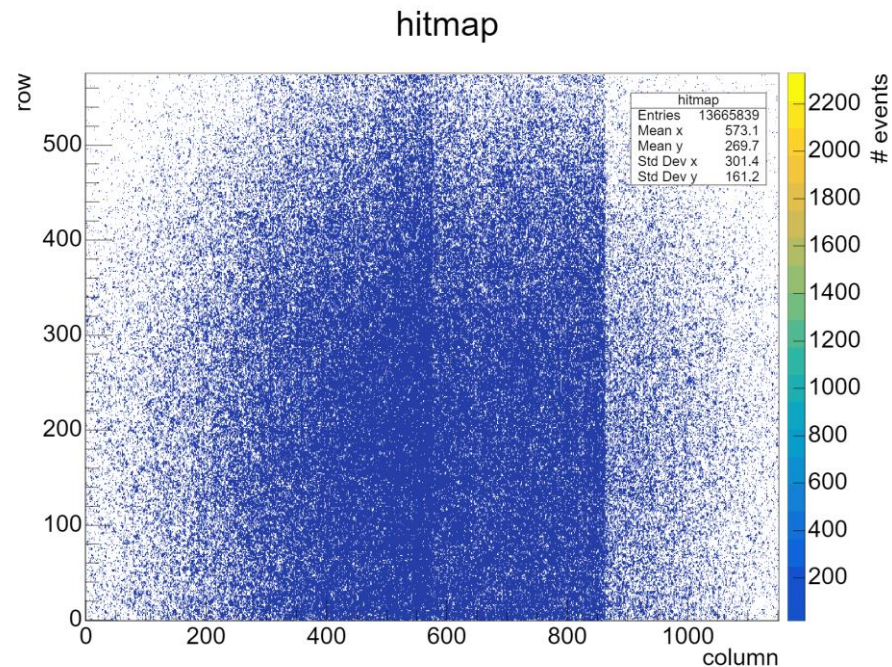


RD50-MPW3: Testbeam and System Integration

Patrick Sieberer, on behalf of the RD50 CMOS working group

- This is a continuation of *RD50-MPW3: Design and initial laboratory evaluation*
 - [Click](#)
 - Introduction of the project and sensor can be found there
- Concepts of DAQ and dataflow presented in last meeting
 - [Click](#)
- This talk focusses on testbeam setup and analysis results

