Beam telescope for testing p- and n-type detectors

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Outline

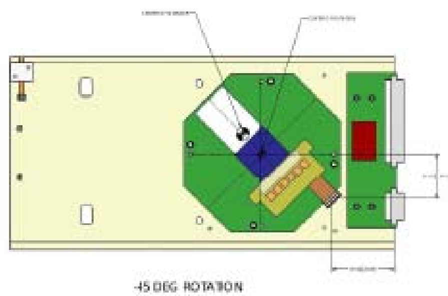
- Motivation for building the telescope and using the APV25 readout
- Description of the telescope
  - Reference detectors
  - Cooling system
  - Readout and software
  - Analysis tools
- Future plans
- Summary

Motivation

- Our group has long experience in building and maintaining reference telescopes
- In CMS there was clear need for a reference telescope for the SLHC detector R&D
- The APV25 readout was chosen for several reasons:
  - it was easily available in the CMS community
  - we already had most of the needed readout components for the telescope system due to the module testing phase of the CMS Tracker detector modules
  - it is possible to read out both signal polarities with the APV25 chip

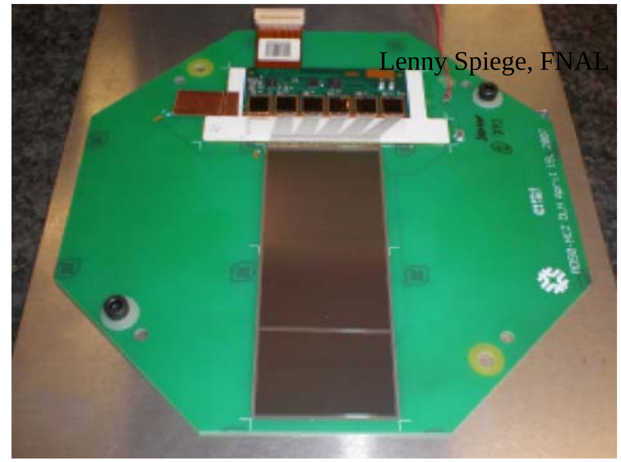
Reference detector modules

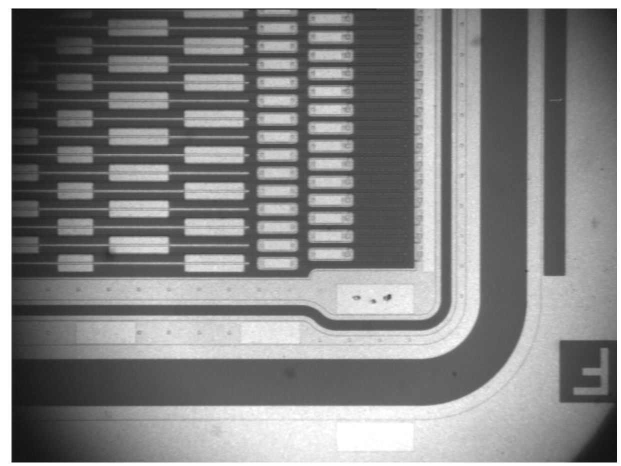
- Reference detectors of the telescope are Hamamatsu sensors originally designed for Fermilab D0 run IIb
  - 60 micron pitch
  - intermediate strips
  - size 4 cm x 9 cm
  - 639 channels



- Readout electronics: CMS APV25
  - Fully analog architecture
  - Can handle both signal polarities

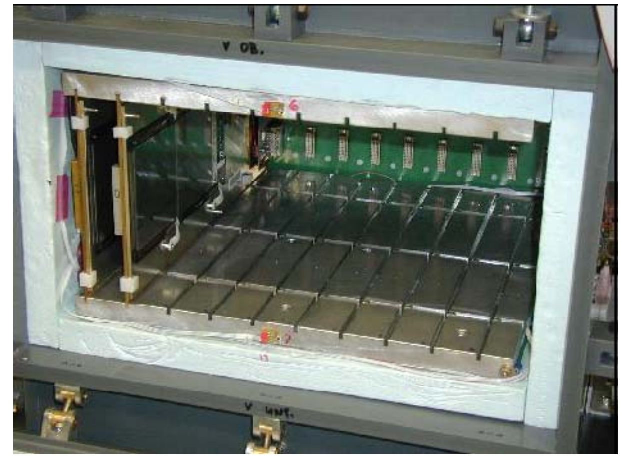
    → Important for the detectors under test

