

## Interactive Visualization & Online Analysis of Timepix Data

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# Outline

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- ATLAS-TPX Detector Network
- Data Transfer Schema
  - Analysis & Control Chain
  - Analysis Process
  - Visualization Chain
  - Interactive Visualization Software
  - Live Demonstration

## **ATLAS-TPX Detector Network**

- Successor of the ATLAS-MPX project.
- 16 detectors installed within the ATLAS Machine.
- A single detector is comprised of:

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echnical

Czech T

**Physics** 

Applied

and

Institute of Experimental

- 2 silicon Timepix chips (300µm, 500µm thick) facing each other
- 4 neutron converter regions (LiF, PE, PE+AI, free region)
- ATLASPIX readout (FPGA, Raspberry Pi)



LIF+AI

Free

PE+AI

PE



## Data Transfer Schema



### Analysis & Control Chain

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- Analysis VMs utilize 24 CPUs and 48 GBs of RAM.
- Raw data is deleted from EOS upon transfer to the backup server.

## **Analysis Process**

- Synchronous: runs at Control PC after the data comes from ATLASPIX.
  - Only the simplest and most important indicators are calculated.
  - Potential to estimate instantaneous luminosity.
  - Measurements will be reported to DCS for FSM live view.
- Asynchronous: runs concurrently in bulk transactions over a time period.
  - 1. Consistency Validation: skipped if there are no hardware faults
  - 2. Coordinate Transformation: slice and rotate pixel matrices
  - 3. Separation: 8-way flood-fill algorithm
  - 4. Calculations: energy calibration, volume, height, average, centroids
  - 5. Morphological Classification:
    - Dot | Small Blob | Curly Track | Heavy Blob | Heavy Track | Straight Track



#### **Visualization Chain**





- Separate environment (completely independent of ACC)
- Data is manipulated in transactions.
  - Current common transaction time span: 1 day
  - System designed to support minimum transaction time span: 1 minute
  - Possibility of real-time (or near-real-time) frame display.
- Operates on ROOT data store of approx. size 12 TBs
  - Original random access time: 12 s (now: ~350 ms)
  - Various indexing techniques to speed up (implemented as <u>bachelor thesis</u>)
- Data store accessible for reading to all ATLAS users:
  - root://eosatlas/eos/atlas/atlascerngroupdisk/tpx

## Visualization Software Demo

#### **Interactive Visualization Software**

- UI inspired by Pixelman.
- HTML5 application: <u>https://tpx-visualizer.cern.ch</u> (access upon request)
- Main objective: preliminary monitoring & analysis
  - Display frames by detector and time (summer 2015 present).
  - Plot flux (number of clusters over a unit of time) and occupancy by detector.

#### • Features:

- Zooming, linear / logarithmic axis, various colormaps.
- Calculate statistics based on track types, estimate energy deposition and approximate instantaneous luminosity from the cluster count.
- Display (and compare) data from multiple detectors at the same time.
- Mask noisy pixels, filter pixels and clusters based on a custom predicate.
- Integrate pixel matrices over consecutive frames.
- Export data in ASCII (CSV) for plotting and further processing.
- Experimental support for MoEDAL-TPX and ATLAS-TPX GaAs detectors.

#### **Interactive Visualization Software**





## Thank you for your attention!

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## Preliminary results: Thermal neutron fluxes measured by different devices



Thermal neutron signal is a reliable indicator for collision periods