FPIX beam test last week

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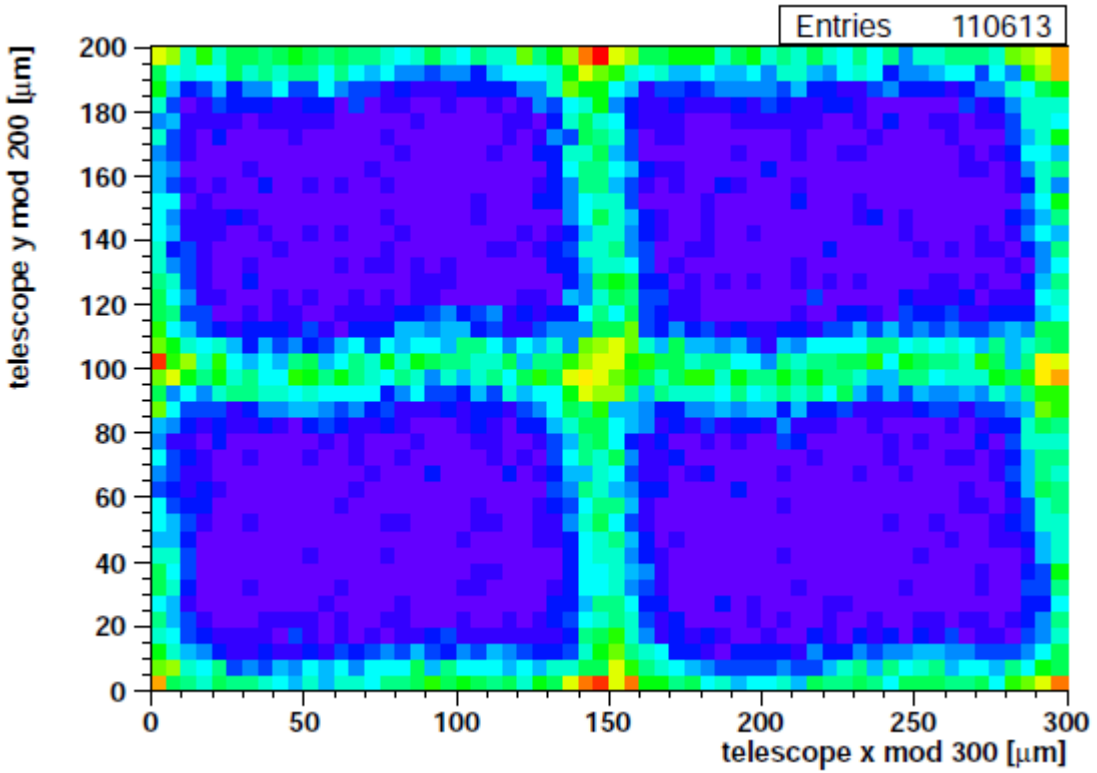
Daniel Pitzl (DESY)

HH CMS Pixel Upgrade meeting, 8.2.2013

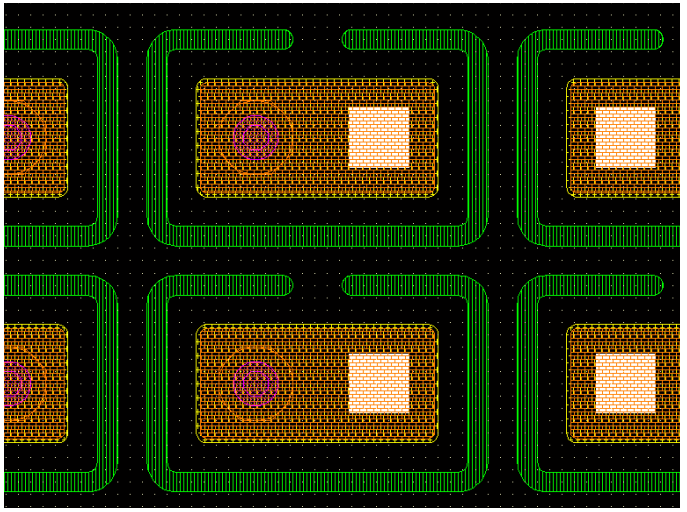


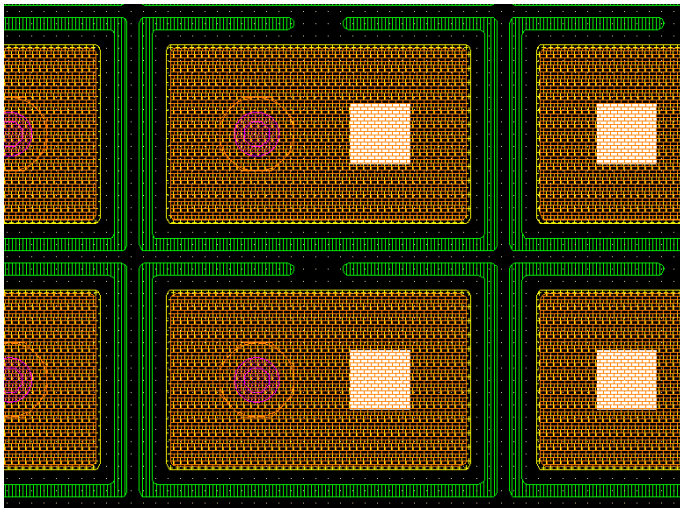
- BPIX sensor
- FPIX sensor
- beam test plan

FPIX sensor design: p-stops

Sensor is DC coupled to ROC: what happens at missing bump bonds?

