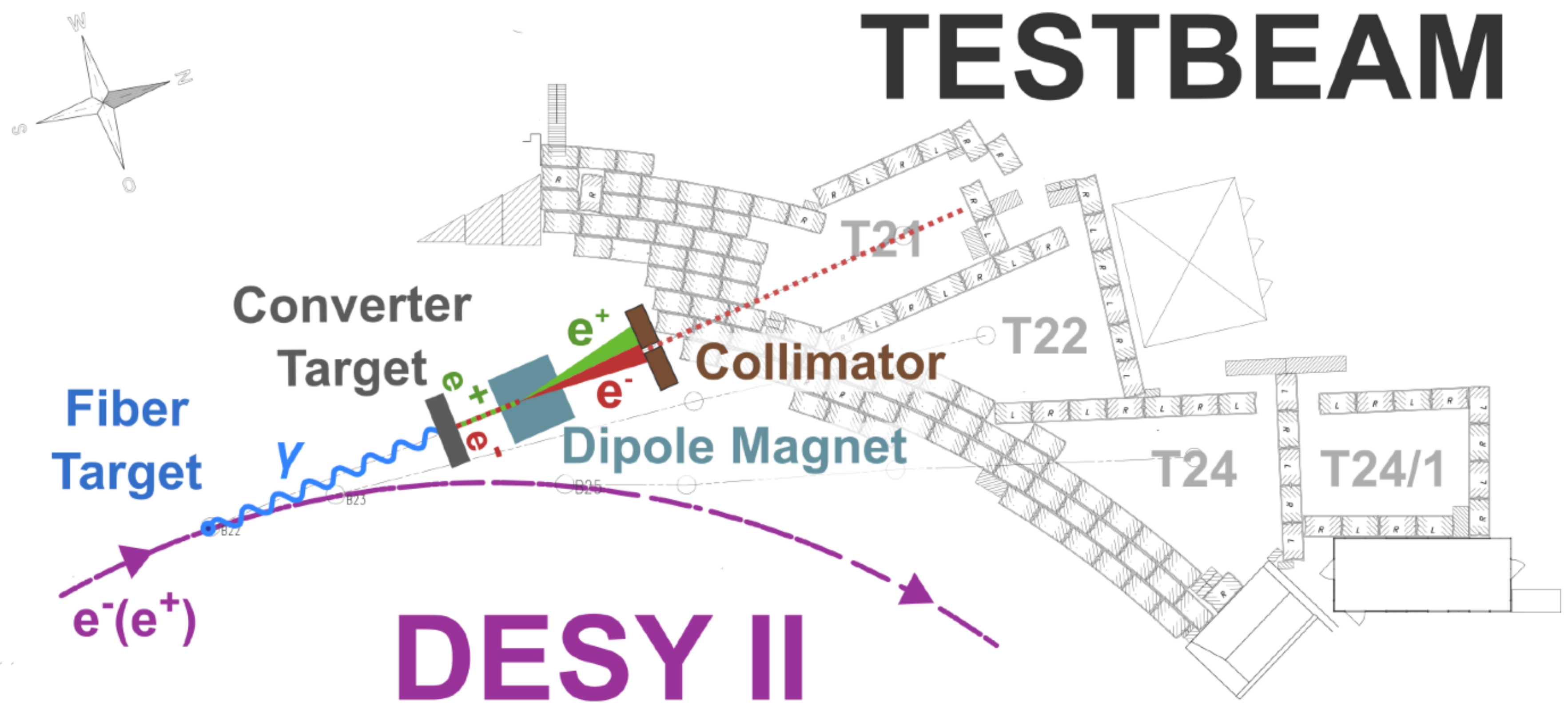
WP15.3 : Improvements of the DESY test beam infrastructure.

D15.2 Silicon strip telescope reference tracker (due by 04/2018)
D15.3 Environmental slow control system (delivered 27/10/2018)



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Zurich, 16 Jan 2017
AIDA2020-WP15 Satellite @ 6th BTTB Workshop

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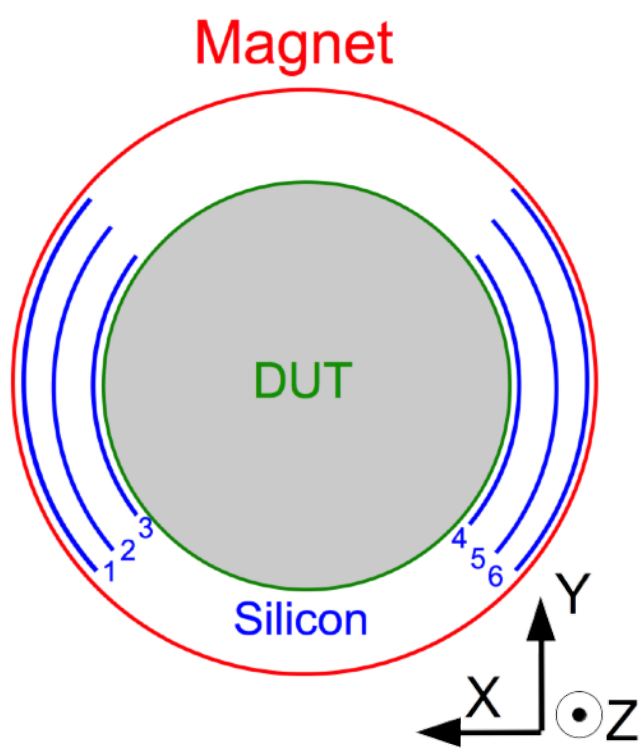
Overview

D15.2 Silicon strip telescope reference tracker in the solenoid (up to 1T) in beam area 24, featured...

- A large coverage area (~10x10 cm²);
- Minimal needed space (~3.5 cm) to allow large DUT inside the magnet (e.g. TPC);
- Spatial resolution better than σ_y= ~10 μm along bending direction of particles in the magnet;
- Resolution along field axis of the magnet less important σ_z= ~1 mm.

D15.3 Environmental slow control system

- a central monitoring system maintained by DESY, to monitor:
  - Common TB parameter;
  - Area specific parameter;
  - User configurables.
- Data outstream easy to integrate to user data;
  - short learning period
  - integrated to common DAQ: i.e. EUDAQ2
- Flexible to integrate user customizing slow control system;
- Mechanical mobility and stability.



D15.2 Silicon strip telescope reference tracker

LYCORIS: a Large Area X-Y Coverage Readout Integrated Strip Telescope

Telescopes at DESY

Mimosa telescopes at DESY: (see Jan's talk)

- 6 layers of pixel planes, 1*2 cm^2, 18 μm pitch;
- Based on Mimosa26;
- Trigger rates up to 3 kHz;
- 3 microns tracking resolution;
- Provideds full tracking and analysis packages;
- Very high demand!
  requested by **~70%** test beam users in 2016;
- In use of **EUDAQ** and EUDET/**AIDA mini-TLU**.

Mimosa is **definately awesome**!
But still user cases **not covered due to**:

- small active area
- support structure demands a lot of space
- high amount of channels -> large power consumption -> dedicated water cooling
- relatively slow readout with an integration time of ~100 μs

Leading to a **new telescope**

Introduction: the LYCORIS strip telescope

With the **AIDA2020** project :

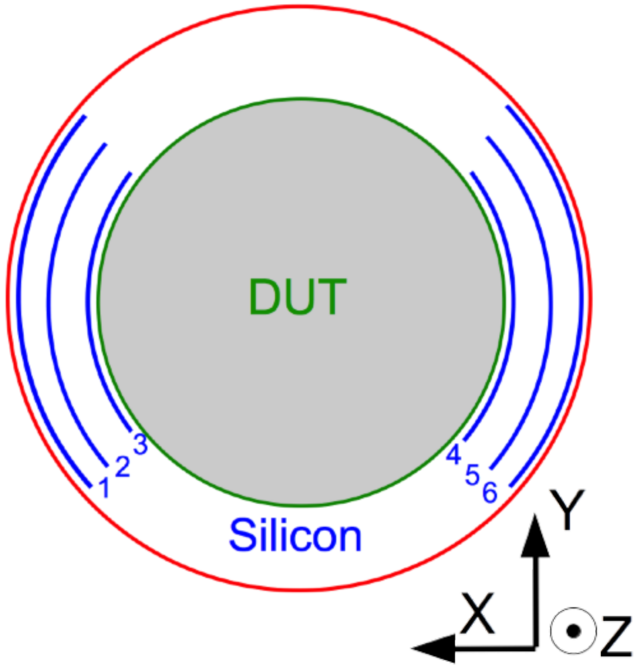
A new large area strip telescope within the solenoid in DESY-II beam area 24

The T24/1 solenoid has:

- ~75 cm usable inner diameter;
- A wall with a radiation length of 0.2 X_0;
- Is mounted on a stage that can be moved/rotated around 3 axes;
- A magnetic field up to 1T.

Telescope demands defined by use case:

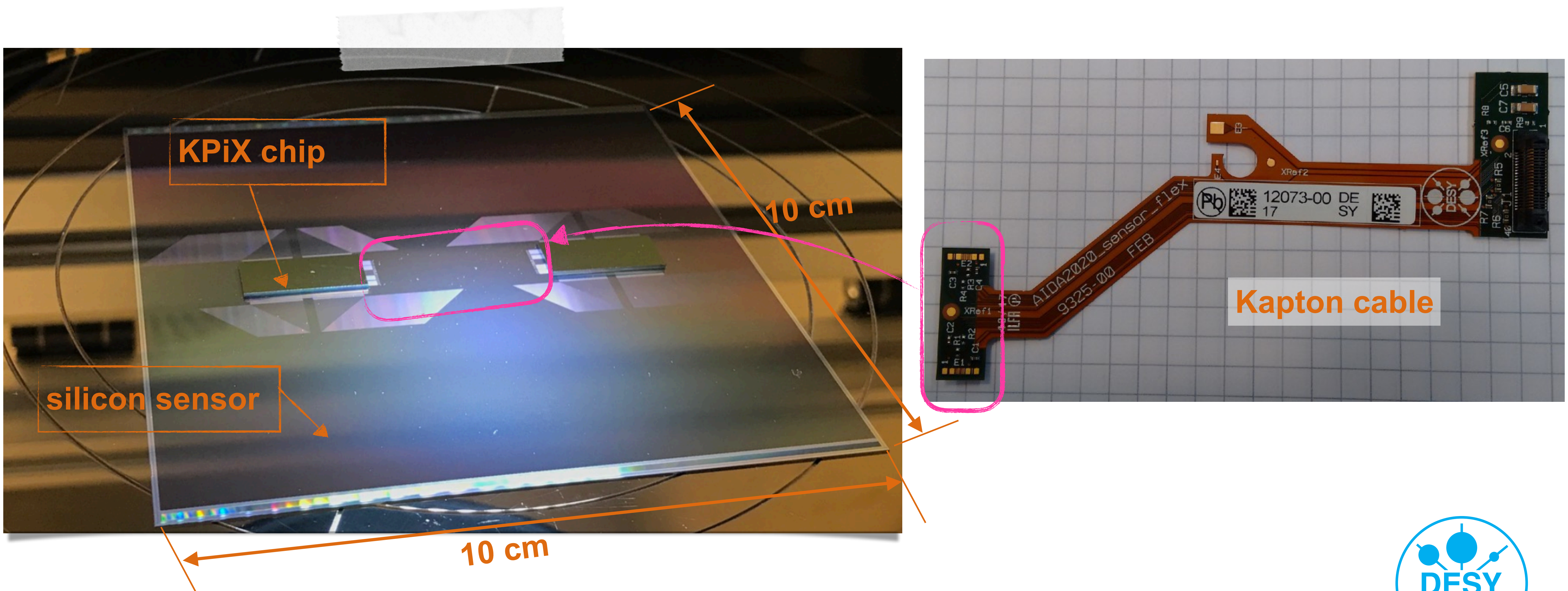
- A large coverage area (~10x10 cm^2)
- Minimal needed space to allow large DUT inside the magnet (e.g. a TPC)
- Spatial resolution better than σ_y= ~10 µm along bending direction of particles in the magnet
- Resolution along field axis of the magnet less important σ_z= ~1 mm



The SiD strip sensor

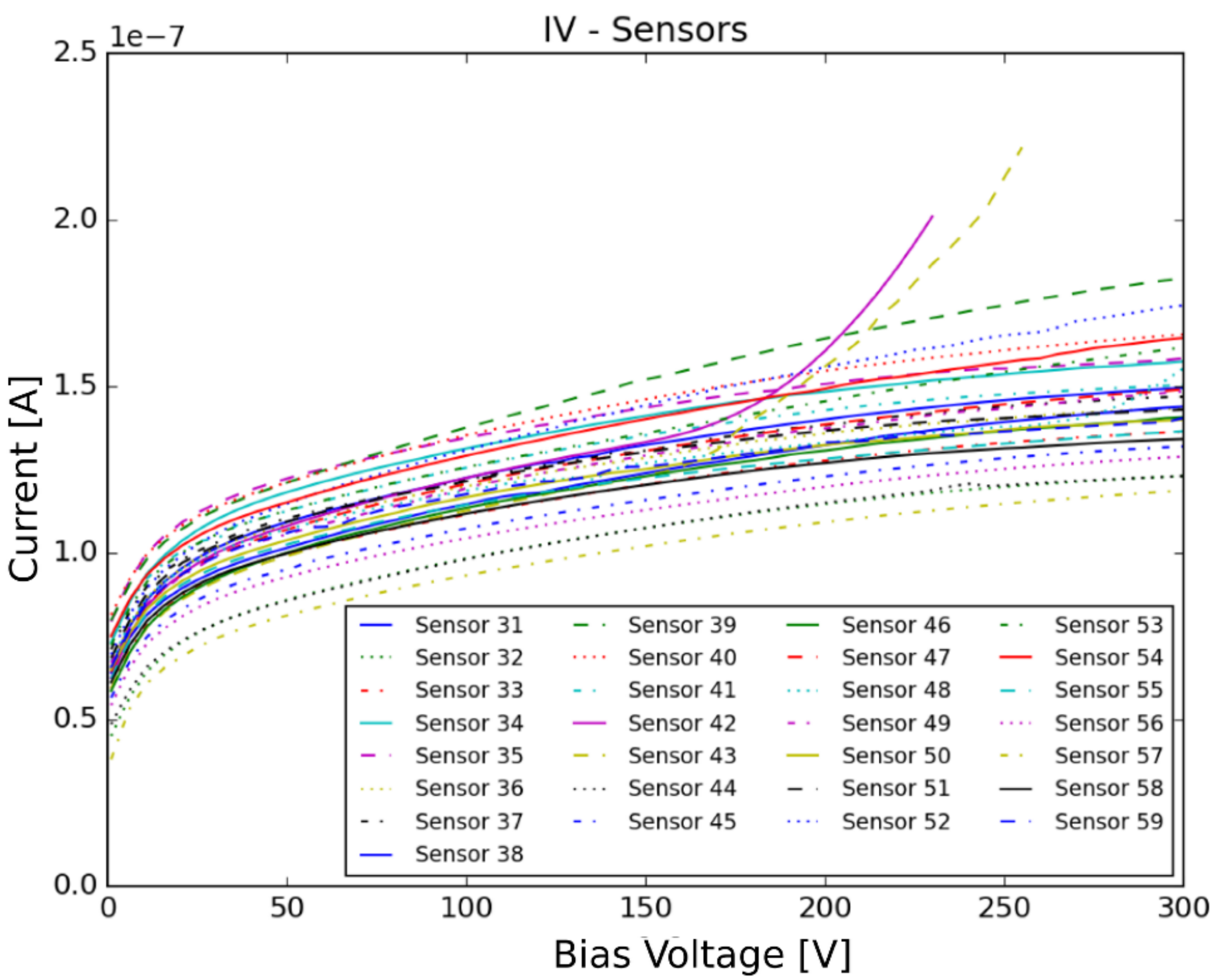
Designed by SLAC for an ILC environment:

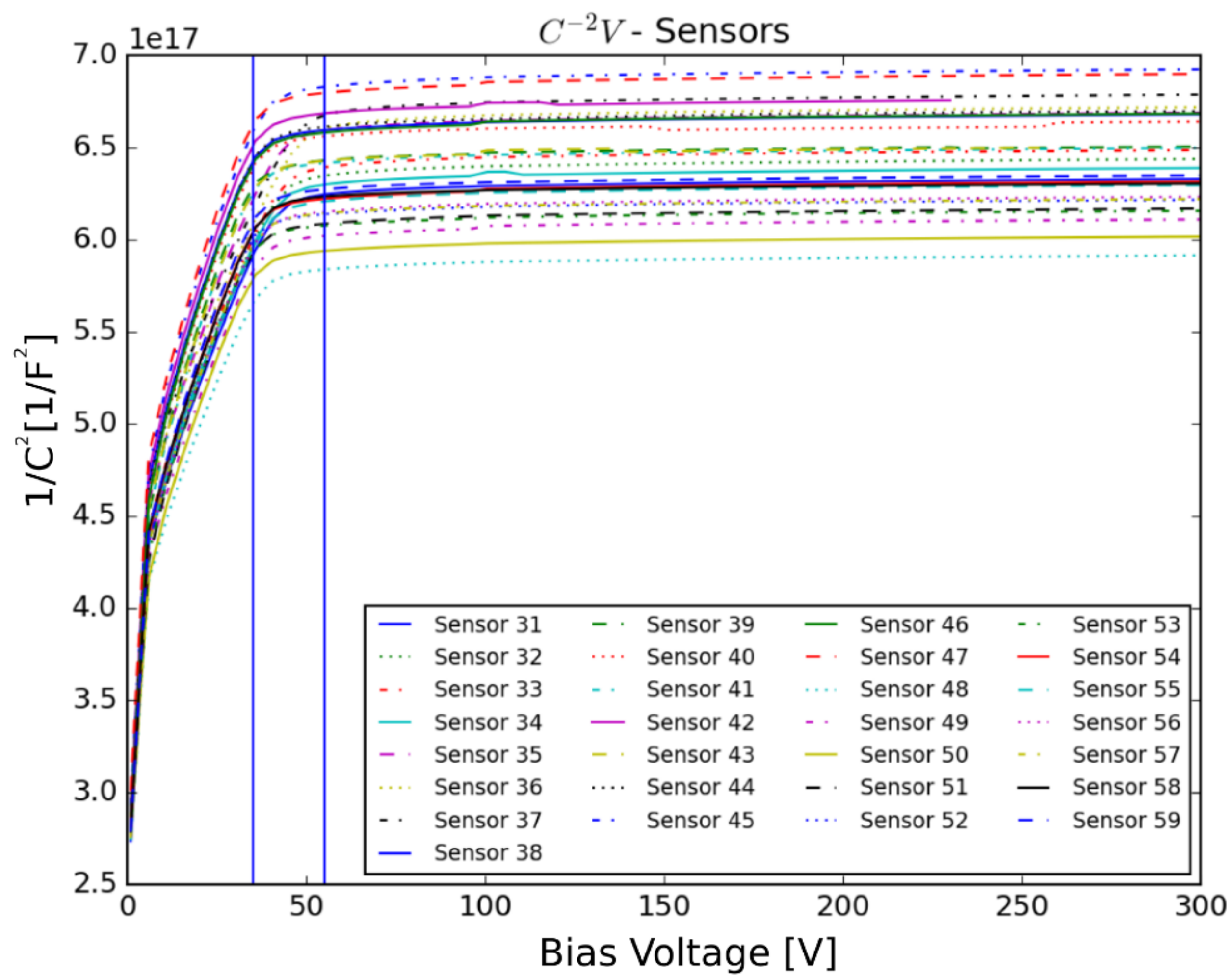
- A strip pitch of 25 μm
- Alternate strips will be read out
- Thickness of 320 μm
- Material budget of 0.3% X_0
- An integrated pitch adapter and digital readout (KPiX)



The SiD strip sensor: IV measurements

- **Good behaviour**:
  - ~100 nA currents and stable up to 300V;
  - Two sensors show the beginning of a breakdown around 280V.
- **Depletion** voltage for all sensors around **50V**;
- **Expected** behaviour **after bump bonding**: still **good IV**-behaviour with **same depletion** voltage.

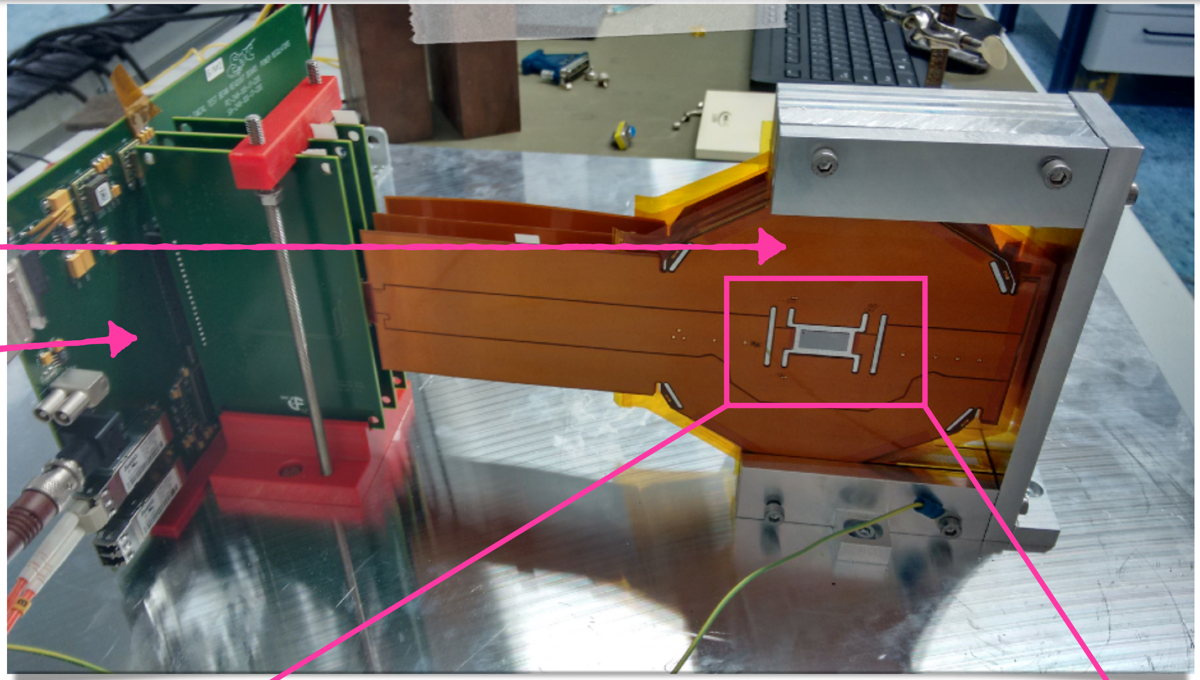


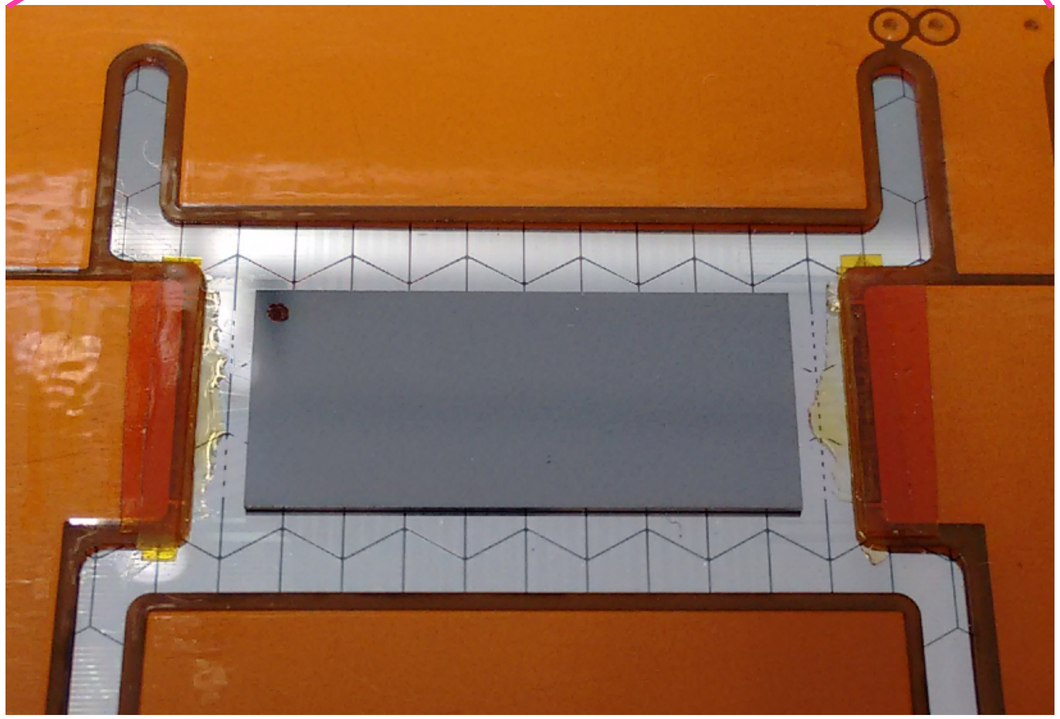


Test the KPiX readout system

The test setup at DESY…

- 3 Pixel sensors
  with large pixel size and bump bonded KPiX
- Readout FPGA board
- Dark box cover to reduce light induced noise



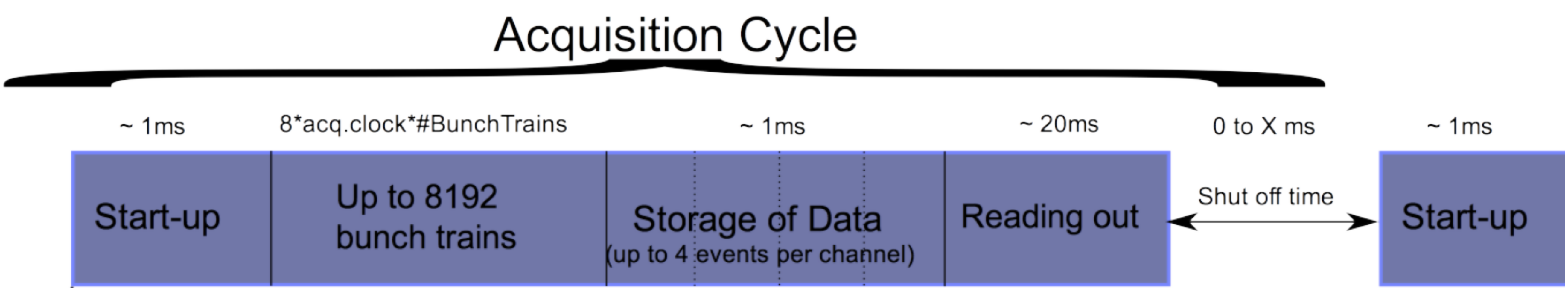


Performance and functionality tests conducted…

- Measurement of heat generation of readout chip
- Test of the chip with pedestals and calibration
- Measurements with a radioactive source
- Testbeam measurements with DAQ synchronisation

