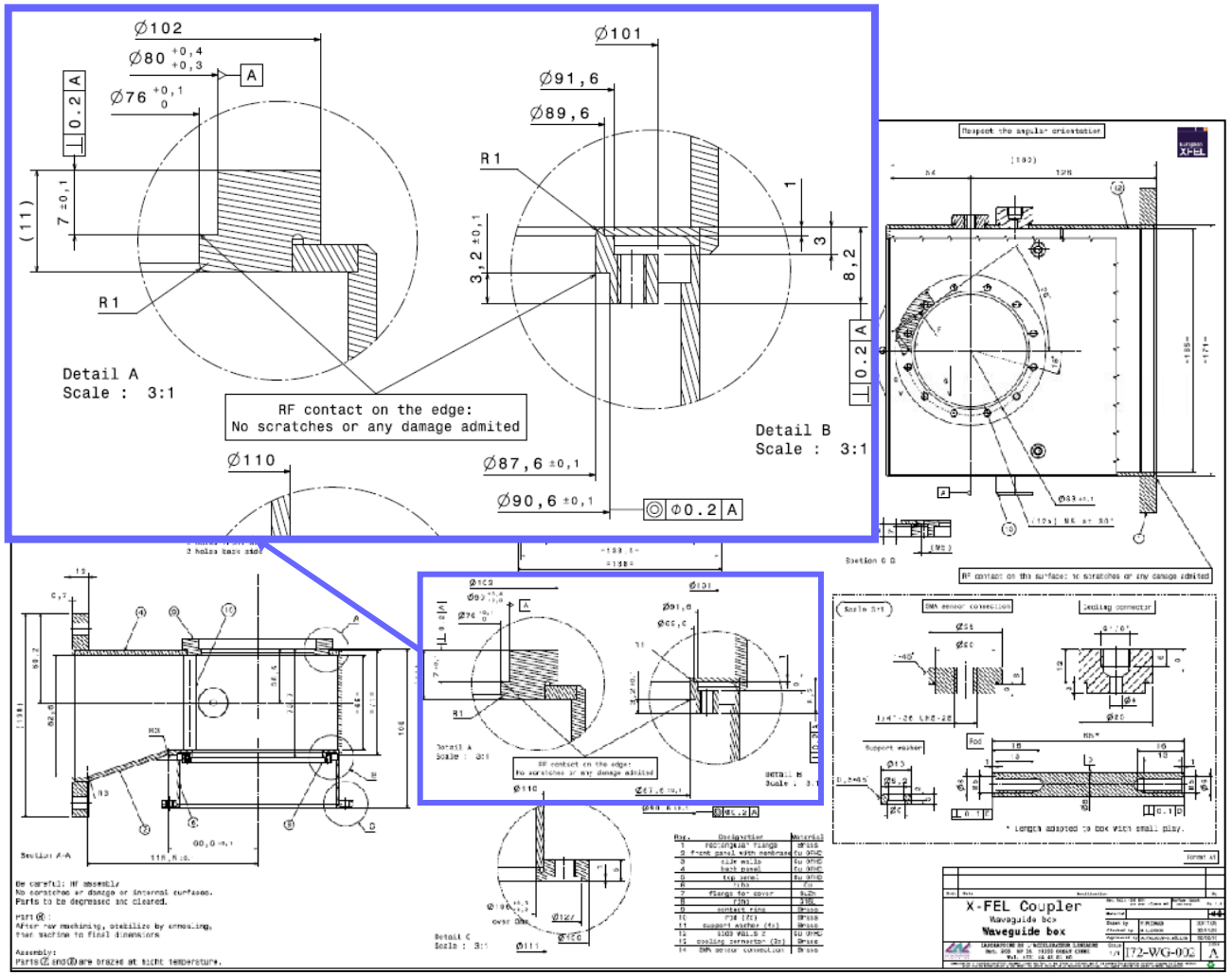


ILC HiGrade WP7 couplers

Fabrication

Process

- Mainly the same than TTF3
- But with focuses on critical aspects



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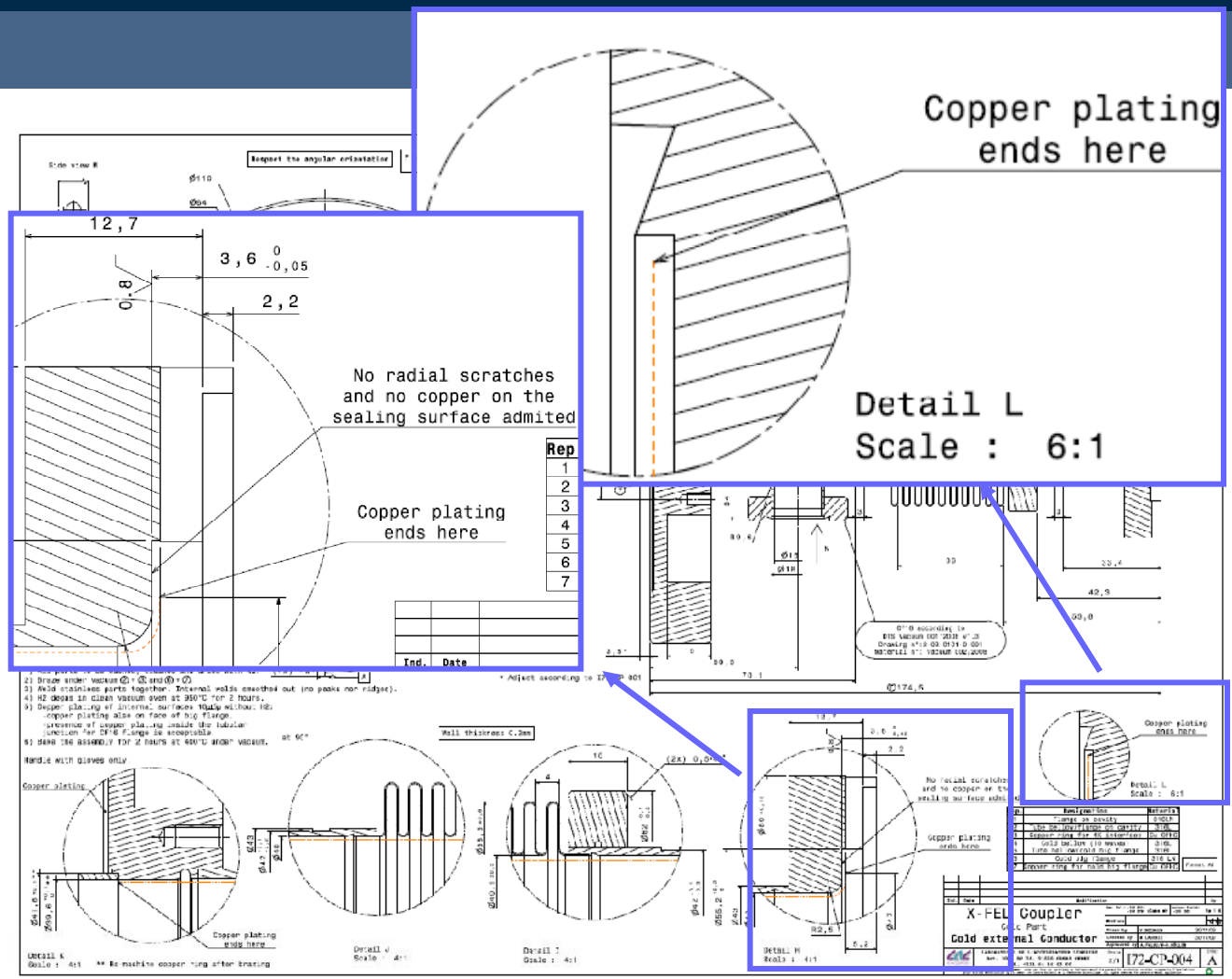


ILC HiGrade WP7 couplers

Cleaning & pre-assembly

Légende	N°	Nom de l'étape
classe 1000	0	Fabrication
classe 10	2	Préparation des kits d'assemblage
Flux laminaire classe 100	3	Lavage des 2 parties froides + transition froide + châssis
Hall		Cycle de séchage
	4	Comptage particules/pré assemblage parties froides/étuvage
		Cycle
	5	Assemblage partie fr + Test + Monta
	6	Lavage des 2 par
		Cycle
	7	Pré assemblage + Étuvage
		Cycle
	8	Mise en place de la partie + Test + Etuvage
		Cycle
	9	Mise en place de la partie ch d'é
	9'	Protection des céramiques c s
	9"	Emballage en
	9'''	Expéd

Stage 4 — Particle count / pre-assembly of cold parts — ISO4

Preparation

Make sure that the N2 bottle, which is outside of the clean room, is open and under pressure of 4 bar.

Necessary material

All parts from the previous stage

Tasks

Write down the reference of the mounting

Visual inspection:
- Do the visual inspection of all cleaned parts

Particle count in cold parts:
- Blow on the cold parts with filtered ionized nitrogen as shown in picture here on the right
- Launch the recording of the particle count
- Measure for 1 min, if fewer than 10 particles of size under 0.3µm, controlled part considered clean. If result not achieved, restart the count until result reached