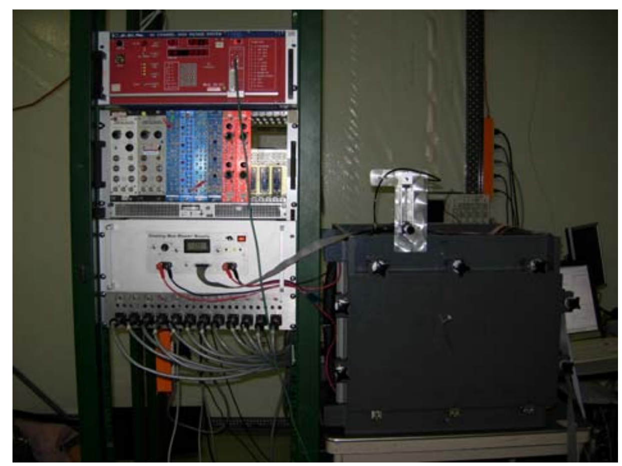




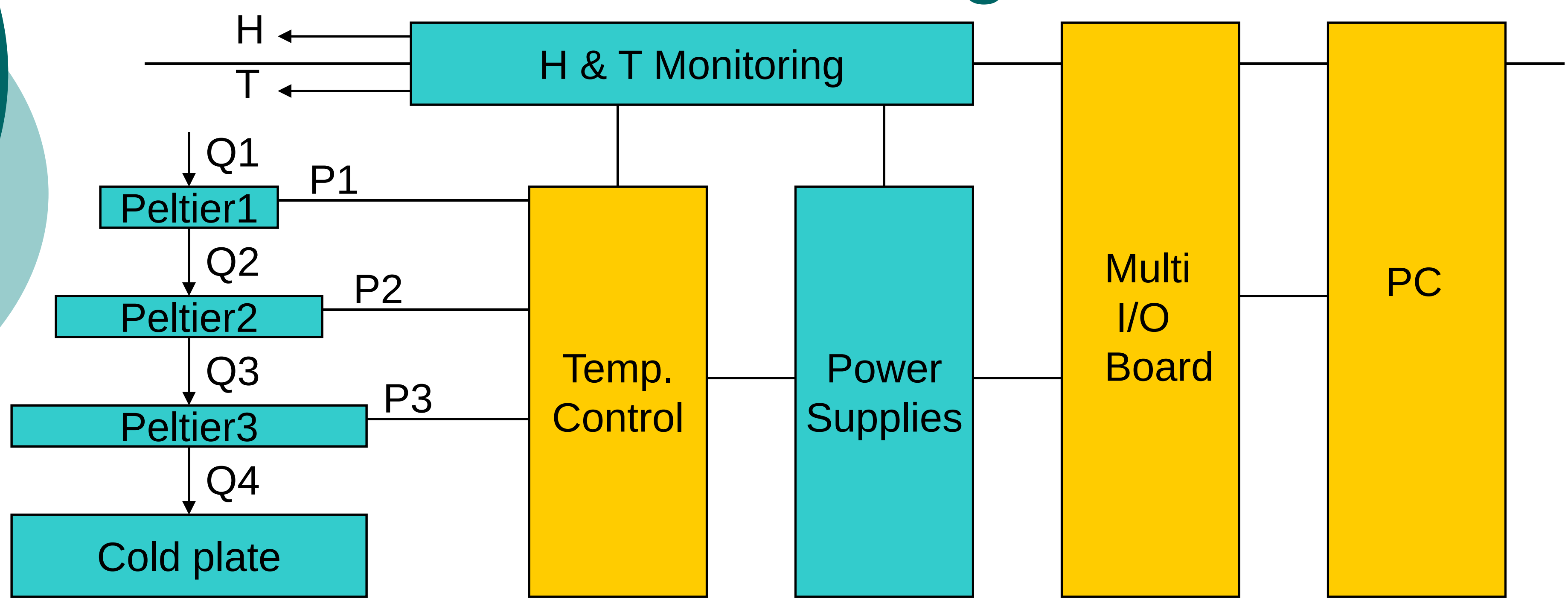
Cooling

- The whole telescope + detectors under test are housed inside a cooling box ("Vienna box")
- The box has slots for up to 10 modules with 4 cm spacing
  - 7-8 slots are used for the reference planes, the rest for test detectors
- The temperature can be set down to -20°C (limited by load, efficiency of Peltier elements (currently two 350 W units) and the chiller cooling capacity)
- Detector planes are installed to ±45 degrees due to space constraints in the cooling box

