CONSEQUENCES FOR ORSAY ACTIVITIES

- Processing of CPI (30) + ACCEL (10) couplers $\geq$ 6 months
- CONDITIONING STUDIES (JRA1 - CARE / FP6)
  - DC Bias sweep to provoke multipactor
  - Argon discharge cleaning
  - Ceramics coated with Zi-Va-Ti
  - Fully TiN coated coupler
  - Effect of different environments on re-conditioning times (vacuum, N_2,…)
  - Establish maximum limits of interlock thresholds
  - Effect of assembly of warm part in class 10 cleanroom
  - Central antenna as an e^- pick-up.
- INDUSTRIALISATION STUDIES
- Alternative proto-types (TTF-V, TW60).

Recommendations from the X-FEL Power Coupler meeting (1)

- It is agreed that the TTF-III coupler, in its present form, meets all the requirements of the X-FEL parameters. However, improved statistics on coupler processing times are needed.

- The infra-structure which now exists at Orsay will allow new data to be obtained on coupler conditioning times. The use of this infra-structure provides us with a perfect opportunity to address this issue.

- Detailed conditioning studies should be performed using some of the 30 couplers from CPI and/or some of the 10 couplers from ACCEL.

- The principle of varying the coupler to cavity coupling by changing the penetration depth of the antenna is retained.

Can we do better than TTF-III ?

→ Probably yes !

Example. TTF-V ≡ TTF-III warm part + 60 mm ϕ cold part.

But! What are the *boundary conditions* ?

- module design
- cavity flange
- schedule!

Development time for new coupler

i.e. design + proto-type tests ~ 2 years (W-D. Moeller, X-FEL mtg. 24/11/03)

+ Industrialisation studies (S. Prat).

→ CONCLUSION

↳ TTF-III is O.K.

Which Coupler for the European X-FEL ?

→ Decision; to be taken by the project study management.

→ Recommendation; from this meeting!

Options - TTF-III coupler as it is.
- TTF-III coupler "slightly" modified.
- Radically new design.

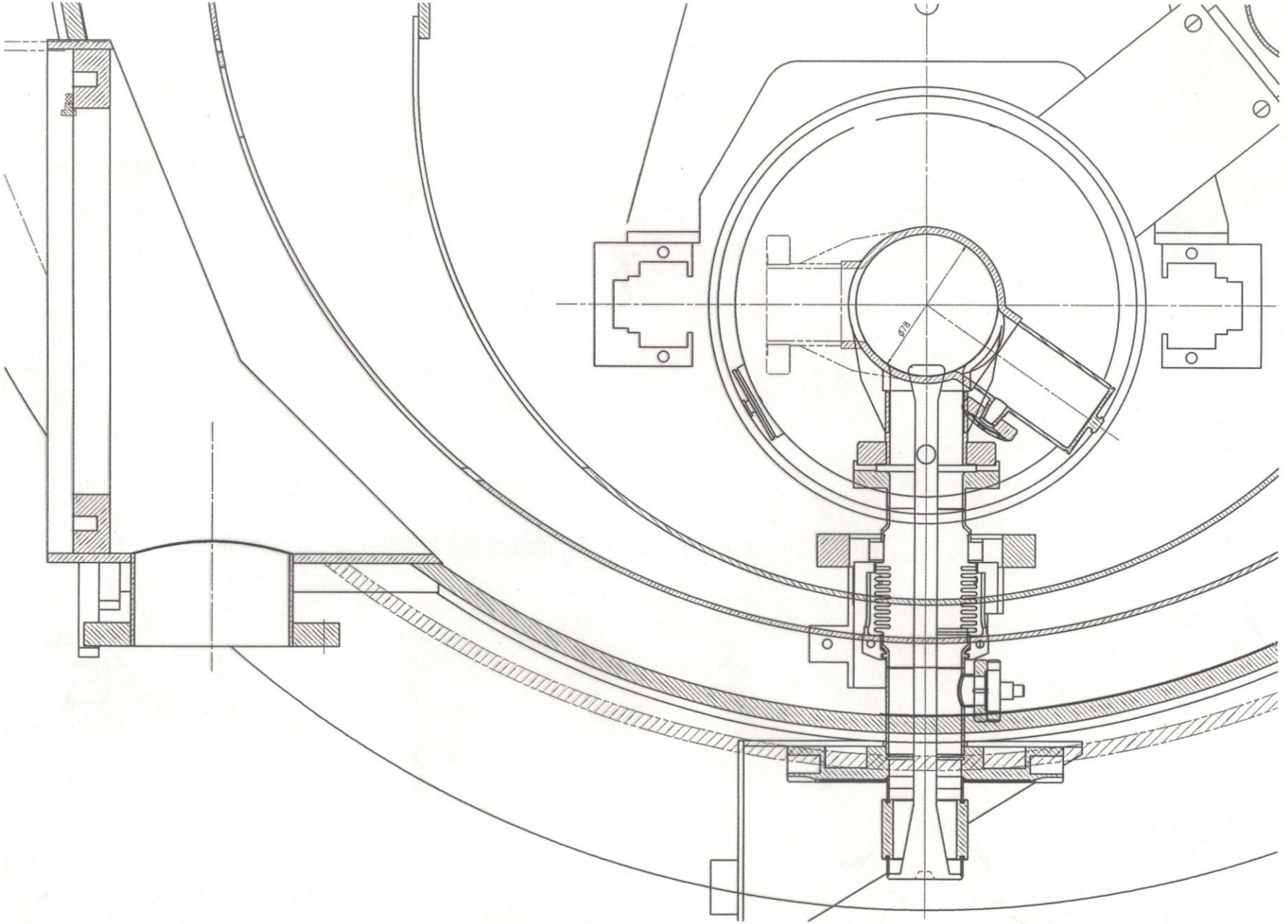
What are consequences in each case? - schedule,
- performance / cost.

