WP 5: Diagnostics

Coordinator: Grahame Blair

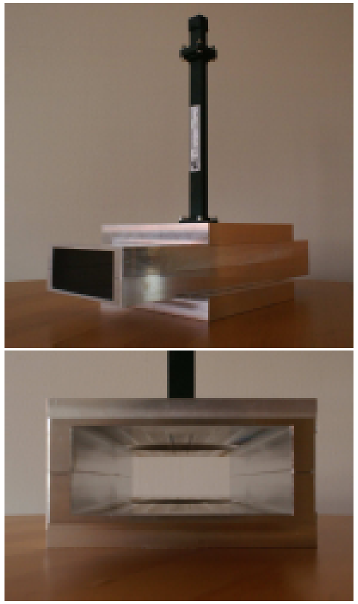
EUROTeV Annual meeting,
Cockcroft Institute / Daresbury,
9th January 2007

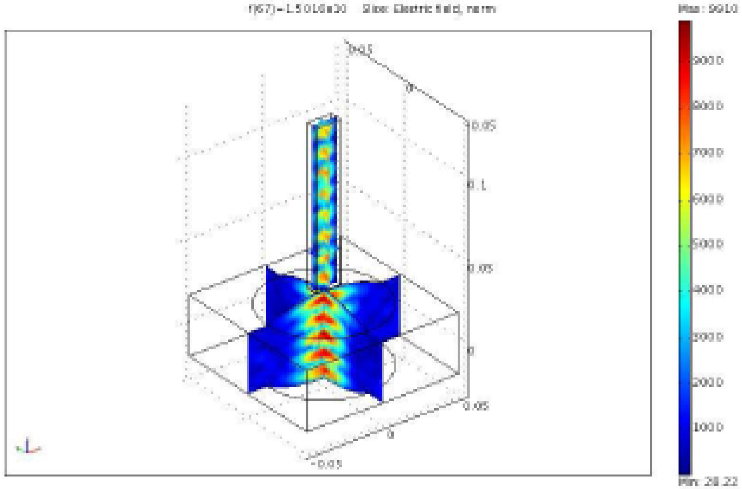
- CFBPM Confocal Resonator BPM.
- LBPM Laser-based Beam Profile Monitor
- PBPM Precision Beam Position Monitor
- ESPEC Precision Energy spectrometry
- HEPOL Precision High Energy Polarimetry.
- TPMON Time and Phase Monitor
- WBCM Wide Band Current Monitor
- FLUM Fast Luminosity Monitoring

CFBPM: Nearly Confocal Resonator

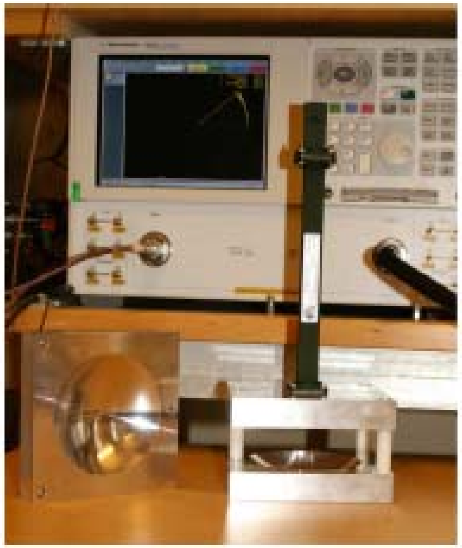
We use a mirror distance $D = 5.345$ cm and a curvature radius $R = 8.908$ cm. This ensures that there is only one eigen-mode at 15 GHz, with small diffraction losses ($Q_d = 3.3 \times 10^5$, while $Q_r = 4.0 \times 10^4$).

NCR prototype on Aluminium pipe

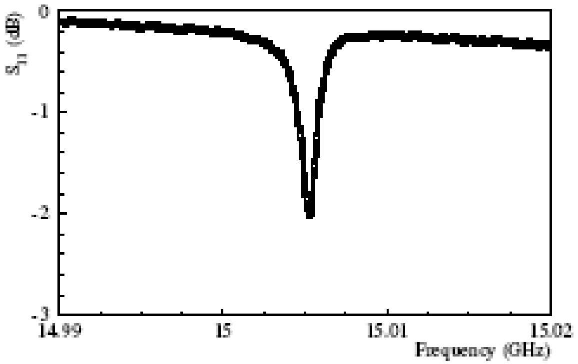




Open NCR prototype



Under-coupled configuration: a clean resonance is observed and the unloaded quality factor is 1.2×10^4.



- We have studied the properties of a nearly confocal resonator with a large quality factor for the diffraction losses, which weakly couples to external fields.
- Two prototypes were constructed and we demonstrated the proof of principle for the NCR pick-up: the rejection of waveguide modes at the resonant frequency.
- One major limitation was identified: when the resonator is under-critically coupled to a waveguide, the quality factor is dominated by the scattering losses at the iris, which also couples to external fields, leading to a worse rejection.

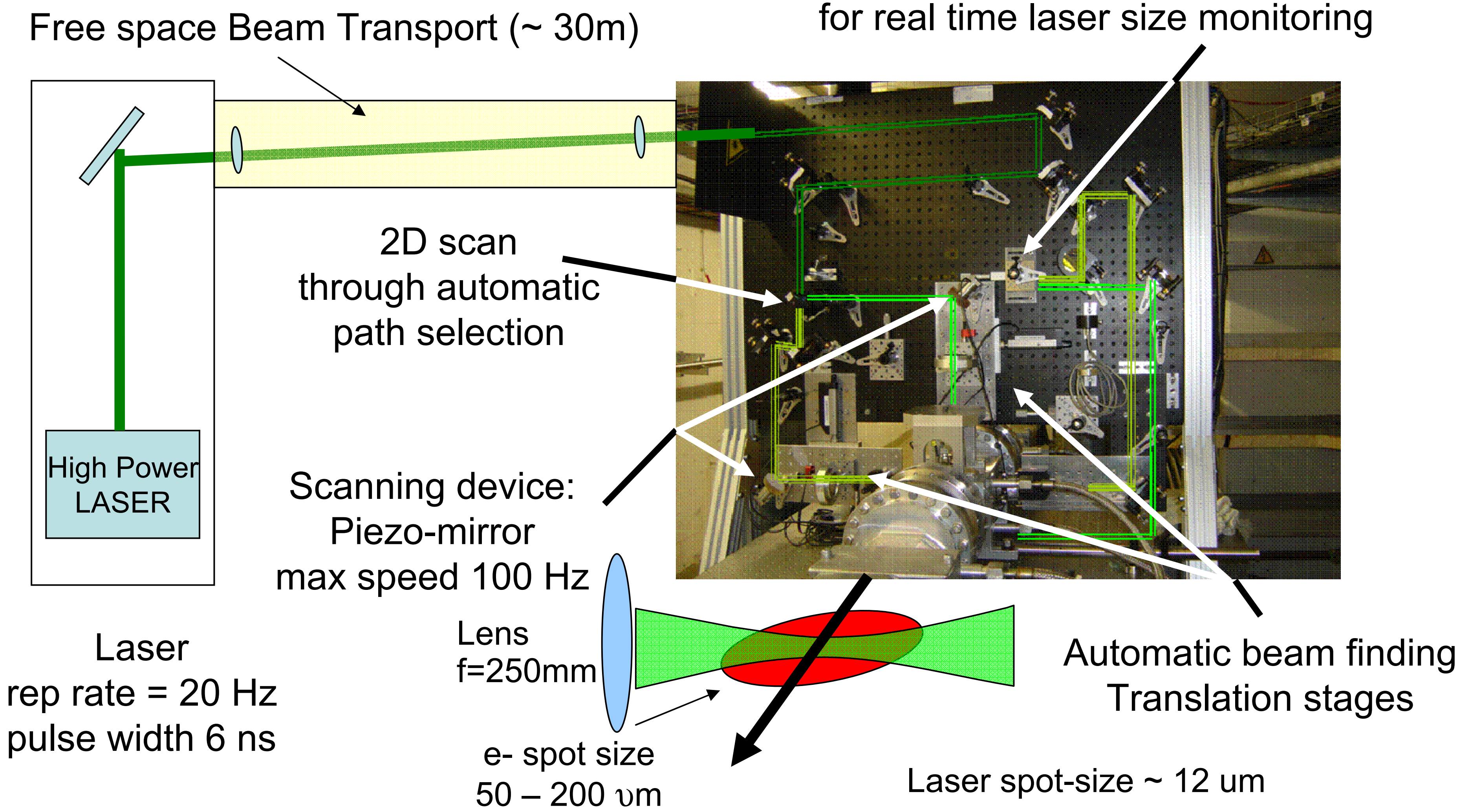
More details in A. Ferrari, M. Johnson, V. Ziemann, E. Öjefors, *Limitations of the confocal resonator pick-up and investigations of nearly confocal configurations*, EUROTeV-Report-2006-081.