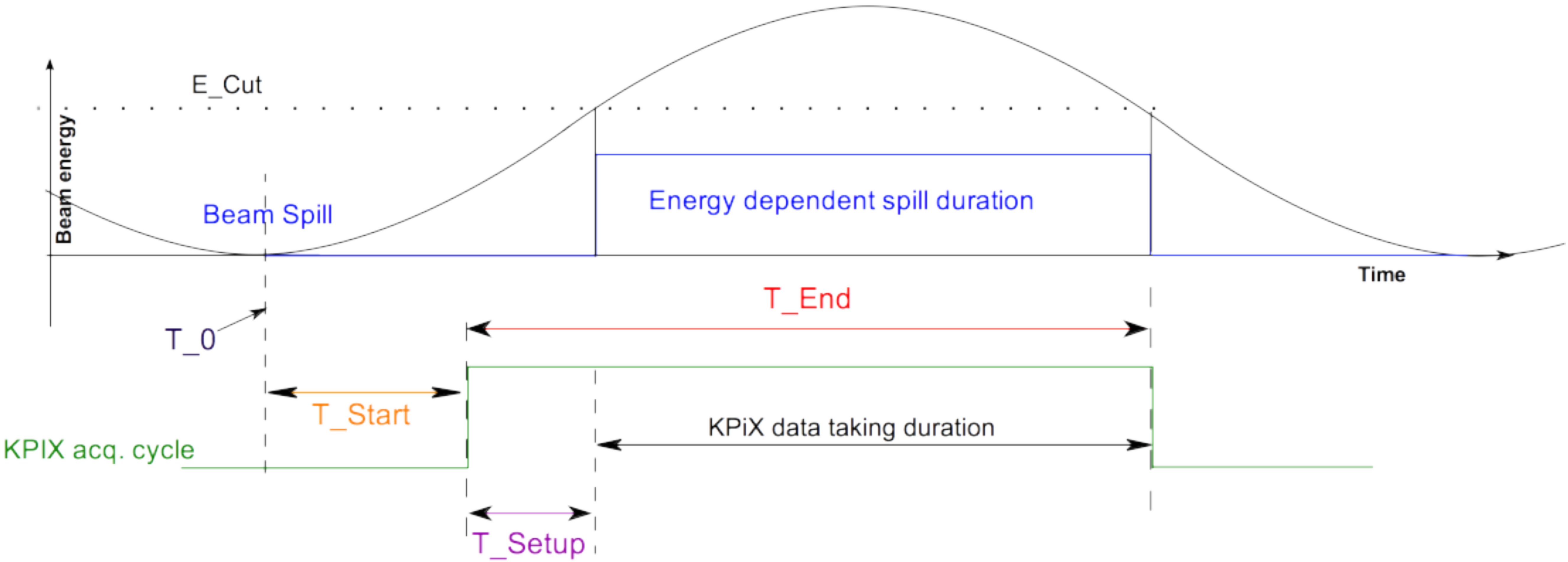
The KPiX readout chip

- Fully digital readout with 13 bit resolution (8192 ADC)
- 100 MHz clock → 10 ns flexible acq. Clock
- Can work in **2** trigger modes:
  - Self trigger = 4 events *per* channel *per* cycle stored
  - External trigger = 4 events *per* cycle stored
- Capable of power pulsing
- Length of the opening period depends on timing resolution



- Only open for a maximum time of 8192*8*acq.clock
  →For example with a 320 ns acq.clock = 20.97 ms

KPiX synchronisation with Beam



- As a result of the power pulsing KPiX needs to be synchronised to beam spill of the accelerator and the different devices.
  - This will be accomplished via a new AIDA2020 TLU (see David's talk).

T_0: Accelerator signal for synchronisation with beam spill.

T_Start: User adjustable delay between T_0 and the KPiX switch on.

T_Setup: Setup time of KPiX. At the end of which KPiX can start the data taking.

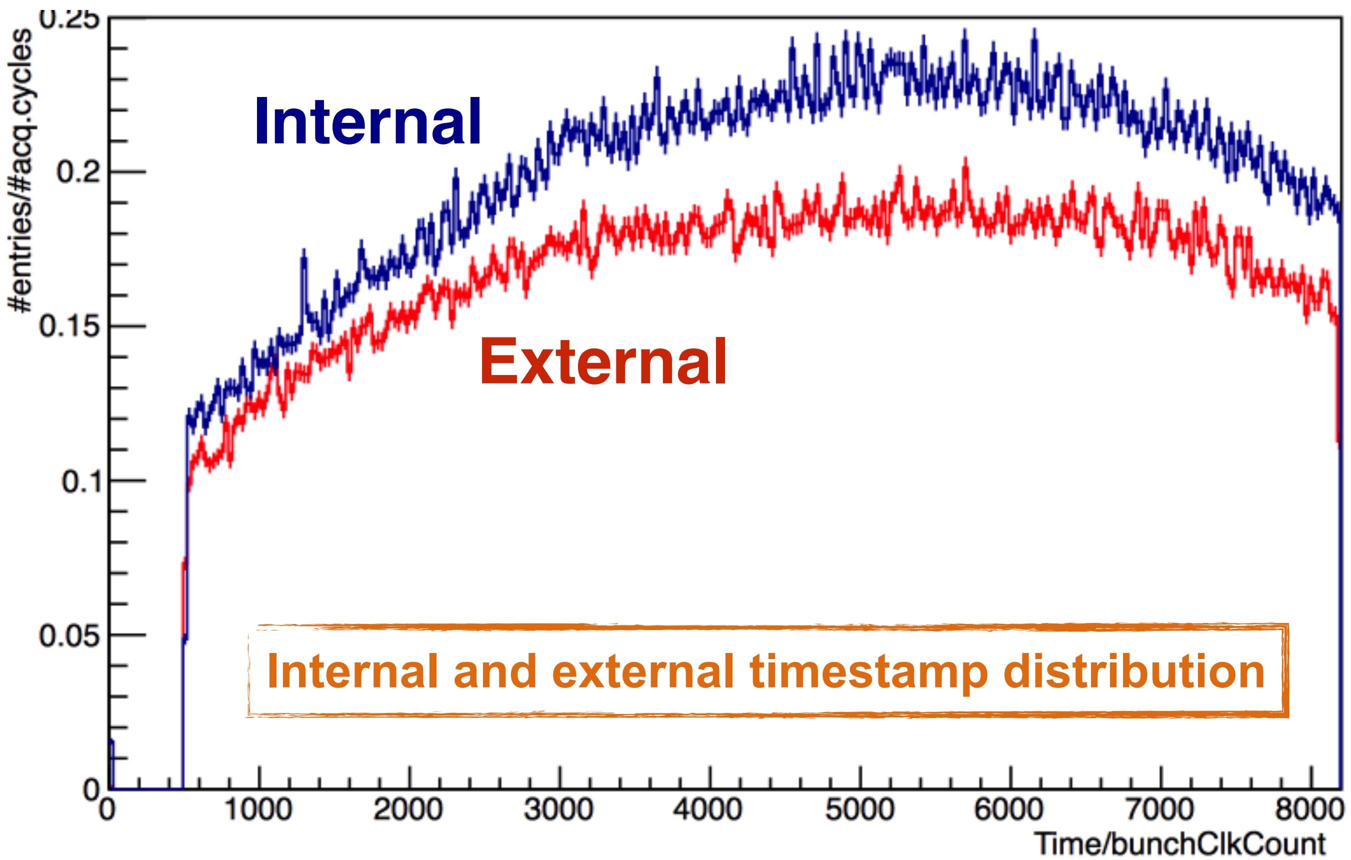
T_End: User Adjustable signal telling all devices that KPiX has stopped data taking.

KPiX readout system: test beam results

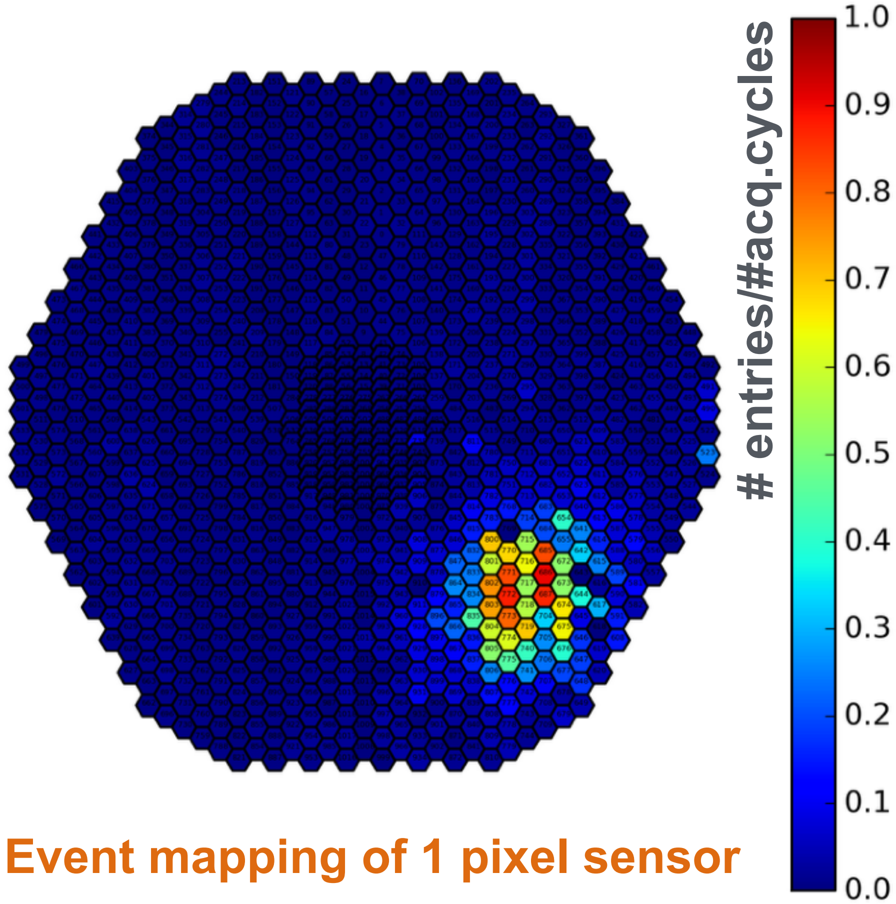
Tests resulted in a good understanding of data taking with KPiX in all aspects:

- Time analysis of events and matching with based on timing with external timestamps
- ADC response of channels and calibration
- Mapping of events onto the testing pixel sensor

→ <u>Well prepared for the final strip sensors!</u>



Internal and external timestamp distribution

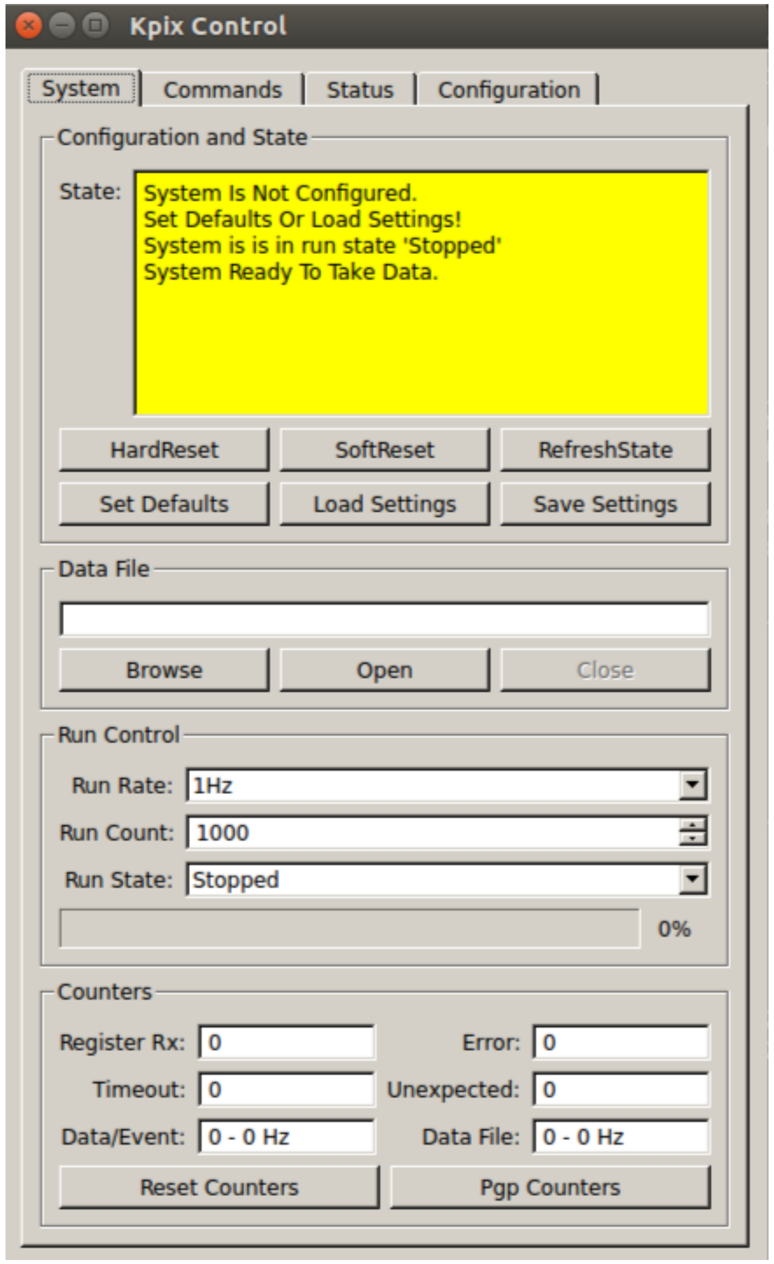


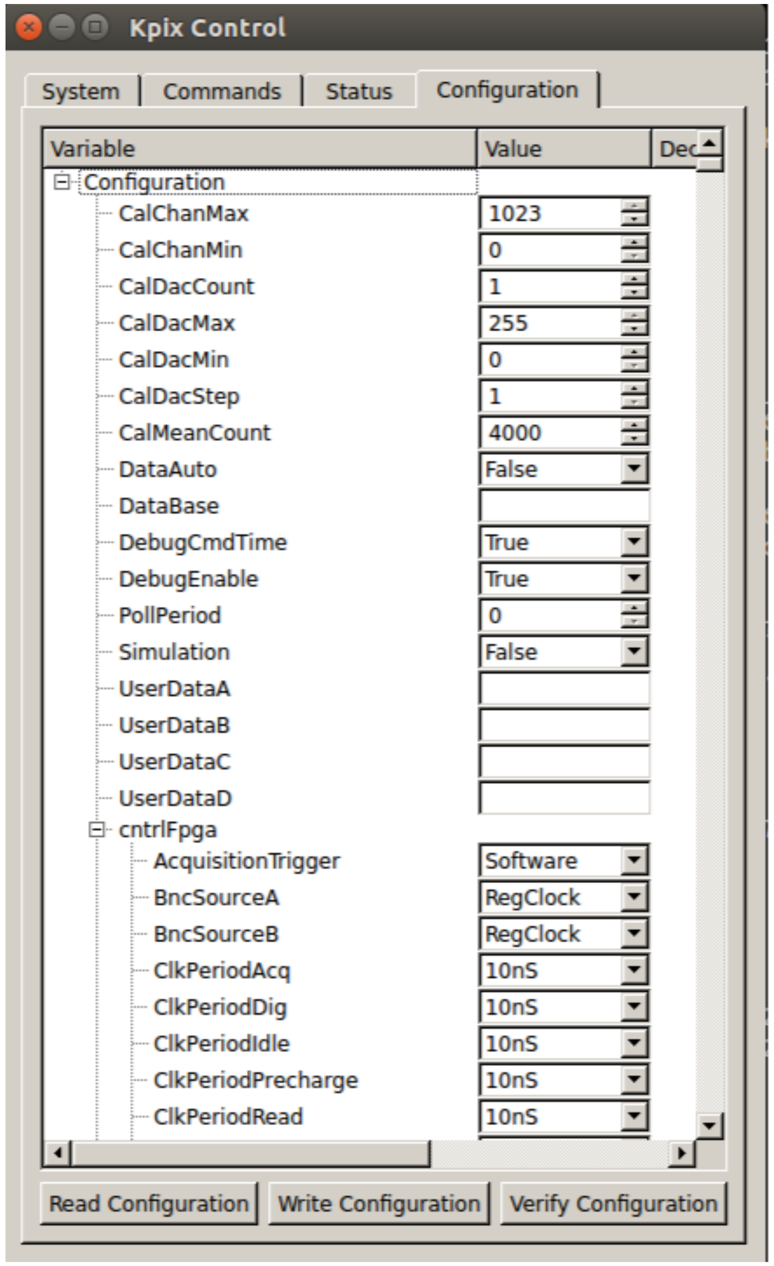
Event mapping of 1 pixel sensor

Integrating to a common DAQ

The KPiX has its own DAQ system developed by SLAC:

- The **control GUI** is very **powerful** to **control/monitor** the chip
- Output data only in binary files, with its own analysis package





However, as a telescope

- Too many functions and print-out => longer training peirod to users + higher possibility for mis-operation;
- Unique output data with special analysis package => difficulty to integrate with other facility.

Result in a integration to =>

EUDAQ

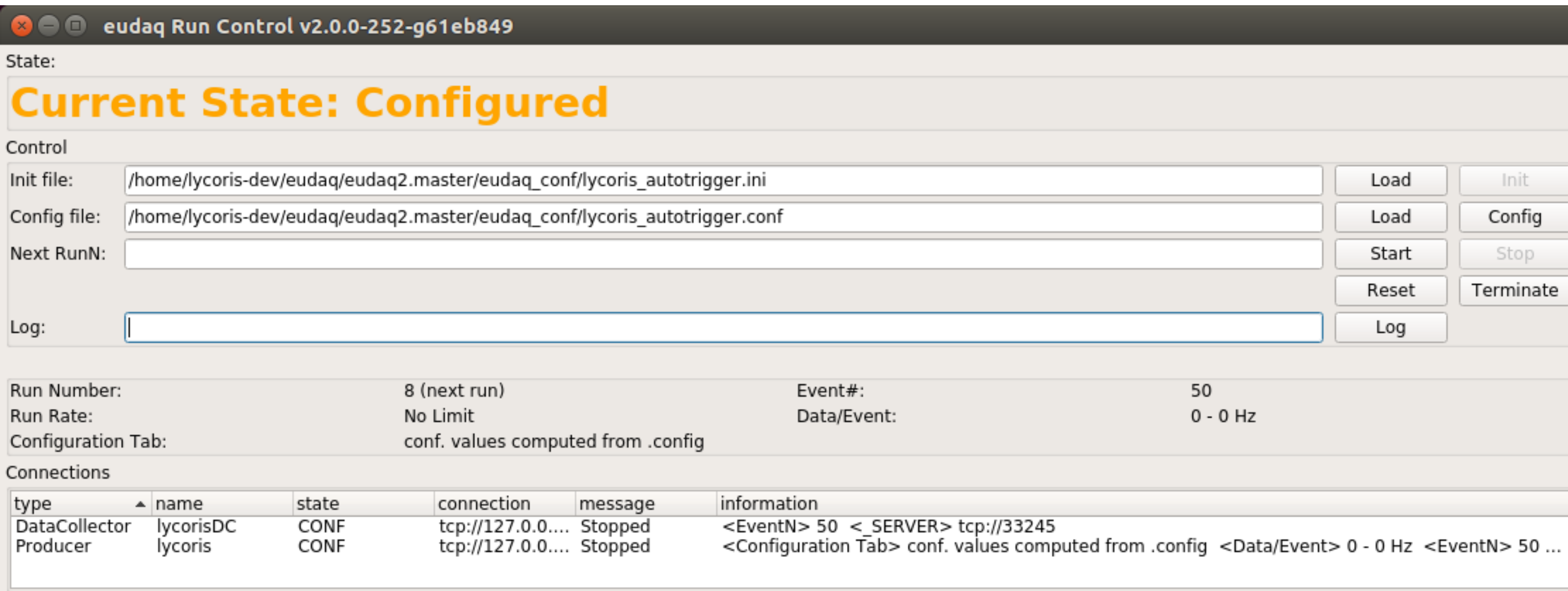
SLAC NATIONAL ACCELERATOR LABORATORY

DESY

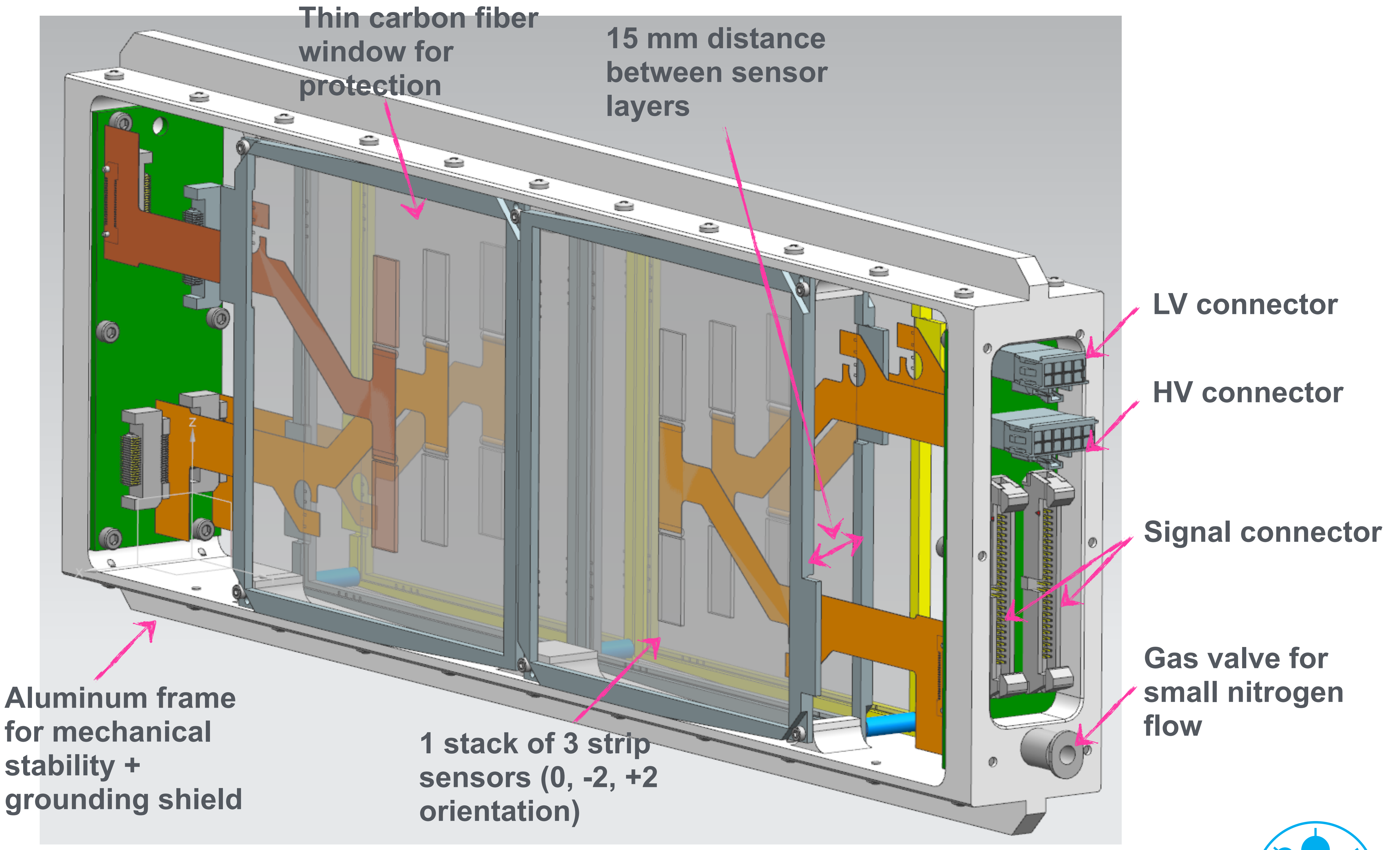
EUDAQ integration

Dedicated Github repository: https://github.com/Lycoris2017/EUDAQ-Lycoris

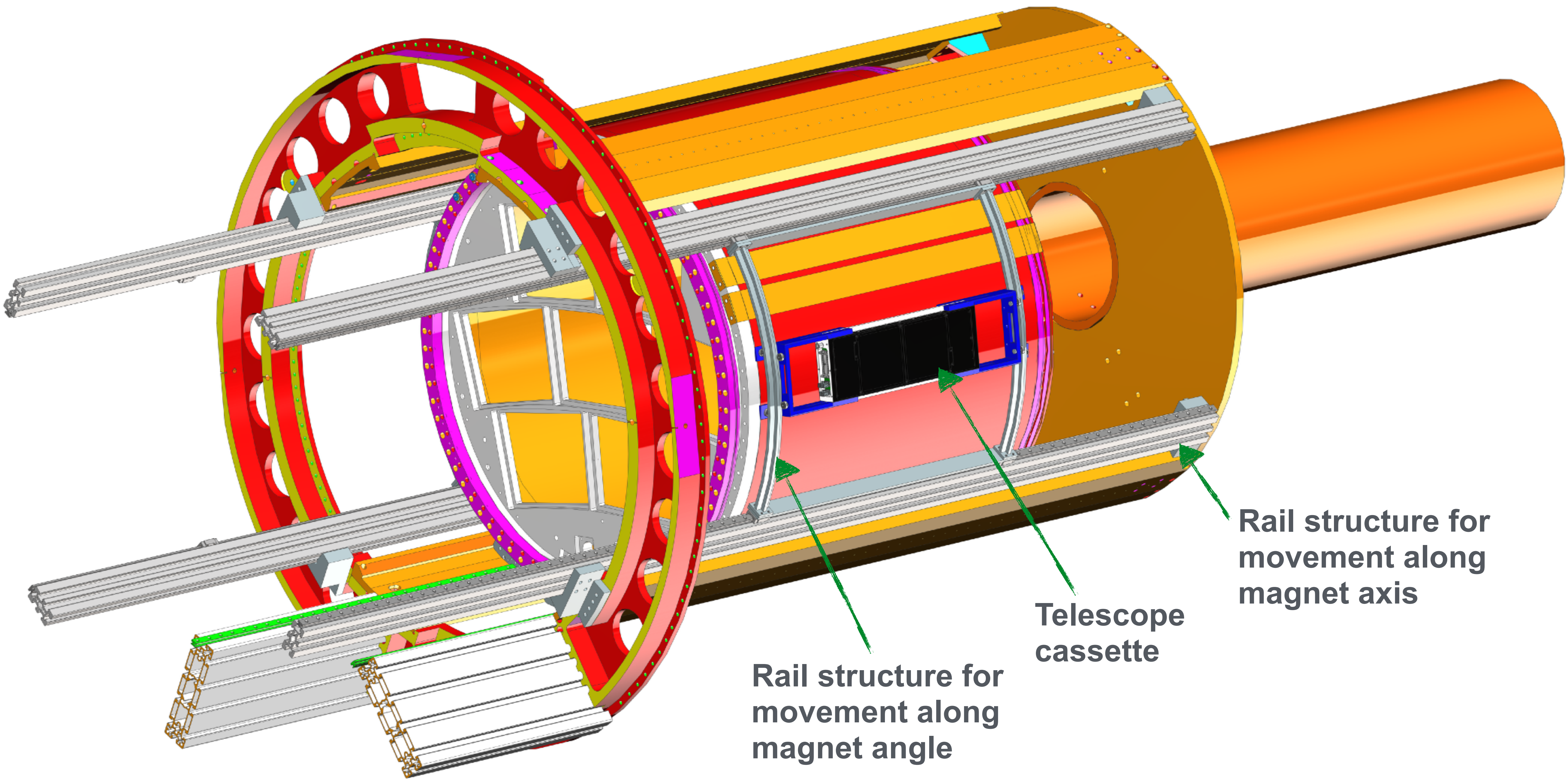
- Base on the central AIDA2020 common DAQ (EUDAQ2), with
- Many modules customized, incl. the RunControl GUI;
- KPiX readout data stored **at the same time** (=> capable for validation)
  - from EUDAQ side: in both formats, KPiX and EUDAQ;
  - from KPiX DAQ side.
- Succeeded in validating EUDAQ output data from lab tests!



The sensor cassette



Magnet telescope structure



Final active area is 10x20 cm^2

Conclusion and Outlook

- Construction of a large area strip telescope is ongoing;
- Multiple tests with KPiX and readout DAQ have been completed;
- Delivery of <Mechanical structure for installation> and <Electronics> expected middle of 02/2018;

Full assembly of the first sensor expected this week

- Being integrated into the EUDAQ framework to provide basic data taking and analysis when using the telescope.
- Thanks to the cooperation with SLAC the project profits from the expertise and manpower of both DESY and SLAC.
- Fruitful cooperation with Bristol and the AIDA2020 WP5 for the synchronization of the new system with DUT and Accelerators.

