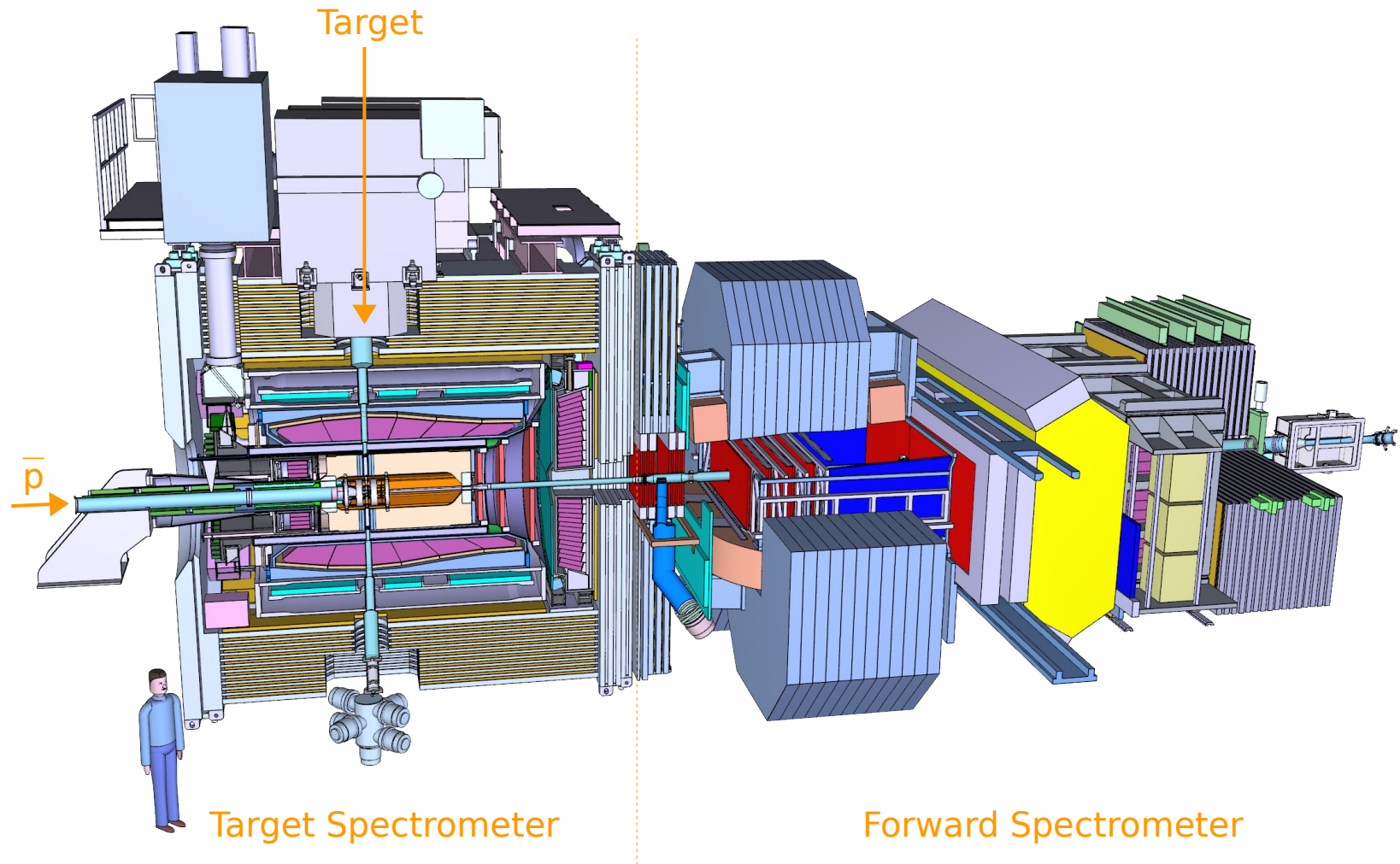


Characterization of the Strip Front-End ASIC of the PANDA MVD with the JDRS

18.03.2019 | DPG SPRING MEETING, ALESSANDRA LAI



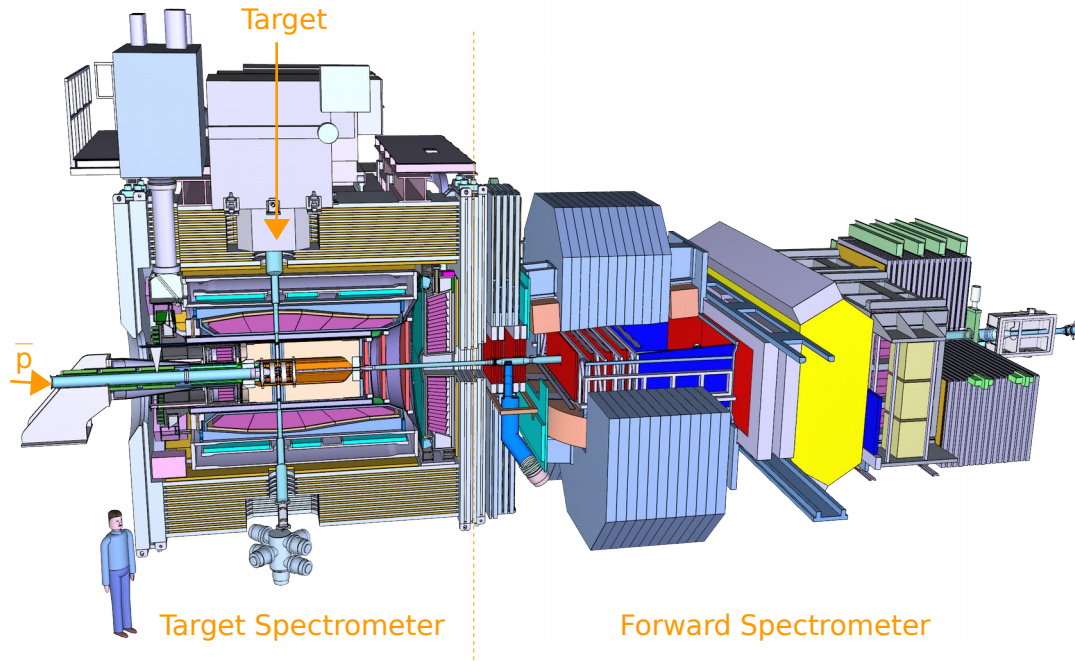
PANDA Experiment



- Cooled \bar{p} beam @HESR
 - $1.5 \text{ GeV}/c < p < 15 \text{ GeV}/c$
 - $\Delta p/p < 10^{-4}$

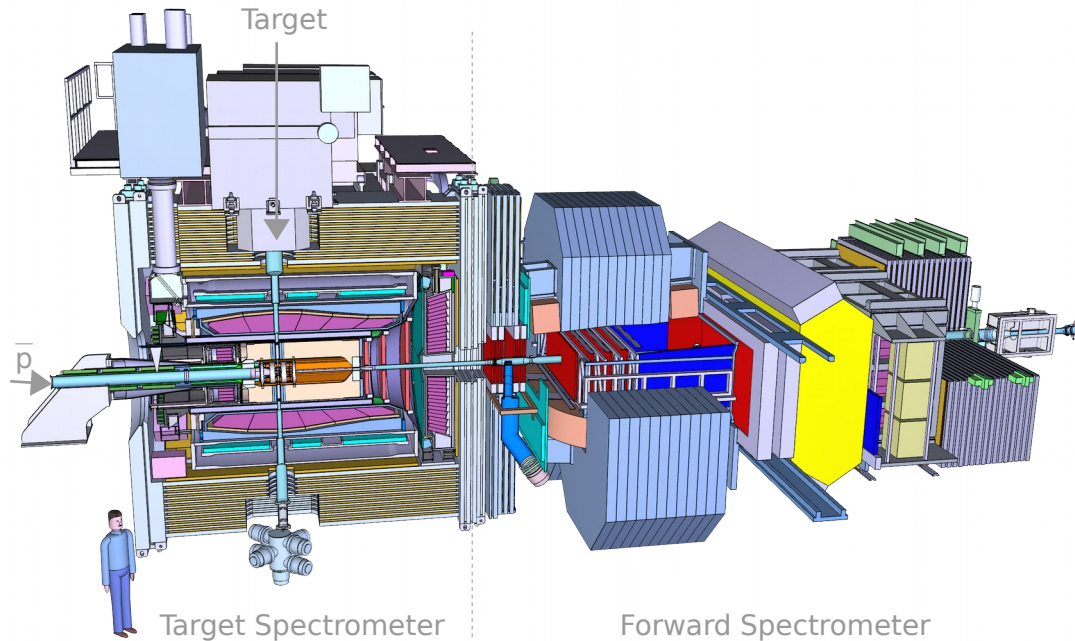
- Study strong interaction
 - Multi-s and c hadron spectroscopy
 - Exotic states
 - Nucleon structure
 - $\bar{p}A$ collisions

PANDA Experiment



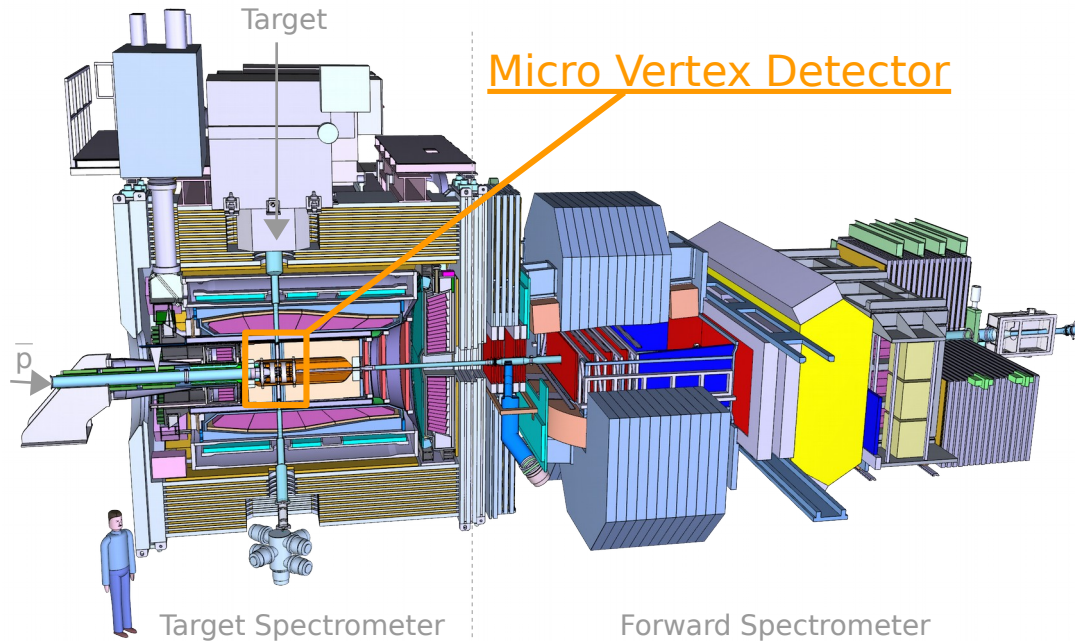
- Cooled antiproton beam @HESR
 - $1.5 \text{ GeV}/c < p < 15 \text{ GeV}/c$
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PANDA Experiment