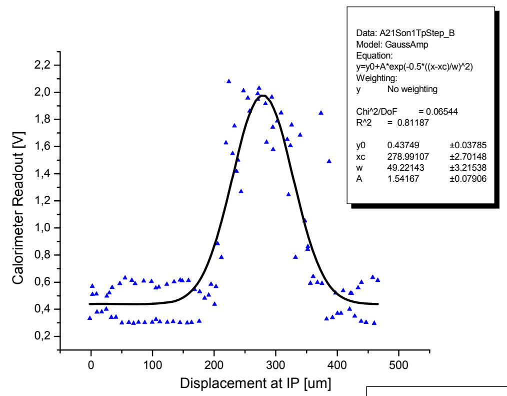
Before building a final prototype and testing it with beam in CTF3, more simulation studies are needed in 2007:

- Simulations with HFSS and/or CST Microwave Studio to estimate the S_{12} spectrum for all incoming modes in the pipe, and better understand the results obtained with the NCR prototype on an Al pipe.
- Simulations of the coupling between a passing (bunched) beam and the NCR pick-up.
- More open questions: over- or under-critical coupling between the resonator and the extraction waveguide, absorbing material around the resonator to get rid of unwanted modes, tolerances?

LBPM: Laser-wire contact: G. Blair (RHUL)

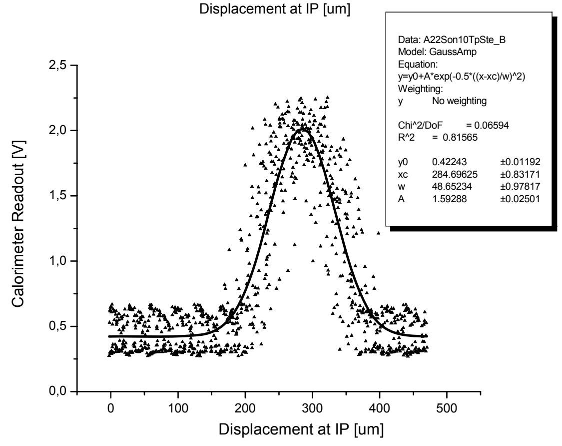
2D LW scanner at PETRA





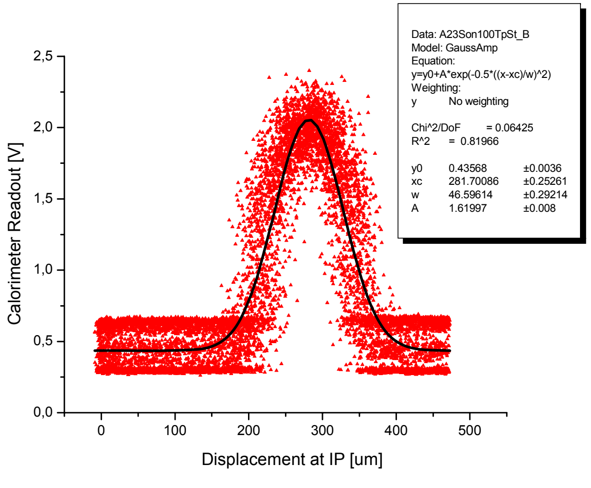
Seeded (100 steps, 1 point per step) 100/20Hz = 5 sec

Sigma ~ 49um



Seeded (100 steps, 10 points per step) 1,000/20Hz = 50sec

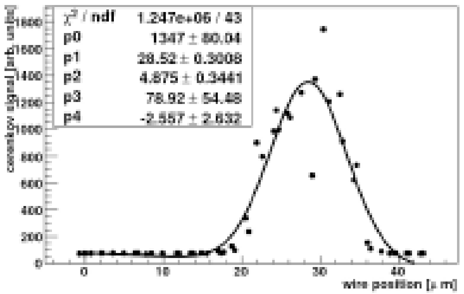
Sigma ~ 49um

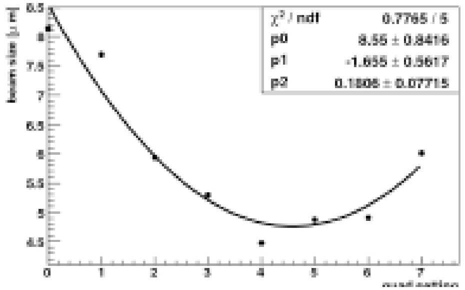


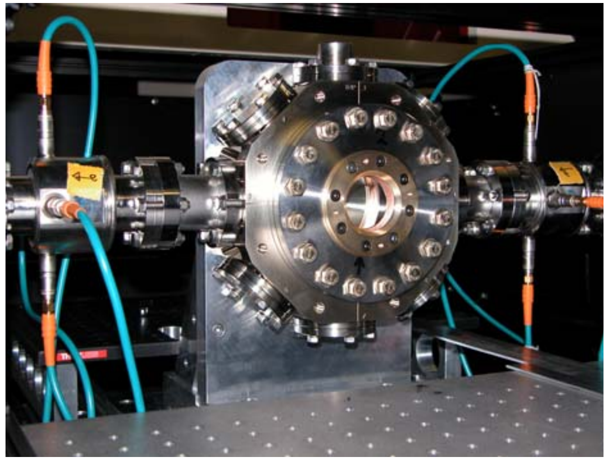
Seeded (100 steps, 100 points per step) 10,000/20Hz = 500sec

Sigma ~ 46um

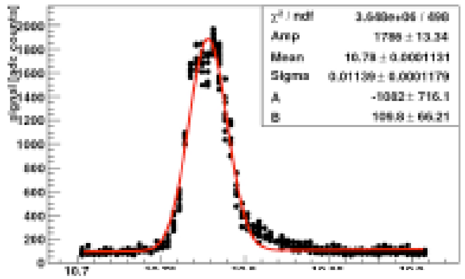
ATF Laser-wire **Results (>Nov 2006)**





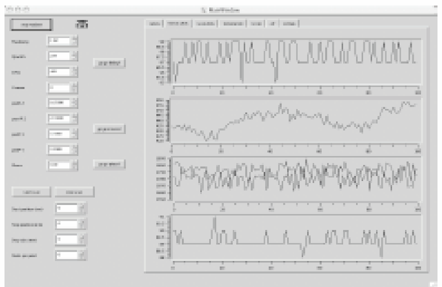


- Wire scanner measurements to confirm optics
  - Electron beam size ~4μm
- Laser scans
  - Laser-electron beam quadrature size ~11.4μm

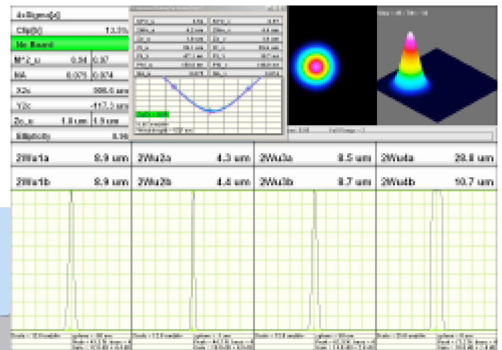


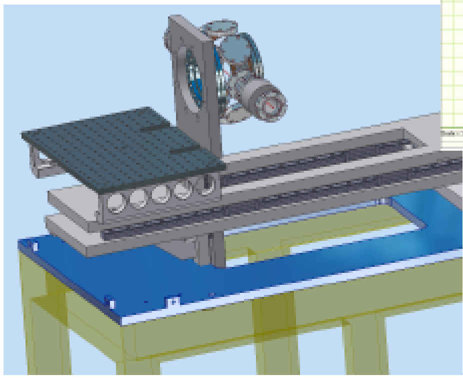
F#2 lens installation

- Integrated DAQ
  - Camac ADCs/TD/TDC
  - Laser power meter
  - ATF-EXT stripline BPMs
  - Wire scanner (stage)
  - Labview control of optics (mirrors)
  - RF phase timing control



