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Silizium Labor Bonn

Status of DATCON

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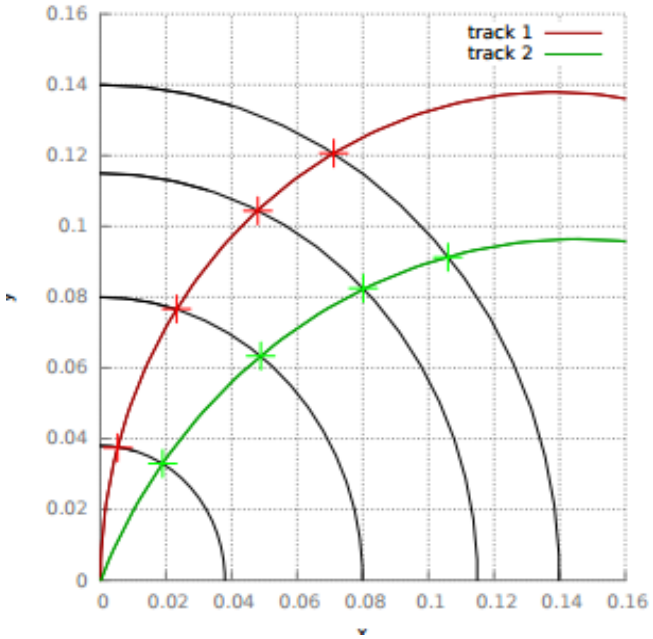
SVD Track Reconstruction

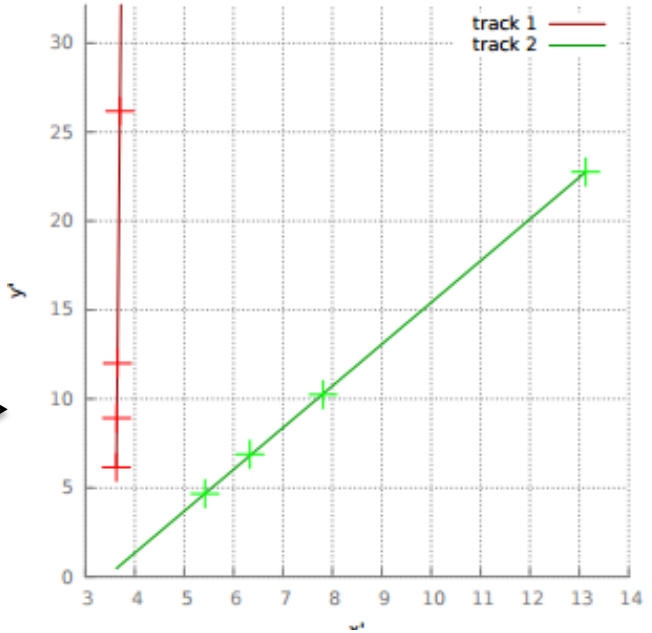
- Use of the Hough transformation:

$$d = x \cdot \cos\alpha + y \cdot \sin\alpha$$

- Drawack: Can only be applied for straight line (as previously implemented on FPGA)
- For circular track a conformal transformation is needed



$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \frac{1}{r^2} \cdot \begin{pmatrix} x \\ y \end{pmatrix}$$



Extrapolation

- Simulations with Y(4S) events are performed

  ⟶ results look promising, but further improvements necessary

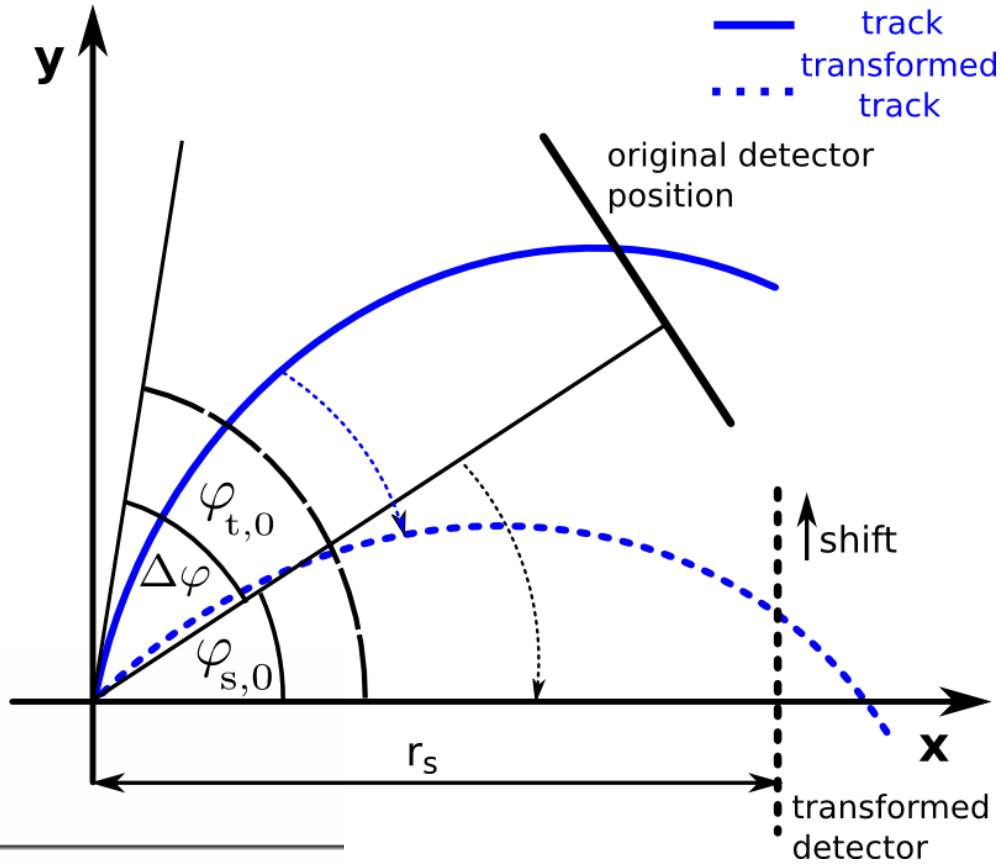
- Also new extrapolation method implemented:
  intersection of circle (= track) with straight line (= detector plane)

