CARE JRA1 SRF

Work-packages 7 to 11

- COUPLERS
- TUNERS
- LOW LEVEL RF
- CRYOSTAT INTEGRATION TESTS
- BEAM DIAGNOSTICS

Treated in highlight talks
by P. Sekalski and S. Simrock

WP7 - Power Couplers

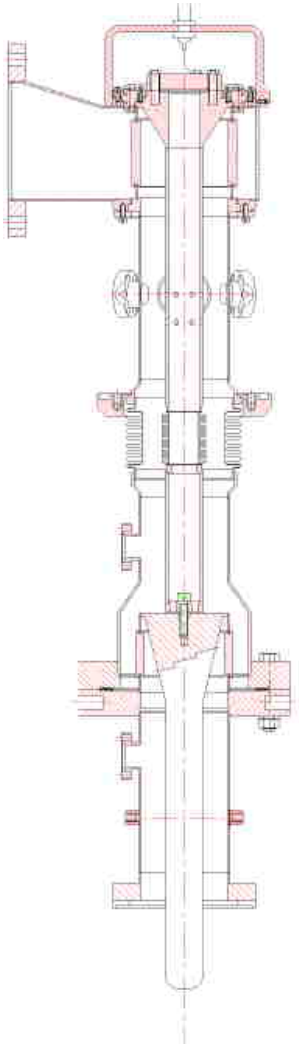
- Three main tasks (LAL-Orsay)*
  - Design and construction of new proto-types
  - Conditioning studies
  - Construction of titanium-nitride coating bench

* with invaluable advice from colleagues at DESY

New proto-types

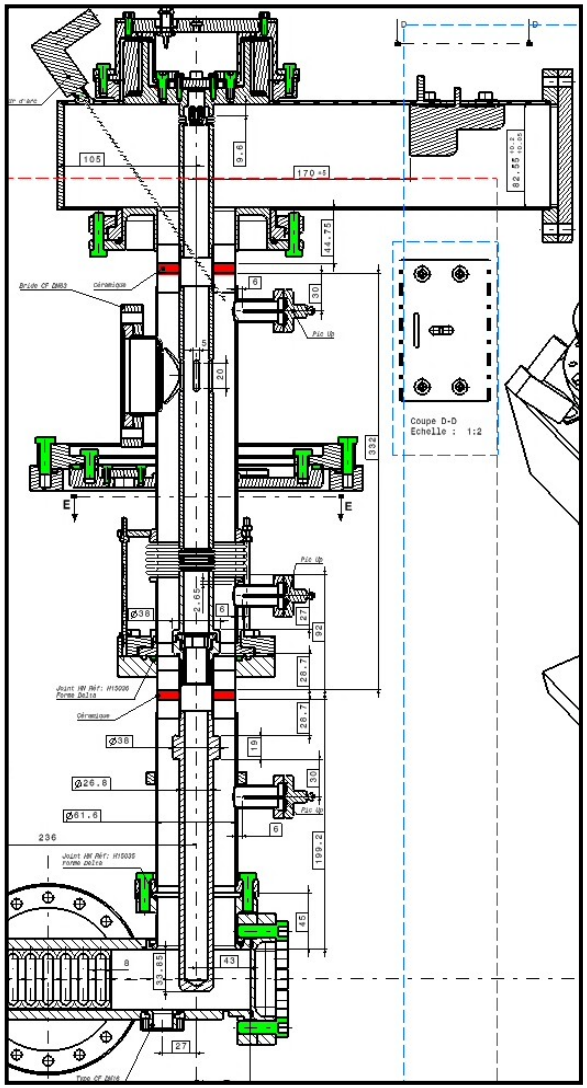
- Three new proto-type designs
  - TTF-V coupler – based on TTF-III design
    - proto-types in construction
  - Traveling Wave 60 mm coupler – different window architecture,
    - proto-types in construction.
  - "Modified" TTF-III coupler,
    - engineering drawings only

TTF-V Proto-type



- Essentially = TTF-III “warm” part + 62 mm ϕ “cold” part.
- Increased diameter for higher power handling and to push back multipactor power levels.
- Candidate coupler for a two x 9 cell ILC cavity
- Engineering drawings and technical specifications completed.
- Tender exercise won by ACCEL
- Four such couplers will be built for high power tests. Delivery in spring 2006.
- Will be subsequently used for studies on RF conditioning times.

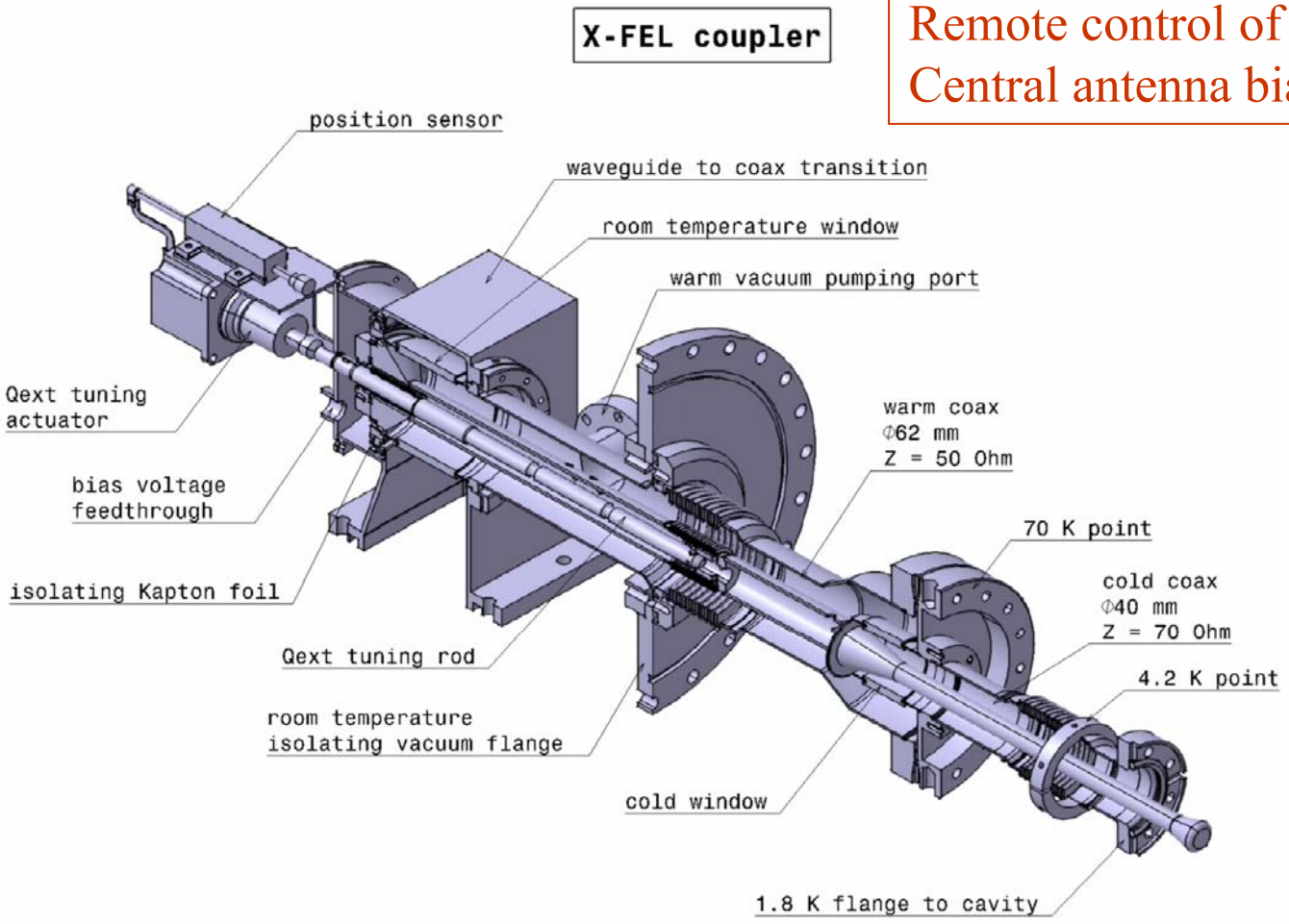
TW60 Coupler Proto-type



- Radically different from DESY coupler
  uses “thin” planar ceramic windows.
- Warm transition is matched with reduced-height wave-guide.
- Cold window matched with reactive impedance elements on inner co-ax.
- Four couplers to be built by ACCEL.
- High power tests planned for 2006. Delivery in summer 2006.

