WP#11 Beam diagnostics

11 Beam Diagnostics (BD)	***M. Castellano***
11.1 Beam position monitor	C. Magne *Saclay*
11.2 Emittance monitor	M. Castellano *Frascati*

Main goal of the activity : Beam Diagnostics (**WP11**)

Two different diagnostics will be designed and constructed.

The first will be an RF cavity based beam position monitor (BPM). This device will have a resolution five times better than existing devices while maintaining high temporal resolution.

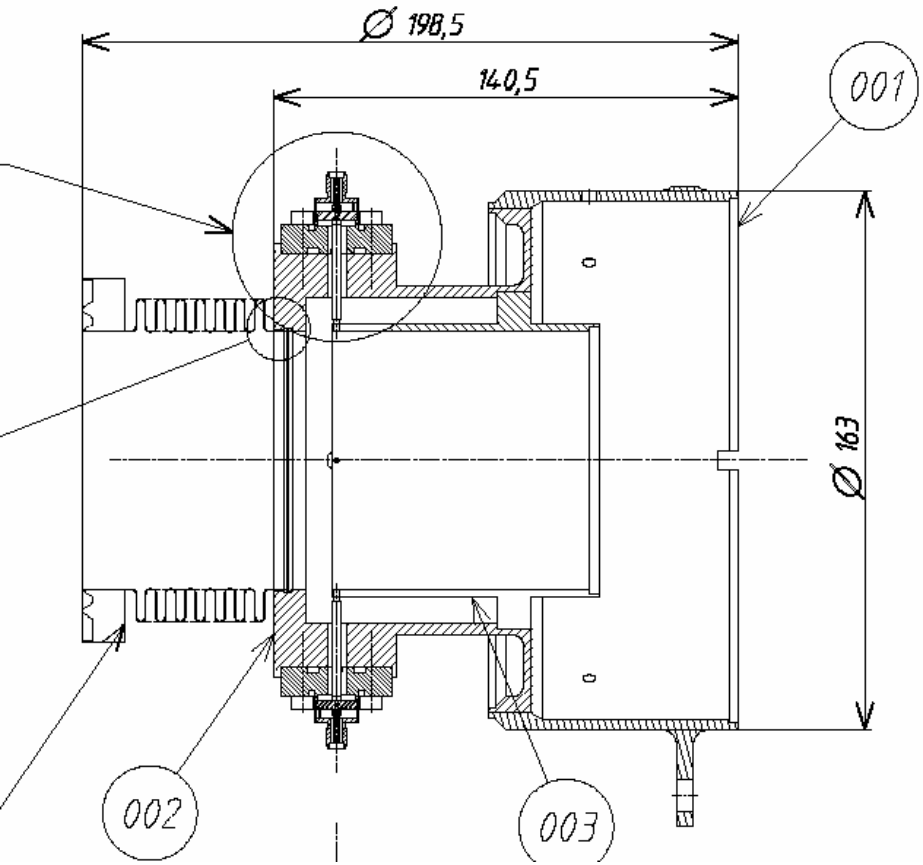
The second will be a non intercepting emittance monitor based on micrometre wave radiation emitted by diffraction effects as the beam traverses a slotted aperture.

These diagnostics, both of which will be tested on TTF, constitute the deliverables of this WP.

Deliverables:
New, improved beam position diagnostics.
Novel emittance monitors.

Cold reentrant BPM

Low-Q RF cavity with 4 antennas
to measure the beam position



-Low beam coupling impedance: reduces the beam break-up forces and minimizes the cryogenic heat-load due to resonances.