- Afterwards: multiplication of (x,y) with rotation matrix to obtain 3d MPH (most probable hit) coordinates

$$\Delta\varphi = \varphi_{\mathrm{t}} - \varphi_{\mathrm{s}}$$

$$x = r_{\mathrm{s}}$$

$$y = r_{\mathrm{t}} \cdot \cos\Delta\varphi + \sqrt{r_{\mathrm{t}}^2 - (r_{\mathrm{s}} - r_{\mathrm{t}} \cdot \sin\Delta\varphi)^2}$$



April TB DATCON crash investigation

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- Wrong APV mapping

  - Mistake in the APV mapping implemented in Verilog (hand written from XML)
  - Need to have automatic XML to Verilog conversion to avoid errors in the future
  - Possibility to reconfigure online the mapping-LUT in case, as in April, unexpected changes have to be made

- DATCON stopped processing DATA

  - Was expecting data on every FTB link. If one has no data the system stops. (Fixed)
  - Errors in event size calculation on small event. No match between expected and recalculated size in the trakcing unit -> system stops (Fixed)

April TB tracking approach (Obsolete)

- x and z value calculated from strip id
- $(x,\ z) = base + strip \cdot pitch$ where *base* is the global reference coordinate of a SVD sensors respectively on x for Φ and z for θ
- Hough transformation is defined by $d = x \cdot \cos\alpha + y \cdot \sin\alpha$

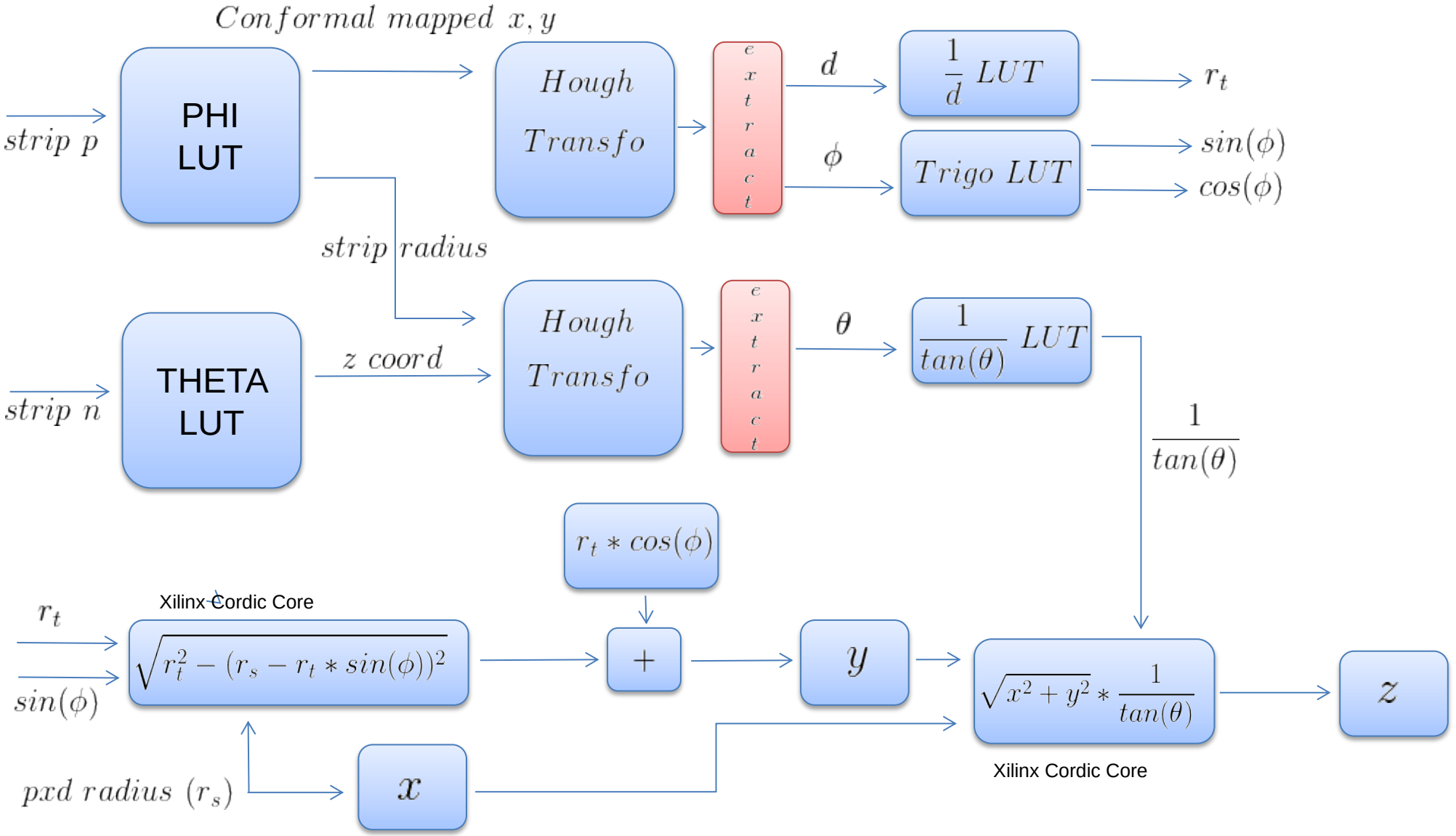
$$\Rightarrow \quad x = \frac{d - y \cdot \sin\alpha}{\cos\alpha}$$