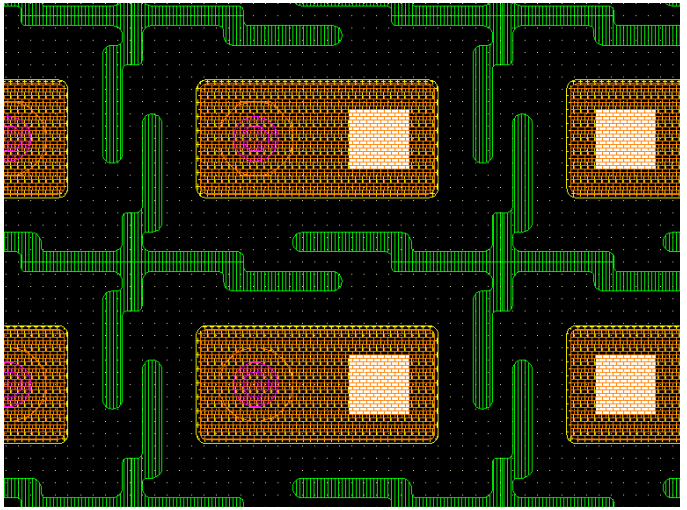
FM old design

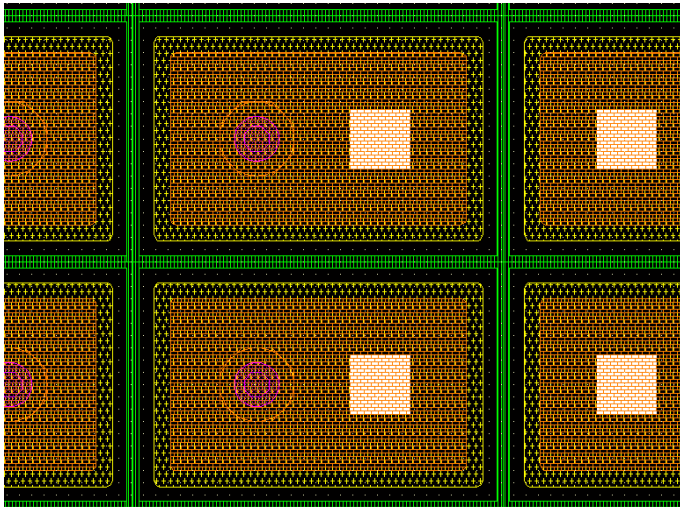




FMM old design

X new more sym-etric





C new max pixel area

G. Bolla, Grindelwald Pixel WS 2012

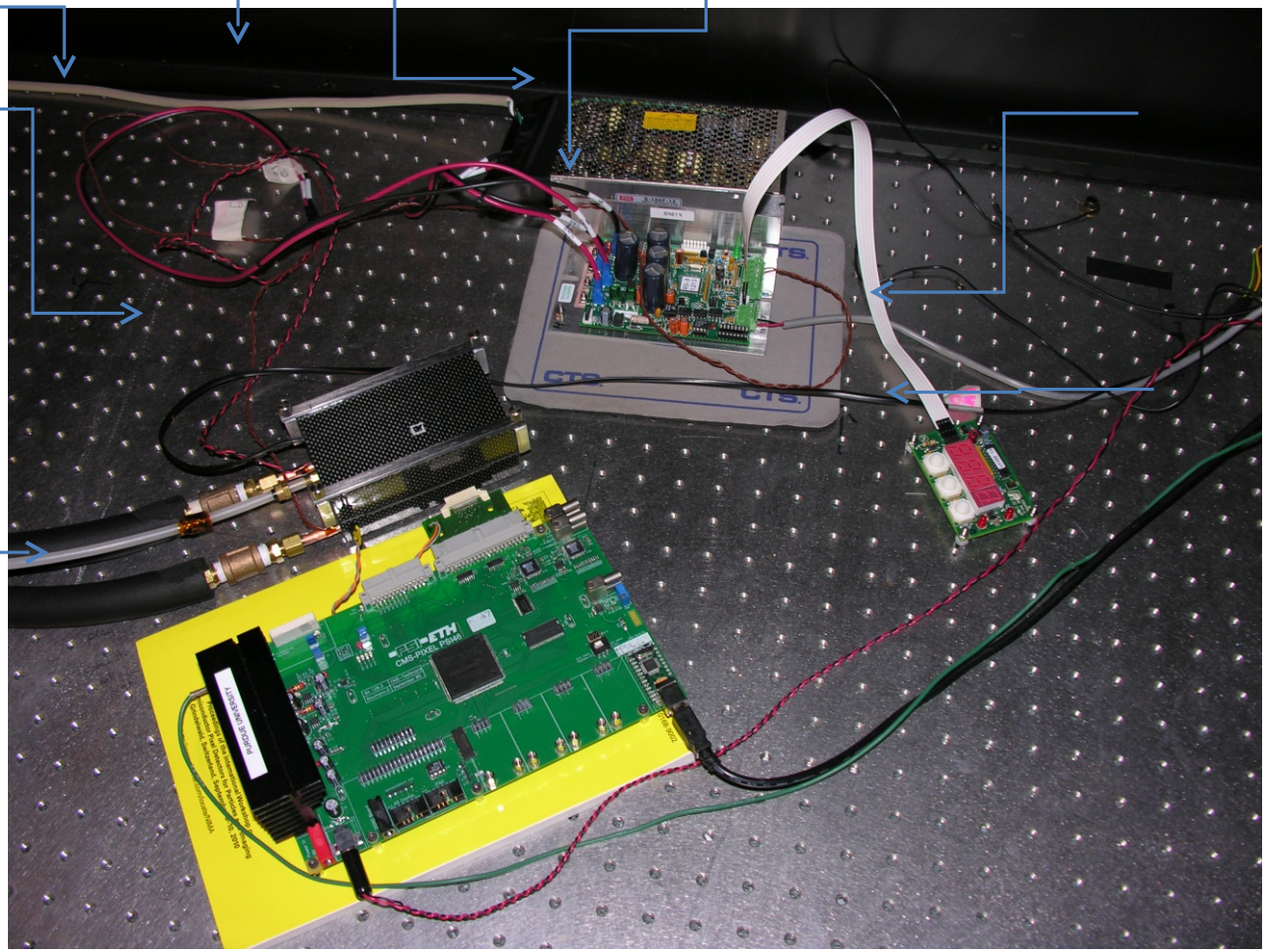
which is best?

FPIX cooled singled chip module system

Power supply for Peltier Module Controller with 110 VAC cable (1 meter length) and USA 3-prong plug.

Thermistor and Peltier ables to Peltier Module Controller (1 meter length)

Peltier Module Controller



Dewpoint sensor USB cable to PC (5 meter length)

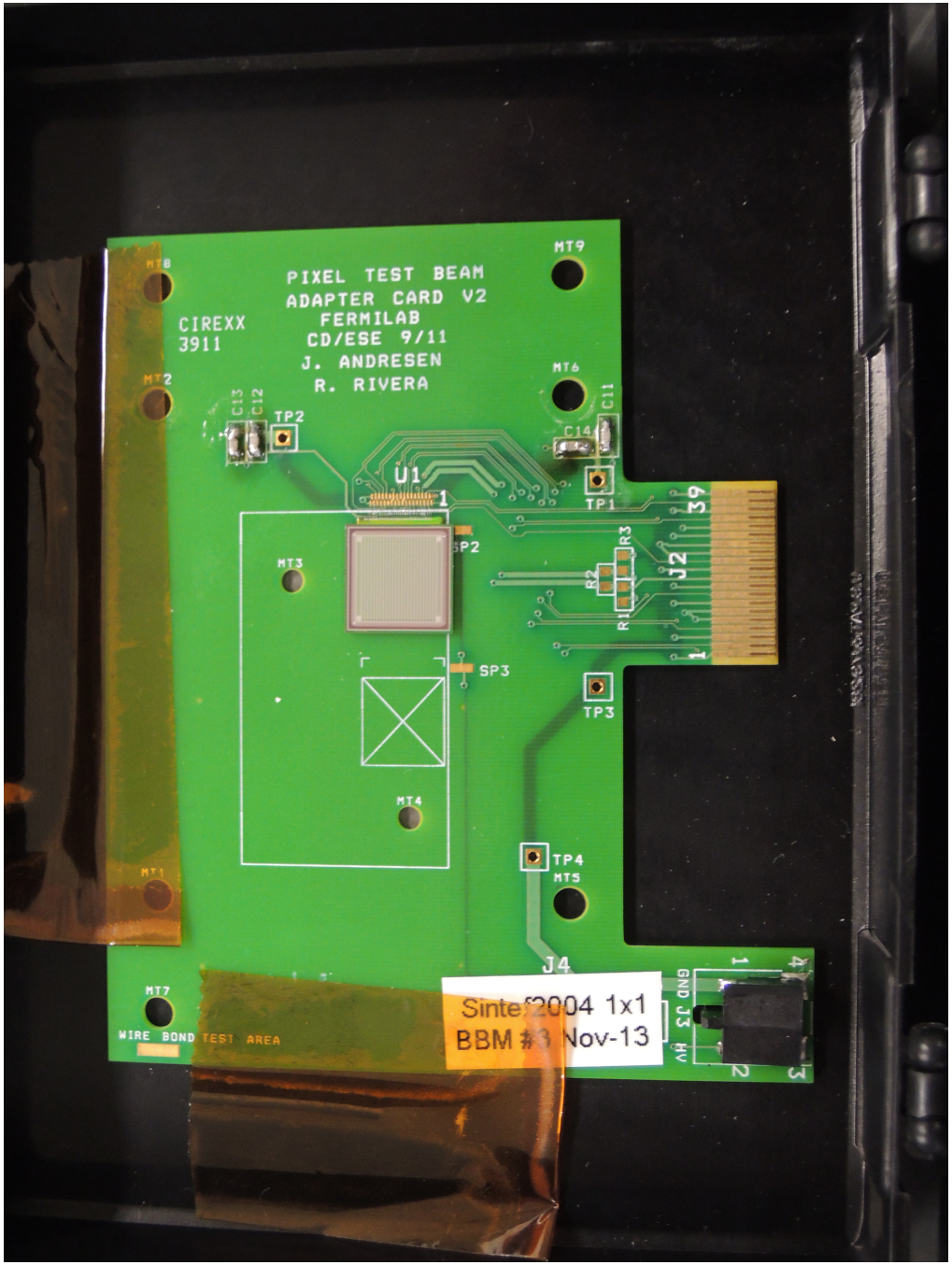
Dry air purge gas tubing

Liquid coolant supply and return hoses

Serial cable (2 meters) from Peltier Module Controller to USB adapter + USB cable (2 meter length)