- If over 9 cycles of 1 min are not giving the aforementioned results, the part considered not clean and has to be re-cleaned in the ultrasonic bath.
- Execute the previous tasks on the positions shown in pictures here below:

- Print the count ticket.
- Execute all these tasks on the second cold part.

Particle count on the transition cavity:
- Place the threaded rods on the transition cavity while the blind flanges are on
  Attention: The operator must be standing opposite from the pumping flange
- Execute the particle count according to the aforementioned cycle in both positions shown on pictures here below

Paire / pair n° S2P1

Composition de la paire/composition on test stand

	Upstream1	Downstream 2
Warm transitions	CP3W43	CP3W44
Condensator	43	44
Warm parts	CP3H43	CP3H44
Cold parts	CP3C57	CP3C58
Test stand	TWG13	
Remarks		

Nettoyage et assemblage parties froides/Cleaning and assembling of Cold parts

Opérations classe 1000 / Class 1000 operations

	22/10/08 0:00	Date			
Ultrasoinic bath	50	T°C	5	Tickopw R33	15 Tps min
Resistivity of rinsing water	>14	M.Ohm/cm			
Remarks					

Opérations classe 10 / Class 10 operations

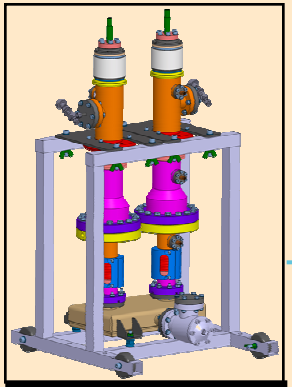
	28/10/08 0:00	Date			
Drying time	144	Heures			
Particle control	OK				
Baking in oven	150	T°C	2	hours	

- Class 10 clean room
- US bath cleaning with detergent at 50°C
- Drying with filtered N2 and under laminar flux
- **Particle count**
- **Leak test**