- New F#2 lens (Oxford)
  - Design R. Bingham
  - Modified design and fabrication N. Delerue
  - Testing Myriam Newman



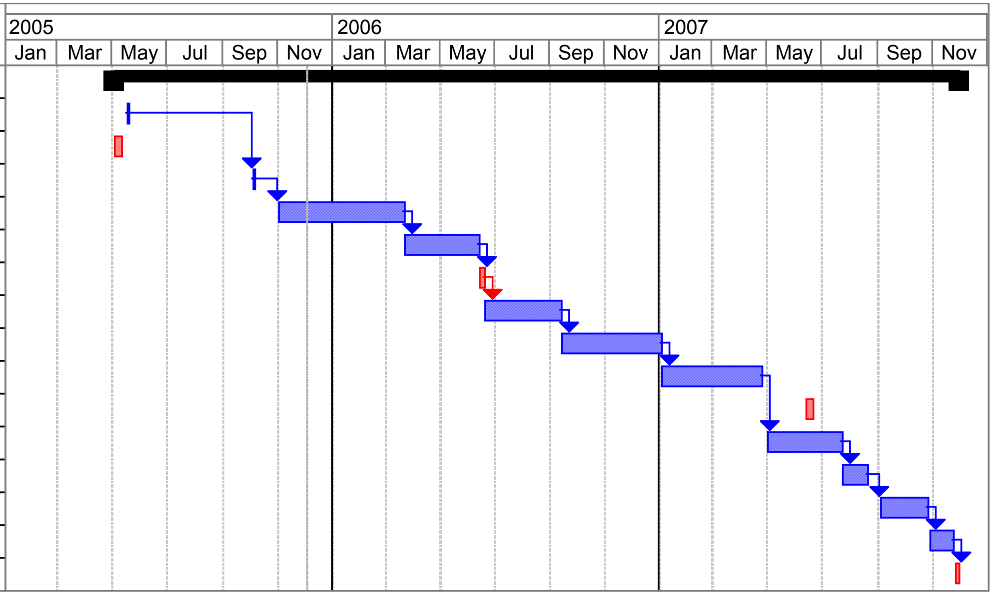


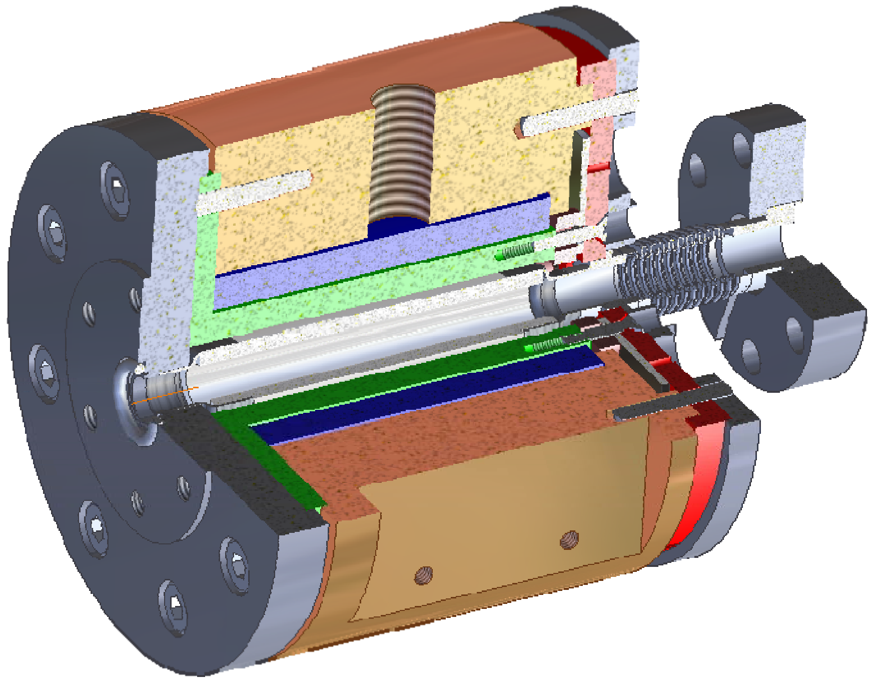
- Chamber mover
  - Small focus requires precision movement of lens
  - F#2 lens "rigidly" mounted to flange
  - Rayleigh range now a problem

PBPM: Precision BPM

L. Soby, I. Podadera Aliseda, CERN

ID	Task Name
1	**PBPM**
2	Publish fellow post
3	Present work plan for EUROTeV
4	Hire fellow
5	Design PBPM
6	Simulate PBPM
7	Present design for EUROTeV
8	Fabrication drawings
9	Fabrication of 1BPM
10	Tests on bench
11	Present Results for EUROTeV
12	Manufacture 3 PBPMs
13	Tests on bench
14	Tests in CTF3
15	Write report
16	Send report to EUROTeV





- On Schedule
- Final Design Complete
- Electronics design
- Electromagnetic simulation

- **R**esolution:100 nm.
- **A**perture: 4-6 mm.
- **A**bsolute precision: 10 mm.
- **R**ise time: 15 ns.

PBPM- deliverables

2005

EUROTeV report prepared and to be published

- Design and build prototype.

(end December 2006)

DONE!

- **Report on bench tests:**
  - Design and build a mechanical stable test bench.
  - Develop front end electronics.
  - Measure PBPM prototype.

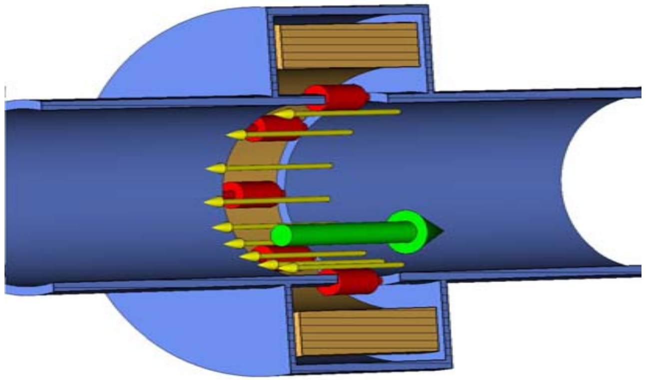
(middle 2007)

