Silicon beam telescope for CMS SLHC detector studies (SiBT

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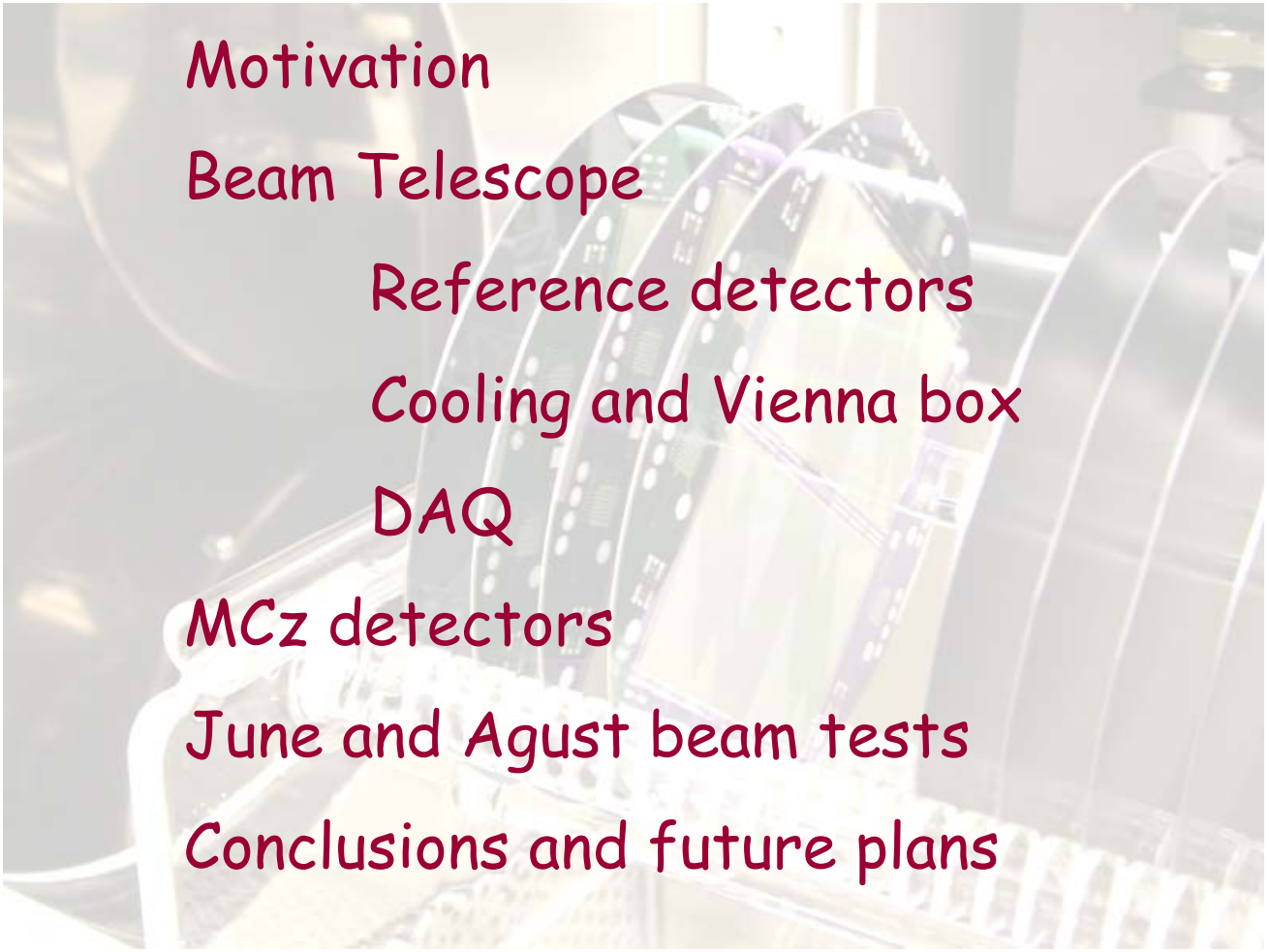
Outline



