BE Beams Department

Long Shutdown (LS1) in the LHC

G. Schneider

Contents

- **Motivation for the interventions**
- **Instruments concerned**
- **Lessons learned**

Motivation for Interventions

- **Repair of damaged components**
- **Service instrument park**
- **Increase performance**
- **Temporary removal or displacement of instruments (SMACC, Bakeout, ….)**

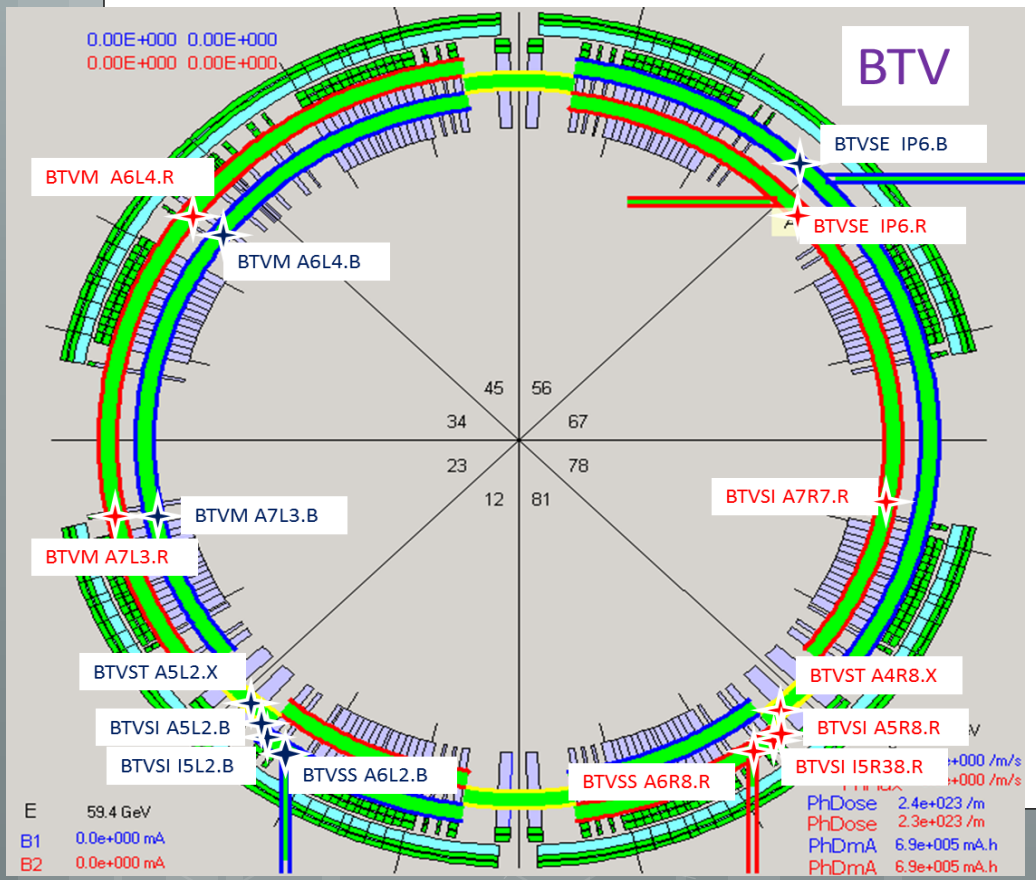
Instruments concerned

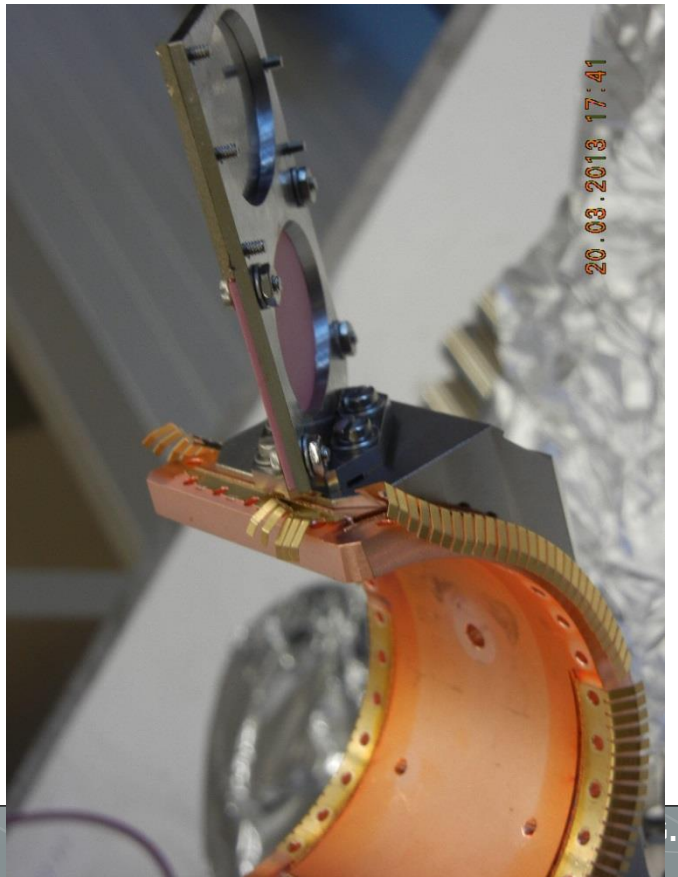
- **BTV**
- **BPM**
- **BRAN**
- **BGI**
- **BGV**
- **BSRT**
- **Wire Scanner**
- **Schottky**
- **BLM**
- **BCT**

BTV:

Set-up instrument to measure the beam profile

- **4x BTVSI and 2x BTVST NEG coated**
- **2x BTVSE, 2x BTVSS RF-contact repair**
- **BTVST: Change Titanium to Aluminium Screen**





