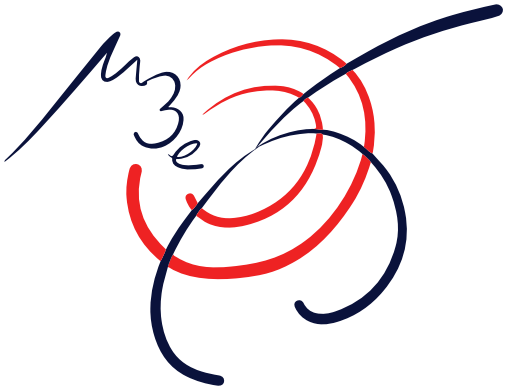
Mu3e DAQ in MIDAS

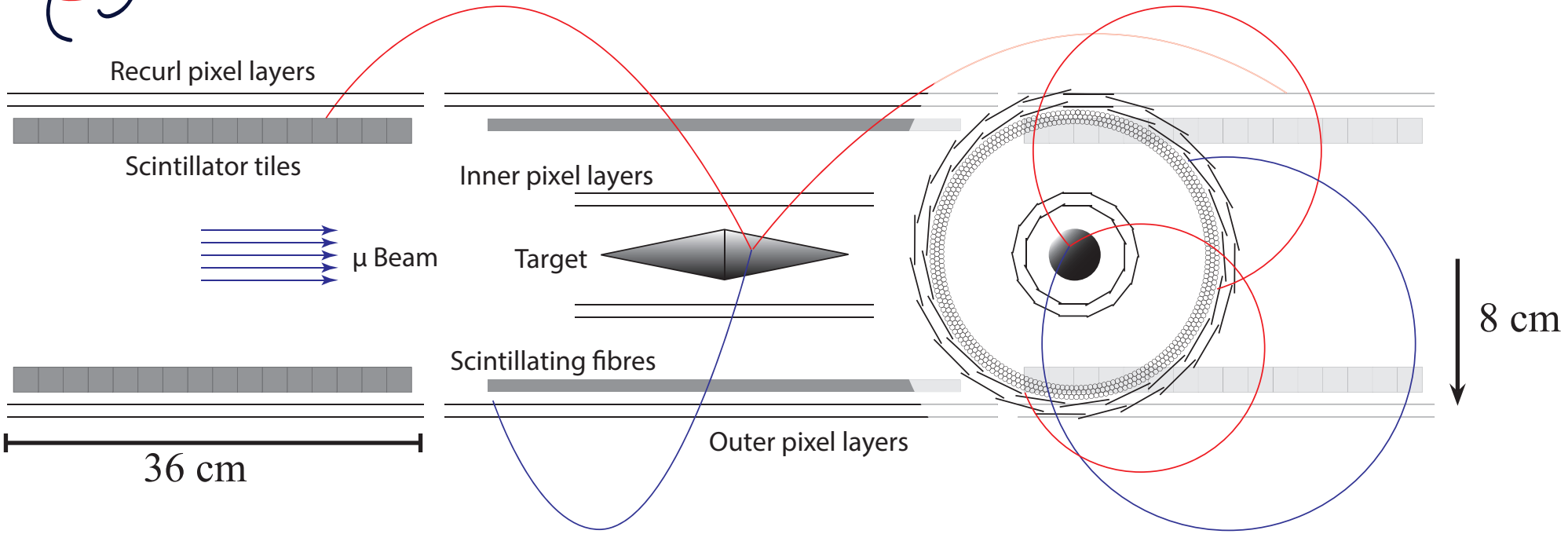


Niklaus Berger

JGU Mainz

MIDAS Workshop, September 2023

The Mu3e Detector

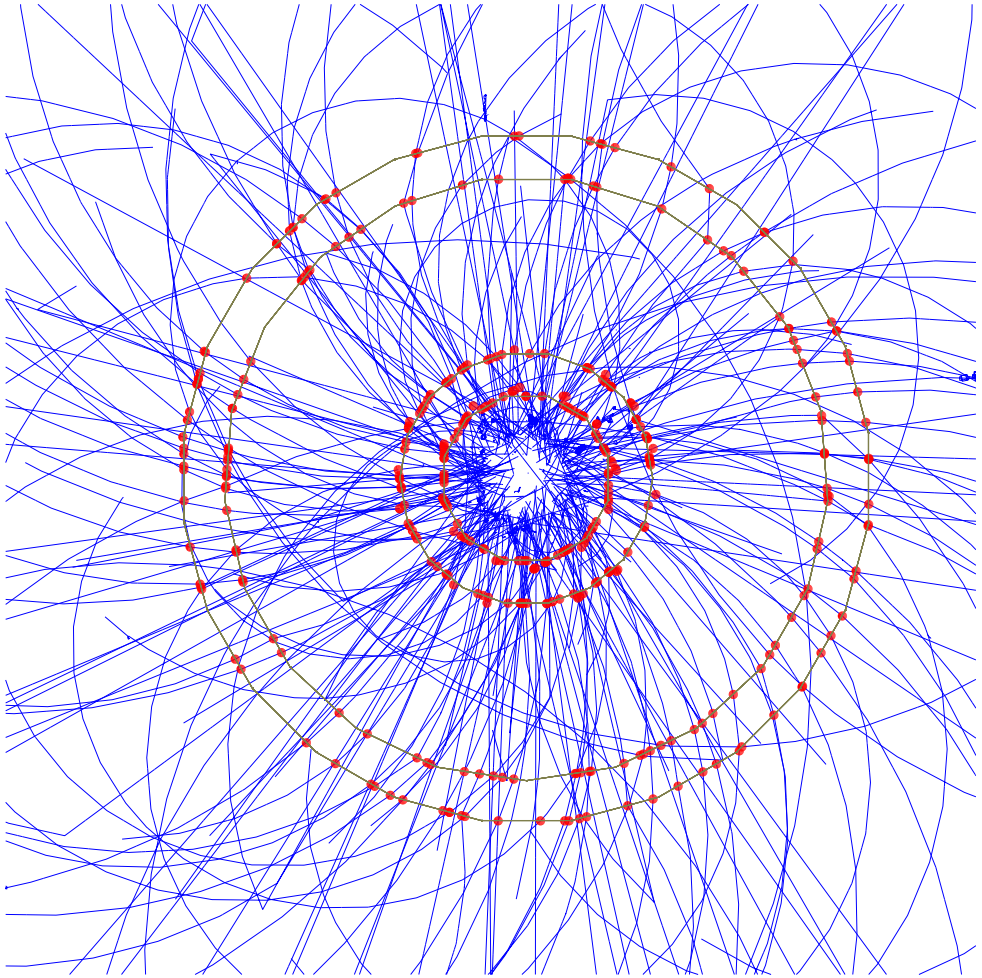


- 1 T solenoid field
- Helium atmosphere to reduce scattering and for cooling
- Minimize material to minimize scattering

