

Mu3e DAQ in MIDAS



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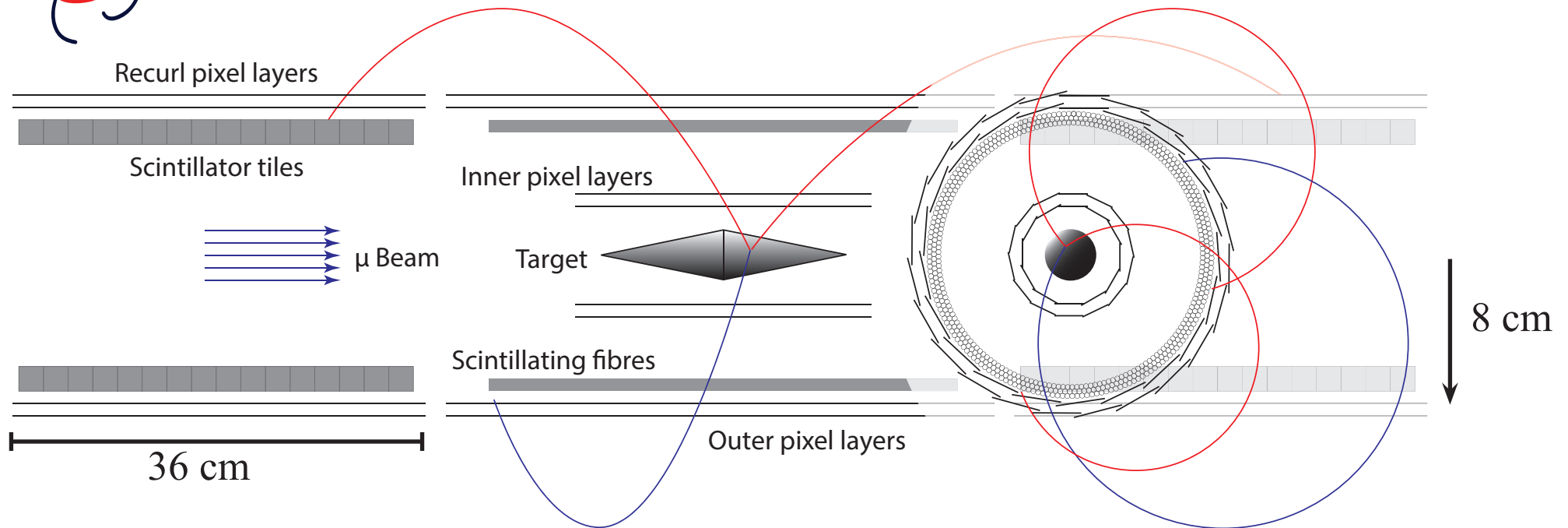
JGU Mainz



