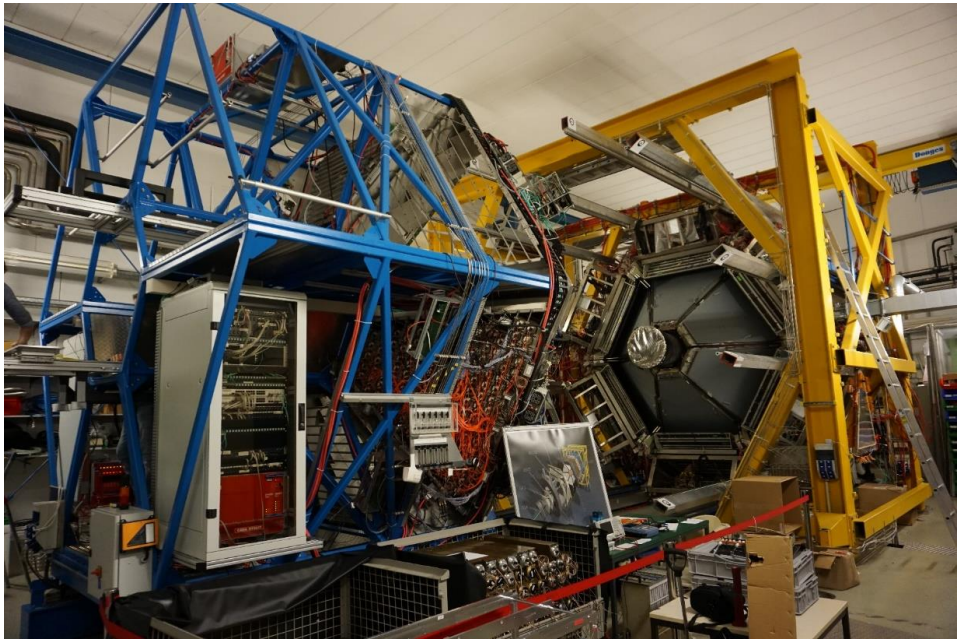
STATUS OF STS TIME CALIBRATION

15.06.2021 I GABRIELA PÉREZ ANDRADE

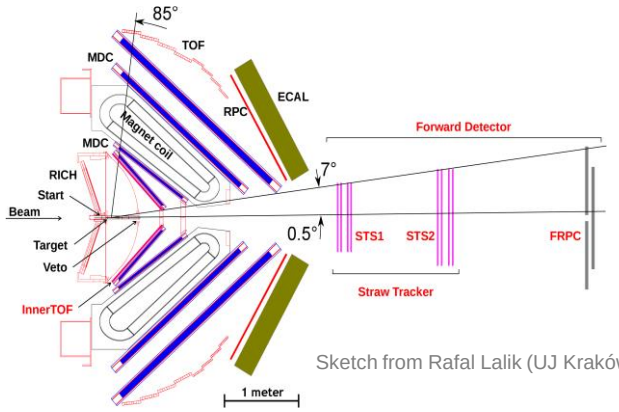
Outlook

- Reminder: Phase-0, STS@HADES
- STS Detector System Overview
- HADES Commisioning Beamtime
- Status of STS calibration
- Summary



Reminder: Phase-0 STS@HADES

- HADES upgrade:
  - Forward straw tracker stations STS1, STS2
  - Forward Resistive Plate Chamber (FRPC)
  - Inner TOF detector
  - Upgrade of DAQ systems.
  - Extends the angular acceptance to small polar angles ~ 0.5 ° < θ < 7°



Sketch from Rafal Lalik (UJ Kraków)

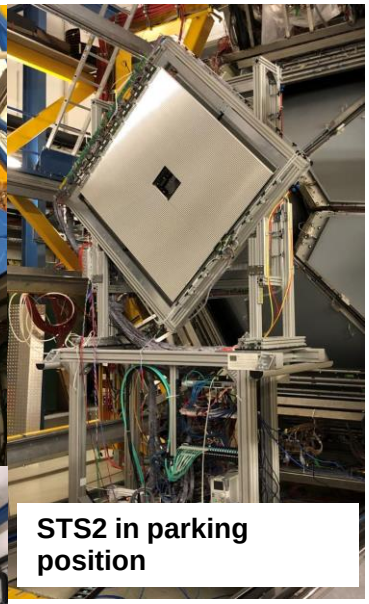
- Essential for the HADES hyperon physics program at SIS18:
  - Hyperon radiative decays.
  - Multi-strangeness production.

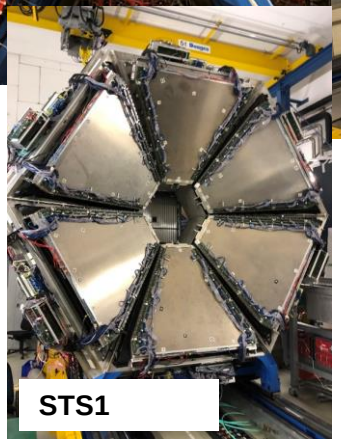
- Synergies between STS systems and PANDA-STT:
  - Straws design, front-end electronics(PASTTREC FE-boards), TRB readout, DAQ
  - Straw system tests under experiment conditions (event tracking and PID)
  - STS will become part of the PANDA-FT
- Differences: experiment hardware trigger

STS detector system

- Two stations (STS1/2) consisting of four double layers of self-supporting gas-filled straws
- Each straw diameter is 10 mm and is made of 27µm thin Al-Mylar walls with 20 µm thin W/Re wire along it axis.
- Gas mixture: Ar/CO_2 (90/10) @ 2 bar
- Front-end electronics(PASTTREC FE-boards), TRB3 readout, common DAQ STS1/2

Station	STS1	STS2
No. Straws	704	1024
Straw length	76 cm	125 cm
Orientation (azimuthal)	0°, 90°, 90°, 0°	0°, 90°, 45°, -45°
Beam opening	8×8 cm^2	16×16 cm^2
Distance to target (commiss. beamtime)	~ 3.50 m	~ 5.50 m

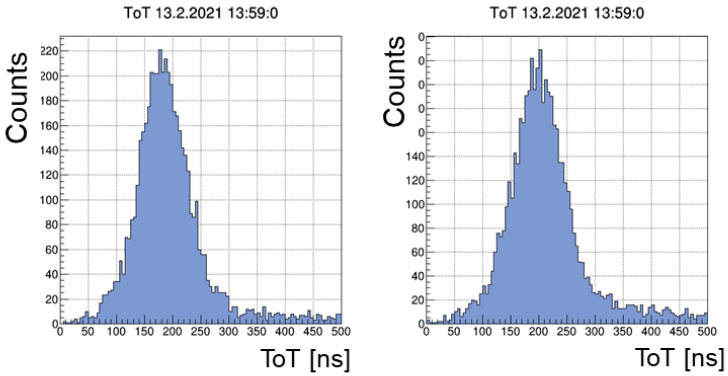




HADES Commissioning Beamtime

February 2021

- SIS18 delivered proton beam with 2 GeV and 4.2 GeV kin. Energy
- STS stations and readout performance tested under experiment conditions (*e.g.* high intensities of 10^5 p/s per straw)
- STS default settings:
  - Threshold = 20 mV (= DAC 10), Gain = 1 mV/fC, peak time 20 ns, HV = 1800 V
- Several data takings for different ASIC settings were completed.
- STS operation was stable and no self-sustaining currents were observed even at the highest beam intensities (10^5 p/s per straw).
- Very low noise was observed, raw data shows clean ToT spectra.
- A rich data base is now available for analysis.