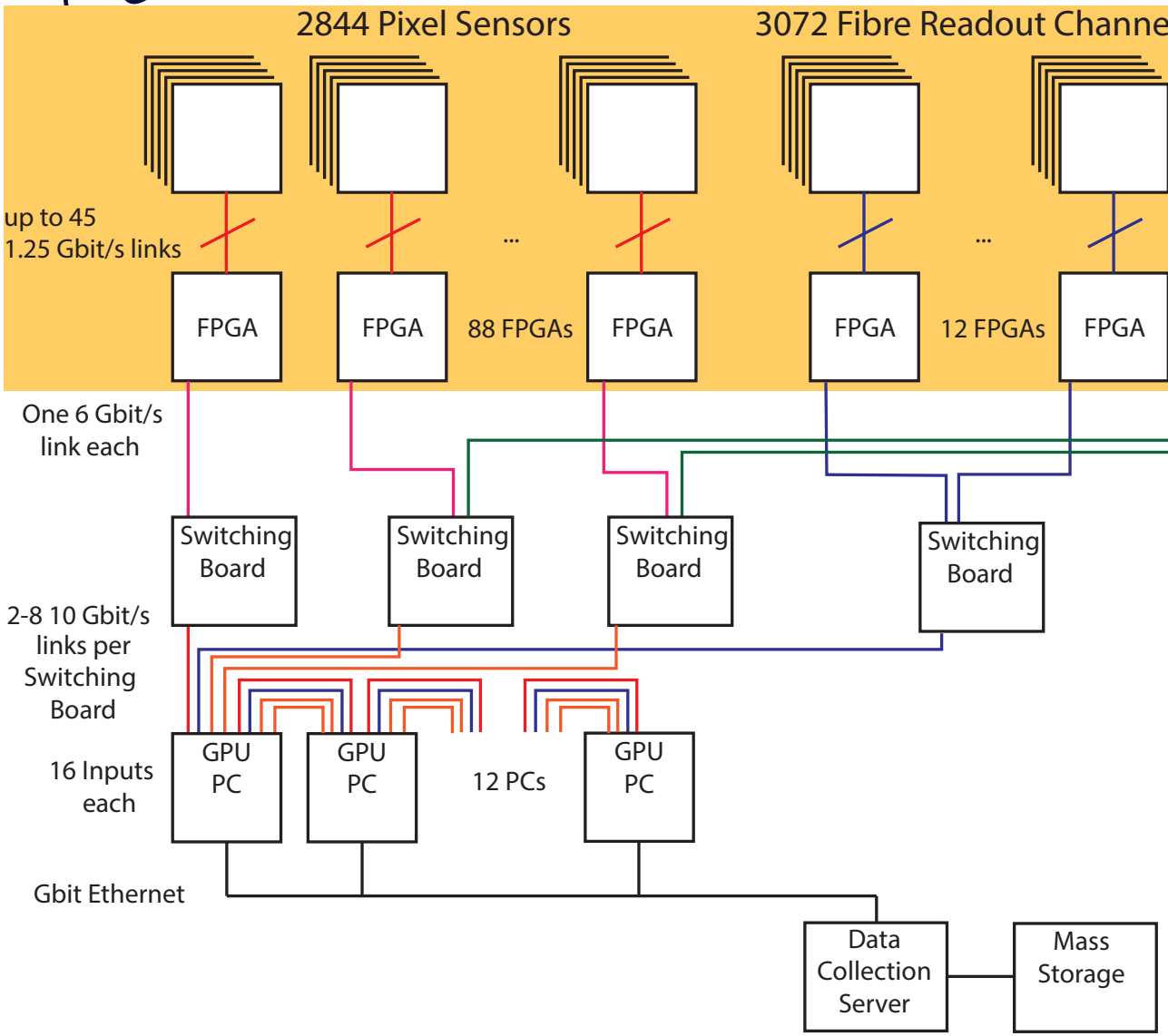
- Ultra-thin layers of high-voltage monolithic active pixel sensors (HV-MAPS)
- Scintillating fibres and tiles for improved timing measurements
- Long lever arm of recurling tracks gives precise momentum measurement

Requirements for the data acquisition

- Up to 10^8 muon decays/s
- 2844 MuPix sensors with 182 million pixels
- 8896 SiPM readout channels - 278 MuTrig TDC ASICs
- ~ 100 Gbit/s data after zero suppression on ASICs
- Highly non-local signal signature
- Can write about 100 MB/s to mass storage