- Works only for TB geometry (linear geometry, one axis), not for the complete detector
- No conformal mapping made for Φ
- Hough transform for θ based on y and z coordinate instead of r and z
- The ROI coordinate has to be converted into pixel id
- => Division by the pixel pitch. In the FPGA multiplaction by the inverse of the pitch (multiply by 1000 to get integer)

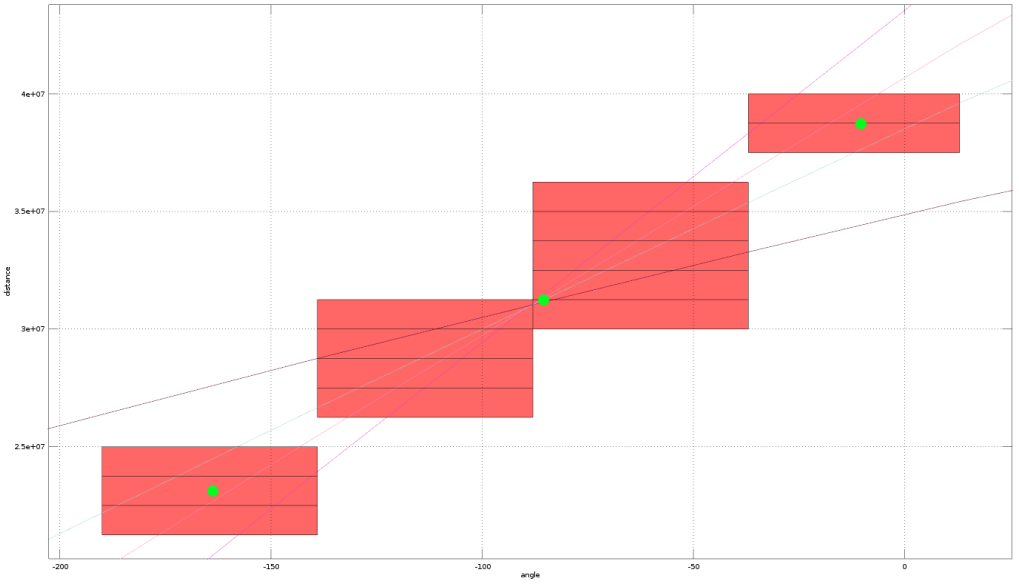
- => Rounded number, no conformal mapping, different coordinate system