MIDAS Workshop, September 2023



The Mu3e Detector

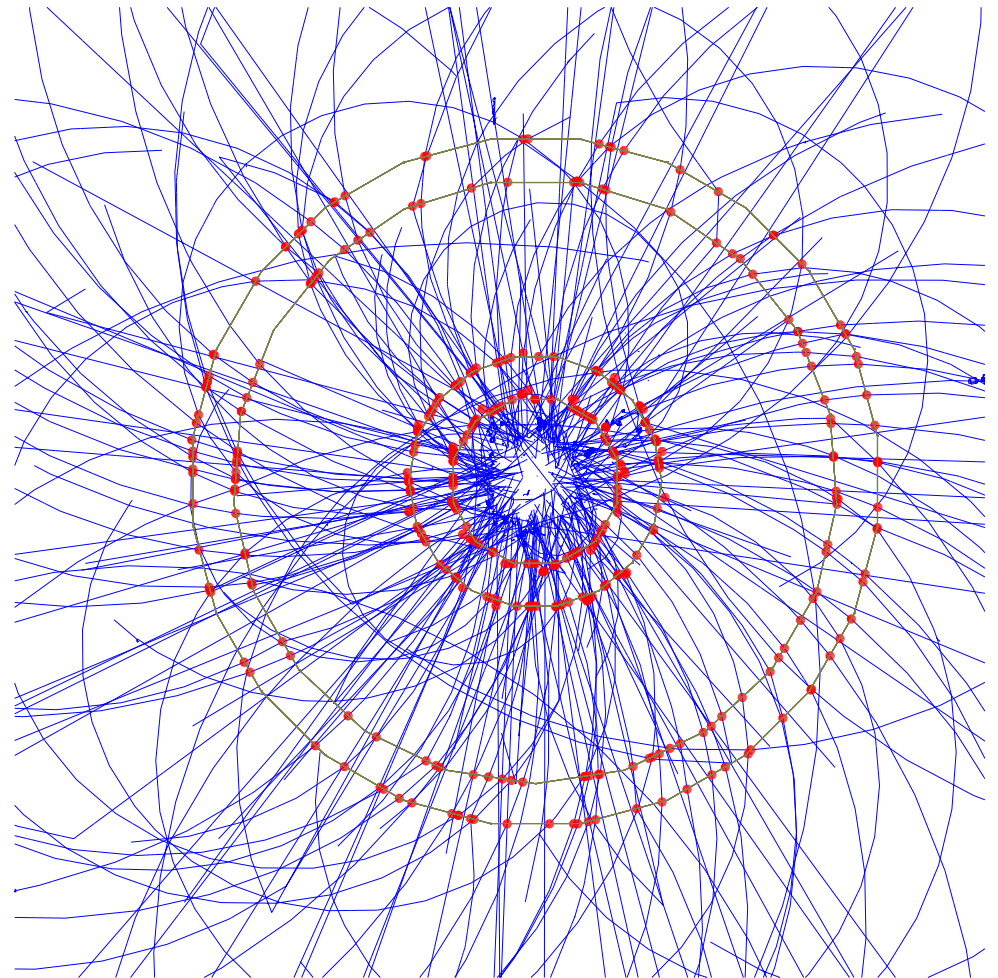


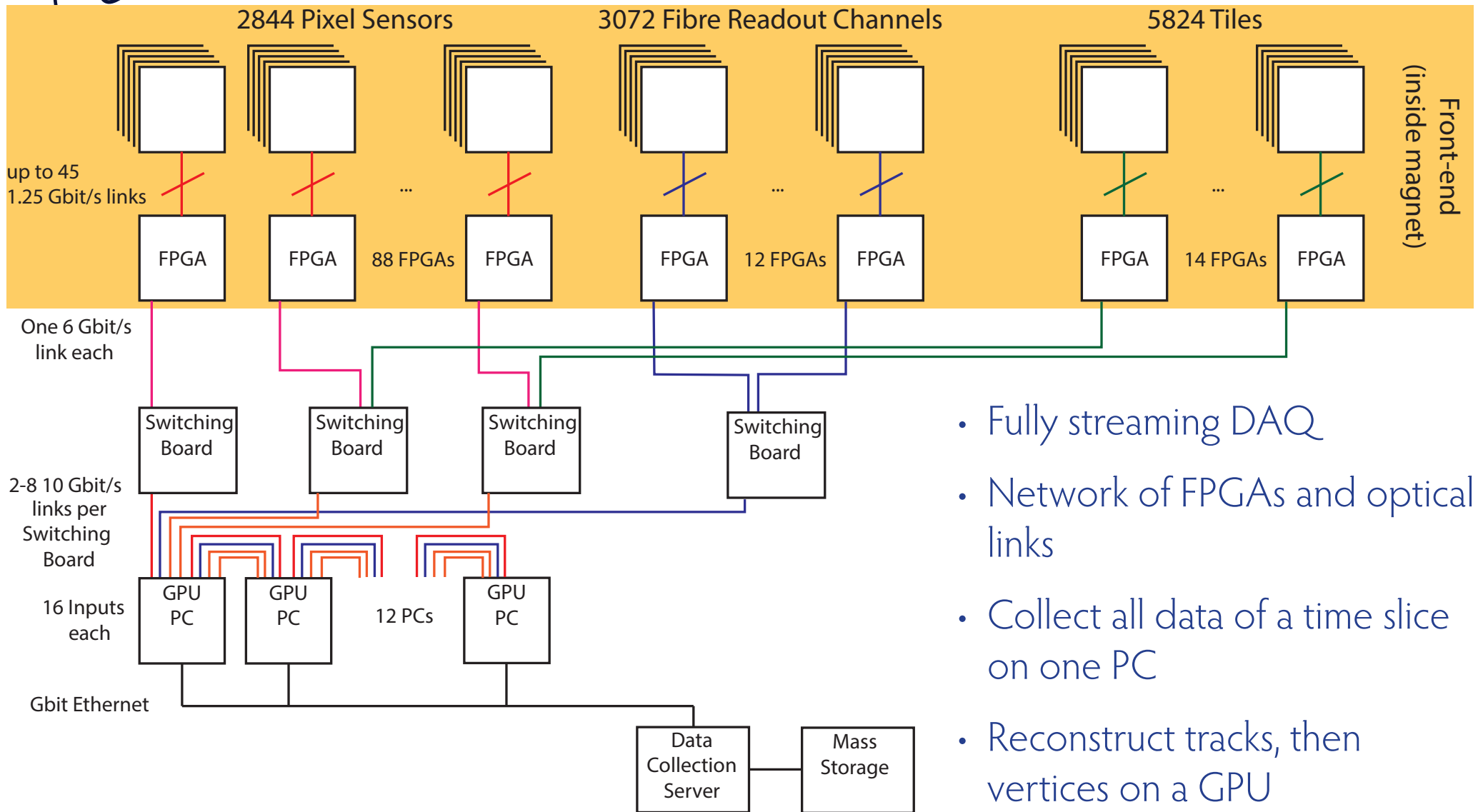
- 1 T solenoid field
- Helium atmosphere to reduce scattering and for cooling
- Minimize material to minimize scattering
- Ultra-thin layers of high-voltage monolithic active pixel sensors (HV-MAPS)
- Scintillating fibres and tiles for improved timing measurements
- Long lever arm of recurling tracks gives precise momentum measurement