ILC HiGrade WP7 couplers

XFEL Coupler production

Manufacturer



Couplers before conditioning

LAL assembly kit

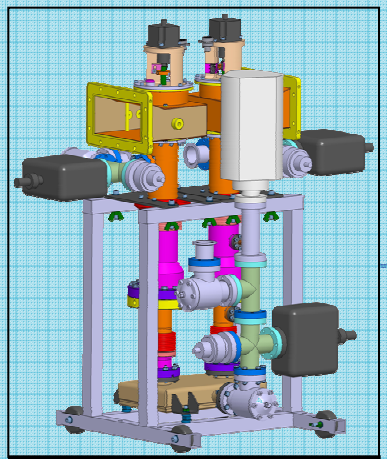
IRFU assembly kit

Call for tender (March)

Notifications (June)

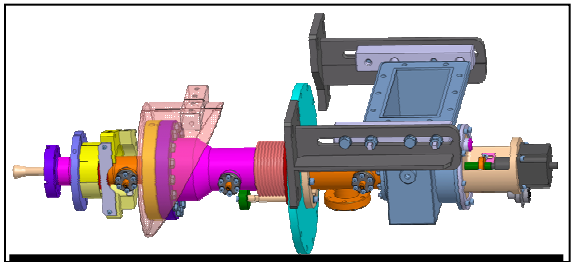
First couplers of the Pre-series (1x12)

LAL



Couplers during conditioning

IRFU



Coupler on cryomodule

2010

2011

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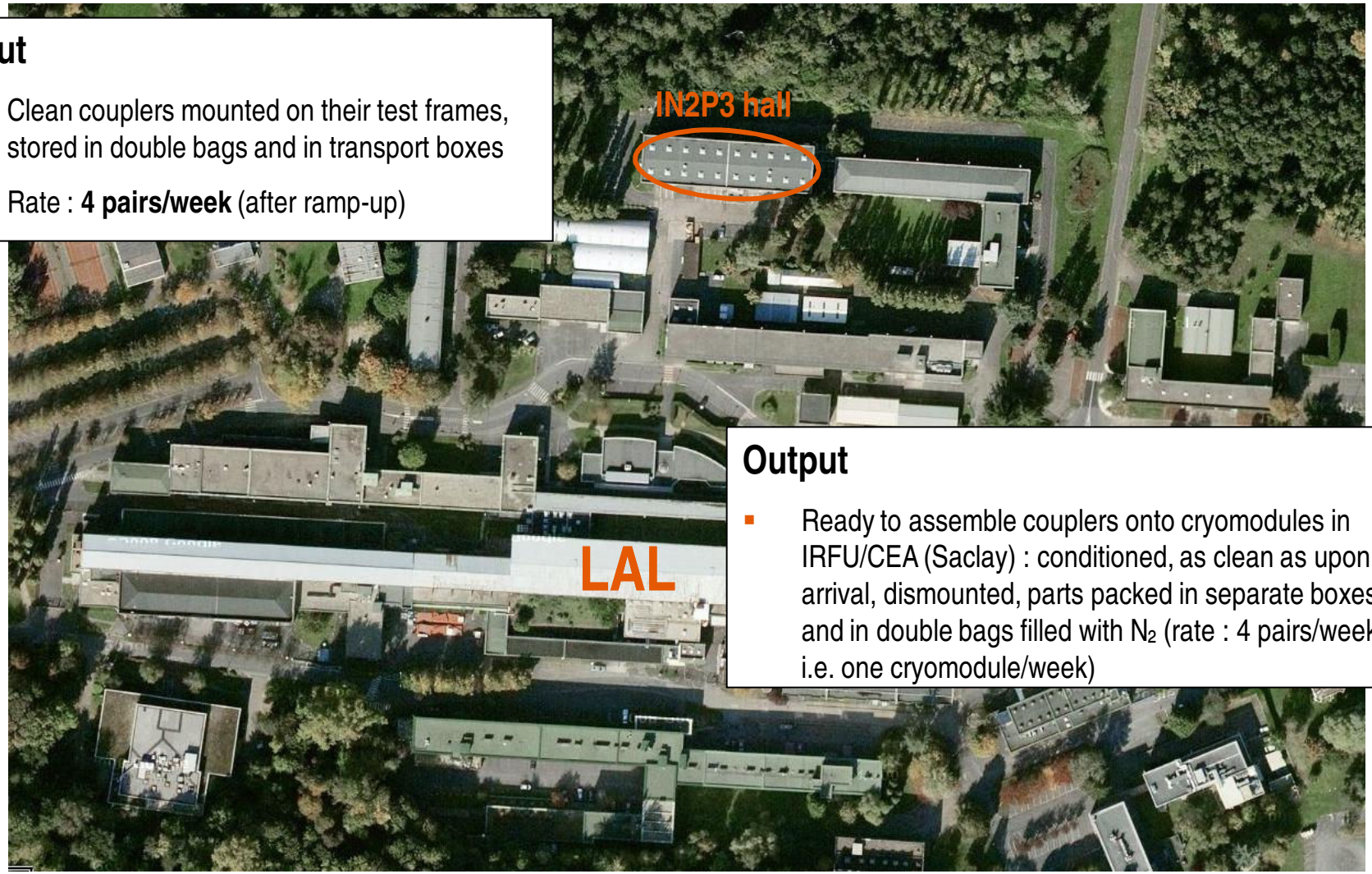
ILC HiGrade WP7 couplers

Localization

Input

- Clean couplers mounted on their test frames, stored in double bags and in transport boxes
- Rate : **4 pairs/week** (after ramp-up)



