Geneva, 28 February 2005

52nd LHC Collimation Working Group meeting

An high resolution gauge for measuring the collimator jaw position with micrometre precision

Results of TT40 measurement

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Support by R. Assmann and O. Aberle

Acknowledgements: F. Loprete, R. Perret, SC-RP, AB-ATB-TD

CERN AB-ABP

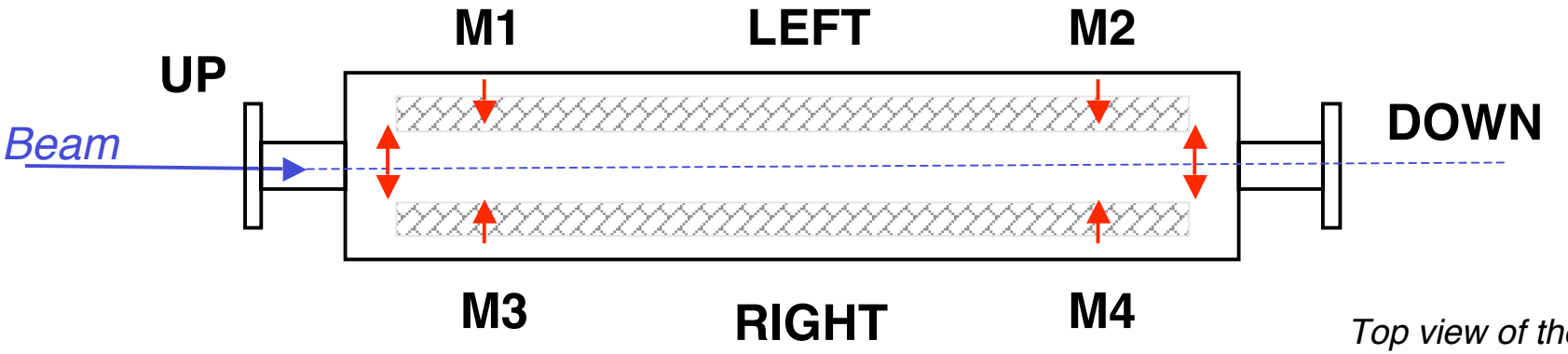
Switzerland

Overview of my talk:

1. Introduction
2. Experimental setup at TT40
3. Data acquisition system
4. Some measurement results
5. Radiation resistance?
6. Conclusions

Introduction - Sensor equipment for the SPS/TT40 tests

Measuring jaw position and angle and gaps require **6 position sensors**!



Top view of the LHC secondary collimator

Main requirements for jaw position and gap measurements

(F. Decorvet, June 2004)

- 5 μm resolution / 20 μm accuracy
- 50 MGy over 10 years
- 300-1500 m long cables
- High reliability / limited human intervention
- Measuring range of 40mm (jaw) and 60 mm (gap)

Foreseen collimator position sensors as of July 2004

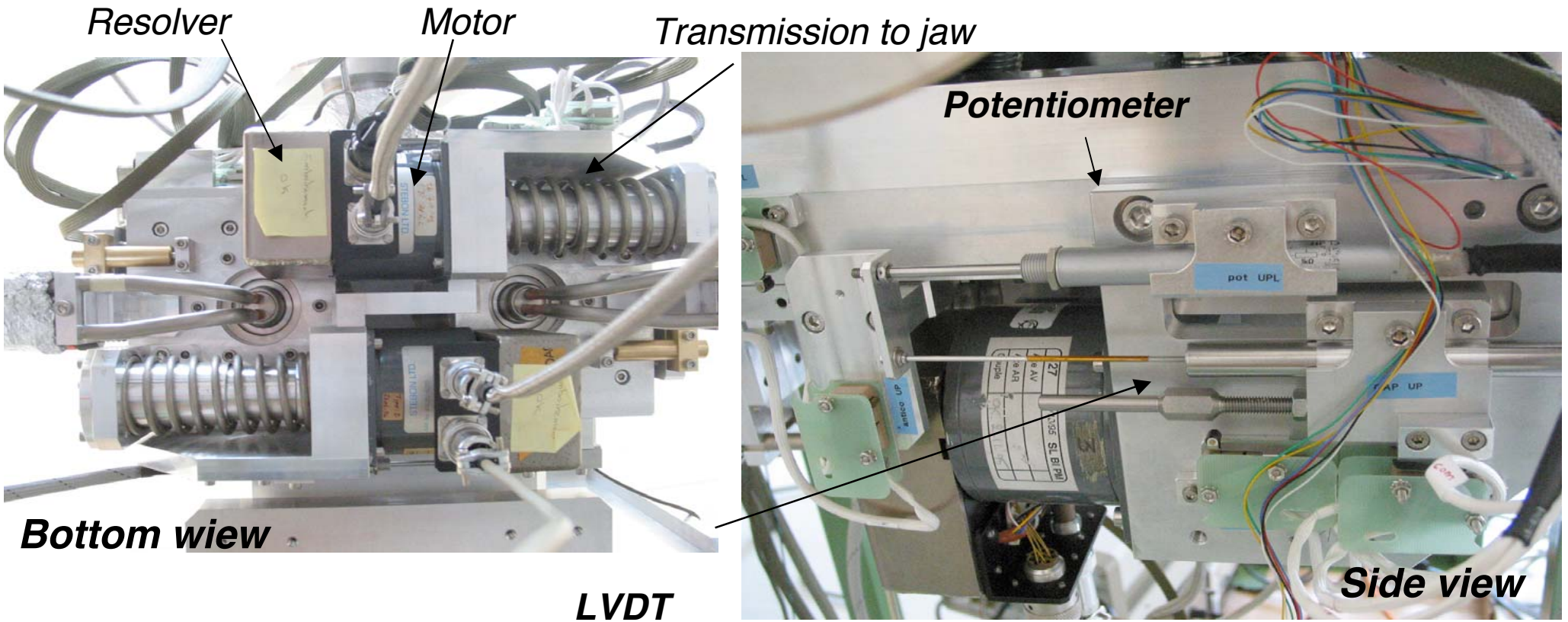
(see SR, 43rd LCWG, 20-09-2004)