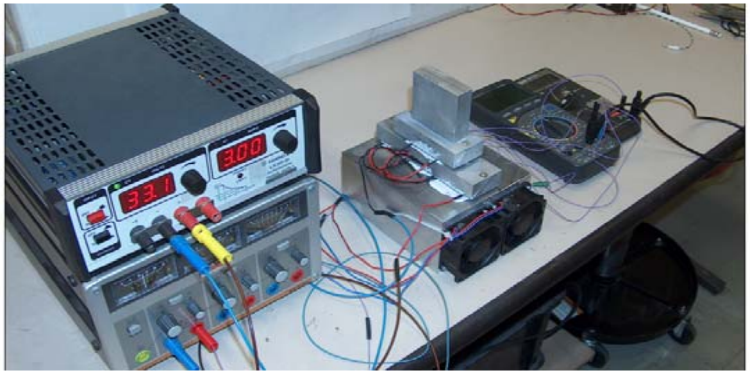




External cold finger

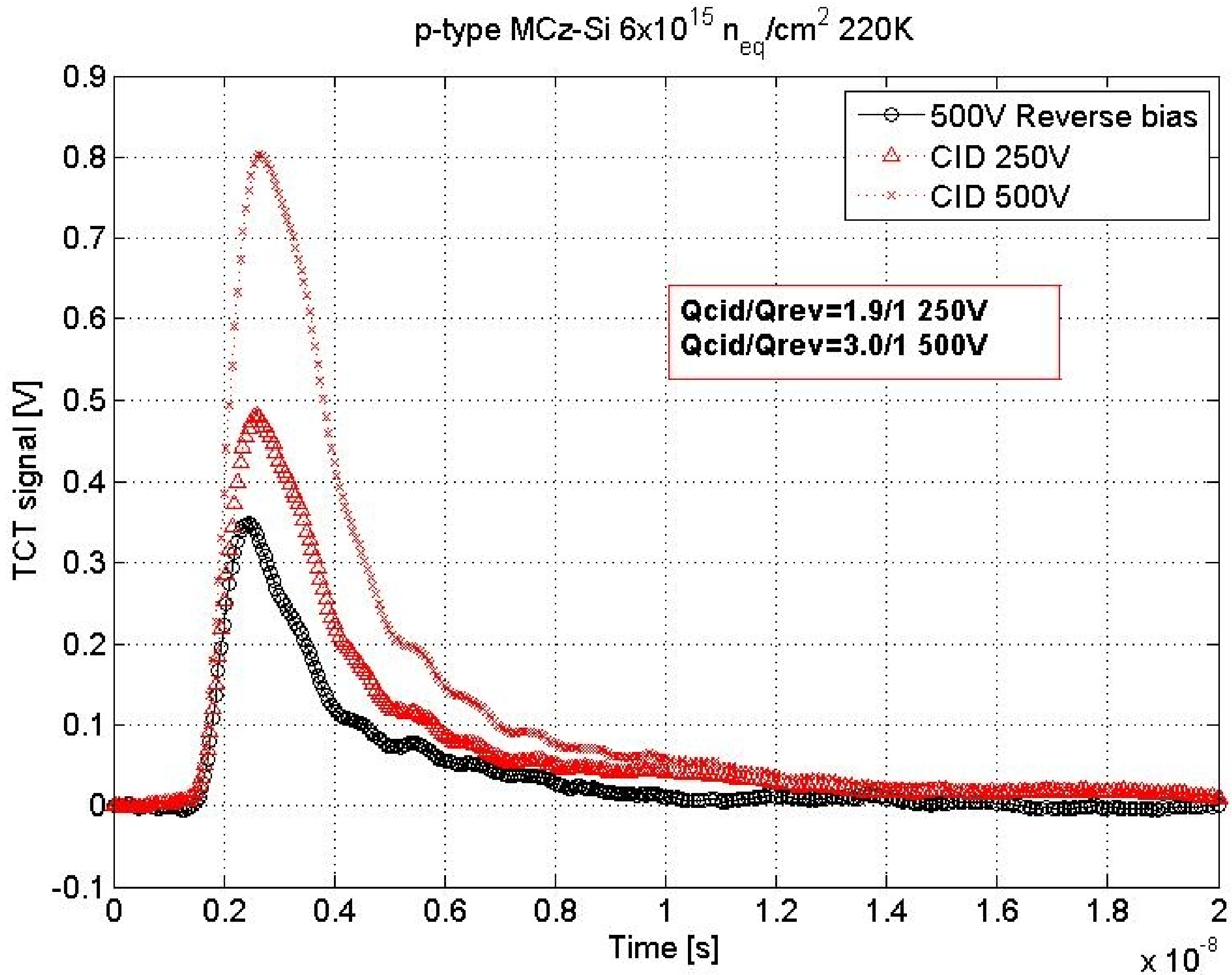


In addition to the large cold box, in summer 2008 the setup will also contain an external cold finger, which can be cooled down to -50 °C.



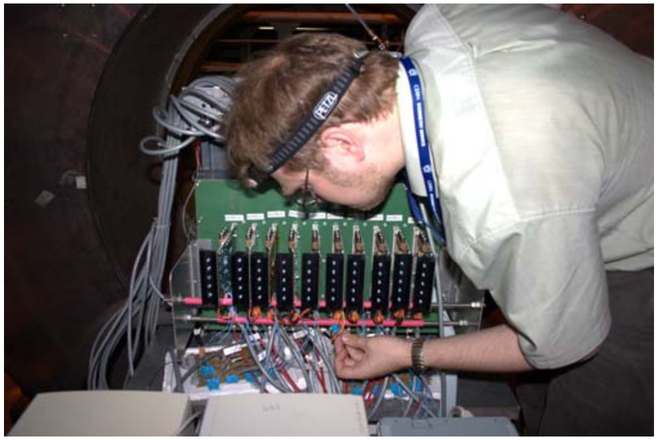