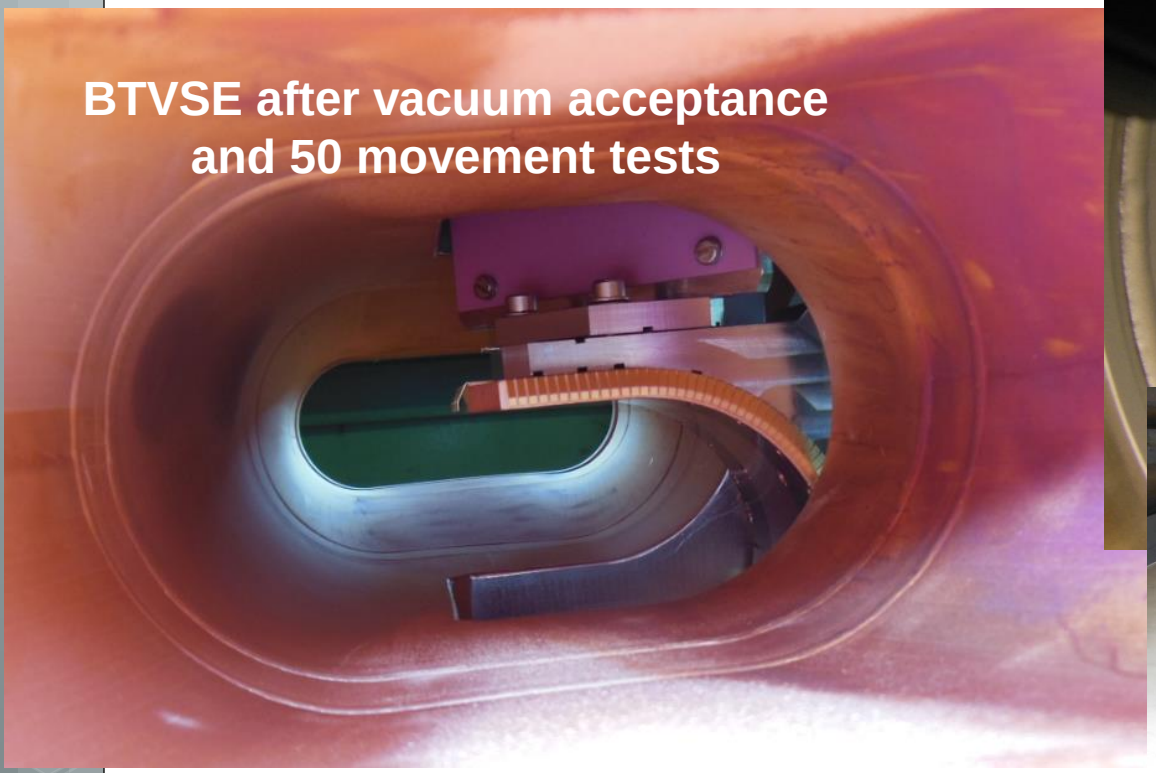
BTV:

- **Work for NEG coating:**
  - Design and manufacture NEG- coating tooling
  - Manufacture and NEG-coat inserts and vacuum chamber (BTVST only)
- **Work for RF-contact repair:**
  - Identify origin or the problem: Excess copper in the vacuum chamber
  - Remove copper
  - Manufacture of new inserts
  - Establish test procedure before and after vacuum acceptance test
- **Work for BTVST Aluminium Screen**
  - Design and make assembly tool
- **Common:**
  - Remove from tunnel, dis-assemble, re-assemble, test, re-installation, camera re-installation
  - New optical line with dual camera system design finished, hardware ready to be installed
- **BTVDD upgrade :**
  - New optical line with dual camera system design finished, hardware ready to be installed
- **Camera exchange due to lower dose rates:**
  - System camera RAD exchange with CCD ones for 2x BTVSS and 4x BTVSI

BTV:

Set-up instrument to measure the beam profile

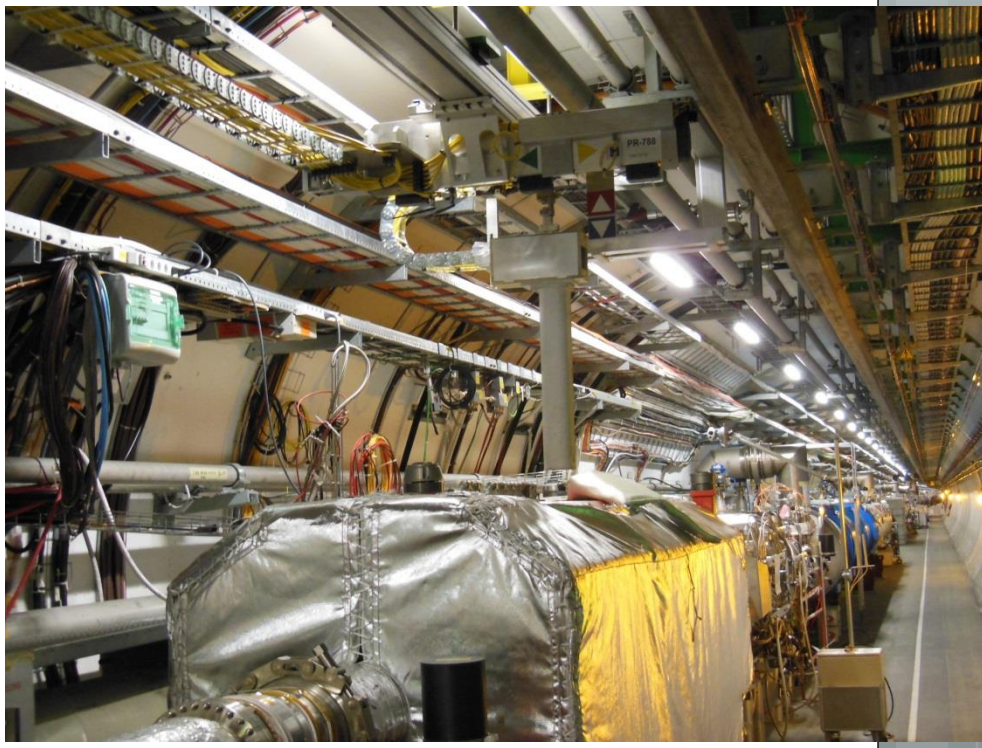
- **After re-assembly**



BRAN:

Beam Rate Neutral Particles, Luminosity measurement on either side of collision points = 8 total

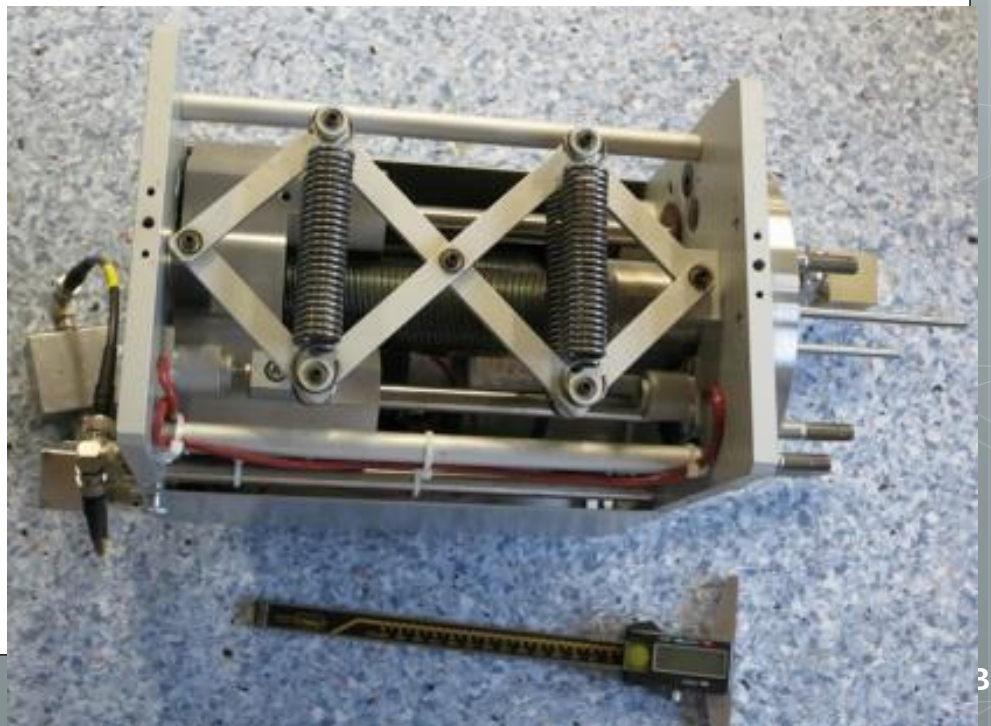
- **Remove and re-install instruments for bakeout**
- **New BRAN C in Point 8 for higher radiation resistance**
- **New installation tooling and procedure**
- **Pressure tests of installation**