Modified TTF-III coupler

Reduced fabrication tolerances.
Remote control of Q_{ext}.
Central antenna biased for e^- p.u.



Titanium-nitride coating bench

DESY bench

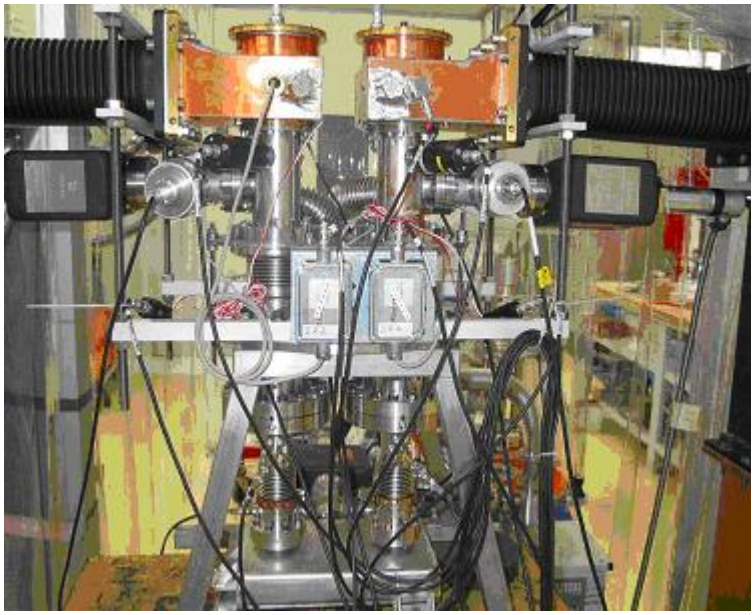
Industry to be consulted with view to building bench "***according to specification***"

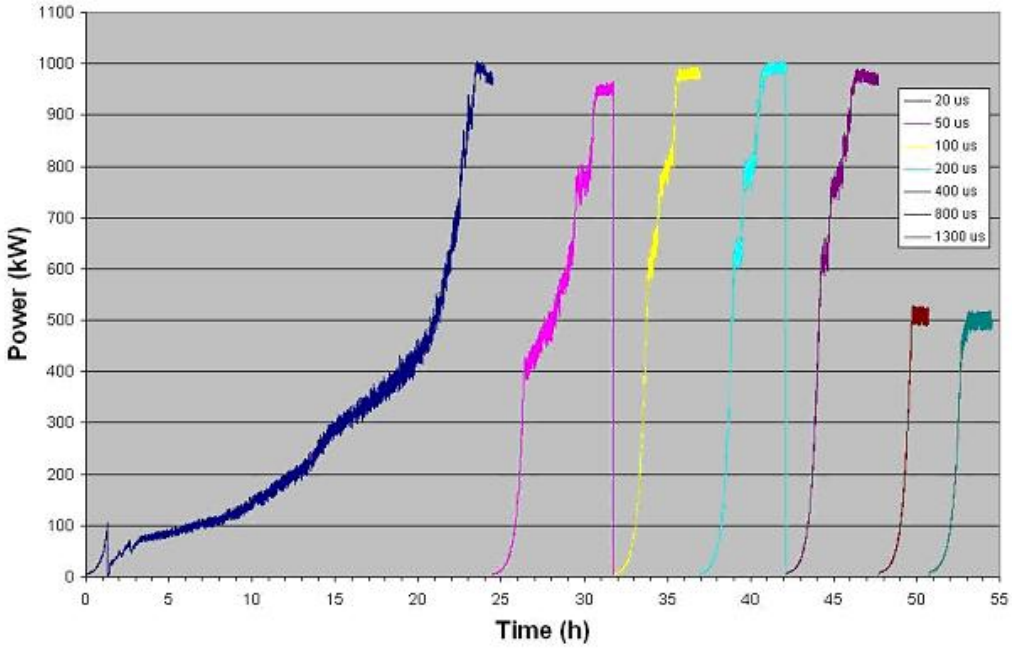
Full technical specification written.
First contacts with potential suppliers.
They all propose coating by sputtering.
Windows to date coated by evaporation.
We will perform tests on sample ceramics to evaluate sputtering w.r.t evaporation.
Delivery time ~ 6 months.

Alternative approach – collaborate with CARE partners, DESY INFN-Legnaro, on "home-built" system.

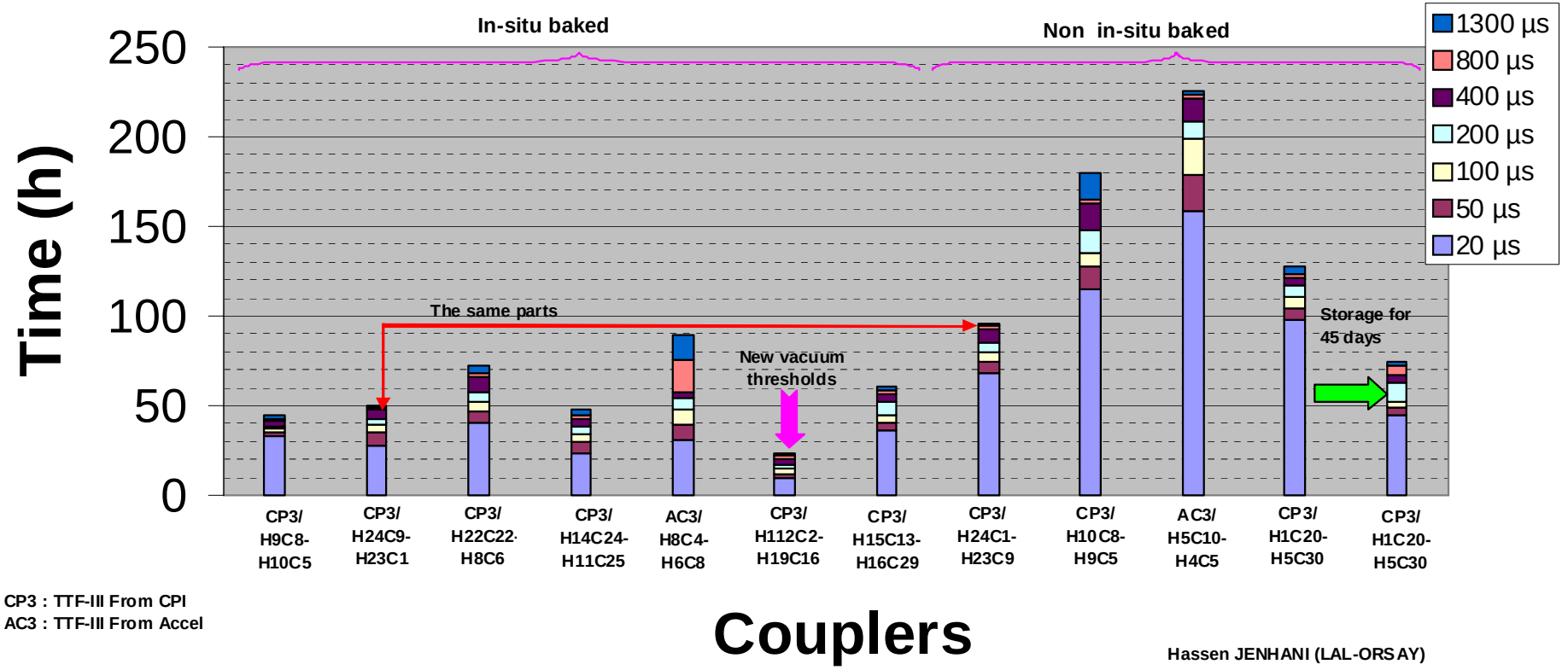
Conditioning of TTF-III couplers

Controlled incrementing of amplitude and length of RF pulse to their full operating values.