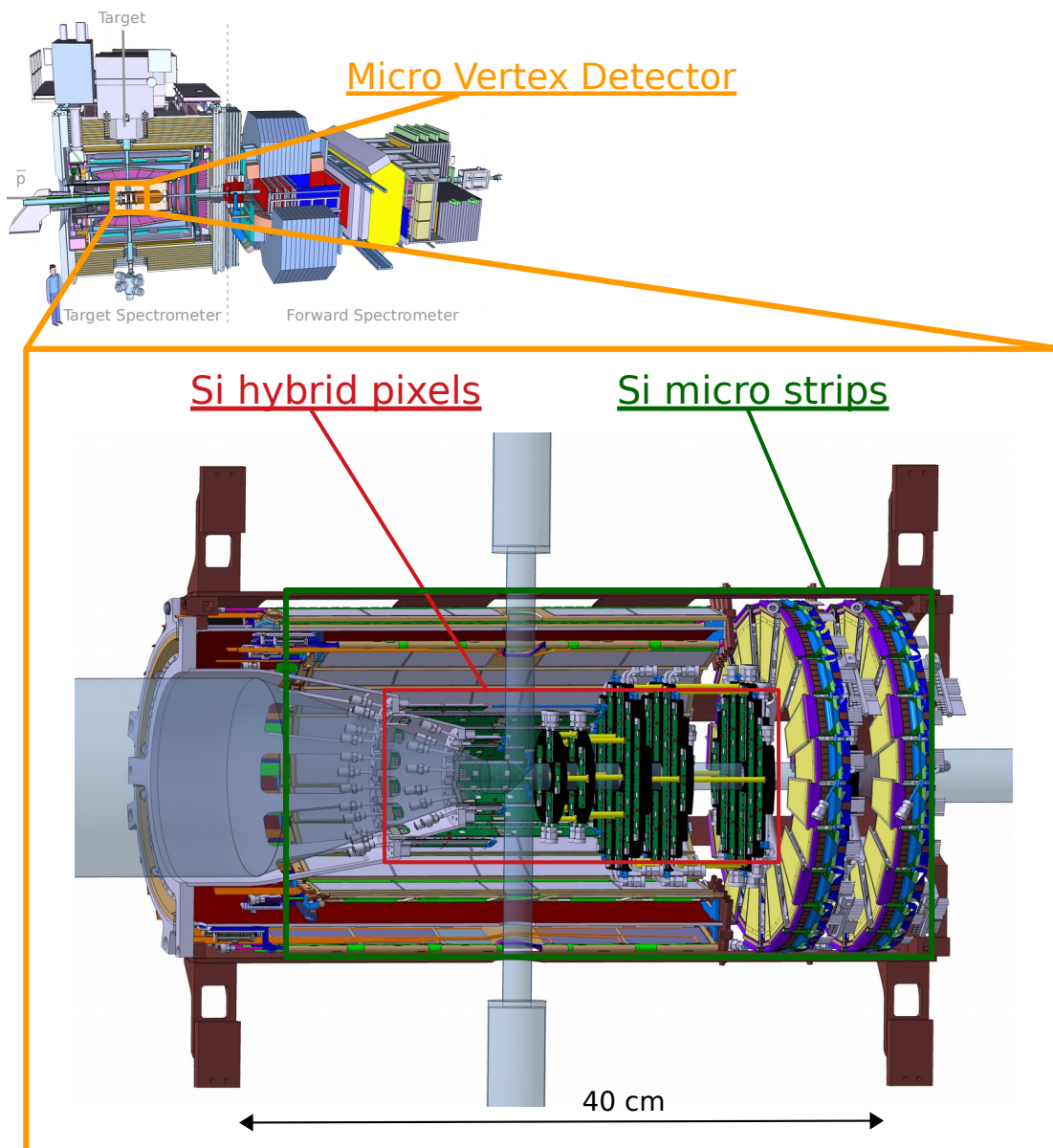
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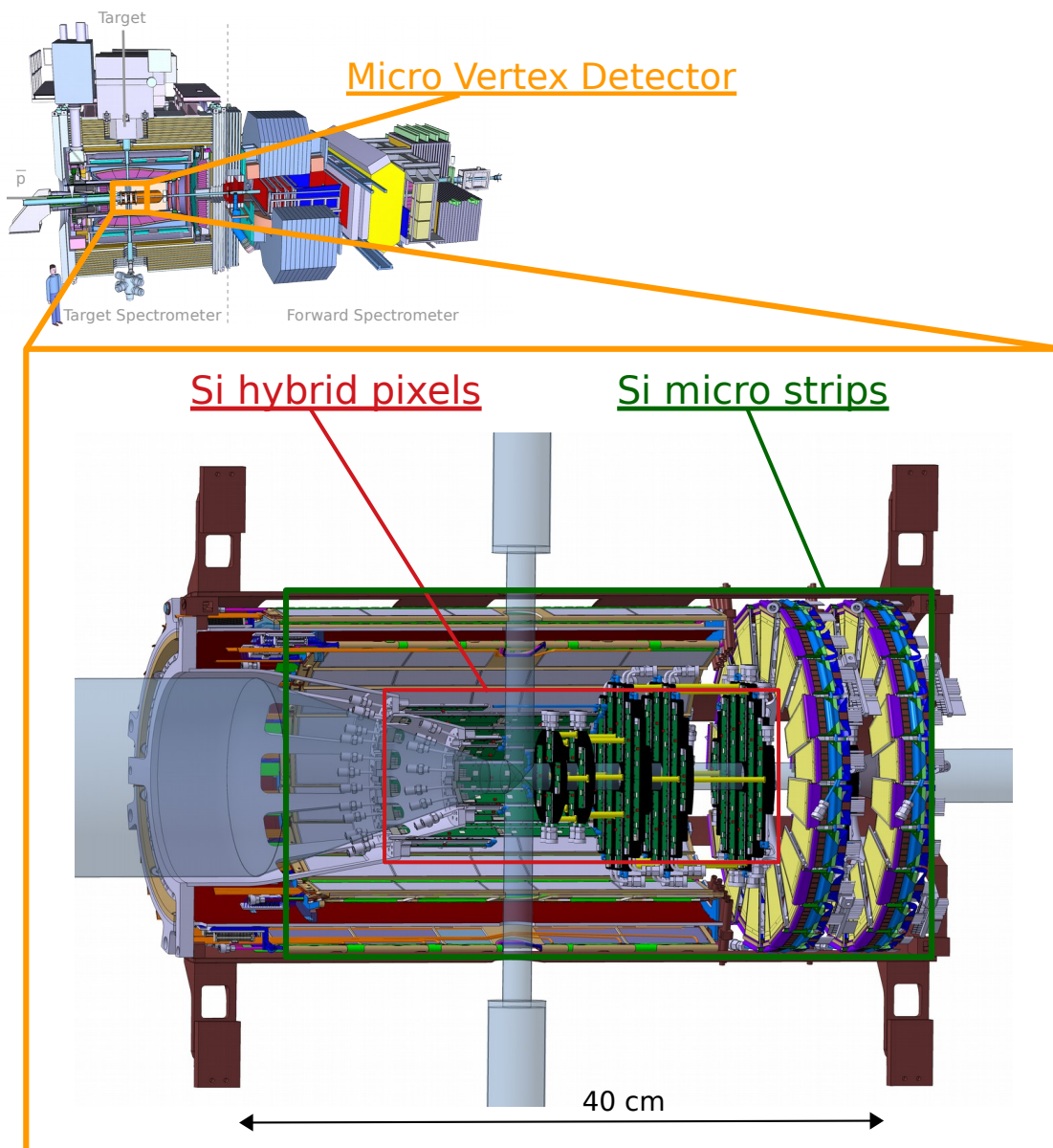
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- Spatial resolution $< 100 \mu\text{m}$
- Time resolution $< 10 \text{ ns}$
- Continuous readout

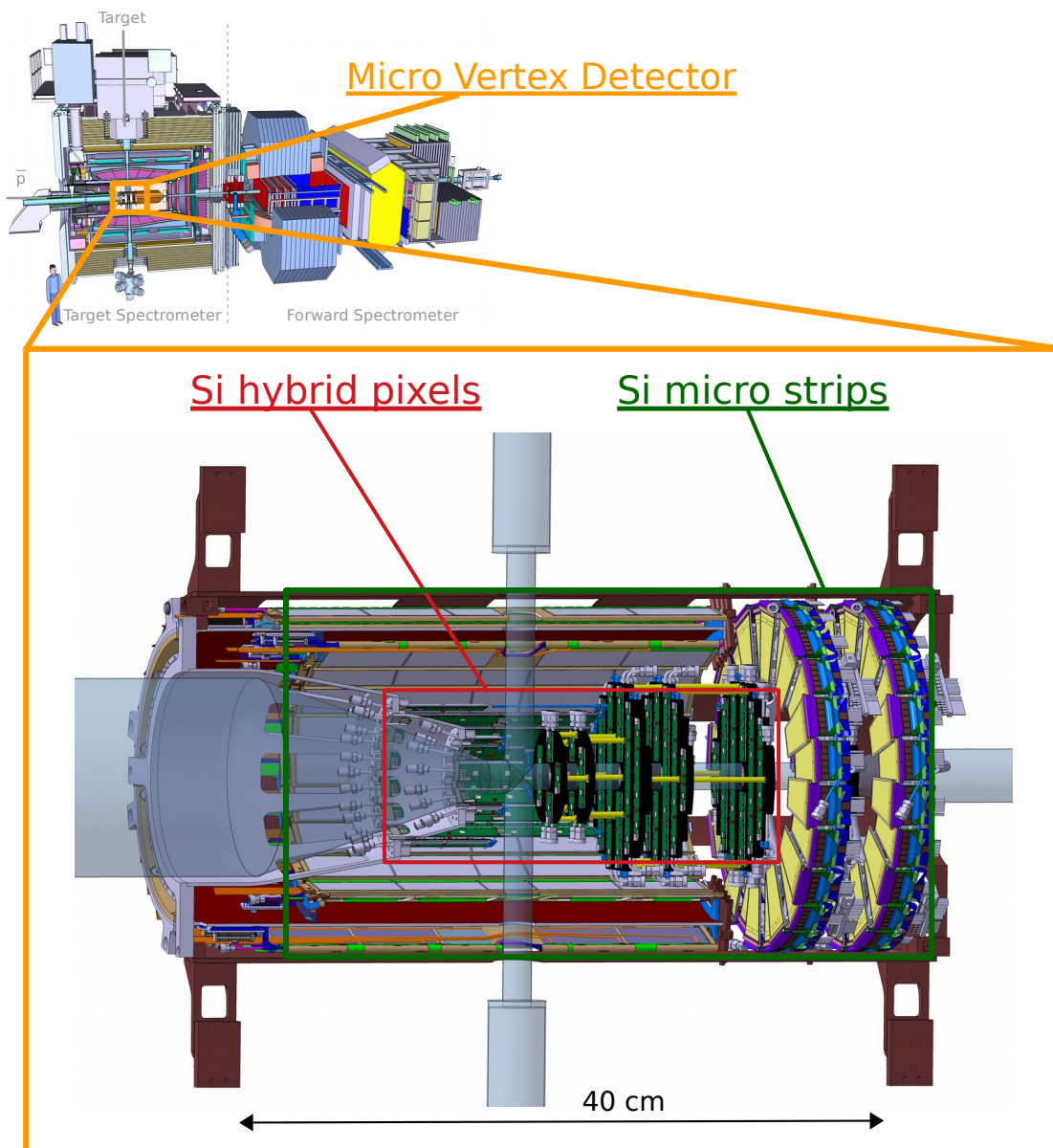
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- Custom front-end chips
 - ToPix, PASTA

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PANDA Experiment

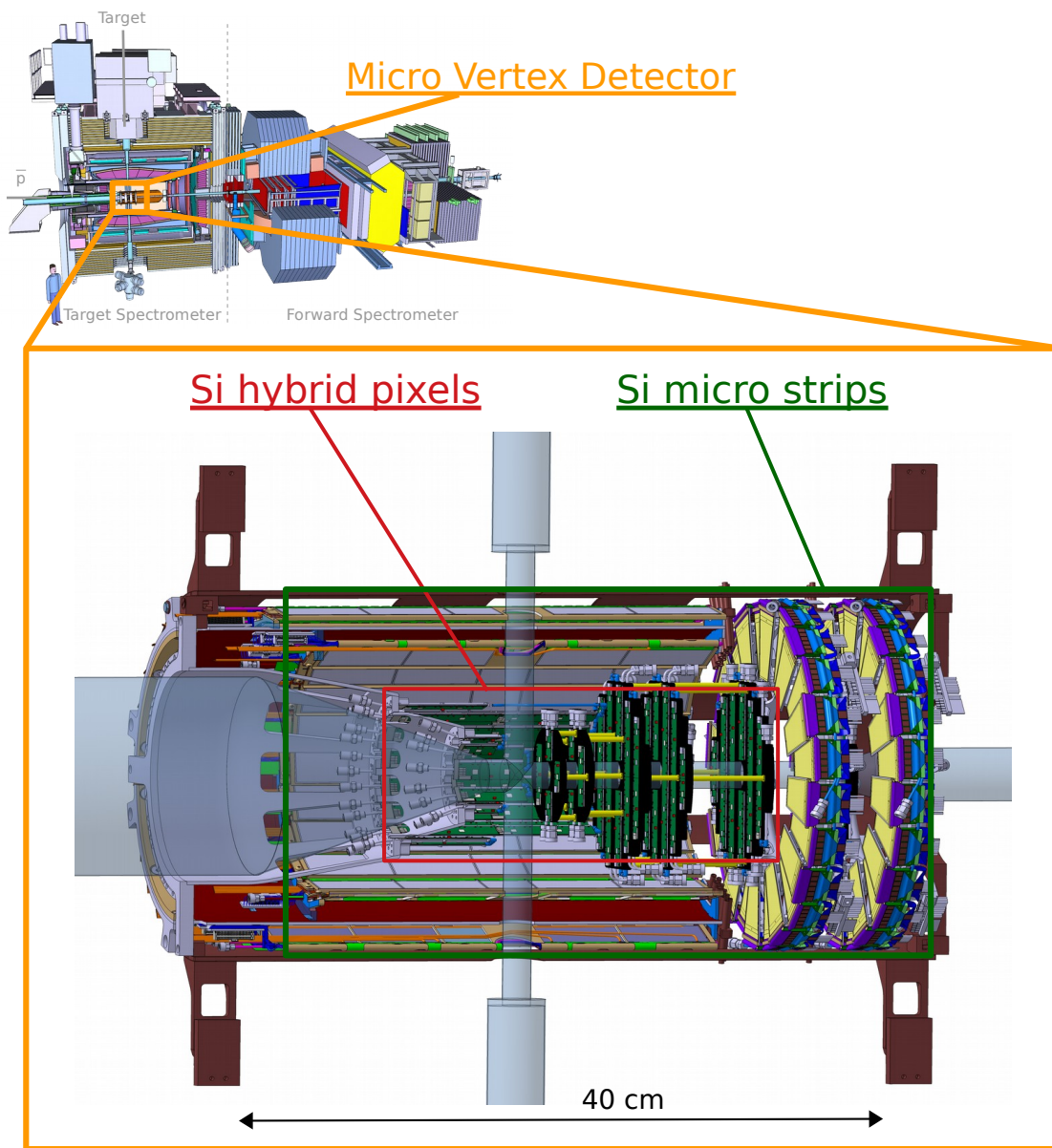


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Versatile data acquisition system for the different front-end prototypes

