To implement Lycoris for TPC distortion measurements

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DESY

LCTPC Topical Analysis Meeting
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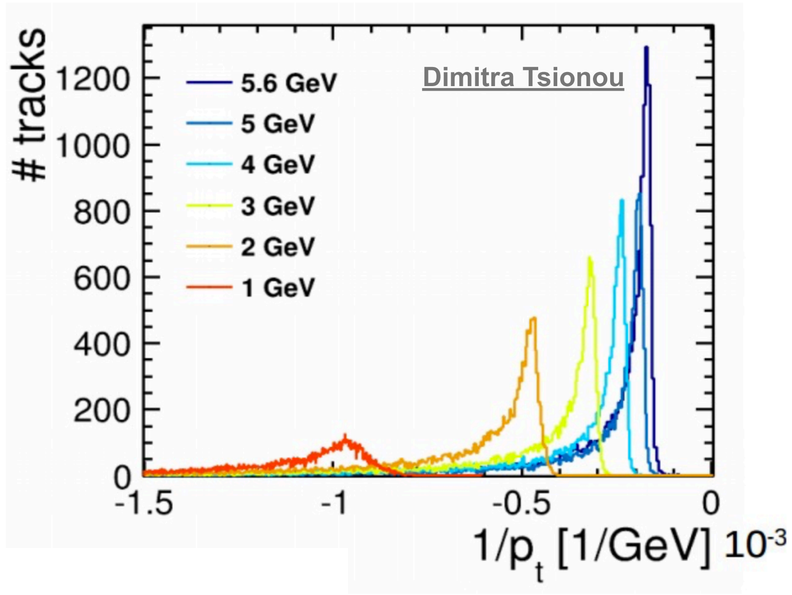
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

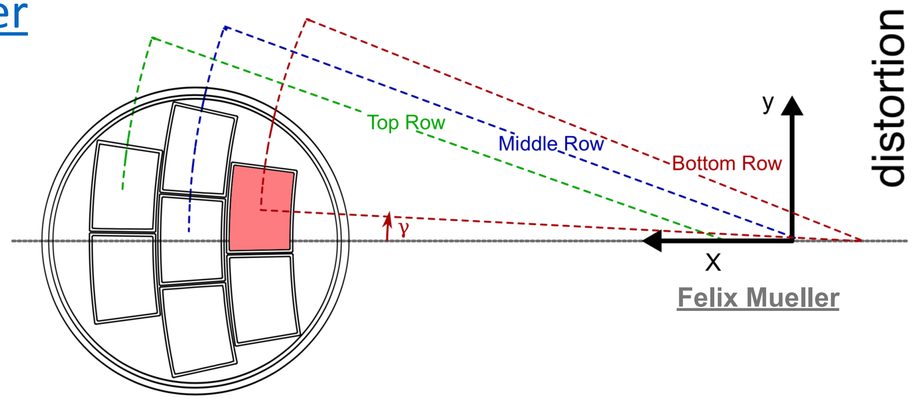
TPC Distortion

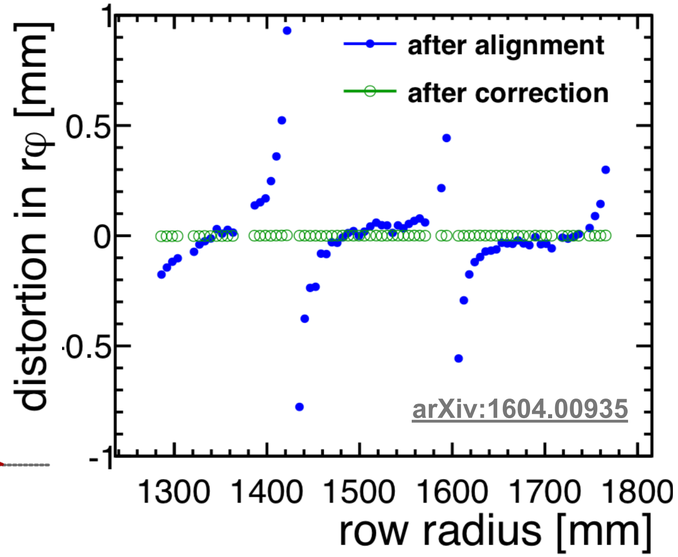
In need of a reference tracker

- A broad energy spectra due to the energy loss in the magnet
  - to determine the momentum resolution
  - —> a **reference momentum measurement** is **in favor**;
- Distortions caused by non-perfect electric fields in particular close to boundaries between modules
  - displaced hits —> impact on momentum measurements
  - —> a **reference position measurement** is **in favor**.