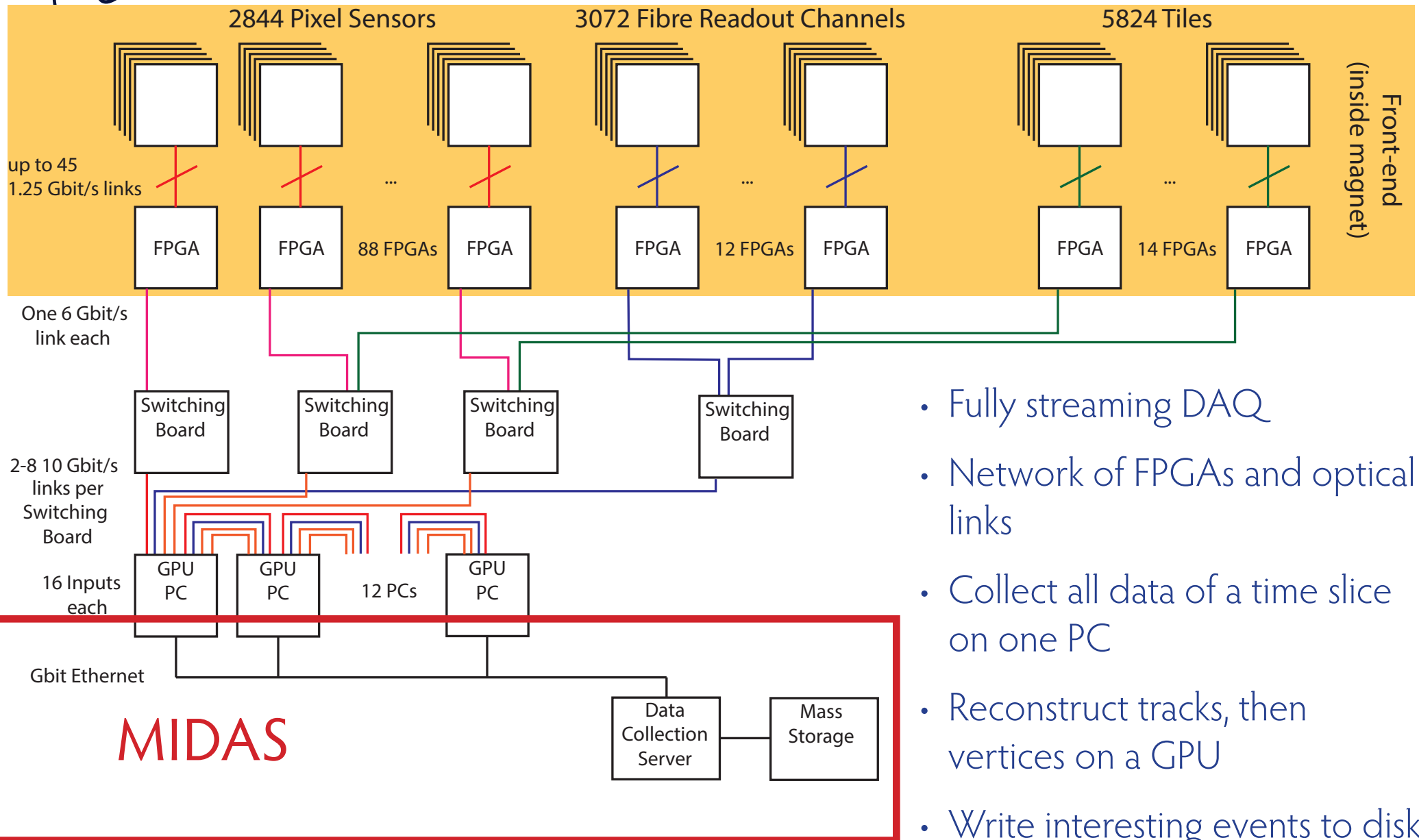
Requirements for the data acquisition

- 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





- 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

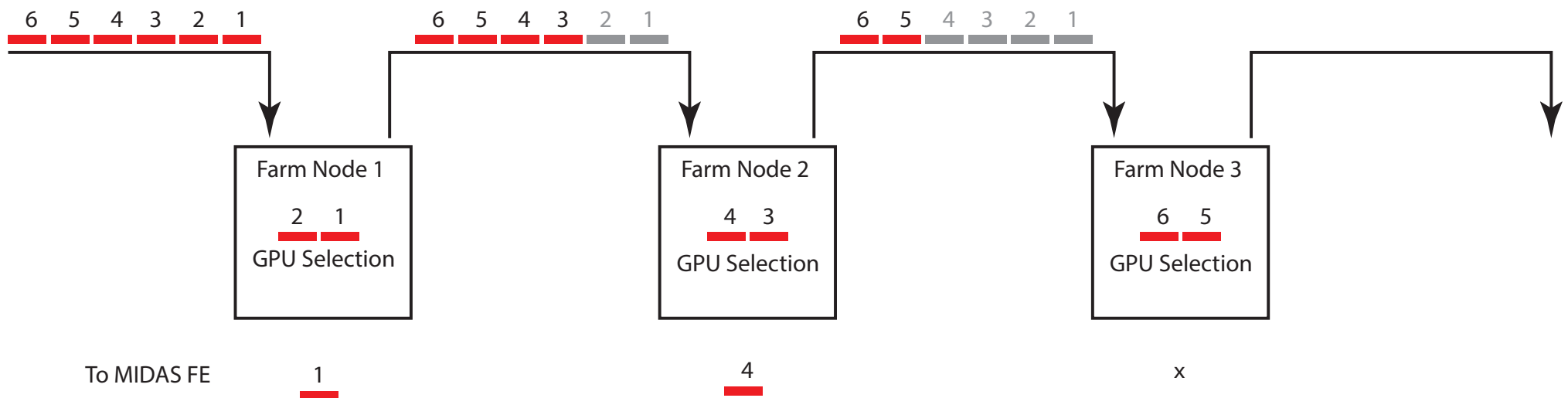


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The Mu3e Filter Farm

- 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	Start: Wed Sep 13 14:15:36 2023	Running time: 0h00m08s
<input type="button" value="Stop"/> <input type="button" value="Pause"/>	Alarms: Off	Restart: On
Data dir: /data1/datachallenge/data/		