Industrialisation perspectives
Topics of development
- 1 -

Alternative design from HF specifications

- Determine maximum acceptable tolerances
- Design for « manufacturability »:
  - identify necessary functions
  - identify possible options for design
  - seek functional simplicity :
    - to minimise the number of parts
    - use standard products whenever possible
    - design for ease of assembly
    - design for ease of control and test
    - in view of packing and transport
  - design acording to methods of fabrication (machining, welding, brazing)
  - material choice

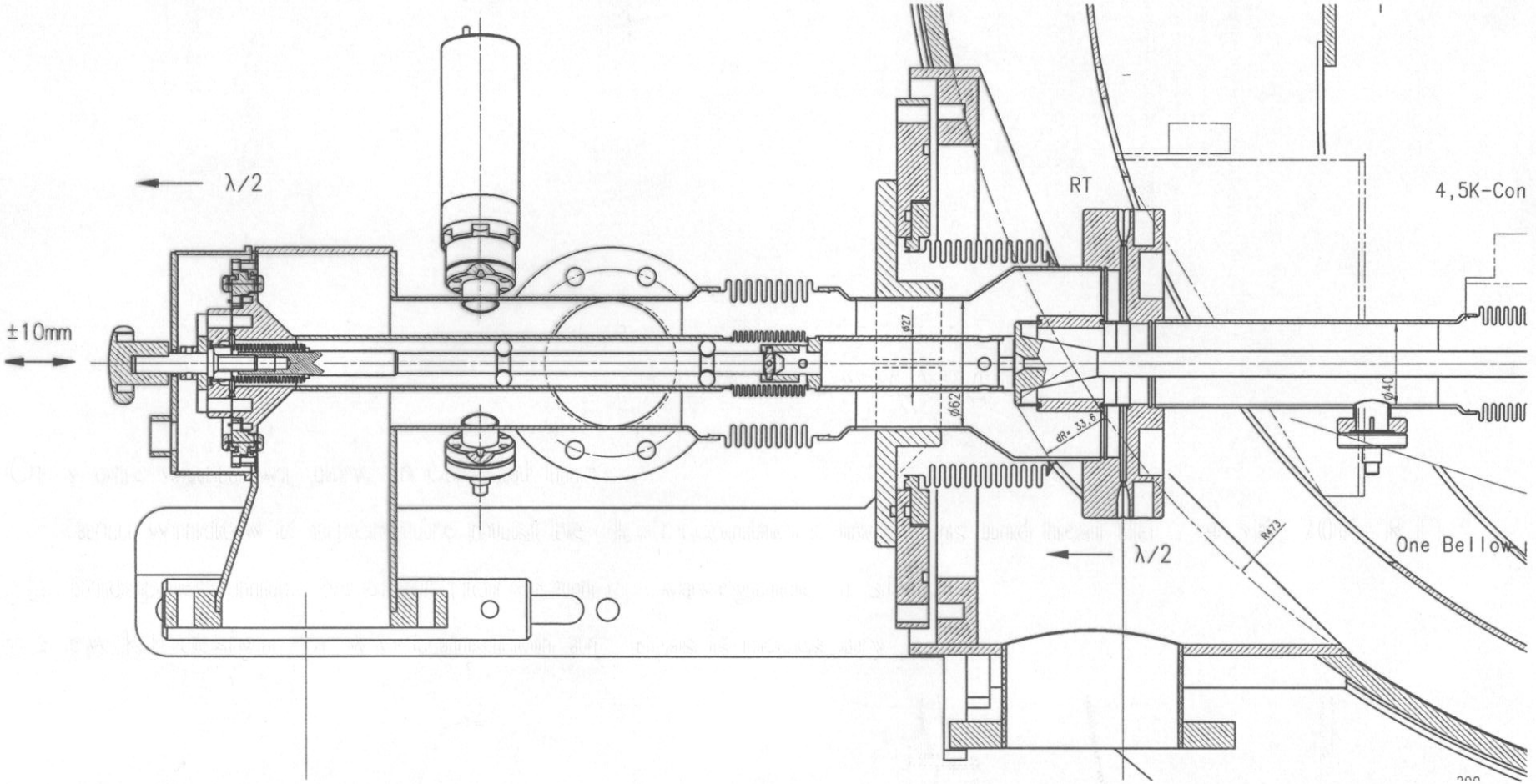
(Rotate cold part in down position) → But Beam Kick!