==> Guide us to an external silicon tracker



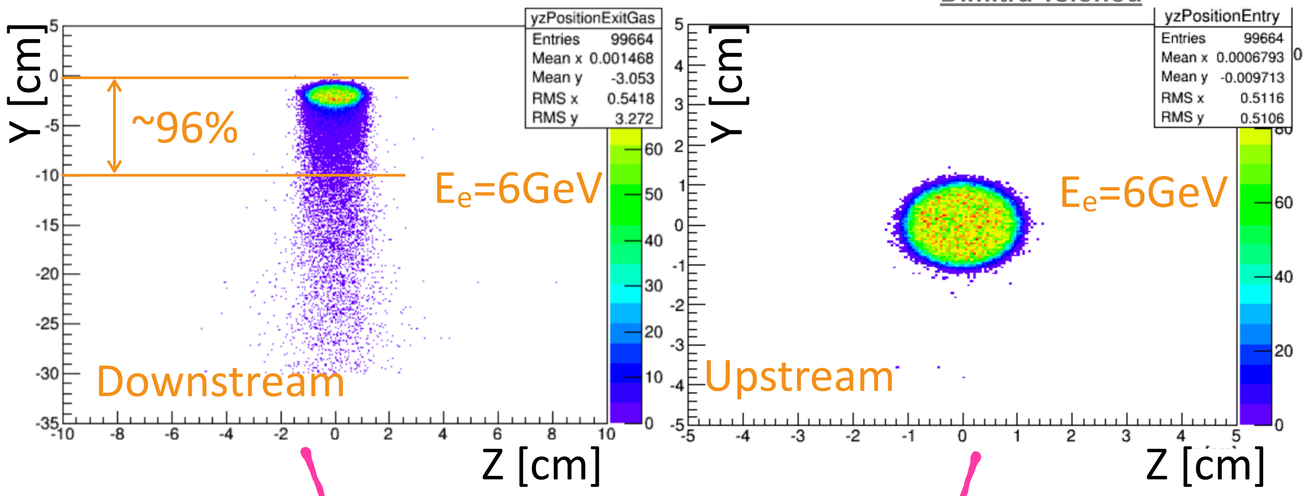


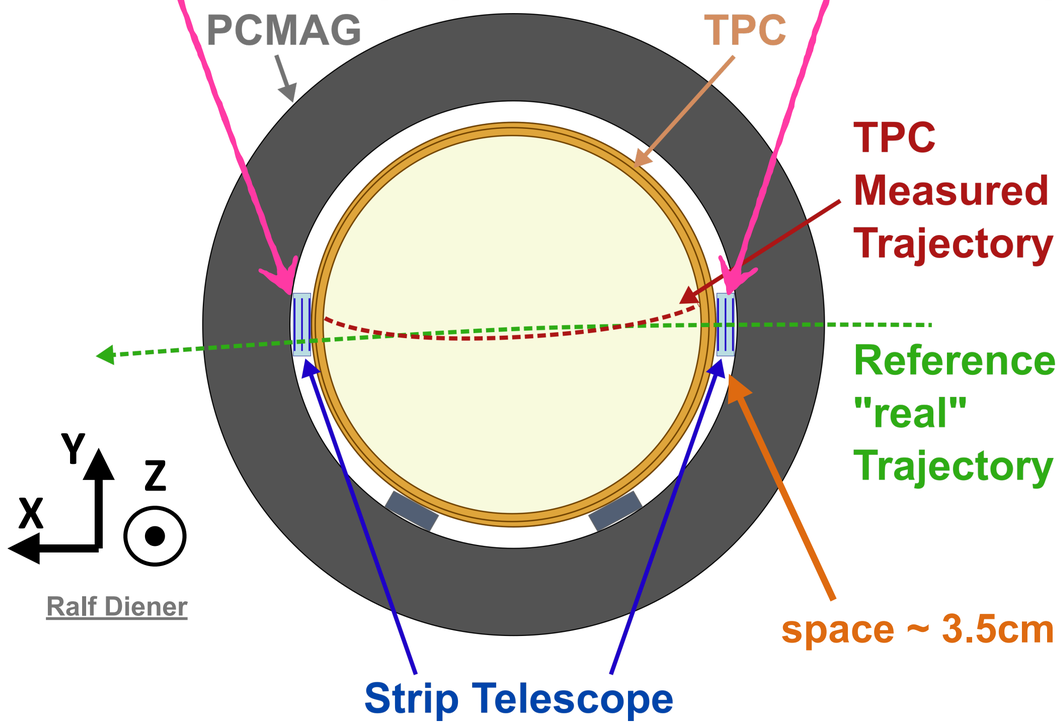
Lycoris in PCMAG with a LP-TPC

Funded by AIDA2020, in collaboration w/ SLAC

- A new large area strip telescope (LYCORIS) in DESY beam area 24/1:
  - **Status:** R&D currently;
- Design comparible for LP-TPC
  - Suitable for a large prototype TPC in PCMAG;
  - Strip Silicon with pitch of 25 µm
    == ~7 µm spatial resultion;
  - Large active area (**10 x 10 cm²**)
    → **90 - 96%** particles (1 - 6 GeV);