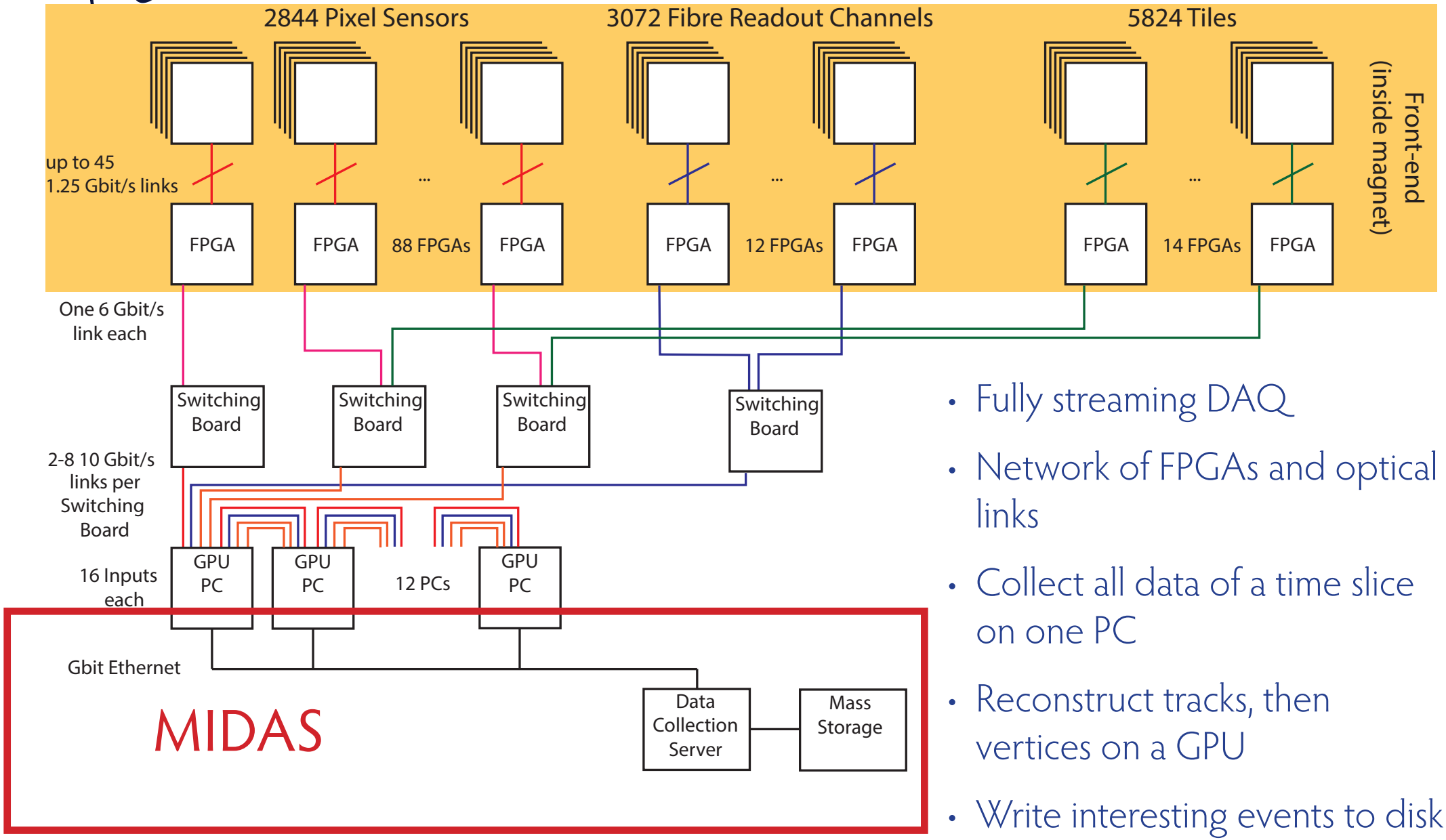


DAQ Design



- Fully streaming DAQ
- Network of FPGAs and optical links
- Collect all data of a time slice on one PC
- Reconstruct tracks, then vertices on a GPU
- Write interesting events to disk