and wrong SVD mapping resulting in unusable results

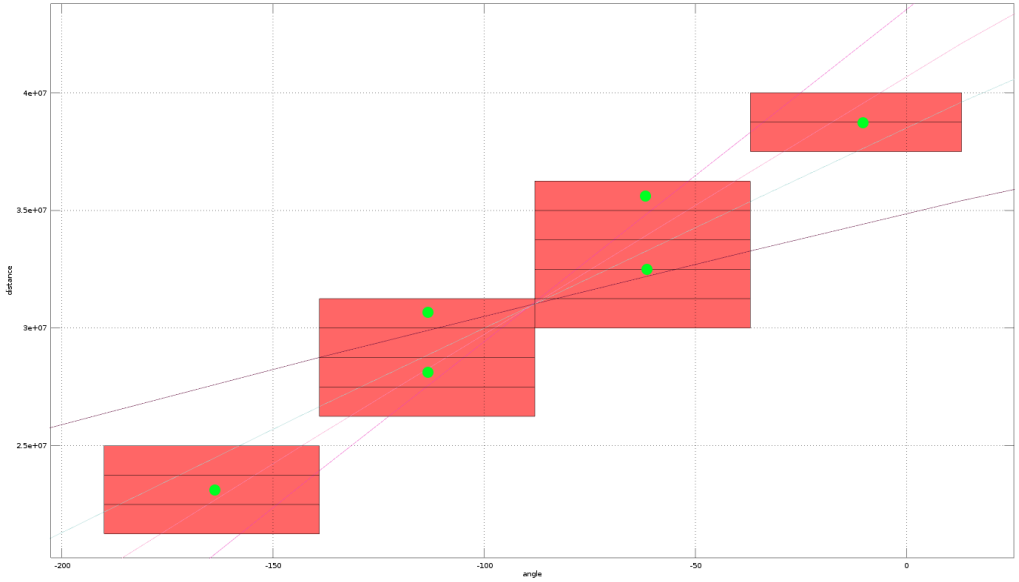
New FPGA implementation



Hough space data extraction



Best case

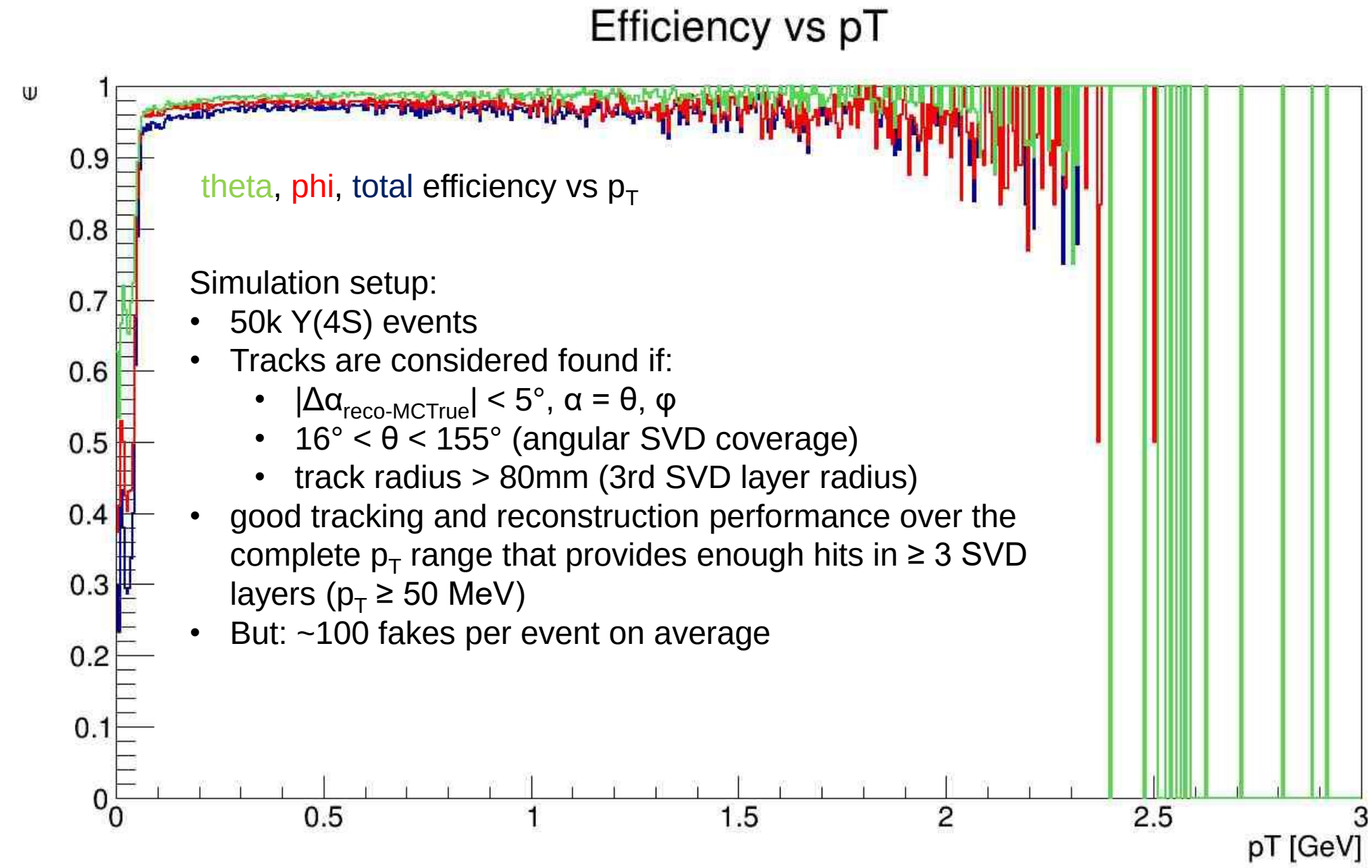


Currently implemented

- Current data extraction can be made in parrallel with Hough Space building,
- But more points are selected since there is no perfect clustering (too slow)
- Different approach under investigation. Not yet implemented

- Finds clusters in 1x4 sector space. From 5 consecutive vertical sectors, the result will be two clusters

Simulation Results - Tracking Performance



theta, phi, total efficiency vs p_T

Simulation setup:

- 50k Y(4S) events
- Tracks are considered found if:
  - $|\Delta\alpha_{\text{reco-MCTrue}}| < 5°$, $\alpha = \theta, \varphi$
  - $16° < \theta < 155°$ (angular SVD coverage)
  - track radius > 80mm (3rd SVD layer radius)
- good tracking and reconstruction performance over the complete p_T range that provides enough hits in ≥ 3 SVD layers ($p_T \geq 50$ MeV)
- But: ~100 fakes per event on average