Motivation for the cold finger

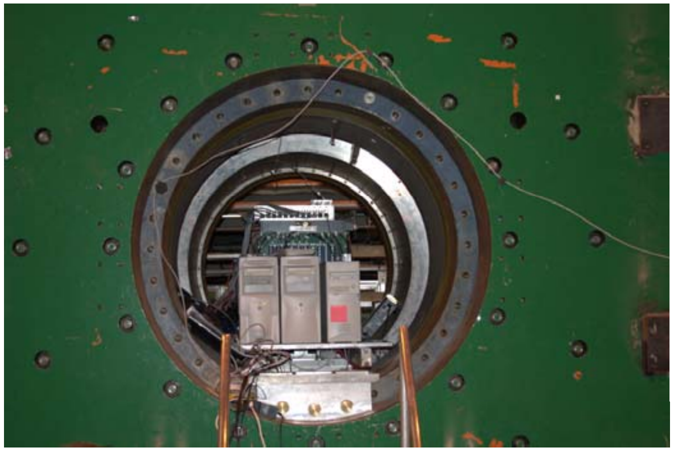
- Measured with an infrared laser
- The collected charge is 1.9 times larger at 250 V and 3 times larger at 500 V in the CID mode than in the normal reverse biased mode
- This measurement was done in -50°C