The conditioning time



CP3 : TTF-III From CPI
AC3 : TTF-III From Accel

Hassen JENHANI (LAL-ORSAY)
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Why are the required conditioning times not all the same?

WP 8 Tuners

CEA, DESY, INFN-Milan, IPN-Orsay, TU-Lodz

Main goals - (see highlight talk by P. Sekalski)

- Development of fast tuners based on piezoelectric and/or magnetostrictive elements.
- Fast and slow tuner integration.
- Aim to develop tuners capable of compensating 1 kHz of detune, allowing the cavities to operate in a stable fashion at 35 MV/m.
- Long lifetime is a major issue - aim to develop tuners allowing 10 years of operation.

WP8 conclusions

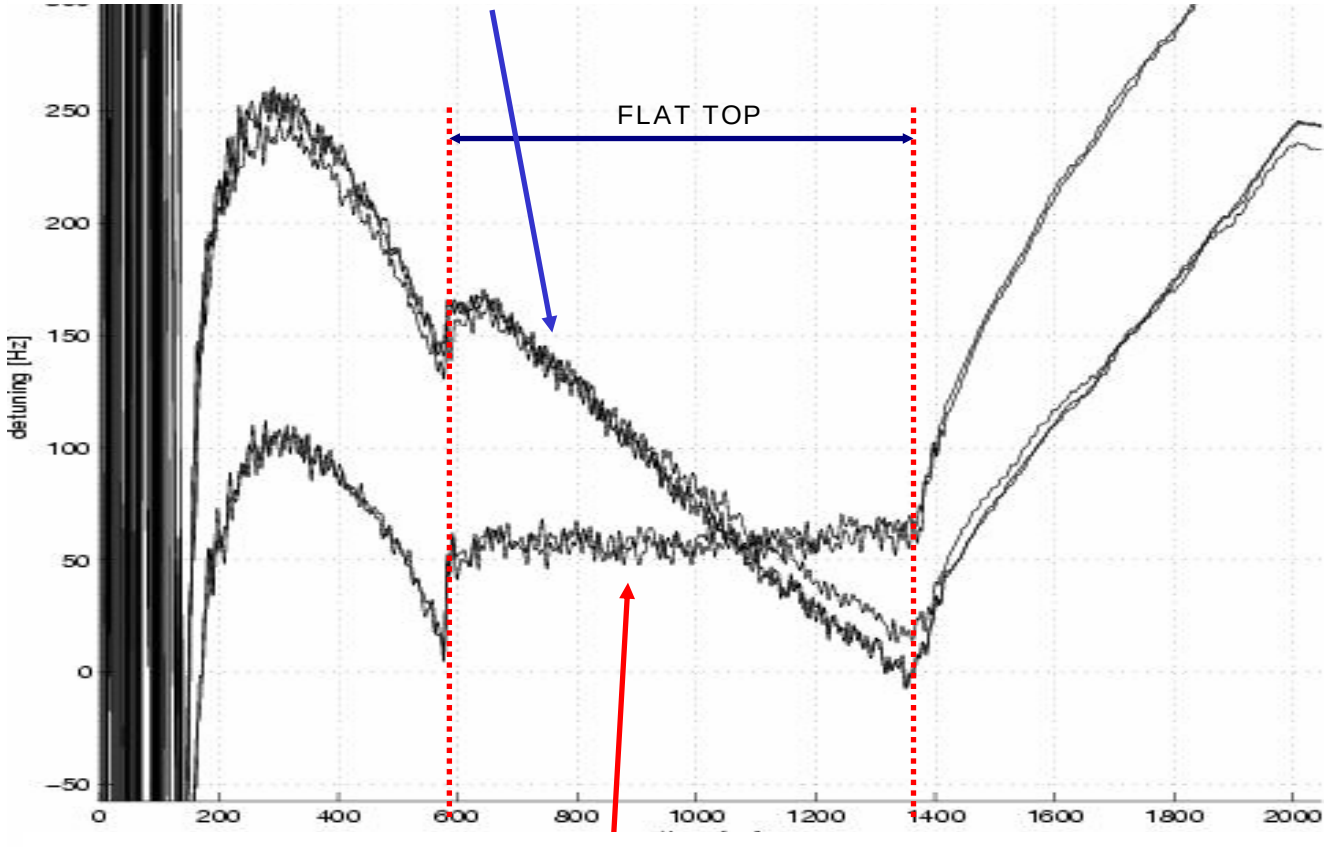
Piezo Tuner System (CEA) and Blade Tuner (INFN) will be **ready** for cold test with cavities **in 2-3 months**.

Piezostack characterization is almost finished (IPNO). Tested actuators are immune to radiation, may work for required lifetime and fulfill requirements for **VUV-FEL**, **X-FEL** and **ILC**.

The magnetostrictive tuner (TUL) was run successfully at LHe temperature. Ready for test with a cavity in one month.

Automatic feed forward algorithm for piezostack-based system for Lorentz force compensation works correctly (DESY, TUL). It damps detuning from 180Hz (15MV/m) down to below 10Hz in **2 iterations**.