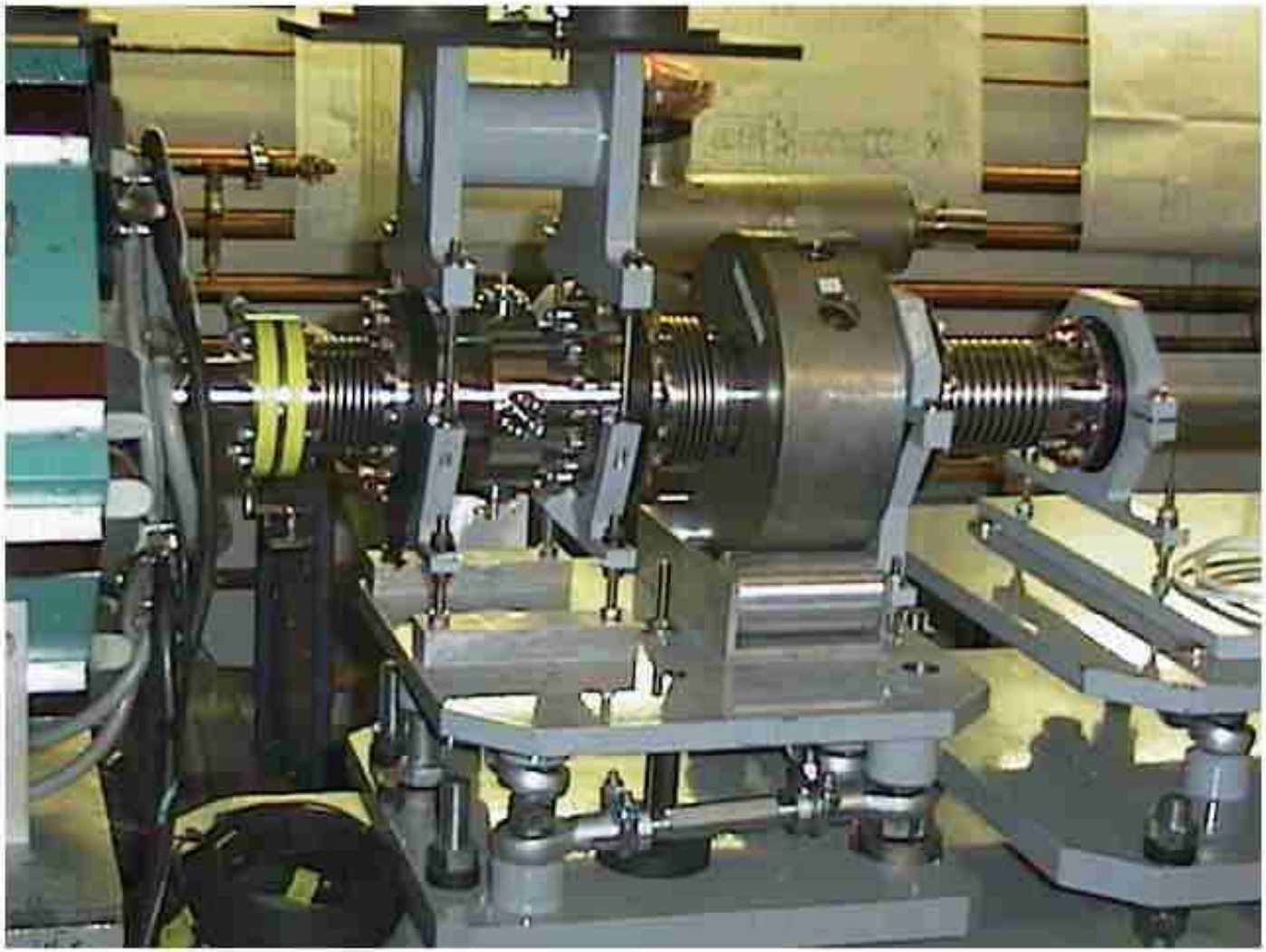
- The (axial) geometry is favorable to cooling to 2K without strain.

- The dimensions are small.

- The design is adapted to UHV dust-free conditions.