Data acquisition

- The DAQ is similar to that of the CMS Tracker
  - It is based on the prototype data acquisition cards that were used in the production phase of the CMS Tracker for the qualification of detector modules.
- An early version of the CMS Tracker DAQ software (XDAQ) was modified for the telescope operation
- This allows us to use the efficient online and offline analysis and alignment tools of the CMS experiment





Telescope performance

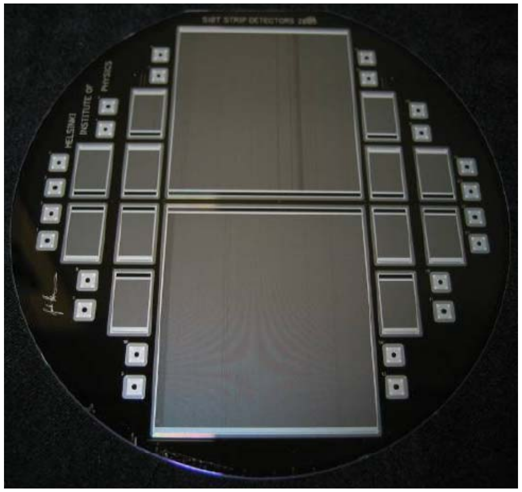
- We had two beam tests with the telescope in summer 2007 at CERN H2 experimental area.
  - In both of these runs the telescope performed well.
- The active area of the telescope is 38 x 38 mm^2.
- It has a S/N of 25 and
- The impact point error at the location of the detectors under test is ~4μm.
- The detailed setup properties can be found in the NIMA article:
  - *T. Mäenpää, P. Luukka, et al. Silicon beam telescope for LHC upgrade tests*
- We had problems with some of the APV25 hybrids, because they temporarely stopped working in -20°C temperature. Thus only 90% of the maximal cooling power was used.
  - However, this is a well known problem and can be solved by the next beam test

Improvements in 2008

- Temperature sensors on the backside of the detectors under test
- More efficient cooling system:
  - Additional cold finger
  - Use of chiller for removing heat from the large cooling box Peltier elements
  - New top and bottom Peltier units in the cooling box
    - The bottom unit failed during the second beam test last summer, and changing both units will improve the reliability of the system
- Slow control in linux
  - temperature, humidity, voltage, current etc. values will be logged automatically during different runs (pedestal, physics)
- New scintillators that match the telecope active area better than the scintillators used in 2007.
- Feedback from offline analysis already during the beam test

Short summary

- The setup is relatively compact and can be transported to other locations than CERN H2 if necessary
  - However, we have some installed services at H2, which we can benefit from (cables, power supplies etc.)
- It can be used for testing n-and p-type strip detectors



- We can also give reference track to other systems outside our telescope. However, this requires some work with the time stamping
- The telescope can benefit from the structured 25 ns beam
- The telescope was approved as an official CMS Upgrade project in 2007.

Status

- We will have our next beam test in 10.7-23.7
- In the next beam test we will have more efficient cooling implemented:
  - Chiller
  - External cold finger that can reach -50°C temperature
- In addition, we will have better triggering system (currently two plastic scintillators that work ok but are too large)
- We will have a new slow control system that logs T, RH, voltage, current etc. values for every run
  - Hopefully also an automatic voltage scan possibility
- We should be able to get feedback from real offiline analysis already during the beam test
- We will have separate temperature sensors on the backside of the irradiated modules in order to get a more precise T measurement during the run