One window design

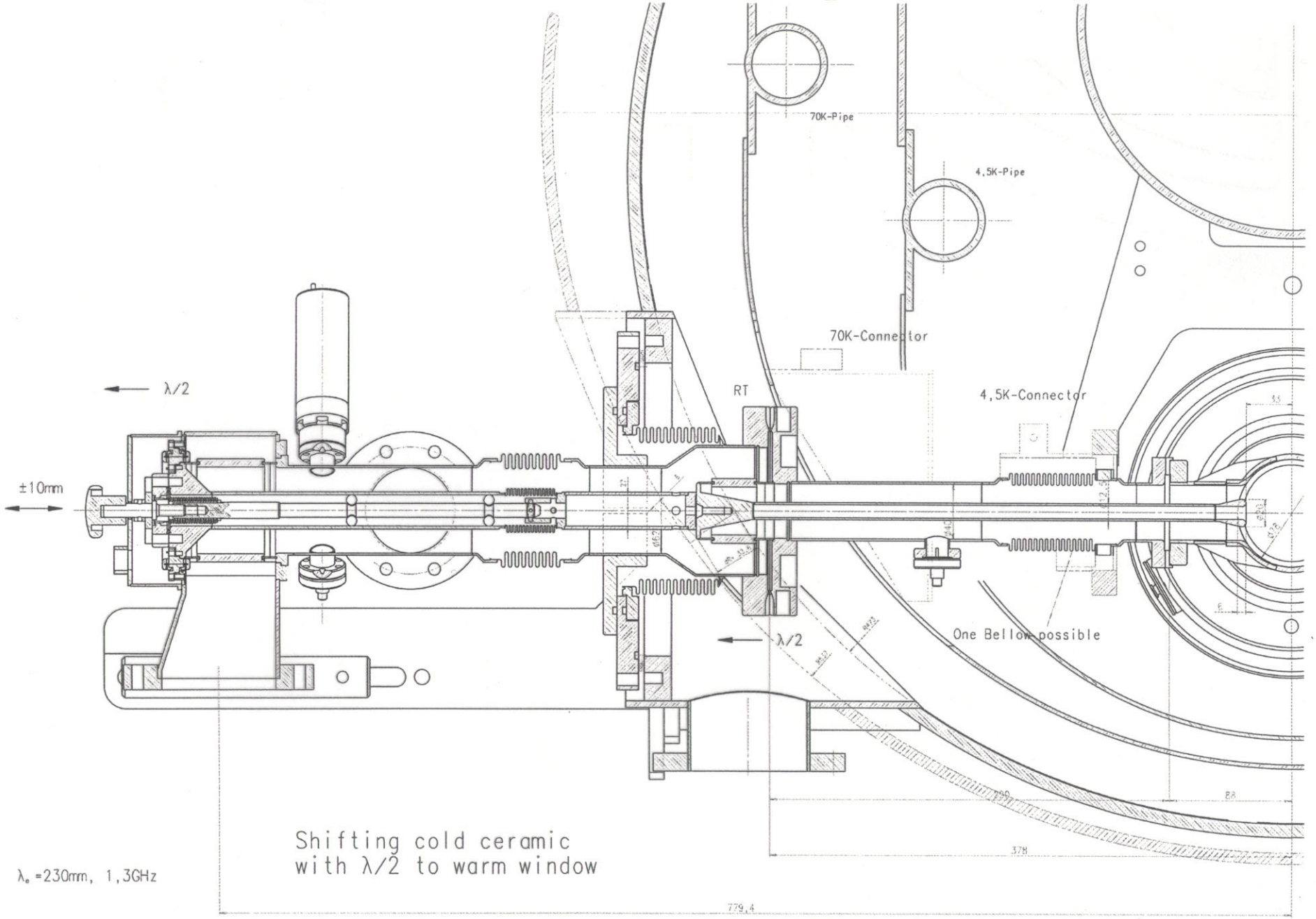
Only one warm window in coaxial line:

- Warm window temperature must be clear (contact conditions and heat flow: 4.5K, 70K, RT)
- Atmosphere must be clear (for example waveguide in SF6)
- New RF design for WG transition and Bias is necessary