AIDA2020 deliverable due is 04/2018

the project is currently well on track to fulfill this goal

D15.3 Environmental slow control system

Brief Opening

- Being **Motivated…**
  - many complex system tests at DESY-II require logging environmental parameters of both detectors and experimental area;
- **Aiming** at…
  - a central monitoring system maintained by DESY
  - to monitor:
    - Common TB parameter;
    - Area specific parameter;
    - User configurables.
- **Requiring** easy to maintain/integrate…
  - Data outstream easy to integrate to user data;
    - short learning period
    - integrated to common DAQ: i.e. EUDAQ2
  - Flexible to integrate user customizing slow control system;
  - Mobility and stability mechanically

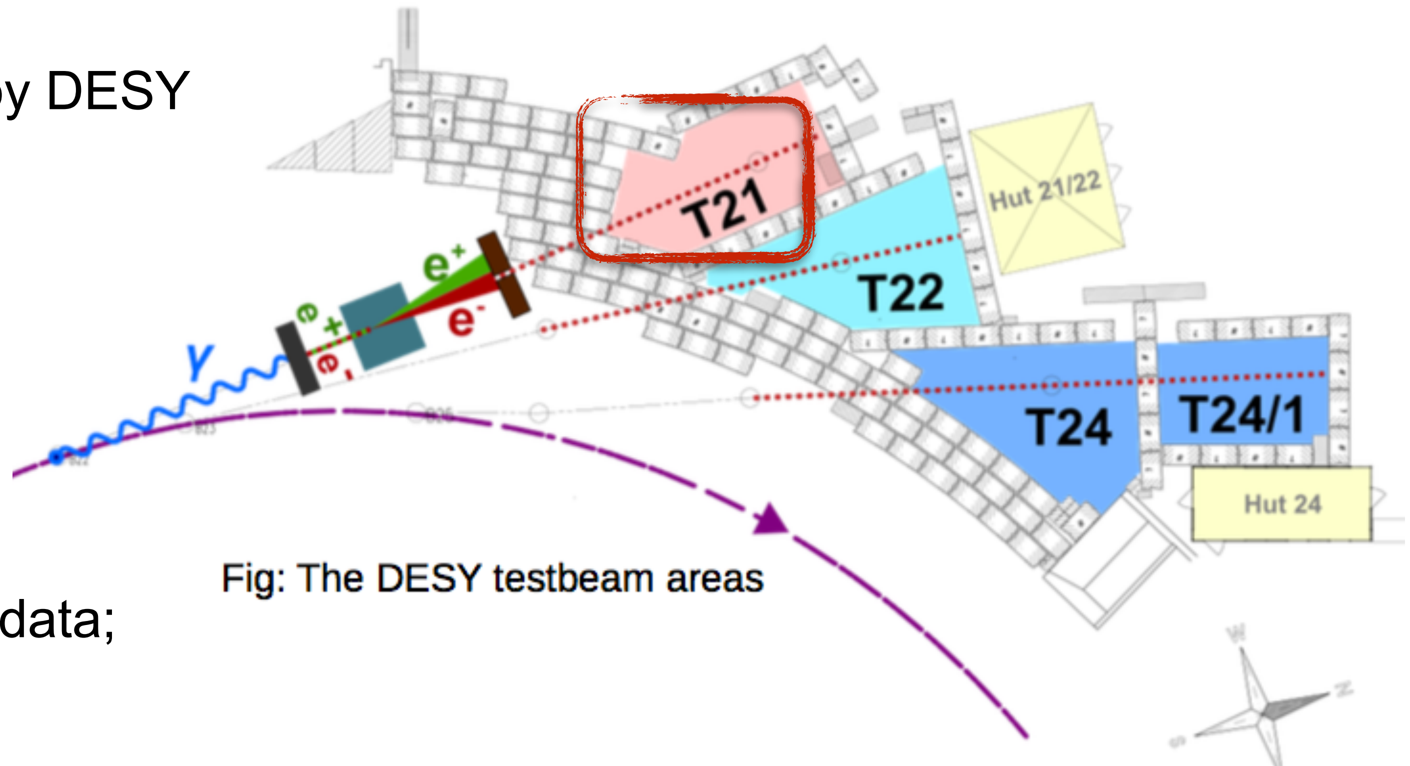


Fig: The DESY testbeam areas

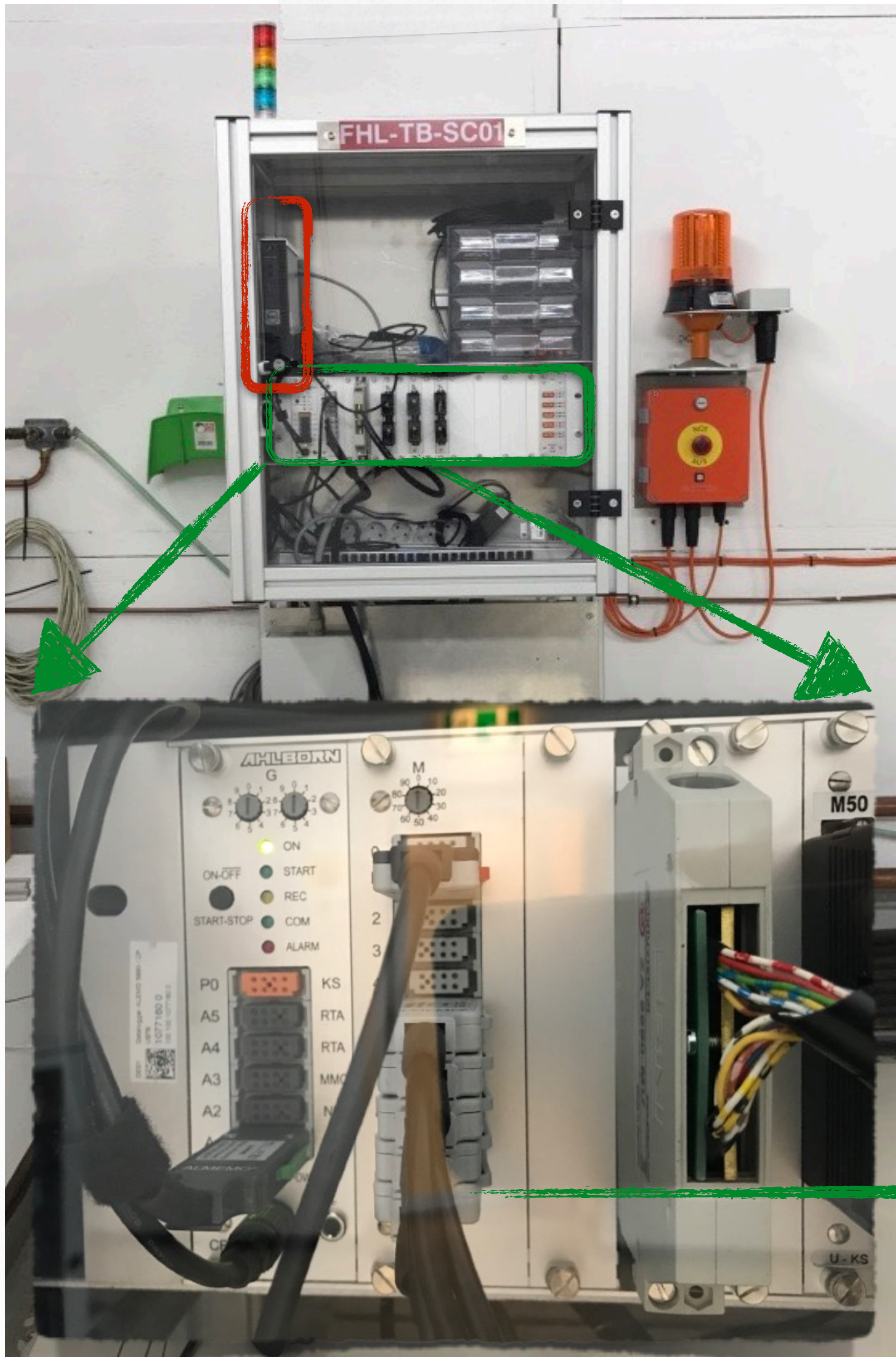
Introduction

* 1st rack installed in DESY-II beam area 21

Current Status Report

- Hardware **assembled** in October 2016
- Software **succeeded in lab** at DESY end of July 2017
- **1st test beam** commissioning in August 2017: **succeeded**;
- Project **delivered** with further development ongoing;
- Documentation done, manual in updating;
- **1st user** case from 11/2017 to 01/2017 with an internship student (Lars Fischer): **successfully** proccessed.

Hardware: mobility, stability, easy to maintain…

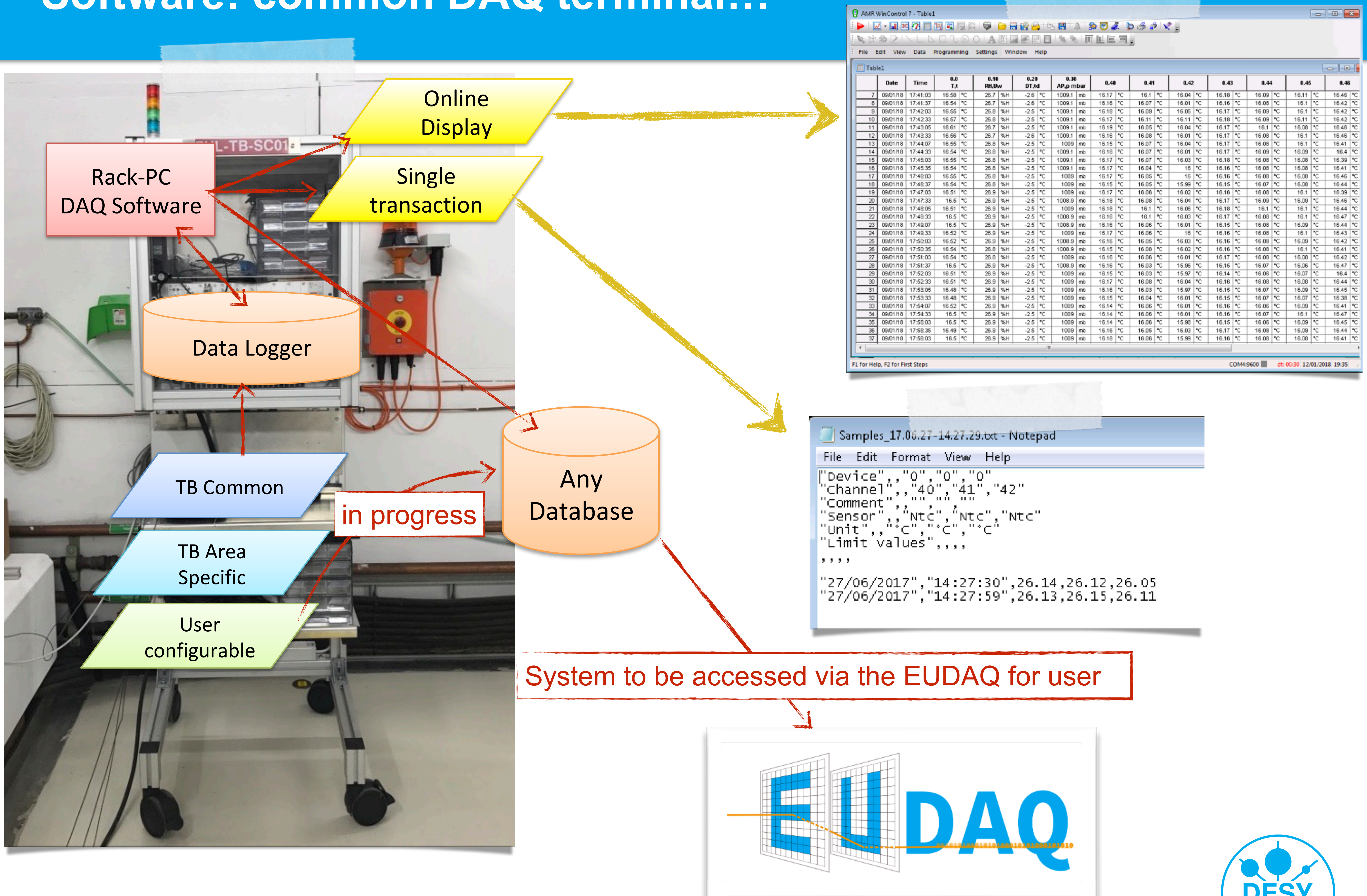


Hardware

- A rack-based SC system built up as shown
  - Four wheels w/ brakes;
  - Fixed data logger able to connect to variable sensors;
  - A rack-PC to collect/distribute data;
  - MySQL database w/ ODBC connections;
  - EUDAQ2 module provided w/ eudaq raw data production prepared.