BWS: Wire Scanners

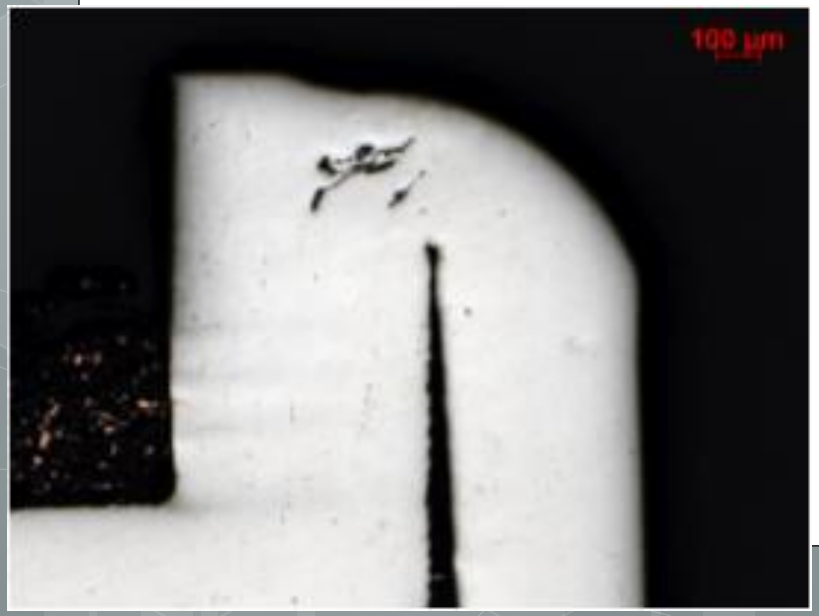
Instrument to measure the beam profile
2 for each horizontal and vertical for each beam = 8 total

- **Leaks on bellows (more than 10000 cycles)**
- **Wire refurbishment**



BWS: Wire Scanners

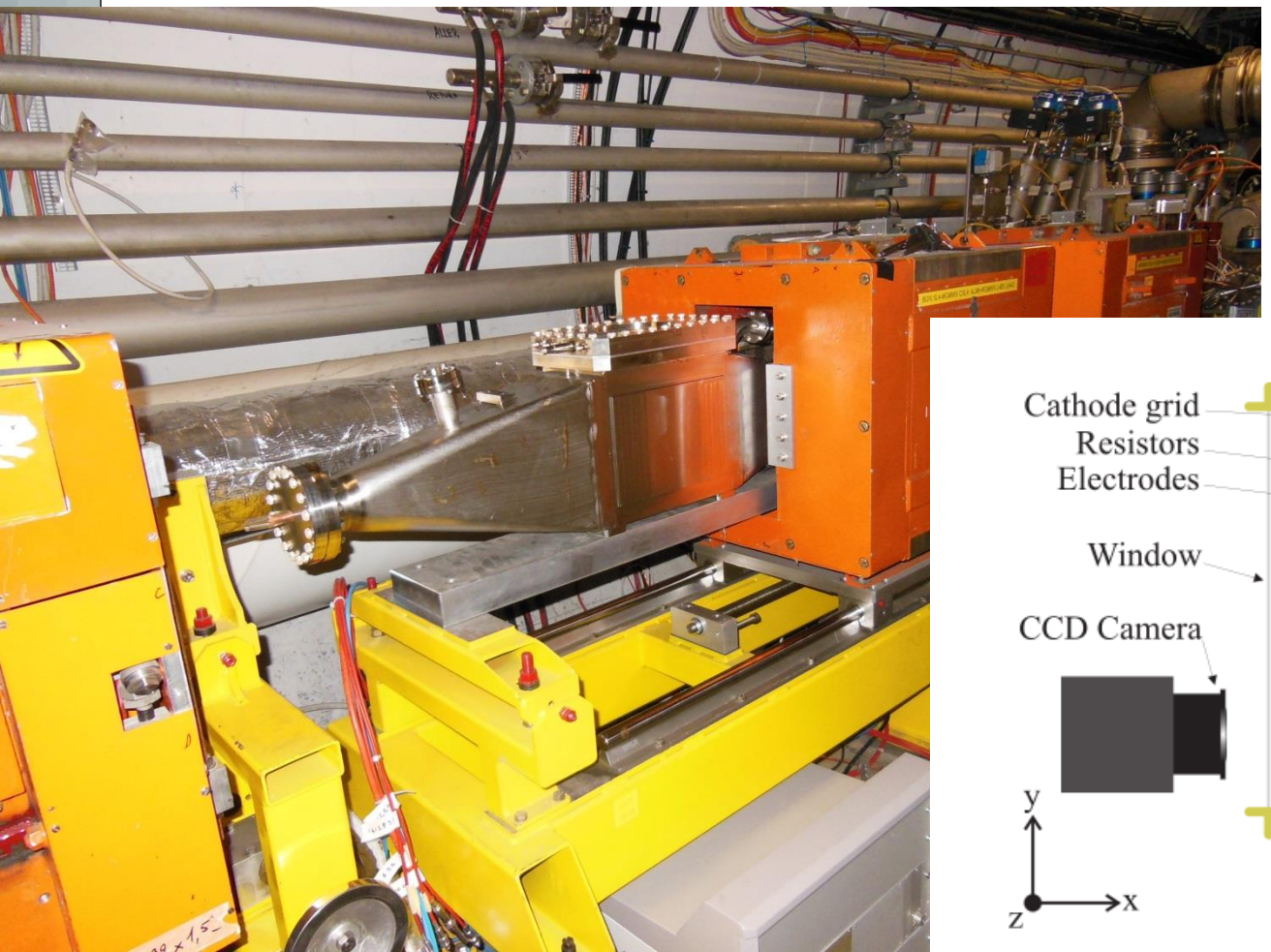
- Scanner (LEP-design) 'reverse engineered' in existing space to allow integration of a bellows rated for 40'000 cycles
- Complex drive mechanism is non-linear and with friction – long analysis and experiments were required to understand and simulate movement → new type of spring for compensation
- Challenging material supply and assembly: Leaks created during final EB weld assembly