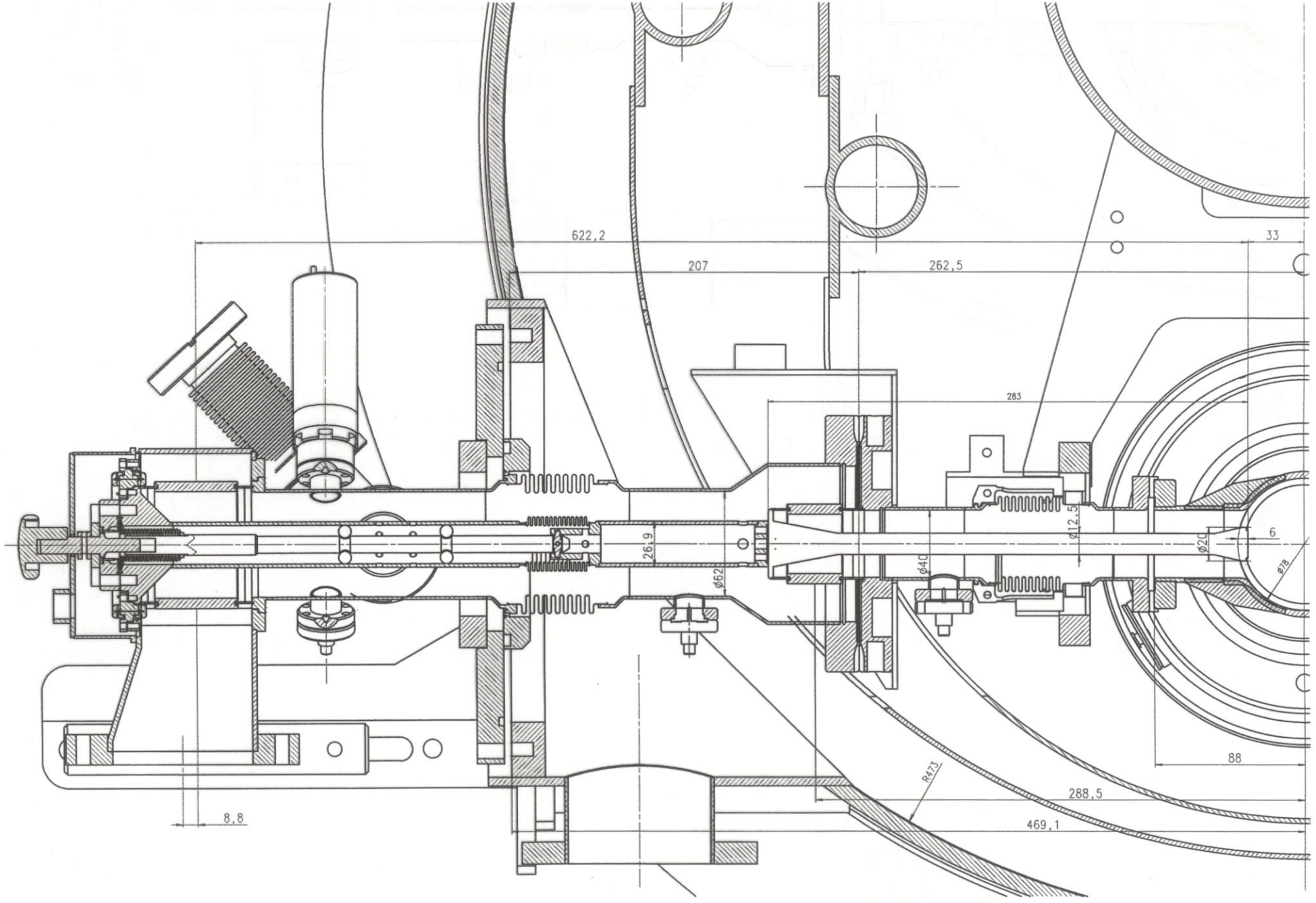
C. MARTENS

Shifting cold window in warm position



C. MARTENS

TTF-coupler-III in Detail



Variation of External Q

Need coupler range from $1.5 \times 10^6 - 1.5 \times 10^7$. OK for TTF-III.

Can be done with adjustable antenna or stub tuner (both need remote control).

Stub tuners needed in any case for phase adjustment.
Cost reduction by eliminating adjustable antenna (but not much).

V. Katalev – survey of WG tuners: Stub, 3dB Hybrid, magic-tee.

A. Labanc – Field enhancement due to stub O.K. Sufficient phase variation.

Three stub tuner for TTF

J. WOJTKIEWICZ

Pumping Speeds (Jerzy's summary)

- Geometry of warm coupler part reasonable w.r.t. conductance.
- Pump speed in module dominated by coupler connection
- Pump speed in CHECHIA dominated by pump line
- * *Effective pumping speed in CHECHIA a factor 2 lower than in module!!!*

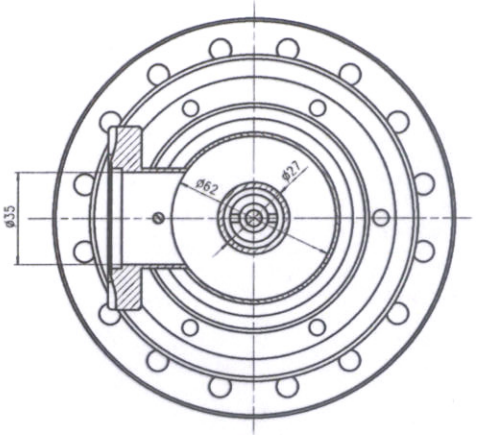
Despite CT faster in CHECHIA than in module.