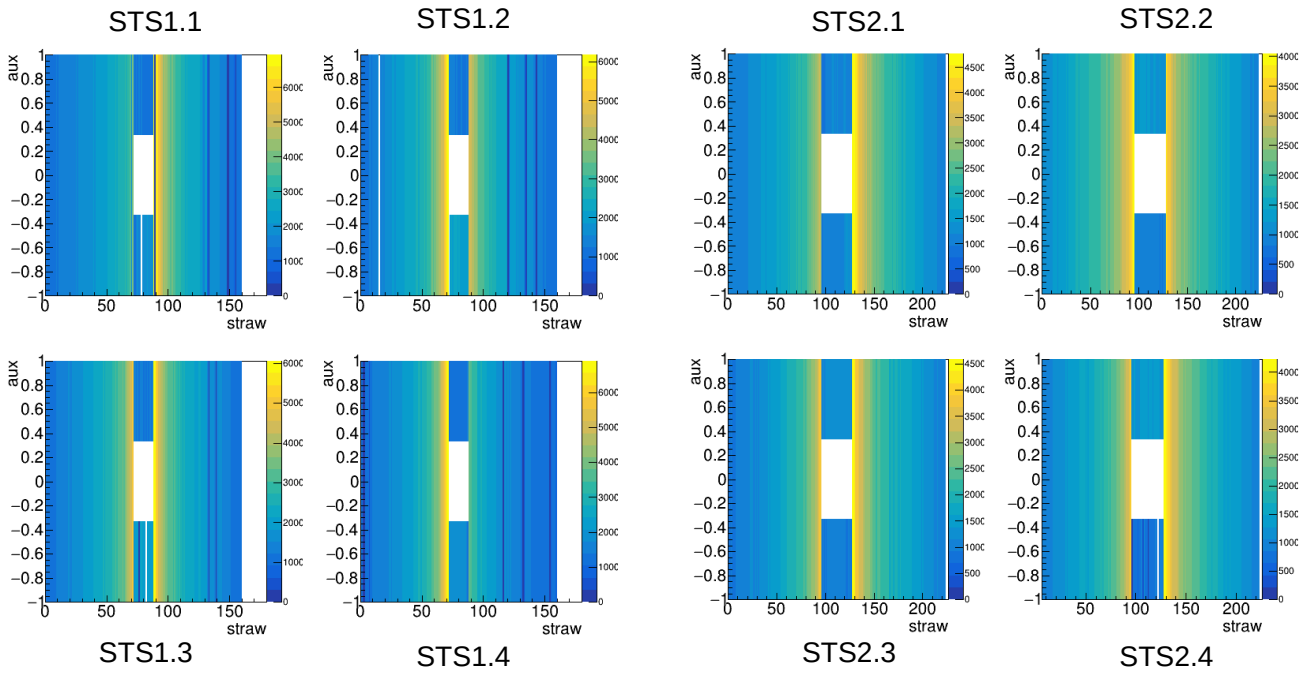


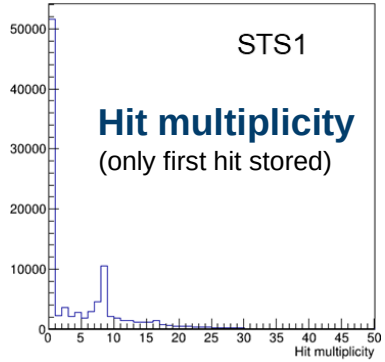
STS1 at default settings STS2 at default settings

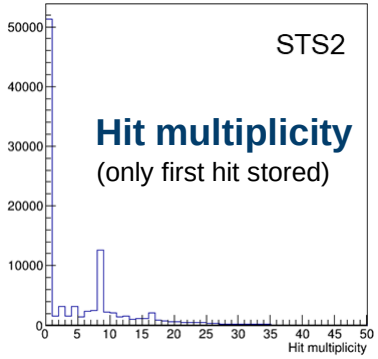
Online QA

STS raw data

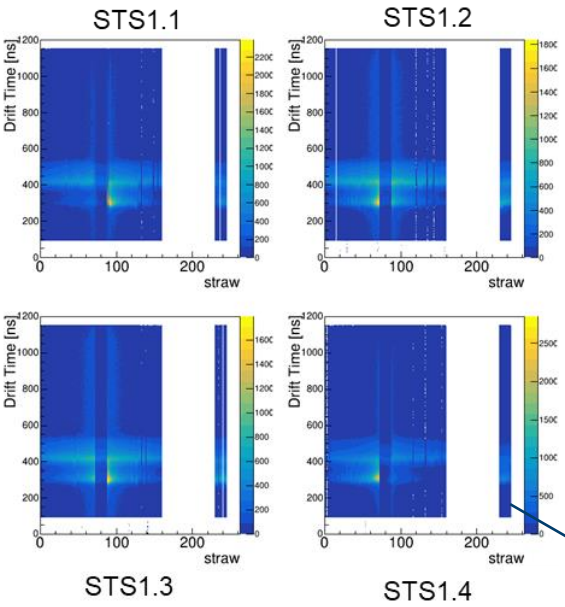
(~ 3 million events , STS at default ASIC settings)

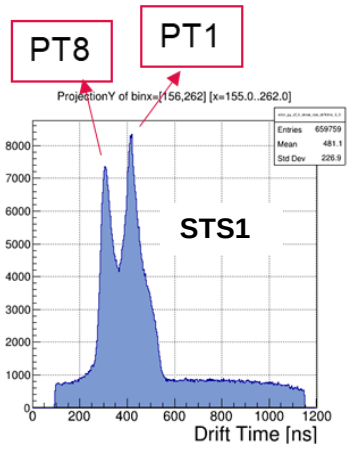




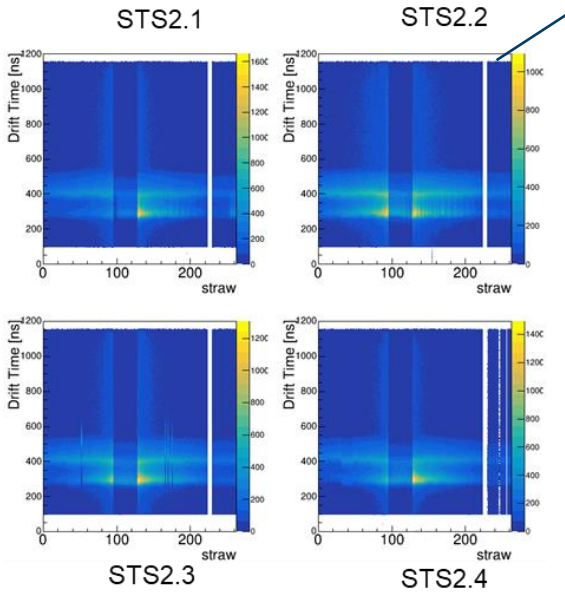


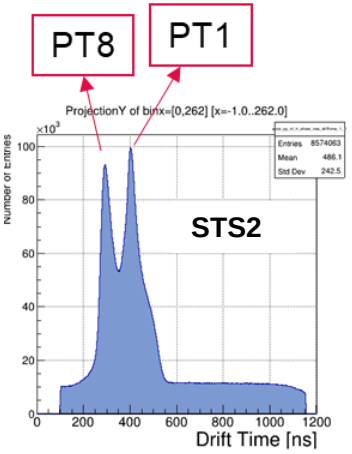
Raw time spectra

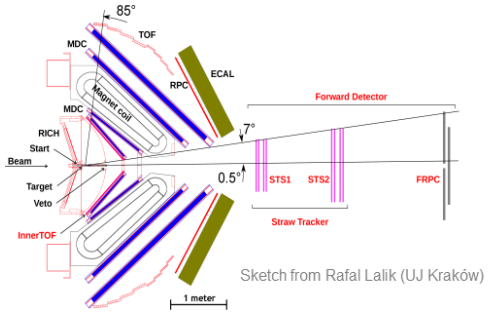




Short straws







Sketch from Rafal Lalik (UJ Kraków)

Raw time: hit detection time (*drift time* + *start offset* + *tof*)

Cal time: drift time

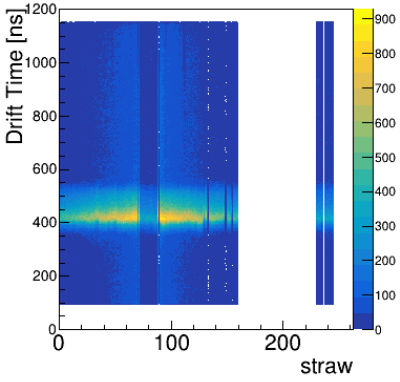
Different triggers used:

- PT8 (registered hit in fRPC)
- PT1 (TOFRPC, Mult > =2)

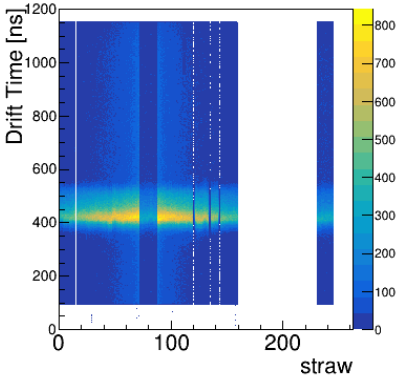
Drift time vs channel (raw)
PT1 only (TOF RPC, mult >=2)