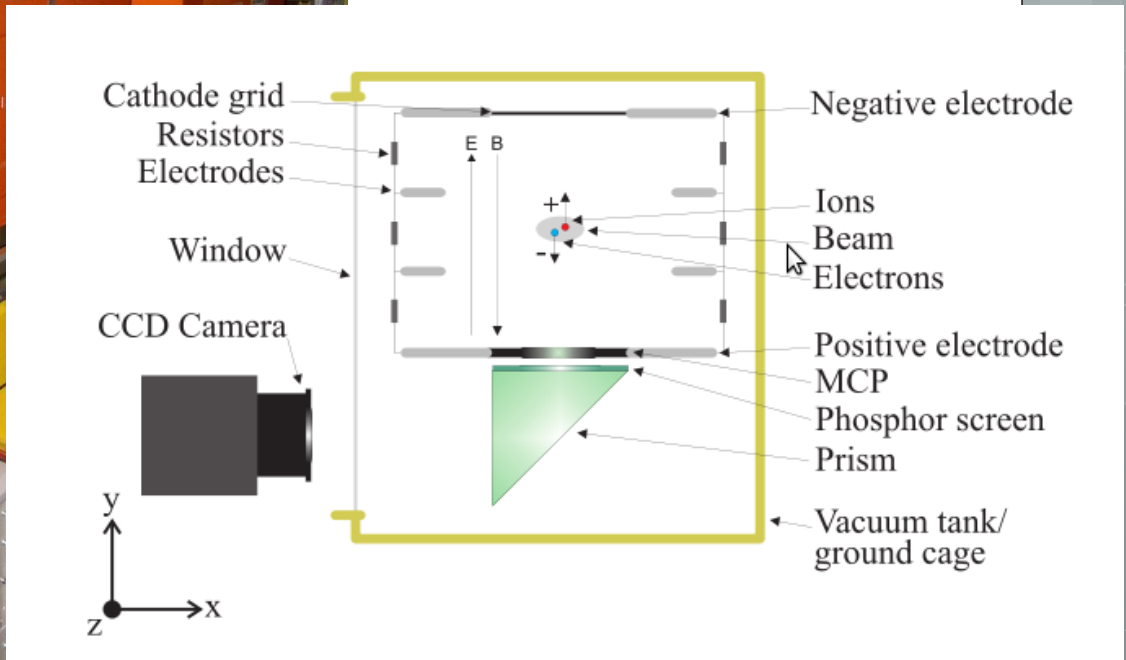


BGI:

Instrument to measure the beam profile using beam – rest gas ionization.

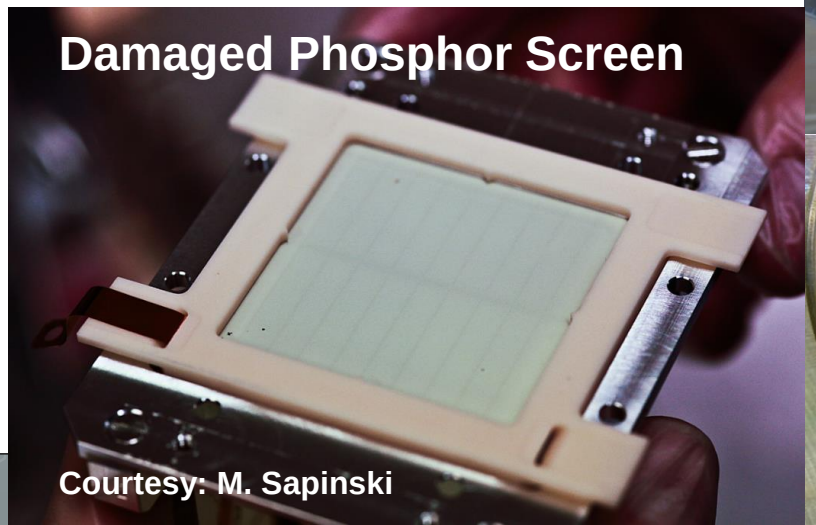
1 horizontal and 1 vertical in each beam line = 4 total

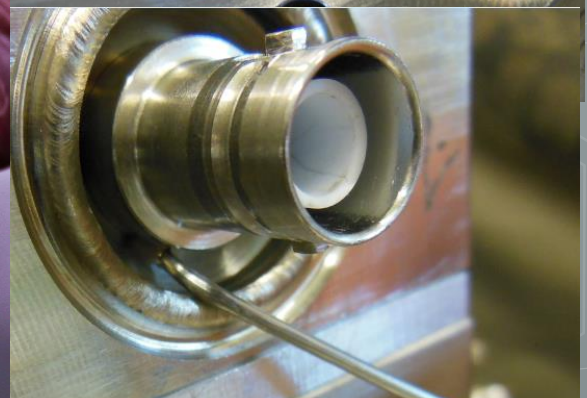




BGI:

- Leak tightness: Surface roughness and profile defined; Seal type changed and grooves in spacer added
- Leaks opened after bakeout. Why?
- Instrument refurbishment:
  - Exchange of MCP (Multi Channel Plate) and Phosphor Screen
  - Cameras more radiation hard
  - Installation of thermometers in vacuum