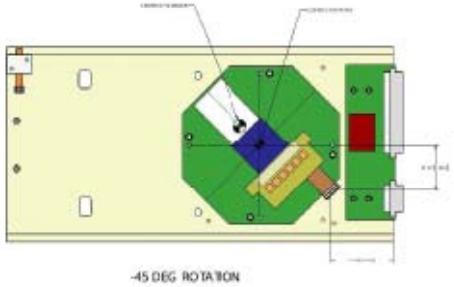
- Motivation
- Beam Telescope
  - Reference detectors
  - Cooling and Vienna box
  - DAQ
- MCz detectors
- June and Agust beam tests
- Conclusions and future plans

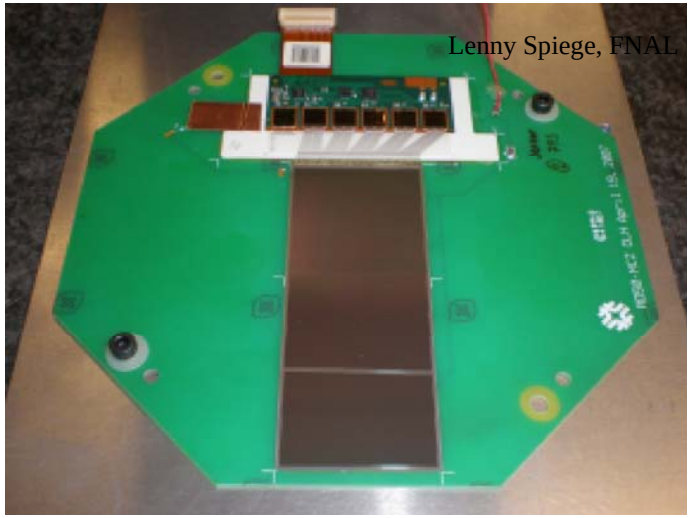
Motivation

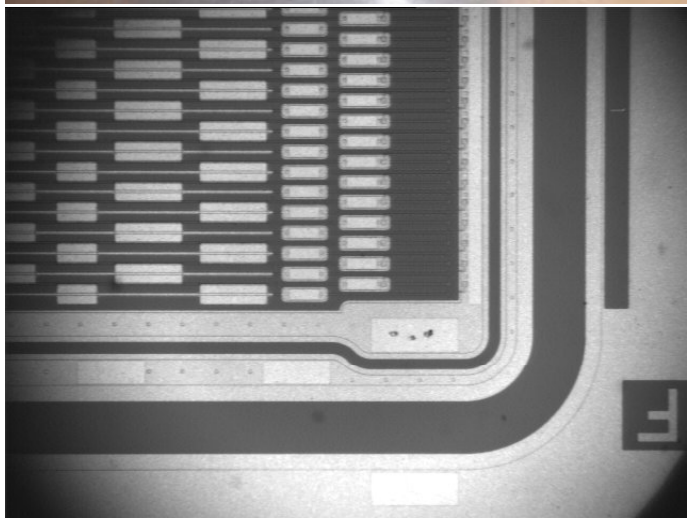
- Helsinki Institute of Physics (HIP) has operated the Silicon Beam Telescope (SiBT) at the CERN H2 test beam since 1990's.
- SiBT is a unique detector testing unit for testing full-size particle detectors..
- The SiBT was upgraded this year to meet the requirements for testing the novel full-size detectors, especially MCz detectors, for the possible SLHC CMS Tracker

Reference detectors

- Reference detectors are Hamamatsu sensors made for Fermilab D0 run IIb
  - 60 micron pitch
  - intermediate strips
  - size 4 cm x 9 cm
  - 639 channels