2007

- **Report on beam tests:**

WCM: wideband current monitor

L. Soby, Alessandro D'Elia - CERN

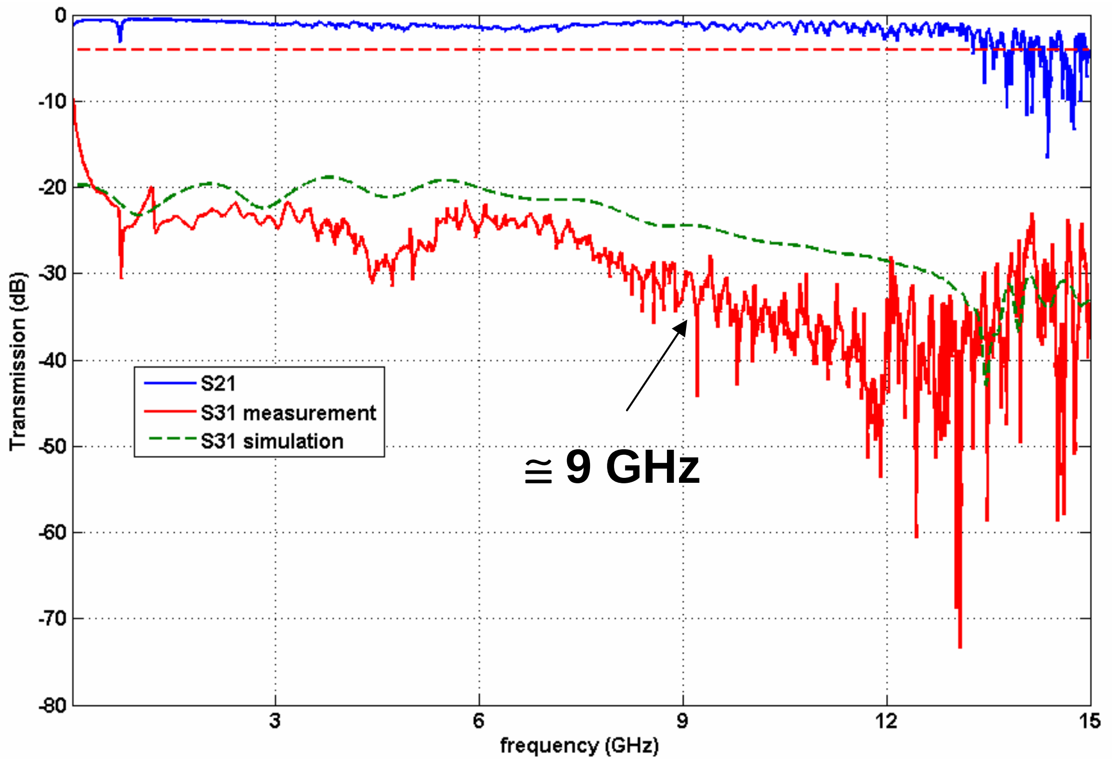


The 3rd generation of CLIC Test Facility (CTF3) foresees a beam formed by bunches separated by

Δ_b = 67 ps **WCM h. f. cut-off = 20 GHz**

for a total pulse duration of

τ_r = 1.54 μs **WCM l. f. cut-off = 100 kHz**

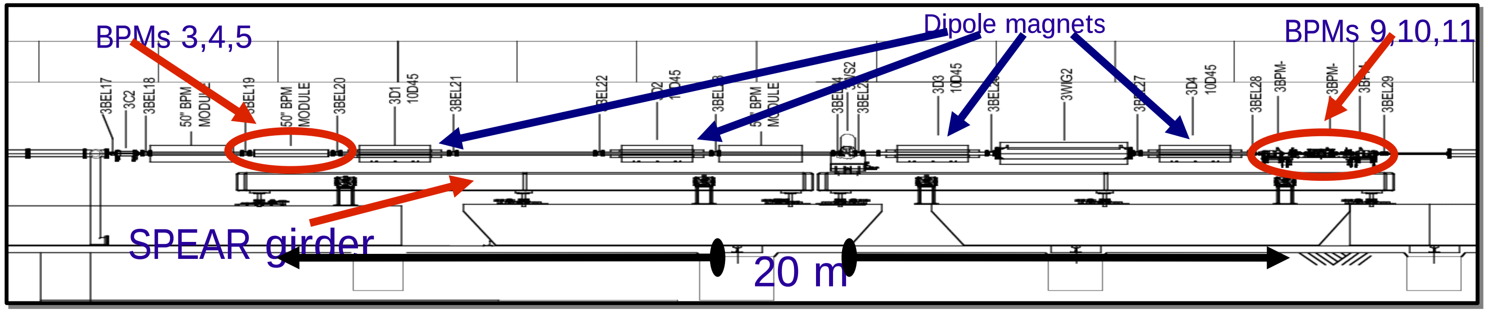


WCM Conclusions

- The test bench has been improved
- The new proposed geometry at the cost of few changing in the old one shows a quite good response for our aims: apart of the TM01 mode at about 5.5 GHz a quite good flat response it is foreseen up to 25 GHz with the possibility of extending the bandwidth up to 30 GHz for future applications
- More accurate studies on the real feedthrough are needed
- Development of a new testbench only for feedthrough
- Feedthrough vacuum leakage
- Reliable ferrite and SiC models in CST MicroWave and/or HFSS
- We are confident, on February, of producing a preliminary mechanical design

ESPEC: Energy Spectrometer

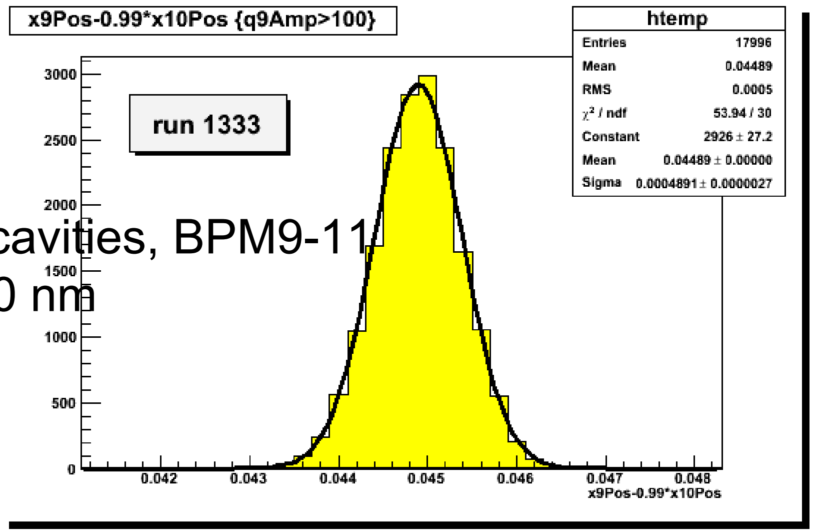
D. Ward, M. Thomson, M. Slater (Cambridge)
S. Boogert, G. Boorman (RHUL)
F. Gournaris, A. Liapine, B. Maiheu, D. Miller, M. Wing (UCL)
and International Collaborators



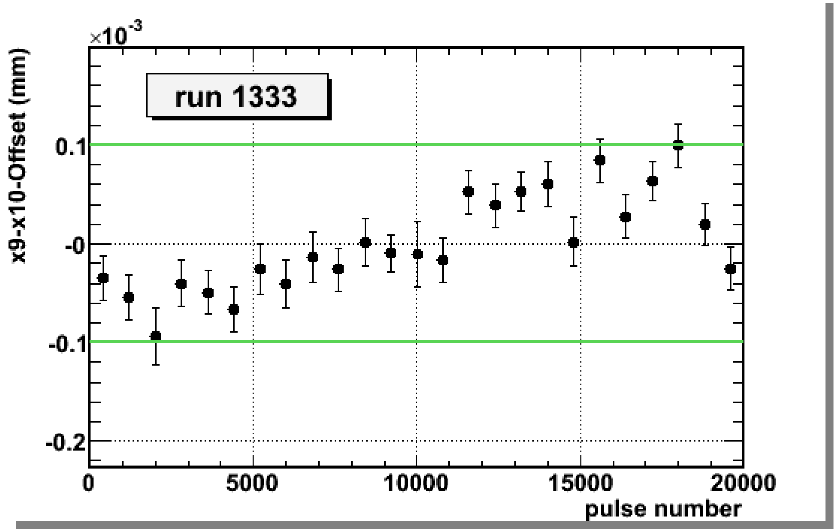
•T474/T491 at ESA

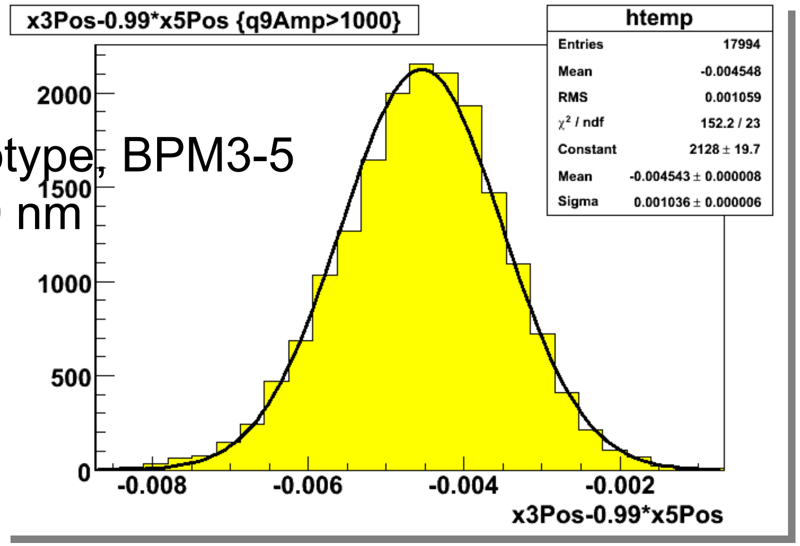
- January 2006 test run (4 days): commissioning BPMs 31,32 and 1,2 upstream
- April 2006 run (2 weeks):
  - o Commissioning new ILC prototype linac BPMs (3,4,5) where 4 is on a (x,y) mover system
  - o Commissioning old SLAC BPMs (9,10,11)
  - o Digitisation/signal processing optimisation
- July 2006 run (2 weeks):
  - o Commisioning Zygo interferometer system (3,4,5) + BPM24 upstream
  - o Further optimisation of hardware
  - o Stability data taking with 10 BPMs, frequent calibrations