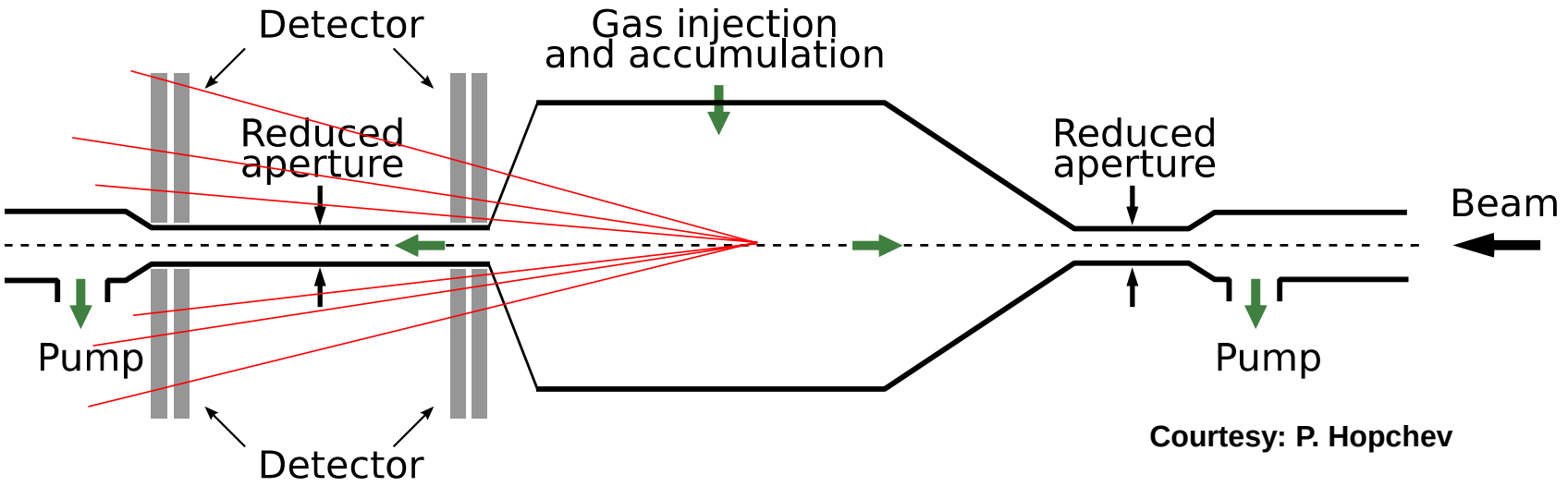




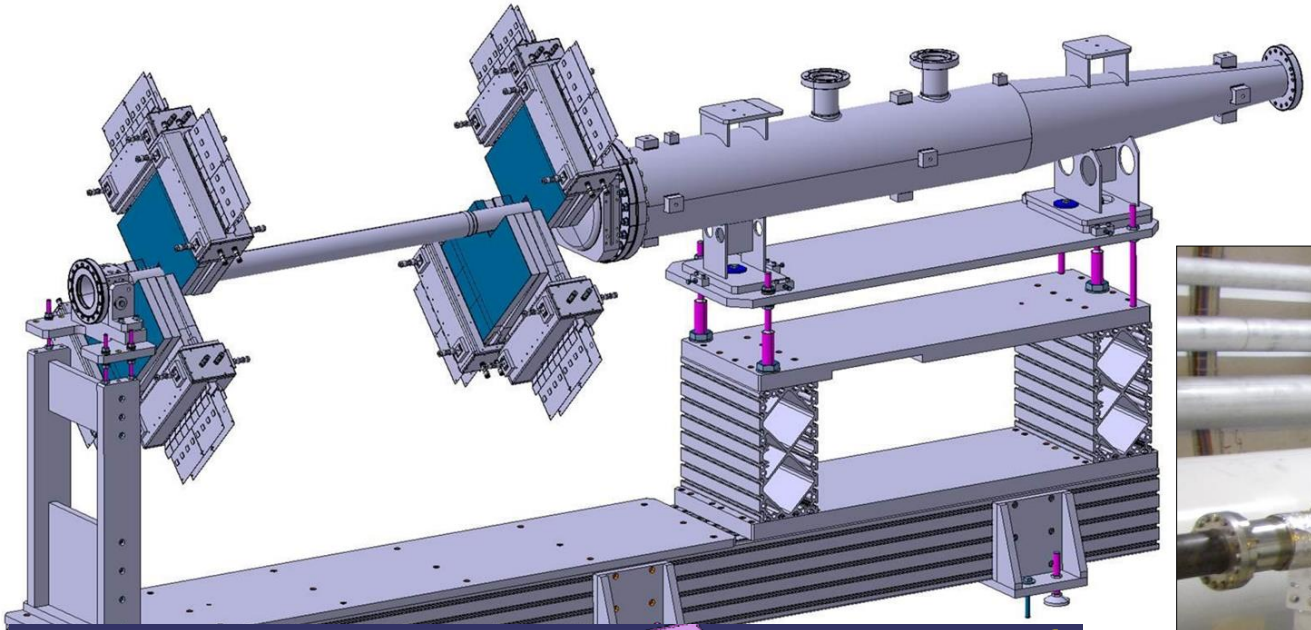
BGV:

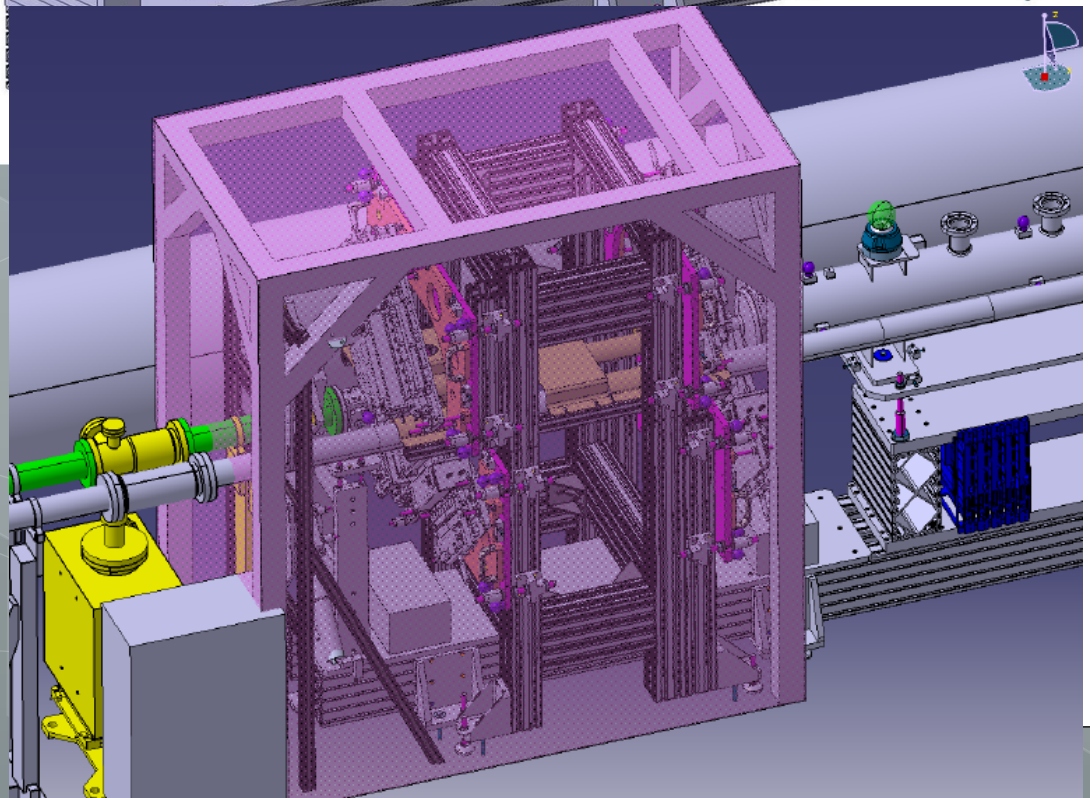
Beam profile measurement; Inspired by VELO detector in LHCb

- **One new demonstration instrument**
  - **Vacuum Chamber**
  - **Detectors (outside the vacuum system)**
  - **Cabling**
  - **Data analyses**



Courtesy: P. Hopchev



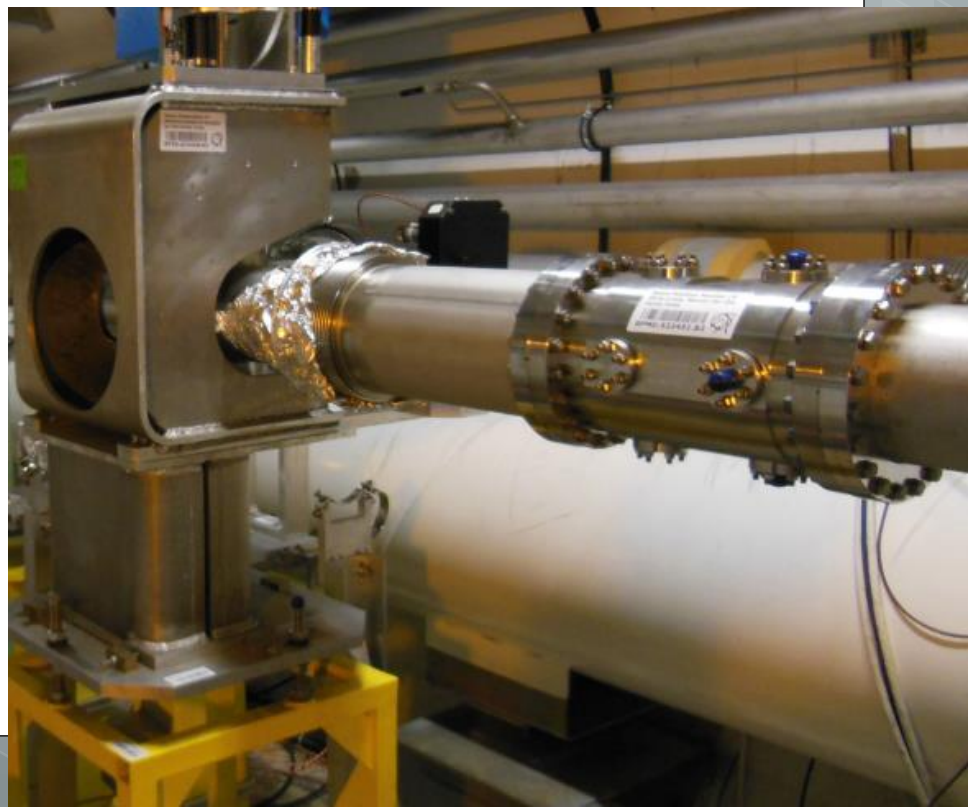


BPM:

Beam Position Monitor

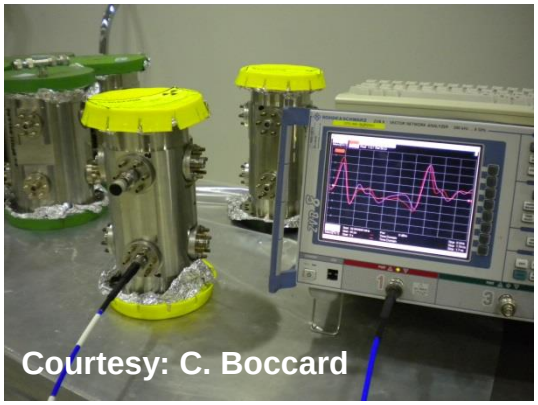
Total 1145 Monitors installed in the machine

- **Engineering Change Requests (ECR) to move, add and change BPMs**
- **BPM cables to be removed for each bakeout**



BPM:

- Modification of Interlock BPMs in IR6 and displacement to make room for TCDQ upgrade
- Installation of new combined BPMWK in TAS->Q1 regions of IP1 & IP5 to optimize mechanical tolerances (vacuum)
- Installation of one BPM per BGI to allow precise BGI calibration with beam
- Re-Alignment of BPMWB close to D2 before Recombination Areas at Points 1 and 5
- New BPLX for Gated Tune measurement
- Replacement of BPMWE for new passive absorbers (TCAPC) in LSS3
- TOTEM Roman Pots stations displaced in IR5
- ATLAS Roman Pots BPM Modification in IR1
- BPMD position measurement added
- NEG coated BPTX in 5L2 & 5R8

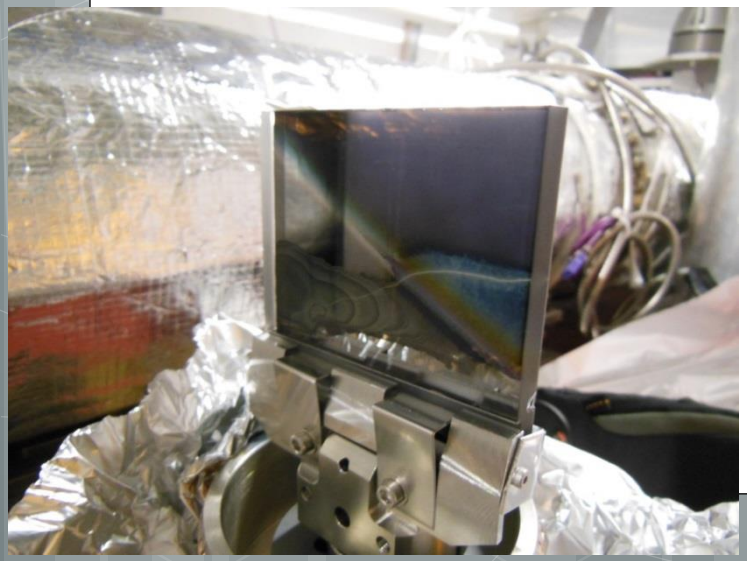

Courtesy: C. Boccard

- Arc BPM: DN100 re-clamped - O-ring seals exchanged - 4 SSS replaced - BPMC cryo cables removed for Interconnect work.
- 18 Collimators with embedded BPMs in all IRs for improved positioning (TCTP & TCSP)

BSRT:

Synchrotron Radiation Telescope to measure the beam profile

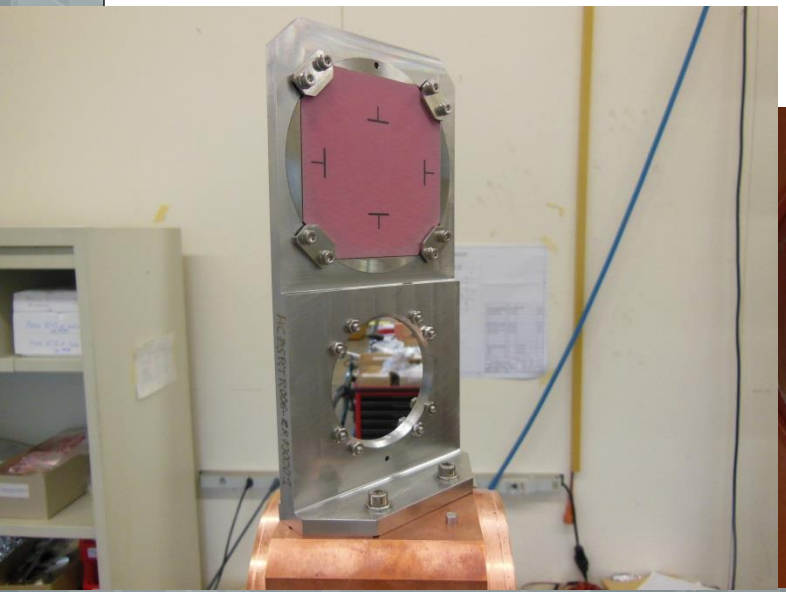
- **Instrument overheated due to RF-coupling in Run1**
- **New design proposed, made and tested**
- **New mirror now made with fused silica instead of silicon**
- **Optical table refurbishment**
  - **focusing lenses in the near UltraViolet (UV, ~250nm) for imaging @ 6.5-7TeV minimizing diffraction**
  - **minor changes in optical filters layout and control**
  - **New interferometer line, for alternative (to imaging) beam size measurements, in principle diffraction-free (ongoing)**