Detuning without piezo compensation ≈ 180Hz



Detuning with piezo compensation < 10Hz

Measurement done in cavity 5, ACC1 VUV-FEL

field gradient ~20 MV/m

WP9 – Low Level RF

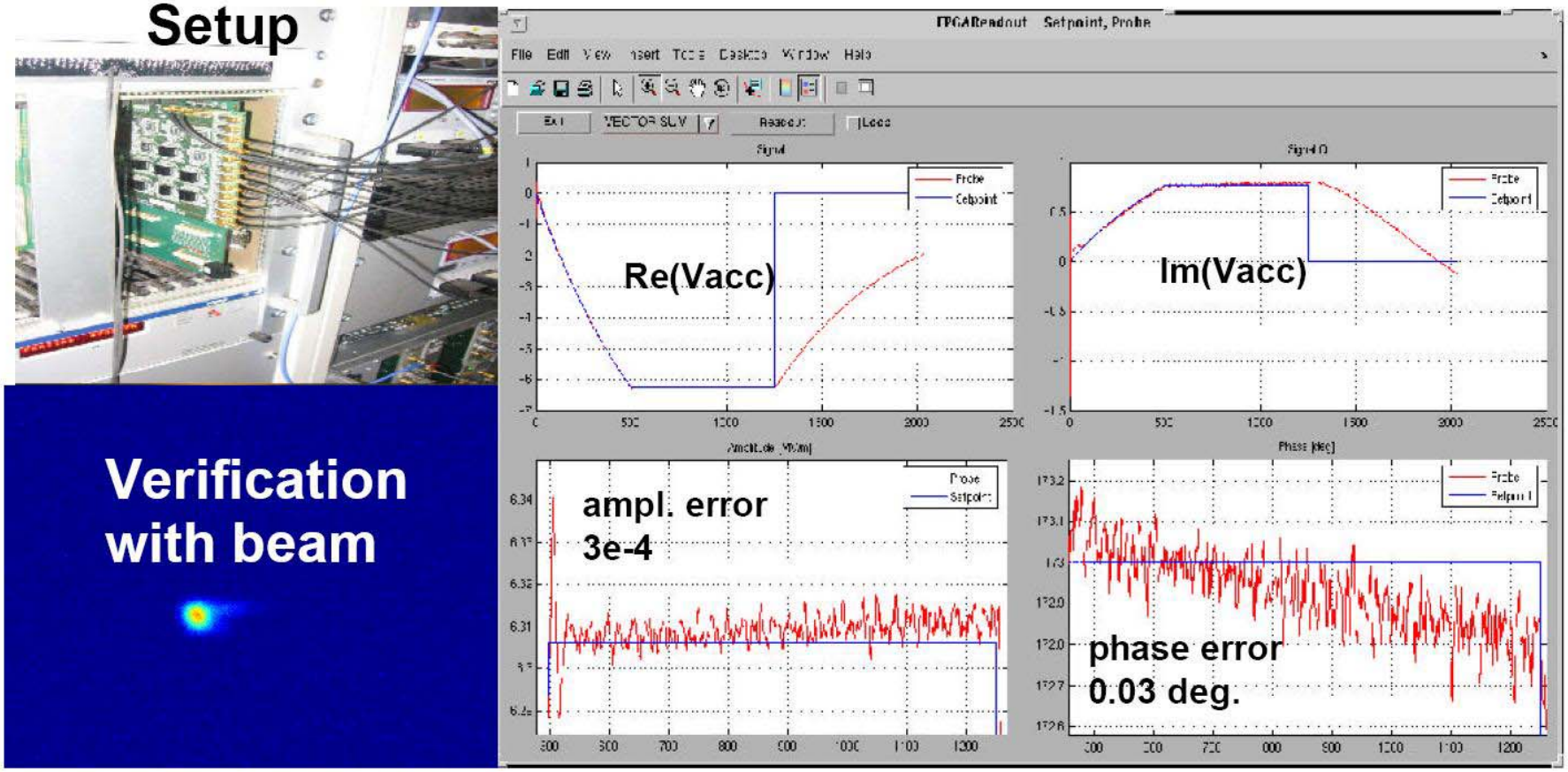
Highlights

- Third Generation RF Control (WUT-ISE ...)
- Single Bunch Transient Detection (TUL-DMCS ...)
- Multichannel Downconverter (WUT-ISE ...)
- Stable M.O. and Frequency Distribution (WUT-ISE ...)
- RF Gun Control (PSI ...)

- Automation of LLRF Control (TUL-DMCS ...)
- Exception handling (DESY ...)
- Data Management Development (TUL-DMCS ...)
- Control Optimisation (DESY ...)

- Cost and Reliability (DESY ...)
- Radiation Effects on Electronics (ALL)

Performance of LLRF Verified at VUV-FEL with Beam



WP 10 Cryostat Integration Tests

Integrated Tests of components from other work-packages.

Provide horizontal test bench to test components from other work-packages at cryogenic temperatures

Nine-cell TESLA cavity @ high RF power with;

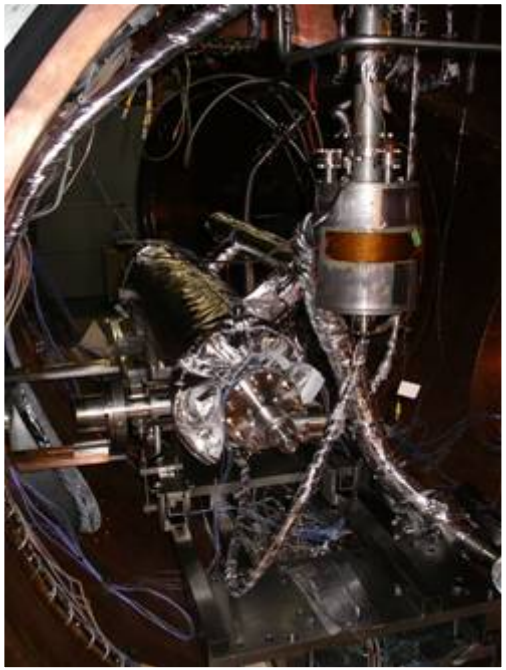
- New Cold Tuning Systems (WP8)
- Piezoelectric and Magneto-strictive Tuners (WP8)
- Fundamental Power Couplers (WP7)

First task (WP10) :
Get CryHoLab ready
for High Power operation @ 1.3 GHz on 9-cell cavity

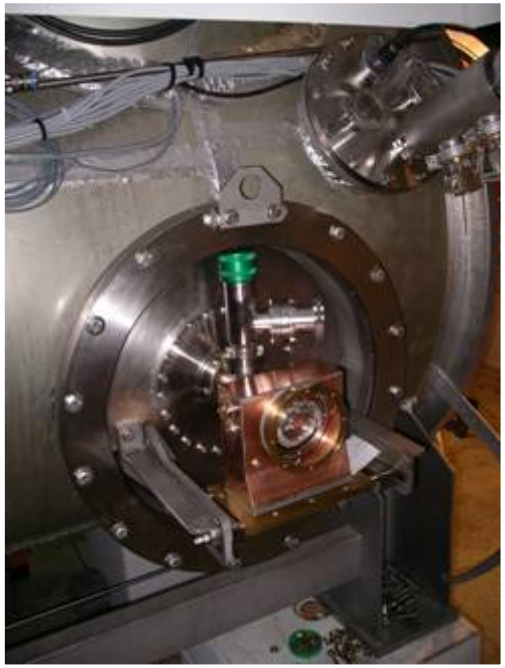
Nine-Cell Cavity in CryHoLab

C45 cavity - 20 MV/m - and
TTF III coupler (warm part)

thermal sensors



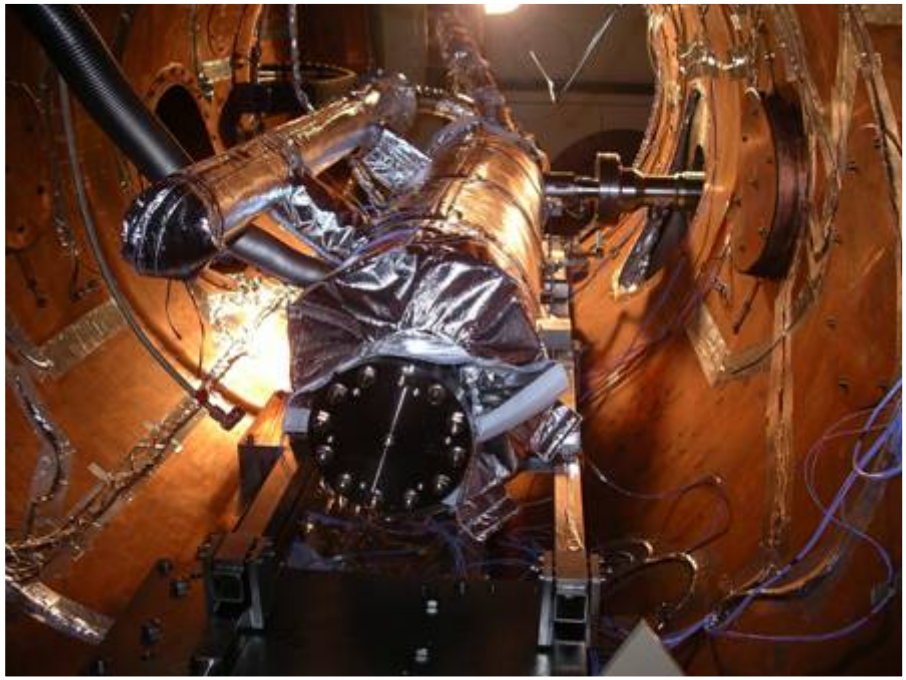
cavity



power coupler

CRYOGENIC OPERATION

(January 2005)



