Beam telescope for testing p- and n-type detectors

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Outline

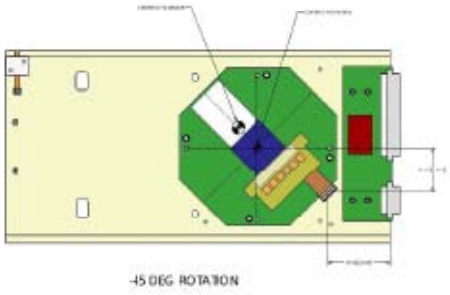
- Motivation for building the telescope and using the APV25 readout
- Description of the telescope
  - Reference detectors
  - Cooling system
  - Readout and software
  - Analysis tools
- Future plans
- Summary

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

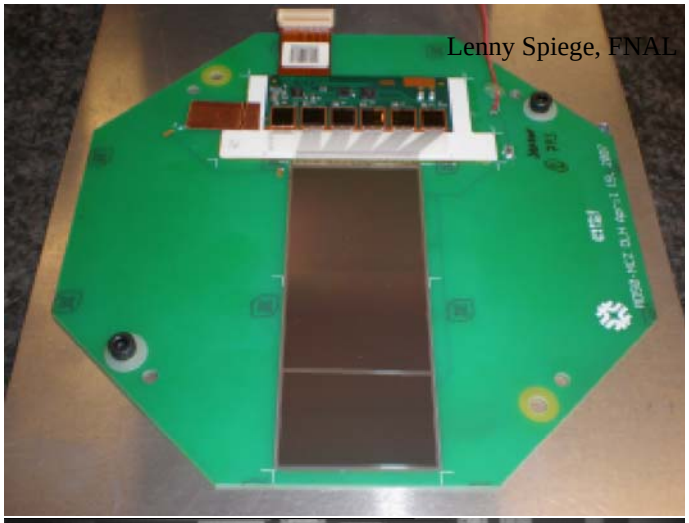
Reference detector modules

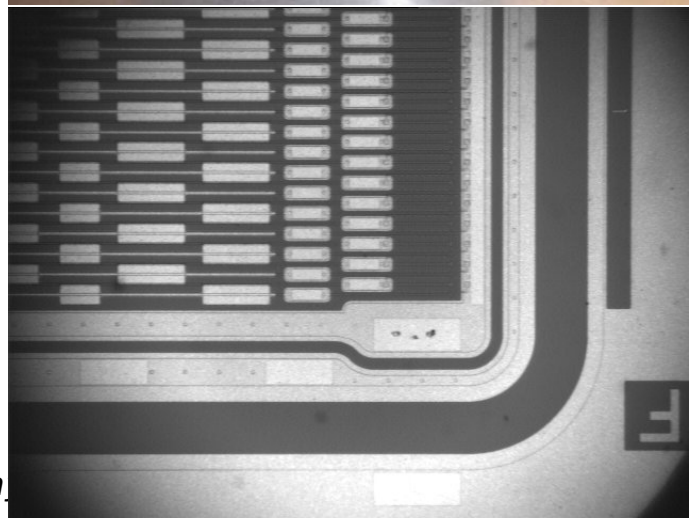
- Reference detectors of the telescope are Hamamatsu sensors originally designed for Fermilab D0 run IIb
  - 60 micron pitch
  - intermediate strips
  - size 4 cm x 9 cm
  - 639 channels



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

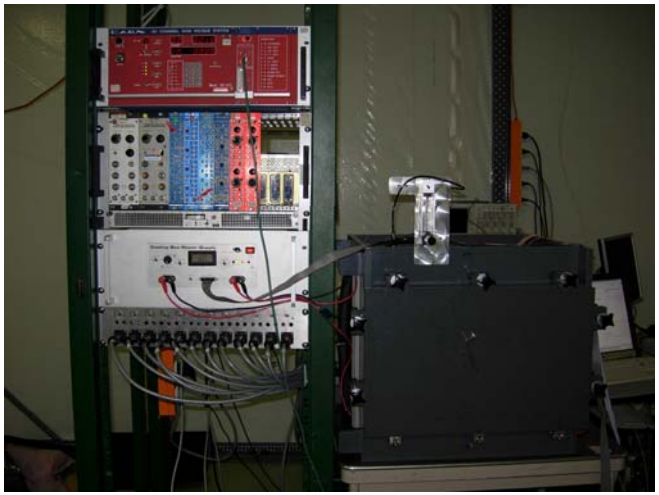
    →Important for the detectors under test