Output

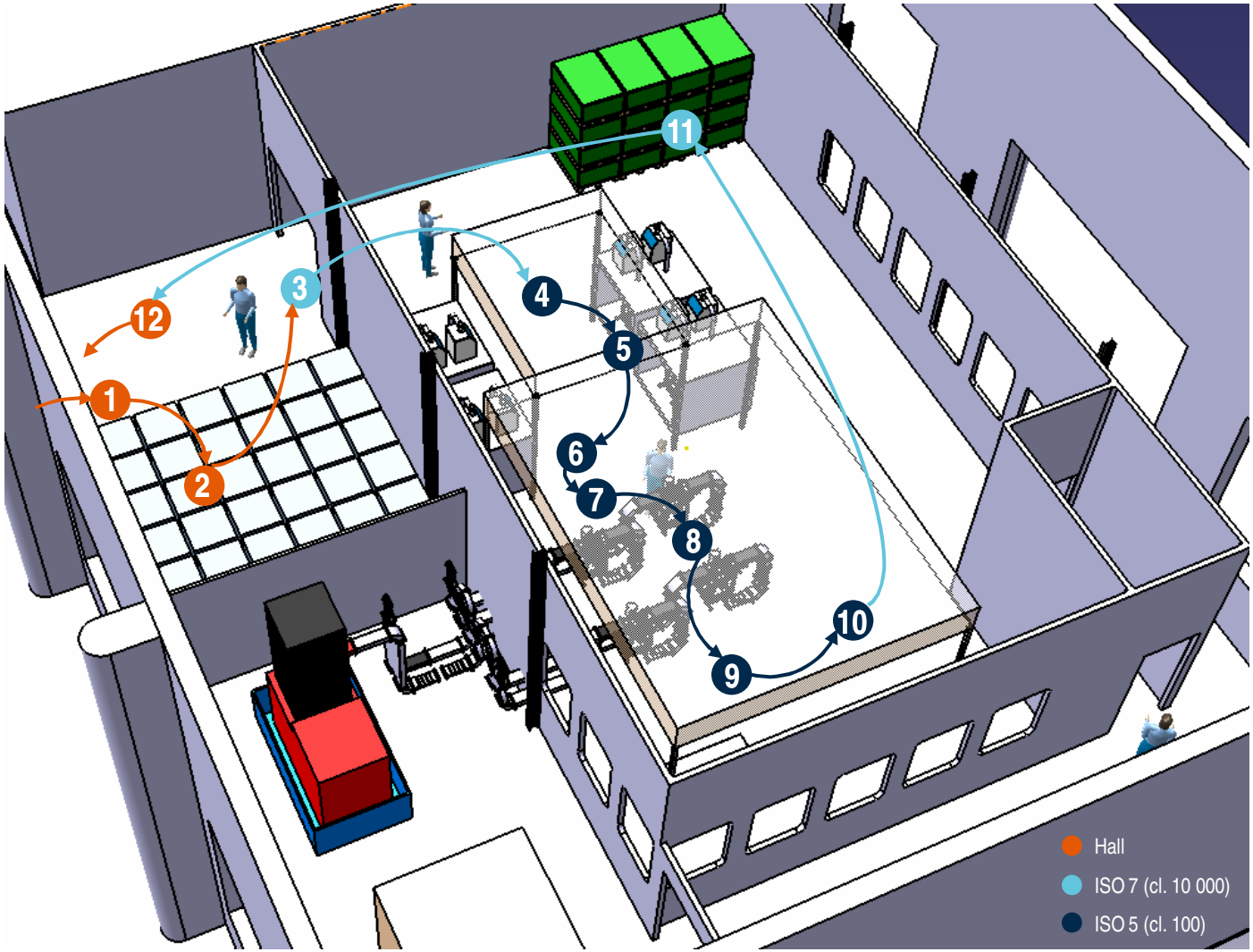
- Ready to assemble couplers onto cryomodules in IRFU/CEA (Saclay) : conditioned, as clean as upon arrival, dismounted, parts packed in separate boxes and in double bags filled with N_2 (rate : 4 pairs/week, i.e. one cryomodule/week)

E. Genesseau et al

ILC HiGrade WP7 couplers

Process and infrastructure layout at LAL

1. Reception
2. Storage
3. Unpacking (box)
4. Unpacking (bag)
5. In situ baking
6. Ionic pumping
7. Antenna adjustment
8. Conditioning
9. Dismounting
10. Packaging
11. Storage
12. Expedition

