DEPFET TB 2010

Belle-II PXD meeting
– Nov 30th 2010 -

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TB2010, our beam period: 15-21 November
Last slot of the season, after SiLC, EUDET telescope requested

TB2010: DUT

1) S3B module based on PXD5 with 4 um gate length (available, but not tested)

2) DCDB-based PXD5 DUT (on hybrid 4.1)

- **(Nearly) full-speed read out**
  row rate/nominal ~ 3, compared to several
  orders of magnitude with previous system)
- **Relevant pedestals, common mode**
  but custom power supplies, cables, etc.
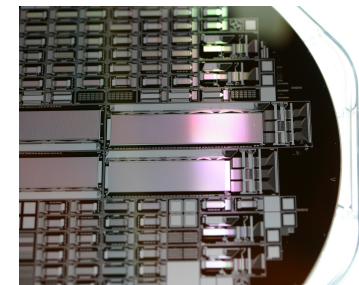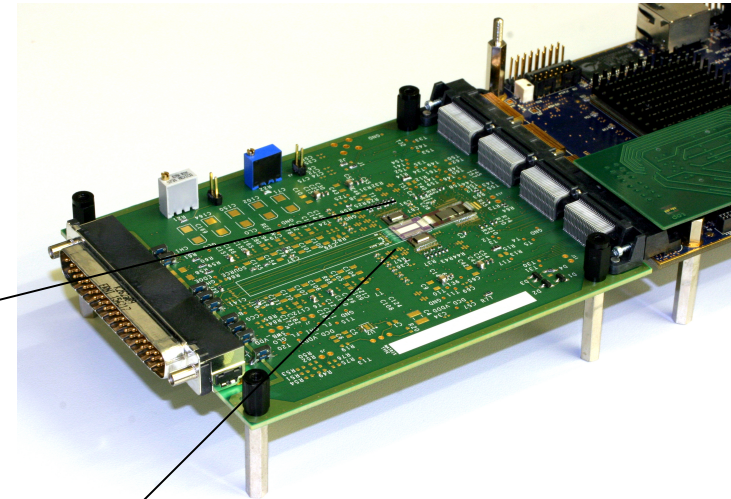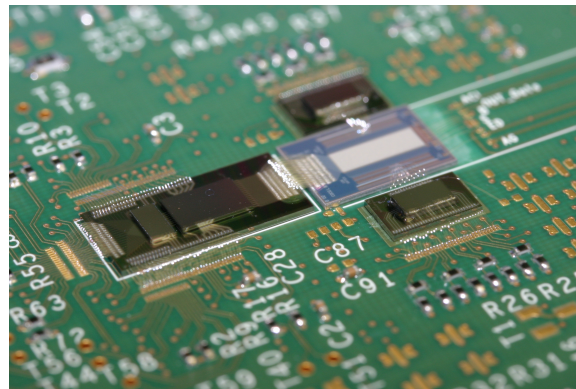
No PXD6 module
(hoped for **mm² ILC design that would have
been first thin DEPFET)**
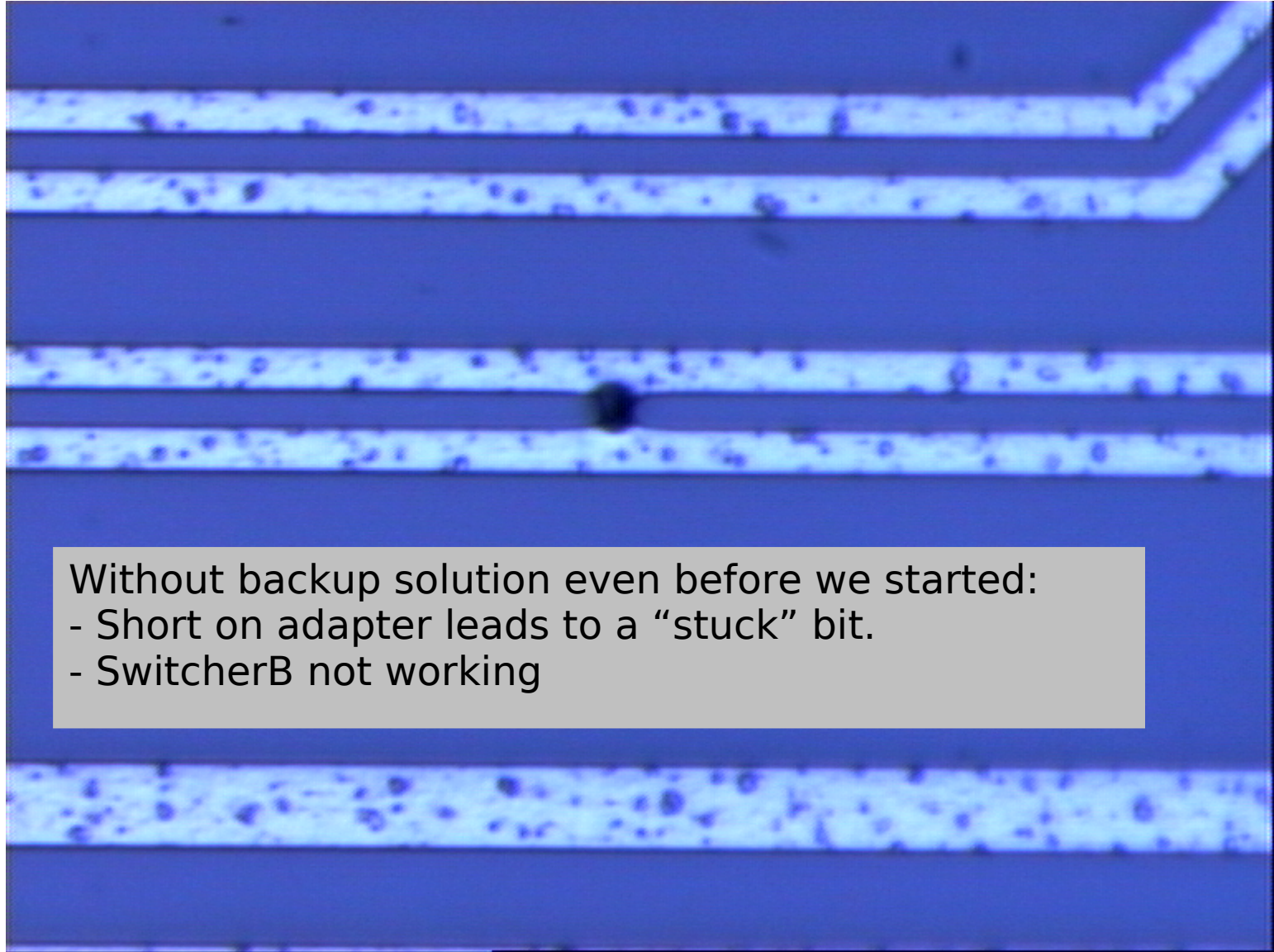
Without backup solution even before we started:
- Short on adapter leads to a "stuck" bit.
- SwitcherB not working