Simulation Results - Tracking Performance

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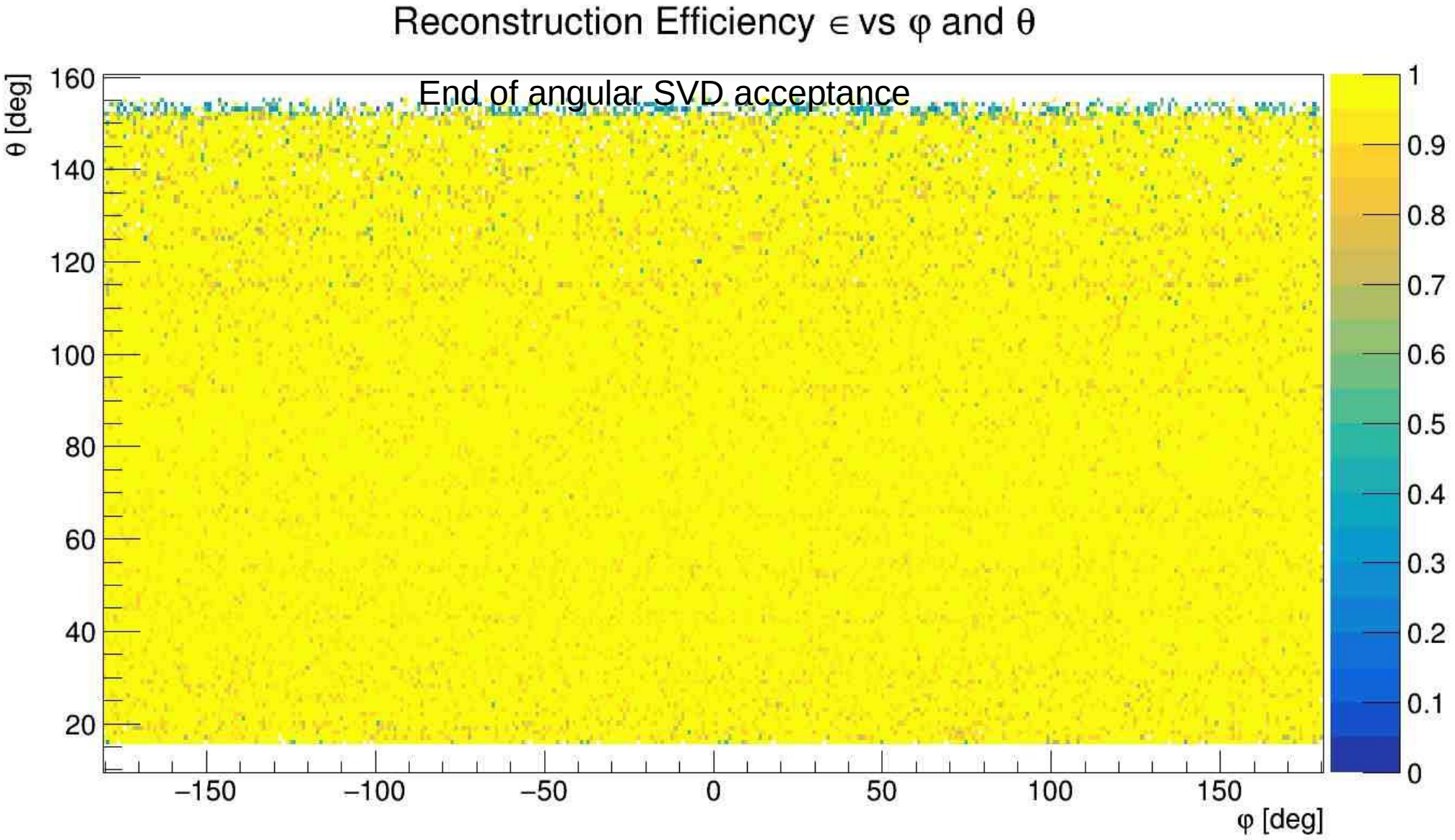
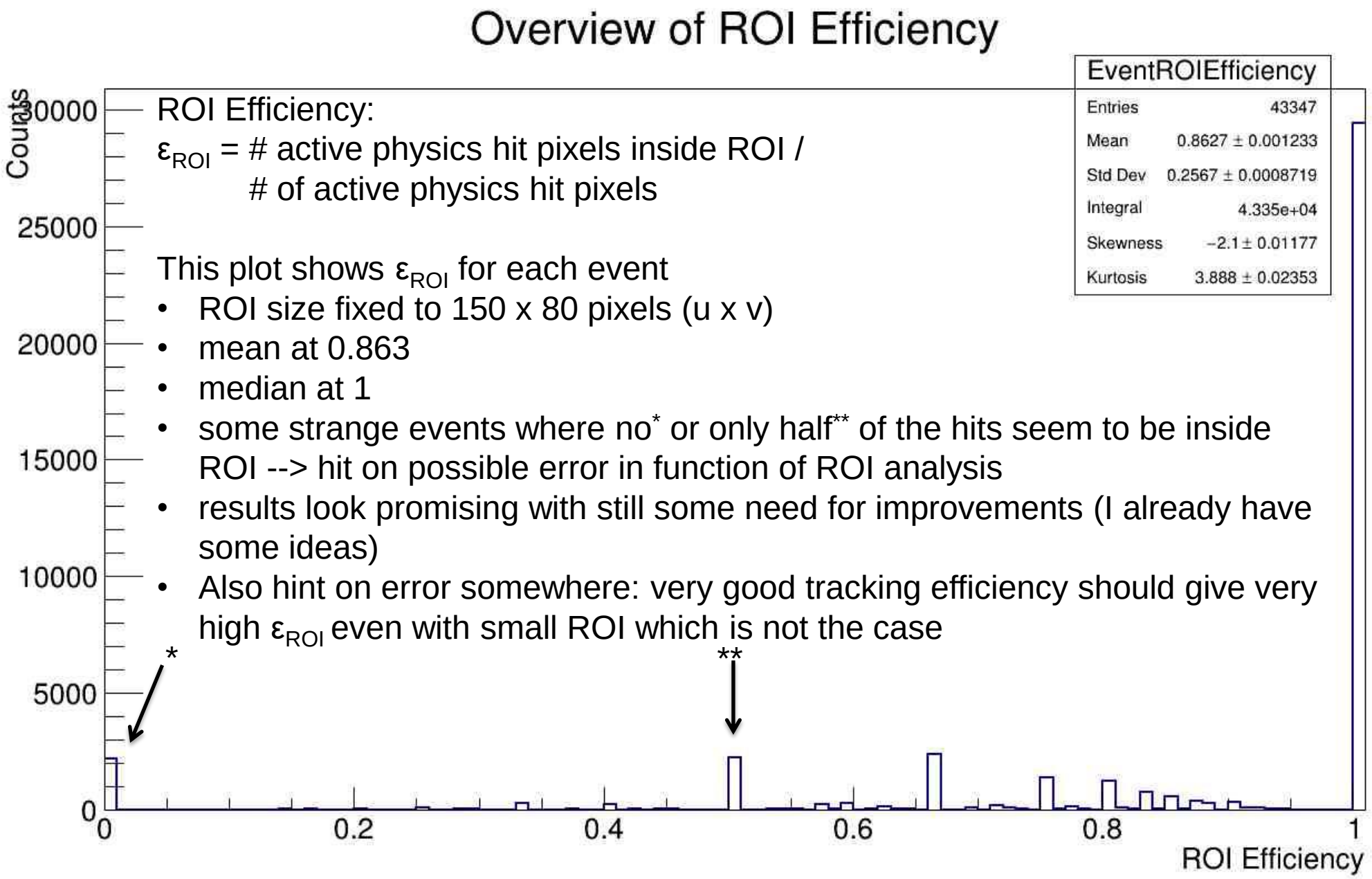