ESA results: resolution and stability

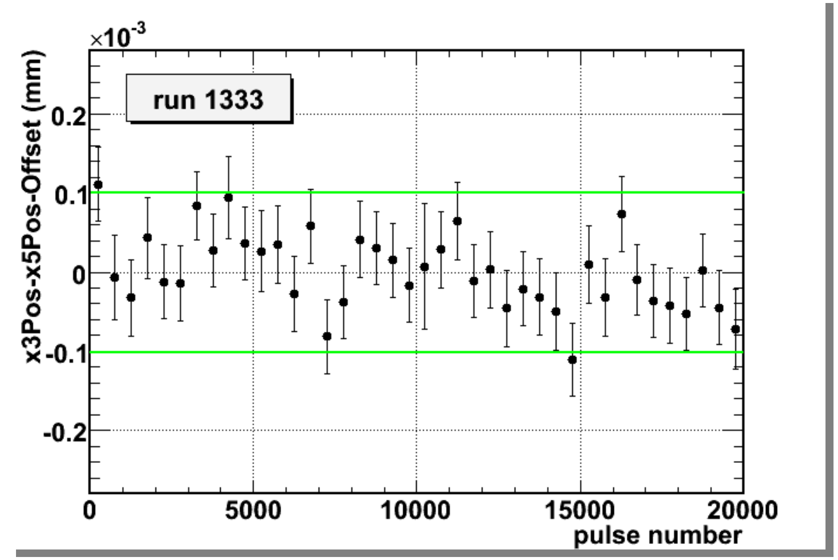


old cavities, BPM9-11
~350 nm





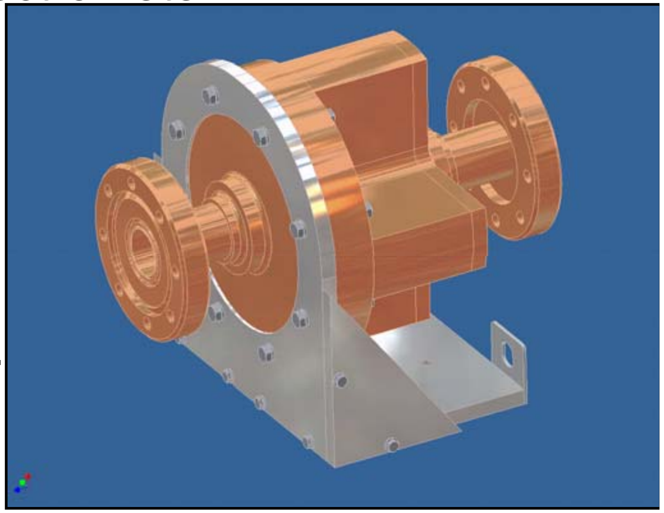
prototype, BPM3-5
~700 nm



~30 mins.

Spectrometer-specific BPM

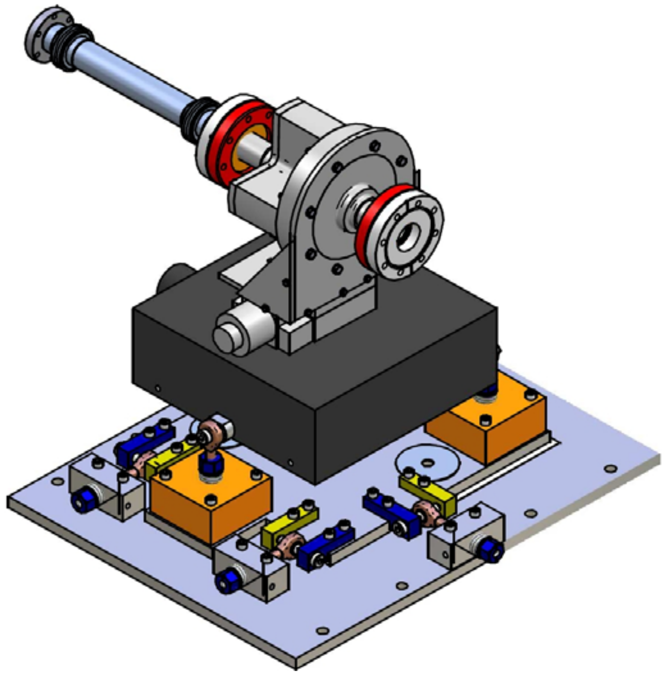
Existing BPM designs are not optimal for an energy spectrometer



- aperture (machine protection)
- resolution, stability
- monopole rejection
- coupling → decay time

Take know-how gained from collaboration work
and design a BPM suitable for an energy spectrometer.

- Al model and Cu vacuum prototype
- 30 mm aperture, 2.878 GHz
- theoretical resolution ~ 11.2 nm



Mover system

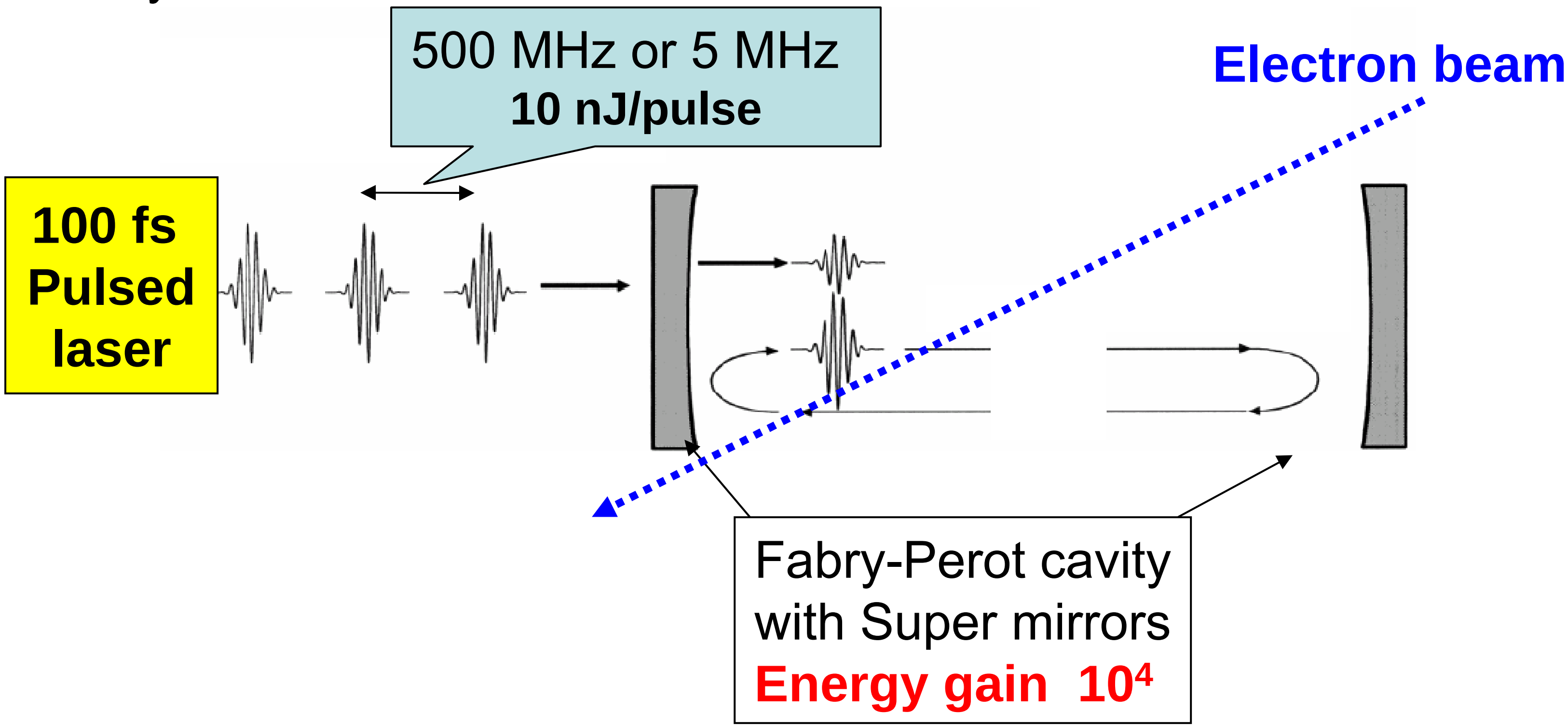
- Horizontal stage: 2” travel range,
15 µm
- Vertical stage: 5 mm travel range,
10 µm accuracy