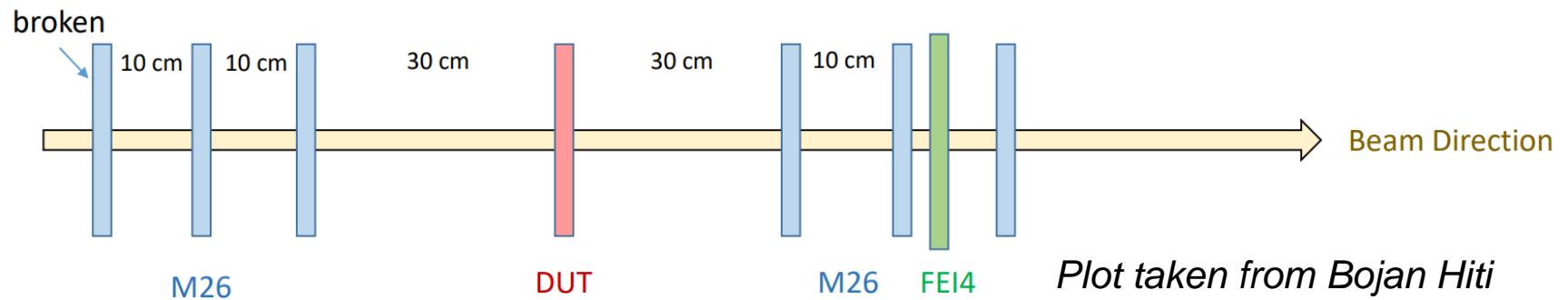
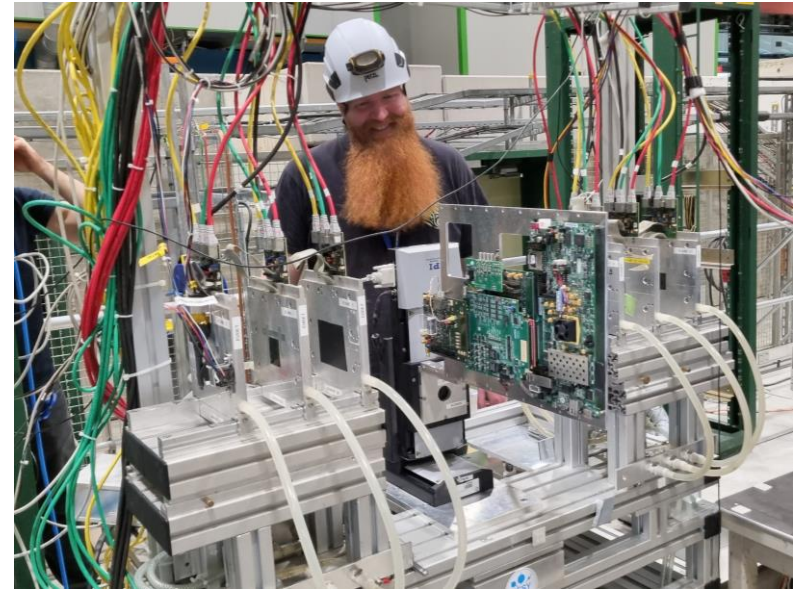
- Testbeam in October 2022 at CERN SPS
 - H6B (PPE 156) in the north area
 - 7 days of data taking
- Beam: 120GeV - “H6 mix”
 - Electrons, pions, ...
 - Beam spot ~9mm
- Recorded data: around 16.2M Events
 - x10 = 160M tracks
 - track multiplicity of around 10, “pile-up”
 - Without timing and spatial cuts
 - Divided into 36 runs of ~30 min each



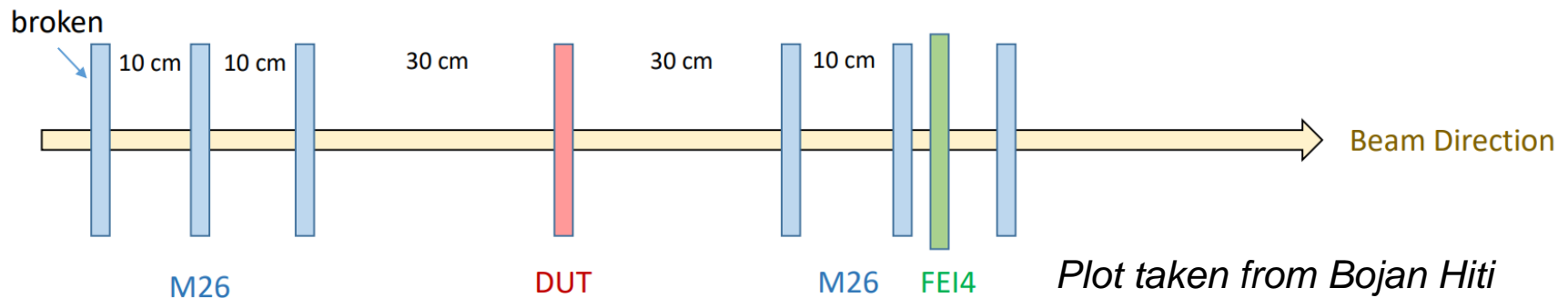
Single plane of telescope (pixel pitch 18.4 x 18.4 μm)

REFERENCE DETECTORS

- 6 Mimosa26 (M26) planes
 - Only 5 working ones (end of lifetime)
 - 2 in front of MPW3
 - 3 at the back of MPW3
- 3D reference tracks reconstructed
- Baseline for the analysis
- AIDA TLU for Trigger handling + Timestamping