- Motor settings
- Resolvers

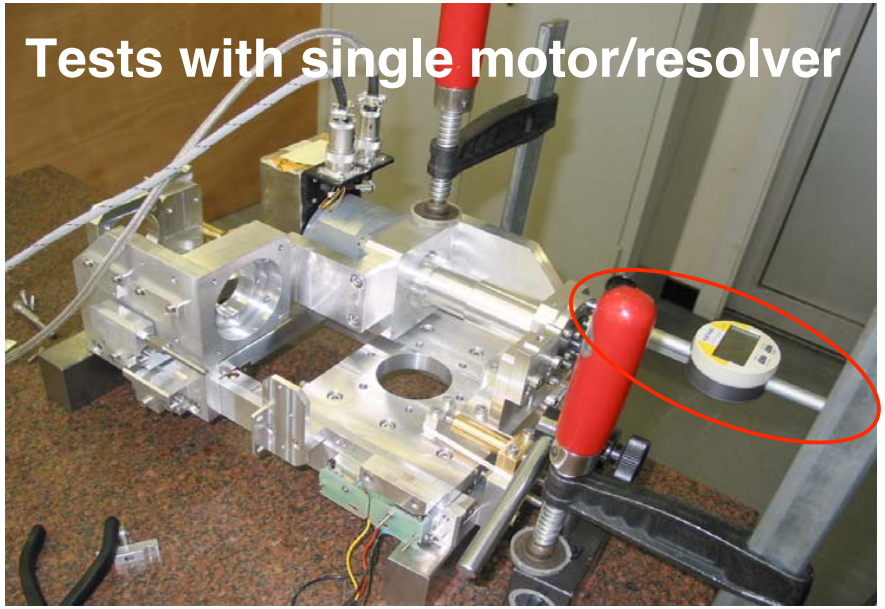
} *"Upstream" of the mechanical structure*