Keypad for setting Peltier Module temperature (does not require connection to a PC)

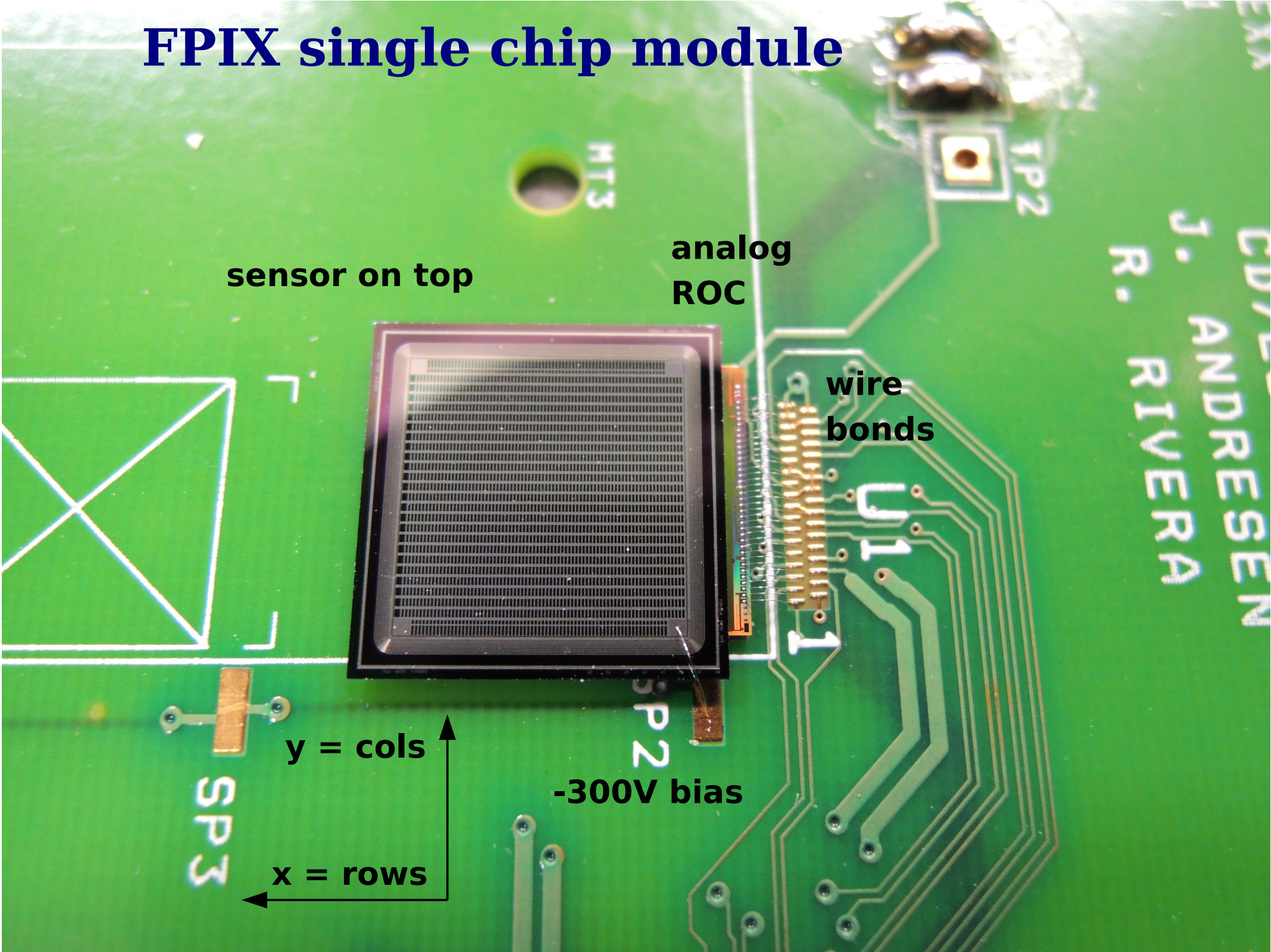
FPIX single chip adapter card



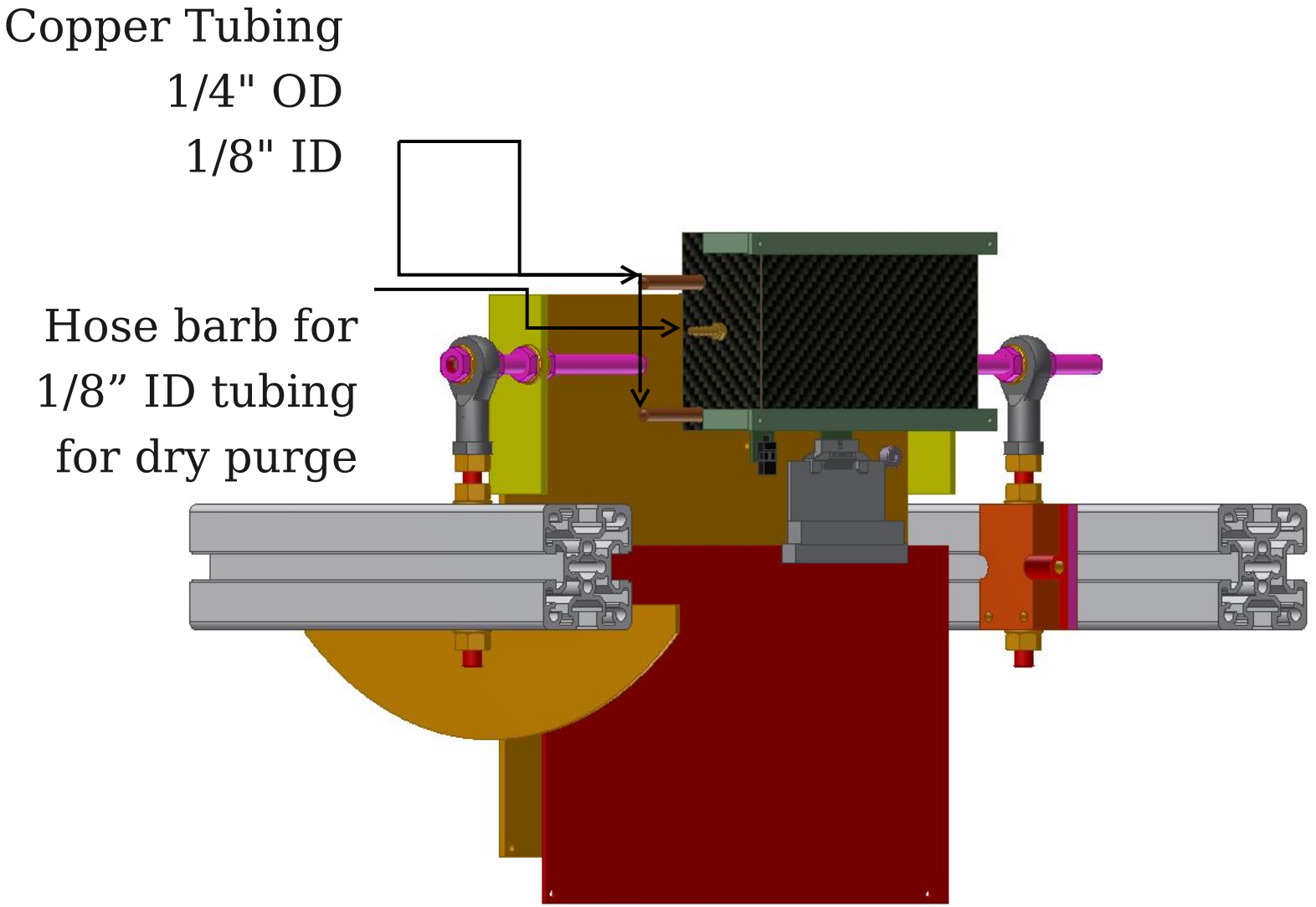
signals to and from test board