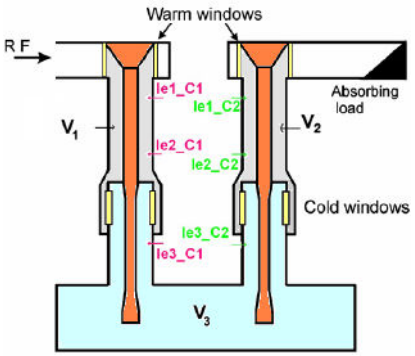


E. Genesseau et al

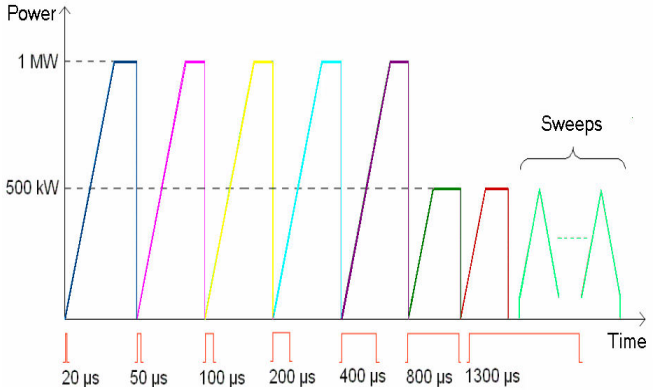
TTF3 → XFEL RF conditioning procedure

RT conditioning @LAL : traveling wave

Test stand



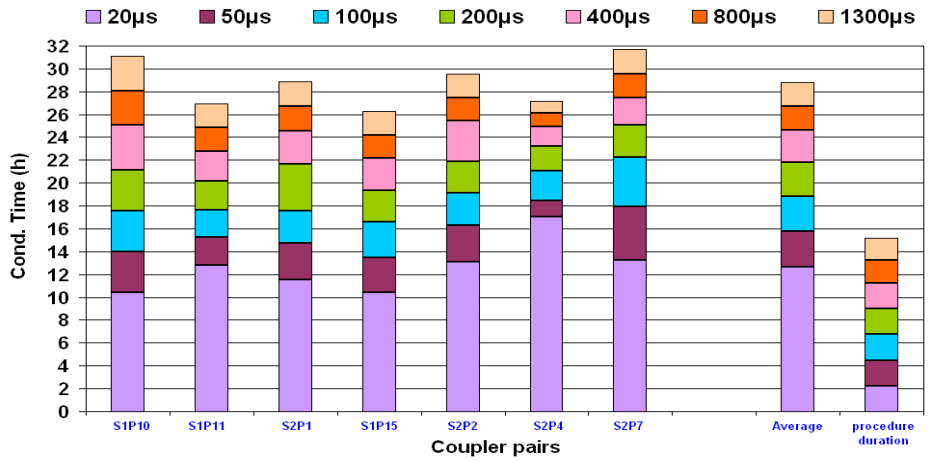
Procedure



XFEL parameters

		Original parameters	Optimised parameters
Vacuum	1st threshold (↓ 0.1 dB)	$2 \cdot 10^{-7}$ mbar	$6 \cdot 10^{-7}$ mbar
	2nd threshold (↓ 0.4 dB)	$4 \cdot 10^{-7}$ mbar	10^{-6} mbar
	IL	10^{-6} mbar	$5 \cdot 10^{-6}$ mbar
e- current IL		5 mA	
Light IL		1 lux	none
Ceramic temperature IL		85 C	
WG arc IL		If any	
Repetition rate		2 Hz	4 Hz
Control loop duration ↑ 0.1 dB		30 s	15 s

Last conditioning tests

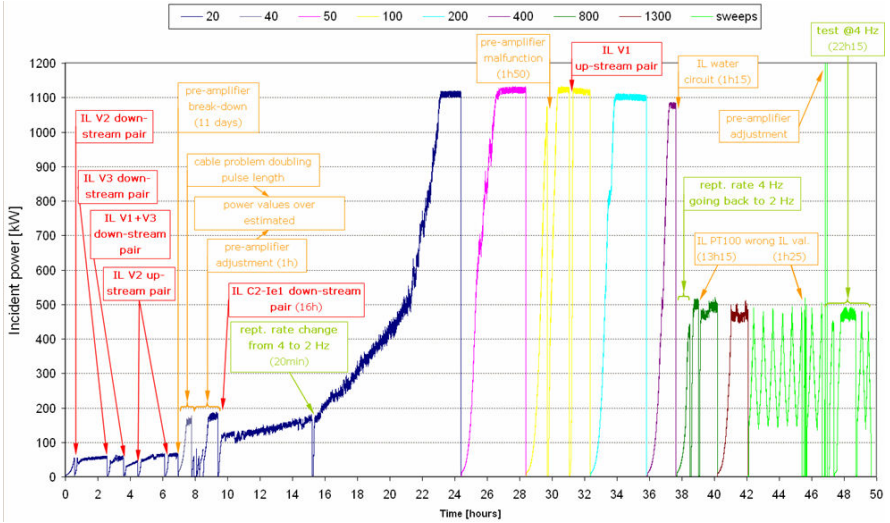


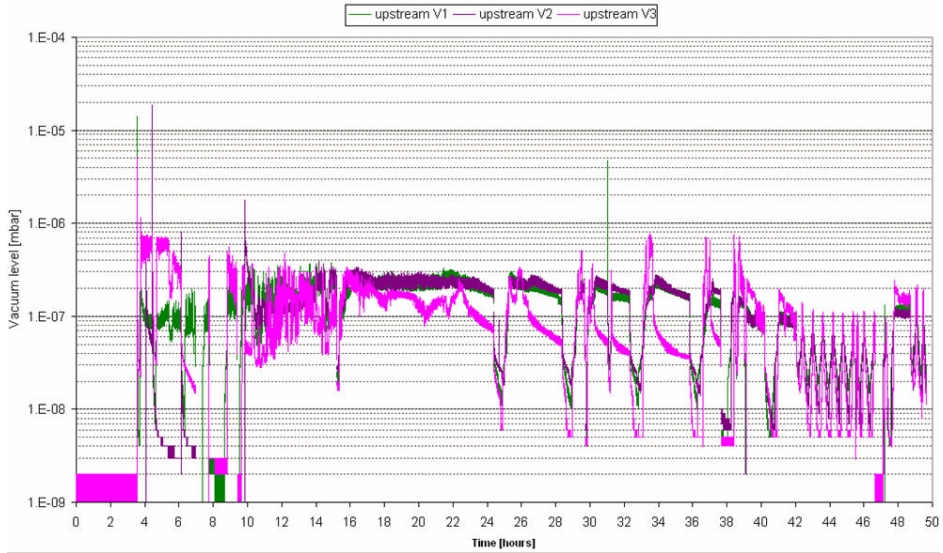
Conditioning steps	RF Power (kW)	Max. tolerated time to achieve a power level or a step (h)
20µs	0 --> 100	6
	0 --> 200	9.5
	0 --> 300	11.5
	0 --> 400	13
	0 --> 500	15
	0 --> 600	17
	0 --> 700	19
	0 --> 800	21
	0 --> 900	23
	0 --> max	$T_{max20\mu s}$ = 25
50µs	0 --> max	$T_{max20\mu s}$ +2.5 = 27.5
100µs	0 --> max	$T_{max20\mu s}$ +2.5+3.5 = 31
200µs	0 --> max	$T_{max20\mu s}$ +2.5+3.5+3 = 34
400µs	0 --> max	$T_{max20\mu s}$ +2.5+3.5+3+3 = 37
800µs	0 --> max	$T_{max20\mu s}$ +2.5+3.5+3+3+2 = 39
1300µs	0 --> max	$T_{max20\mu s}$ +2.5+3.5+3+3+2+5 = 44