- Spatial resolution $< 100 \mu\text{m}$
- Time resolution $< 10 \text{ ns}$
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PANDA Experiment



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 - $1.5 \text{ GeV}/c < p < 15 \text{ GeV}/c$
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Versatile data acquisition system for the different front-end prototypes

Jülich Digital Readout System

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- Time resolution $< 10 \text{ ns}$
- Continuous readout

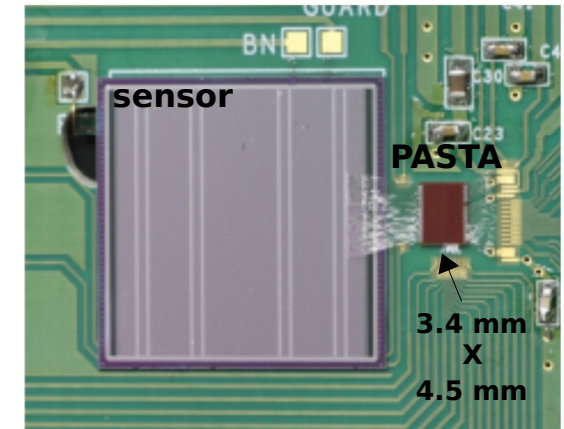
PASTA and JDRS

PASTA

- Time-over-threshold: time + charge measurement
 - low threshold: leading edge time stamp
 - high threshold: deposited charge

Self trigger capability

Number of channels	64
Frequency	160 MHz
Time resolution	6.25 ns



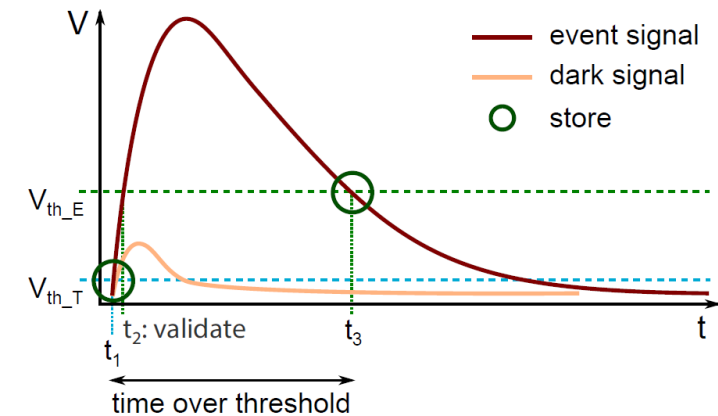
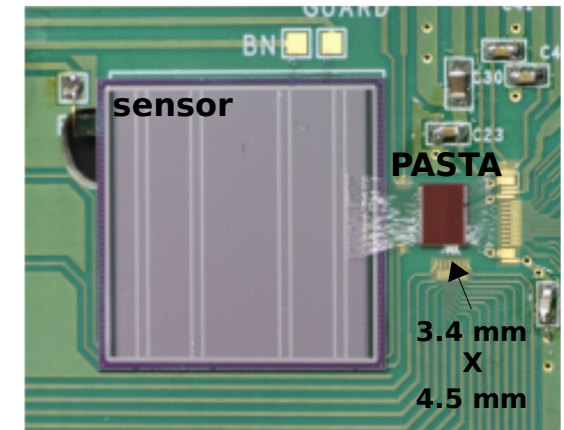
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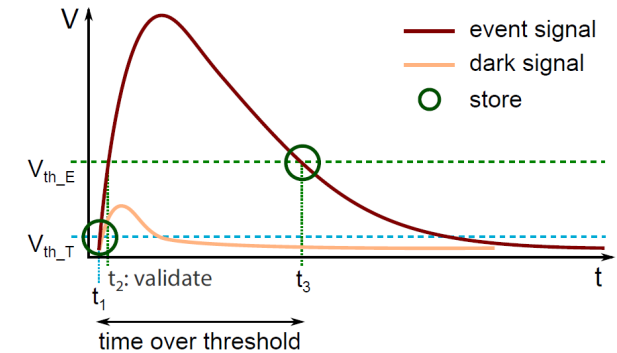
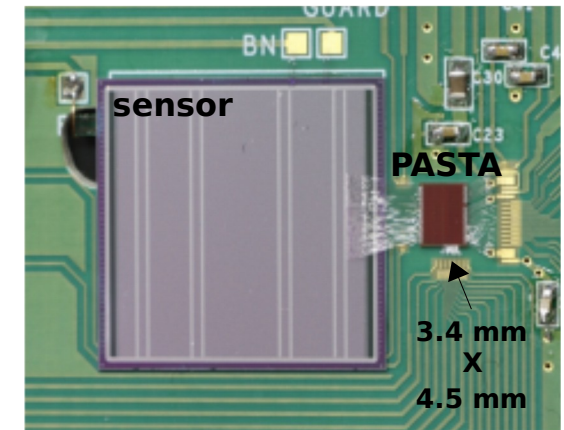
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PASTA

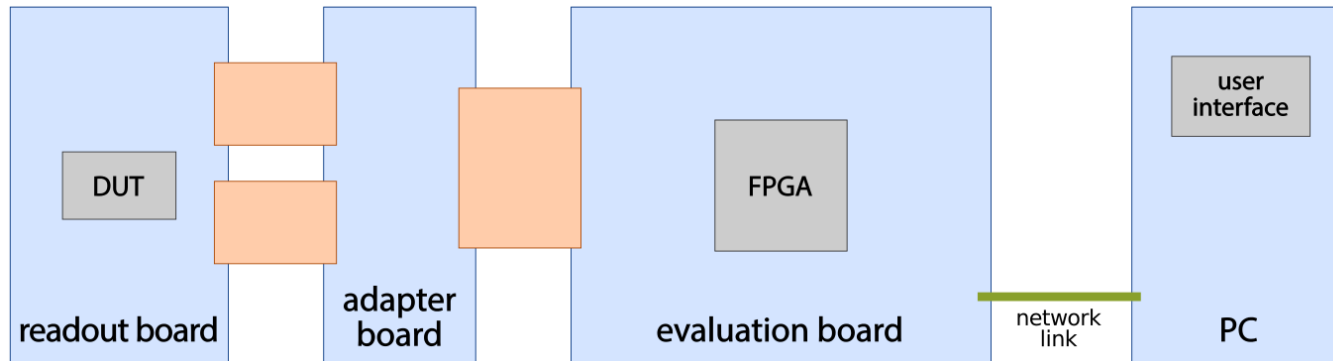
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JDRS



- Data flow
 - Encoded event data in PASTA
 - First processing and storing in FPGA register
 - Transfer to PC and further processing

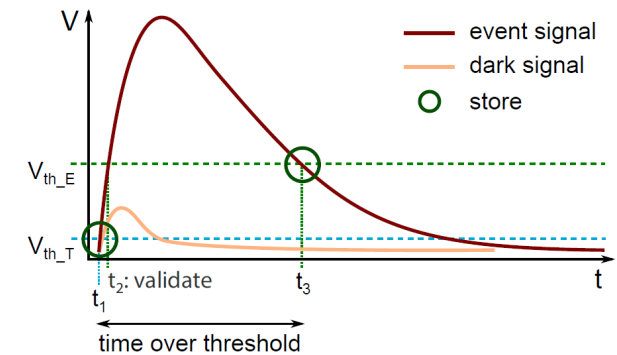
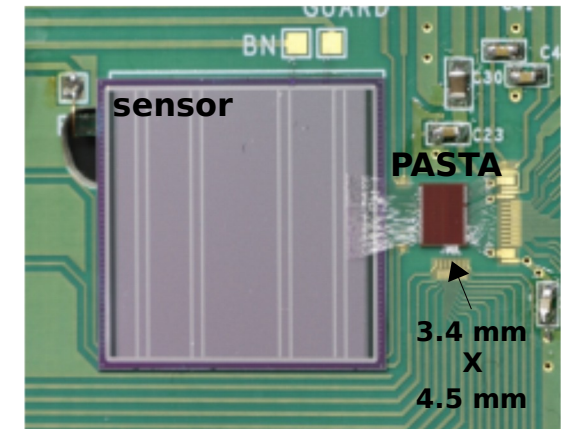
PASTA and JDRS

PASTA

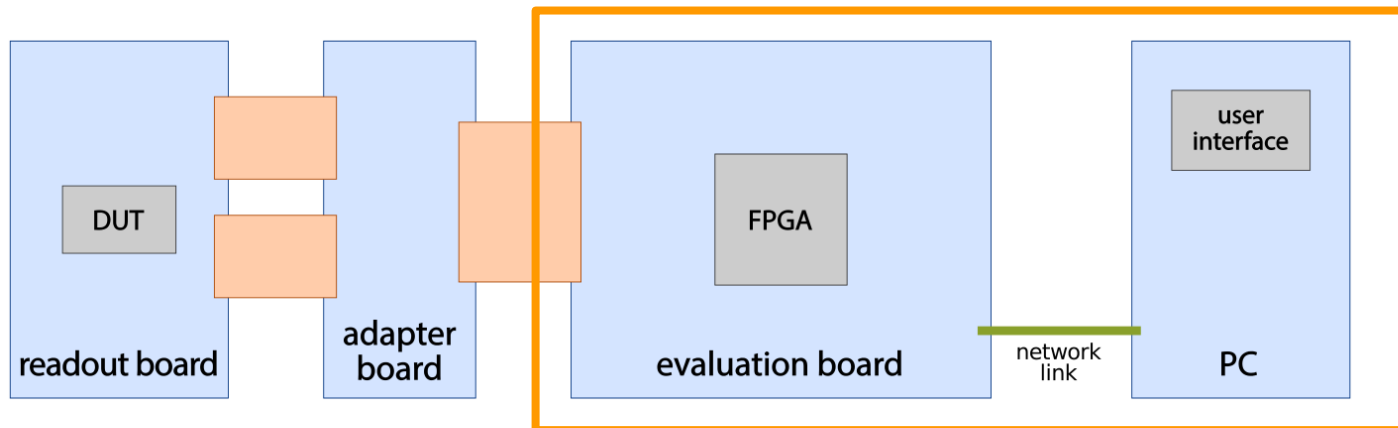
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Integration of PASTA in the JDRS

- Former version of JDRS (ToPix)
 - Lack of modularity and flexibility

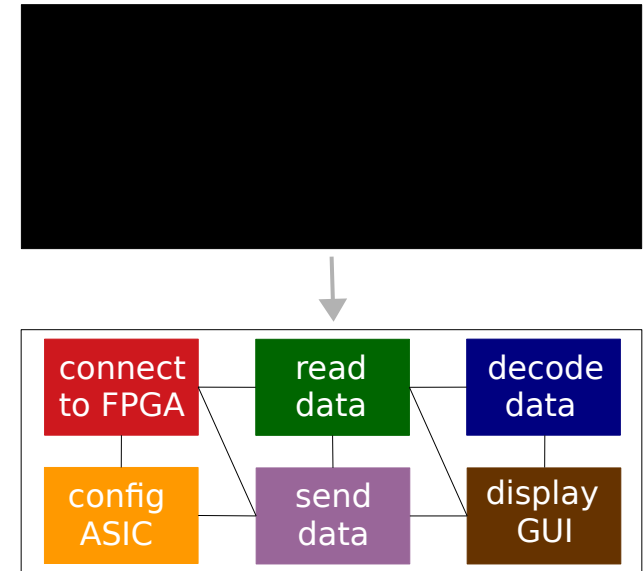
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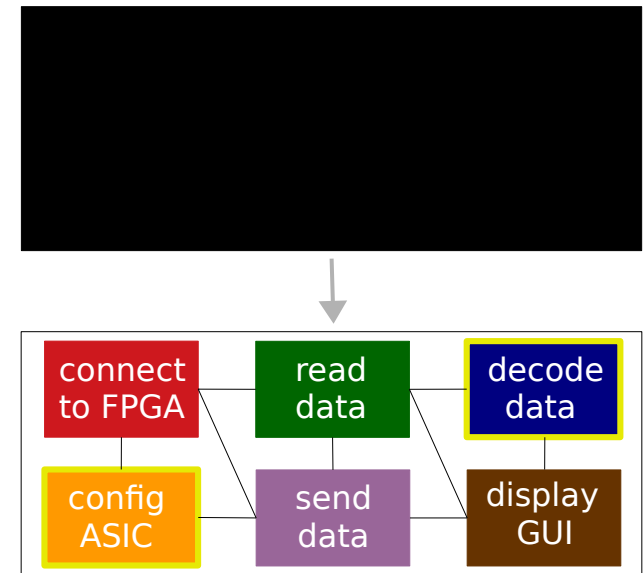
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- Restructuring of the code
 - Use multiple interconnected modules
 - Separate reusable modules from ASIC specific