TB2010: telescope

Telescope: use EUDET (3-5 μm pointing precision)
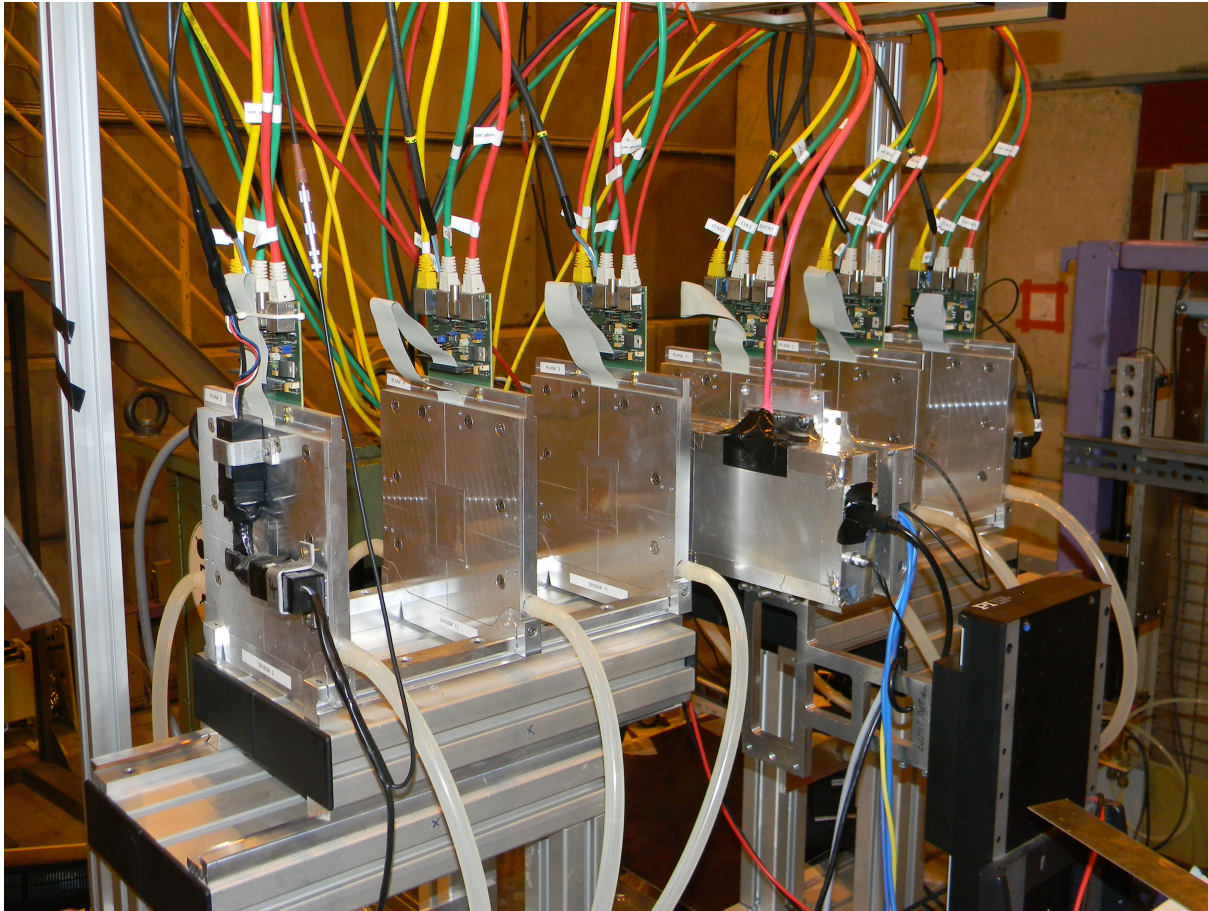
Used EUDET out of a desire to minimize our requirements on limited DEPFET resources (manpower, mostly)

Limited possibilities to characterize DUT resolution (turns out not be a big problem).