separate bias voltage

FPIX single chip module

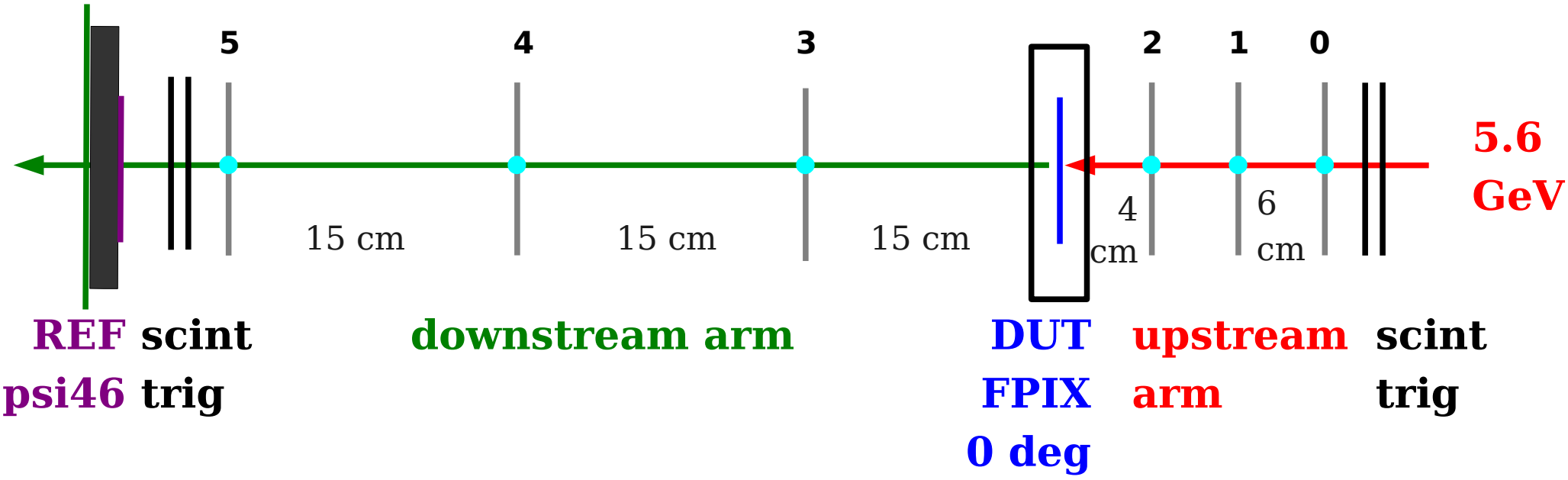


FPIX box on DESY tilting beam support



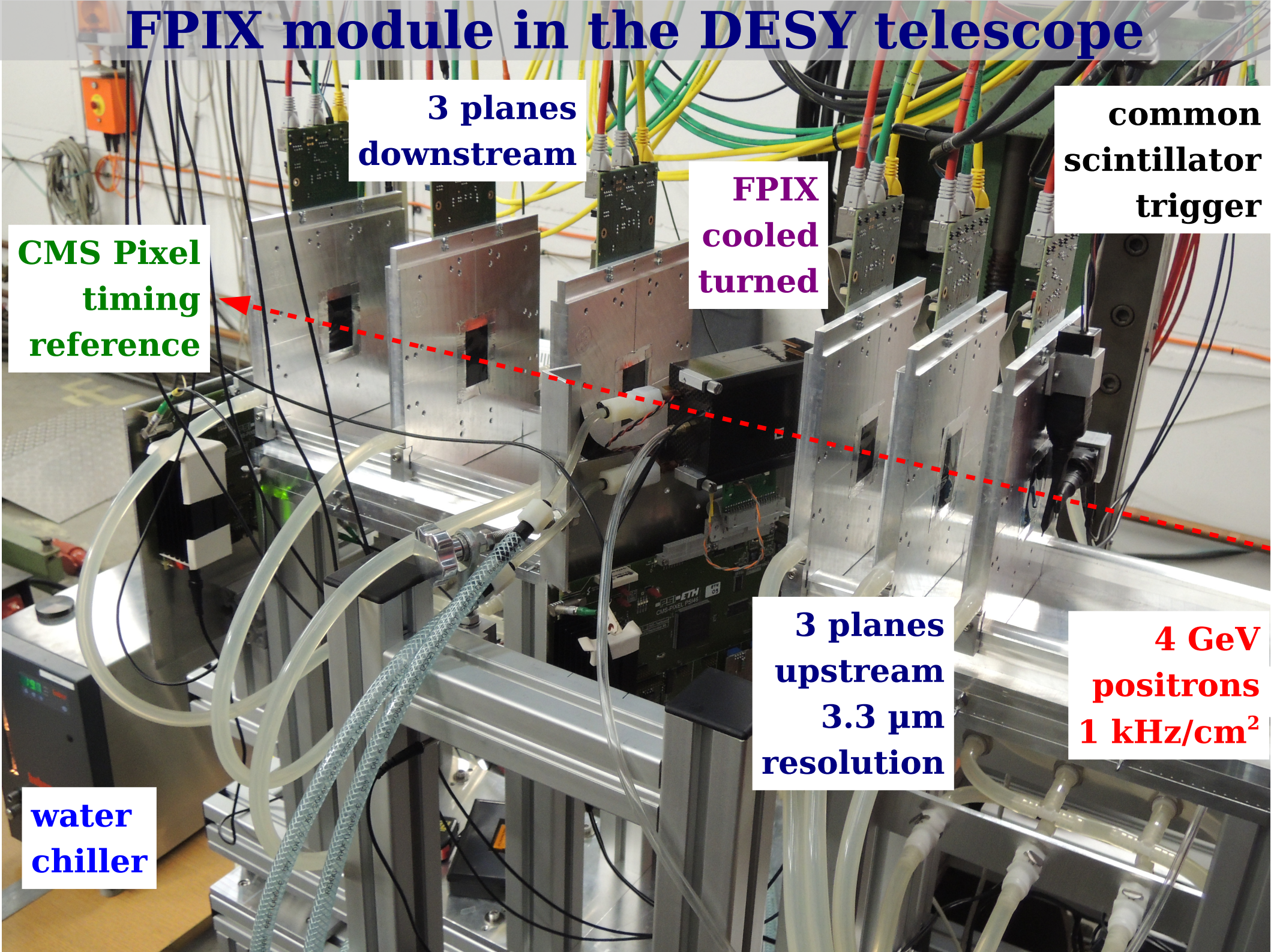
CAD drawings exchanged between Kirk Arndt and Adam Zuber