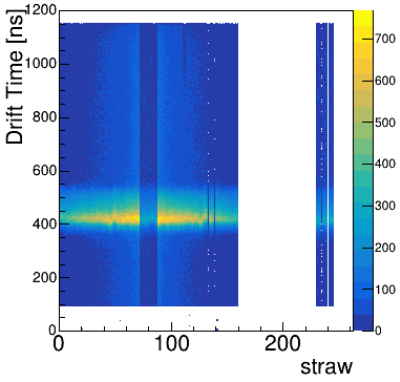
STS1

STS1.1

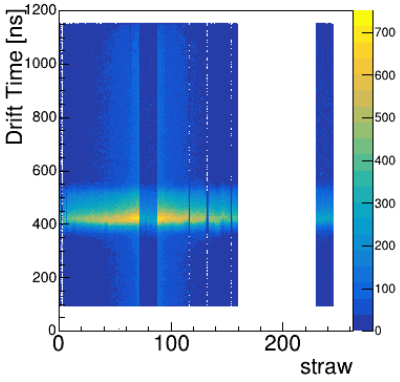


STS1.2

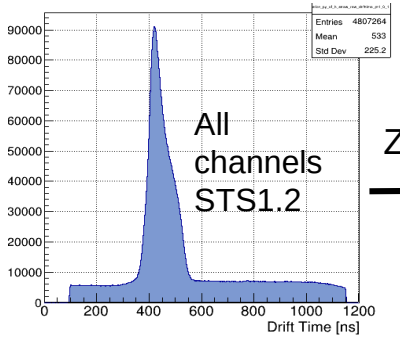




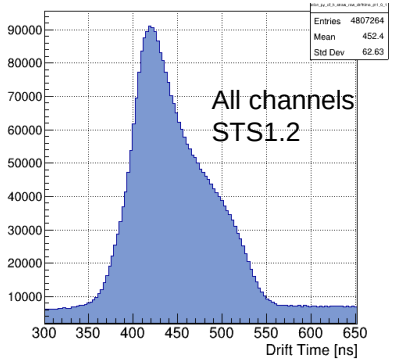
STS1.3



STS1.4



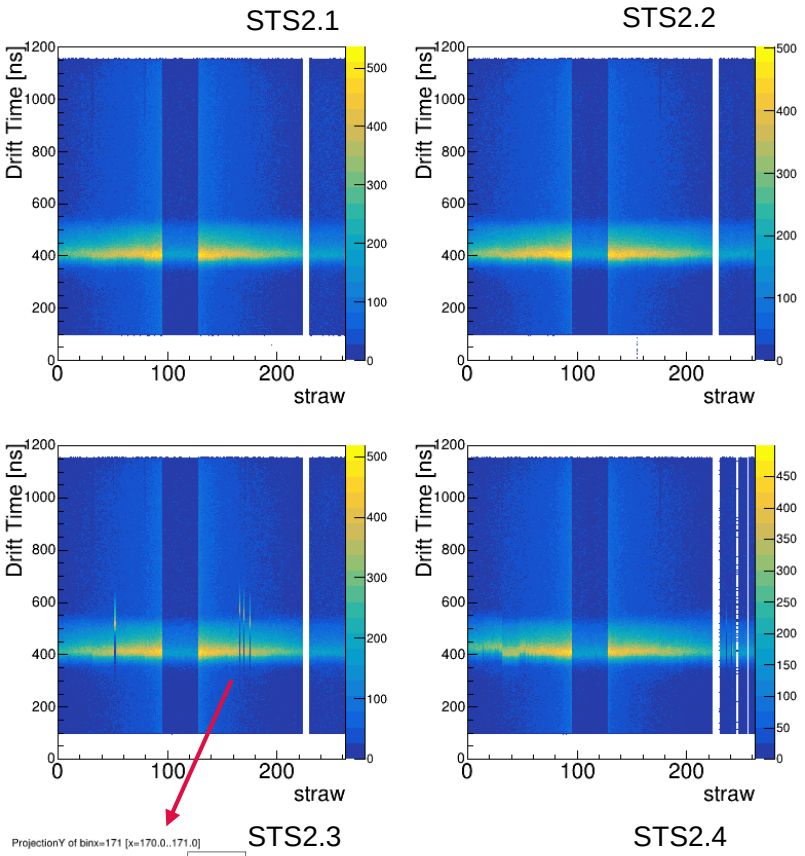
Zoom

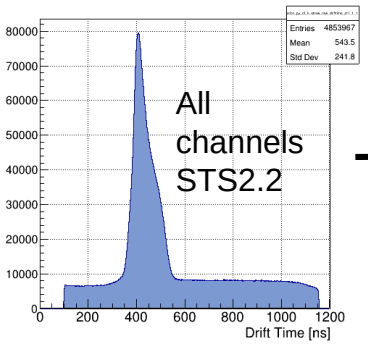


- Almost all straws illuminated uniformly
- Broad leading edge: harder to define starting of spectra leads to calculated drift time range of up to ~ 180 ns

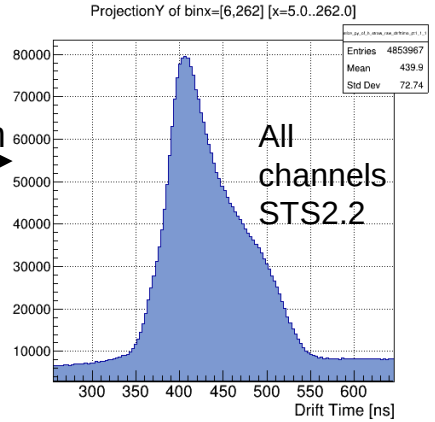
Drift time vs channel (raw)
PT1 only (TOF RPC, mult >=2)

STS2





Zoom



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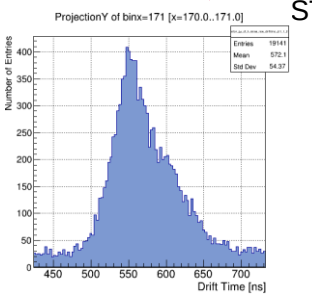
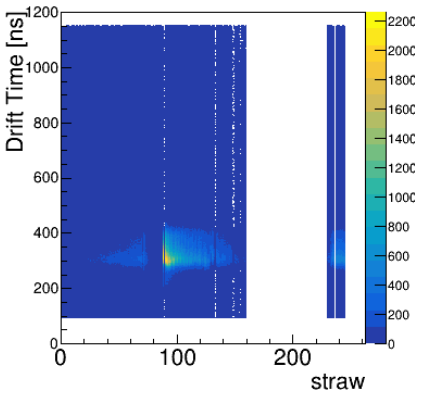


Some channels show shifted drift time spectra

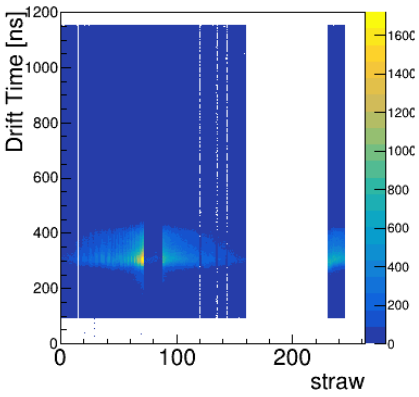
Drift time vs channel (raw)
PT8 only (fRPC)

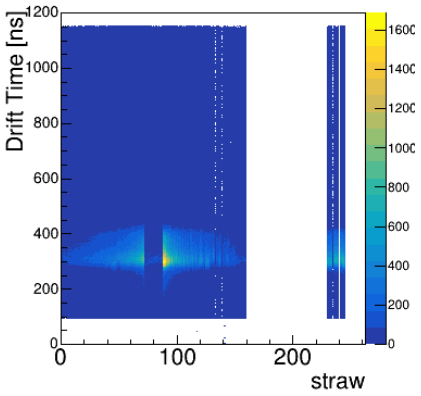
STS1

STS1.1

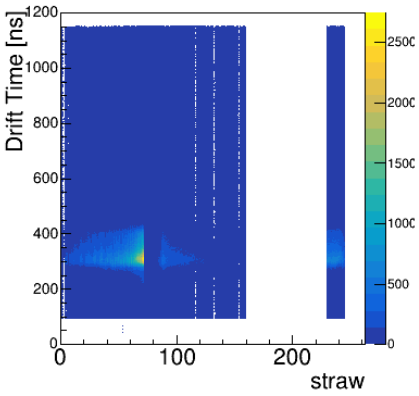


STS1.2

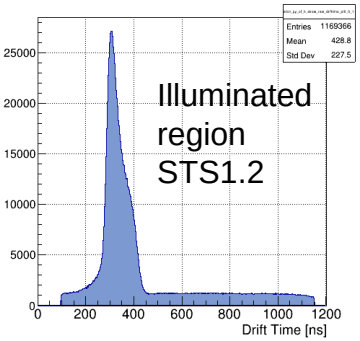




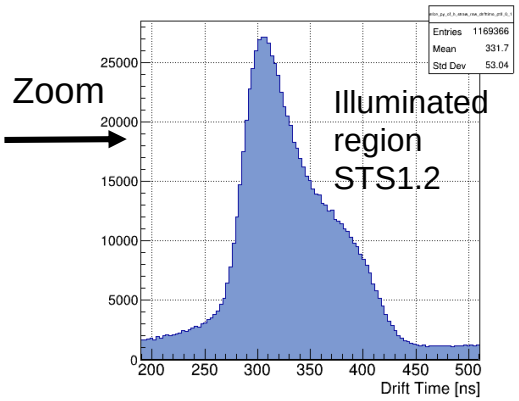
STS1.3



STS1.4



Zoom



- Less statistics: STS partially covered by fRPC
- Not sharp leading edge: hard to define starting of spectra leads to calculated drift time range of ~ 180 ns