Simulation Results - ROI Performance



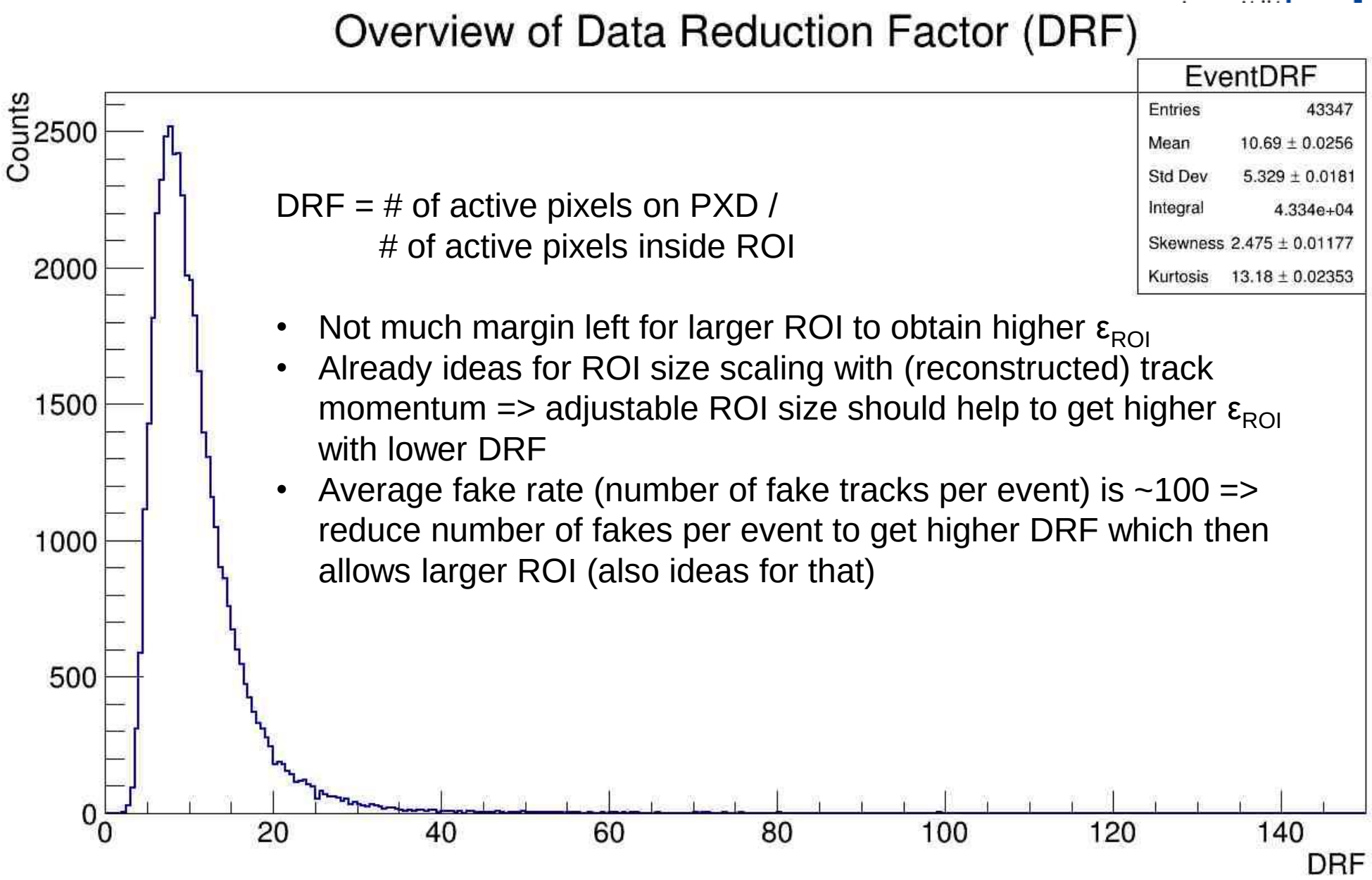
ROI Efficiency:

ε_{ROI} = # active physics hit pixels inside ROI /
# of active physics hit pixels

This plot shows ε_{ROI} for each event

- ROI size fixed to 150 x 80 pixels (u x v)
- mean at 0.863
- median at 1
- some strange events where no* or only half** of the hits seem to be inside ROI --> hit on possible error in function of ROI analysis
- results look promising with still some need for improvements (I already have some ideas)
- Also hint on error somewhere: very good tracking efficiency should give very high ε_{ROI} even with small ROI which is not the case

Simulation Results - ROI Performance



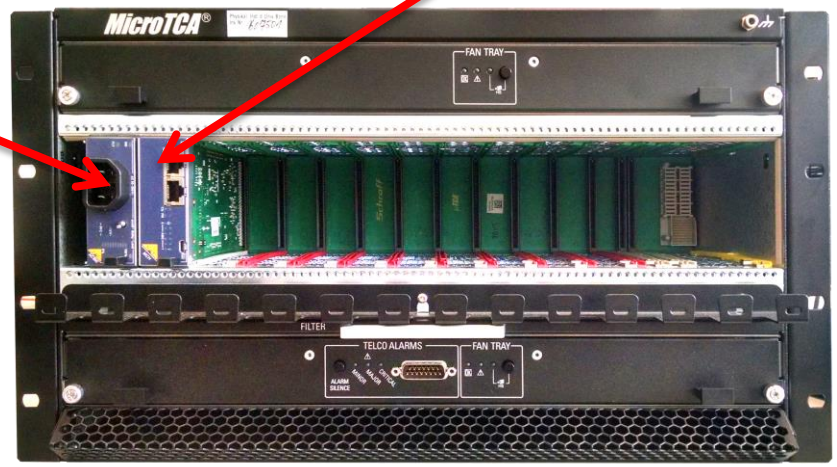
DRF = # of active pixels on PXD /
# of active pixels inside ROI

- Not much margin left for larger ROI to obtain higher ε_{ROI}
- Already ideas for ROI size scaling with (reconstructed) track momentum => adjustable ROI size should help to get higher ε_{ROI} with lower DRF
- Average fake rate (number of fake tracks per event) is ~100 => reduce number of fakes per event to get higher DRF which then allows larger ROI (also ideas for that)

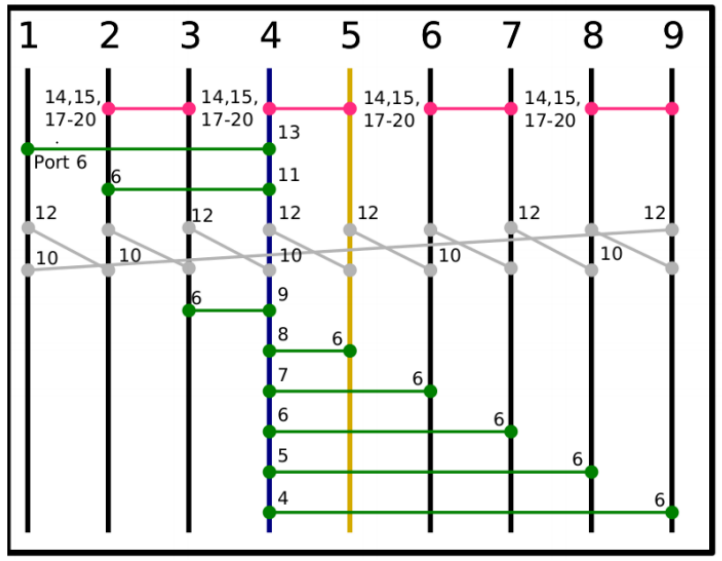
New crate

N.A.T Power Module

N.A.T MCH



Backplane Layout (fat-pipes)



- New crate from PENTAIR
- 9 AMC slots
- Custom backplane connection
- Custom JTAG routing
- N.A.T-MCH (MicroTCA Carrier Hub)
- N.A.T 600W AC power module
- 2 more shelfs+MCH+PM to be ordered

- Flashing FPGA successfully tested on every slot. JTAG routing works well

Slow Control

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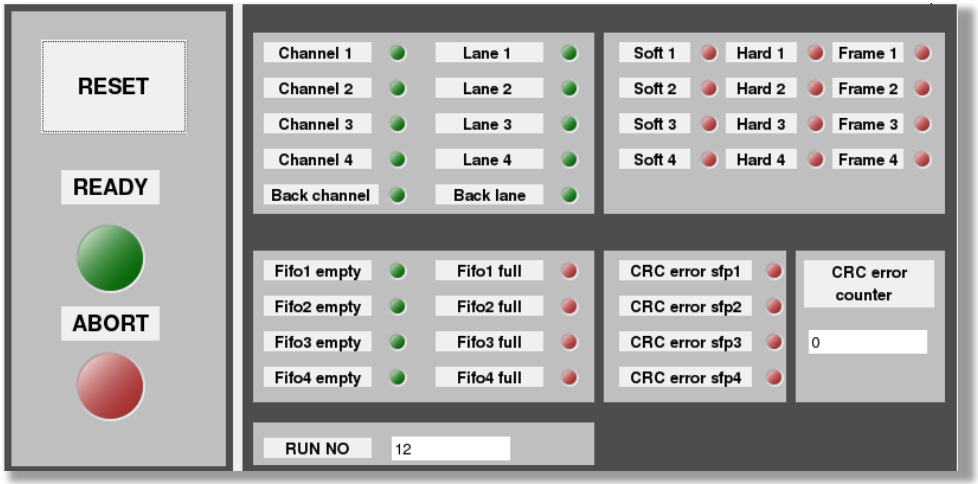
- April TB