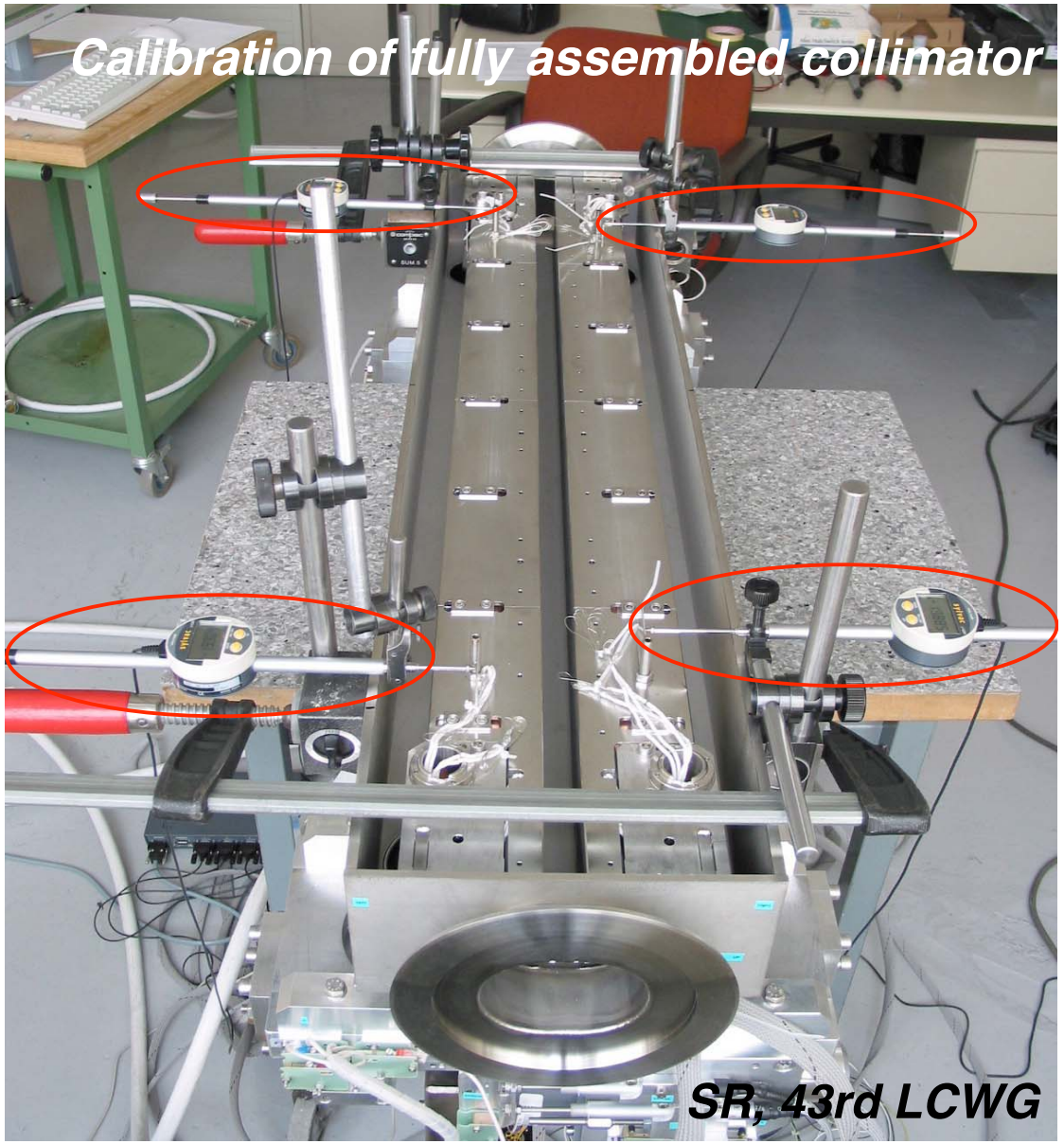
- LVDT
- Potentiometers

} *Measure "directly" the jaw positions*
Different types and ranges (40-60 mm)



Test-bench measurements carried out with ***capacitive gauges*** (June/July 2004)



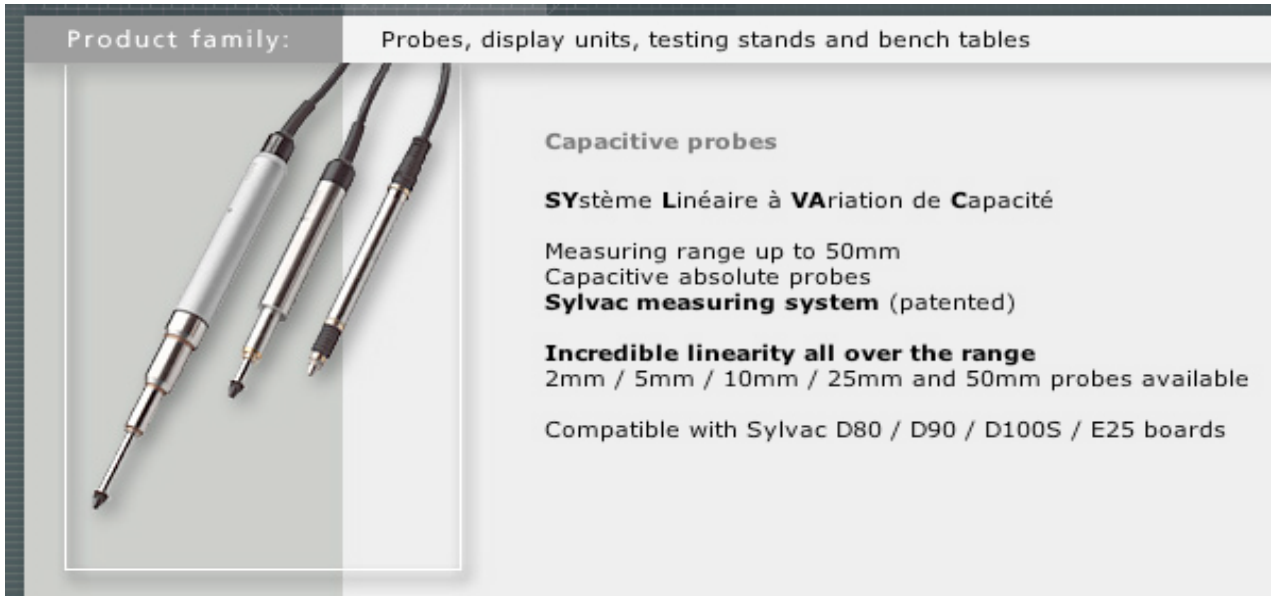


Capacity gauges by ***Sylvac***

(sold by **HHW**, Switzerland):

- Proven accuracy of **~ 1 μm**
- Measurement range: **50-100 mm**
- Connection to PC for automatic data acquisitions

Can we use these gauges for the LHC?



Resolution **0.1 μm**!!