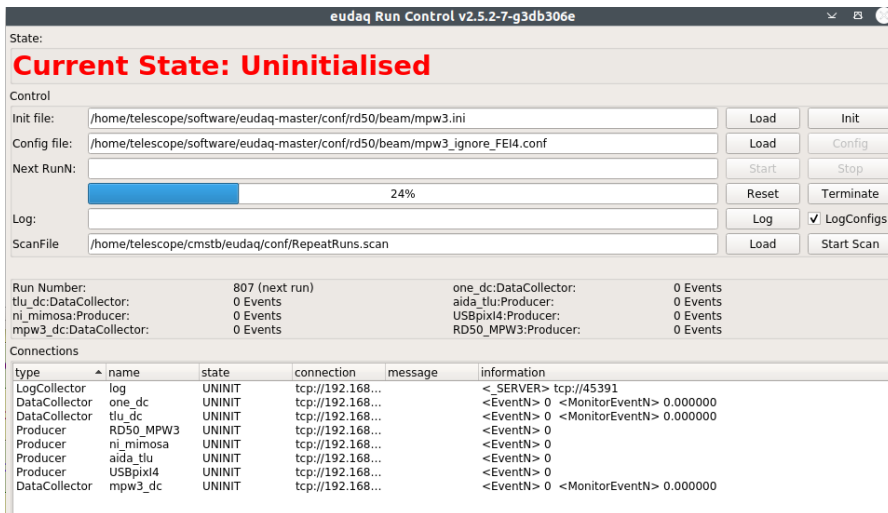


- FEI4 and Timepix3 plane tried as timing reference layer
- FEI4 setup by previous group, worked with some issues
 - Crashes every ~30min (know bug, but not to us at the beginning) -> Data loss for 1 night
 - Solution: Sam scripted some magic to automatically move to mouse to click Stop, Configure and Start every 30min
 - Overwrites data from telescopes -> Data loss for ~2 days (as we didn't check this)
 - Issues seem to be due to an incompatibility of the FEI4 with EUDAQ2
- Timepix3 setup
 - We did not manage to get it working due to more serious issues with other detectors



DATA TAKING

EUDAQ2



State: **Current State: Uninitialised**

Control

Init file: /home/telescope/software/eudaq-master/conf/rd50/beam/mpw3.ini [Load] [Init]

Config file: /home/telescope/software/eudaq-master/conf/rd50/beam/mpw3_ignore_FEI4.conf [Load] [Config]

Next RunN: [Start] [Stop]

Log: [Reset] [Terminate]

ScanFile: /home/telescope/cmstb/eudaq/conf/RepeatRuns.scan [Log] [Start Scan] LogConfigs

Run Number: 807 (next run) one_dc:DataCollector: 0 Events

tlu_dc:DataCollector: 0 Events aida_tlu:Producer: 0 Events

ni_mimosa:Producer: 0 Events USBpixi4:Producer: 0 Events

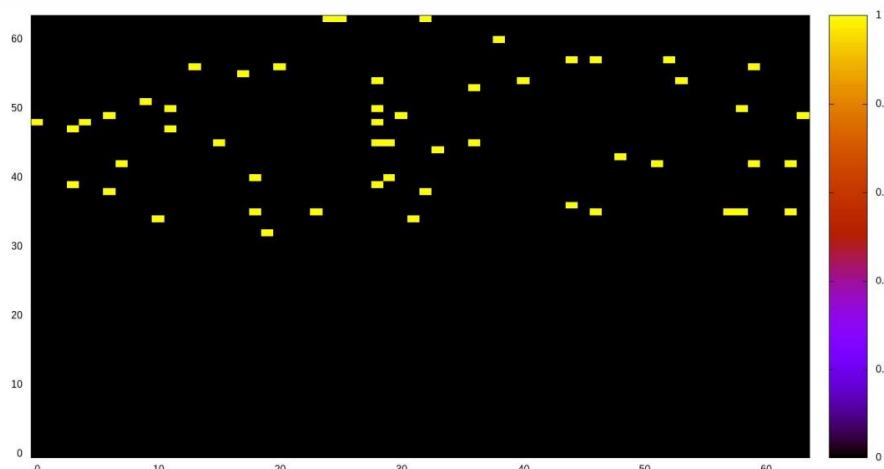
mpw3_dc:DataCollector: 0 Events RD50_MPW3:Producer: 0 Events