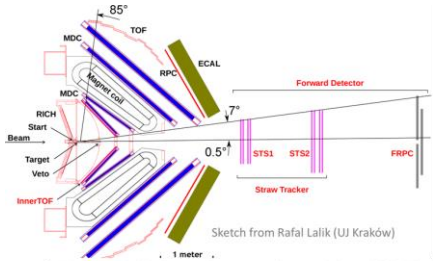
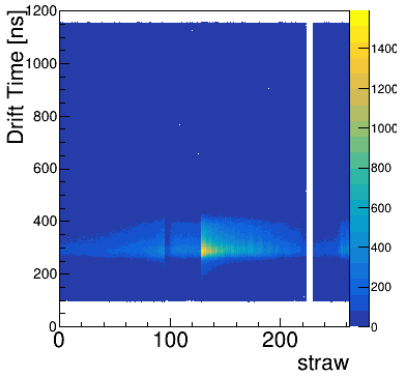


Figure 2. Schematic overview of the HADES spectrometer, including the newly added FD components. The STS1(2) shown in magenta.

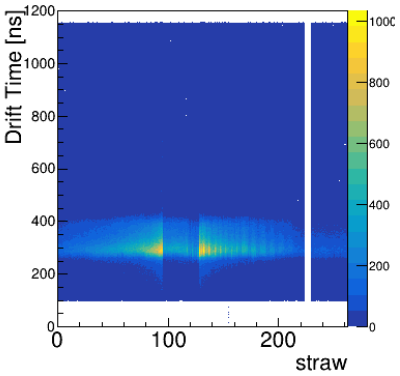
Drift time vs channel (raw)
PT8 only (fRPC)

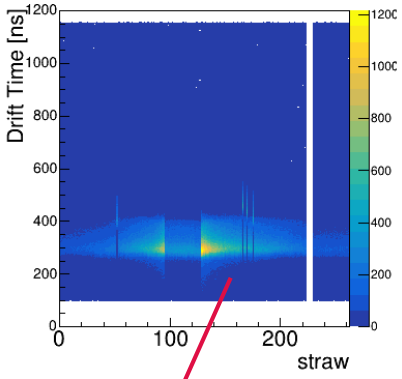
STS2

STS2.1

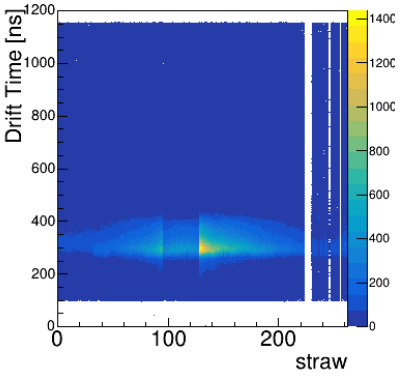


STS2.2

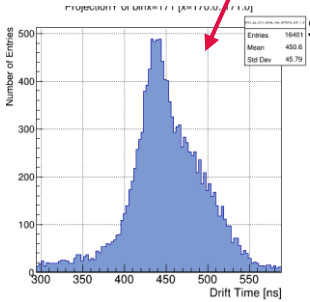




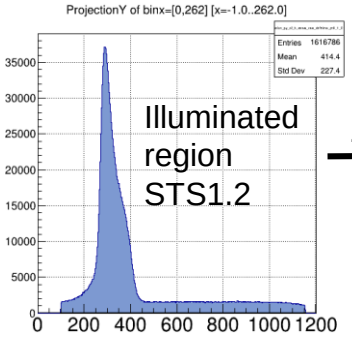
STS2.3



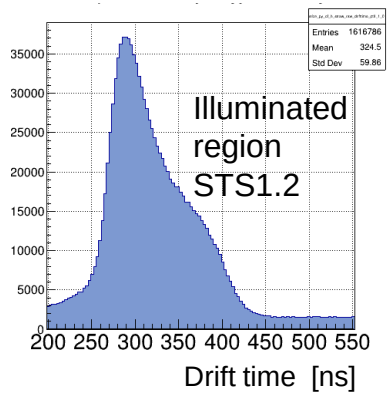
STS2.4



Some channels show shifted drift time spectra



Zoom



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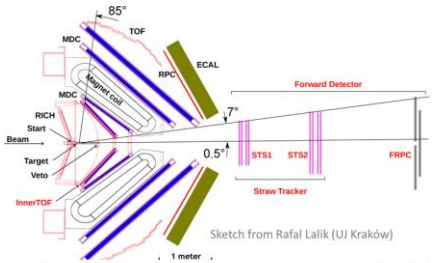
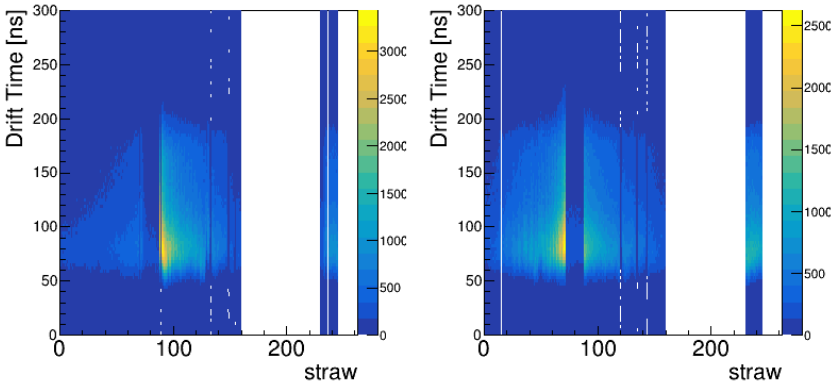


Figure 2. Schematic overview of the HADES spectrometer, including the newly added FD components. The STS1(2) shown in magenta.

After correction by fRPC time
STS1

STS1.1

STS1.2

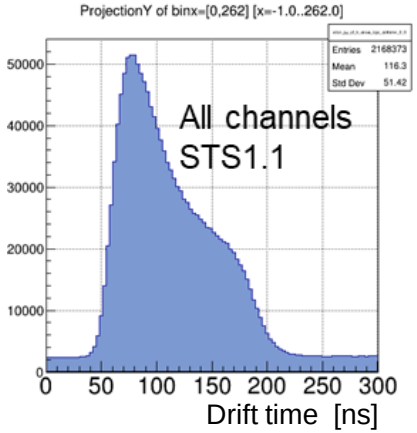


STS1.3

STS1.4

Events with registered fRPC

Drift time = Time in straws – fRPC time (shortest registered):



- Better defined leading edge
- Drift time range ~ 150 ns
- Less statistics, STS partially covered by fRPC

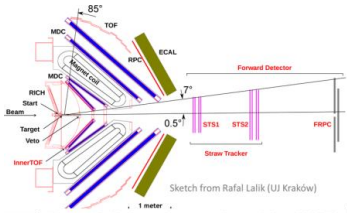
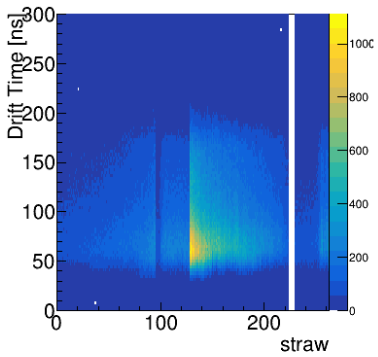


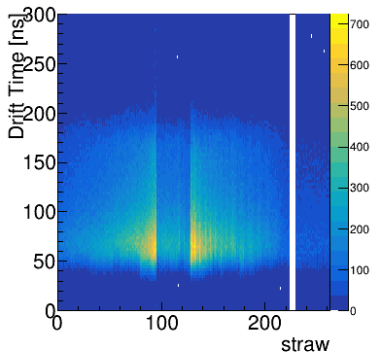
Figure 2. Schematic overview of the HADES spectrometer, including the newly added FD components. The STS1(2) shown in magenta.