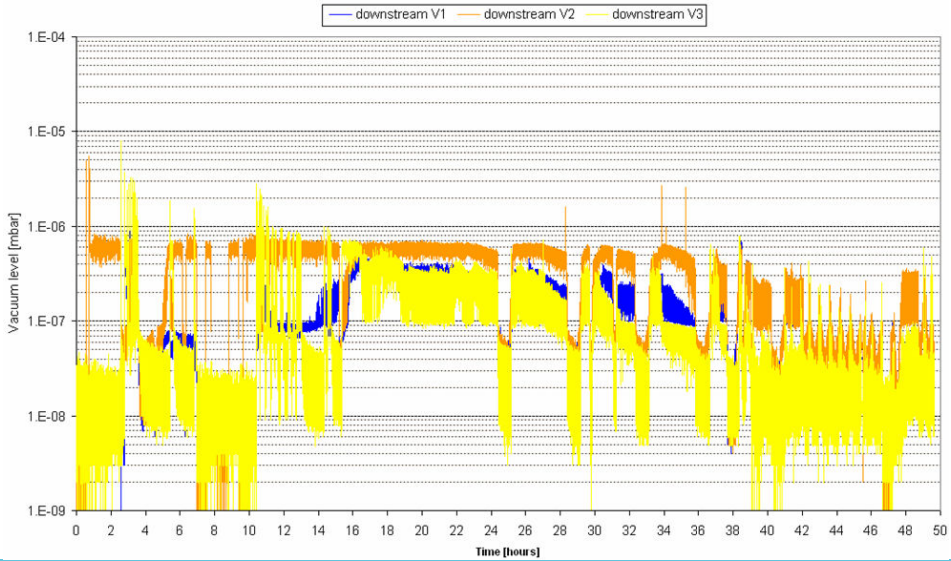
H. Jenhani et al., NIM A 595 (2008)

ILC HiGrade WP7 couplers

Conditioning of 2 pairs of TTF3 couplers in series







L. Lukovac et al

ILC HiGrade WP7 couplers

Infrastructure → Current situation

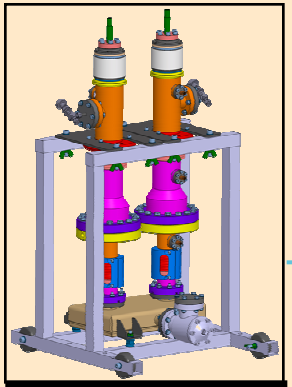
Task Name	2009	2010	2011
WP 05 Power Coupler			
In-coming Milestones			
10 Couplers Mass Production (total 808 couplers)			
RF Station at LAL-Orsay			
RF system			
RF station			
call for tender			
notification			
manufacturing, delivery, installation and commissioning			
RF station ready for conditioning			
conditioning software			
power distribution and conditioning benches			
cooling station and water distribution			
conditioning room			
preparation of XFEL area at LAL			
clean room			
air conditioning system			
laminar flows			
ovens, pumps, tooling, furniture			
Infrastructure ready for training			
Infrastructure ready for conditioning			

Station ready by January 2011

ILC HiGrade WP7 couplers

XFEL Coupler production

Manufacturer

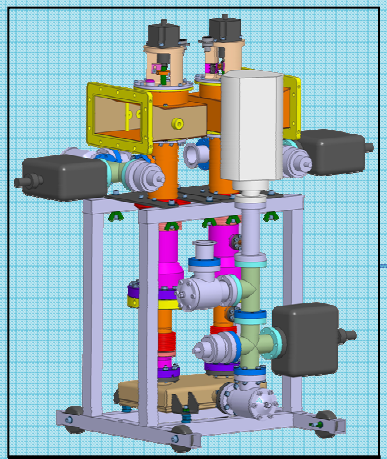


Couplers before conditioning

LAL assembly kit

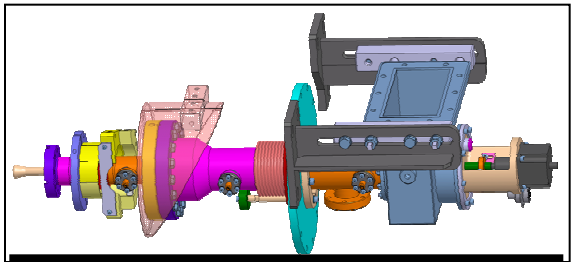
IRFU assembly kit

LAL



Couplers during conditioning

IRFU



Coupler on cryomodule

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Station Ready (January)

First delivery (February)

2010

2011

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ILC HiGrade WP7 couplers

ILC HiGrade schedule scenaries

Scenario 1

- LAL First Coupler delivery date < IRFU First cryomodule assembly date

→ In that case, all the first couplers can be delivered to ILC HiGrade

Scenario 2

- LAL First Coupler delivery date > or = IRFU First cryomodule assembly date
- Flow of coupler delivery > Flow of coupler needed at IRFU

→ In that case, a pourcentage of the couplers can be delivered to ILC HiGrade along the production but the ILC HiGrade schedule may be delayed

Scenario 3

- LAL First Coupler delivery date > or = IRFU First cryomodule assembly date
- Flow of coupler delivery < Flow of coupler needed at IRFU

→ In that case, ILC HiGrade have to wait the end of XFEL production, the ILC HiGrade schedule will be delayed

ILC HiGrade WP7 couplers

Summary

- ILC HiGrade base line strategy
- XFEL Coupler Design
- XFEL Coupler production
  - Sub-contractor: Fabrication/Cleaning & pre-assembly
  - LAL: Baking/Conditioning/Disassembly
- ILC Higrade schedule scenaries
- ILC Higrade cost scenaries

ILC HiGrade WP7 couplers

ILC HiGrade cost scenaries

Scenario 1

- Cost of 30 XFEL couplers < ILC HiGrade Budget

→ 30 couplers will be ordered, everybody is very happy!!!!