DAQ Design



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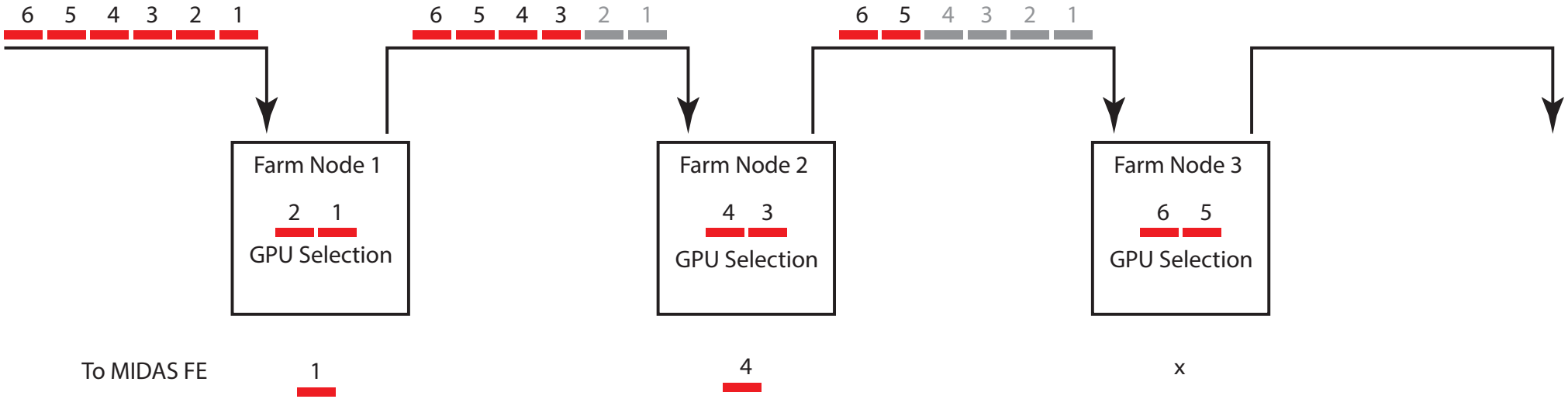
The Mu3e Filter Farm

- 12 boxes with an FPGA card and a GPU
- FPGA card with 160 Gbit/s optical in- and output
- Daisy-chained: Each FPGA card potentially sees the full data stream
- Picks timeslices from the stream when GPU is no busy - simple load balancing
- GPU reconstruction and selection (data buffered on FPGA card during that time)
- Selected events transferred to main memory (and MIDAS)



MIDAS: Farm frontends

- We use the old-style/C frontends
- One on each farm node
- All sending the same type of event:
  Full Mu3e detector information for
  different time slices
  (no event building required after that)