EUDET (Emlyn) has responded very well when we had problems.
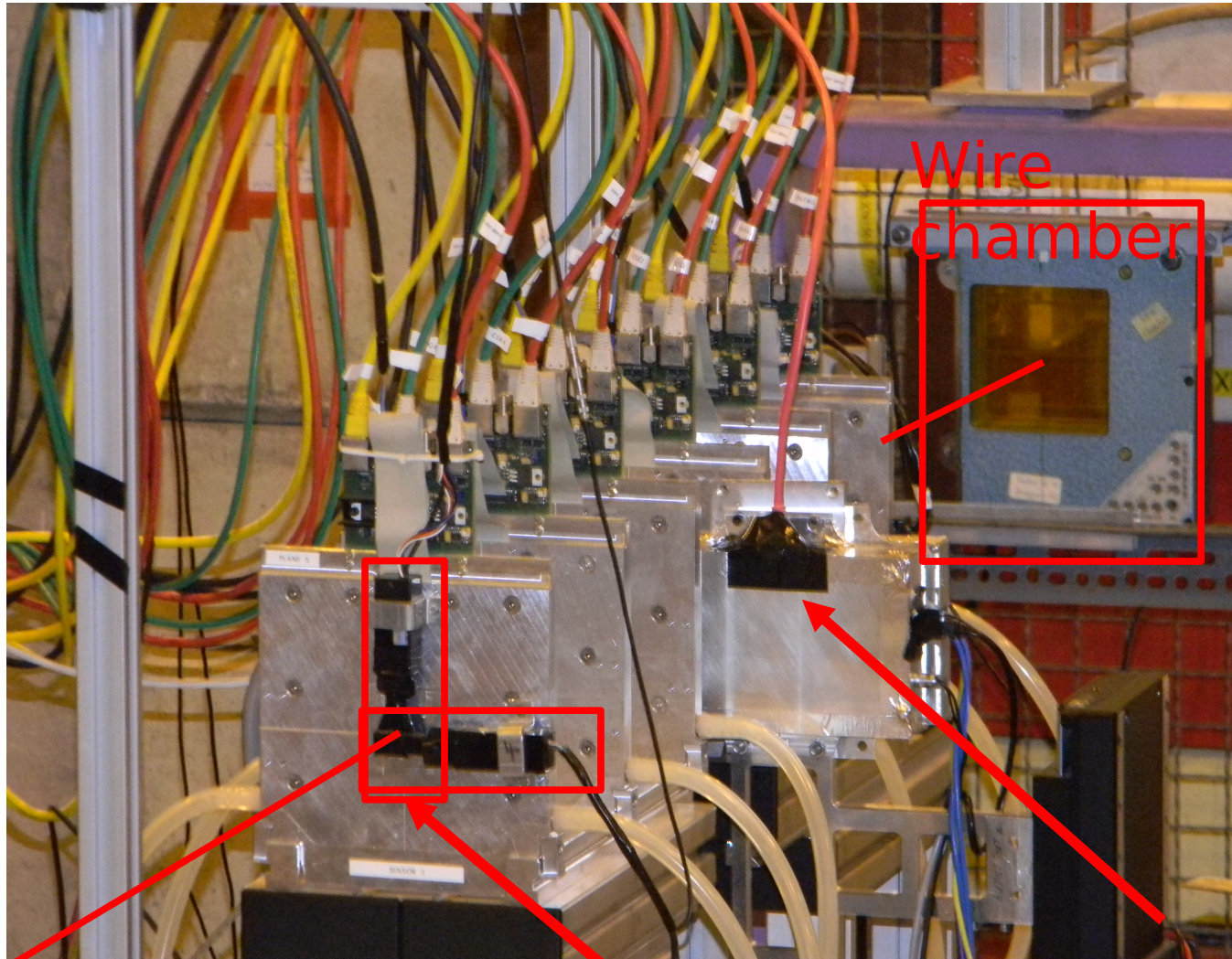
Wire chamber

SPS H6 beam line

Scintillator triggers

DEPFET DUT

EUDET
telescope

Even more
of them!!!