Scenario 2

- Cost of 30 XFEL couplers > ILC HiGrade Budget > Cost of 24 XFEL couplers

→ « n » couplers will be ordered (24 < n < 30), everybody is happy!

Scenario 3

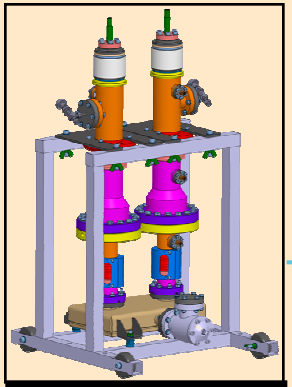
- Cost of 24 XFEL couplers > ILC HiGrade Budget

→ « n » couplers will be ordered (n < 24), everybody is looking for an **additional budget!!!!**

ILC HiGrade WP7 couplers

XFEL Coupler production

Manufacturer

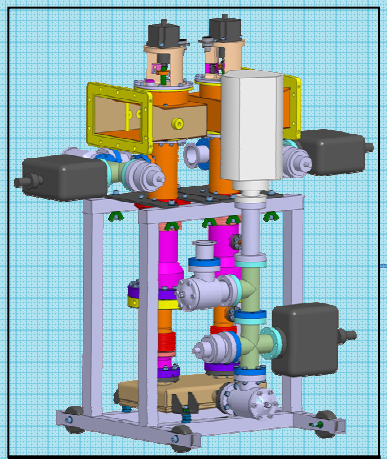


Couplers before conditioning

LAL assembly kit

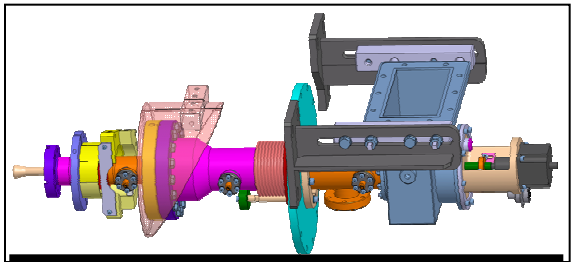
IRFU assembly kit

LAL



Couplers during conditioning

IRFU



Coupler on cryomodule

Call for tender (March)

Notifications (June)

First couplers of the Pre-series (1x12)

Station Ready (January)

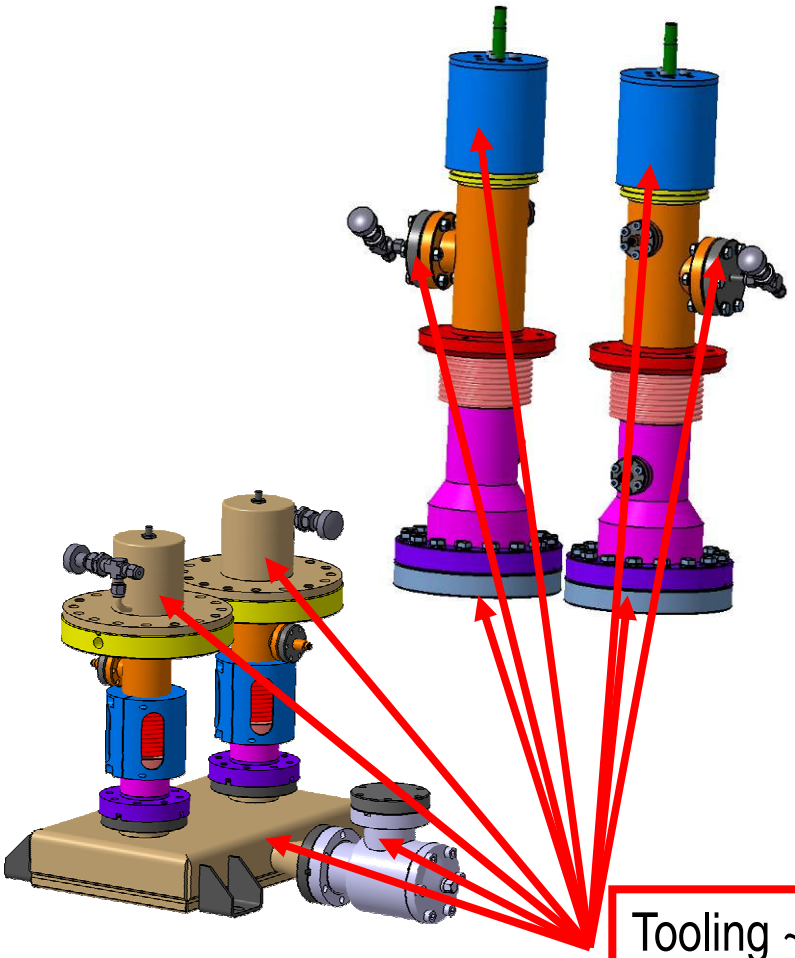
First delivery (February)