Acquisition box programmable via RS 232

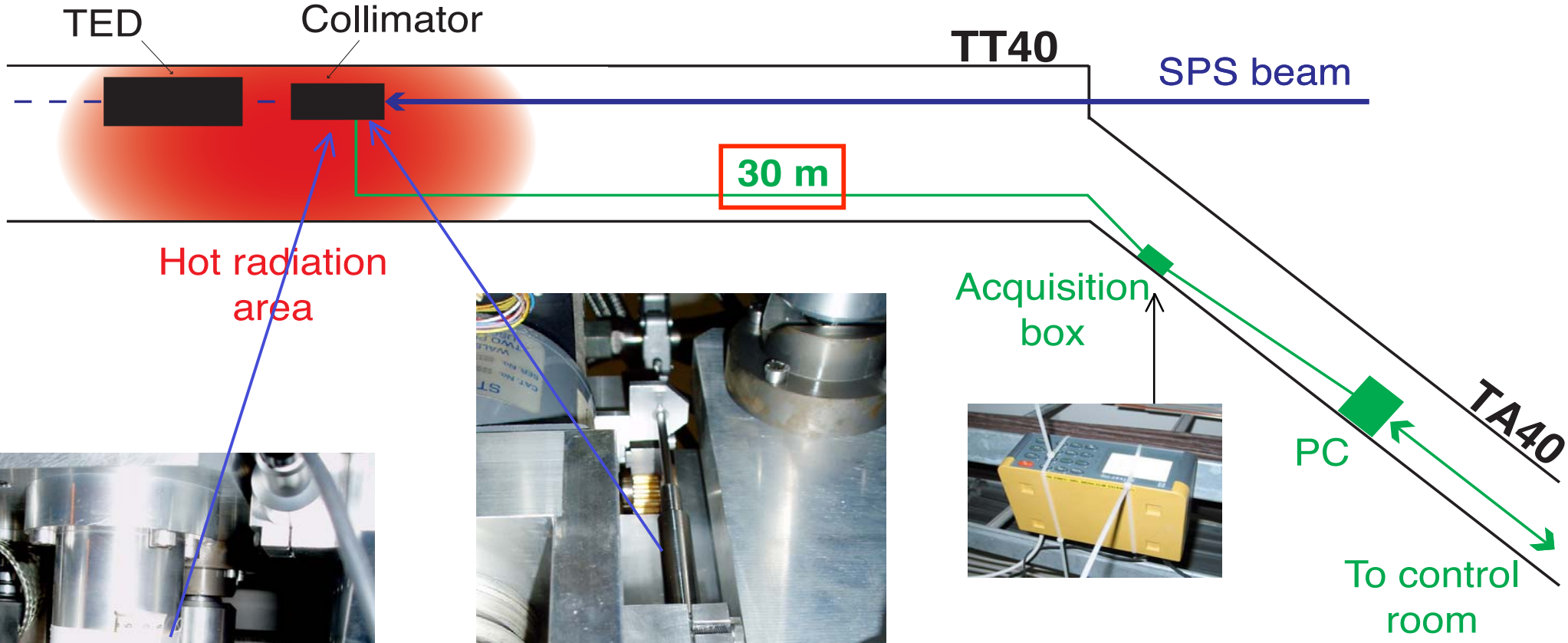
No active electronics in the sensor - ok for radiation?

A sensor prototype offered *almost for free* for the TT40 collimator test (high radiation).

Efficient help from **HHW**
(J.M. Schaffter, C. Murdter):

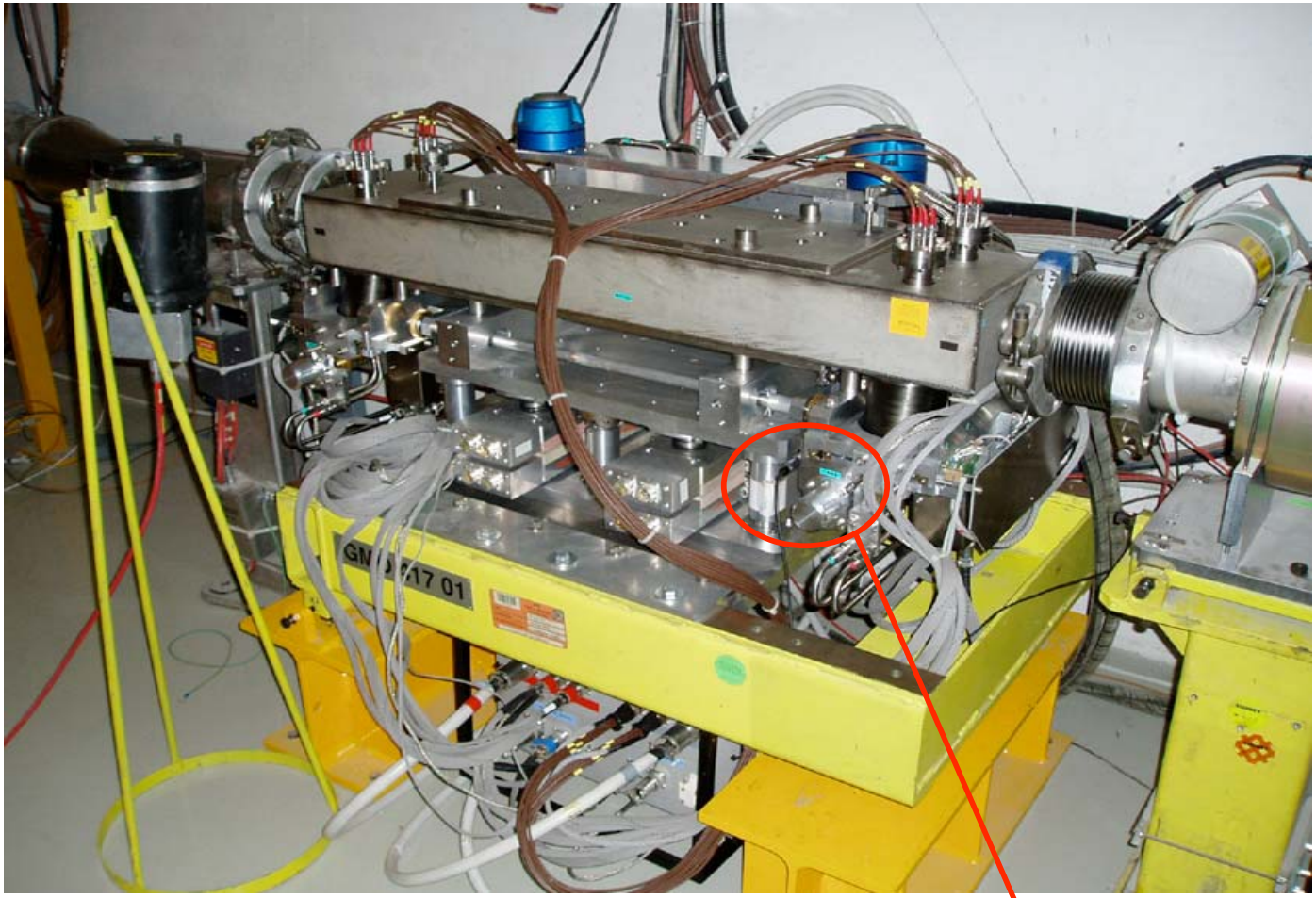
- fast delivery
- special calibration with 30m long cable