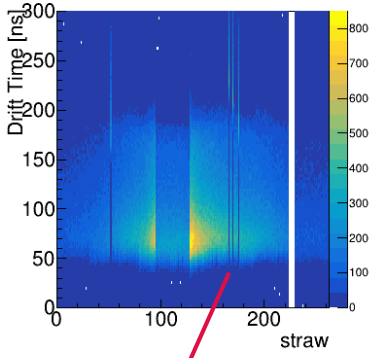
After correction by fRPC time
STS2

STS2.1

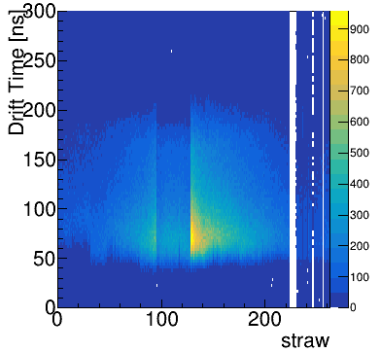


STS2.2

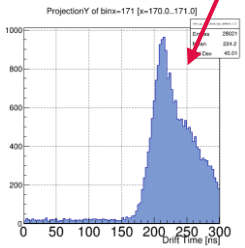




STS2.3

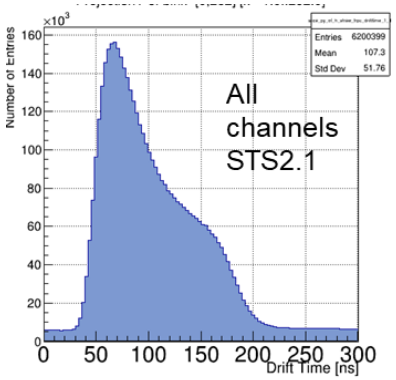


STS2.4

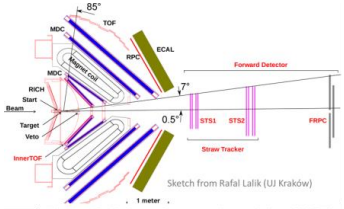


Events with registered fRPC

Drift time = Time in straws – fRPC time (shortest registered):



- Sharper leading edge
- Drift time range ~ 150 ns
- Less statistics, STS partially covered by fRPC



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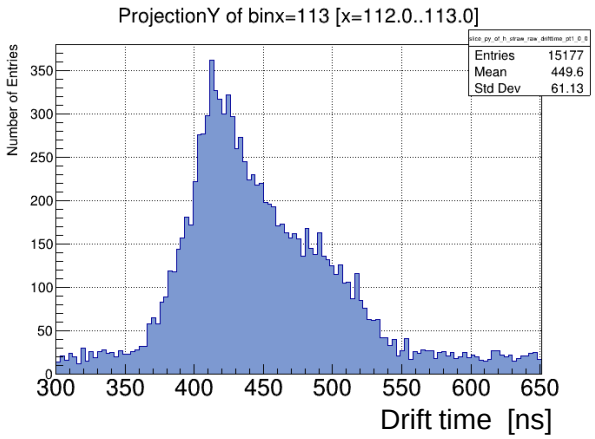
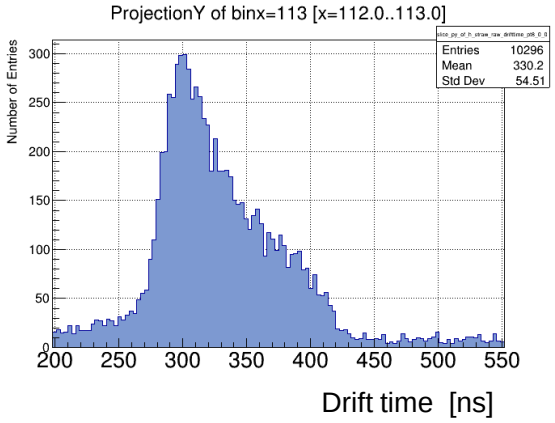
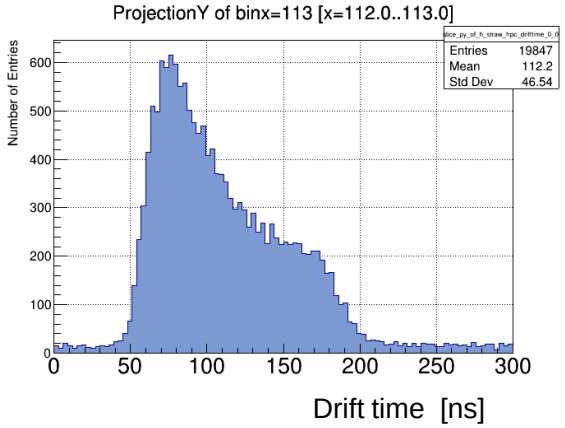
PT1 only (TOF RPC, mult >=2)



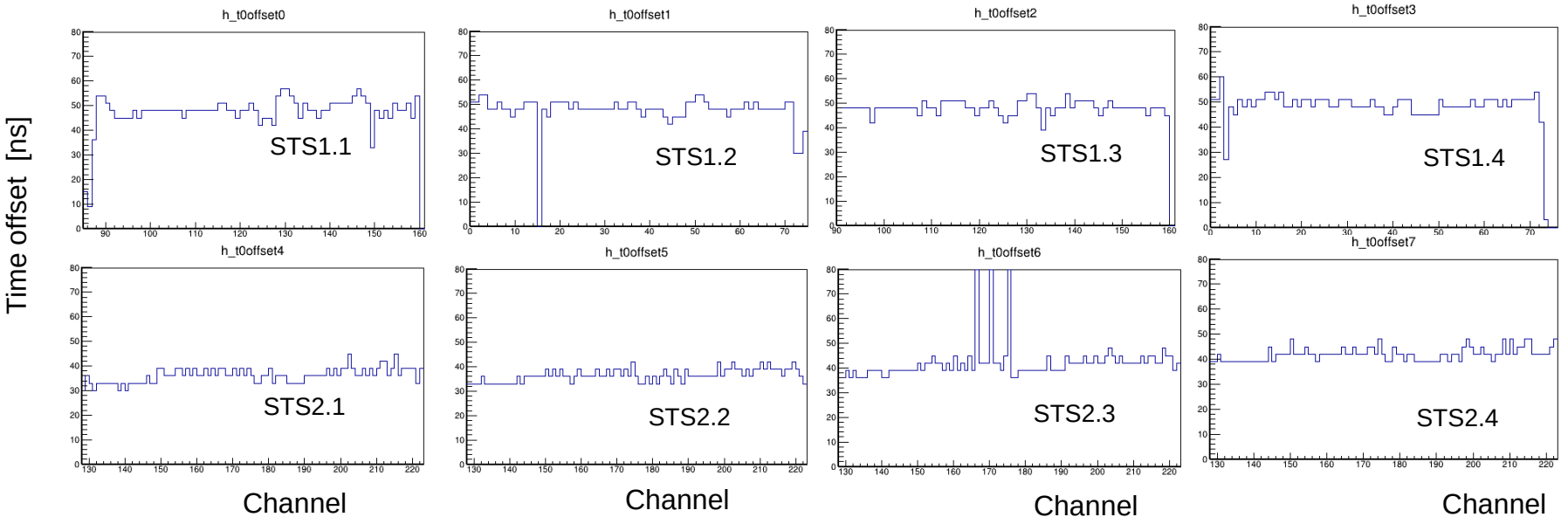
PT8 only (fRPC)



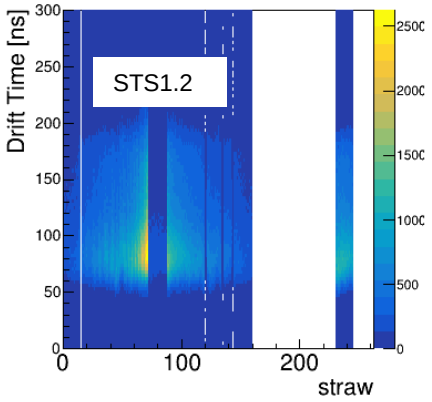
After correction by fRPC time



Time offset correction corrected by fRPC time (uniformly illuminated regions)