Default set up

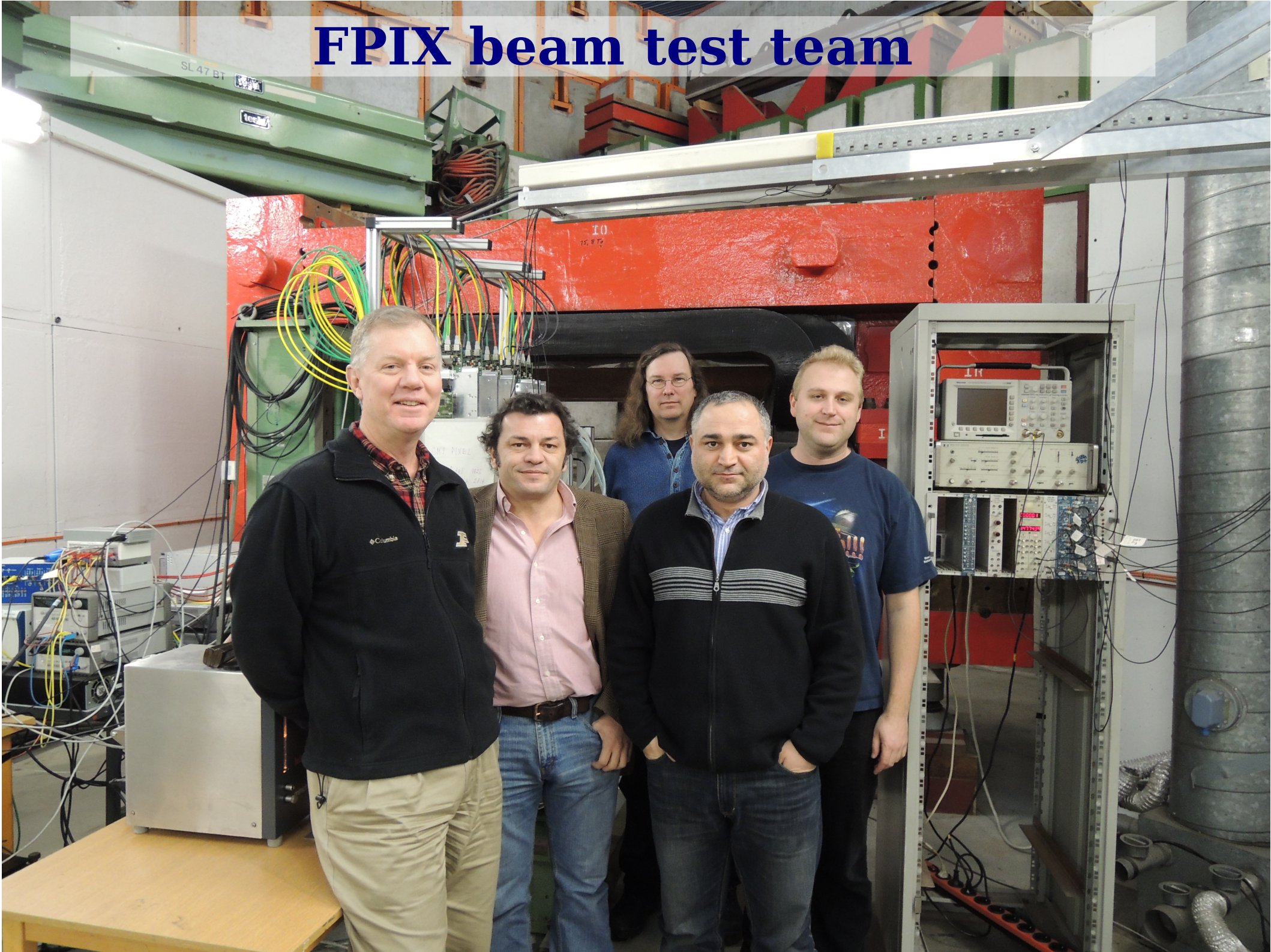


- Upstream arm 0-1-2:
  - as close as possible to DUT, but allow for tilting
- DUT = single chip module, no tilt
- Downstream arm 3-4-5:
  - equally spaced between DUT and REF
- REF = single chip module for timing, as close as possible behind scint
- trigger: 4-fold scintillator coincidence, 2×1 cm^2 area