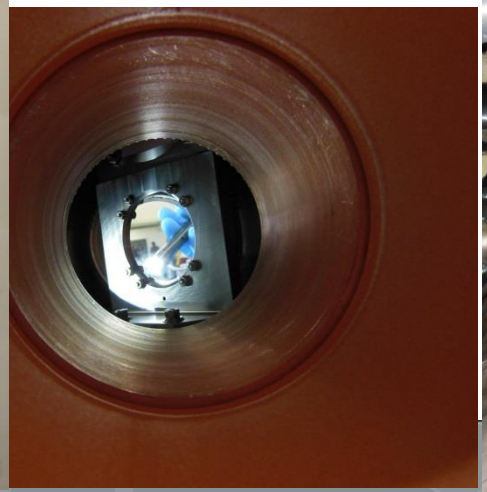


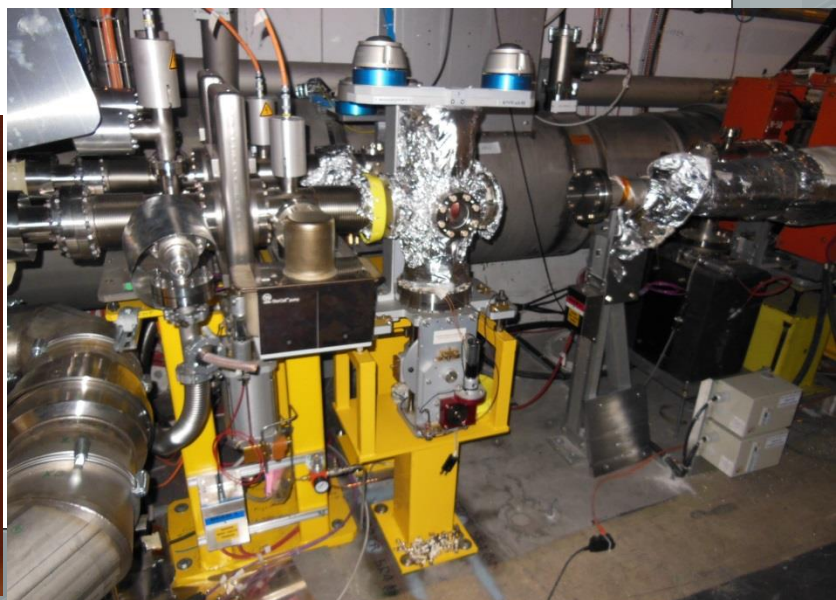
BSRTR:

New calibration instrument for BSRT-system, replaces BSRTA

- **Motivation: free about 30% space on the optical table**
- **Alignement and calibration done via the same optical line. Laser/target light sent into the beam pipe via BSRTR.**
- **Based on BTVSI-design**



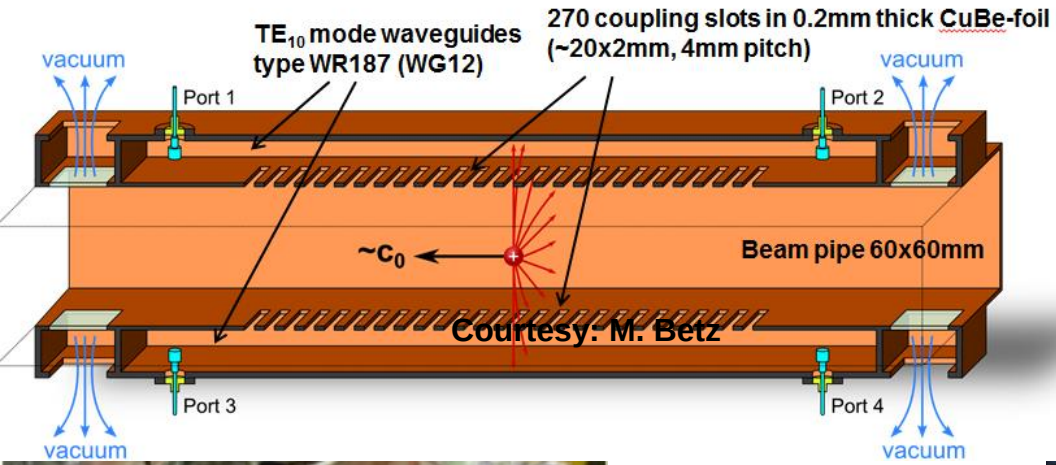


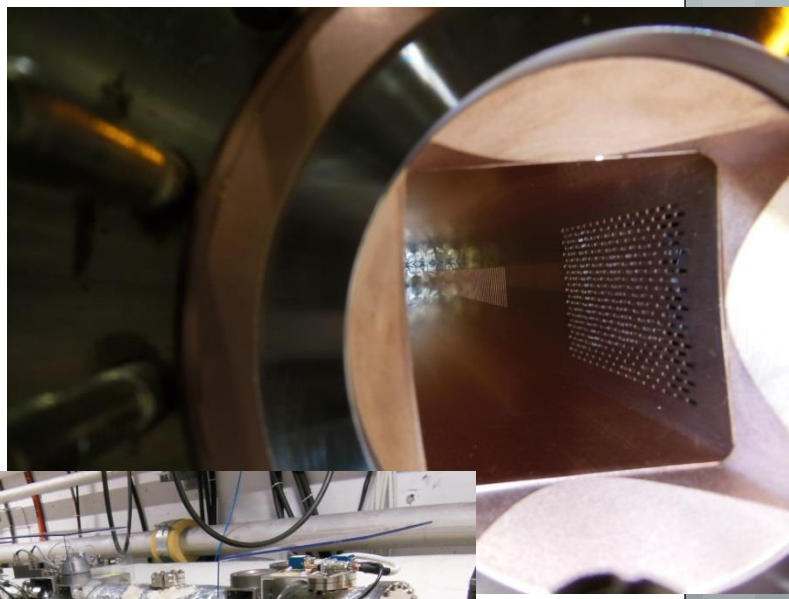


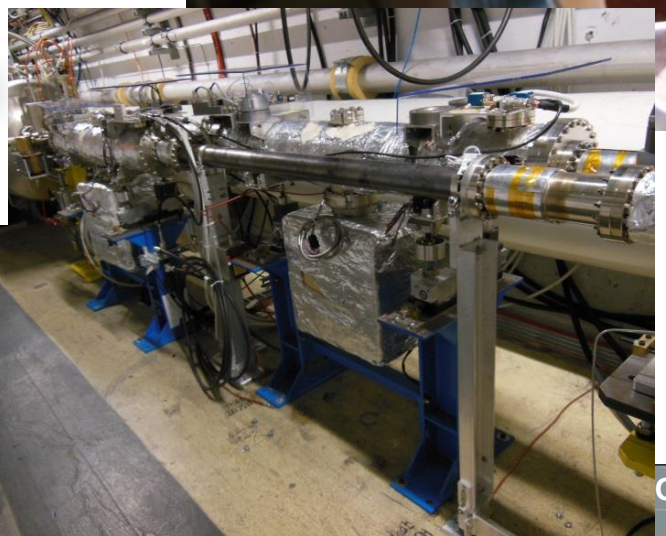
Schottky (BQS):

Incoherent tune and chromaticity measurement instrument
1 for each horizontal and vertical for each beam = 4 total

- **Aluminium wave guide changed to copper**
- **Slots optimised**
- **Performance measured**
- **Front end electronics overhaul**





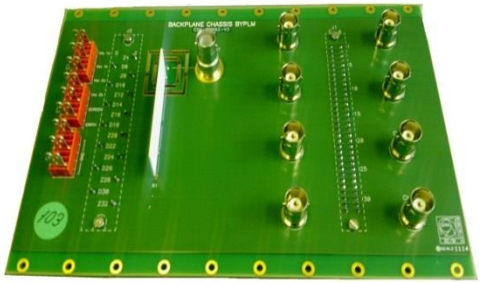


Beam Loss Monitor (BLM):
Outside beam vacuum

- **Remove and reinstall BLMs in order to have access to the interconnects**
  - **all BLMs in ARCS (total ~2500 of which 816 were re-located)**
  - **about 70% of LSS BLMs (total ~1000)**