Bench power
supplies!!!!
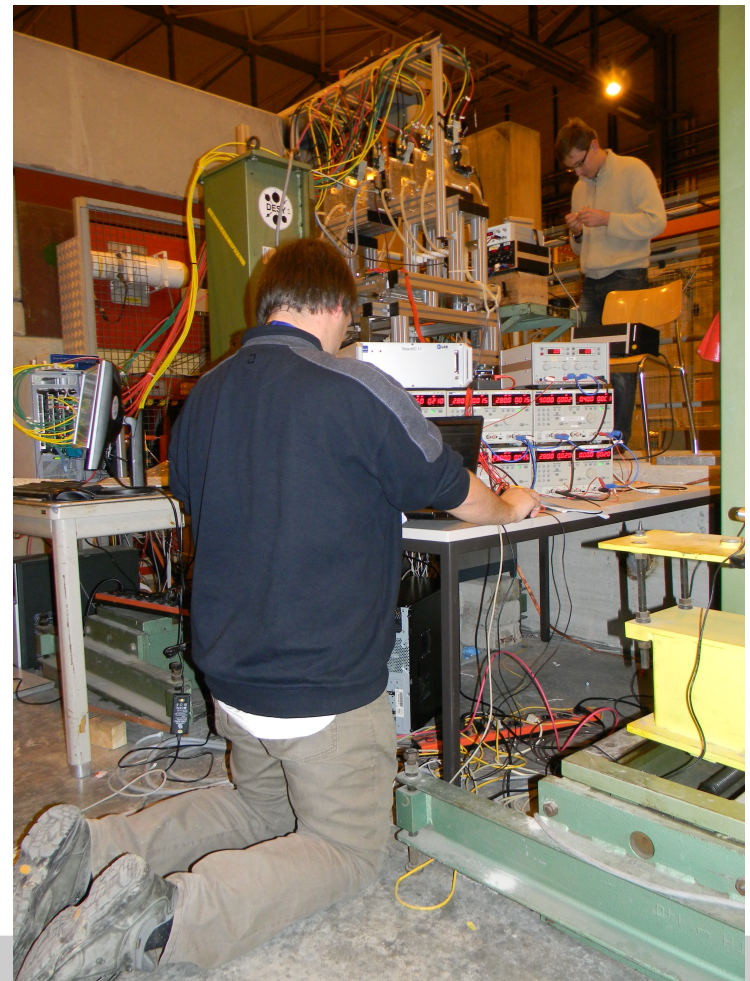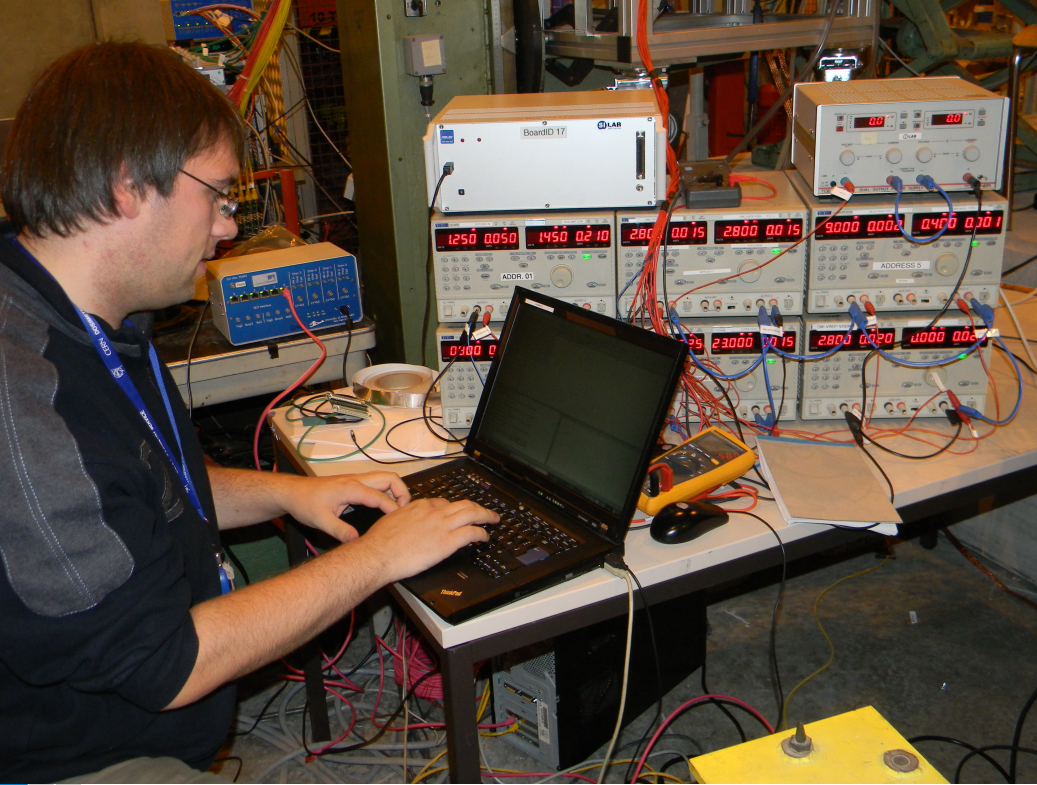
Power supplies:
- Semi-automated start-up sequence
- Remote control
- Monitoring
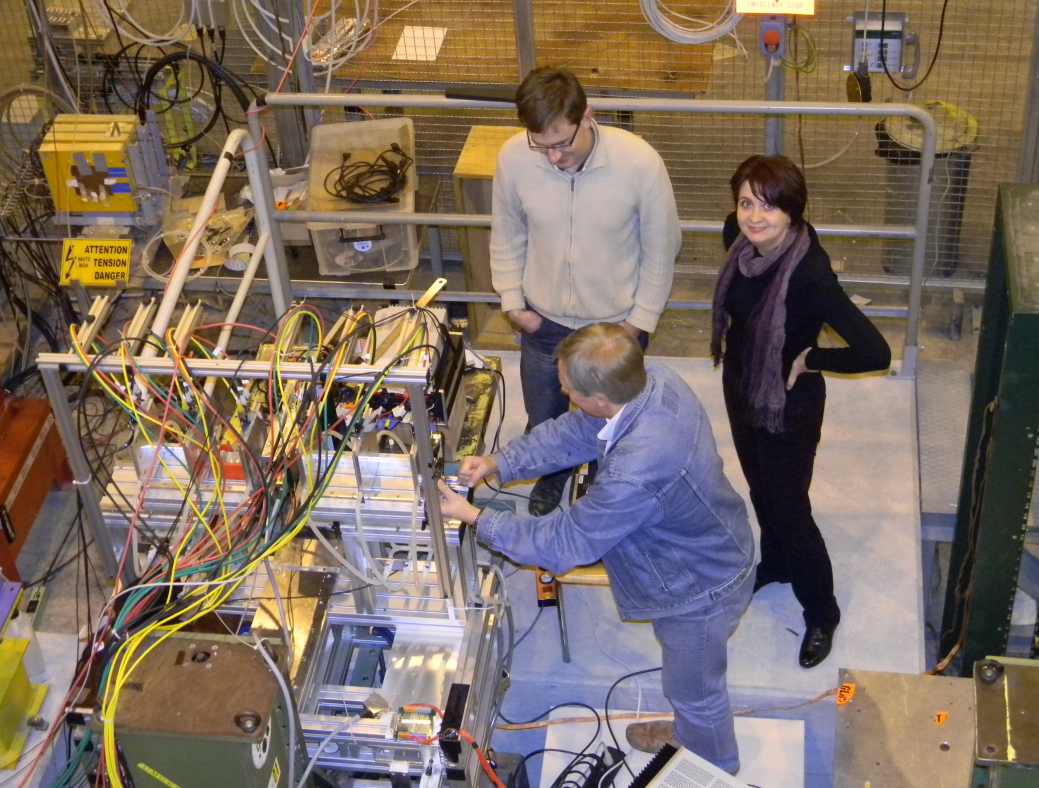
Installing extra trigger "finger"