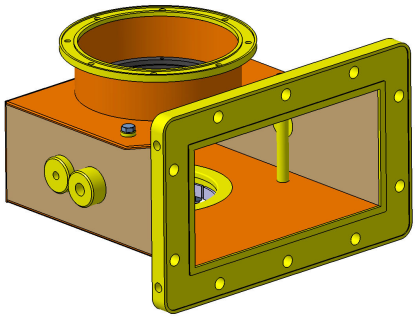
2010

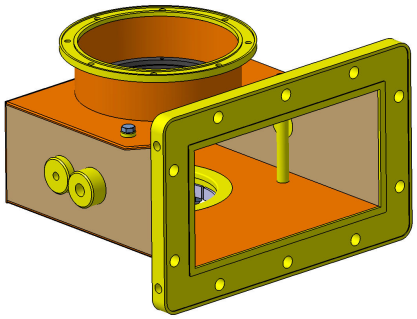
2011

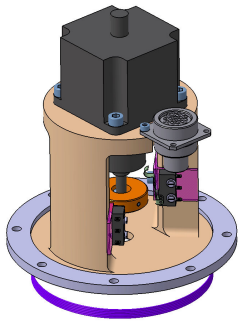
ILC HiGrade WP7 couplers

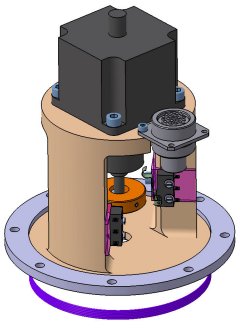
XFEL Coupler production

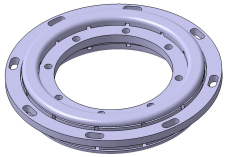


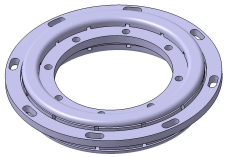








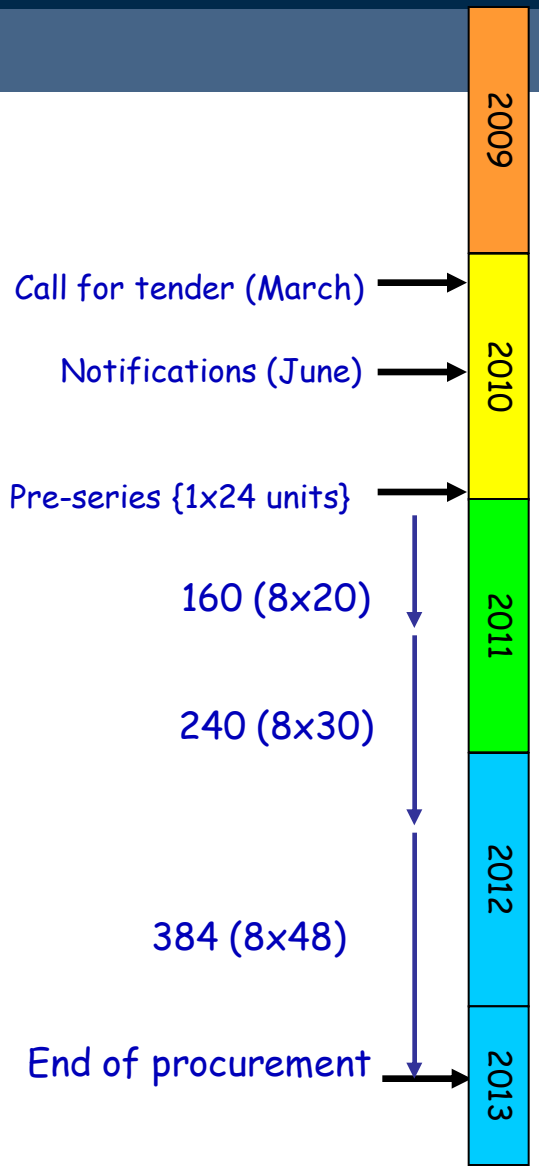




Tooling ~ 2000€ per pair

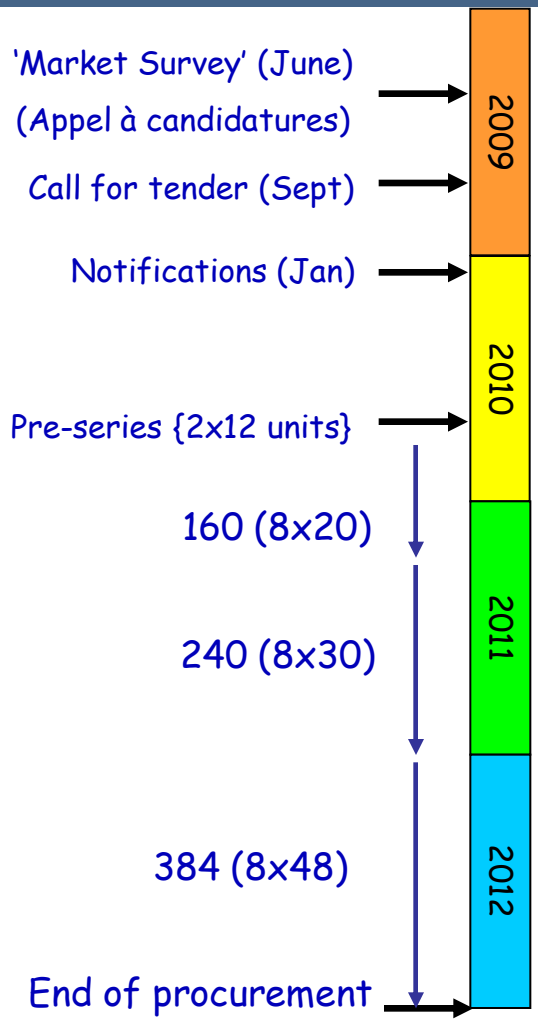
ILC HiGrade WP7 couplers

XFEL Schedule



ILC HiGrade WP7 couplers

XFEL Schedule



Delay of 6 months