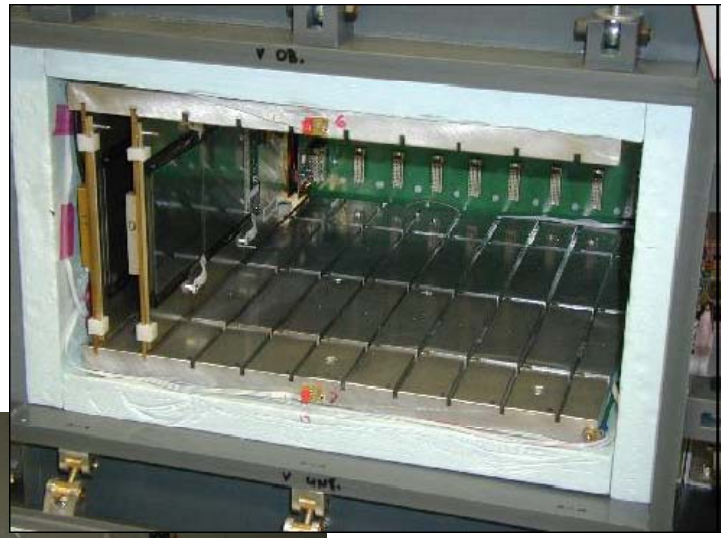


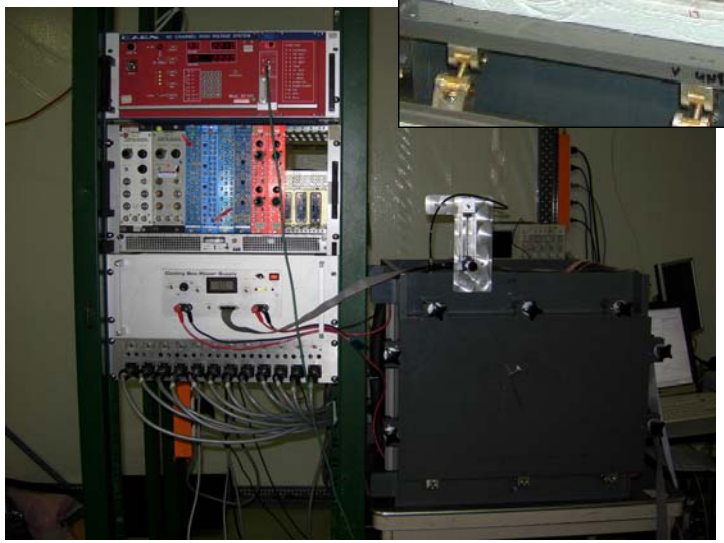


- Readout electronics: CMS 6-APV chip Tracker Outer Barrel hybrids (5 chips bonded)
- The reference detector modules were built in Fermilab.