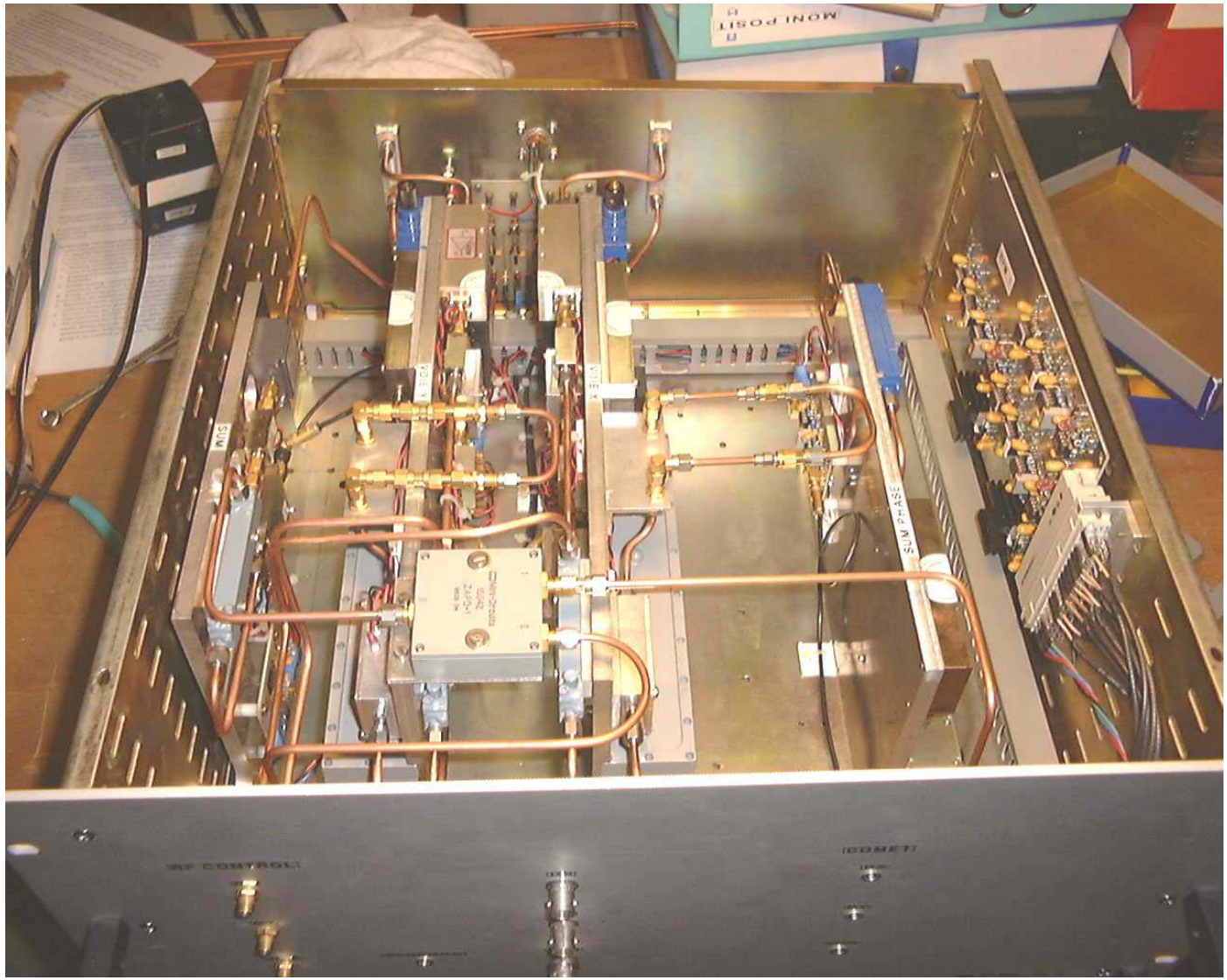
- The mechanics is relatively simple to machine (lathe→precision of axial sym.)