Installation at TT40



Dosimeter for integrated dose measurements…

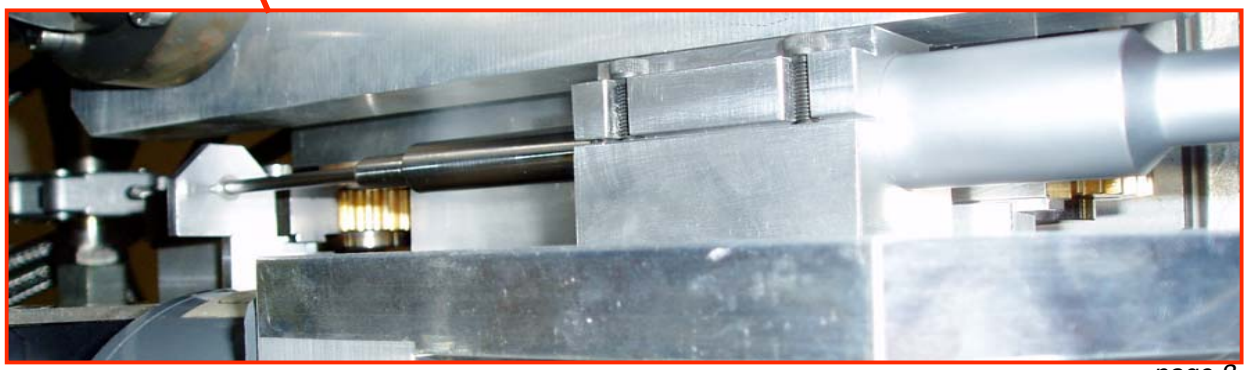
More pictures …



Installation at TT40 (too late for SPS) carried out on 06/09/2004.

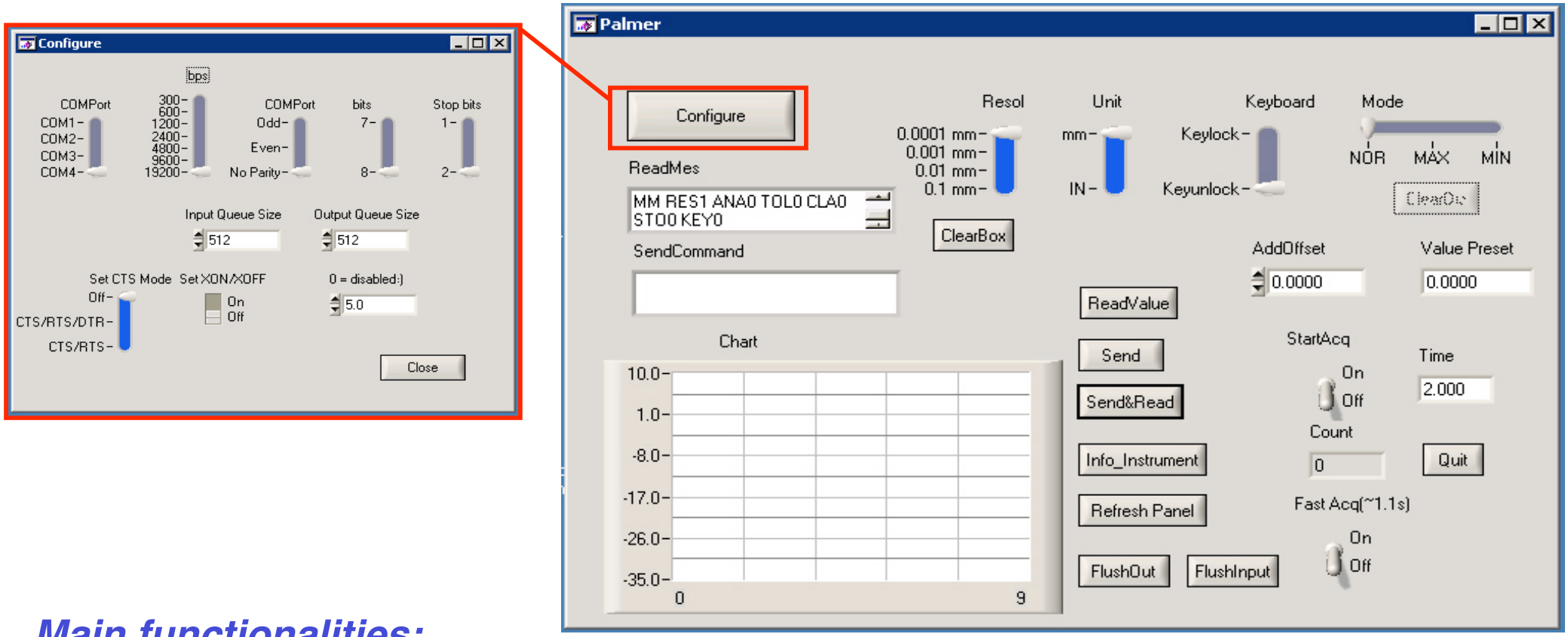
Sensor on the upsteam side w.r to the beam (less radiation..)