FPIX module in the DESY telescope



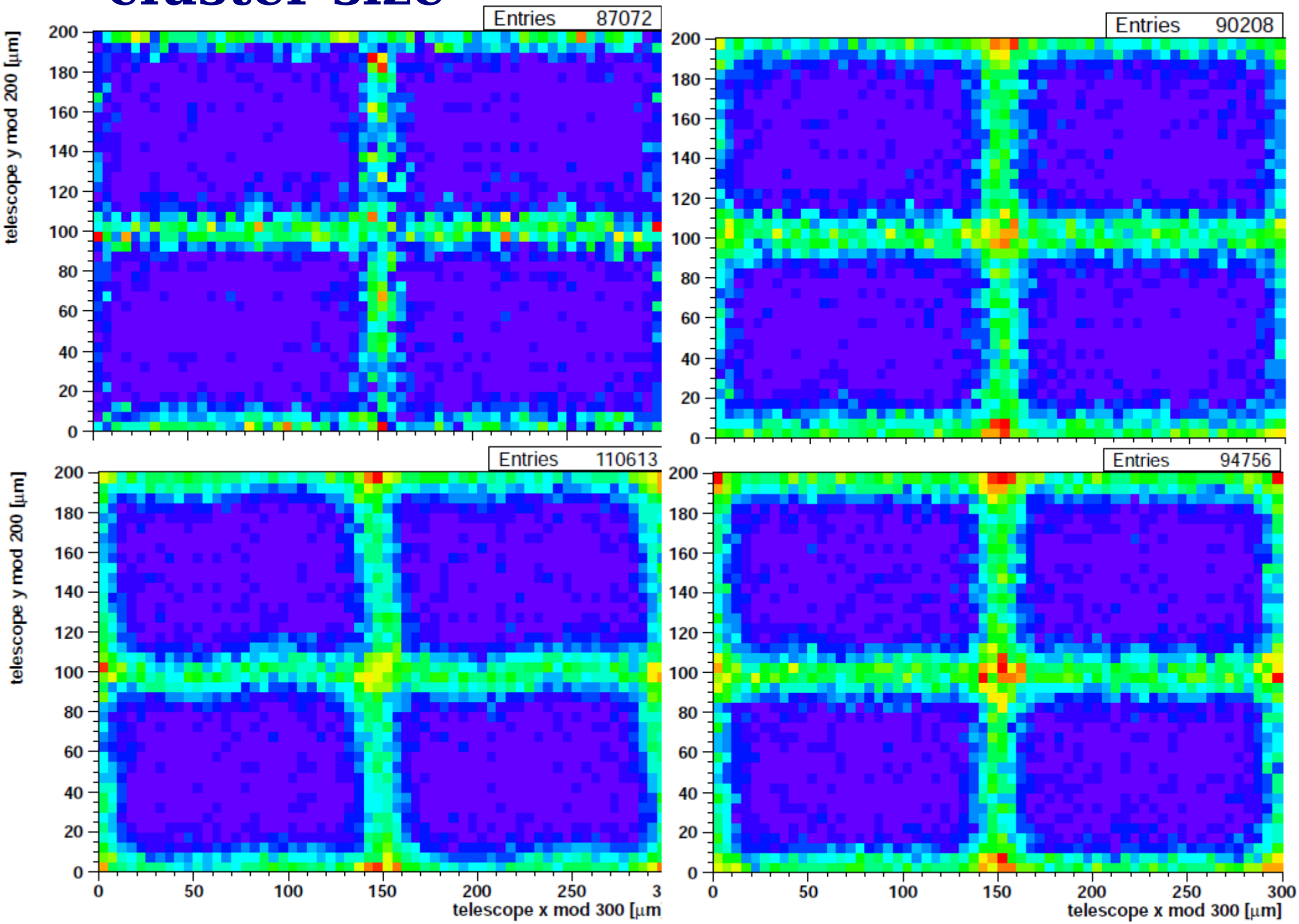
FPIX beam test team



FPIX beam test week

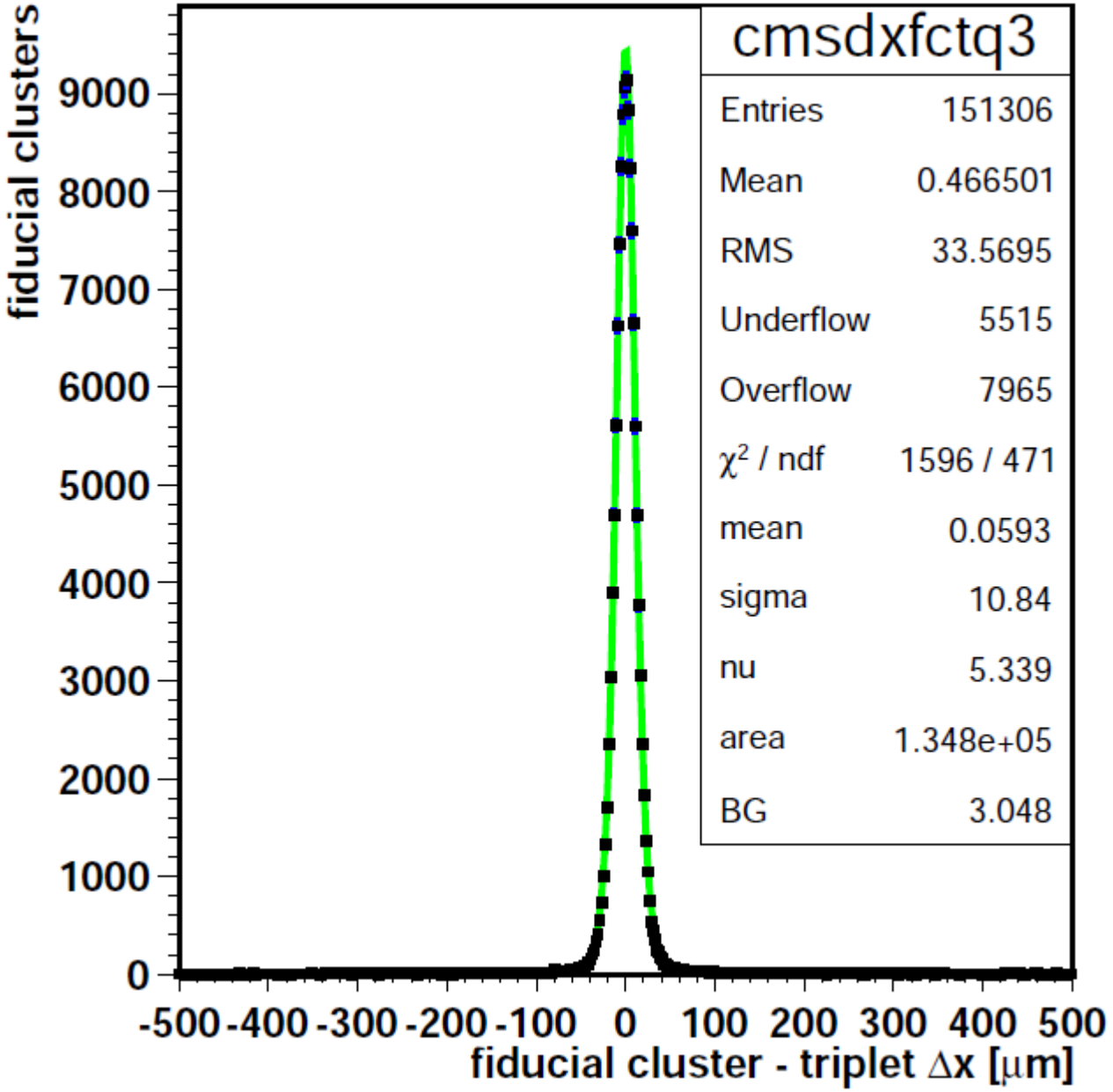
- Setting up mechanics, cooling, and DAQ on Monday
  - thanks to Adam Zuber
- six days (and 5 nights) of data taking
  - 400 runs (10 min each)
  - 120 GB of raw data
  - all devices measured
  - 0^{o} and 19^{o} incident angle
  - program completed!
- They will come back with irradiated sensors

cluster size

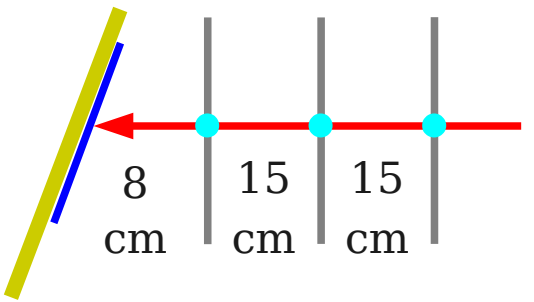


FPIX row resolution with turn angle

chip 24 = X, 20° turn, run 5949, 4.4 GeV



top view:



- Horizontal = rows
  - pixel width 100 µm
- turn angle:
  - charge sharing
- track-cluster residual:
  - sigma = 10.8 µm
  - subtract telescope 7 µm
  - σ_{row} = 8.4 µm

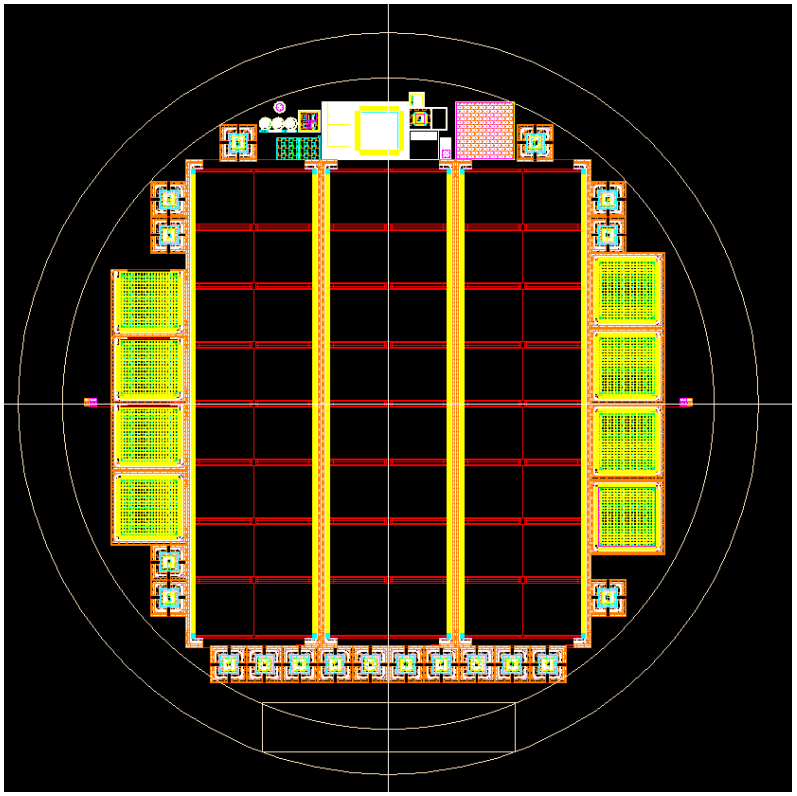
Back up

FPIX sensor production 2012

18 wafers (4”) from Sintef (Bergen) finished in May 2012

10 wafers came to Purdue (6 regular wafers and 4 MCZ)