Dimitra Tsionou



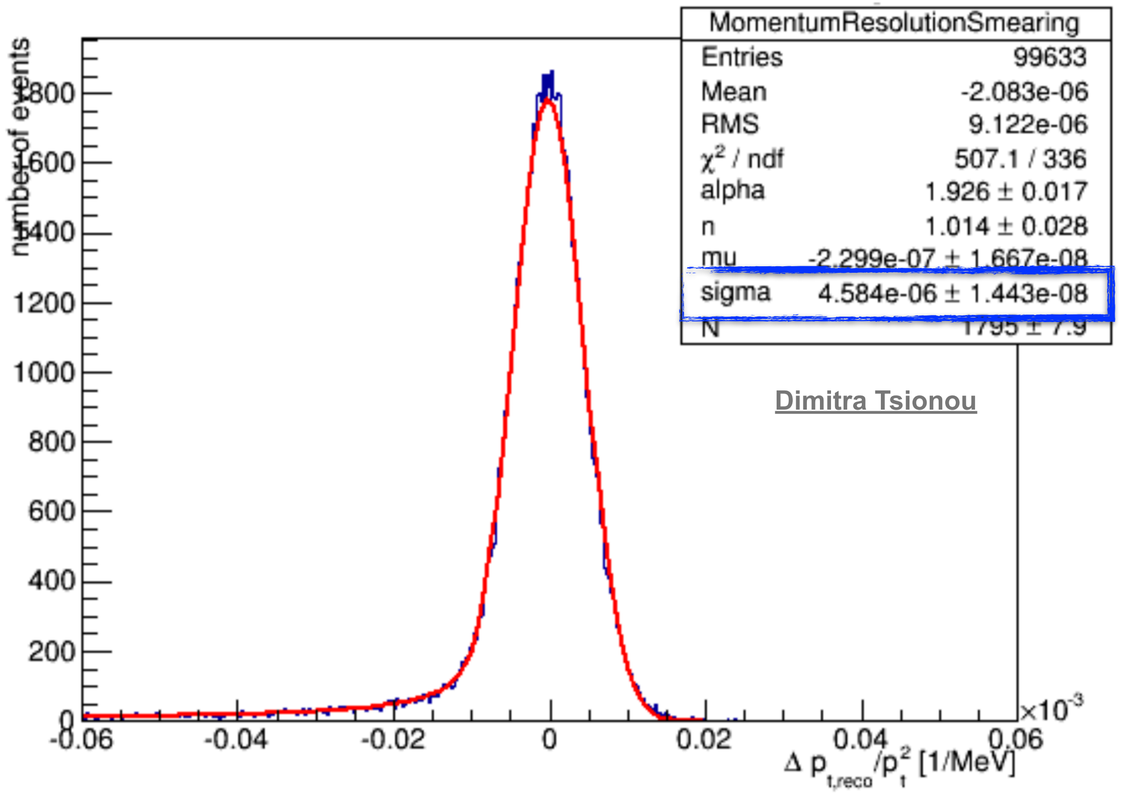


Ralf Diener

Determine LP-TPC momentum resolution

Preliminary simulation study based on a 4-layer setup

- Simulated TPC momentum resolution
  - ~4.584 x 10^{-6} [1/MeV]
- To achieve a better resolution as a reference, and limited by space (<3.5 cm) to fit LP-TPC in PCMAG,
  —> Lycoris needs:
  - spatial resolution > **10 µm** along **bending direction Y**;
  - Resolution along field direction Z less important:
    σ_Z > 1 mm

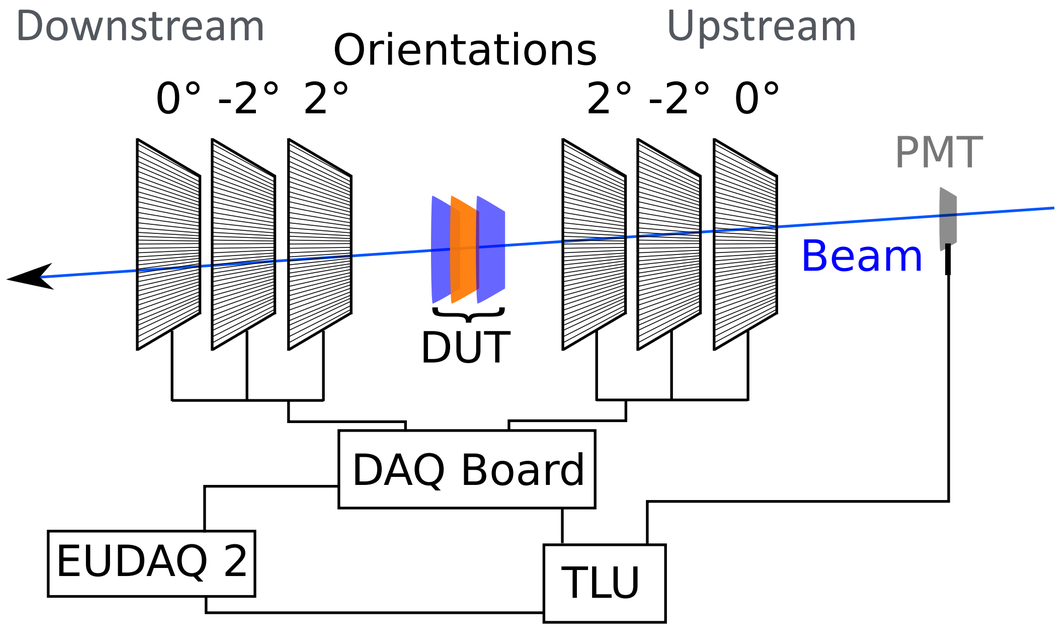


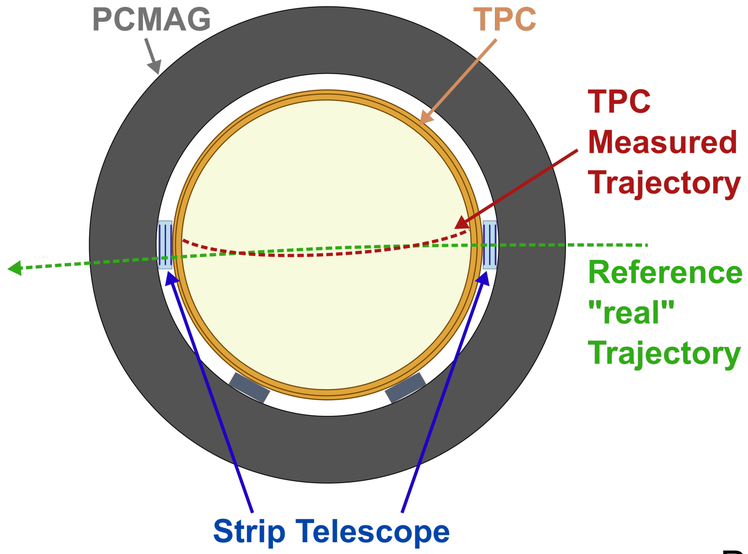
		Distance between inner and outer Si layer			
		4 cm	3 cm	2 cm	1 cm
Sensor spatial resolution	2.5 μm	2.85	2.90	3.00	3.68
	5 μm	3.05	3.21	3.63	5.52
	7.5 μm	3.37	3.65	4.43	7.92
	10 μm	3.68	4.16	5.33	9.90
	15 μm	4.49	5.36	7.53	14.3

Discussion

Measure TPC distortion with the Lycoris

- Lycoris, Software working status:
  - Reconstruction with Alignment software under development;
  - TBD: how to work with data from TPC
- TPC distortion measurements:
  - Simulation study?
  - method?