Shifter looking at the online logbook (I think)

Offline analysis trying to keep up

Lessons learned during operation

Raw data → geographic matrix map

- DAQ stores analog information from matrix in the order that it comes out of the DCD (one lossless multiplexing step is performed on hybrid)
- Columns reshuffled according to know map
- Row reshuffled to correct switcher-sensor bonding feature

In TB x-check with laser spot, large MIP clusters, row without clear
Proposed measurement: laser scan through the whole matrix, take one row out of clear sequence
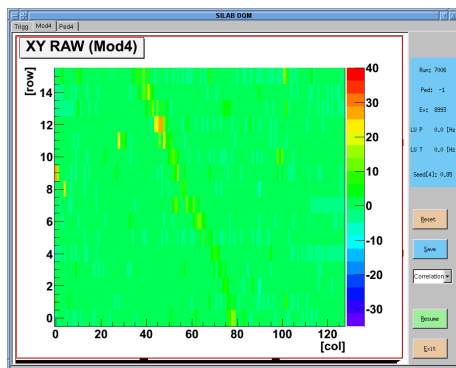
Interesting cluster
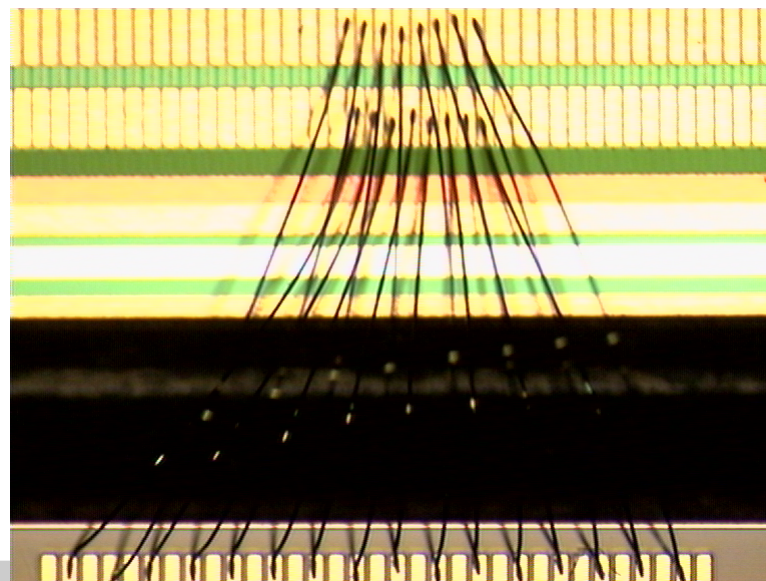
Photograph by CERN bonding lab
of sensor – switcher bonds

Lessons learned during operation

SwitcherB operated successfully during TB2010, after two SwitcherB chips died on first hybrid 4.1 (one after brief period with life signs)
  - SwitcherS has no problems (and no JTAG)
  - programming wrong settings to switcher2 DAC settings can drive them to suicide...
          what about SwitcherB?
  - configuration is loaded onto chips (currents change)
  - JTAG blocks switcher and DCD connected

Proposed follow-up: Probe Switcher switch-on sequence, confirming each of the steps

DCD Pedestal spread over 2/3 of dynamic range
(subtraction DACs not yet available... will be there for next TB???)
  - offset current 11 mA/128 channels : 90 uA offset current, expected 50 uA for gate ON voltage we chose
(Rainer: incomplete clear?)
  - spread limits the gate ON voltage and therefore the matrix performance!!
  - Source for offset current subtraction too weak?

Proposed measurement: Systematically map GateSource current vs. gate ON voltage (Bonn)
                    Vary detector bias, temperature (whatever is needed to understand current)

Lessons learned during operation

DCD pedestal variations
- Variations with time of a few counts observed

Proposed action: careful analysis (Benjamin, Prague, Valencia)

DCD noise:
- 0.8 LSB noise before TB and in H6 when run with same parameters in TB (no extra source)
- 1.3 LSB noise... when we changed matrix settings (ADC gain = 60 nA/ADU)