Not calibrated at the metrology.



Software for data taking and acquisition settings

Work of Giovanni Spiezia, student from Naples University



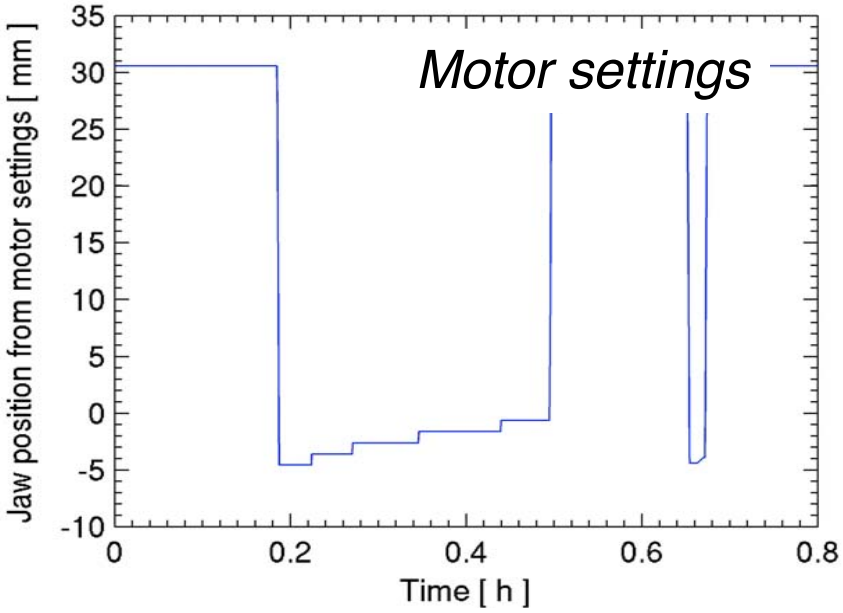
Main functionalities:

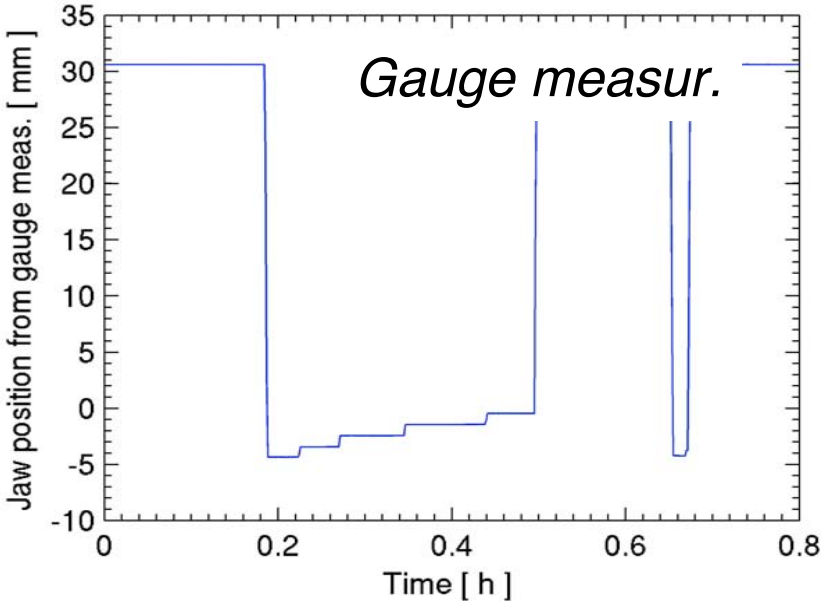
Remotely set all acquisition parameters (zeroing, resolution, …) via RS232