Design of Pumping Port

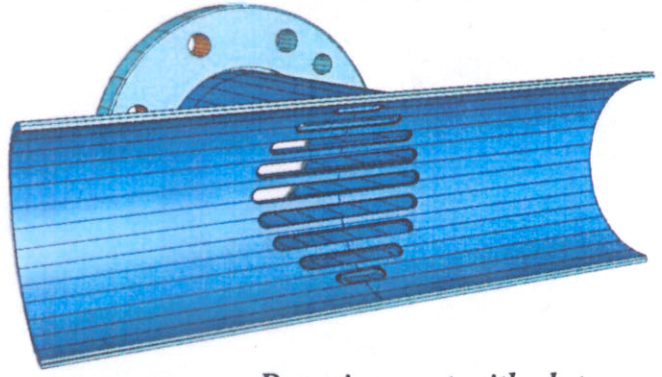
- How to increase pumping power:
  - bigger crossection
    (CF63 instead of CF35, CF63 cutted)
  - increase number of pumping-ports
    for example: 4mm Slots, 9x

Version	Crossection/mm² (%)
Koax Ø62x27	2447 (100%)
CF35 (TTF-Coupler III)	962 (39%)
CF63, 9x slots	1433 (59%)
2x CF63, slots	2866 (117%)

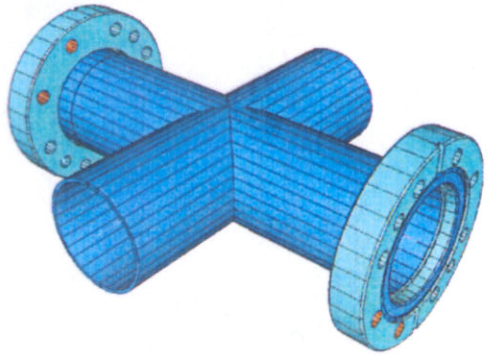
Tab: Koax. crossection and pumping crossections for diff. designs



Crossection of „warm part“



Pumping port with slots



Two instead of one port

4. Summary

1. Developed MP calculation tools (MultiPac) allows MP levels determinations at coupler design stage.

2. TTF III coupler tests: MP levels found around 150kW, 250kW, 450kW in the warm coupler part, 150 and 450kW in the cold coupler part (not in the all tests). Calculations also show MP near to this power levels. Those levels are not dangerous.

3. Applying the high voltage (HV) between inner and outer coax parts of negative value down to –3.5kV caused lots of activity and general deterioration of coupler performance, while positive values of HV up to +3.5kV made almost no difference to no HV at all, just shifting of the multipacting levels as it must be. So, as a conclusion, we don't need HV to operate the coupler.

4. It is clear, that TiN coating of the ceramic windows dramatically reduces MP in TTF III coupler.

Proposition for 'in-situ' bake-out scheme in module at 150 °C.

→ problem for thermal shields, cables, super insulation…
→ suggest 'thermal switch' operated by gas pressure to disconnect coupler from shield during baking.

- RGA – initially shows H_2O, H_2*, CO, CO_2 + hydrocarbons. Baked coupler shows less water content.
- Survey of surface dependent SEC by D. Kostin (based on work of N. Hilleret).
- Multipacting - not a problem for power levels of interest. Also have DC bias.