Electronics box almost complete

Laser amplification cavity for ILC polarimeter

HEPOL: Contact: Fabian Zomer

- Orsay

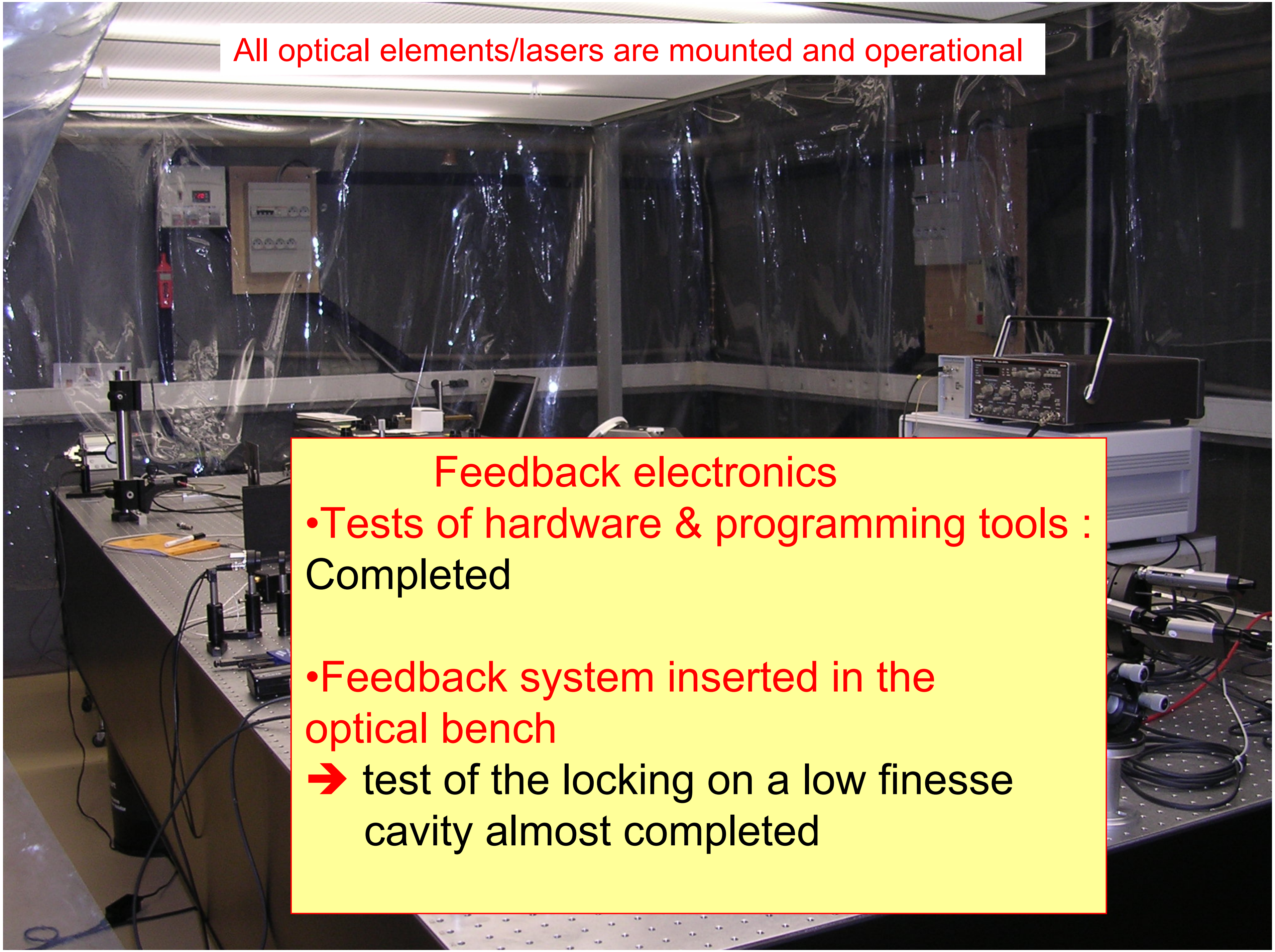


J. Bonis, V. Brisson, J.N. Cayla, R. Chiche, R. Cizeron, J. Colin, Y. Fedala, G. Guilhem, M. Jacquet-Lemire, D. Jehanno, L. Losev, R. Marie, K. Moenig, V. Soskov, C. Sylvia, A. Variola and F. Zomer

LAL-Orsay & Lebedev Inst.-Moscow

1. Resonance of a high gain Fabry-Perot Cavity with a fs laser
2. Realization of a specific confocal cavity

All optical elements/lasers are mounted and operational



Feedback electronics

•Tests of hardware & programming tools : Completed

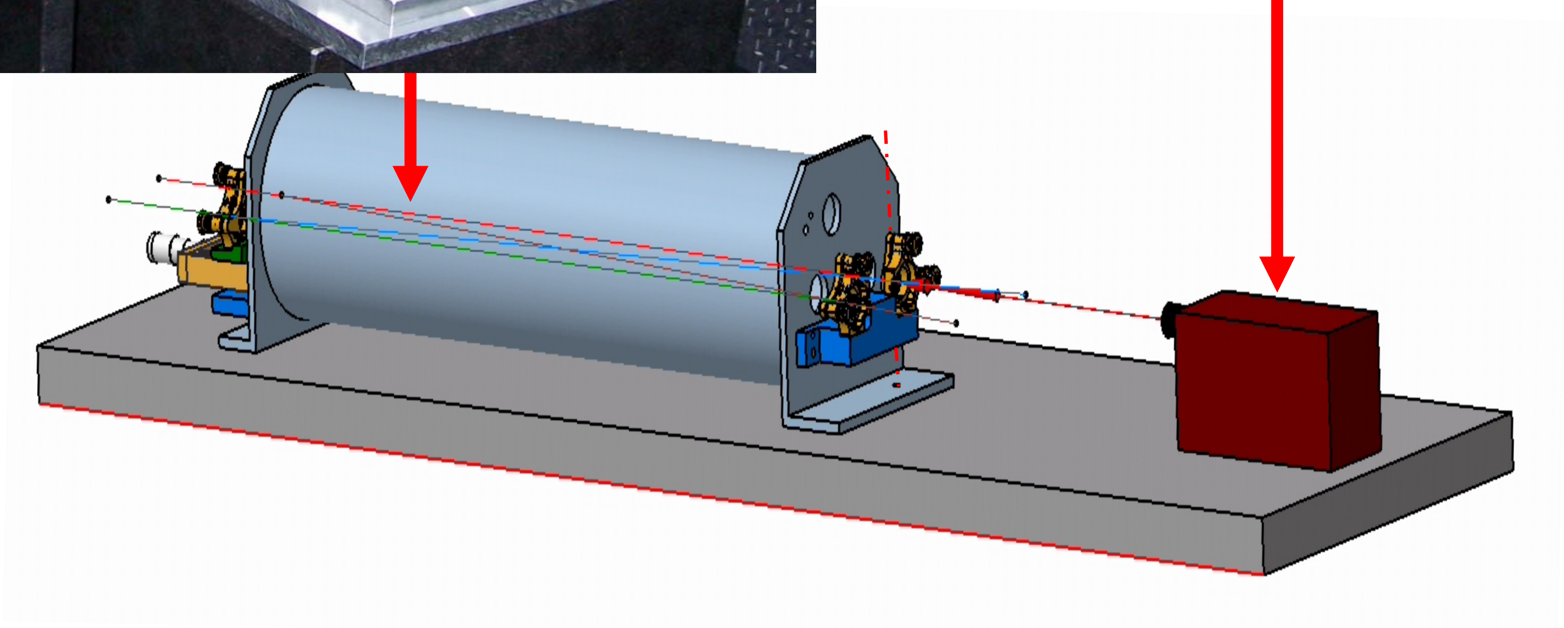
•Feedback system inserted in the optical bench