Material based-on

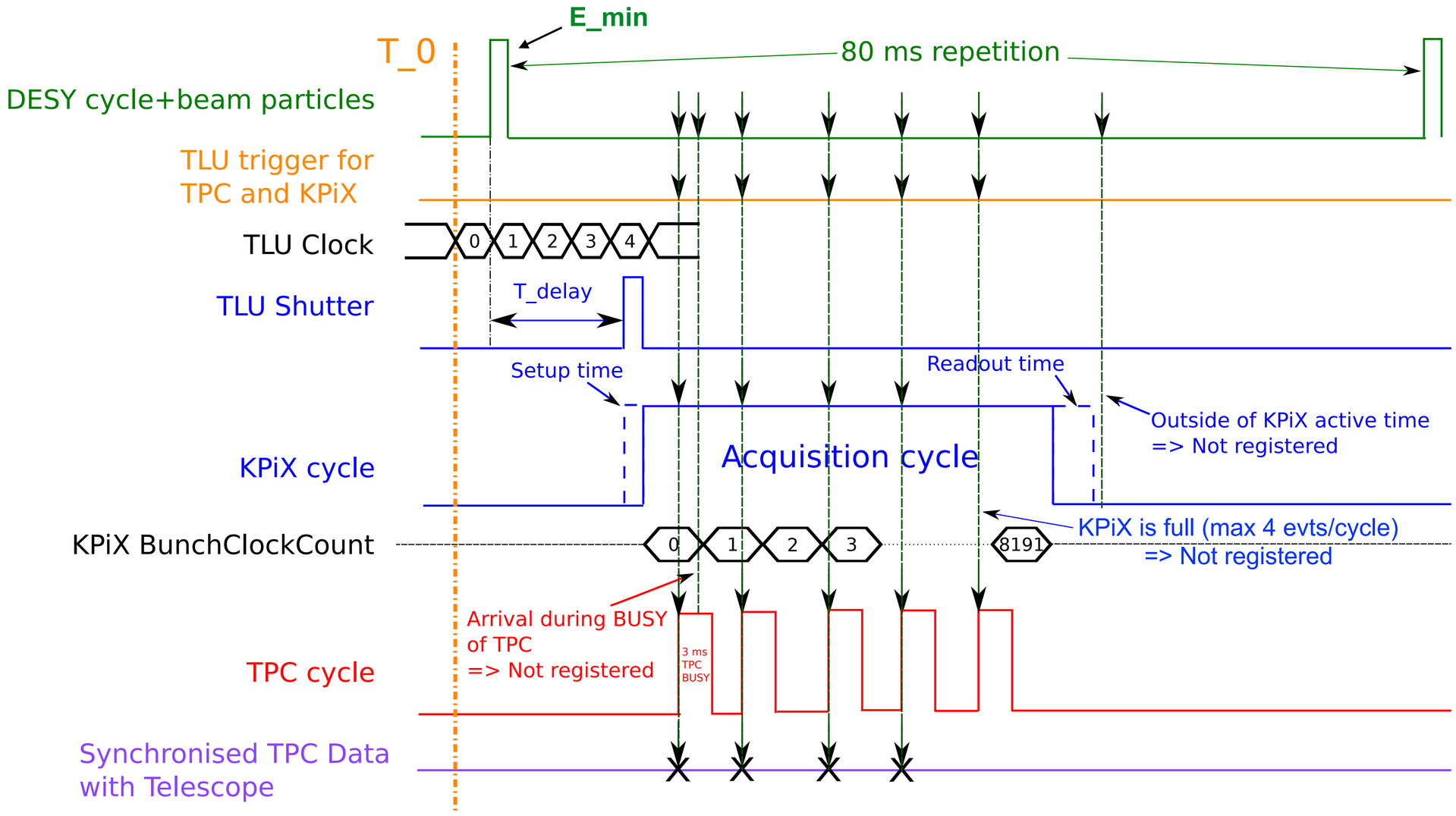
- Felix Mueller: thesis — doi:10.3204/PUBDB-2016-02659
- Dimitra Tsionou : internal note "*Simulation Studies for a Silicon telescope in Test Beam area T24/1 accompanying the LCTPC prototype*"

Thank you for your attention!