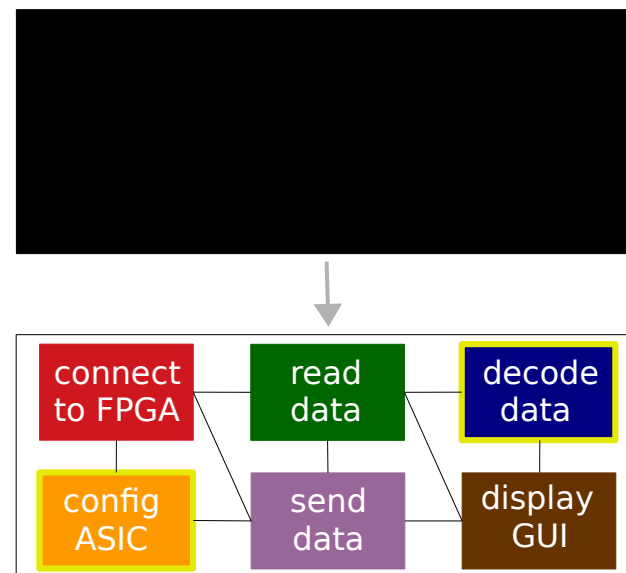
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21 parameters ↓

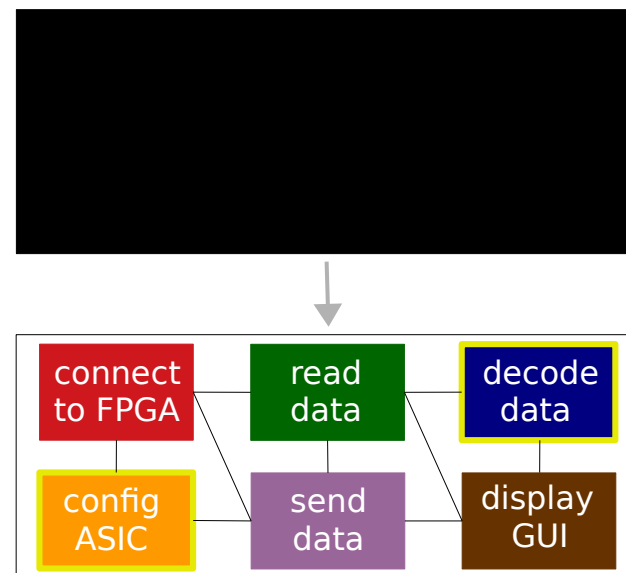
Item	Pos	Len	Min	Max
1 HCLDAC_e	28:32	5	0	31
2 HCLDAC_t	23:27	5	0	31
3 If	18:22	5	0	31
4 Iref_ratio_e	37:40	4	0	15
5 Iref_ratio_t	33:36	4	0	15
6 channel_en	0	1	0	1
7 count_discarded_evt	13	1	0	1
8 count_local_SEU	16	1	0	1
9 count_missed_evt	14	1	0	1
10 count_noise_evt	12	1	0	1
11 count_refresh	15	1	0	1
12 count_valid_evt	11	1	0	1
13 finish_config	41	1	0	1
14 hit_validation	5	1	0	1
15 parallel_sync_FF	6	1	0	1
16 prediction_mode	4	1	0	1
17 stop_signal_delay	9:10	2	0	3
18 sync_chain_length	7:8	2	0	3
19 test_mode_en	1	1	0	1
20 trigger_mode	2:3	2	0	3
21 use_delay_line	17	1	0	1

64 channels →

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
3	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

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11 count_refresh	15	1	0	1
12 count_valid_evt	11	1	0	1
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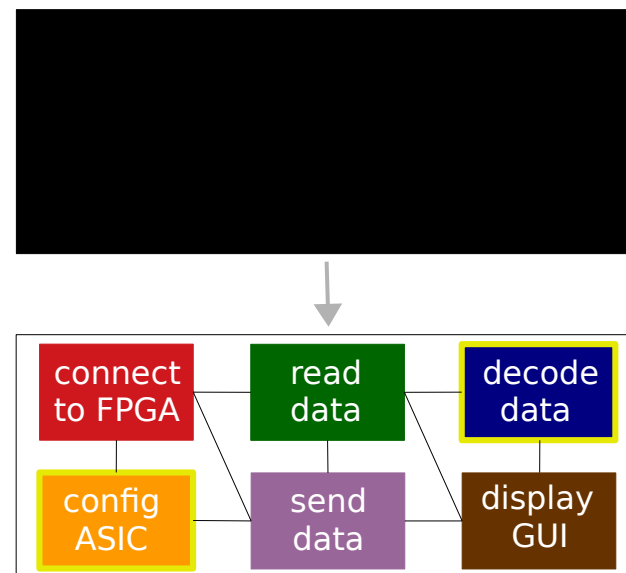
64 channels →

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
3	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

More than 1000 parameters to tune

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5 Iref_ratio_t	33:36	4	0	15
6 channel_en	0	1	0	1
7 count_discarded_evt	13	1	0	1
8 count_local_SEU	16	1	0	1
9 count_missed_evt	14	1	0	1
10 count_noise_evt	12	1	0	1
11 count_refresh	15	1	0	1
12 count_valid_evt	11	1	0	1
13 finish_config	41	1	0	1
14 hit_validation	5	1	0	1
15 parallel_sync_FF	6	1	0	1
16 prediction_mode	4	1	0	1
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	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
3	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

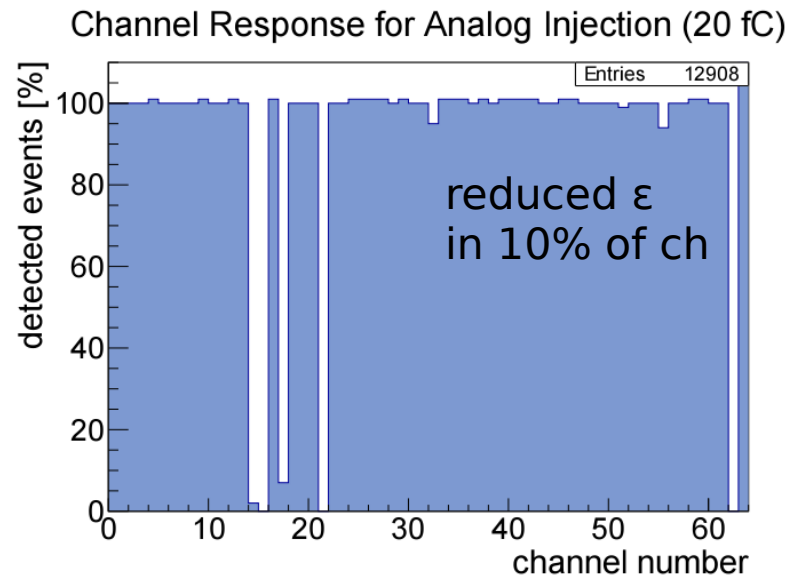
More than 1000 parameters to tune



Automatic routines

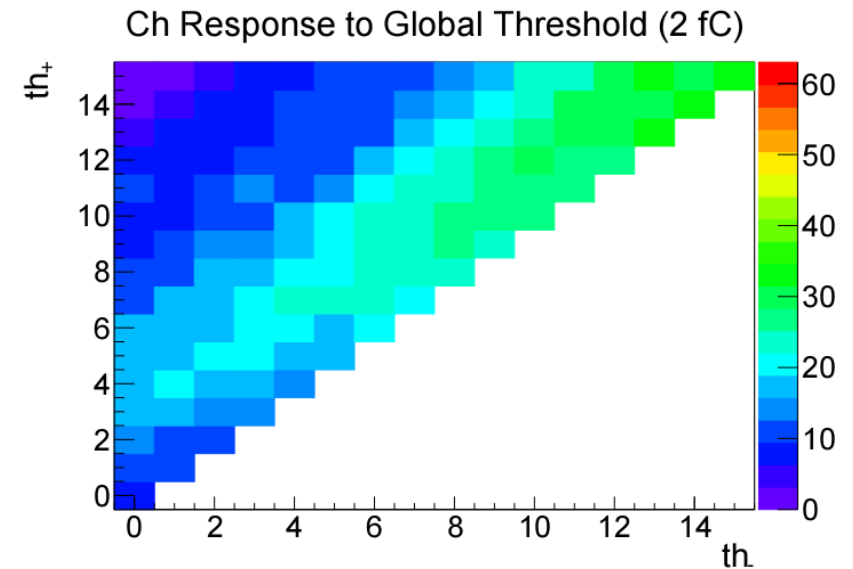
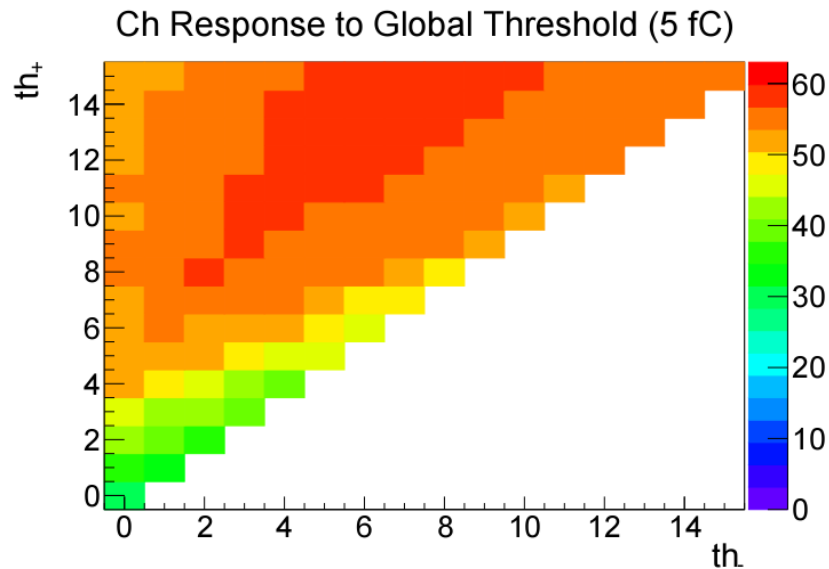
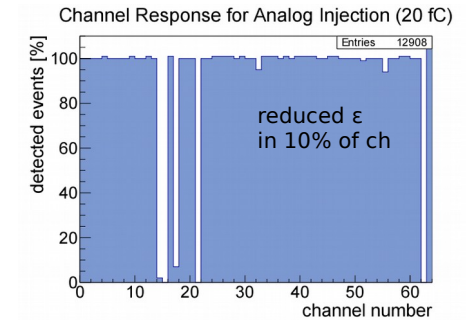
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response