type	name	state	connection	message	information
LogCollector	log	UNINIT	tcp://192.168...		< SERVER> tcp://45391
DataCollector	one_dc	UNINIT	tcp://192.168...		<EventN> 0 <MonitorEventN> 0.000000
DataCollector	tlu_dc	UNINIT	tcp://192.168...		<EventN> 0 <MonitorEventN> 0.000000
Producer	RD50_MPW3	UNINIT	tcp://192.168...		<EventN> 0
Producer	ni_mimosa	UNINIT	tcp://192.168...		<EventN> 0
Producer	aida_tlu	UNINIT	tcp://192.168...		<EventN> 0
Producer	USBpixi4	UNINIT	tcp://192.168...		<EventN> 0
DataCollector	mpw3_dc	UNINIT	tcp://192.168...		<EventN> 0 <MonitorEventN> 0.000000

- Producer: Slow Control of detectors
- DataCollector: Stores data from detectors to disk
- Monitor: Live plotting of some fraction of the data. Monitor for RD50-MPW3 available (not connected in RunControl)

Data Storage

- Local storage: Data Collectors store either on external HDD or internal disk
- Remote storage: Data uploaded to CERN file server EOS
 - Using CERNbox automatic sync for Rd50-MPW3 data
 - Using rsync for all other data
- ELOG used for storing general run data



- Low data rate issue with calculating global timestamp (TS) in RD50-MPW3: too long waiting time, we do not see all TS overflows
 - Solution: Attach a 64 bit TS counter to UDP packet
 - Change of firmware during testbeam!
 - Did cost us 3 days to find the issue
- Need to slow down the TLU clock (communication issue between periphery and matrix inside the chip), but this does not slow down the whole interface
 - Firmware didn't capture every (still fast) t0 signal (used for synchronization) anymore
 - Solution: Another fix in the firmware, during the testbeam ;)
 - Did cost us another ~1 day to find out
- Only ~1 day left for data taking

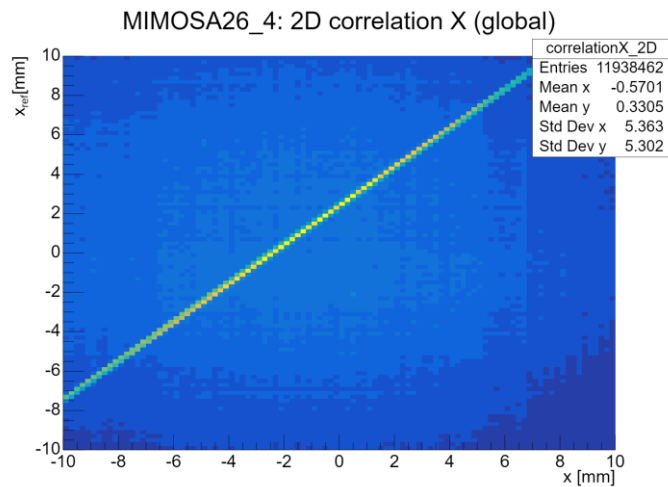
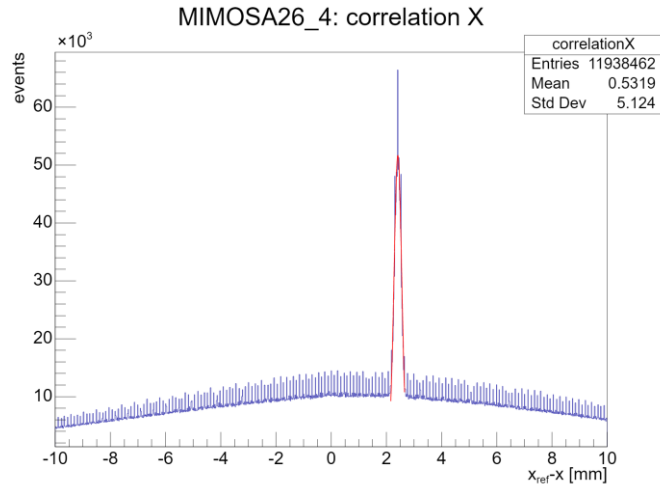
*Combined effort from the whole testbeam crew.
Special thanks to Uwe Krämer, Bojan Hiti and Bernhard Pils.*