Ability to measure sum signal and dark current



(WARM) REENTRANT BPM

IN THE COLLIMATOR SECTION OF TTF1



Analog electronics @650 MHz

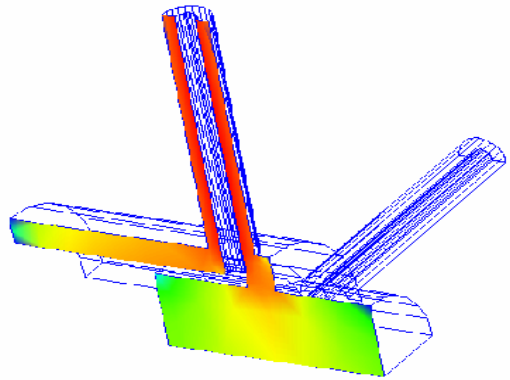
Next R&D

Simulate, design, and fabricate a prototype for the XFEL

welded one-block piece,

with holes to make cleaning easier,

re-design feedthroughs associating the excellent RF properties needed for instrumentation and robustness to thermal cycles.



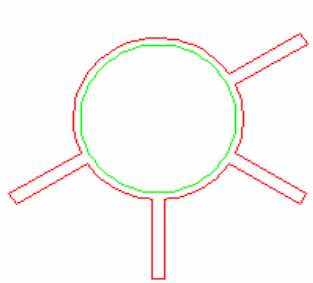
rf field in cavity - HFSS simulation

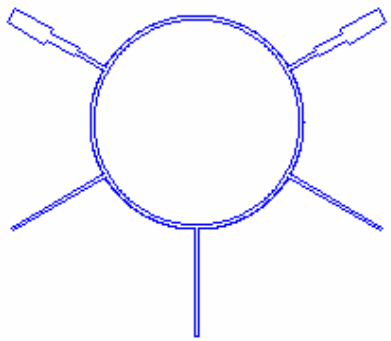
New front end electronics – rf hybrid coupler