* survives longest

PROCESSING

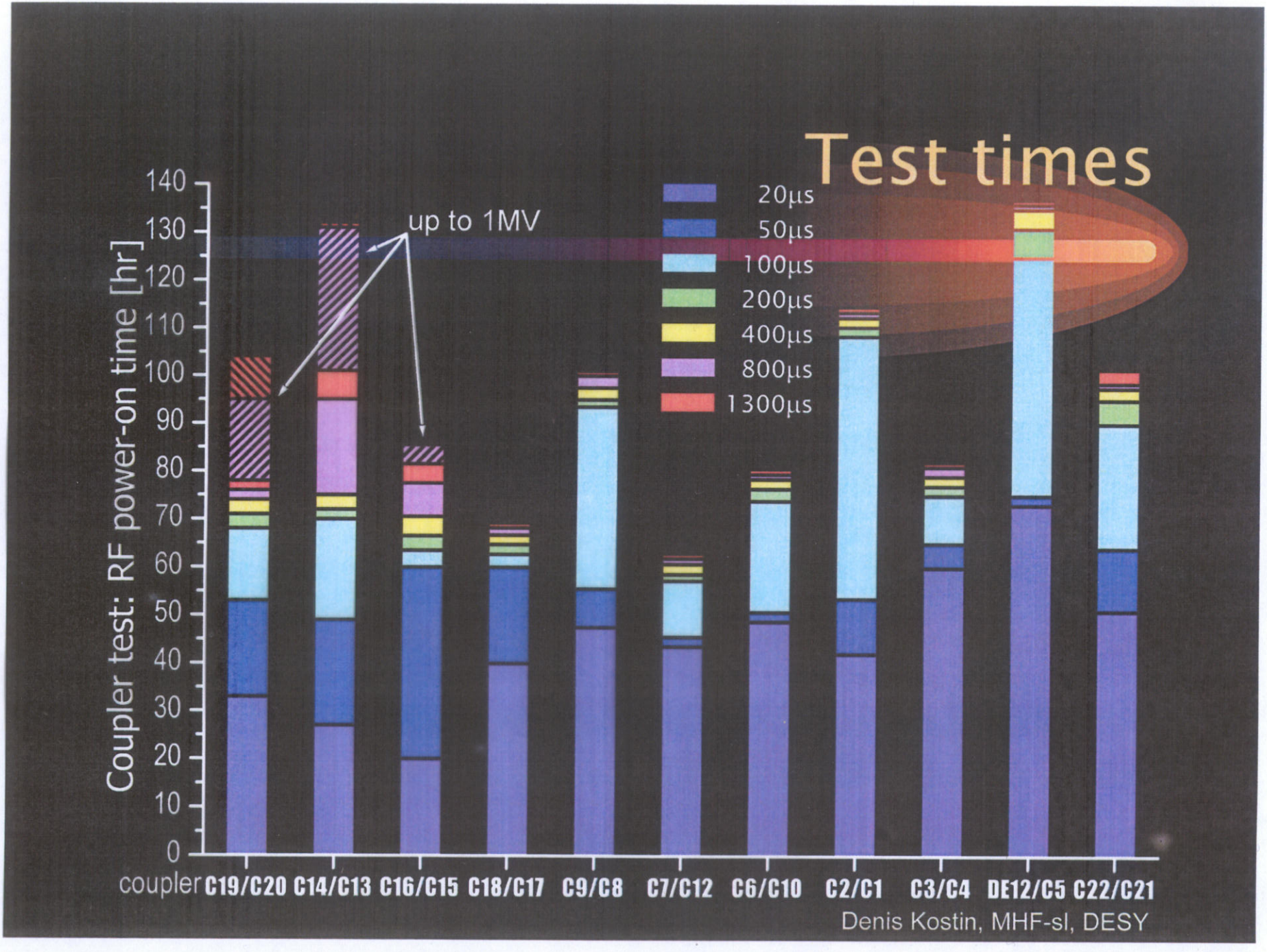
Fastest conditioning time (CT) demonstrated in CHECHIA (~ 20 hours).
In-situ bake-out and dedicated klystron in this case.
But CT can be ~ 6 days employing DESY 'recipe'. → See Kastin chart.
CT dependent on interlock levels. Are they too severe?
↳ To be investigated!

Difficult to compare experience with TTF-III couplers on module. Processing is in parallel with other module.