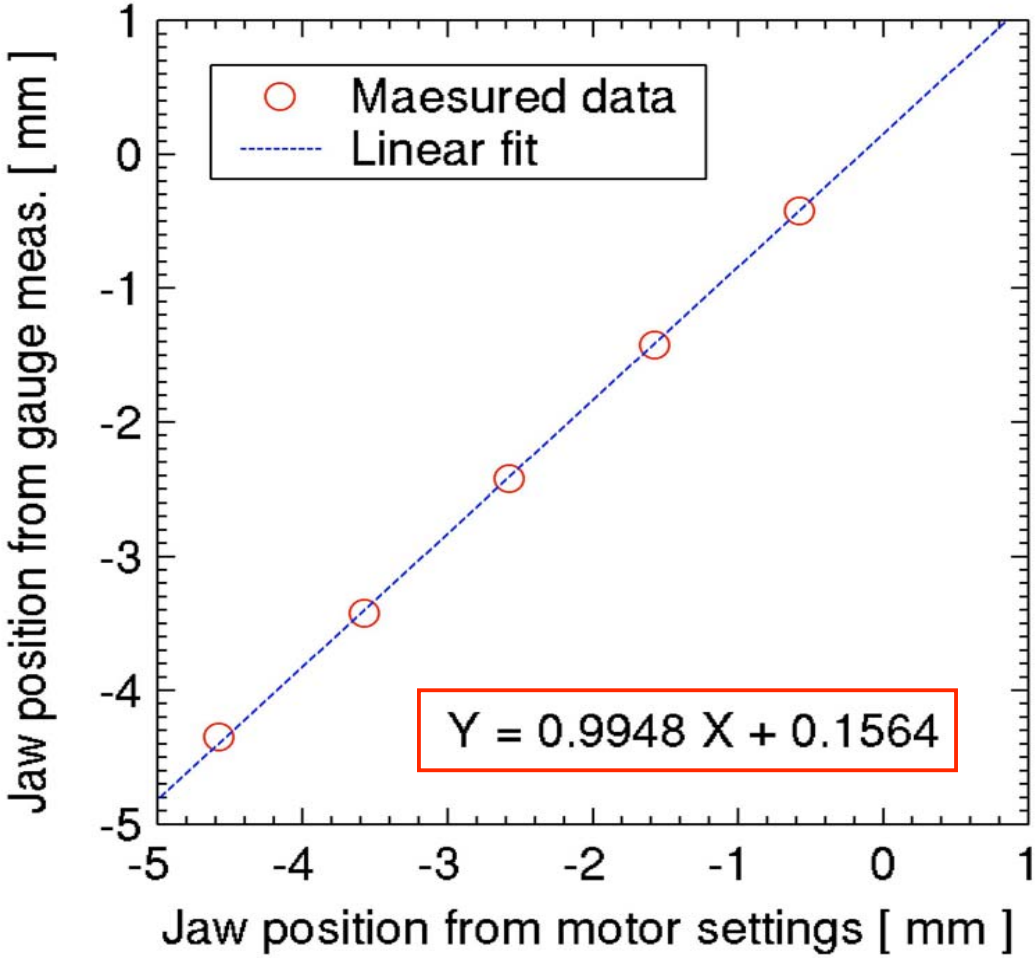
On-line plotting in control room

Data logging for later analysis (f_{acq} ~ 0.5 Hz limited by RS232 transmission)

Example of measurement data





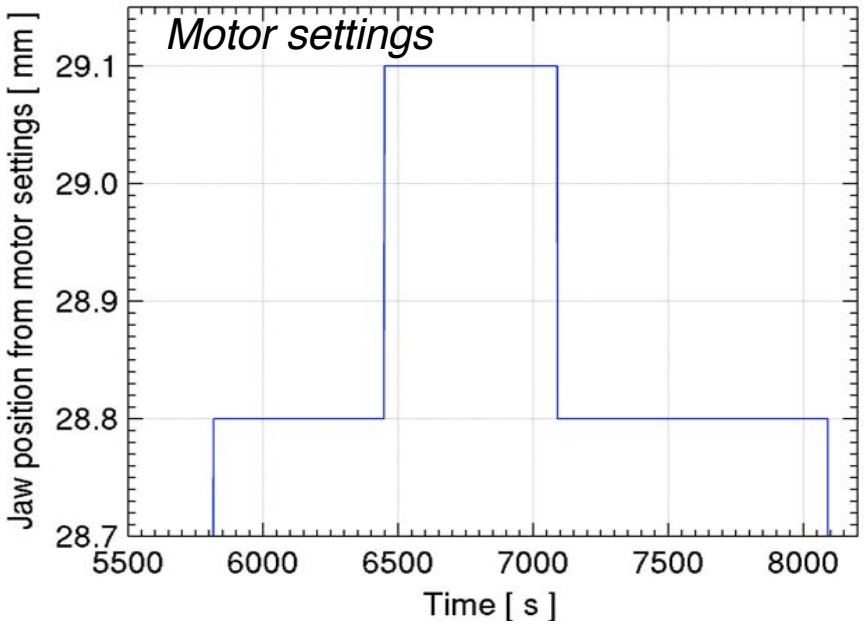


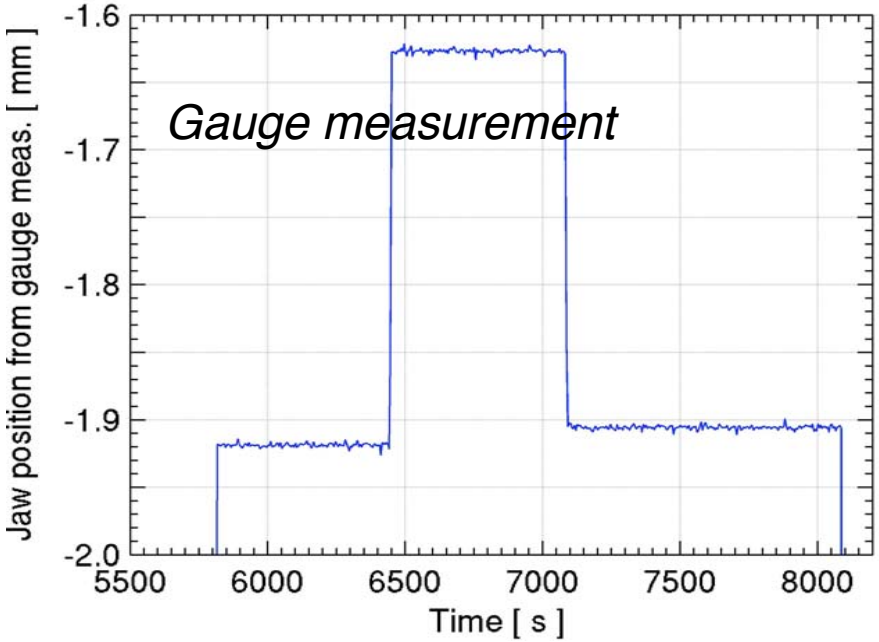
Error of **~0.5 %** on the slope.