Design and build an RF hybrid coupler,

stripline or microstrip,

achieving RF difference D and sum S with high isolation S/D

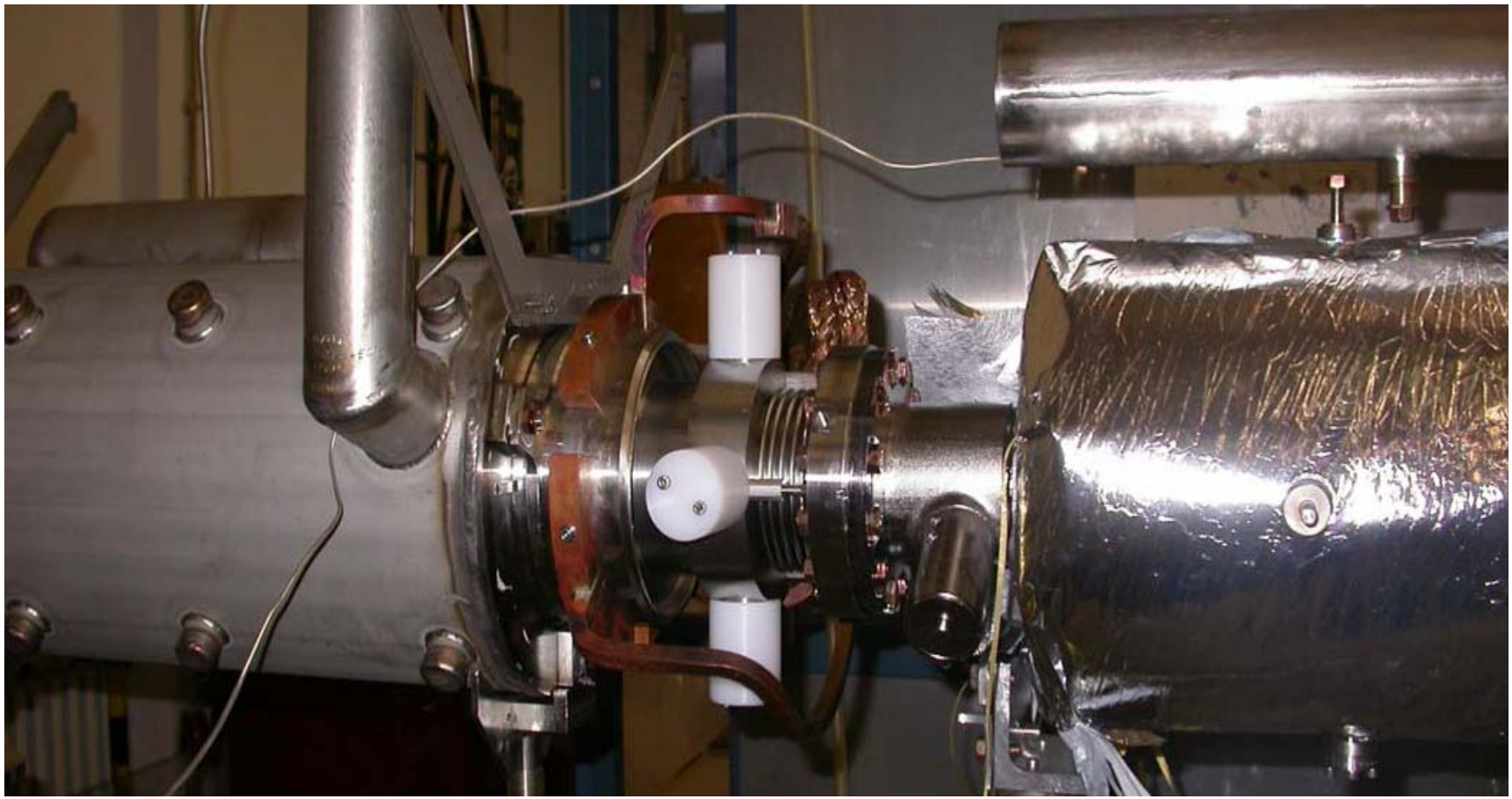




New processing electronics – digital signal processing

More flexibility

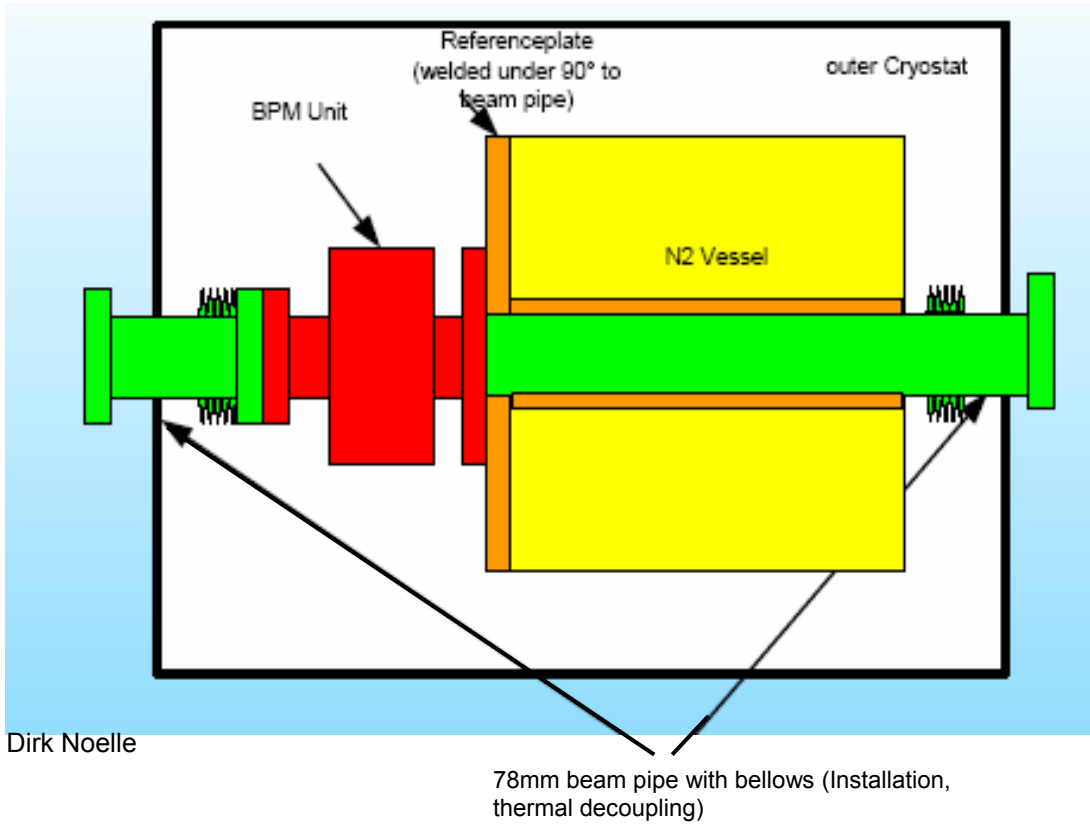
Beam Position Monitor mounted on the module 2* of TTF2