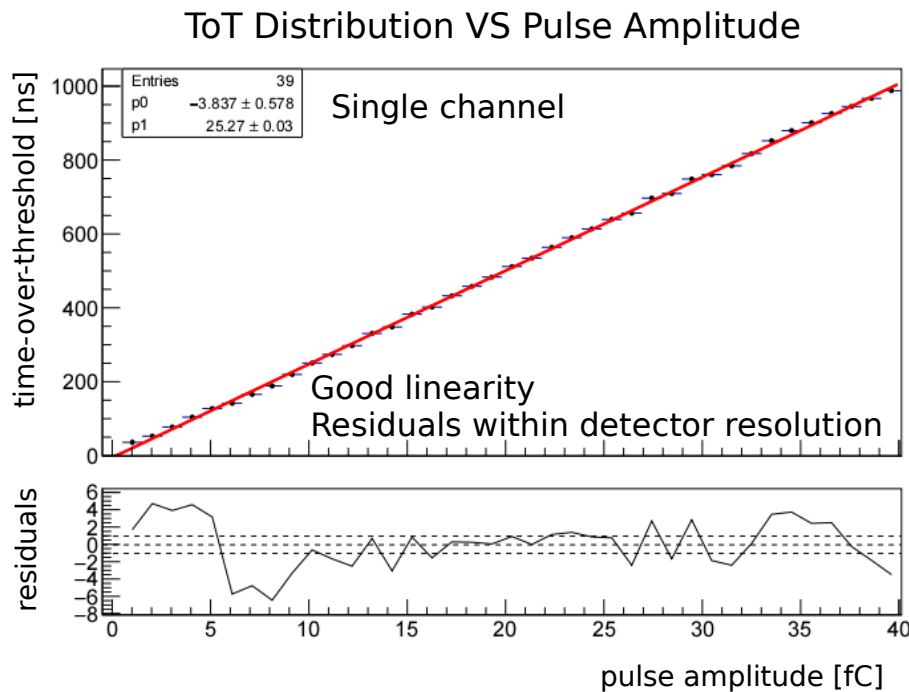
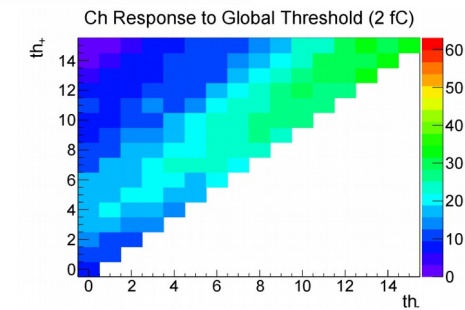
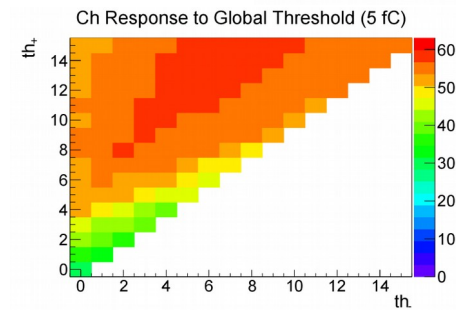
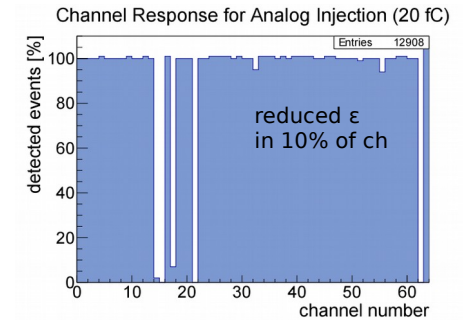
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)



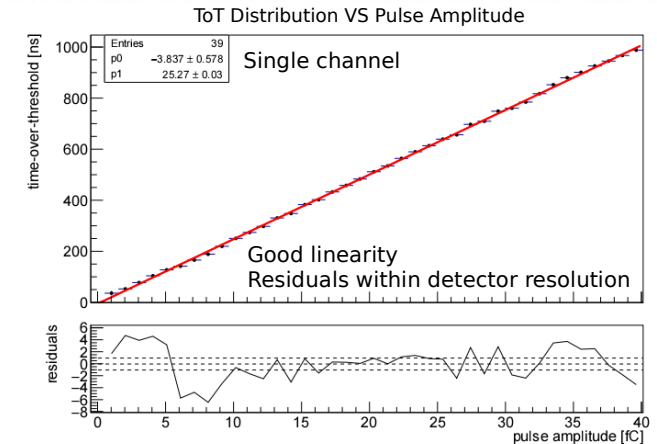
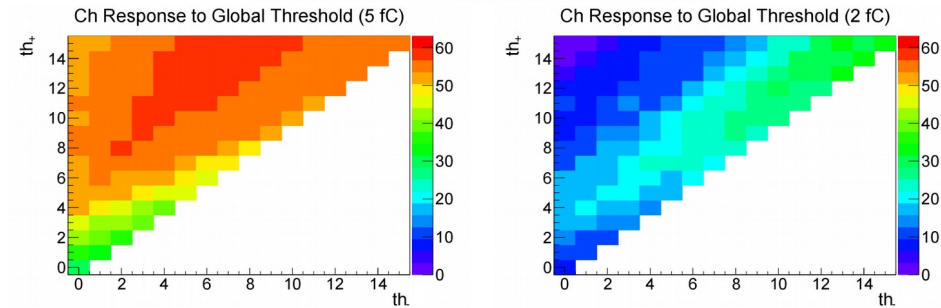
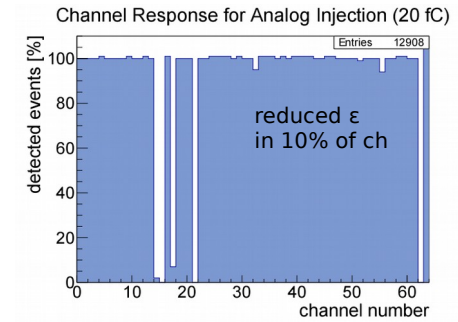
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end



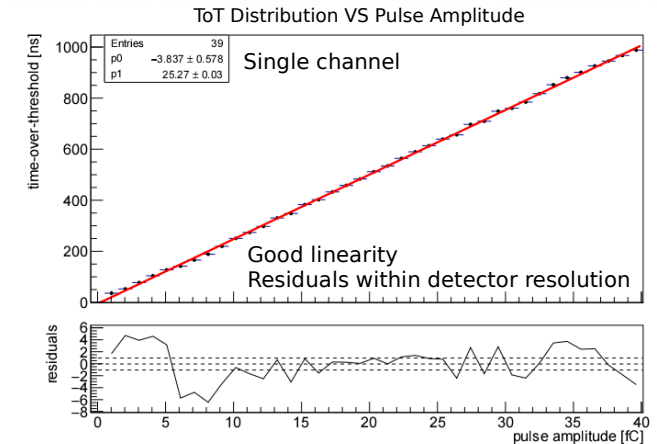
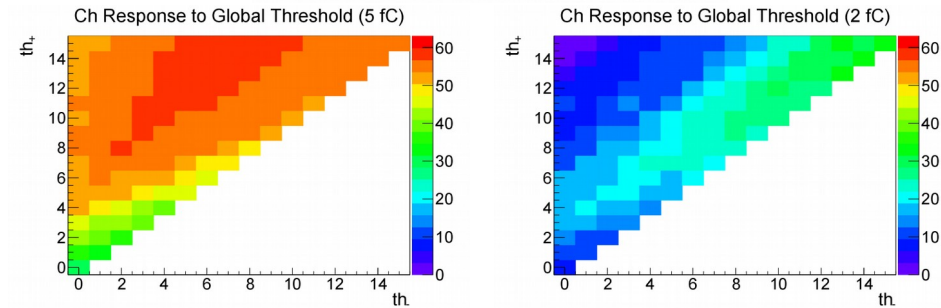
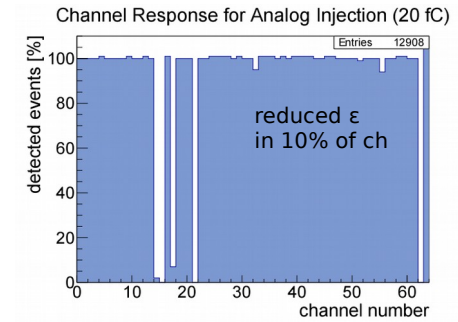
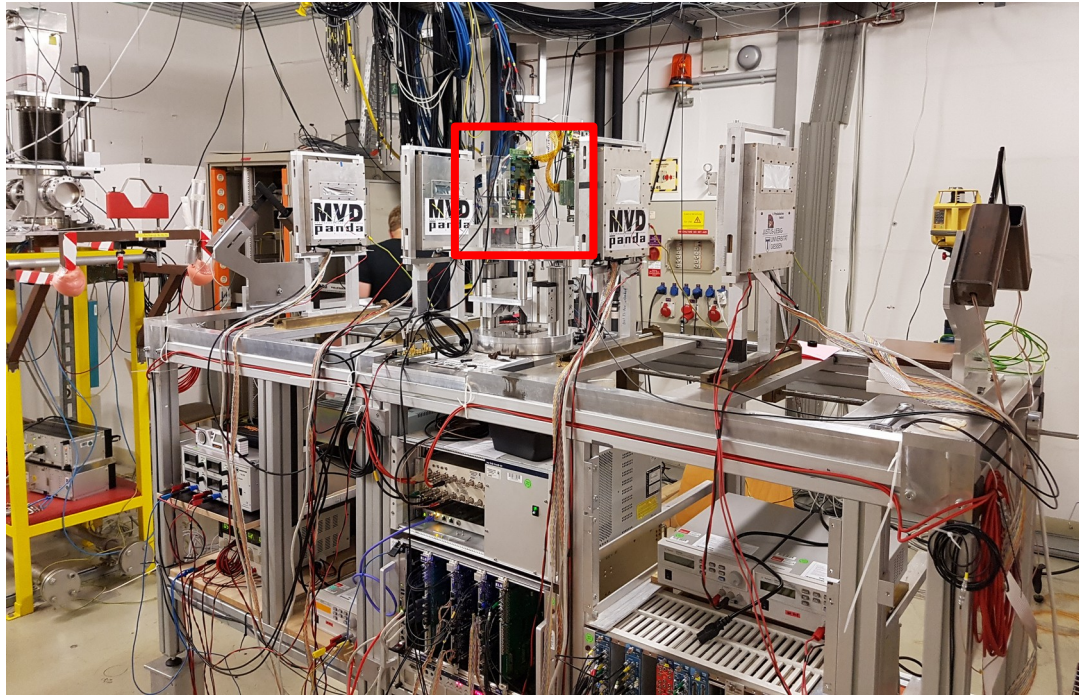
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam



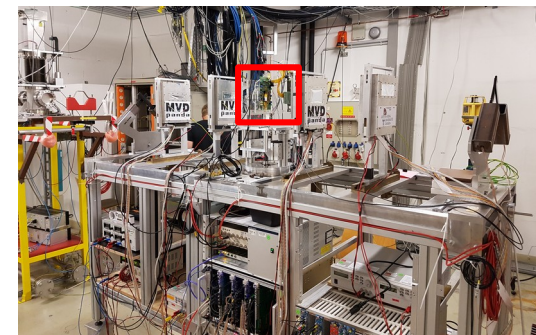
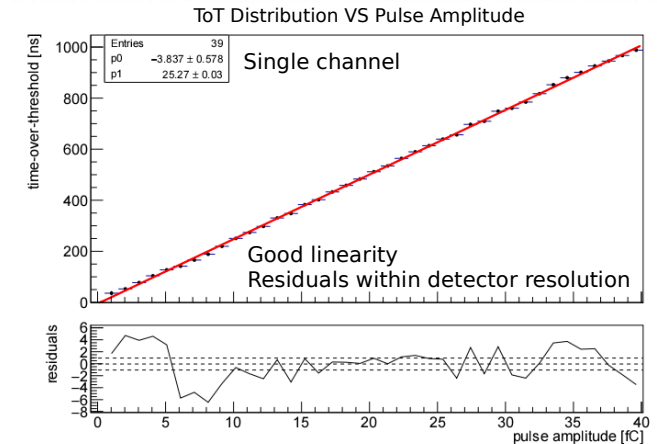
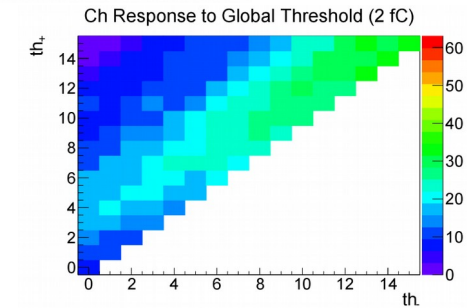
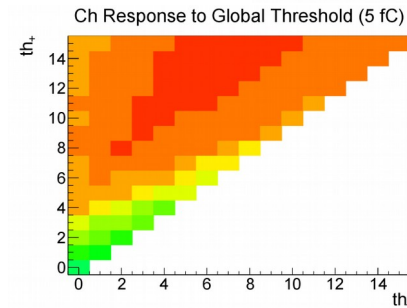
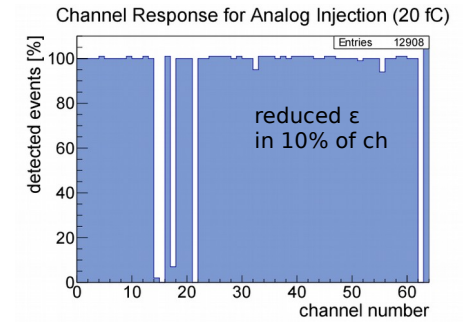
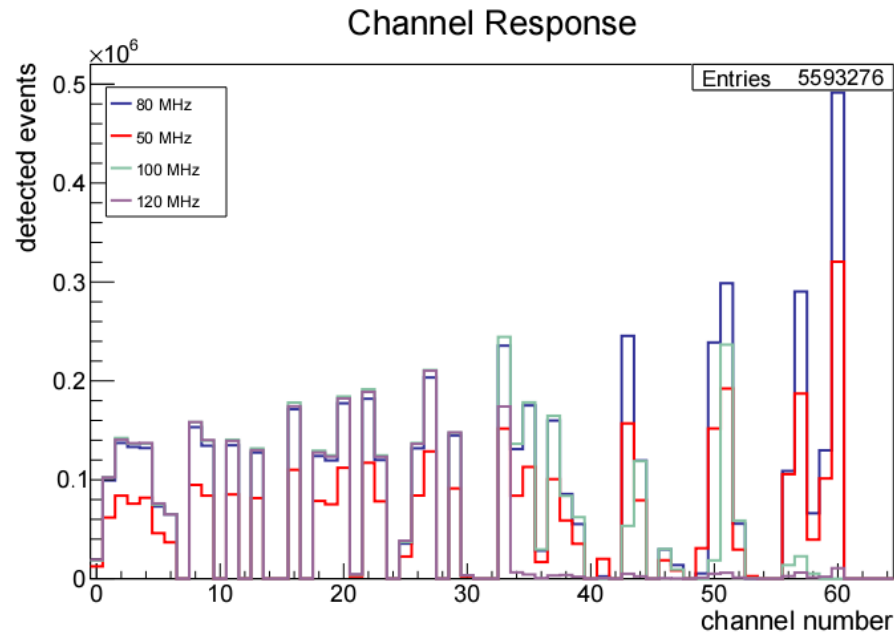
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam



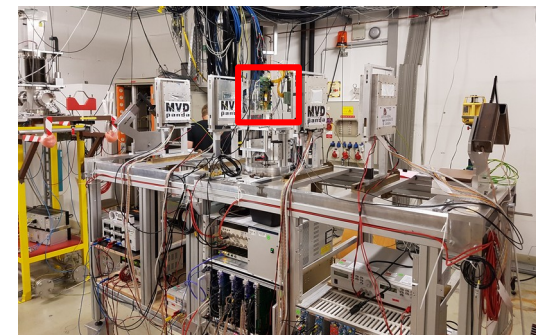
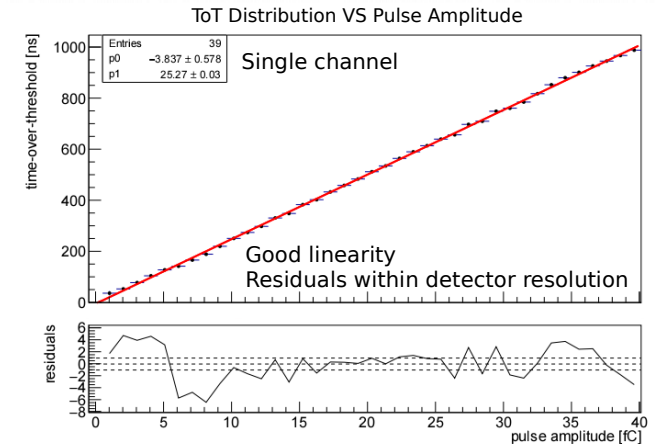
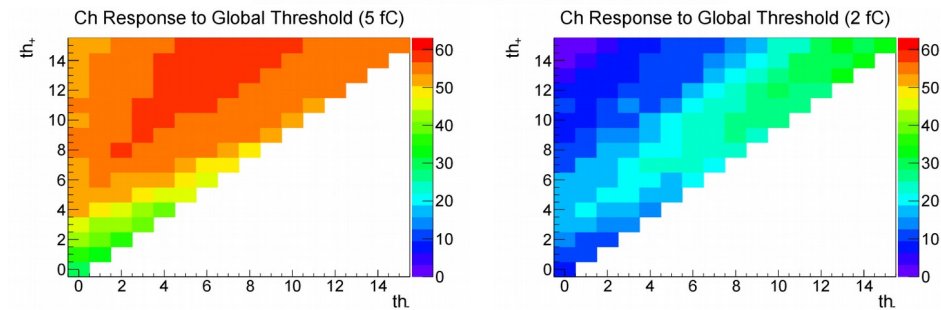
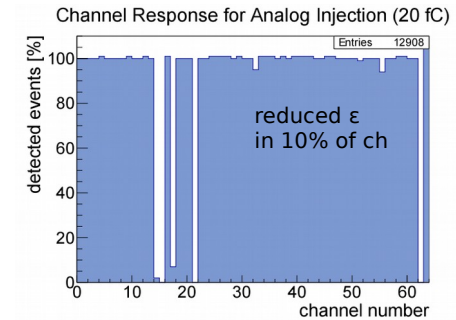
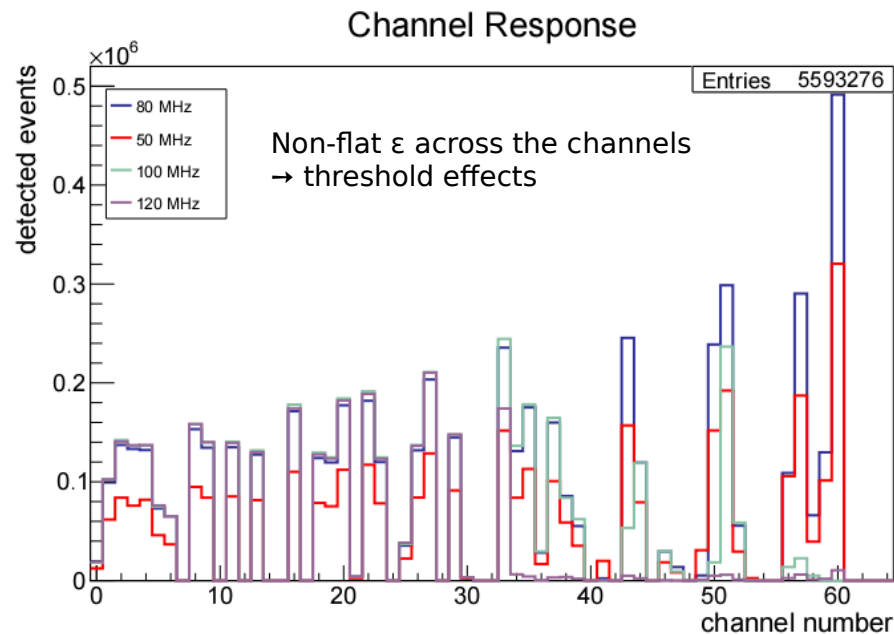
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam
 - Frequency-dependent response



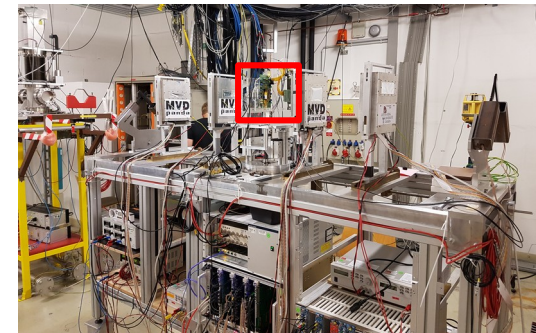
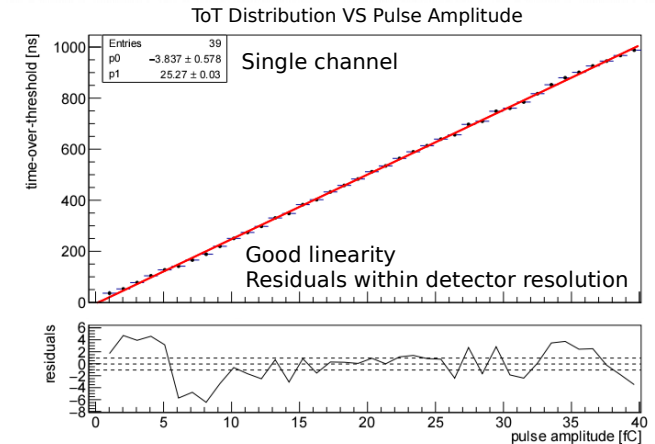
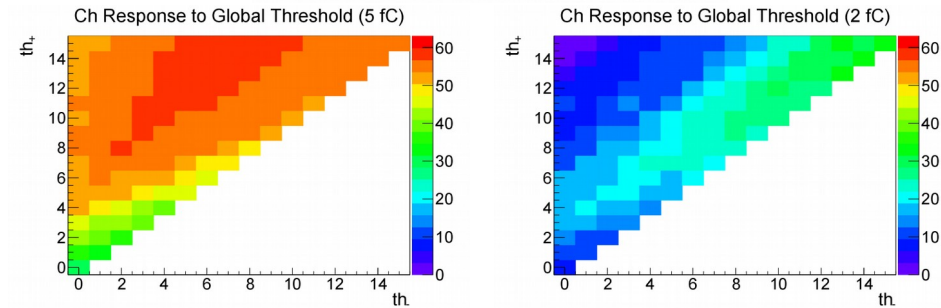
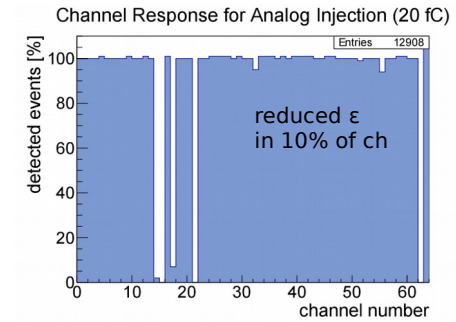
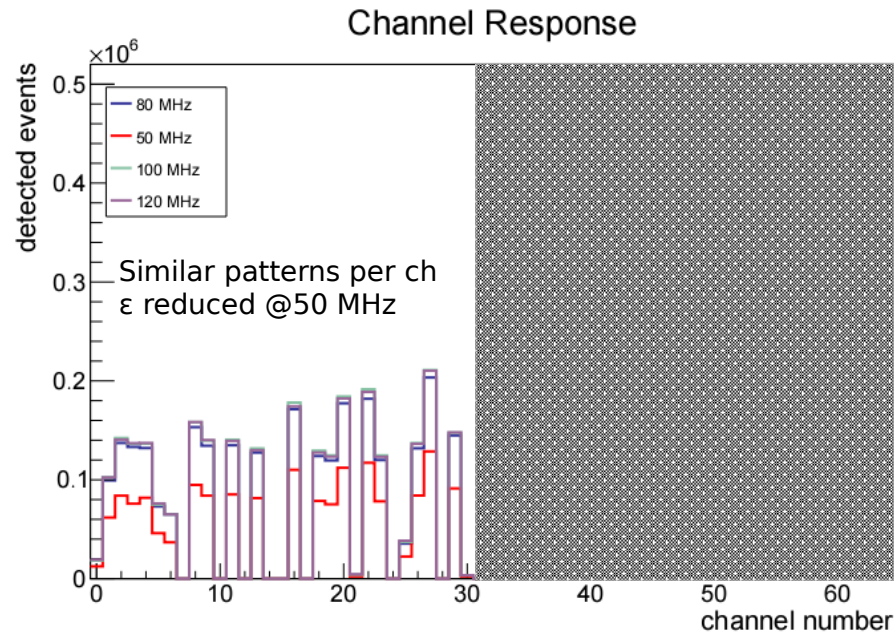
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- **Proton beam**
 - Frequency-dependent response