- **1 regular wafer diced and irradiated with CO-60**
- **4 regular and 1 MCz now at IZM for UBM**



+8 regular wafers at FNAL for probing

All measurements match well those at Sintef:

- **Depletion voltage around 80 V**
- **Leakage current around 20 nA/cm^2 @Vdep**
- **Linear increase until Breakdown.**
- **Breakdown voltage between 200 and 300 V before irradiation**
- **Breakdown voltage increases (but not always) all the way to 600-1000 V post irradiation (only 2Mrad with CO-60).**

FPIX DUTs

single chip modules
old analog psi46 bump bonded to

- **8 (2×4 flavors) from Sintef 4” wafer 2012**
- **2 FPIX 2006 FM**
- **2 slim edge (the slimmest = S1)**

Work plan I

Monday and Tuesday:

Safety instruction Mo 13:00 (Marcel Stanitzki)

Installation of hardware (electronic and cooling)

cooling Peltier set at +20 deg C

Calibrate the DUT

Get familiar with the software for the telescope.

Start taking data with a FM device at 200V

Find the beam

Check the timing

Cluster charge should be at a maximum

Cluster size should be at a maximum

Do a BIAS scan: 50, 70, 90, 100, 110, 120, 130, 140, 150, 200, 300 V (about 10-20 minutes of data taking per point).

Once this is done take several hours of data in optimized conditions at 150V and/or 300V

Work plan II

Wednesday:

Swap DUT with a FMM

Start taking data with a FMM device at 200V

Beam location should be the same

Timing should be the same

Do a BIAS scan: 50, 70, 90, 100, 110, 120, 130, 140, 150, 200, 300 V (about 10-20 minutes of data taking per point).

Once this is done take several hours of data in optimized conditions at 150V and/or 300V

Thursday:

Swap DUT with a X (Cross)

Same as Wednesday for the FMM

Friday:

Swap DUT with a C (Closed)

Same as Wednesday for the FMM

Work plan III

Saturday and Sunday:

If we did not accomplish the already described plan of work keep working on it.

If the plan of work is accomplished we should consider pursuing any of the following options:

take data with one of the previous devices at different temperature to understand how cold we can go with our setup.

take data with devices from the 2006 production (only FM and FMM available) for comparison between the two production runs.

take some data with a tilt angle (suggestion 20 deg)

take some data with slim edges devices

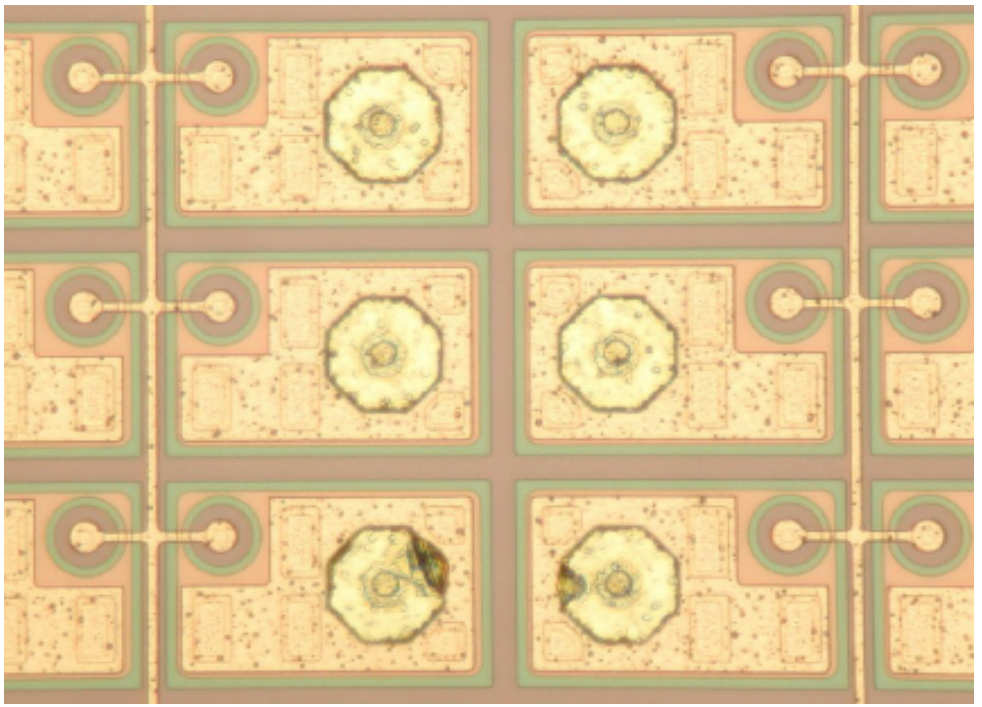
take some data with a 3D device

Things to take from Purdue to DESY

1. 12x SINTEF_2011 sensors and 2x SINTEF_2006 sensors (14 total)
2. Peltier controller, power supply and power cord, twisted pair control cables, keypad and its flat cable, chiller supply and return fittings
3. DUT cooling box, humidity sensors (2x) and usb adapters (2x)
4. Tweezers, kapton tape, screwdrivers, wrenches, screws for mounting DUT box to the DESY telescope setup frame
5. HP Windows 7 laptop (COOLING control), ACER ubuntu linux laptop (PSI46 DAQ), power cords
6. PSI46 DAQ board, USB cable, USB extension hub, low voltage cable, plaquette adaptor (2x)
7. 1x PGS sheet
8. 3x plug adapters (from 3-prong US to german) or an US multiplug with one plug adaptor
9. offline laptop with SLC5