Back-ups

Synchronization: with Beam and/or TPC

via a new AIDA2020 TLU

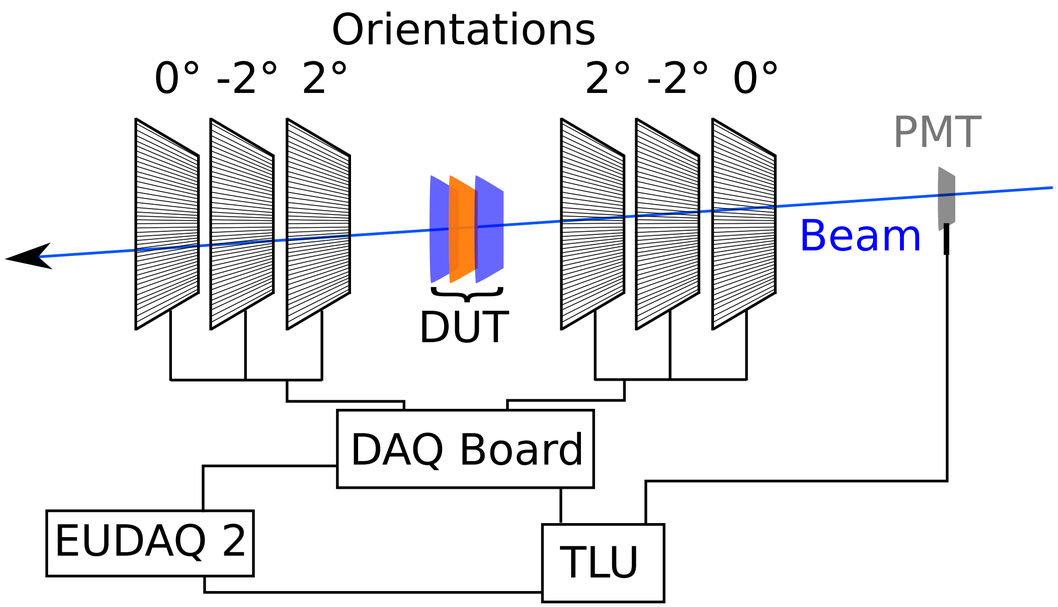


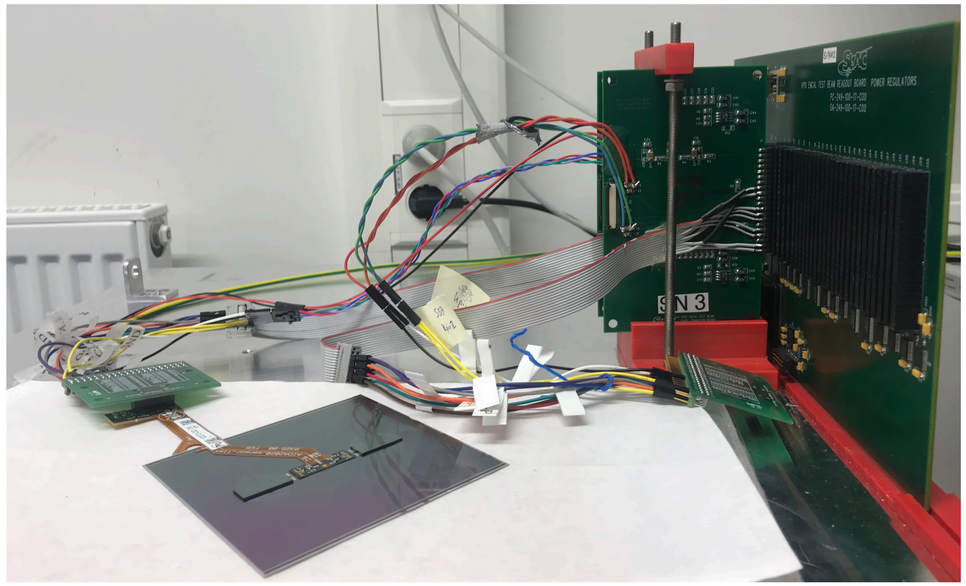
- **KPiX** sync to **DESY** via a shutter signal generated by **TLU** to start the KPiX acq. cycle:
  Status: **tested/validated** by feeding a manipulated shutter signal to KPiX.
- **KPiX** synced to **TLU** via a common TLU clock:
  Status: to test, new TLU exp. mid-June.
- **TPC** synced to TLU by counting triggers, so sync **TPC** & **KPiX** by a common start **T_0**
  Status: to test, testbeam exp. this fall.

Data Acquisition Overview

External trigger mode, used for TPC use case

- KPiX runs in pulse cycles, max. 4 evts/channel/cycle;
- Run control by EUDAQ2, implemented via a DAQ board;
- Data Acquisition:
  - **In** each **cycle**, once a particle passing through:
    - PMT triggered —> TLU sent trigger to DAQ board
    - Trigger sent to all connected KPiX: ADC count on all activated channels recorded by KPiX;
  - **End** of a **cycle**:
    - digitize recorded KPiX data and send to DAQ board,
    - DAQ board pack & send to EUDAQ2 via optic fibre.