He tank filling – Cool-down (4.2K & 1.8K) – Thermal Insulation

→ Improve Thermalisation of support table

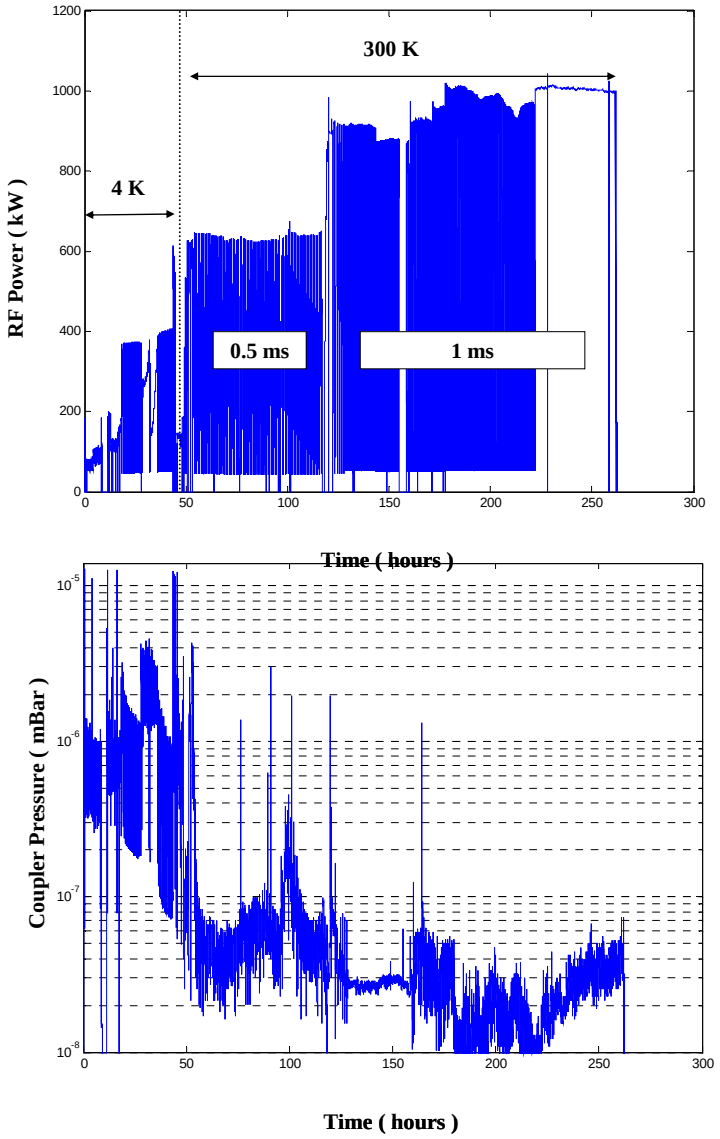
FPC Conditioning

300 K
(detuned cavity)

→ 1MW / 1 ms
3.8 Hz

$P_{ionic\ pump}$

5.10^{-8} mbar



RF Measurements

August 2005

4 K
(tuned cavity)

900 kW / 250 μs
0.88 Hz
no flat top

* $E_{acc} = \frac{1}{L}\sqrt{P_t\, Q_t\, R/Q} \approx \boxed{18\ MV/m}$

$L = 1.038\ m \qquad R/Q = 1036\ \Omega$

$Q_t = 8.1 \cdot 10^{10} \qquad P_t \approx 4\ W$

FE with X-rays detection : $1 \rightarrow 7$ μSv/h

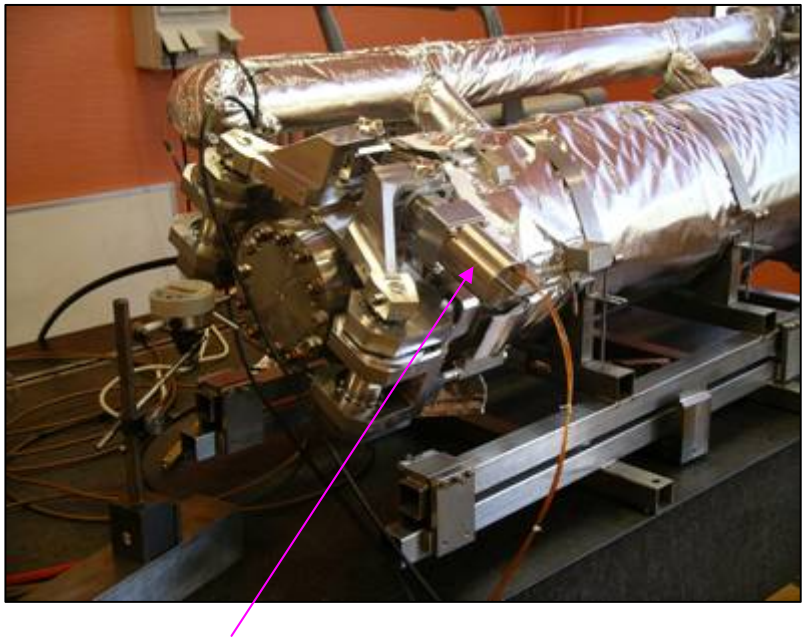
* Q_0 *calorimetric measurements*

Measurement to be improved
(He instabilities)

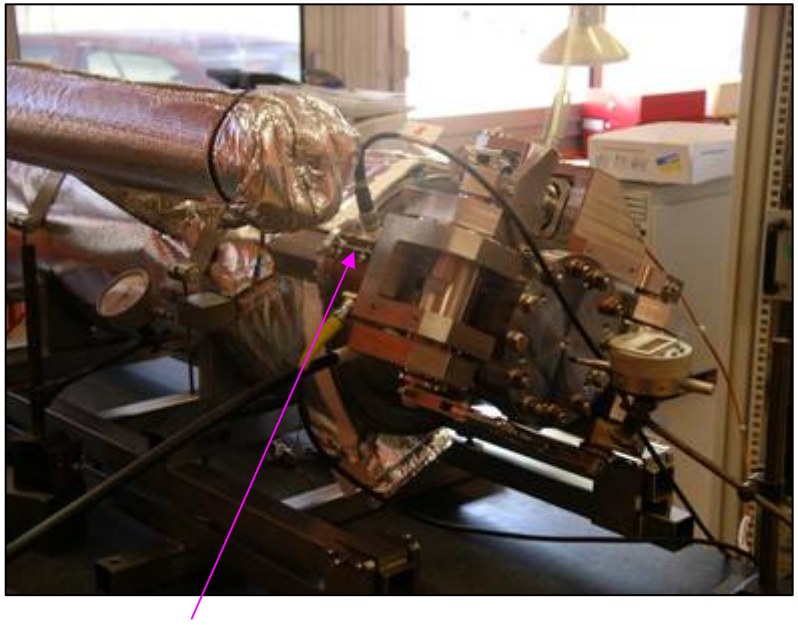
Cold Tuning System & Piezo Actuators (Warm Test)

Lorentz force detuning (20 MV/m)

September 2005 → RF lab. (WP8 : assembly , pre-loading)



stepping motor (Phytron)



PZT (Noliac)

CTS & PZT : cold test in CryHoLab

November 2005 → December 2005

<u>Magnetic shield improvement</u>

Static : μ metal
Dynamic : coils
(20 mG)
+
cryoperm structure
around the cavity
(sheets provided by DESY)

WP-10 2005 schedule

Preparation (cavity - cryogenic test) : → Jan. 2005

Preparation (high power coupler - RF) : → July-Aug. 2005

1st series (CEA tuner with Noliac PZT) : → Dec. 2005

Magneto-strictive tuner

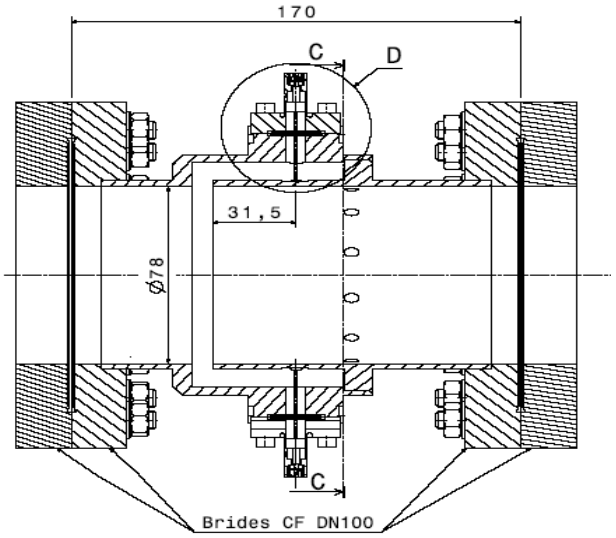
CryHoLab removal and re-installation : *Jan. 2006*

(9 months ?)