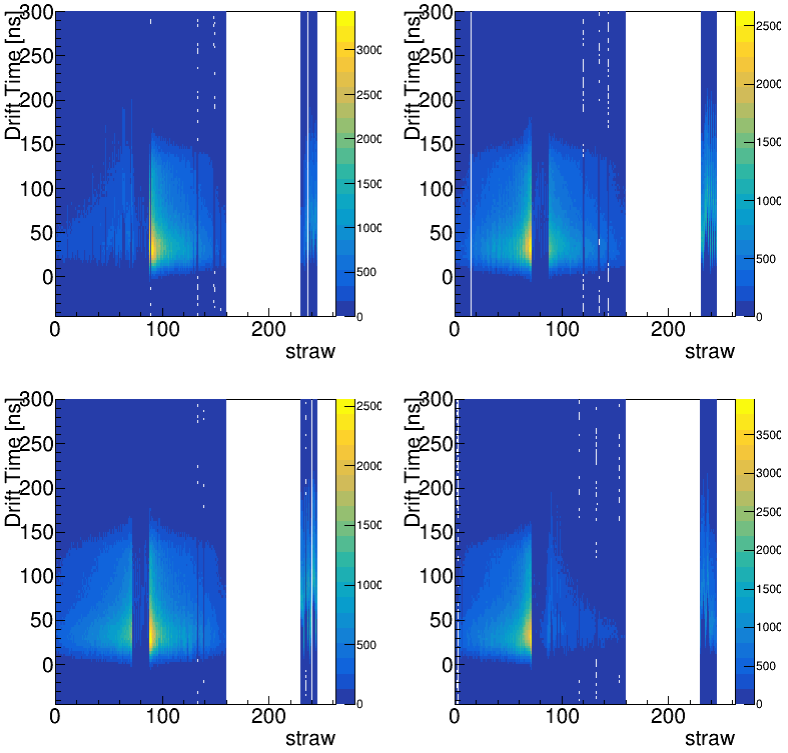


- Calculated using threshold method (taking 15% and 70% of peak)
- Average time offset correction is **~ 50 ns in STS1** and **~ 40 ns in STS2** (with σ ~ 3 ns in both)

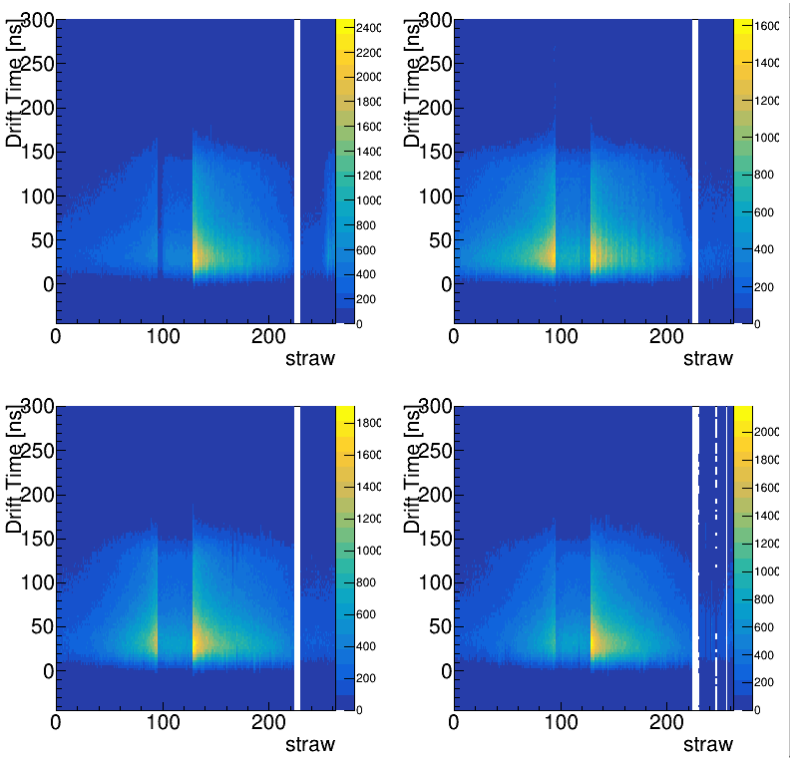


After correction by fRPC time and time offset correction

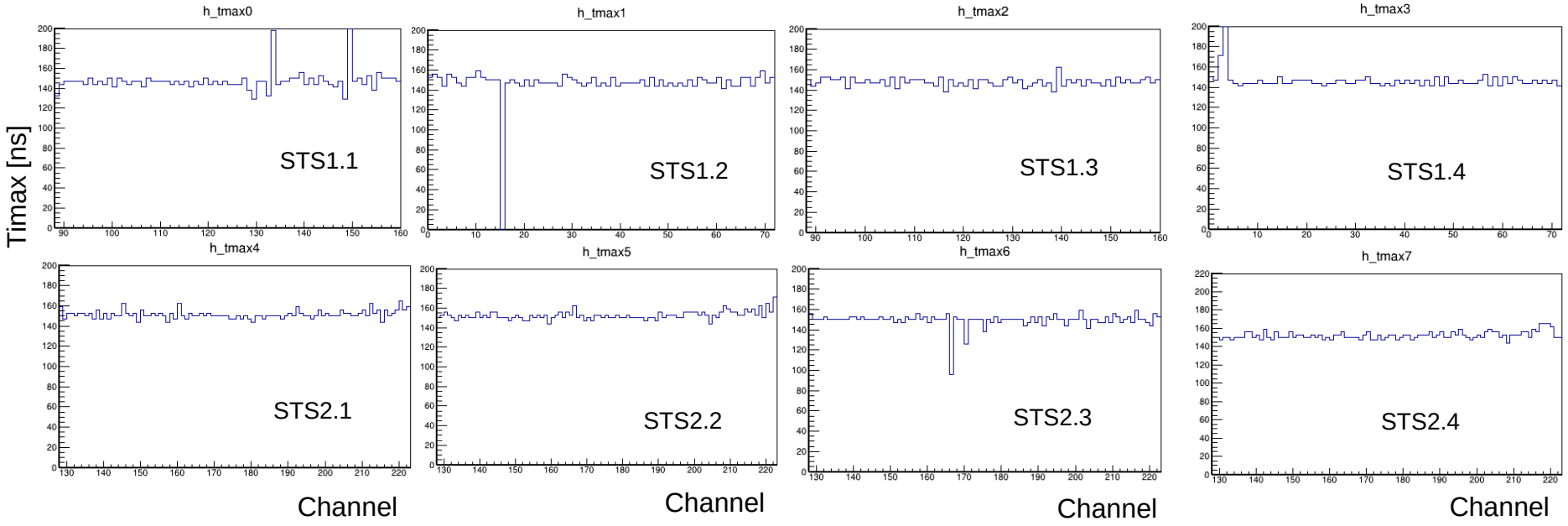
STS1



STS2



Tmax after correction corrected by fRPC time (uniformly illuminated regions)



- Calculated using threshold method
- Average **tmax is ~ 150 ns** (with σ ~ 4 ns): global isochrone calibration might be feasible

Summary / To do

- Clean drift time distributions for STS1/2 after subtraction of particle time of flight using fRPC time.
- Drift time spectra range is of ~150 ns (σ ~ 4 ns).
- Well determined edges are required to get a correct isochrone parametrization and calibration.

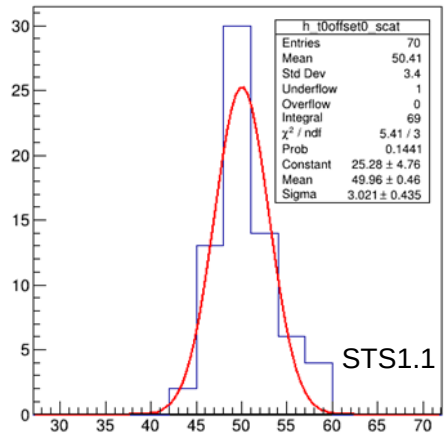
- It might be necessary to restrict time offset correction calculation to straws in well. illuminated areas (fRPC doesn't fully cover STS).
- Is it feasible to use a global or partially global calibration?
- To improve method : better selection of fRPC time.

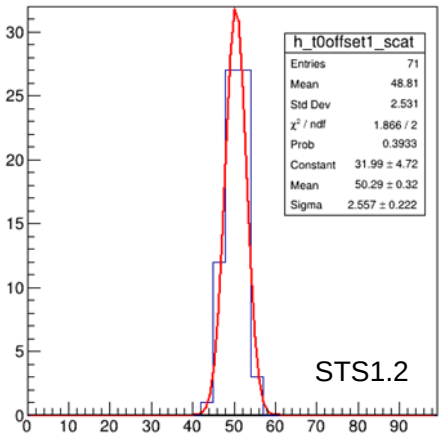
THANK YOU !