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

Equipment

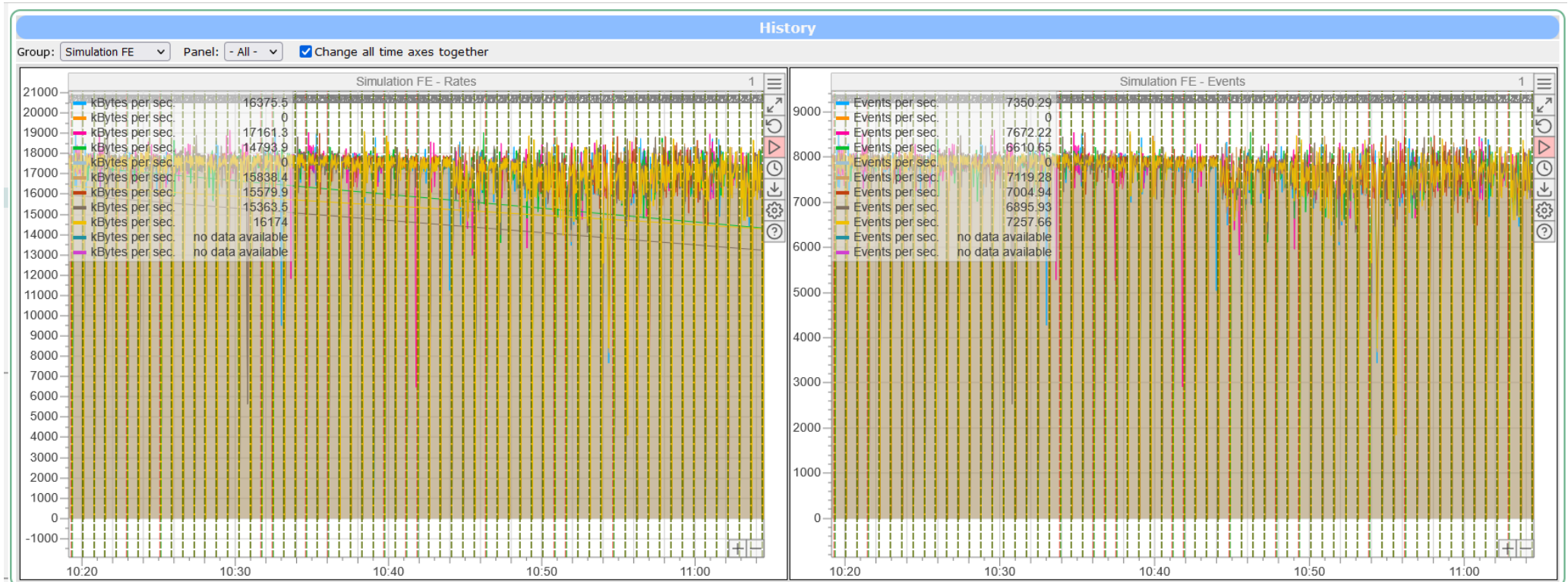
Equipment +	Status	Events	Events[/s]	Data[MB/s]
FEBCrates	Frontend stopped	930	0.0	0.000
Clock Reset	Frontend stopped	284	0.0	0.000
SwitchingCentral	Frontend stopped	6346	1.0	0.009
LinksCentral	Frontend stopped	6345	1.0	0.000
SciFiCentral	Disabled	0	0.0	0.000
TilesCentral	Disabled	0	0.0	0.000
PixelsCentral	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

System active:	<input checked="" type="checkbox"/>
TX_CLK_MASK:	170
TX_RST_MASK:	2720
TX_CLK_INVERT_MASK:	2560
TX_RST_INVERT_MASK:	0
RX_MASK:	0
TX_MASK[0]:	0
TX_INVERT_MASK[0]:	0

Central	Recur US	Recur DS	Fibres
0/0	48	98	144
0/1	49	97	145
2	50	98	148
3	51	99	147
4	52	100	148
1/0	53	101	149
2/3	54	102	150
2/2	55	103	151
2/1	56	104	152
0	57	105	153
3/3	58	106	154
10	59	107	155
11	60	108	156
3/0	61	109	157
12	62	110	158
-1/1	63	111	159
13	64	112	160
-1/1	65	113	161
14	66	114	162
-1/1	67	115	163
15	68	116	164
-1/1	69	117	165
16	70	118	166
-1/1	71	119	167
17	72	120	168
-1/1	73	121	169
18	74	122	170
-1/1	75	123	171
19	76	124	172
-1/1	77	125	173
20	78	126	174
-1/1	79	127	175
21	80	128	176
-1/1	81	129	177
22	82	130	178
-1/1	83	131	179
23	84	132	180
-1/1	85	133	181
24	86	134	182
-1/1	87	135	183
25	88	136	184
-1/1	89	137	185
26	90	138	186
-1/1	91	139	187
27	92	140	188
-1/1	93	141	189
28	94	142	190
-1/1	95	143	191
29	96	144	192
-1/1	97	145	193
30	98	146	194
-1/1	99	147	195
31	100	148	196
-1/1	101	149	197
32	102	150	198
-1/1	103	151	199

Firmware File:
 (empty)
 FEB ID:
 0
 Is emergency image:

 Load Firmware



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!