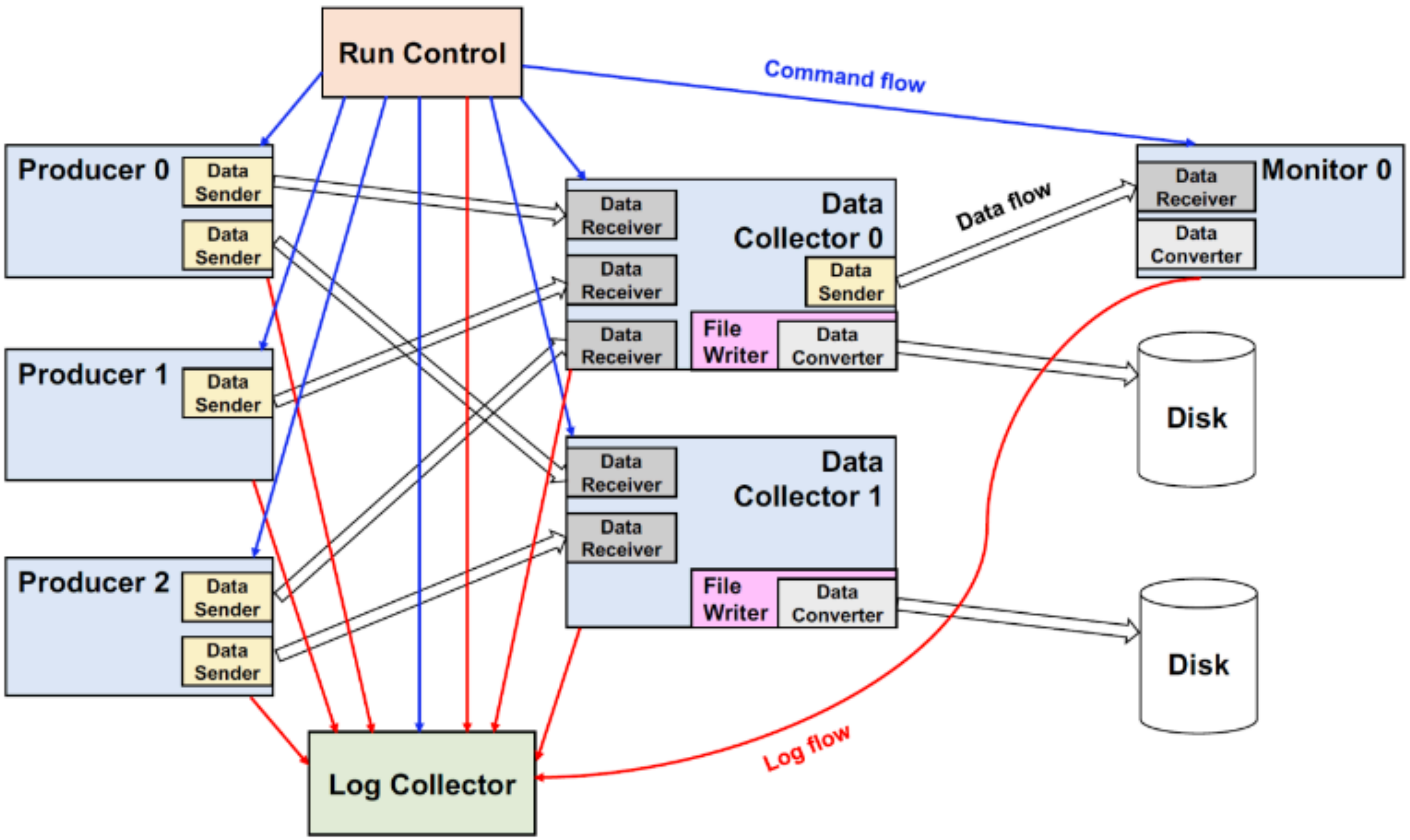
* Currently 10 NTC and 1 DIGI connceted (temperature, humidity, dew-point and pressure)

Software: common DAQ terminal…



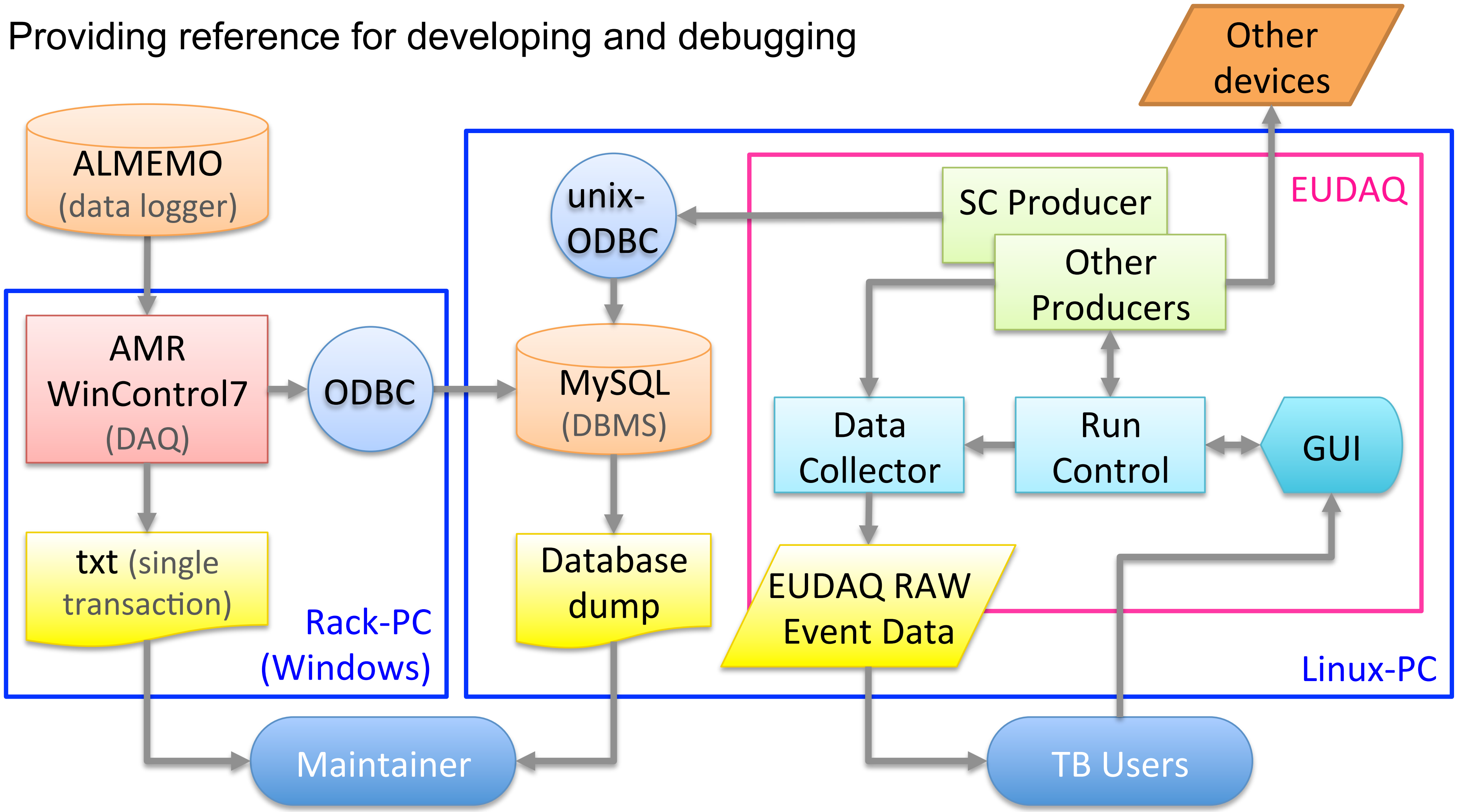
A glimpse at EUDAQ2

- Eudaq2 now provides nice scheme for derivatives development
- With the sync keeping easily
- For our use, we modify the following modules:
  - Run control and it's GUI
  - Producer
  - DataCollector
  - Eudaq std evt/clip evt converter
  - EuCliConverter/ Reader

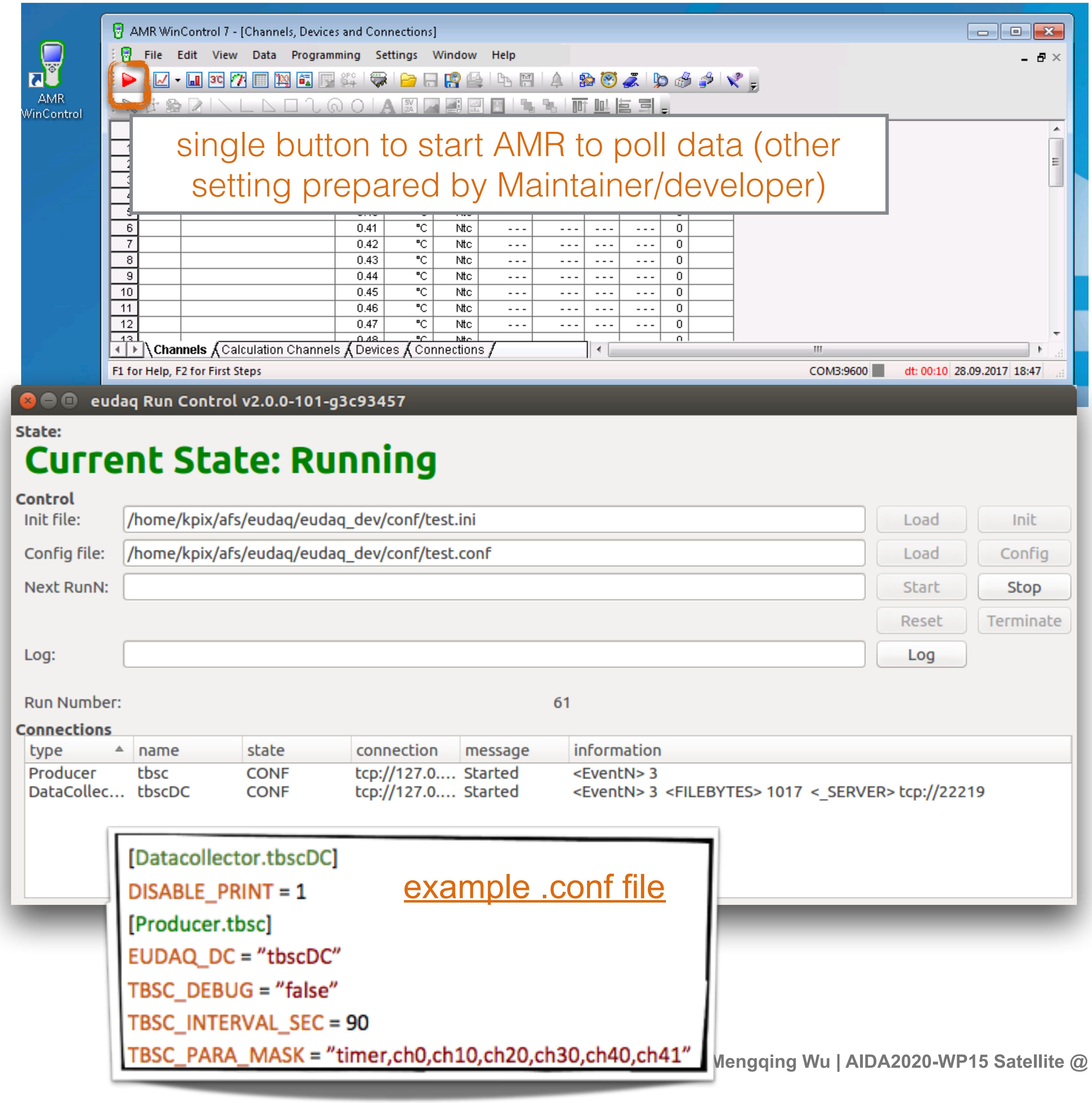


A bite for developer

- A correspondent DAQ software AMR from Alhborn
- Able to export data every 90 seconds (adjustable) to any database
  - MySQL is chosen here
- For each data-taking from AMR, it can do online monitoring and save data in a single transaction
  - Providing reference for developing and debugging



A bit for User cases



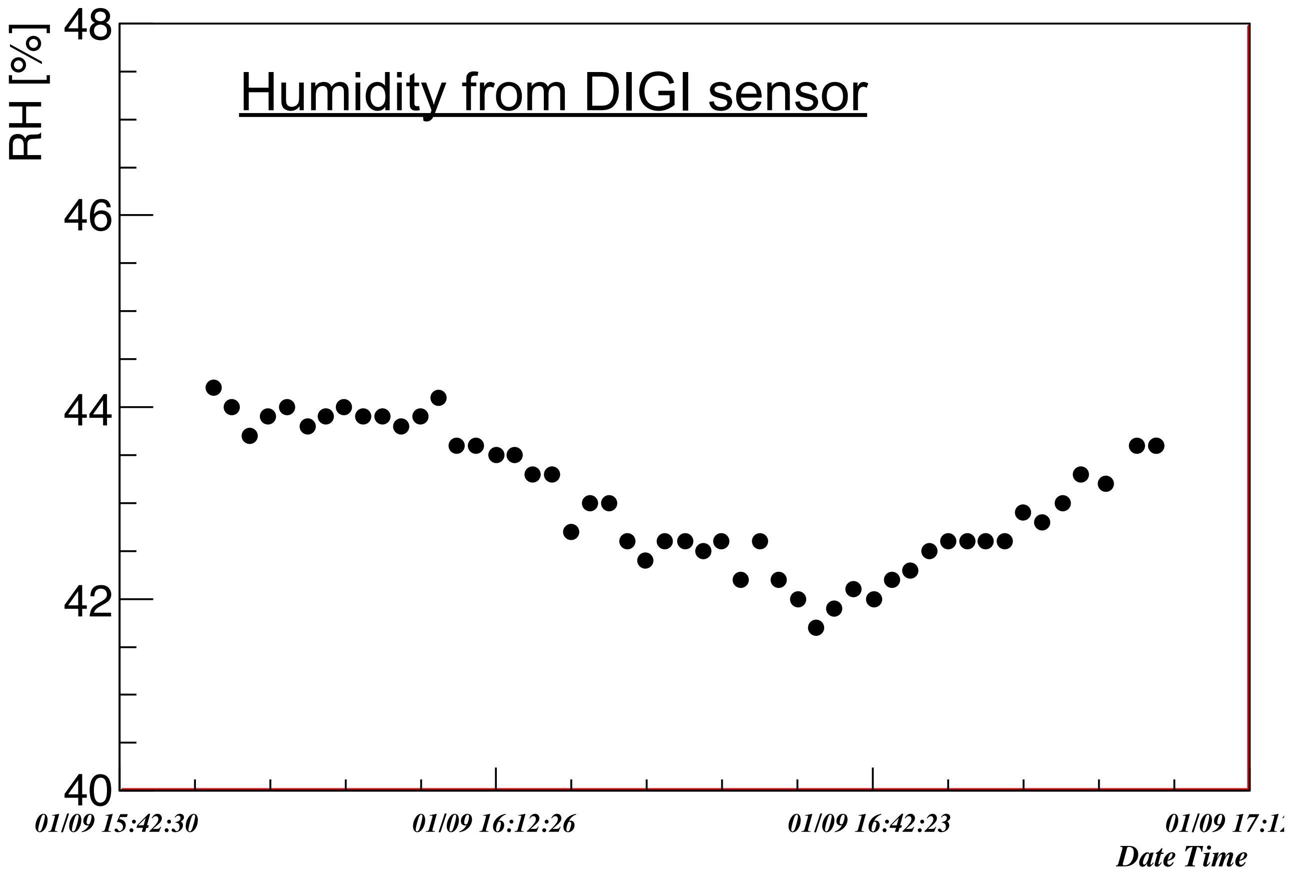
- MySQL database is currently built up on the same PC as Eudaq2
  - Ideally if data increasing rapidly, can be moved to a centralized PC
  - Able to dump an xml file for cross-check
- Eudaq2 module in Github (link)
  - **Producer/DataCollector** provided
  - **DataConverter** provided
  - Misc.: example ini/conf files, SQL file to setup an example MySQL DB, and other mini tools provided
  - Able to produce/sync to user data stream in the std **EUDAQ raw** format.