Beam Loss Monitor (BLM):

- **Exchange 40 multiwire cables with the NES18 type**
  - **Reduce noise on 240 detectors**
- **Exchange 360 acquisition crate backplanes (ARC)**
  - **Under ARC quadrupole**
  - **Better defined feedback voltage to improve reset and test function of electronic cards**



Improved backplane

- **Modify 309 signal distribution boxes and add high voltage divider boxes (LSS)**
  - **Better defined feedback voltage to improve reset and test function of electronic cards**
- **Installation/Connection to WorldFIP**
  - **Allow remote access and re-set per card**

Beam Loss Monitor (BLM):

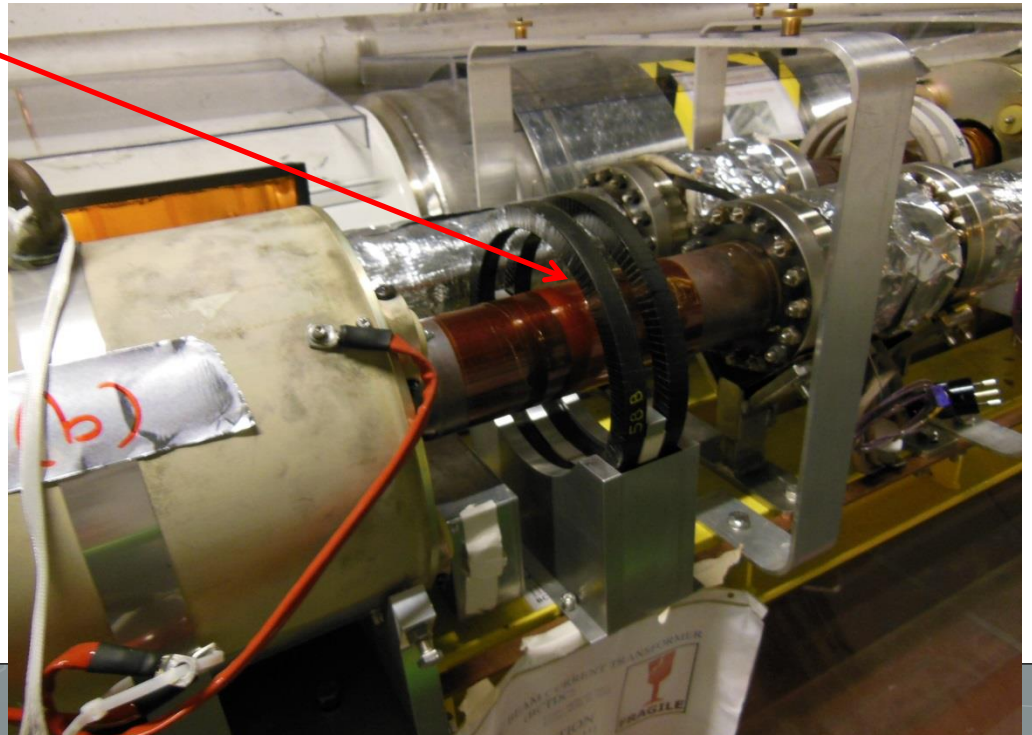
- **Modifications in the tunnel acquisition electronics**
- **Modifications in the surface installation**
  - **Racks now with water cooling**
  - **Removal and re-installation of crates, cables….**
- **Preventive maintenance of the Treshhold Comparator electronics**
  - **Cleaning and re-testing of the cards**
- **Modification of the BLECS and BLETC firmware**

Courtesy: Ch. Zamantzas; E. Effinger

BCTDC:

Integrated Beam Current Transformer
2 per beam

- **Addition of magnetic cores in order to reduce the interferences in the RF-range**

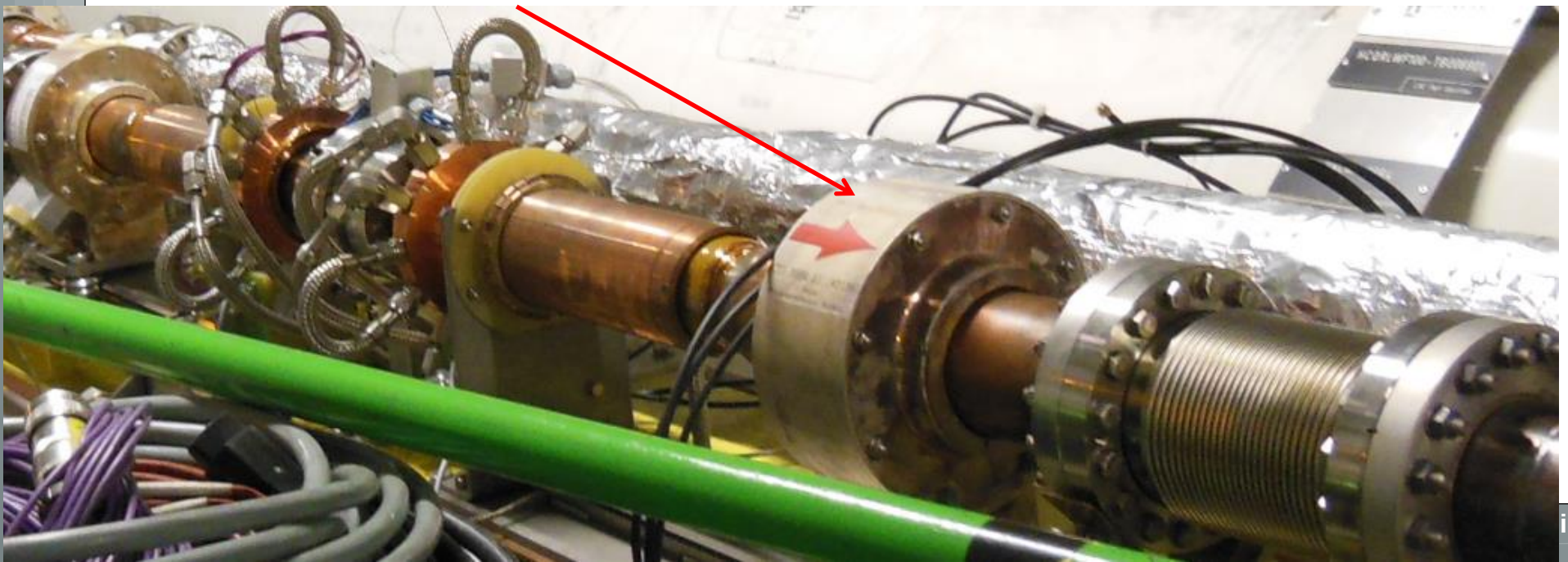


BCTF:

Fast Beam Current Transformer
Motivation: Reduce bunch length and bunch position dependency

- **Two new types (BCTI and BCTW) were developed**
  BCTI already installed, BCTW foreseen to be installed before end 2014

BCTI



Lessons Learned

- **Definition in advance what to do saves time, nerves and resources**
  - Designer availability
  - Orders are more relaxed
  - Workshop has more time to prepare
- **Document the work done and make information available**