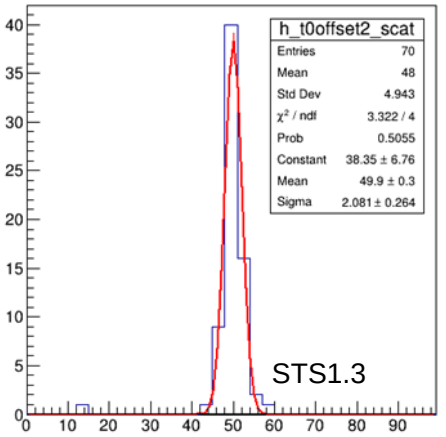
Questions?

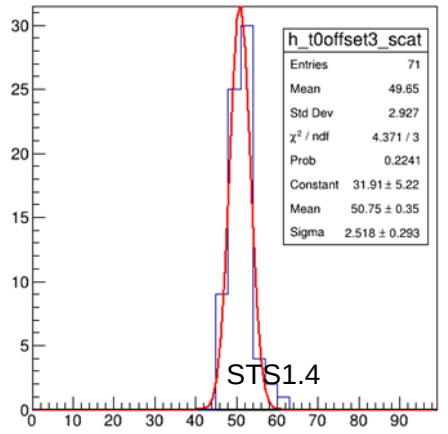
BACK UP

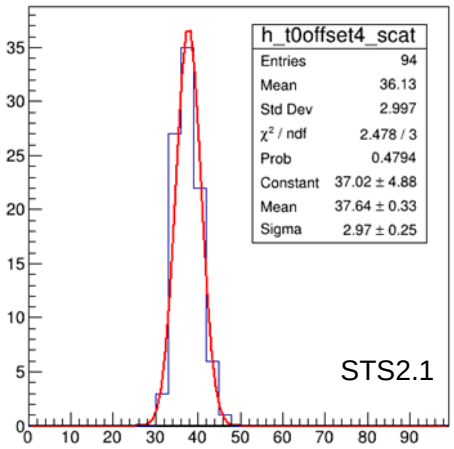
Time offset correction corrected by fRPC time (uniformly illuminated regions)

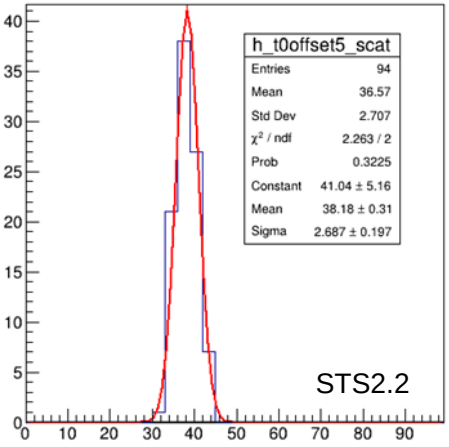


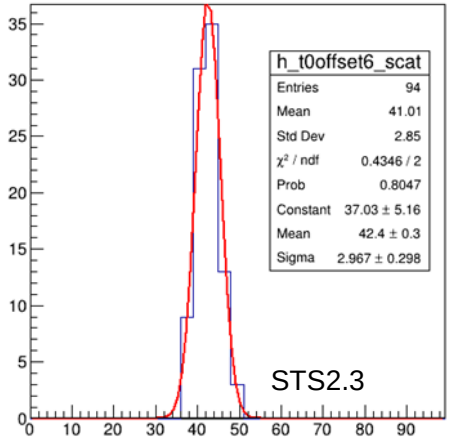


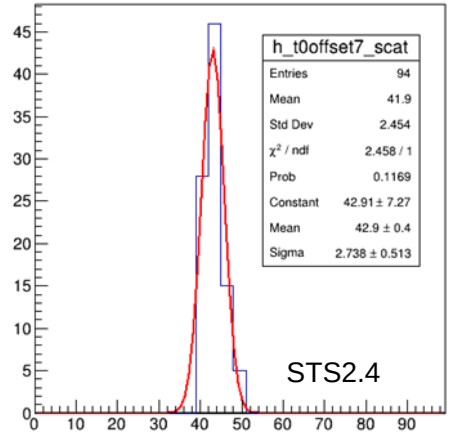




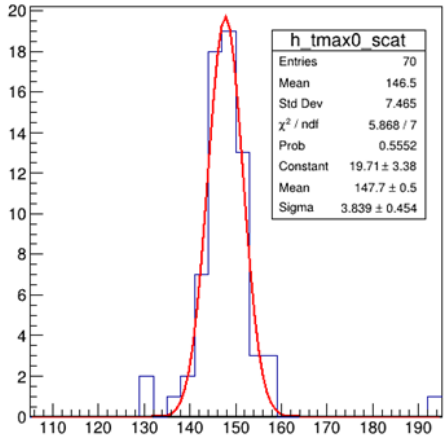


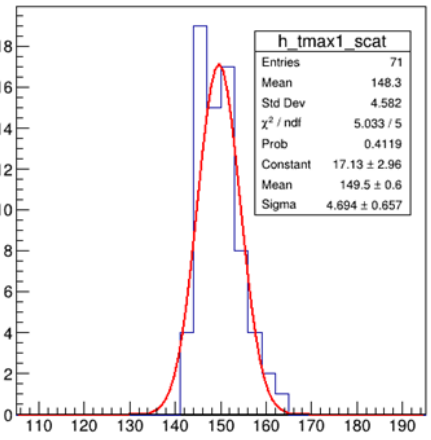


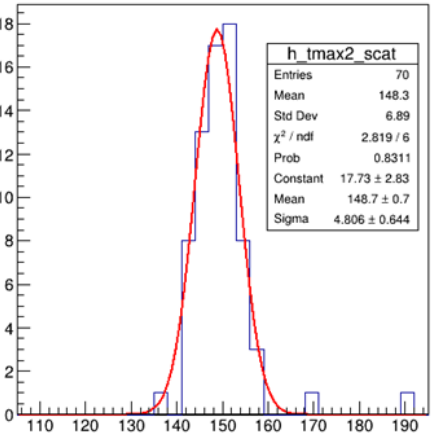


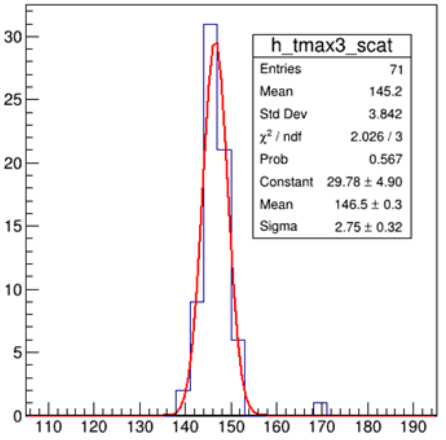


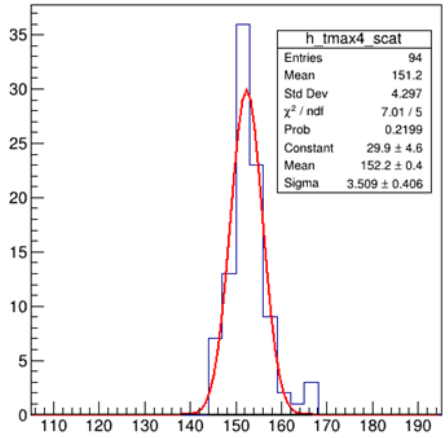
Tmax after correction corrected by fRPC time (uniformly illuminated regions)