- Need the "same" FE several times,
  indexed are not doing what I want

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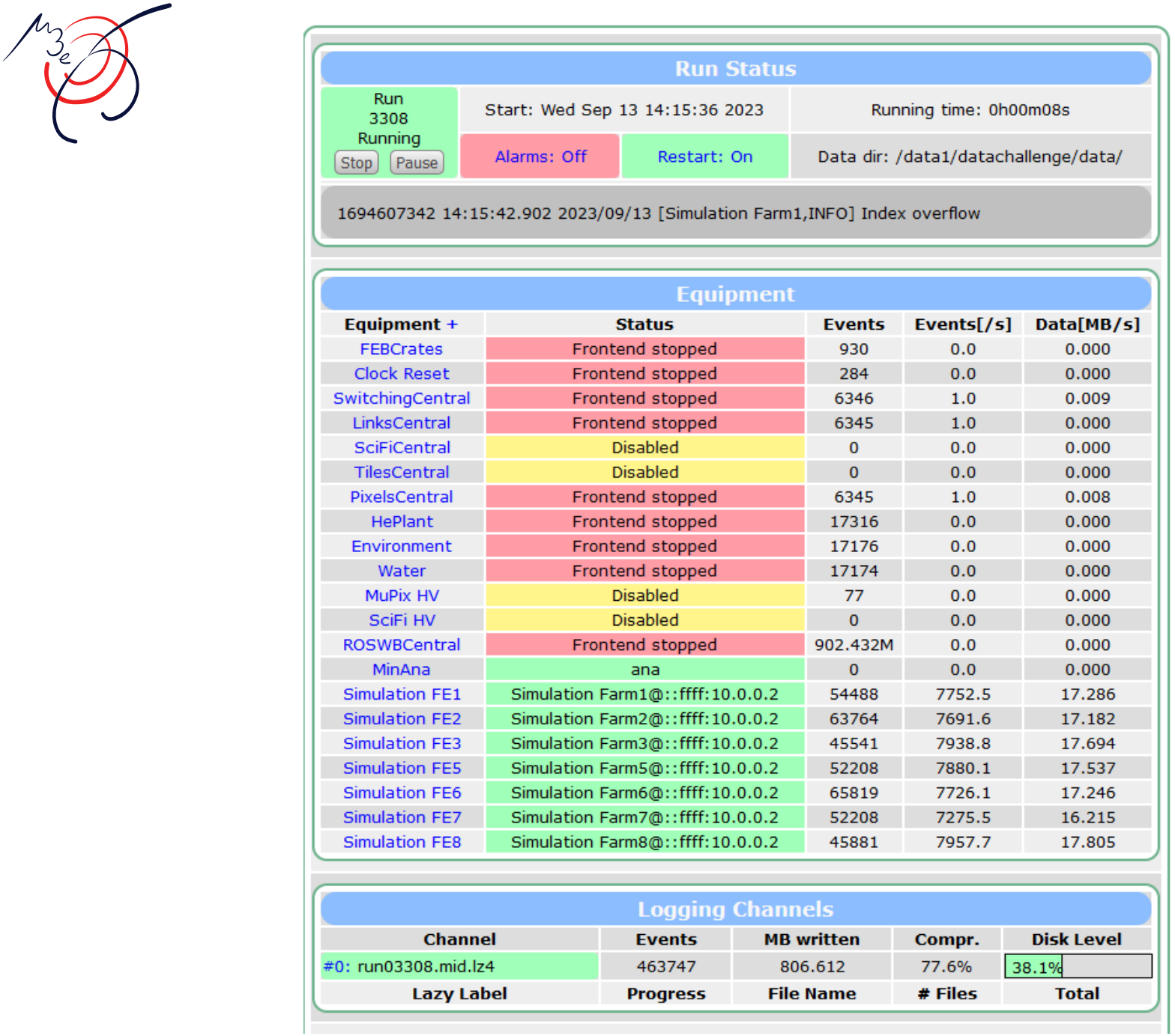
Hack (?!):

- Compile the same MIDAS FE several times with a different name
  (Farm1, Farm2 etc...)
- If you ever wondered what for-loops in CMake could be useful for...
- Each MIDAS FE produces unique event serial numbers
  (serial = serial * NFARMS + index)
- This works...



Run Status

Run 3308 Running Stop Pause	Start: Wed Sep 13 14:15:36 2023		Running time: 0h00m08s
	Alarms: Off	Restart: On	Data dir: /data1/datachallenge/data/