ANALYSIS

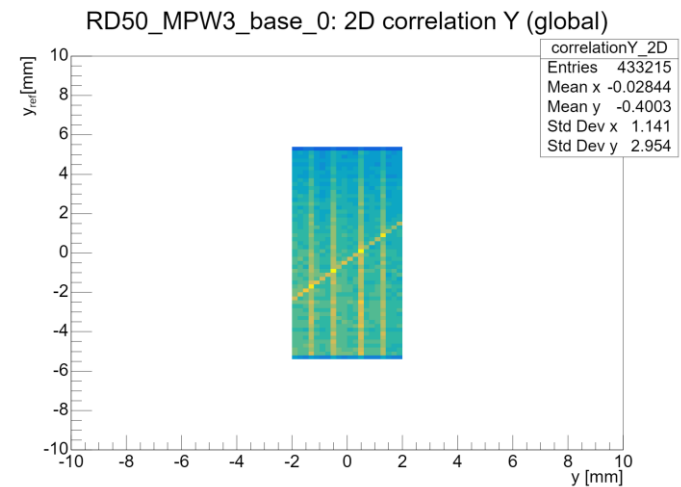
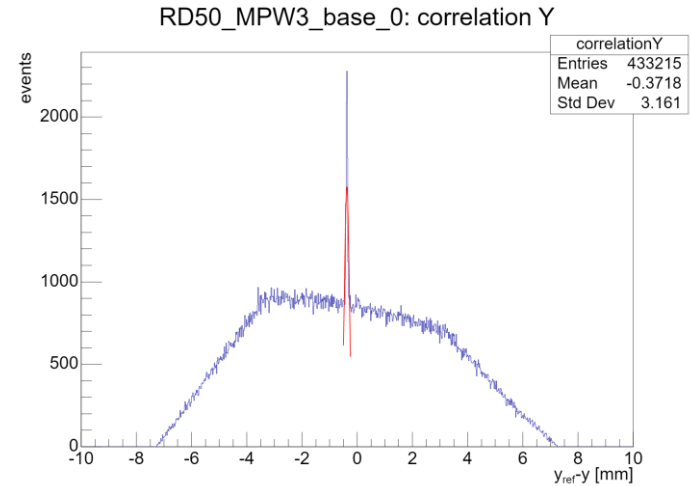
- Have a look at <https://project-corryvreckan.web.cern.ch/project-corryvreckan/>
 - Tutorial, workshop, detailed documentation available
- Event Definition taken from Mimoso26
 - 230us event duration around the trigger
 - Track multiplicity of 10-15 within this timeframe
- Prealignment:
 - Define reference plane
 - Move correlation $x - x_{ref}$ to 0
- Alignment:
 - Track-based, minimize Chi2 (Minuit2 algorithm)
 - Separate for RD50-MPW3 and reference detectors (no bias)
- Analysis