150 μm offset in the zero

(gauge not calibrated at metrology…)

Mechanical play of the collimator jaw



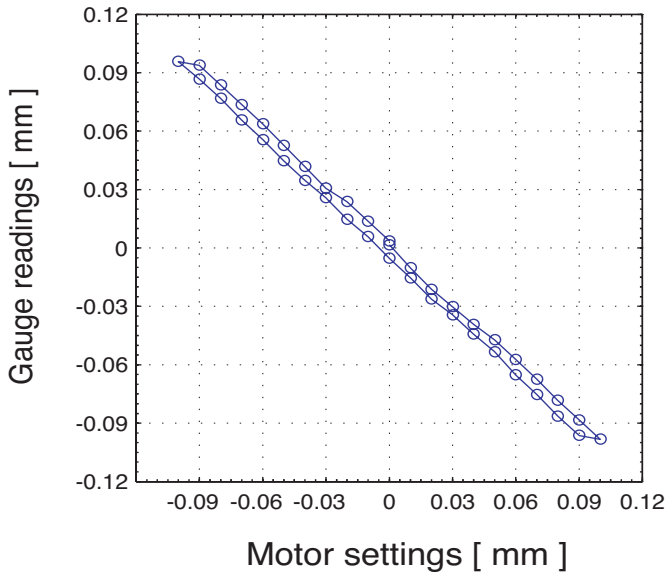


Going up → **-1.9186 ± 0.0014 mm**

Going down → **-1.9056 ± 0.0016 mm**

Mechanical play of **13 ± 3 μm** only measurable with the gauge!

Confirmed in test-bench measurements with open collimator (SR, 43rd LCWG): ~ 8-10 μm



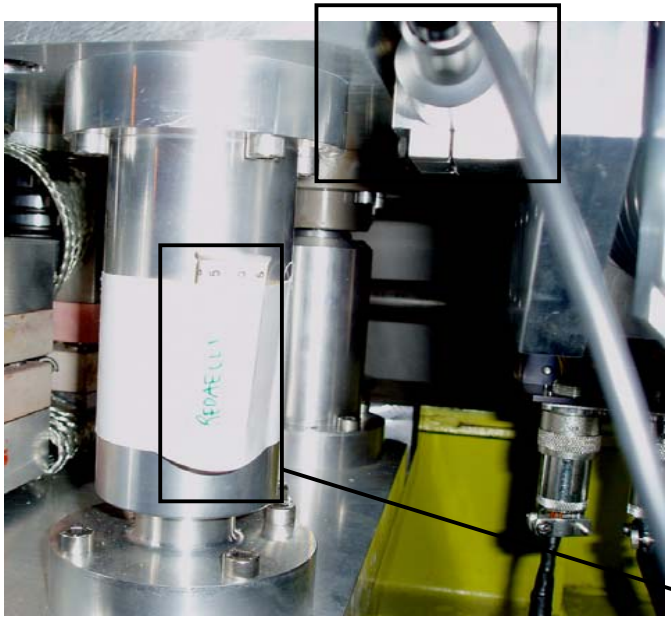
Comments on total radiation dose

Radiation sensors installed on 06/09/2004 and measured integrated until January 2005 (not only from collimator).

	Nominal Dose (Gy)	Upper Dose (Gy)	Lower Dose (Gy)
Alanine	90	97	84
RPL	87	89	85

Thanks to F. Loprete (AB-ATB) and I. Brunner, H. Vincke (SC-RP)

Sensor



Total integrated dose of approximately **90 Gy**.

The sensor kept working.

Small doses compared to the LHC requirements…

Can we exclude the presence of “very sensitive” electronics?

Dosimeters provided by I. Brunner (SC-RP)

Conclusions

- ✓ An high resolution gauge for measuring collimator jaw positions was successfully tested at the TT40 test.
- ✓ Measurement accuracy of ~3.5 μm is well below the LHC requirements. Offsets in the measurements of 150 μm, due to lack of calibration at metrology.
- ✓ Performance Vs. LHC requirements
  - Radiation resistance → Seems ok (no active electronics)
  - Robustness over thousands cycles → To be assessed
  - Electric stability (with radiation) → To be assessed
  - Material → Margin to optimize
  - DAQ (long cables) → To be developed
  - Cost → Remain an issue…
- ✓ Very positive feedback from the company, willing to study *ad hoc* solutions for us (R. Losito is in contact with the company)
- ✓ Do we have time to address all the above issues?

The gauge worked well!

Several potential problems **remain to be addressed in detail**

BUT

it does not seem more critical than the other proposed solutions!

Therefore, it should be seriously
taken into account as an option for the LHC!