1694607342 14:15:42.902 2023/09/13 [Simulation Farm1,INFO] Index overflow

Equipment

Equipment +	Status	Events	Events[/s]	Data[MB/s]
FEBCrates	Frontend stopped	930	0.0	0.000
Clock Reset	Frontend stopped	284	0.0	0.000
SwitchingCentral	Frontend stopped	6346	1.0	0.009
LinksCentral	Frontend stopped	6345	1.0	0.000
SciFiCentral	Disabled	0	0.0	0.000
TilesCentral	Disabled	0	0.0	0.000
PixelsCentral	Frontend stopped	6345	1.0	0.008
HePlant	Frontend stopped	17316	0.0	0.000
Environment	Frontend stopped	17176	0.0	0.000
Water	Frontend stopped	17174	0.0	0.000
MuPix HV	Disabled	77	0.0	0.000
SciFi HV	Disabled	0	0.0	0.000
ROSWBCentral	Frontend stopped	902.432M	0.0	0.000
MinAna	ana	0	0.0	0.000
Simulation FE1	Simulation Farm1@::ffff:10.0.0.2	54488	7752.5	17.286
Simulation FE2	Simulation Farm2@::ffff:10.0.0.2	63764	7691.6	17.182
Simulation FE3	Simulation Farm3@::ffff:10.0.0.2	45541	7938.8	17.694
Simulation FE5	Simulation Farm5@::ffff:10.0.0.2	52208	7880.1	17.537
Simulation FE6	Simulation Farm6@::ffff:10.0.0.2	65819	7726.1	17.246
Simulation FE7	Simulation Farm7@::ffff:10.0.0.2	52208	7275.5	16.215
Simulation FE8	Simulation Farm8@::ffff:10.0.0.2	45881	7957.7	17.805