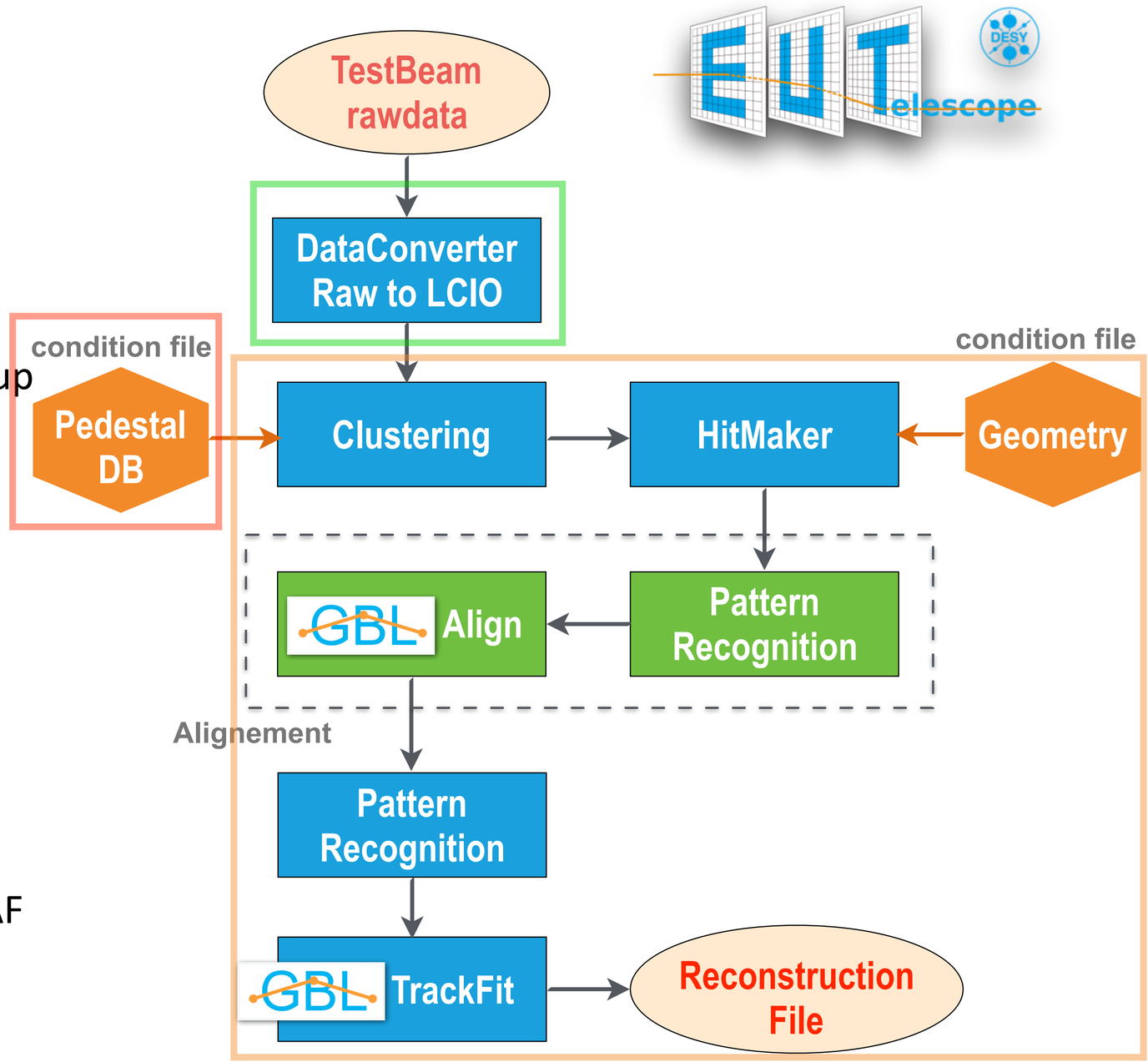


Data Analyzing: EuTelescope

one analysis software candidate

Current status

- no tracker data available to prepare code for the test beam campaign forseen this fall;
- need to prepare analysis code in parallel to catch up the scheduled delivery 01/2019;
- Flow chart based on EuTelescope of ATLAS ITk version
  - binary readout, no pedestal DB used;
  - only one strip layer as DUT w/ Mimosa;
  - Raw to LCIO converter: done in EUDAQ side;
  - Other modules: to be tuned;
  - 11/05/2018: successfully installed under ILC NAF condition (finally).

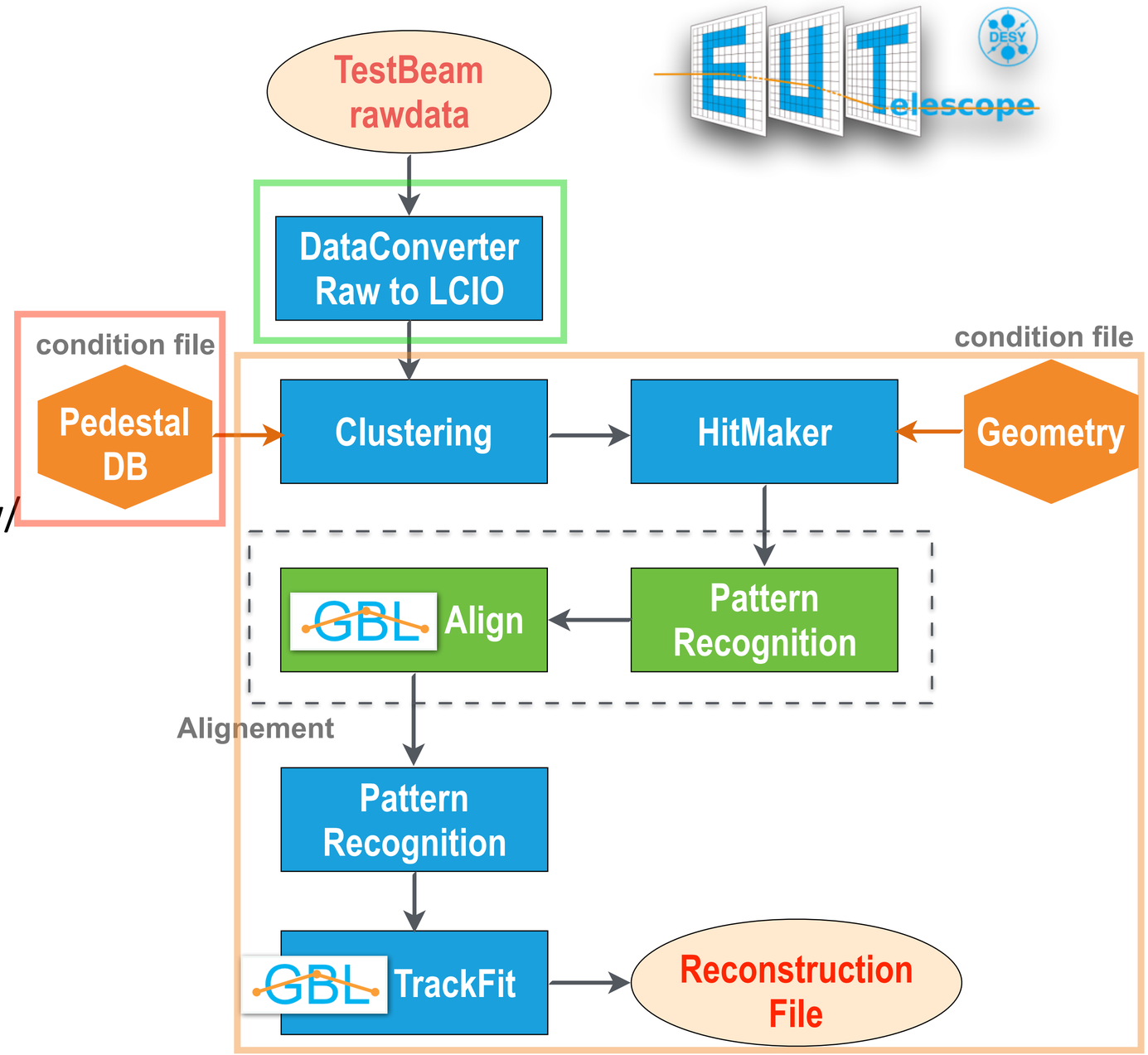


Data Analyzing: EuTelescope

one analysis software candidate

Strategy

- 1st step target: analyzing data w/ Mimosa.
- Todo list:
  - Try out with ATLAS data for ideas to tune data converter, as well as other modules;
  - pedestal DB: noise suppression development w/ ECal data.