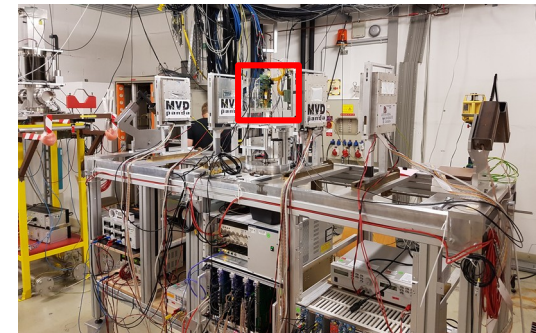
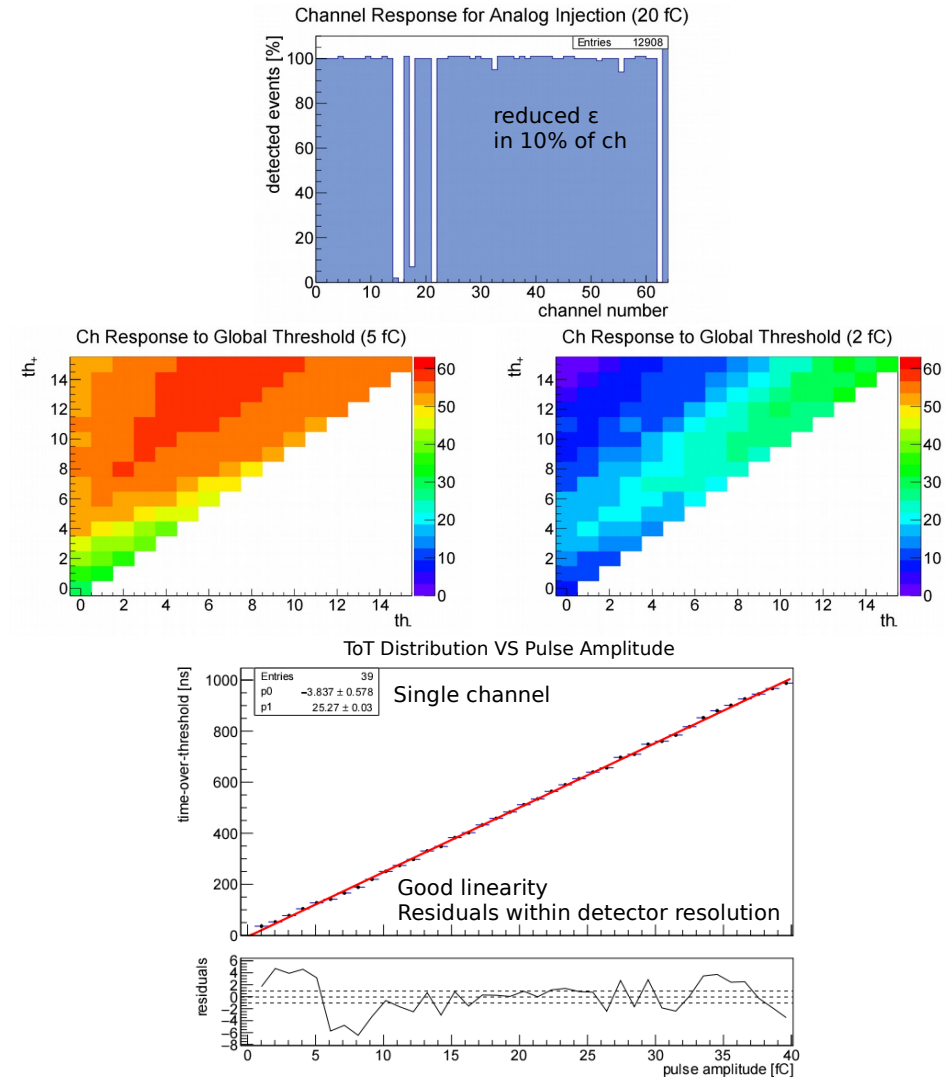
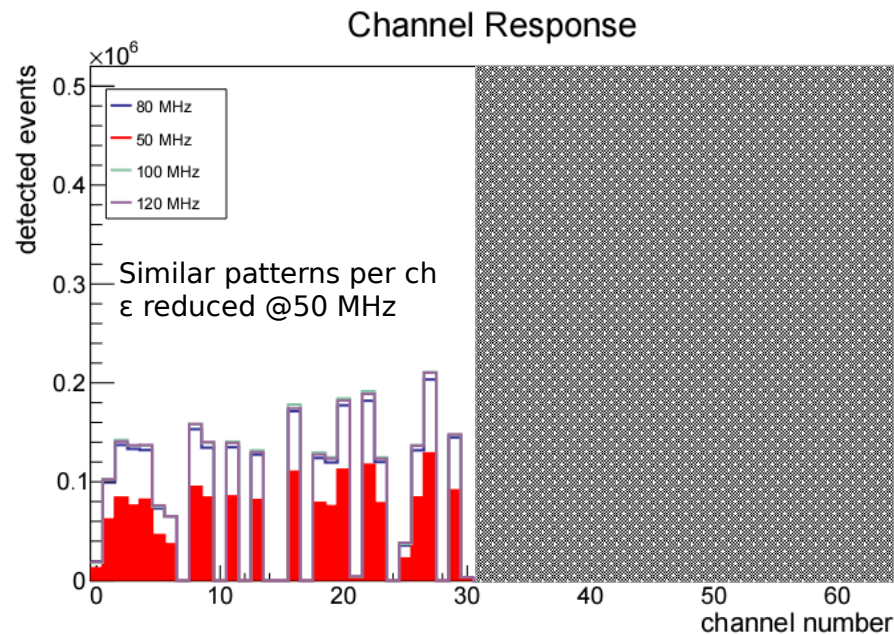
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam
 - Frequency-dependent response



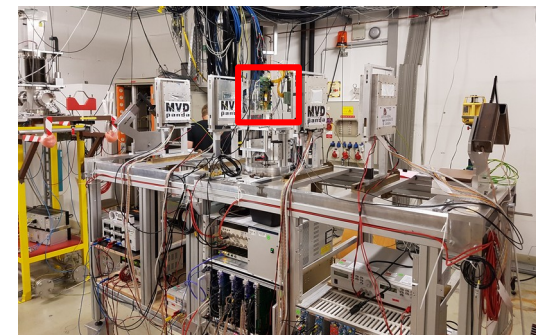
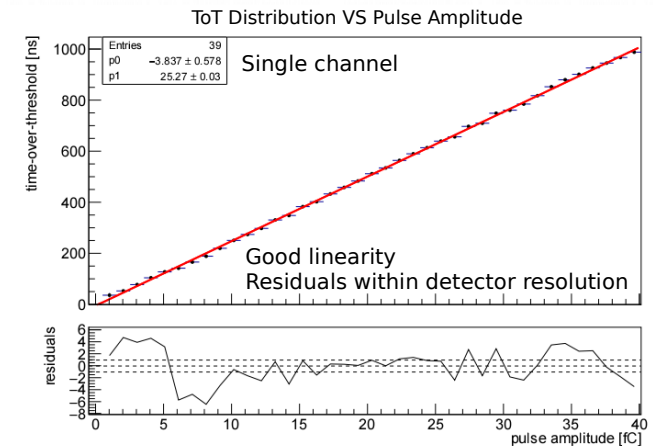
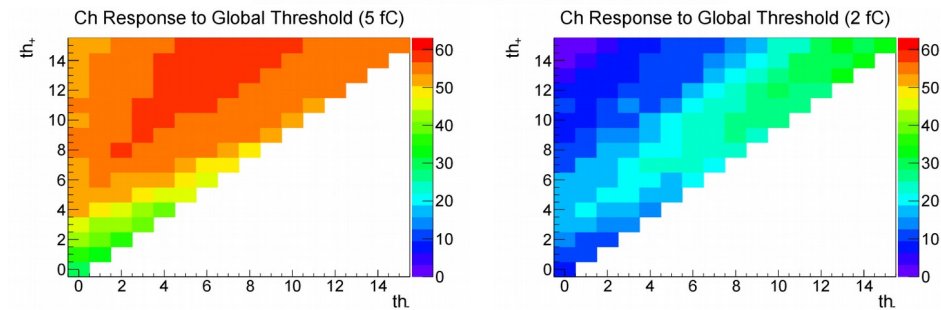
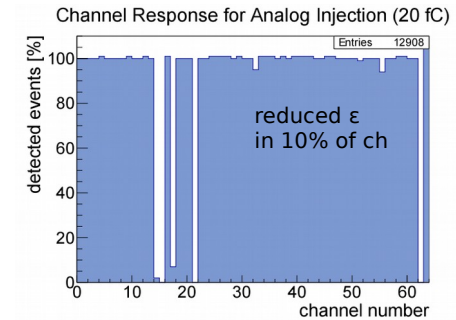
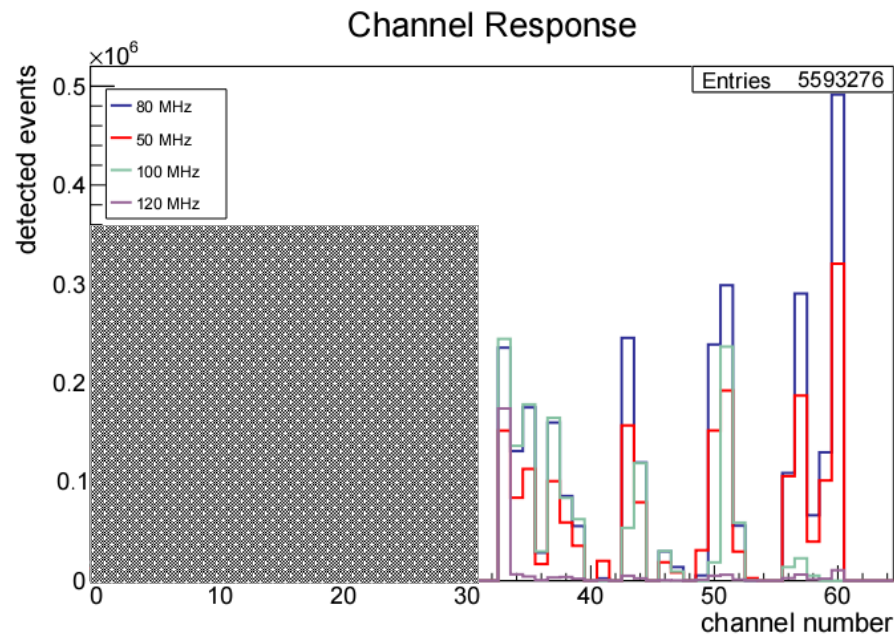
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam
 - Frequency-dependent response



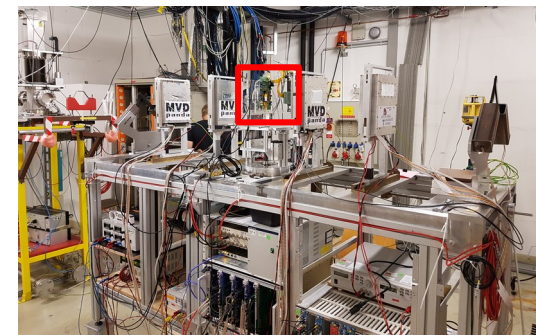
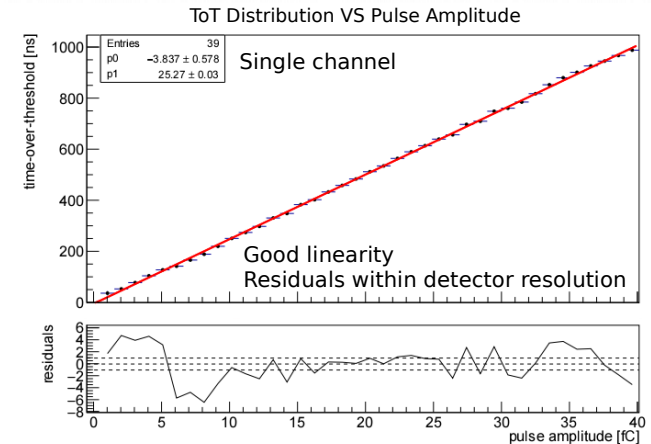
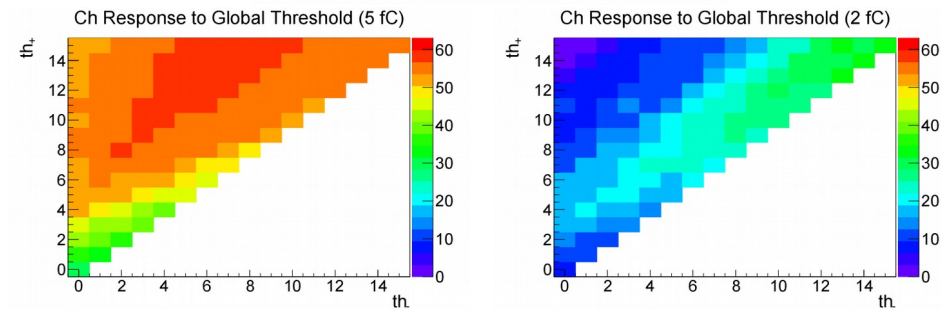
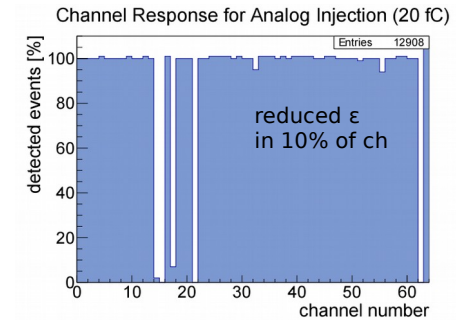
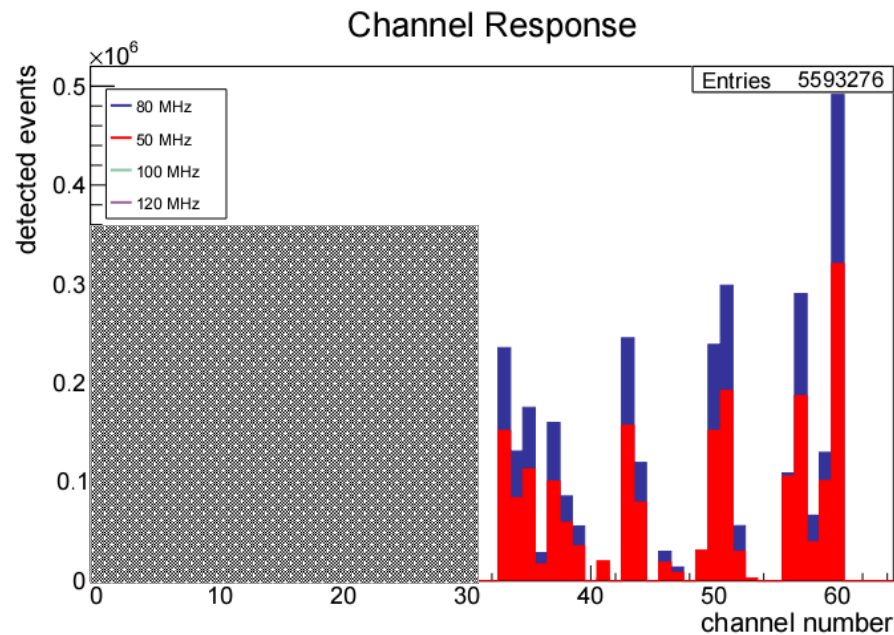
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam
 - Frequency-dependent response