BPIX pixel sensor

barrel pixel sensor: n-in-n with p-spray

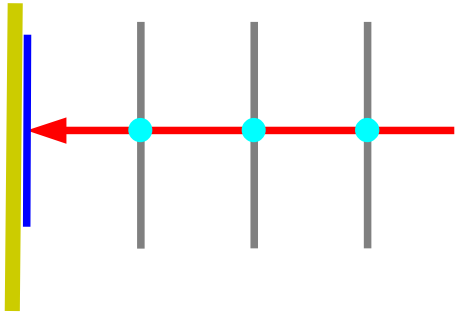


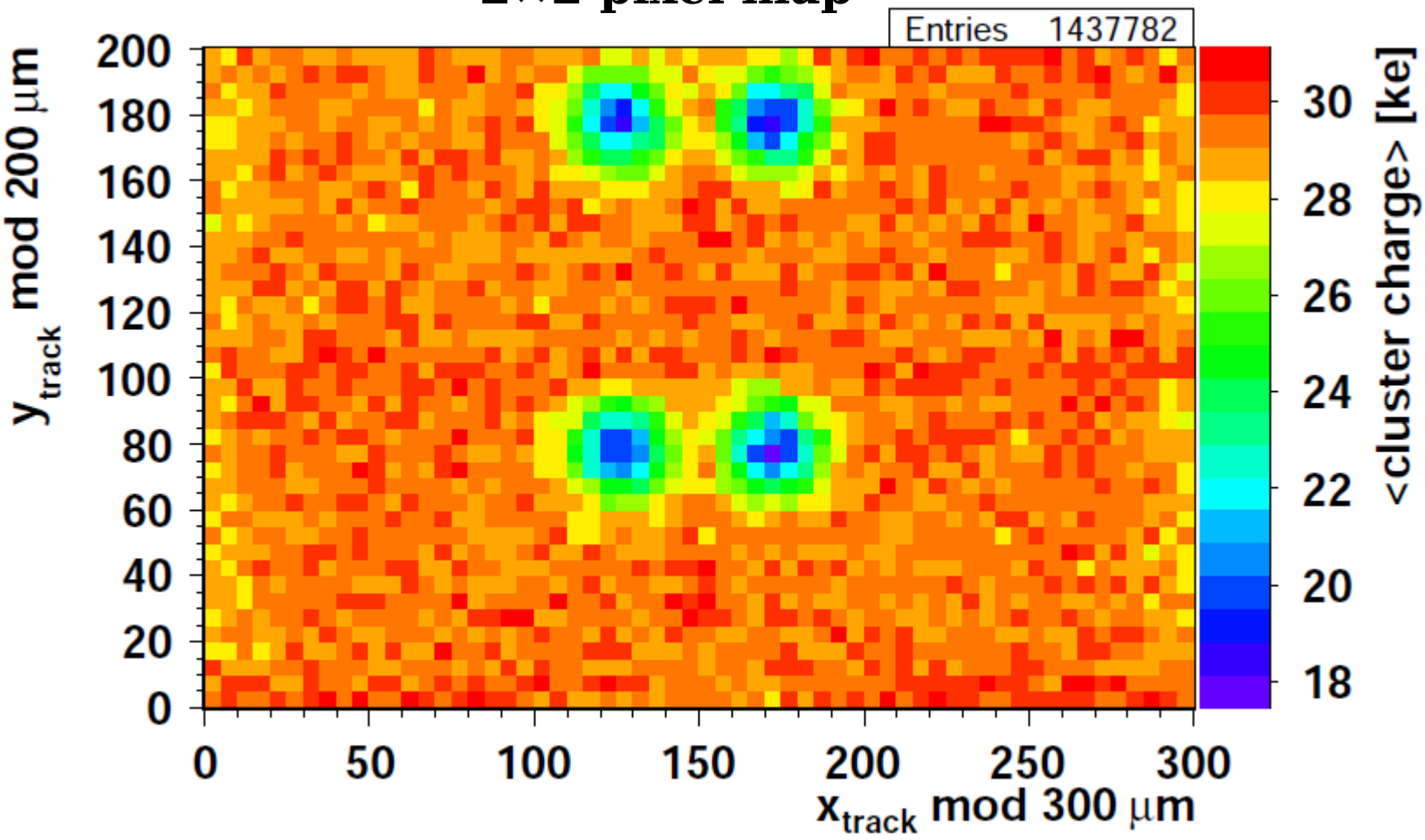
high resistivity
n-type substrate.
p-n junction at back

working well
no change for phase I upgrade

T. Rohe, talk 2009

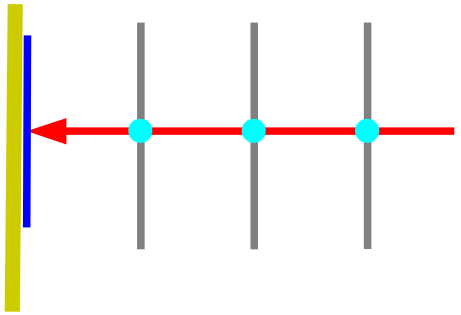
BPIX charge map, vertical incidence

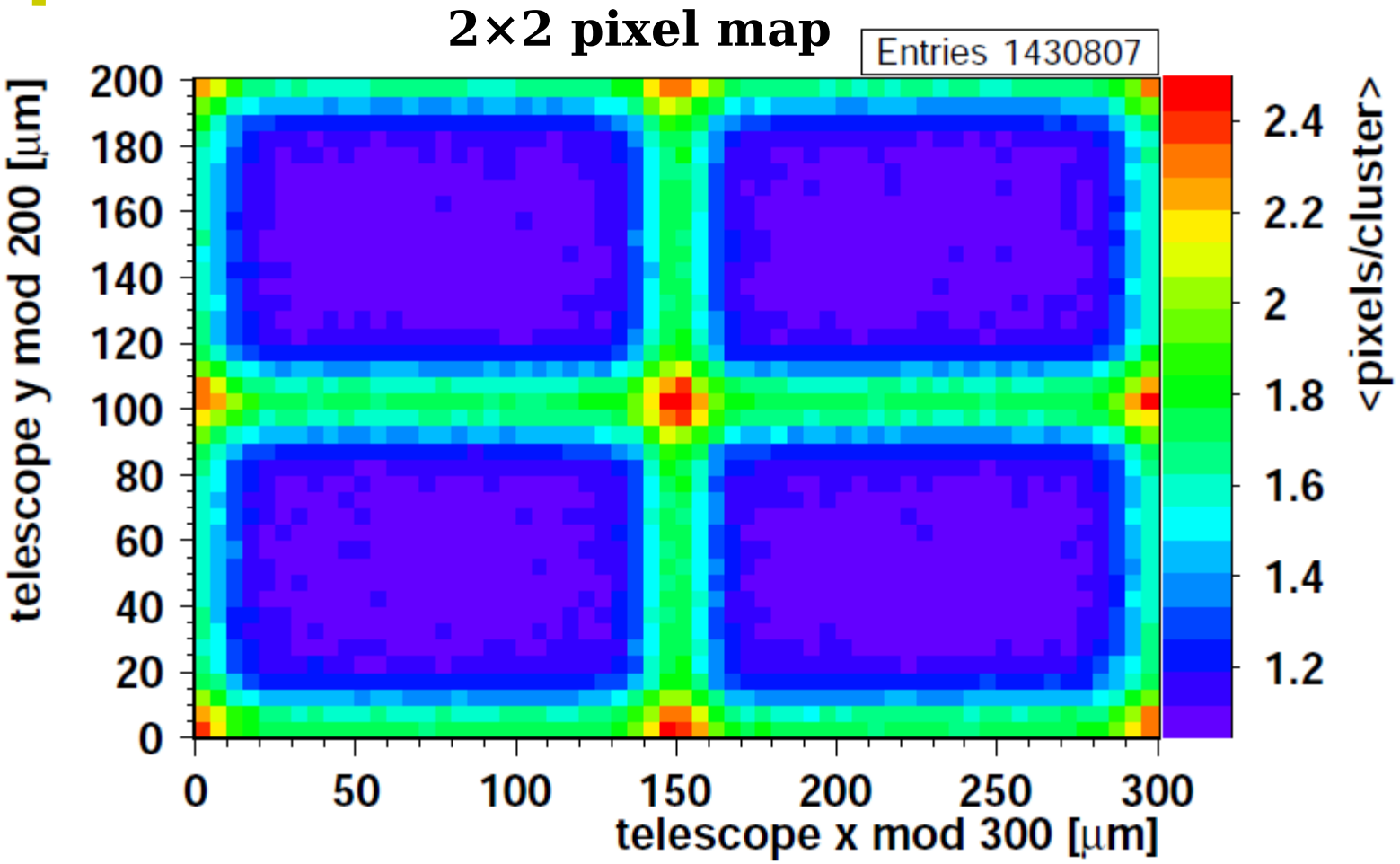




- c202, **0° tilt**
- 4.8 GeV runs 4716-4726
- Telescope track position
- **bias dots: charge deficit**
  - **smaller for inclined tracks and with Lorentz drift**

BPIX cluster size map, vertical beam





- c202, **0º tilt**
- 4.8 GeV runs 4716-4726
- Telescope track has 6 µm precision
- **pixel core**
- **pixel edge**
- **pixel corner**
- **Charge diffusion radius is about 8 µm.**