Mimosa26 plane 4



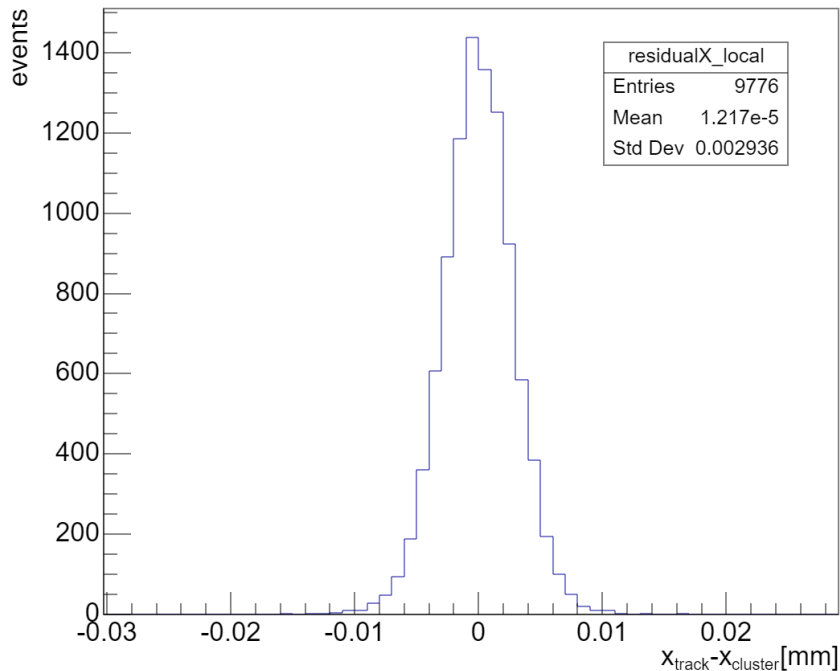
RD50-MPW3



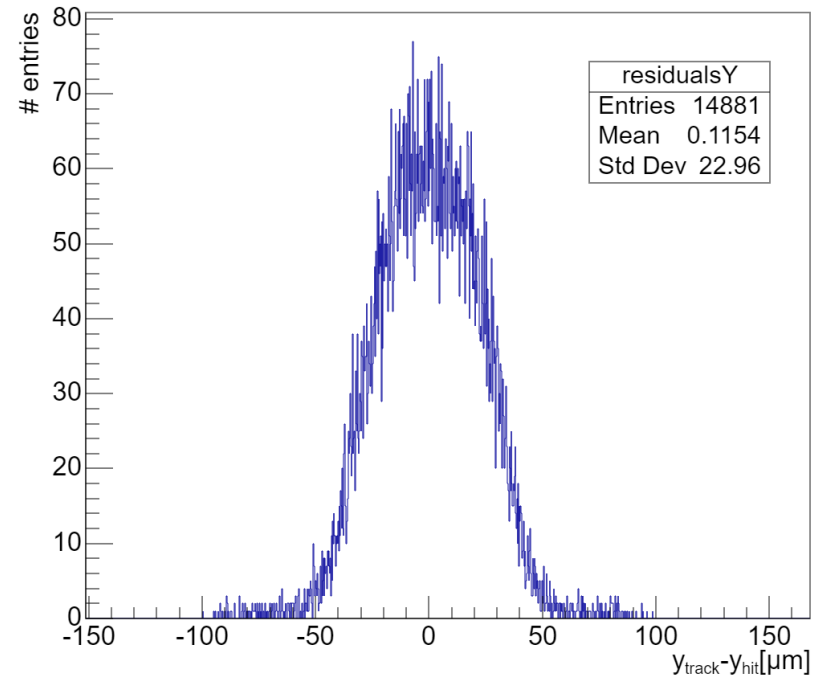
Mimosa26 plane 4

RD50-MPW3

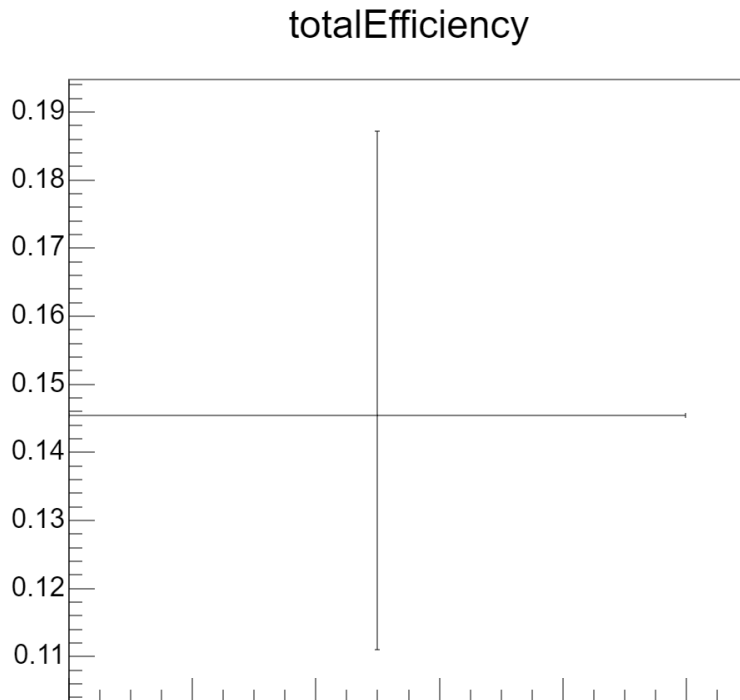
MIMOSA26_4 Biased residual X (local)



Residual in local Y



Different scale!



Very preliminary!

- Without FEI4
 - 3D tracking only
 - FEI4 efficiency seems to be very low
- Very low statistics
 - 15k tracks per run on DUT only
 - Tight cuts during tracking
 - More analysis ongoing
- Efficiency: around 14.5%
 - Very high threshold!
 - Time processing of RD50-MPW3 to be checked

- Supporting testbeam infrastructure is now well understood
 - Good starting point for a follow up testbeam
 - Did cost us a lot of time and data
- RD50-MPW3 is ready for testbeam
 - Data taking of the chip works stable and reliable
 - The chip can be integrated into the DAQ system and synchronized.
 - Analyzing efficiency is possible.