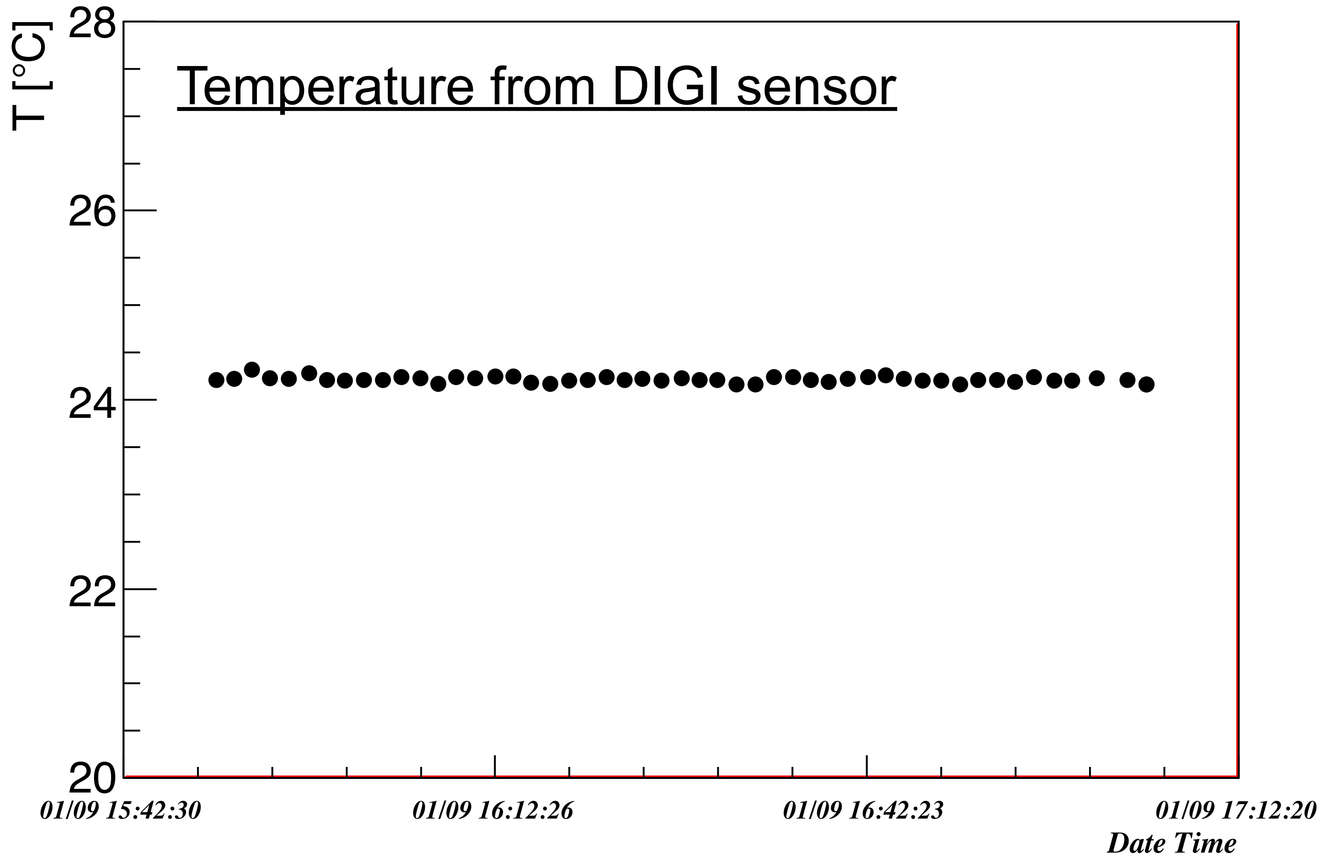
1st test beam commissioning: system validated

Example:

- Data collected at DESY TB Area 21 on 01/09/2017 from 16:50 to 18:05:
- cross checked with MySQL database dumped csv file;
- perfect agreed as expected,

Date Time	T	RH
01/09/17 16:49	24.21	44.2
01/09/17 16:51	24.22	44
01/09/17 16:52	24.32	43.7
01/09/17 16:54	24.23	43.9
01/09/17 16:55	24.22	44
01/09/17 16:57	24.28	43.8

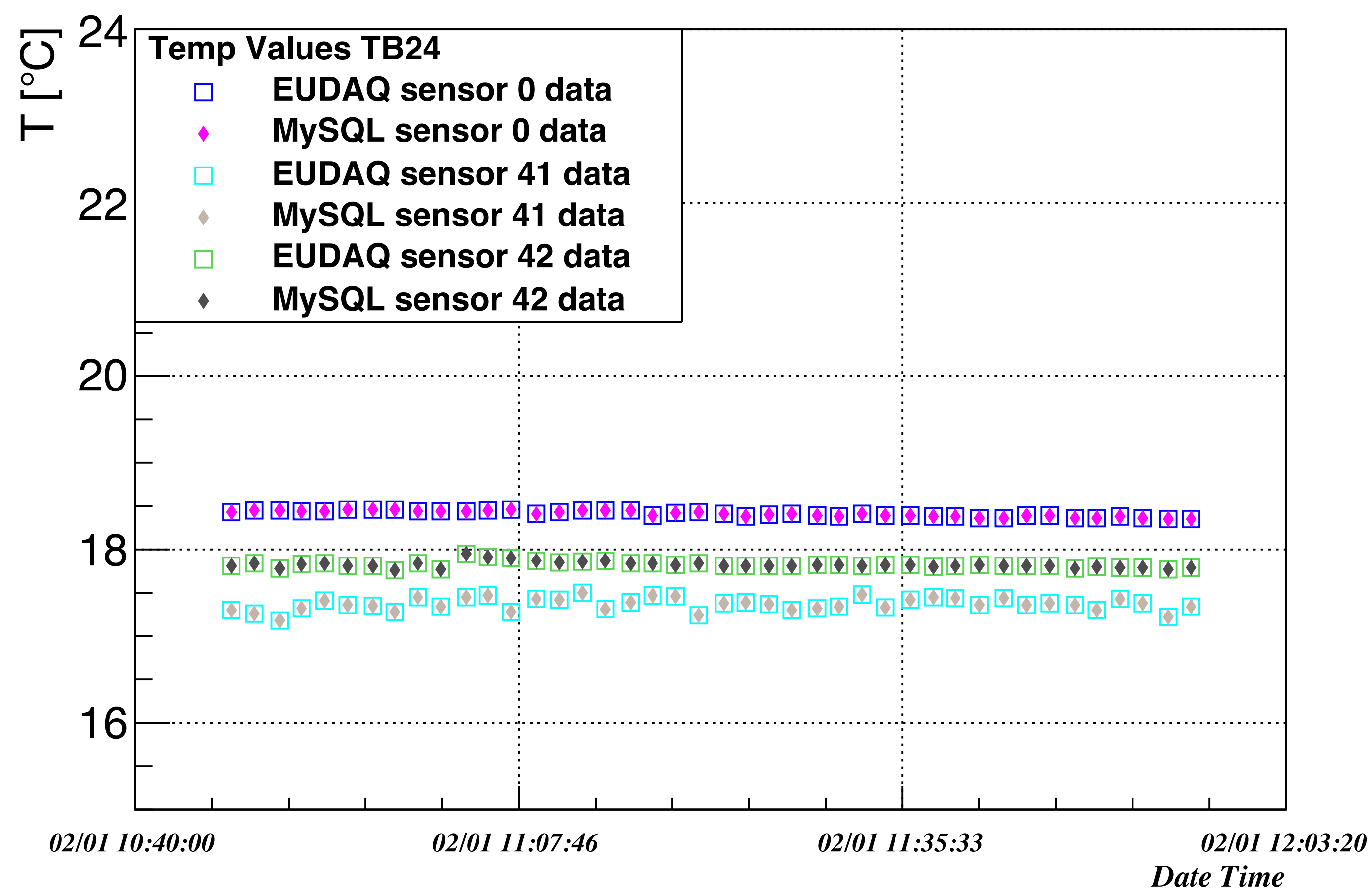




1st user commissioning

Testing a **second rack** in DESY-II **beam area 24**:

- Data collected on 02/01/2018 from 10:40 to 12:00;
- Cross checked with MySQL database dumped csv file;
- Perfect **agreed** as **expected**;
- Able to conduct cross-rack comparison with EUDAQ2.
- Installation and data taking by intern student:
  - proof for short learning period;
  - 1st user experience helped to update the system.



Environmental slow control system at DESY-II testbeam

Closing

- System ready w/ first test beam commisionning succeed
- manual is on updating see http://cds.cern.ch/record/2284369.
- project delivered on 27/10/2017;
- 1st user experience from one intern student Lars Fischer:
  - sucessfully install a second rack;
  - manage to take data and validate system.
- **More users** are **welcomed**!

Outlook

- Possible futher development/update under discussion
  - possible to use **DQM4HEP** as the **online monitor** module for the system;
  - possible to **integrate user's** customized **slow control** system, benefiting from the SQL module used in this system.

谢谢观赏！

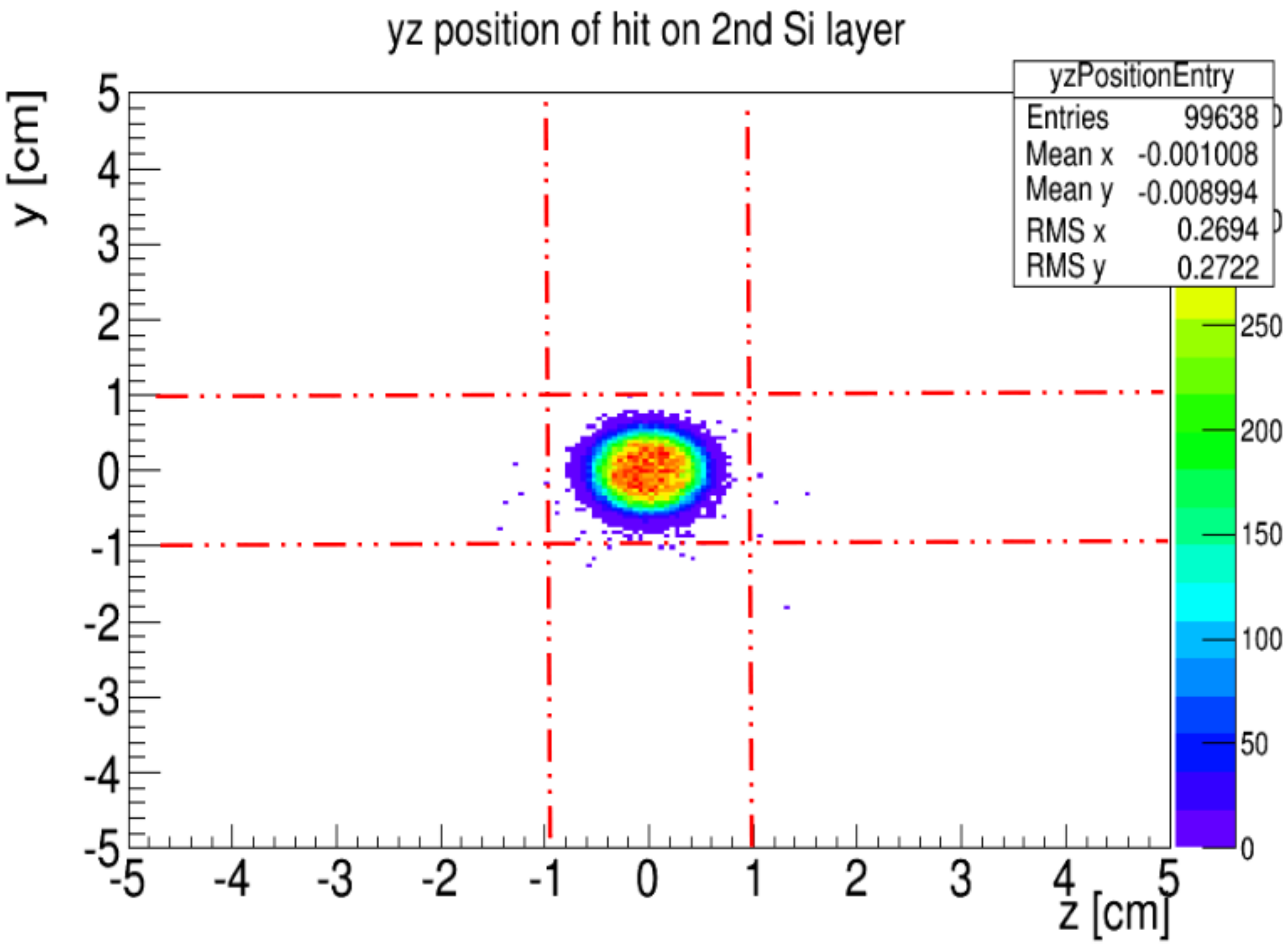
Many thanks for your attention!