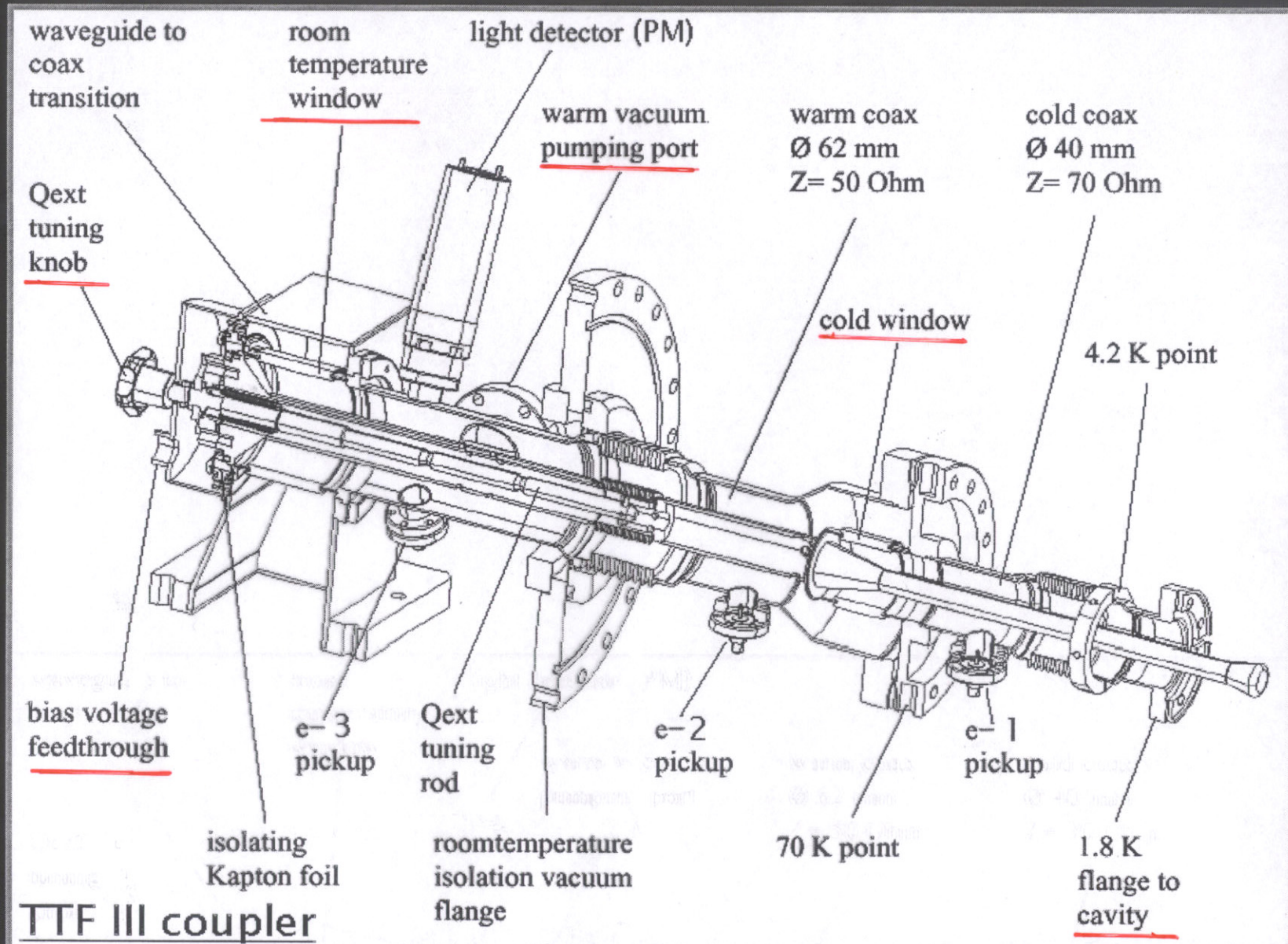
Processing experience at CERN / LANL / KEK / TJNAL - see advantages of
smaller static vacuum,
power dependent interlock thresholds,
'in-situ' baking (all labs use it) → received wisdom (cf. M. Seidl talk).

But 'in-situ' baking inconclusive on CHECHIA. Varies from 20 ~ 100 hours (baked),
~ 100 hours (un-baked).

Re-processing – importance of storing couplers correctly; must strictly limit exposure time to air.
c.f. TTF warm parts


Test times
up to 1MV
20µs
50µs
100µs
200µs
400µs
800µs
1300µs
Coupler test: RF power-on time [hr]
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
coupler
C19/C20
C14/C13
C16/C15
C18/C17
C9/C8
C7/C12
C6/C10
C2/C1
C3/C4
DE12/C5
C22/C21
Denis Kostin, MHF-sl, DESY