Data Analyzing: EuTelescope

one analysis software candidate

A comprehensive set of MARLIN processors. Each reconstruction step has a steering file containing multiple processors

– **converter**(noisypixel): converter (determine noisy pixels/strips)

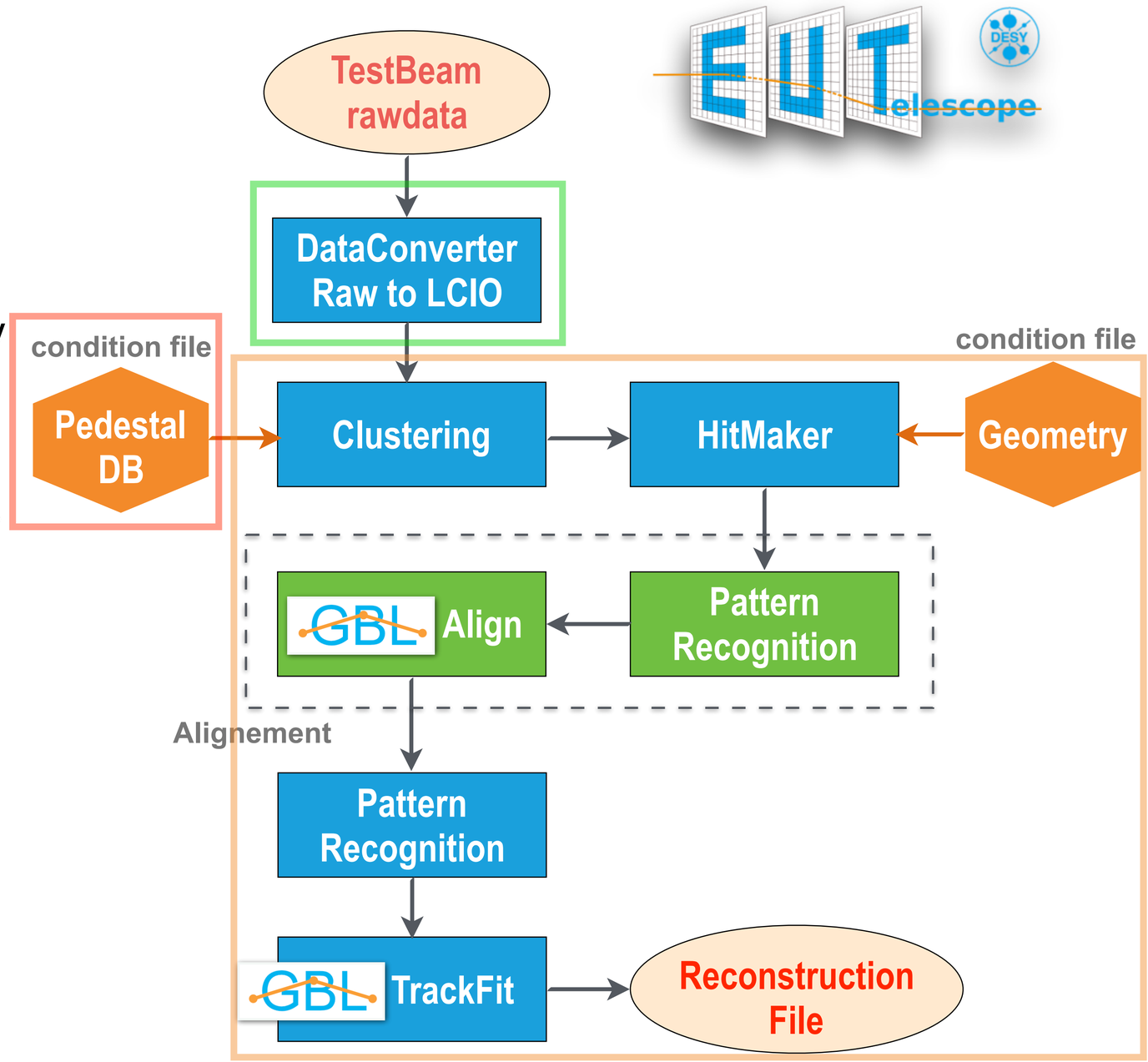
– **clustering**: retrieve the geometry of the sensor and give the coordinate of the strips/pixels center; group nearby strips/pixels together with noise pixel/ strips removed

– **hitmaker** : find the cluster center to give the hit position

– **patternRecognition** : attach hits from planes together to form a track

– **GBLAlign** : determination of transformation from global frame to each local plane frame

– **GBLTrackFit** : fit of the track using hits attached together from pattern recognition



Project Overview

Milestones to achieve before delivery

- Key target: convey a 1st user analysis —> testbeam w/ TPC forseen in fall 2018:
- Hardware to be ready:
  - **Mechanics** for final system: well track to be on time (see Uwe talk);
  - Make assembled Lycoris sensor **module** work (see talks from Uwe & Sebas);
  - **New DAQ board** exp. 18/06/2018: 1-2 weeks to SLAC to learn & test;
  - **New** AIDA2020 **TLU** exp. 06/2018: both hardware & software to test, and w/ new DAQ board;
- Software to be ready:
  - Lycoris module works w/ TLU + mimosa on simple e-lab tests: EUDAQ2 to be ready;
  - **Alignment**, **characterize module** w/ mimosa: beam time needed
    - event definition and EuTelescope to be ready.