2nd series (IN2P3 PI piezo – LAL coupler) : autumn 2006 →

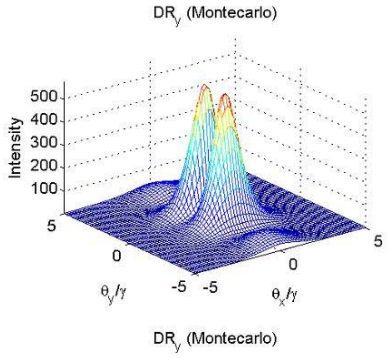
WP 11 – Beam Diagnostics

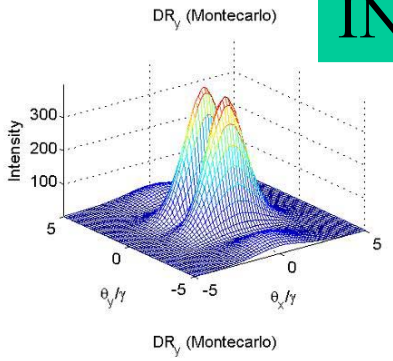
Two principal tasks



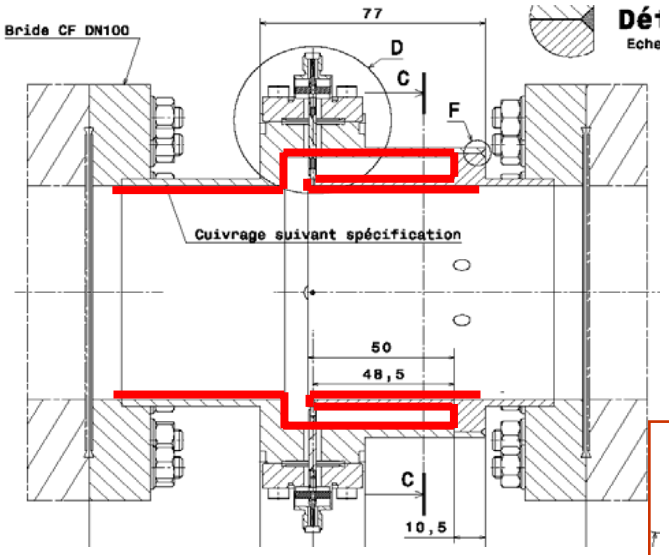
Development of Beam Position Monitors – CEA and DESY – Re-entrant cavity type.

Development of a Diffraction Radiation monitor for beam size and emittance – INFN-Frascati and INFN-Roma2



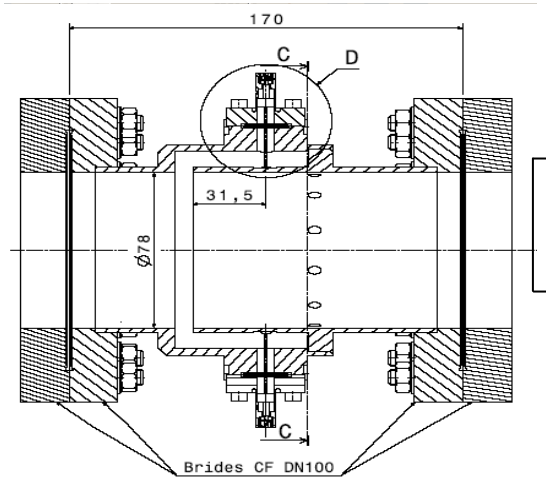


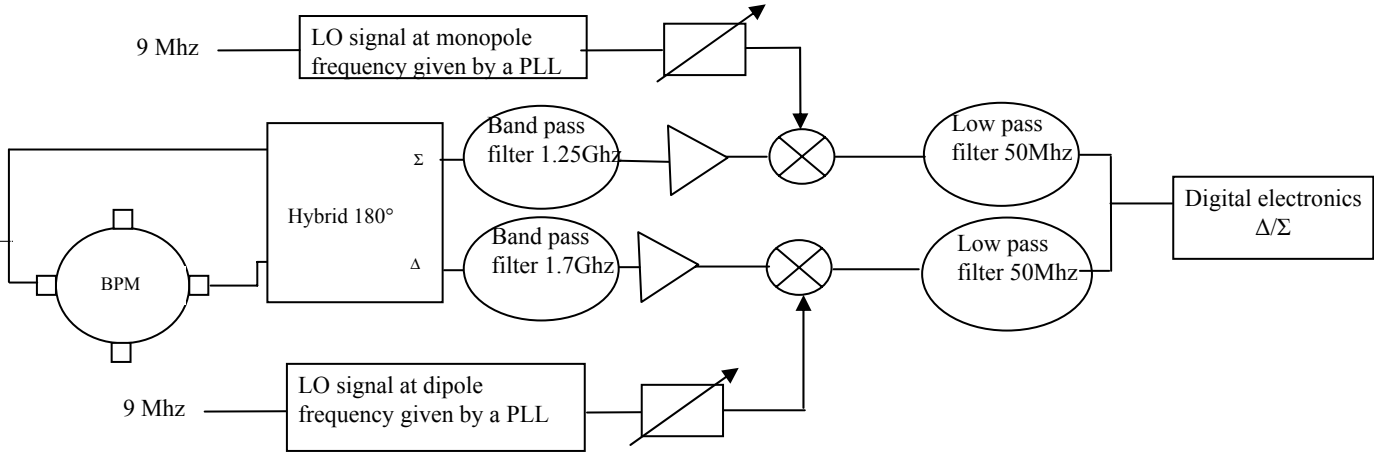
WP11 Beam Diagnostics - BPM



- BPM in TTF/ACC1 (old type, < 10µm)

New BPM design - improved resolution (< 1 µm), fast time resolution ~ 10 ns, more reliable feed-throughs, improved discrimination between monopole and dipole signals, more compatible with cryogenic environment.



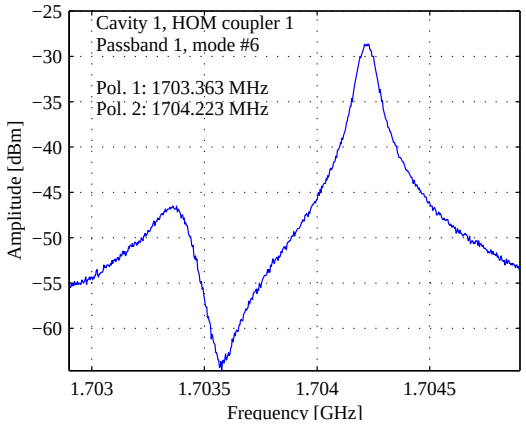


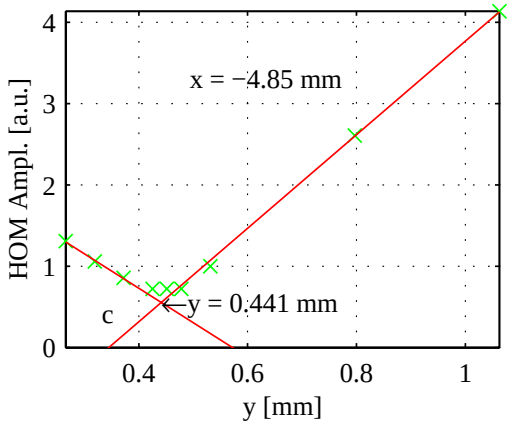
BPM Schedule

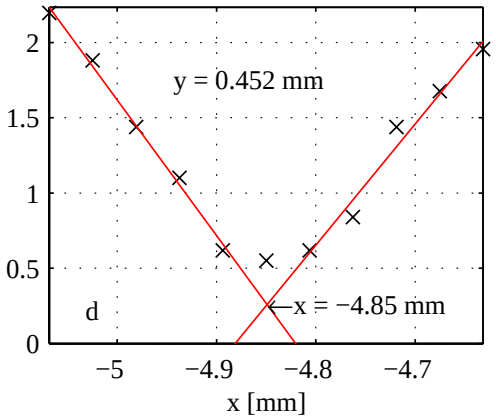
- **Sept. 05 - Dec. 05**: Fabrication of the 1st BPM cavity (TTF room temperature).
- **Oct.05** : Test and commissioning of the old type BPM in ACC1
- **Oct. 05 - Jan. 06**: Fabrication of the 2nd BPM cavity (TTF cryogenic temperature).
- **Jan. 06: RF tests with beam at DESY**
- **Feb.06 - Apr. 06**: Validation of the RF board + Programming and validation of the digital electronics.
- **May 06 - June 06**: Tests at DESY (2 weeks) on the cavity which is at room temperature with its electronics but without control-command interface. The tests will be done with displacement of the beam to evaluate the noise, the dynamic range and to calibrate the system.
- **Feb. 06 - Sept. 06**: Installation and preparation of the cold BPM cavity.
- **Oct. 06**: Tests of the cold cavity with the beam and electronics without the control-command interface.
- **Nov. 06 - Feb. 07**: Programming of the control-command interface.
- **March 07: Tests of the cold cavity and its electronics.**