Proposed action: noise measurement for different gate ON voltages

DCD ADC response:
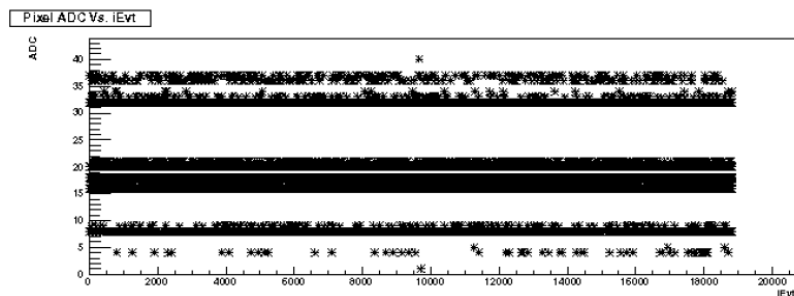During TB Benjamin discovered "jumps" in baseline in some channels.
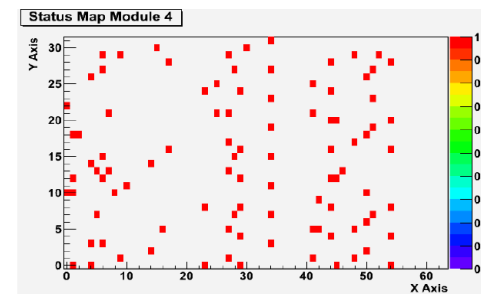Slightly more careful analysis reveals instabilities in fraction of ADCs
Jochen and Benjamin confirmed faulty response of a few selected ADCs in situ

Proposed measurement: Systematic check of all ADC responses
Repeat on several DCDs

<----- Baseline vs. event number. Discrete "jumps" are bit flips
Bad ADC map   ----->

Matrix response

– Signal initially approximately 30 ADU (expect S/N > 130)
– Increased to 70-100 ADU by scanning voltages

Proposed action: careful analysis to clarify this number

» (and then try to understand it)

Early 5x5 cluster
signal distribution
from online monitor
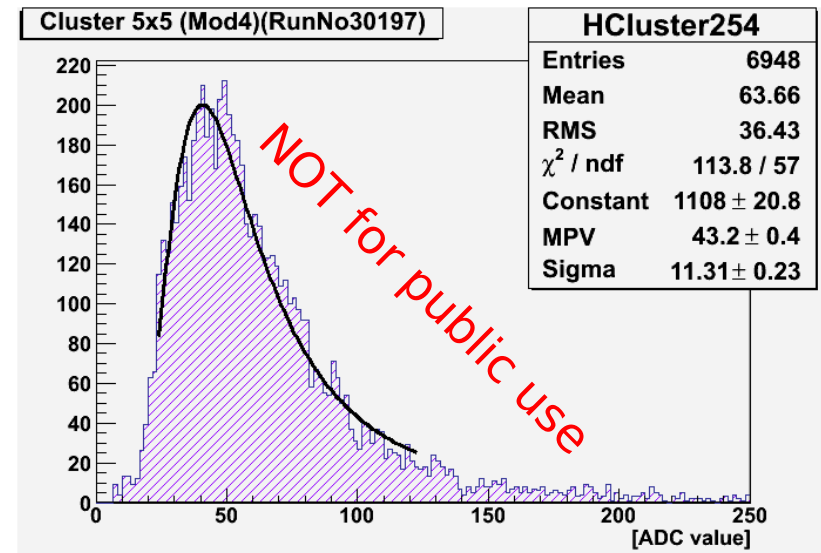
Conclusions

Thanks once more to the entire team! A great collective effort.,

Too early for conclusions and interpretation. Obviously this was not a "plug-and-play" TB with "demonstrator" results, but it is an important step towards the complete system:

- Very fast development on tools (DAQ!)
- Great progress understanding DCD. Many "features" uncovered (that could have been uncovered without beam)

Not only an investment for a PXD6 TB: I do expect some "conference-quality" results. Define priority areas where deeper understanding is needed. Careful, but rapid analysis (unfortunately undermanned) to get to the bottom of urgent issues as soon as possible.

Need to submit request TB2011. June (for quick feedback on PXD6) or later (time to build a demonstrator DUT). New DCD will not be in time for 2011 SPS season.