in progress

TBD

TBD

TBD

TBD

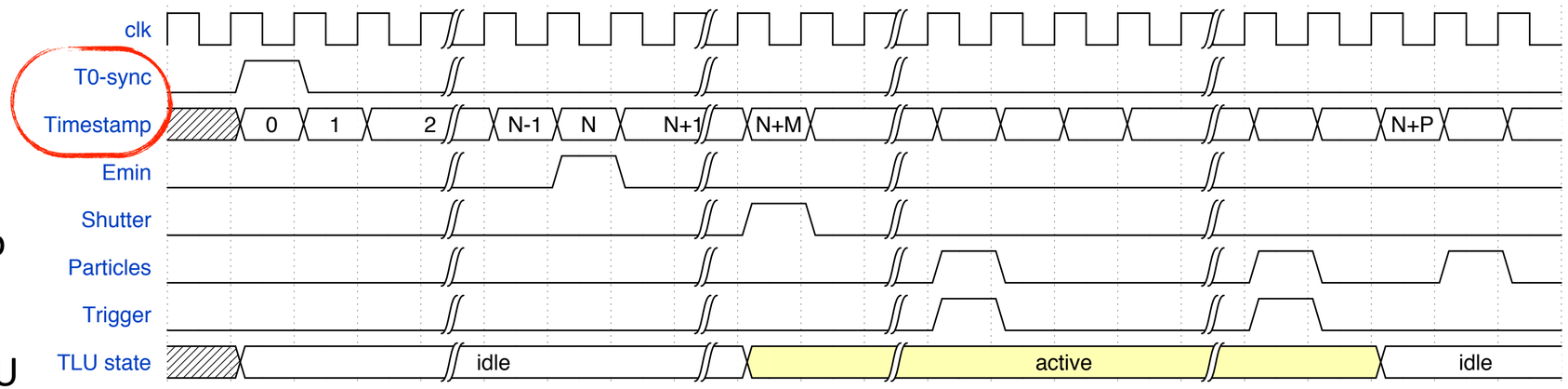
TLU integration: KPiX sync to DUTs

DUT syn to TLU

from David Cussans

In general, DUTs can be categorized:
<u>sync to TLU or not</u>

1. a DUT sync to the TLU:
   - The **TLU** common **global clock** to **sync** all devices;
   - Activation (shutter) issued by TLU
   - Busy signals (TLU state idle) to TLU: either global or local
     - <u>Global</u>: no trigger when any device is busy;
     - <u>Local</u>: trigger continuously issuing though some device busy



Shutter: activation signal
T0_sync: 1 per run, common start signal

TLU integration: KPiX sync to DUTs

DUT unsync to TLU

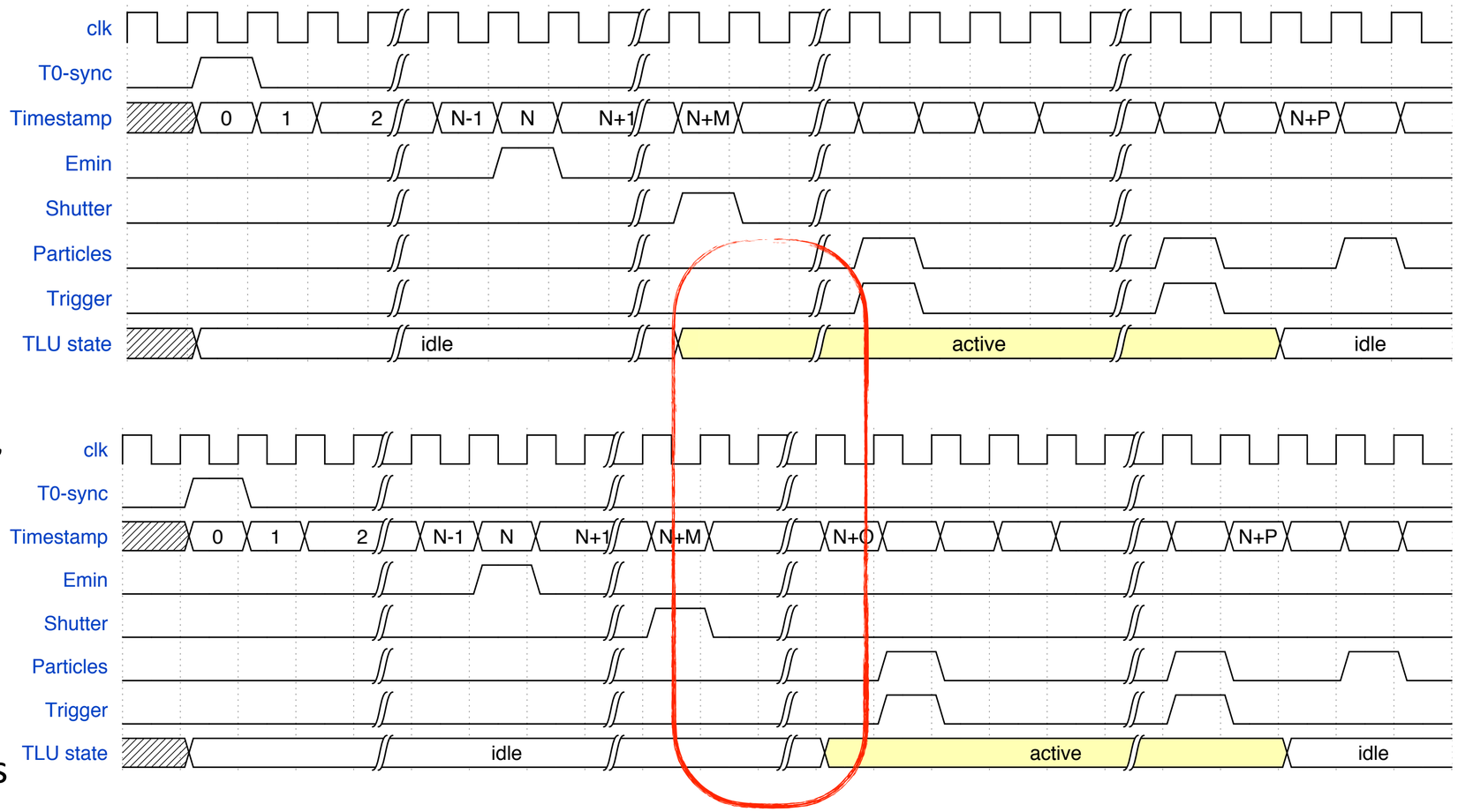
from David Cussans

In general, DUTs can be categorized: sync to TLU or not;

1. a DUT sync to the TLU:
2. a DUT unsync to the TLU:
   - Synchronization by **trigger counting**;
   - Global busy used: no trigger sent, when either device is busy;
   - Add-on TLU func: **configurable delayed** TLU active period

Status:

- new TLU will be issued by end of this month;
- a first use case needed to test.



Shutter: activation signal
T0_sync: 1 per run, common start signal