BACKUP

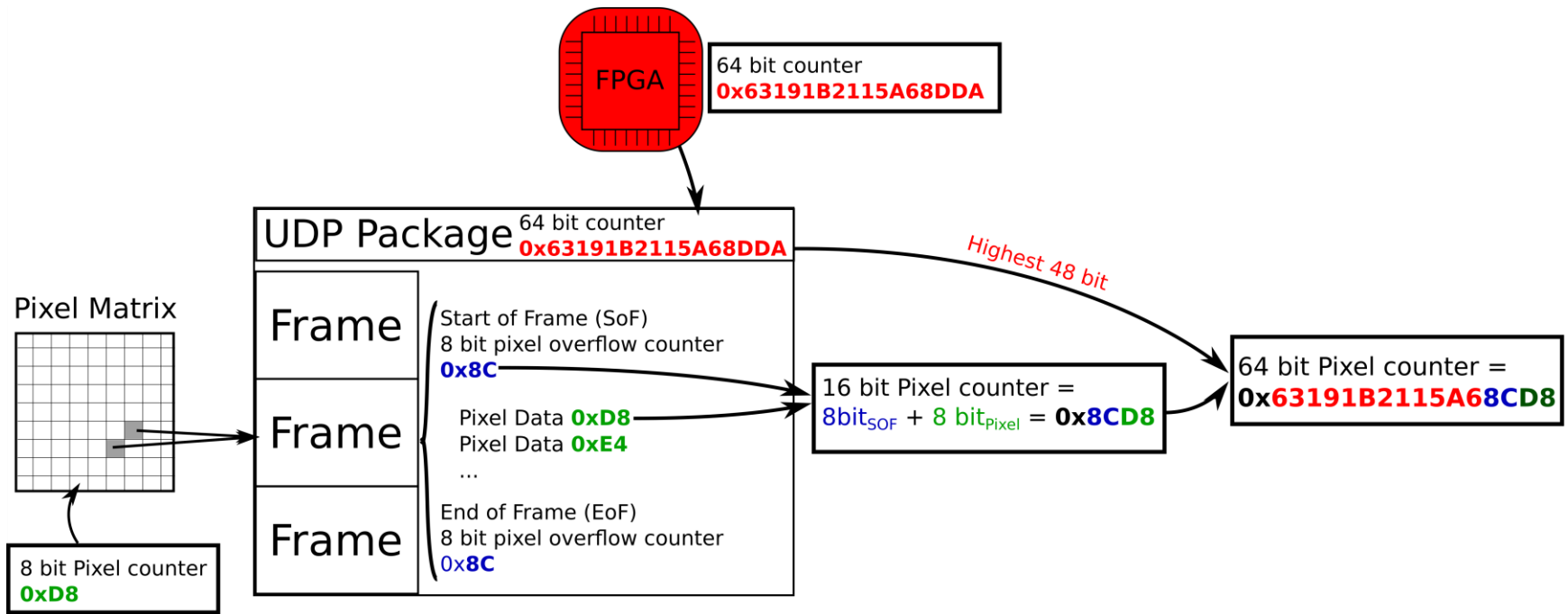


Figure by: Uwe Krämer

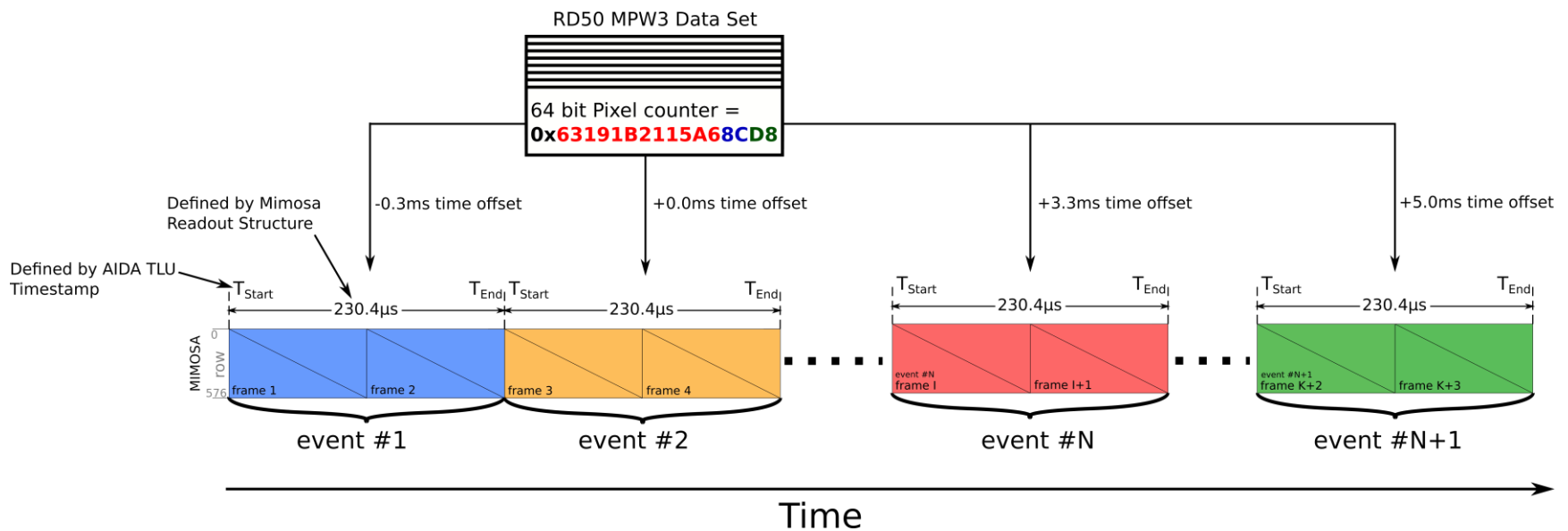


Figure by: Uwe Krämer