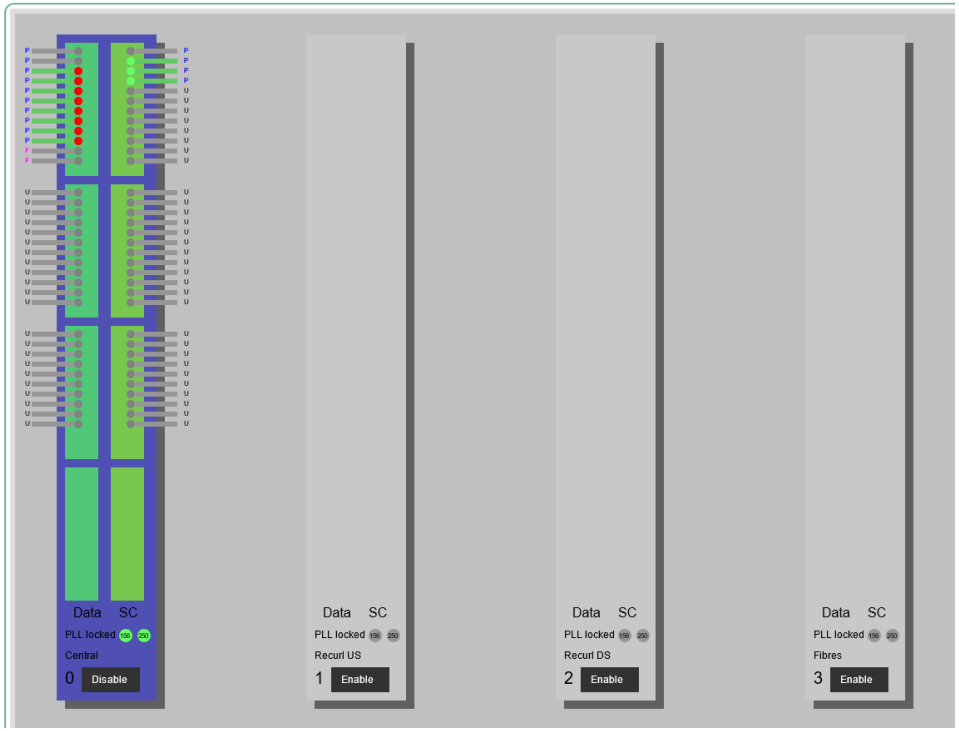
Logging Channels

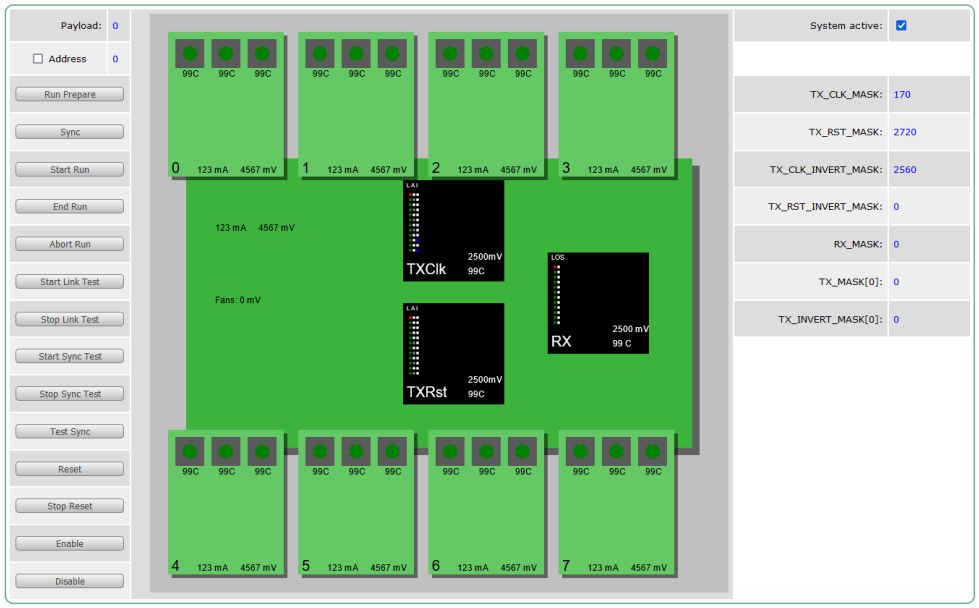
Channel	Events	MB written	Compr.	Disk Level
#0: run03308.mid.lz4	463747	806.612	77.6%	38.1%
Lazy Label	**Progress**	**File Name**	**# Files**	**Total**

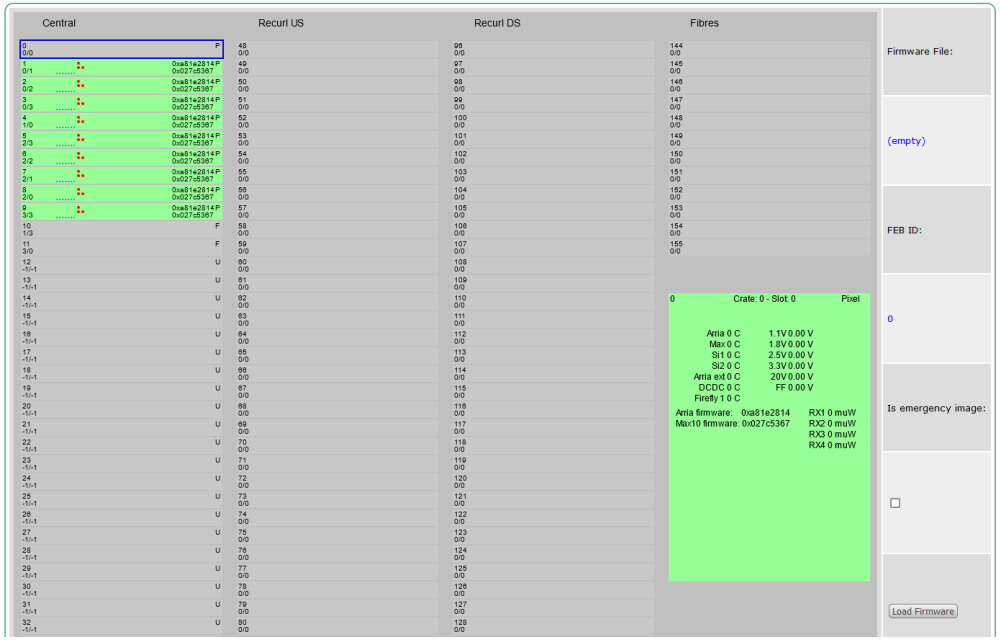
- Mu3e data challenge this week (data from simulation files)
- Runs without problems for hours

Things not talked about

- We have most of the experiment control and monitoring (including custom pages) up and running







Things that came up

- Can I get 64 bit integers in the ODB (our system is full of 35 bit or 48 bit bitmasks)?

- Is there a more clever way to get a dozen identical frontends?

Thanks to the MIDAS team for their great work!