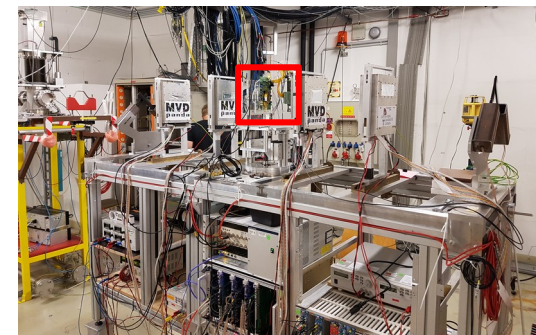
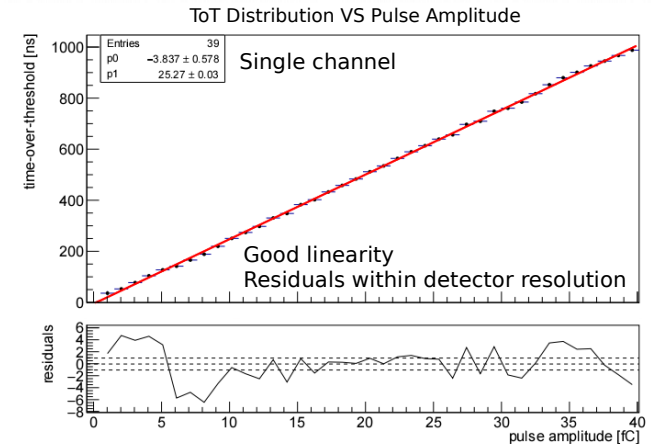
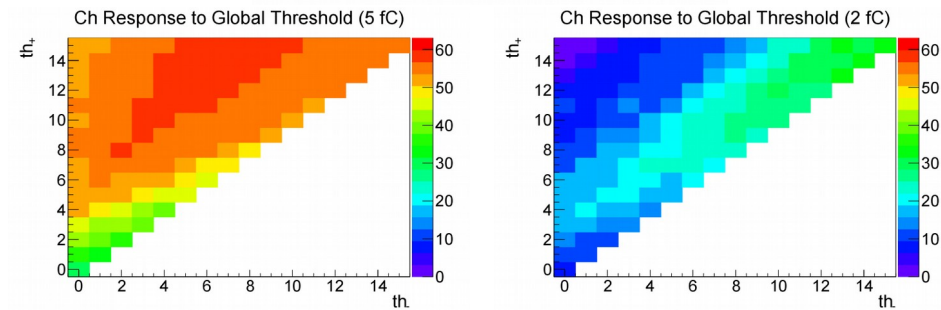
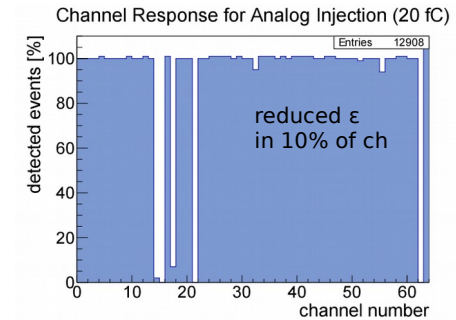
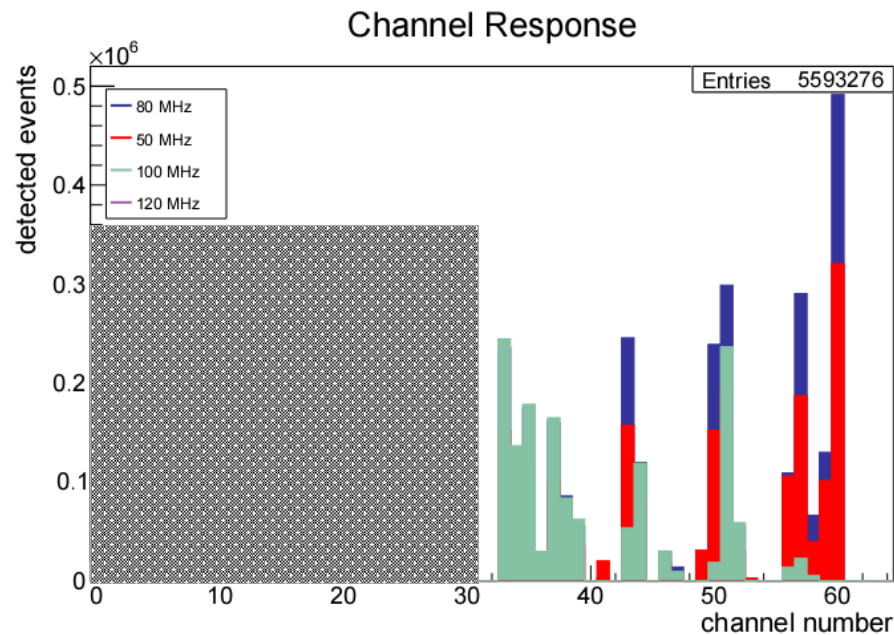
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam
 - Frequency-dependent response



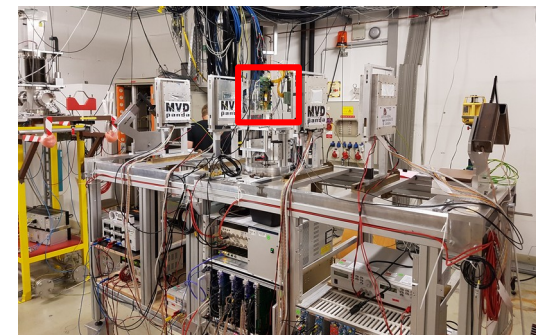
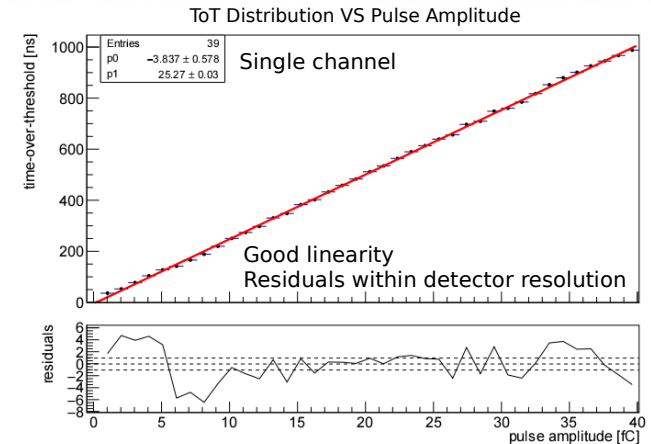
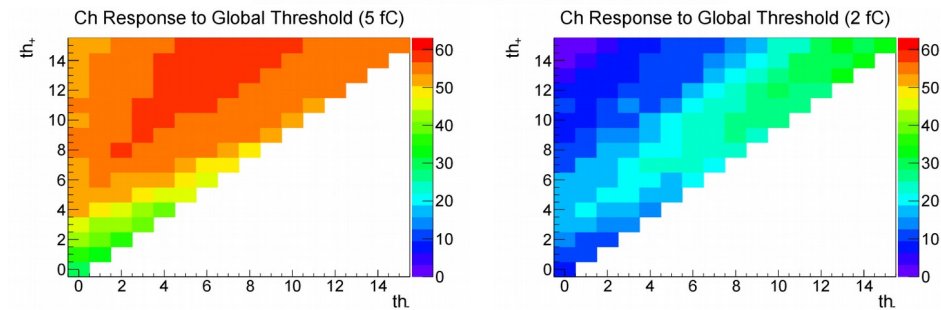
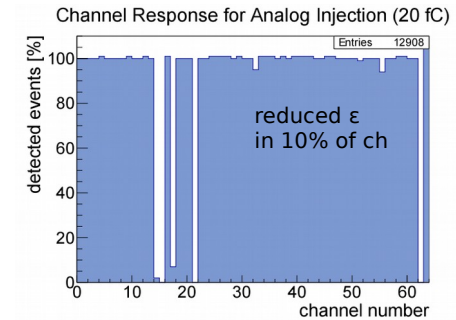
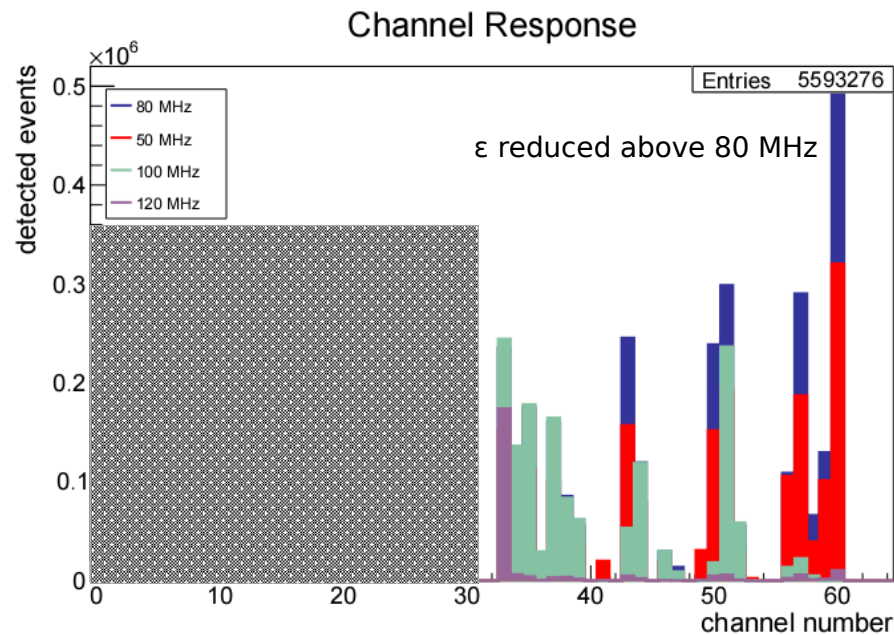
Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam
 - Frequency-dependent response



Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- Proton beam
 - Frequency-dependent response



Evaluation of the Performance of PASTA

- Internal injection
 - Channel response
 - Threshold calibration
 - differential scheme ($th_+ - th_- \geq 0$)
 - Linearity of the front-end
- **Proton beam**
 - Frequency-dependent response

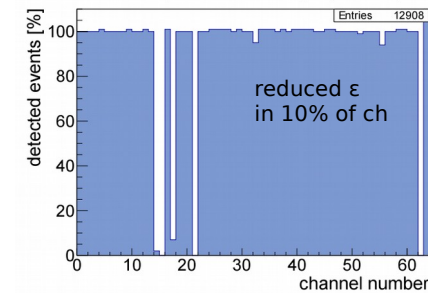
• Data acquisition system

- Modular integration of PASTA in the JDRS
- User-friendly GUI
- Stable operation (incl. **in-beam**)

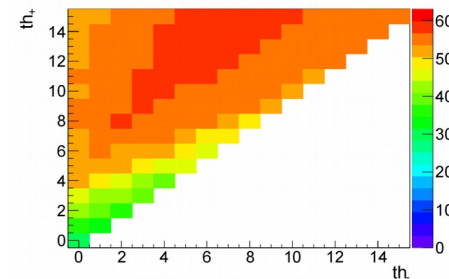
• PASTA

- Principle of operation verified
- Operation of individual channel
- Critical optimization of global settings
- Frequency-related issues
- Significant input for PASTA 2.0

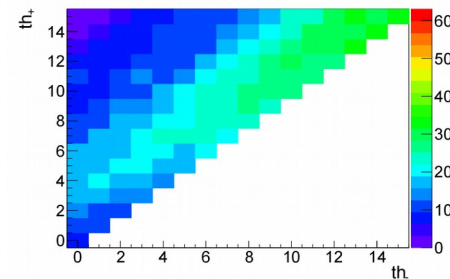
Channel Response for Analog Injection (20 fC)



Ch Response to Global Threshold (5 fC)



Ch Response to Global Threshold (2 fC)



ToT Distribution VS Pulse Amplitude