New sub-task for WP11- HOM based BPM

- RF Cavity Dipole Higher Order Mode signals ⇒ BPM

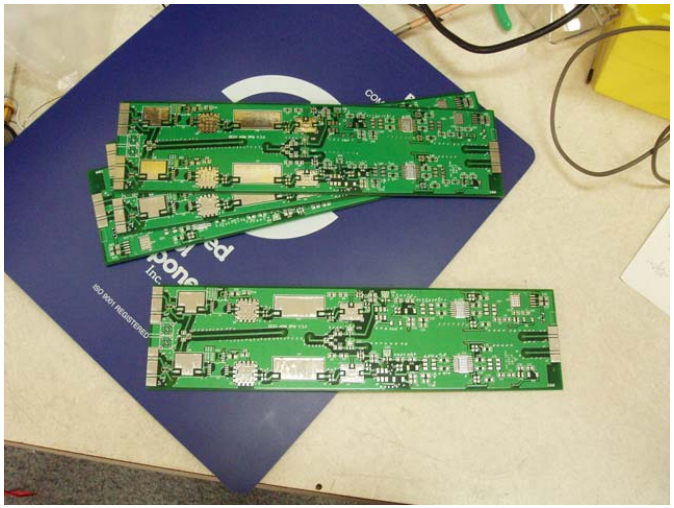






Centering accuracy and 'BPM' resolution better than 50 µm (TTF, 2004)

• The 40 cavities of TTF will be equipped with the SLAC-DESY HOM electronics with the aid of CARE manpower.



WP 11 Beam Diagnostics / Beam Emittance and Size Monitor based on Diffraction Radiation

Use DR from a fine slit as a non-intercepting monitor

Installation status

- Diffraction Radiation target was installed in June 2005
- Optical system and lead shielding was installed in Sept. 2005
- The CCD camera is now in place
- The high sensitivity Hamamatsu CCD will be installed ONLY during the DR measurements
- The transport optics in the by-pass has been checked
- We are ready to test the whole set-up, depending on the TTF linac schedule
- Dedicated beam time will be requested for the next machine development period in February-March 2006

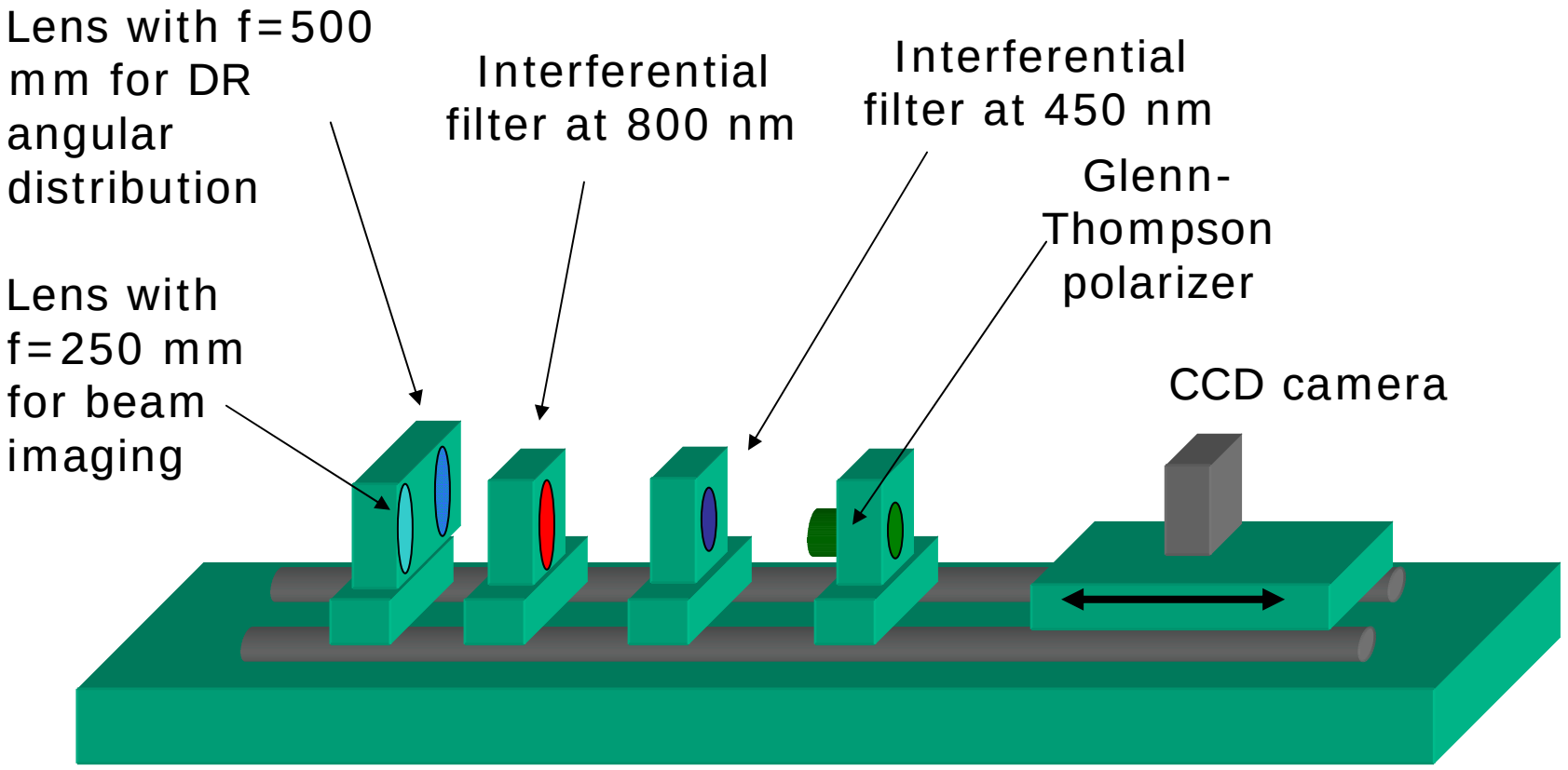
DR radiator

- The target was made using a lithography technique starting from a silicon-nitride wafer and opening the slit by means of chemical etching.
- The surface roughness, the planarity of the target mounted in the holder, and the sharpness of the aperture borders were all carefully checked.

Optical system

- There are 2 lenses, one to image the beam, the other to produce the DR angular distribution
- f=500 mm double convex with antireflection coating
- f=250 mm achromatic doublet for beam imaging
- 2 interferential filters at 800 nm and 450 nm
- A polariser to select only the vertical component
- The camera holder is movable and is compatible both for Basler CCD camera and Hamamatsu camera

Optical system



Electronic control of targets and cameras via precision stepper motors
Driven by an industrial PC using a custom driver is ready

Present status (from M. Castellano, Legnaro, 20/10/05)