  - First time DATCON was connected to EPICS
  - Basic interface with few controls
  - IPBUS connection



- For December tesbeam

  - Slow control for concentrator is done and operationnal. Still can be improved, not final version
  - Channel/Lane status, Aurora errors, FIFO status and CRC errors detection
  - Tracking board slow control is not implemented yet
  - Live plot of SVD hits as well as extrapolated hits onto PXD. # reconstructed tracks

Concentrator slow control

Conclusion

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- Reasons for poor DATCON performance in April TB found and corrected
- New extrapolation works in simulation
- Implementation of extrapolation on FPGA ongoing
- Very good tracking performance of BASF2 DATCON algorithm (> 95%) for generic Y(4S) events
- Good ROI finding efficiency (~ 85-90% with DRF of 10), but still space for improvements (for e^+e^- particle gun events from origin 96% ROI efficiency)
- New Hardware received, tested and functional
- Slow Control improved, tracking SC part implementation ongoing
- Ready for the integration campaign end of October

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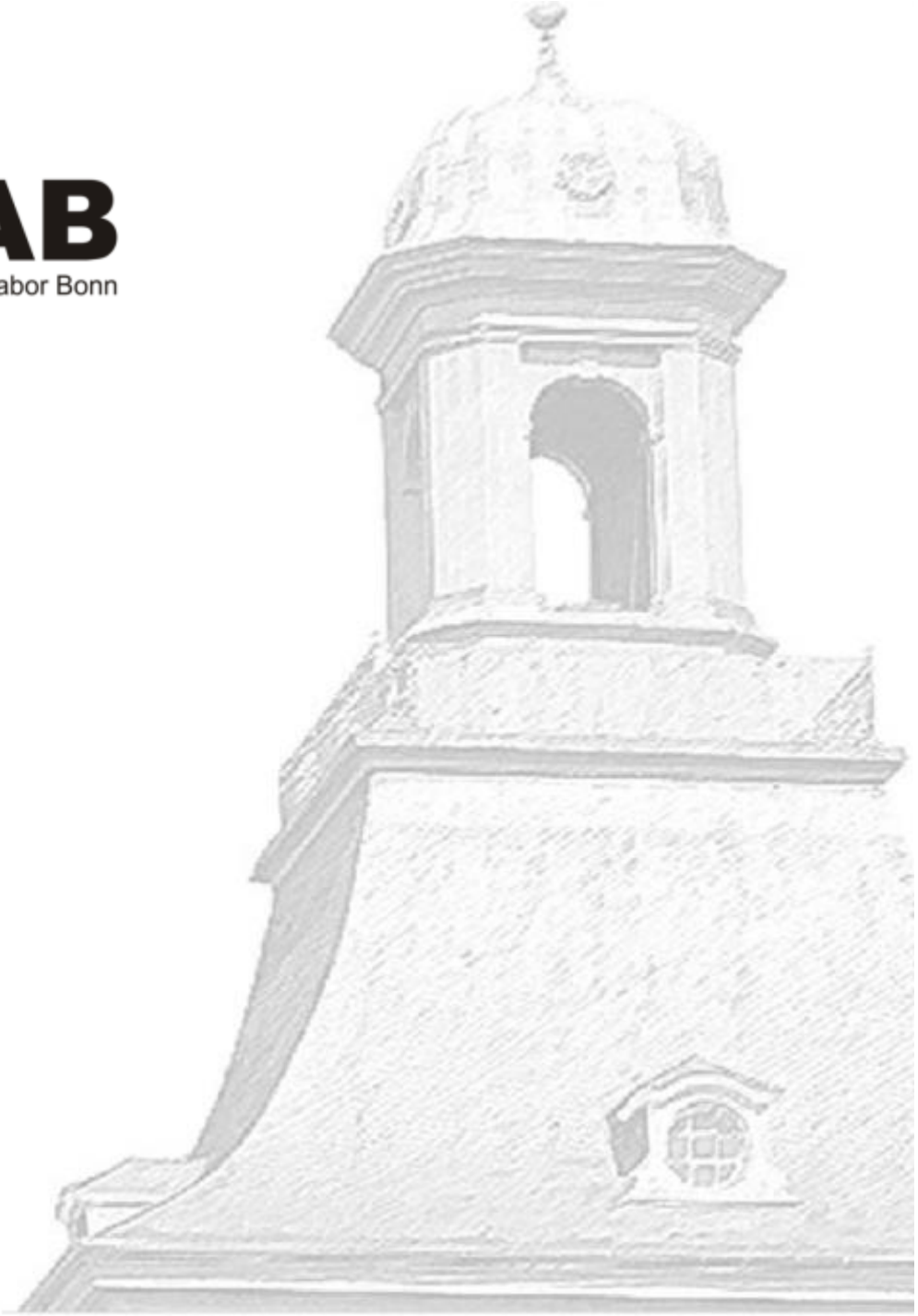

Thank you

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