Teststand on TTF2 beamline

Cryogenic test of the first prototype @ 77K

RF measurements with the old analog electronics



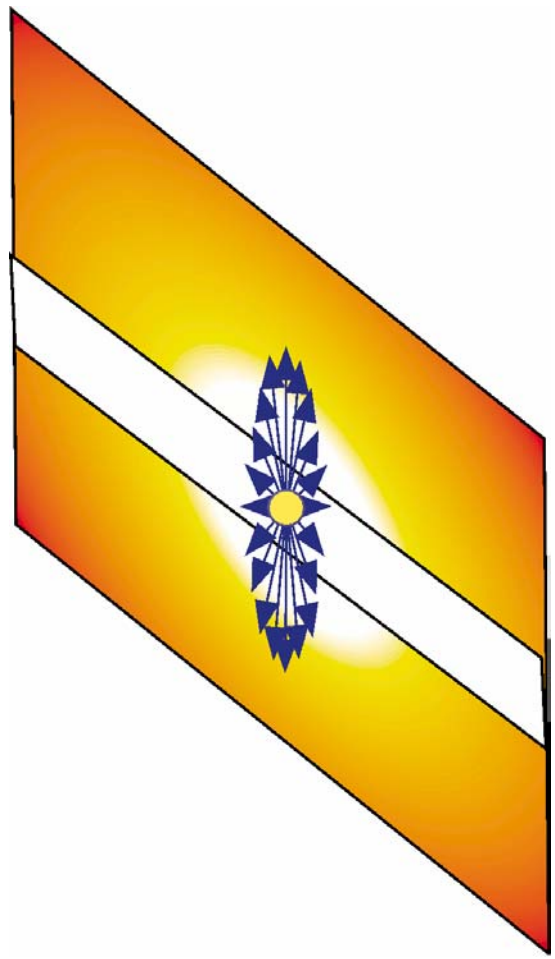
Work of first 18 months

	MILESTONES(during first 18 months)	GOALS (over 4 years)
Present BPM installed in TTF module ACC1		
Design of new BPM cavity	Design report 01/10/04	
Fabrication of one BPM cavity	Cavity ready 01/04/05	
Start the tests at 77K in the TTF beamline		Results of 77K beamline tests: cryogenic losses, performance with analog electronics.
Start the development of new hybrid & electronics		
Start the design of Digital Signal Processing		Commissionning of BPM with new digital electronics.

Diffraction Radiation

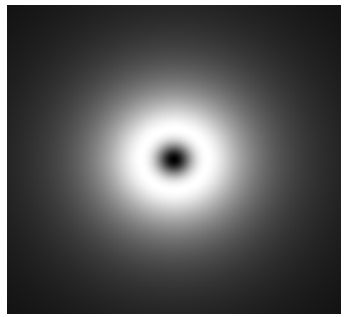
- **Generated in the interaction between a conductive plate with the EM field of a travelling charge**

- **Excellent candidate to measure several beam parameters (beam size, energy, angular divergence, emittance) in a totally non intercepting way**