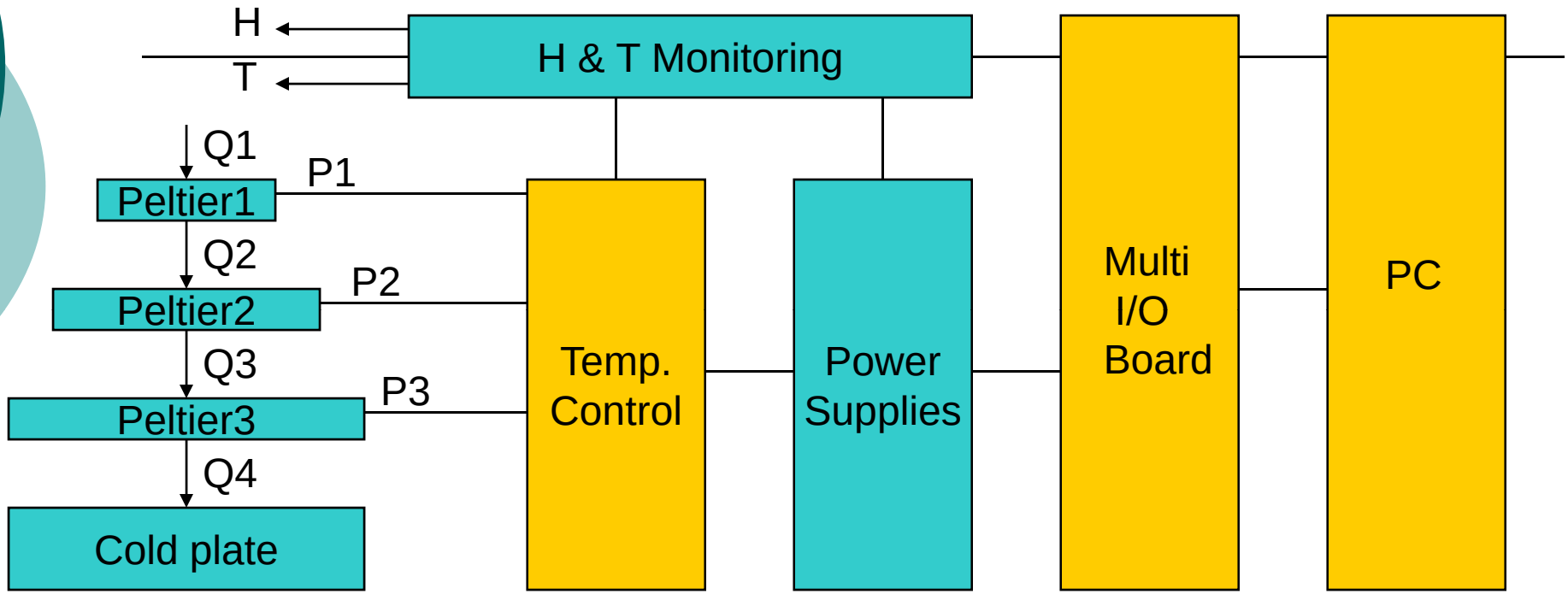


Cooling

- The whole telescope + detectors under test are housed inside a cooling box.
- 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 -30°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