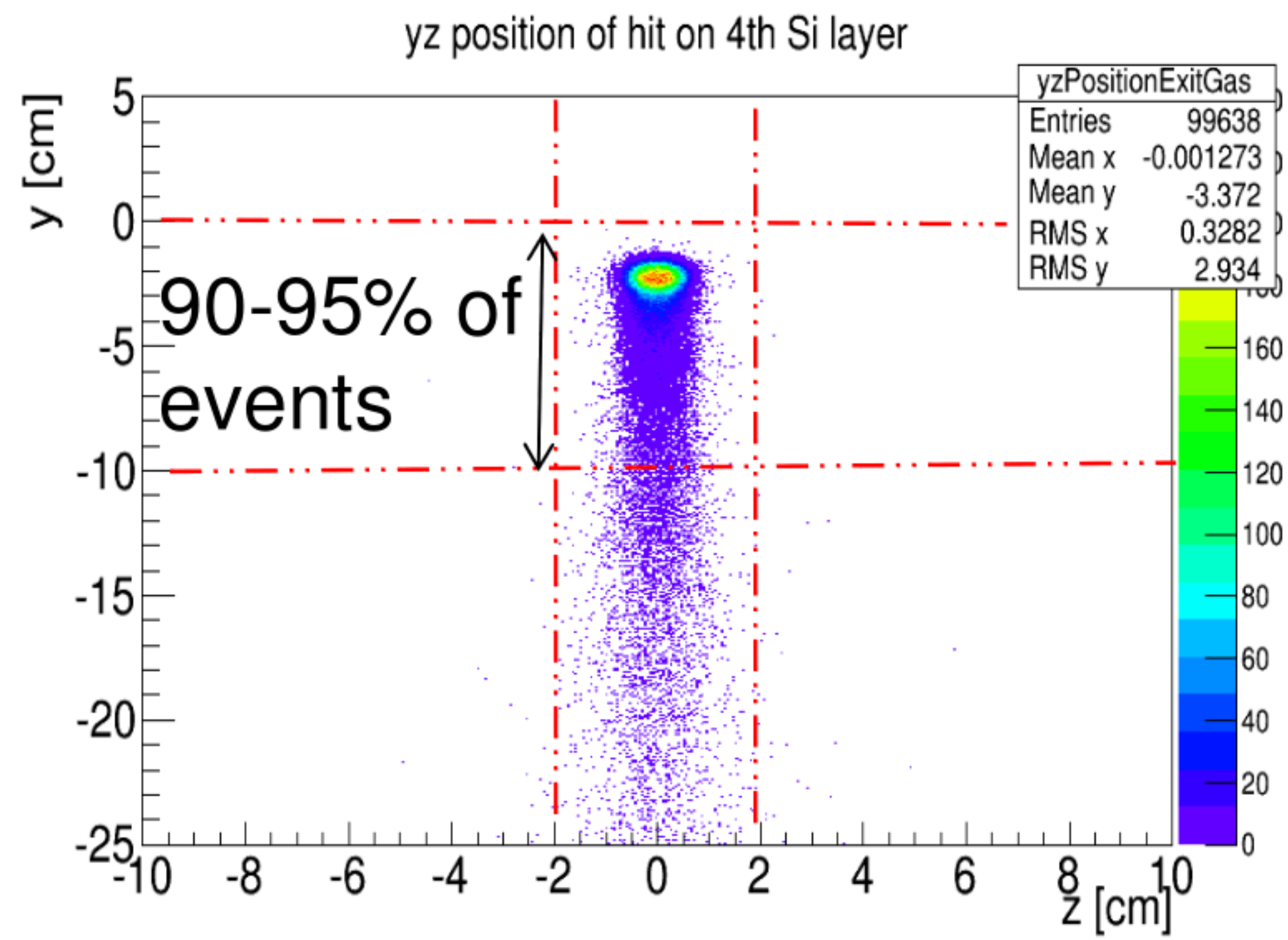
Danke schön!

Merci beaucoup!

Everyone needs back up :)

Demand for Coverage Area

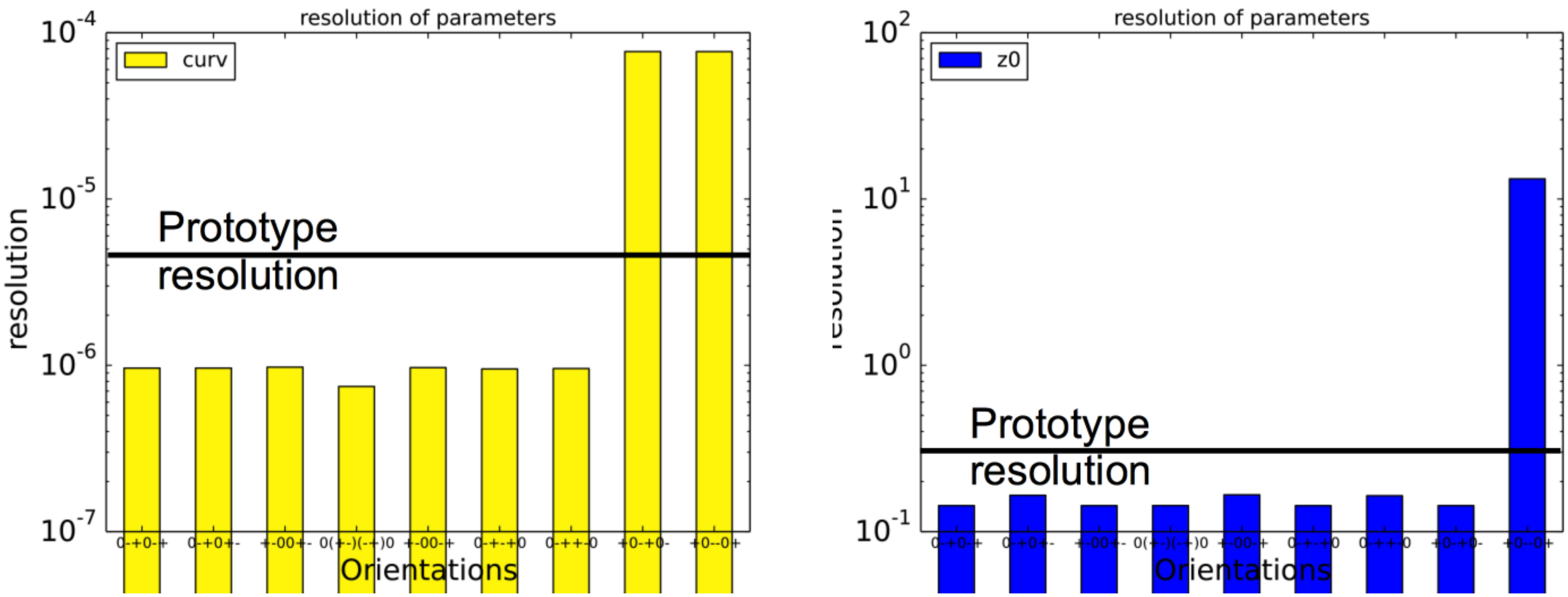




- For lower energy beams, the hit distribution on the back sensors is more spread and shifted to lower y values
- Larger coverage area is beneficial (e.g. less moving and alignment of the system)

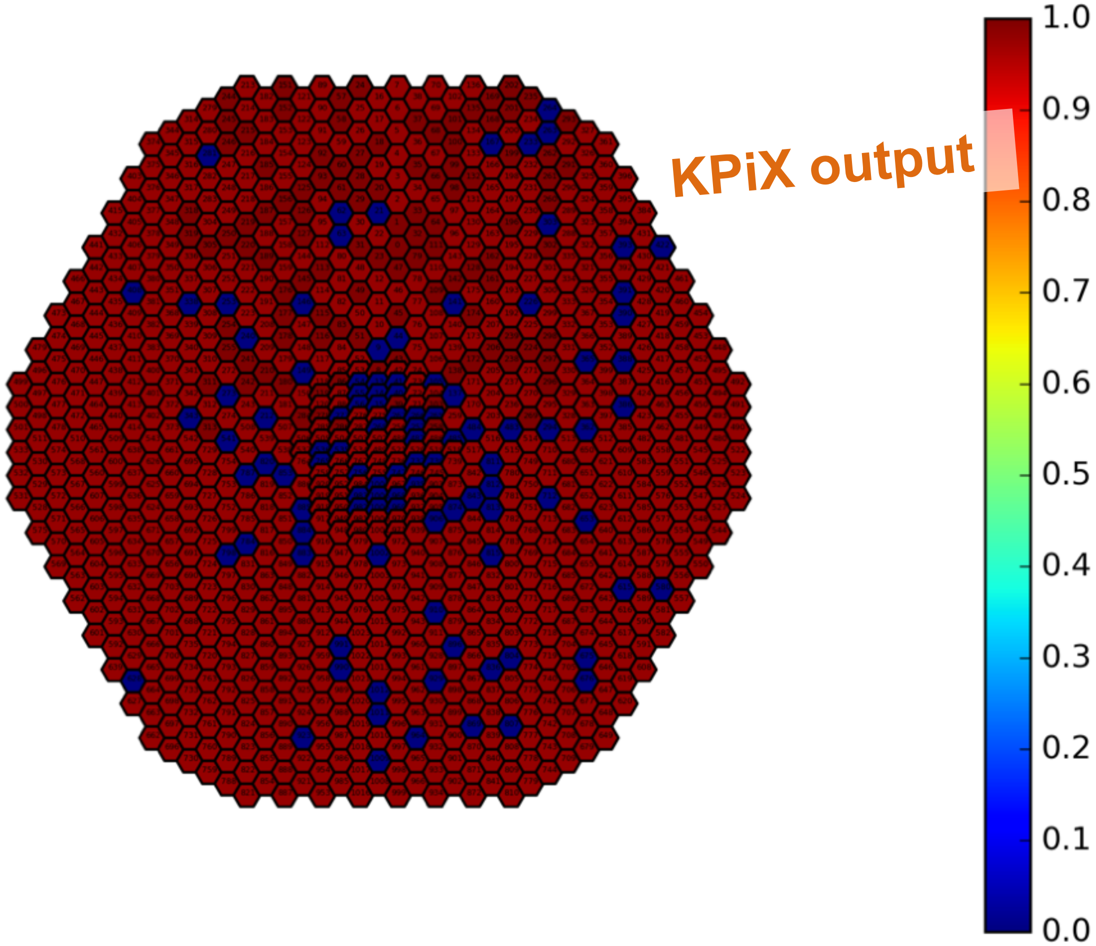
Study on Sensor Orientation

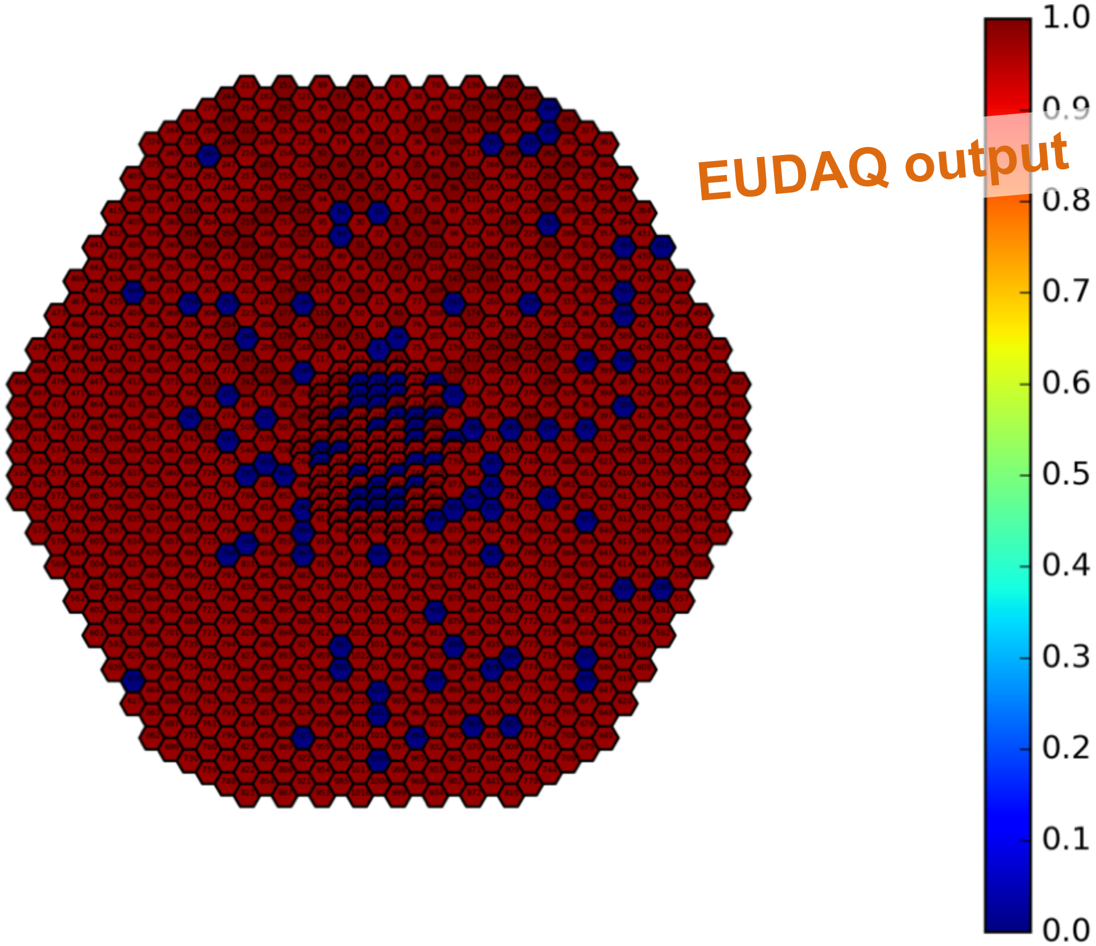
- Analytical calculations using GeneralBrokenLines (GBL) by Claus Kleinwort with a 25 µm pitch strip sensor;
- Depending on the orientations, correlations between planes severely limit the resolution;
- The right orientation means the Telescope can easily achieve the curvature resolution needed for the LP TPC.



Software status update: lab test succeeded

- Same analysis and event mapping code
- Exact same results from EUDAQ to KPiX for same data-taking





* **event mapping on the ECal sensor for KPiX tests at DESY**
* **same sensor, same bucket**