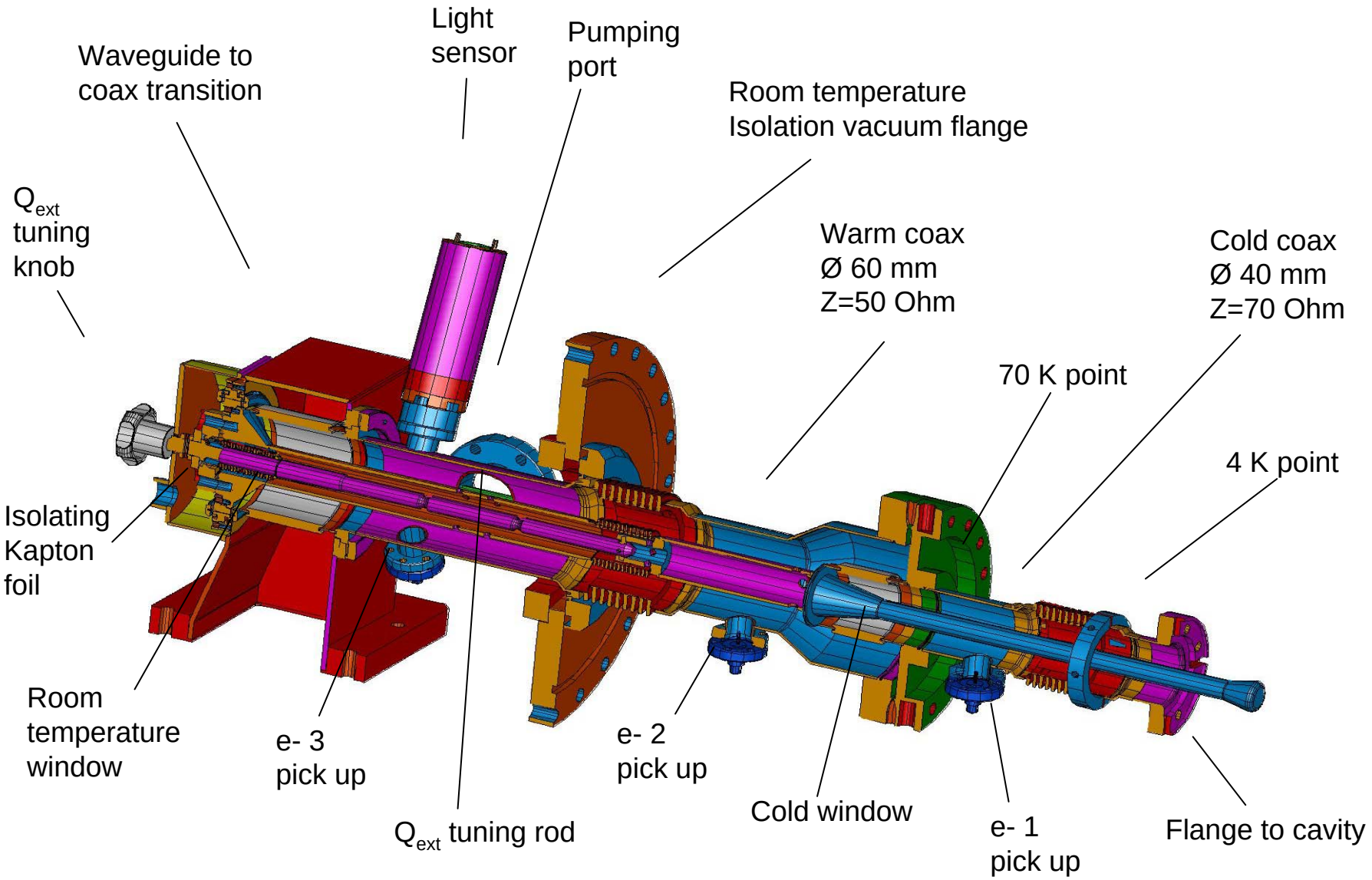
- All the hardware is installed.
- We are ready to take first data, as of our milestone of 31/12/2005.
- At the present time, the schedule of the machine does not allow this possibility before the end of the year.
- Adequate beam time will be requested for the machine development period of February-March 2006.

Concluding remarks

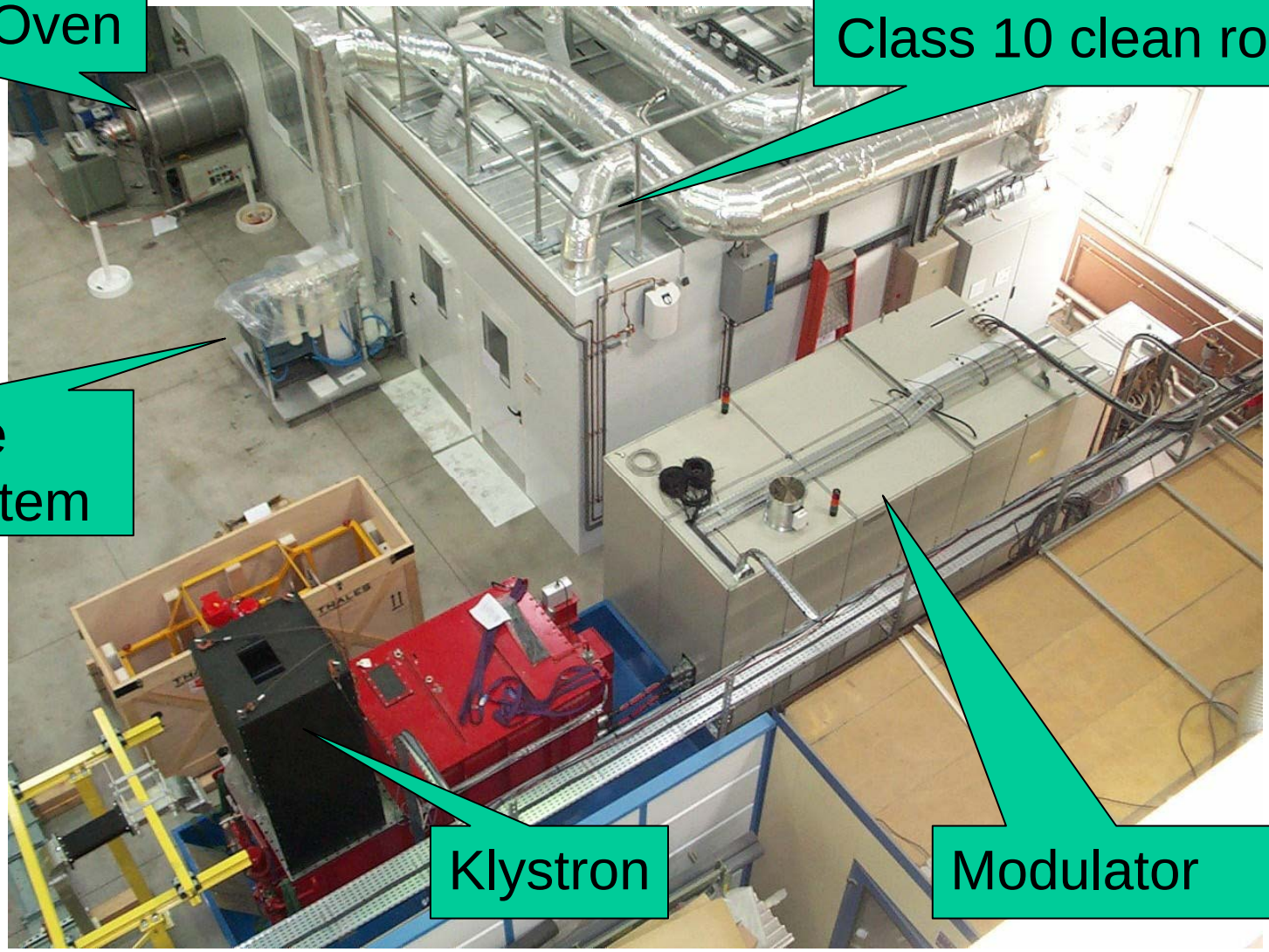
- The detailed presentations at the *Legnaro* meeting, and two highlights talks from this week, show evidence of *substantial progress on all SRF work-packages* from 7 through to 11.
- Several milestones have been met and others are on the verge of being met and will be completed in 2006.
- Fuller details than have been given here will be available in the SRF 2005 annual report.

Thank you for your attention !

Conditioning TTF-III Couplers



Infra-structure for coupler conditioning



Coupler preparation

- Ultra-sonic cleaning using ultra-pure water
  (ρ = 18 MΩ.cm) with 1% Tickopur solution.
- Rinsing with UP water.
- Drying in class 10 clean room area
- Baking in vacuum oven.
- Assembly of cold coupler parts to WG test box in Class 10 clean room.
- Assembly of warm parts.
- Leak test and in-situ bake-out
- Connection of couplers to high power source under mobile laminar flow (class 100).

Labour intensive process !!

Cold Part Assembly in Class 10 clean room

Warm Part Assembly in Local Clean Room