Sensors layout



TTF III coupler

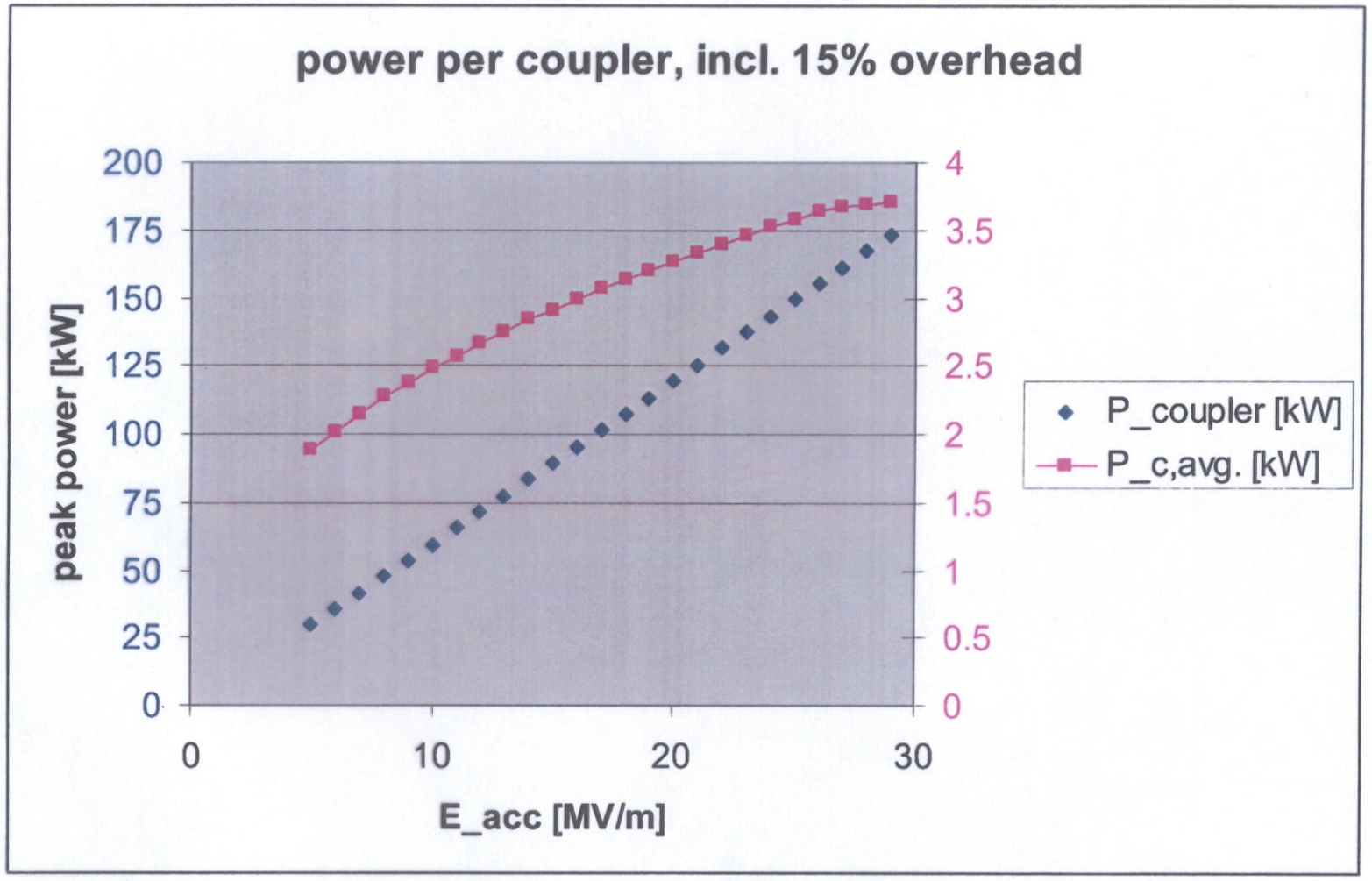
R. Brinkmann

Summary

An RF coupler with the following capabilities would cover all presently conceivable operating parameters for the XFEL linac:

150 kW peak power, 3.5 kW average power, tuning range for $Q_{ext} = 1.5 \times 10^6 - 1.5 \times 10^7$

If 3-stub tuners can provide a tuning range by a factor of three in both directions, a fixed coupler at ~ 4.6×10^6 would be acceptable



Note: average power includes filling time!

RF coupler parameter range for XFEL linac

(design status Nov. 2003)

R. Brinkmann

RF coupler workshop, Nov. 25, 2003

W. D. Moeller

we have to answer following questions:

1. Do we need a new coupler design?
2. If yes, how should the new coupler look like?
3. Is only a modification of the TTF3 coupler necessary?
4. If yes, what has to be changed?
5. What is the impact on the module design?
6. What are the time and manpower needed?

We will prepare a written recommendation on this issues

Points for discussion

Processing experience -	D. Kostin
residual gas analysis (TTF-III and elsewhere),	D. Kostin
multipactor / secondary emission coefficients,	D. Kostin
conditioning procedures (at different laboratories).	P. Lepercq
Vacuum pumping speed – is it sufficient?	J. Wojtkiewicz
Bake-out practices	M. Seidel
D.C. voltage bias – do we need it ?	
'In-situ' bake-out – proposal	J. Hauschild
Cold vs. warm windows	C. Martens
How to vary Q_{ext} – adjustable antenna or WG stub tuner ?	A. Labance / V. Katalev
Commissioning experience.	W.D. Moeller
Industrialisation.	S. Prat

Motivation for the meeting

- Perception that the coupler processing time is too long

- Coupler cost is too high!

→ *Need to carry out industrialisation studies* (S. Prat /LAL proposal).
(recommendation from DESY/LAL Coupler Steering Committee, 1/10/03,
- fix coupler design before performing industrial studies).

Existing candidate: TTF-III coupler

- capable of handling the power necessary for the X-FEL
- little operational experience to date

Summary of the X-FEL Power Coupler Meeting

Held at DESY on the 25th and 26th November, 2003.

T. Garvey
LAL – Orsay

Participants ~ 20 DESY, 6 LAL.

Objective : Fix (once and for all) the architecture of the X-FEL coupler.

Review requirements.

Review experience at DESY and elsewhere.

Recommendations from the X-FEL Power Coupler meeting (2)

- We recommend the development of a proto-type "in-situ" bake-out system as proposed during the meeting. The proposed system should have only a minor impact on the cryo-module design.

- We agree that modifications to the module and cavity input flange should be avoided.

- We recommend that industrialisation studies, aimed at reducing costs for large series production, should be launched. These studies should include a review of the demanding technical specifications, especially regarding tolerances, which are presently required.