➔ test of the locking on a low finesse cavity almost completed

Four mirror 'bow tie' cavity

1st Prototype for studying mode structures and beam waist
Built in the LAL workshop

Cheap laser= laser diode



Schedule for 2007

- Step 1: manpower problem solved
  - 1.5 FTE more for analog electronics (starts Jan.-Feb. 2007).
  - First results for high finesse (Gain=10^4) expected mid-2007, very high finesse (Gain=10^5) at the end of 2007
- Step 2: progressing
  - End of the mode structure studies for non-planar bow-tie cavity expected in spring 2007
  - Study of the length control of such cavity will start in Feb. 2007
- Step1+Step 2 would require one more year…
  - Possible experimental implementation at ATF

TPMON

Precision beam phase measurement

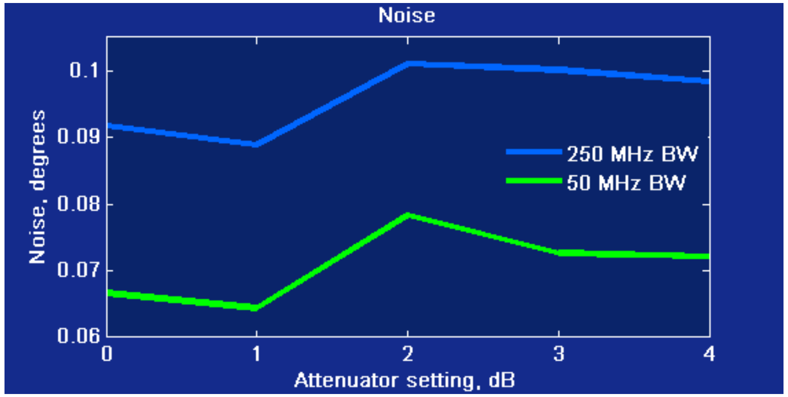
Contact: Jonathan Sladen Alexandra Andersson (CERN)

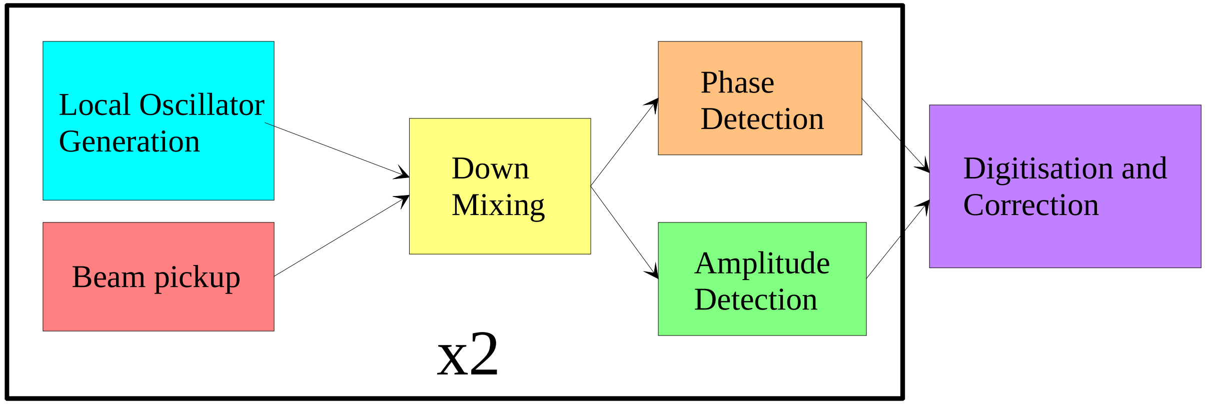
Aim

- The aim of the task is to investigate the feasibility of a precision bunch train timing measurement at 30 GHz, with an accuracy of 10 fs, and a bandwidth of at least 50MHz.
- Tests of the electronics have begun at CERN's CTF3.

Requirements

- Phase accuracy: 0.1º
- Amplitude range: ~6dB
- Bandwidth: 50MHz, system investigated up to 250MHz





CTF3 Results:

- noise for two systems
- promising at both 250MHz and 50MHz

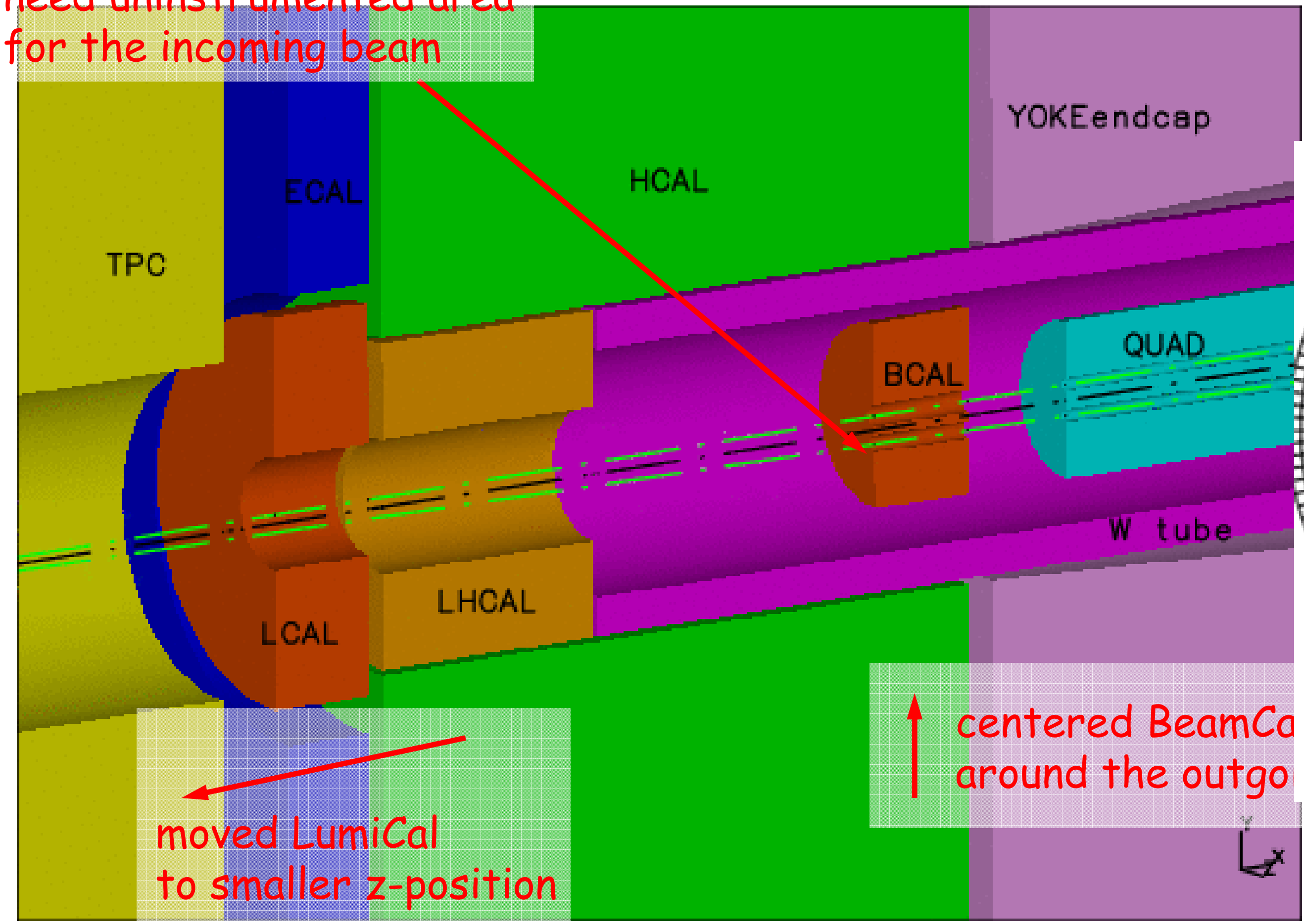
Work to be completed:

- Complete static correction algorithm to correct amplitude dependent phase offset
- Develop a dynamic correction algorithm to correct step response of the system
- Characterise temperature drift
- Improve calibration routine
- Hardware modifications of down converters
- Further beam tests

FLUM: Fast Luminosity Monitor   C. Grah (DESY)

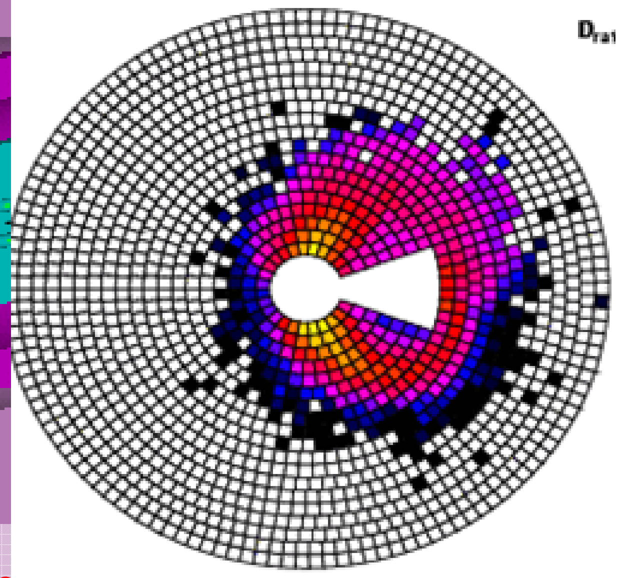
Geometry for the new ILC baseline of 14mrad

need uninstrumented area
for the incoming beam



centered BeamCa
around the outgo

moved LumiCal
to smaller z-position

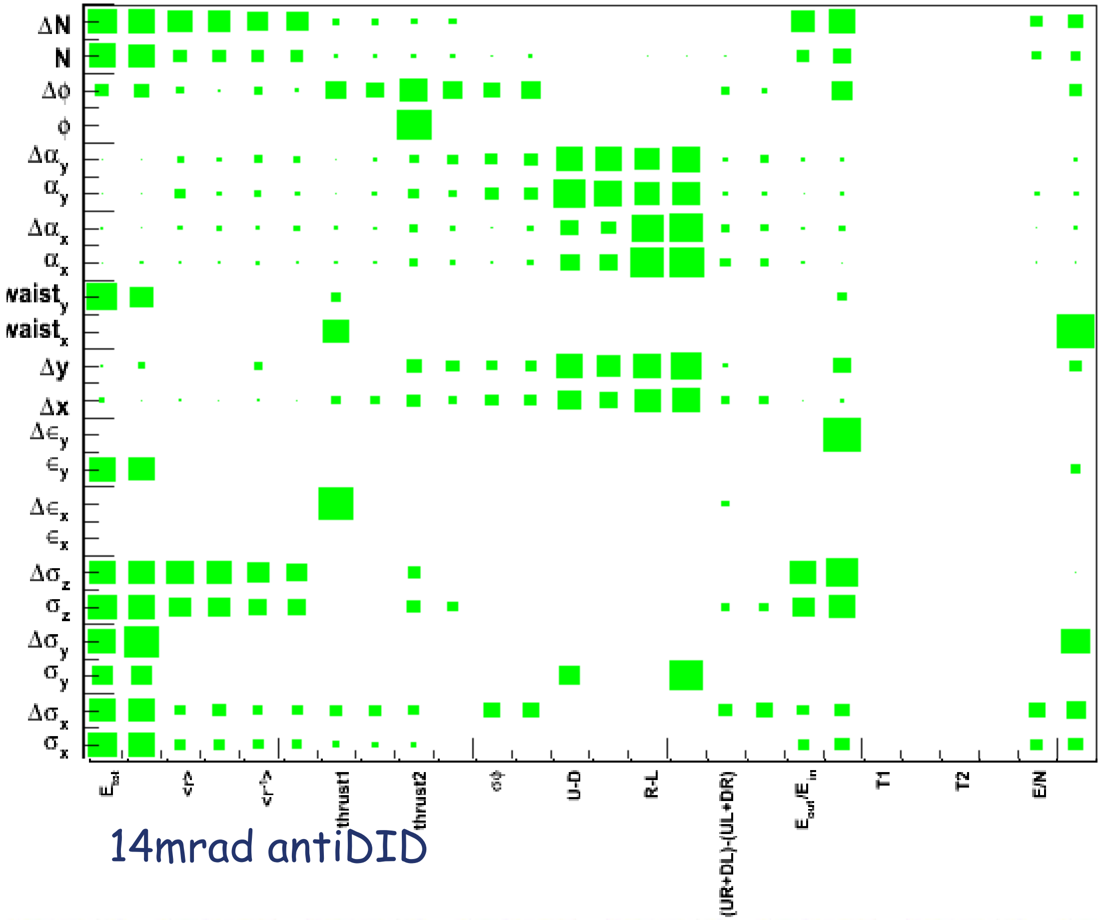


-z BeamCal

changed LumiCal
and BeamCal
acceptance

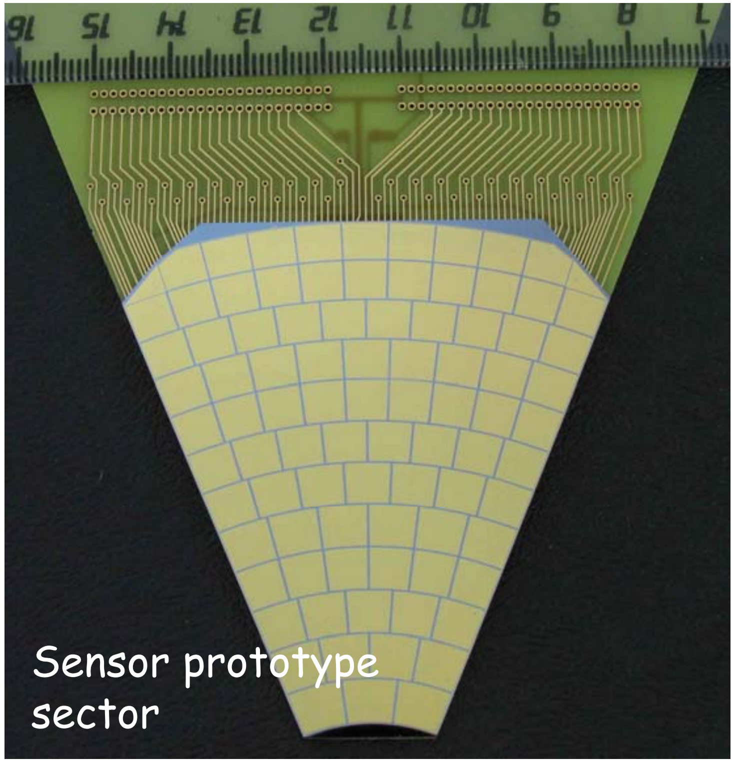
Beam Parameter Reconstruction

Beamparameters vs Observables
slopes (significance) normalized to sigmas



14mrad antiDID

Readout Scheme
for BeamCal



Summary and Outlook

- The geometry of the forward region was adjusted to the case of a large crossing angle.
- We investigated the impact of a change in the segmentation on the electron veto efficiency. 0.8 R_M is still good and reduces the total channel number.
- Tested the fast beam parameter reconstruction for 2, 14 and 20 mrad configurations with DID/AntiDID field.
- A Geant4 simulation of BeamCal (BeCaS) is ready for use. It is fast enough, so that we do not need a shower parametrization.
- First tests show that a subset (some layers) of the detector information seems sufficient for beam parameter

WP5 Summary

- DIAG work package includes a range of systems important to the ILC.
- All tasks are now in “full steam” and are highly productive
- Lots of interplay with the other WPs
- Lots of activity – groups and hardware are in place/being delivered and tested with beam.