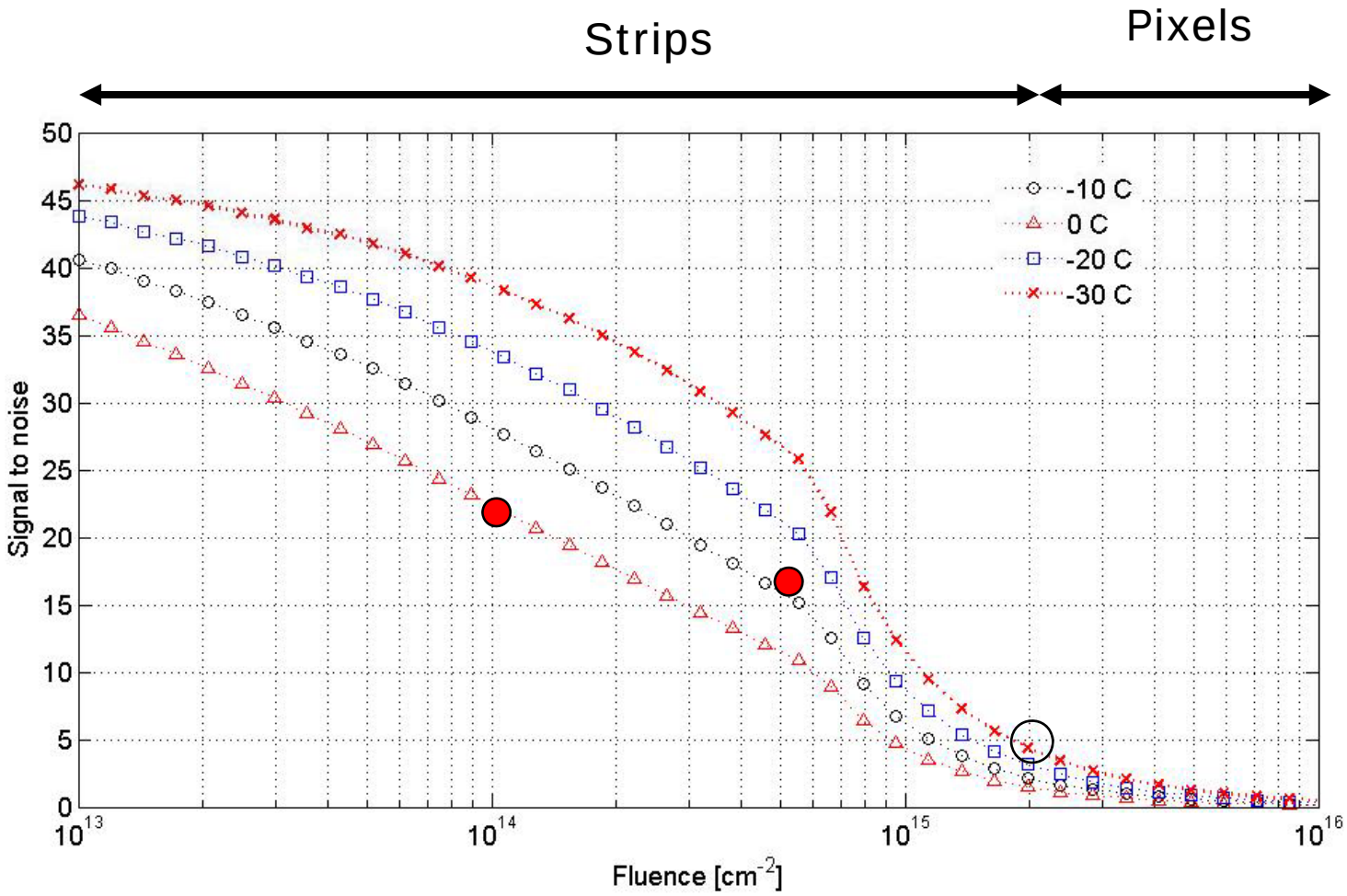


External cold finger



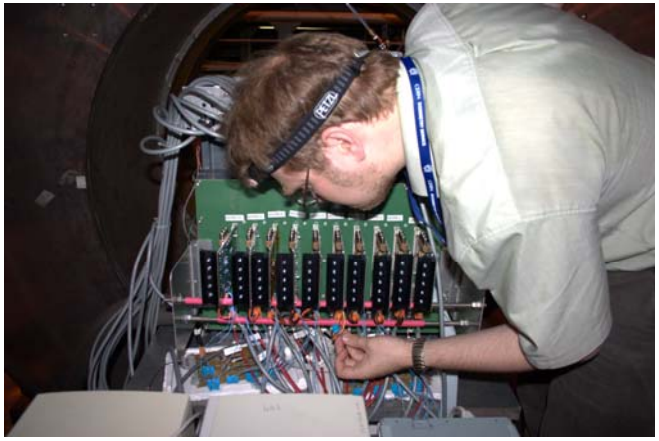
Next summer the setup will also contain en external cold finger that can reach -50 °C.

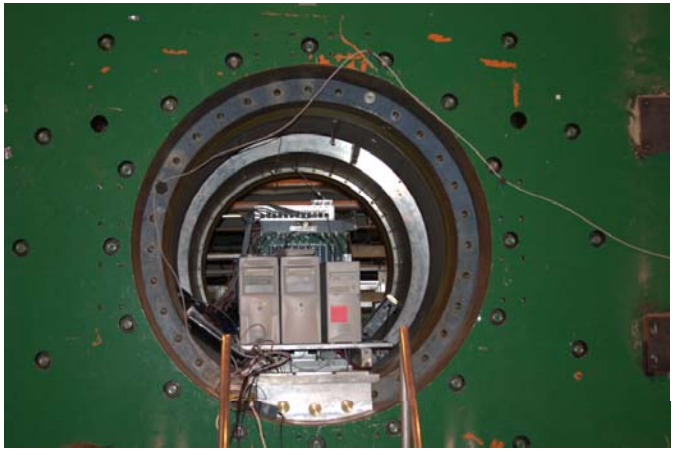
Expected performance



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 offilne analysis and alignment tools of the CMS experiment





Telescope performance

- We made 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.
- 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

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 a CMS Upgrade project in 2007.

Future plans

- Next beam test will be 10.7-23.7
- By that time we want to solve the problem with the APV hybrids not functioning in less than -20°C.
  - Well known problem and should be solvable by inserting PLL reset commands in the startup sequence
- We will implement a chiller to the system.
  - This should increase the efficiency of the cooling
- Moreover, we plan to cool down the nitrogen that is flushed to the cooling box in order to avoid water condensation inside the box
- In addition, we will implement better triggering system (currently two old plastic scintillators that work but are noisy)
- and we will have an external cold finger that can reach -50°C temperature.