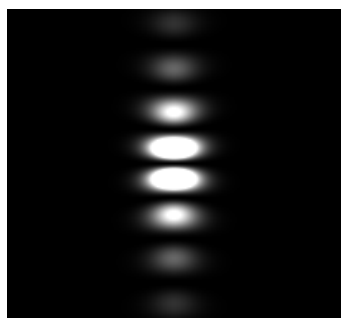


Important parameter

$$\frac{\gamma\lambda}{2\pi} >> a$$ Transition radiation



$$\frac{\gamma\lambda}{2\pi} \cong a$$ Diffraction Radiation



$$\frac{\gamma\lambda}{2\pi} << a$$ Nothing

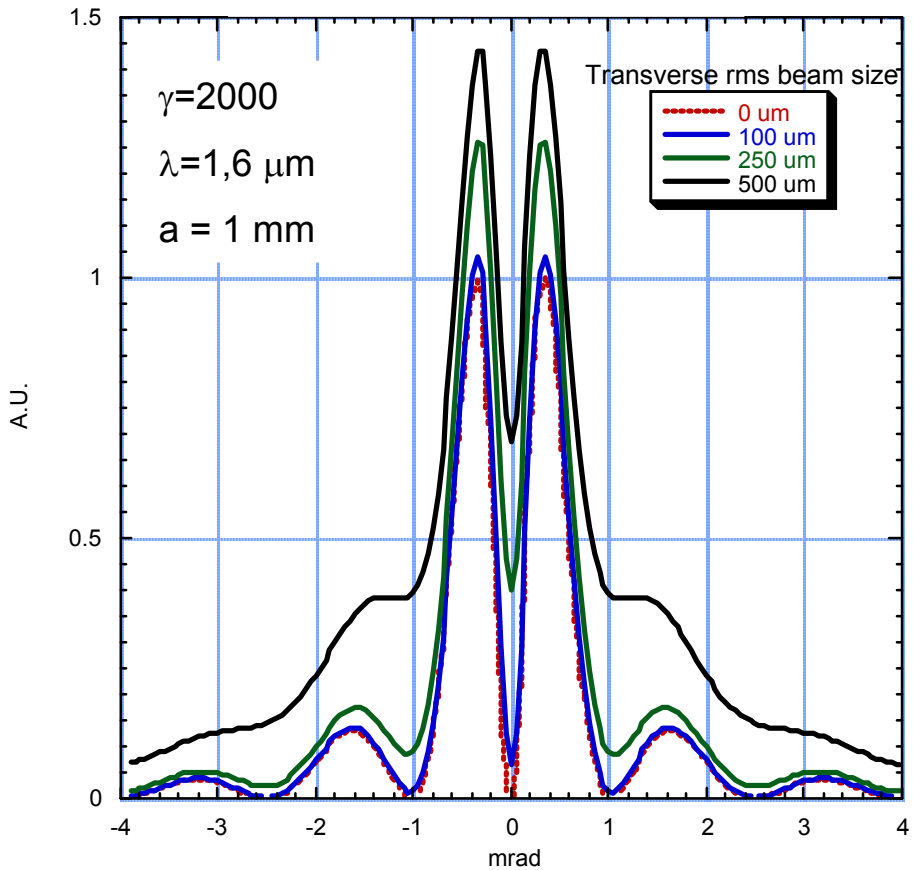
a is the size of the aperture

Diffraction Radiation profile

In the profile of the radiation distribution is clear the interference nature of the diffraction radiation

From this profile it is possible to obtain the beam parameters

(size, angular divergence, emittance)



Schedule over 18 first months

Task Name	Milestones	Deliverables
WP11 Beam diagnostics		
11.1 Beam position monitors		
11.1.1 Present BPM installed in TTF	**Start of measurements**	
11.1.2 Cryogenic measurements on BPM		
11.1.3 Beam tests of BPM on TTF		
11.1.4 Design of BPM cavity		
11.1.4.1 Design of BPM cavity ready	**Design report**	
11.1.5 Fabrication of BPM cavity		
11.1.5.1 BPM cavity ready	**BPM cavity**	
11.1.6 Development of new hybrid & electronics		
11.1.7 Design of digital signal processing		
11.2 Beam emittance monitors		
11.2.1 Slit with simulations		
11.2.2 Slit design		
11.2.3 Optics simulation		
11.2.4 Optics appropriation		
11.2.5 System assembly and tests		
11.2.6 Mechanical assembly at TTF		
11.2.7 optical assembly at TTF		
11.2.8 Integration of controls into TTF