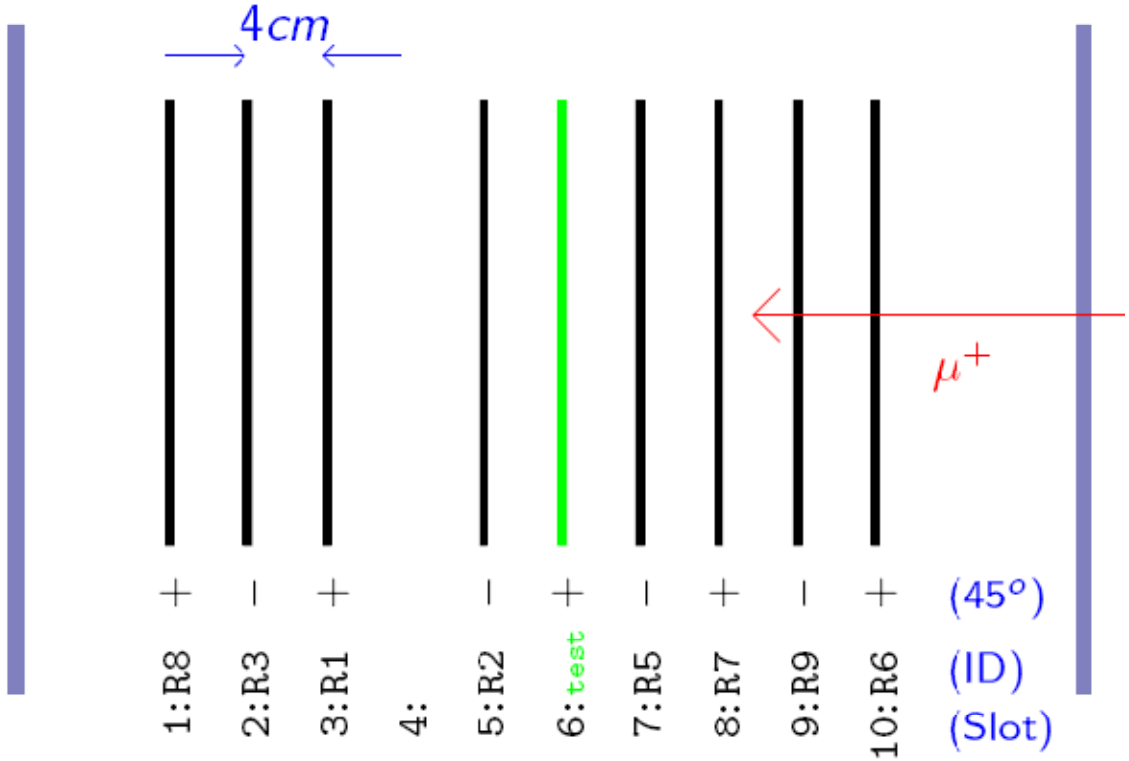
Cooling and Vienna box

- The whole telescope + detectors under test are housed inside a so-called Vienna box.
- The box has slots for up to 10 modules with 4 mm spacing
- The temperature can be set down to -20°C (limited by load, efficiency of Peltierelements and chiller/water circulation)
- Detector planes are installed to ±45 degrees in order to get a proper track measurement





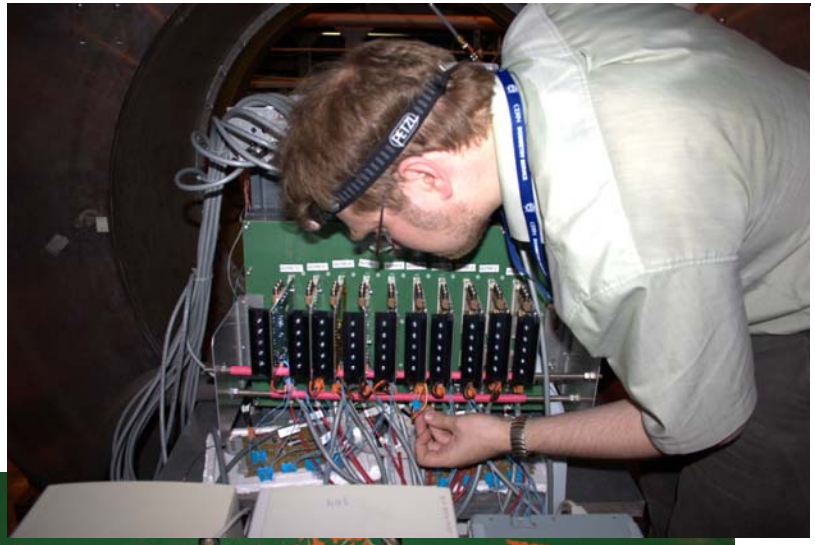
Cooling and Vienna box

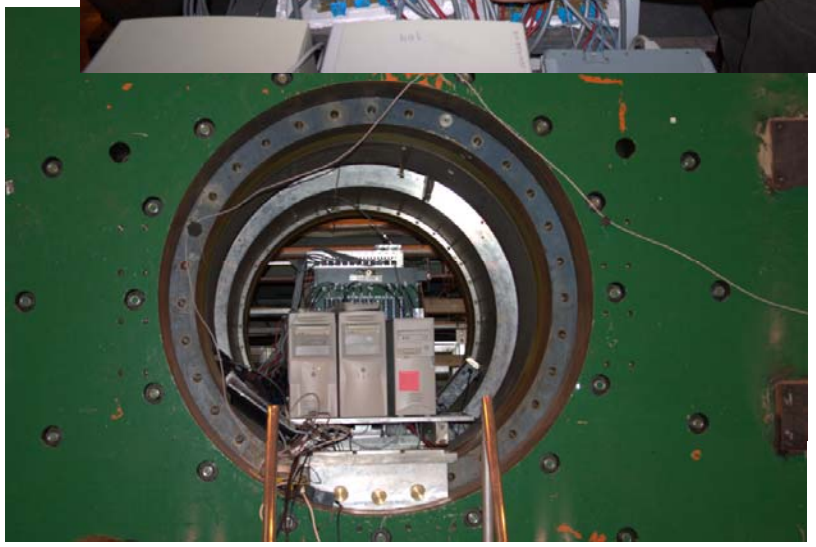


- This summer the detectors under test were investigated one at a time
- They were placed into slot 6 in order to have always 4 reference planes before and after the detector under test
- We can test two detectors at the same time, or even more, if we use only 6 or 7 reference planes

Data Acquisition

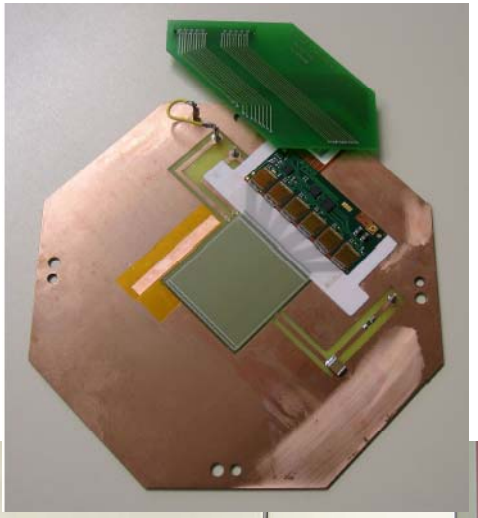
- SiBT DAQ is similar to that of the CMS Tracker.
- Components (FED, FEC etc.) for the DAQ were recycled from the CMS Tracker module production test stations that became obsolete after finishing the module production
- One version of the CMS Tracker DAQ software (XDAQ) was modified for the SiBT operation





MCz detectors

- Detector processing was done at the clean room of Helsinki University of Technology (TKK) Micro and Nanofabrication Centre (MINFAB)
  - Material was Magnetic Czochralski 4" n-type silicon wafers
  - Pitch 50 μm
  - 768 strips per detector (=6*128)
  - Suitable for CMS 6-APV hybrid
- Pitch adapters for reference and MCz sensors were made at MINFAB
  - glass material with Cr-Al metallization
- The MCz detector modules were built in Karlsruhe



June and August beam tests

- The main goal for this summer was to test the functionality of the upgraded telescope
  - The interpolated position resolution of the SiBT was found to be 9 μm, it has a S/N of 25, and an active area of 4 x 4 cm^2.

- We had two beam test runs, one main user run in June and one parasitic run in August (results in the next talk by Martin Frey)
  - In the first run we tested the telescope and a non-irradiated MCz-detector
  - In the second run we tested two proton irradiated MCz-detectors.
    - However, in the second run we couldn't go very low in T (only to zero degrees), because one of our cooling box Peltiers broke in the middle of the run

Summary and conclusions

- Commissioning of the telescope was very successful!
  - We have now a reliable instrument for studying novel full-size silicon detectors
- The setup is relatively compact and can be transported to other locations than H2
  - However, this will be further improved for the next summer
- The cooling needs to be improved and its reliablility increased
- We need to implement a cooling system for the nitrogen flow

Future plans

- Upgrade certain parts of the telescope to suit better for a beam telescope use
  - This includes protection boxes of certain cards, safer connectors, implementation of an efficient chiller etc.
- Tracking in CMSSW framework for the CMS Tracker
  - So far offline-analysis has been done only with "home made" software
- Systematic study of MCz detectors up to the n_{eq} fluence of 2E15
- Systematic study of Fz silicon versus MCz silicon
- P-type detectors
- Thinned 180 μm MCz-Si sensors
- Implement other readout systems to the telescope, if need arises