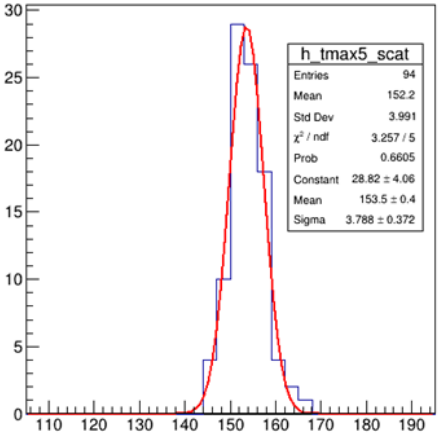


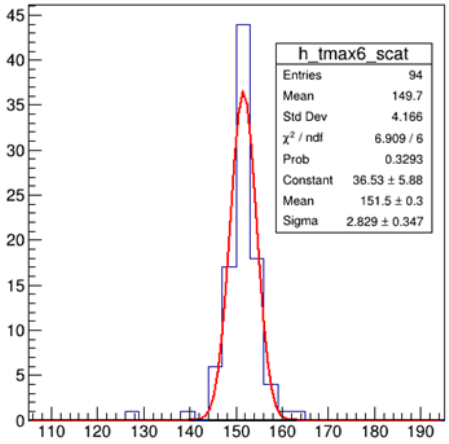


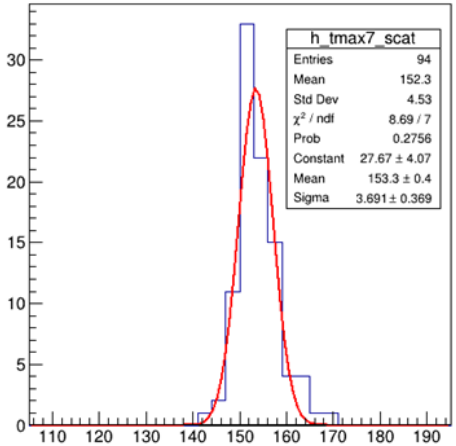




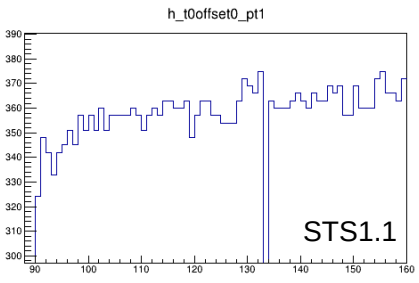


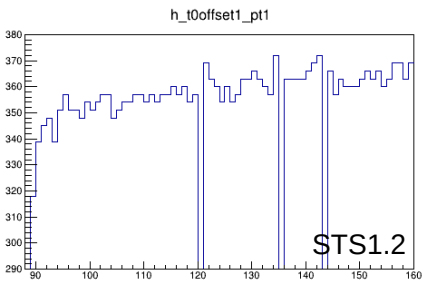


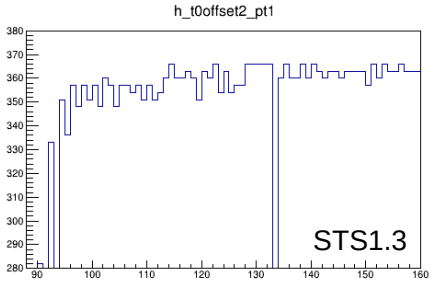


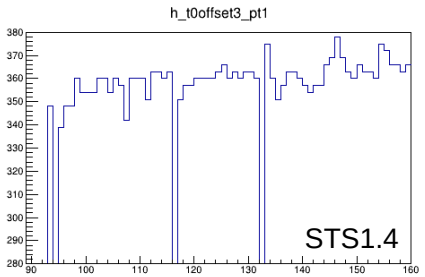


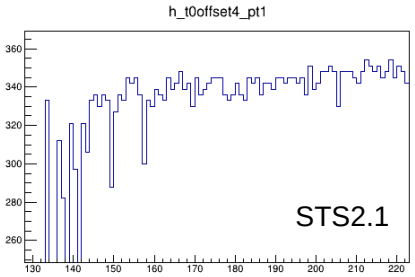
Time offset correction with PT1 data (uniformly illuminated regions)

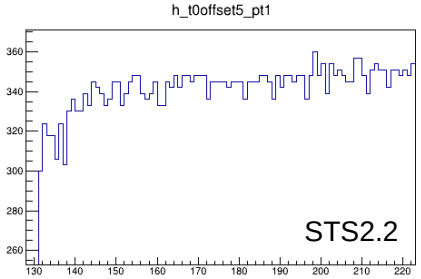


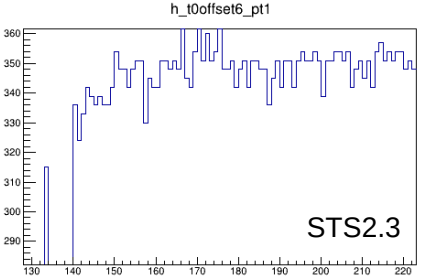


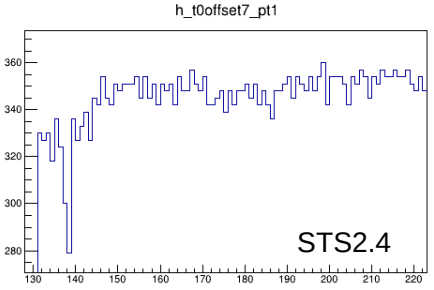






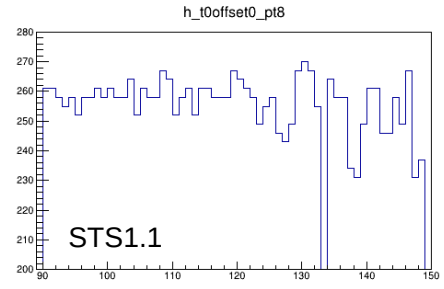


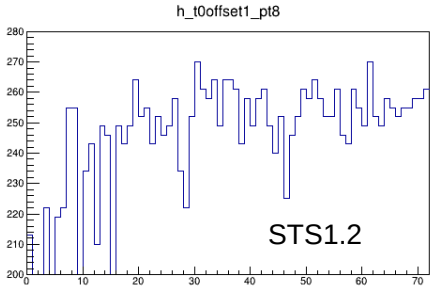


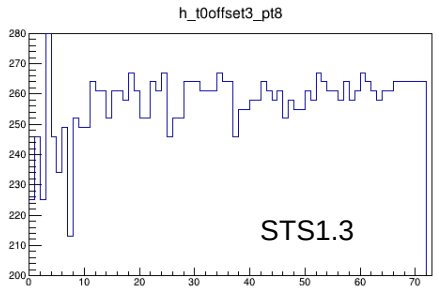


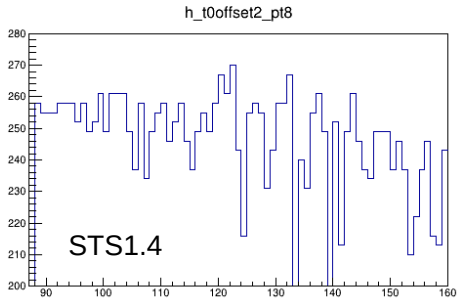
Up to 10 ns variation in time offset correction

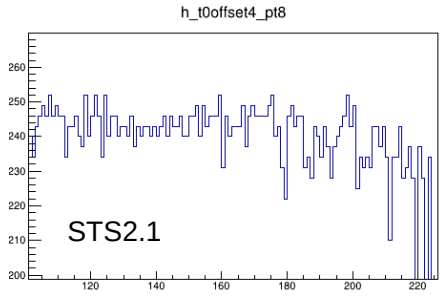
Time offset correction with PT8 data (selected uniformly illuminated region)

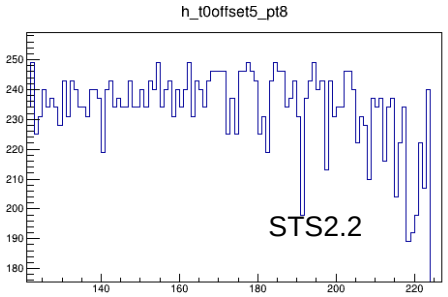


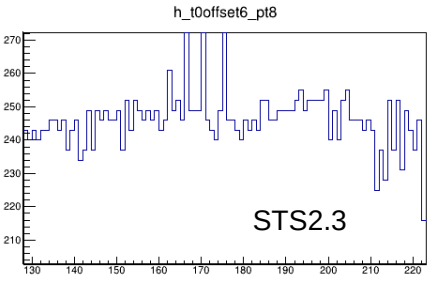


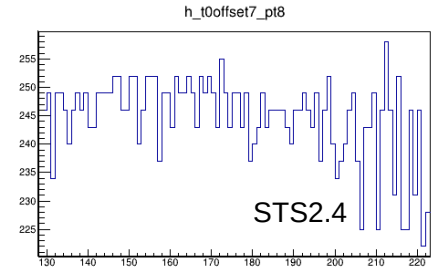




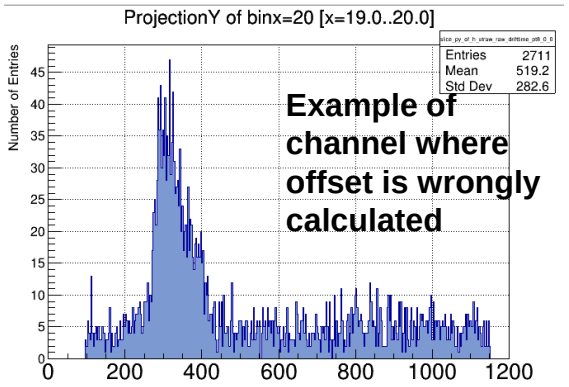


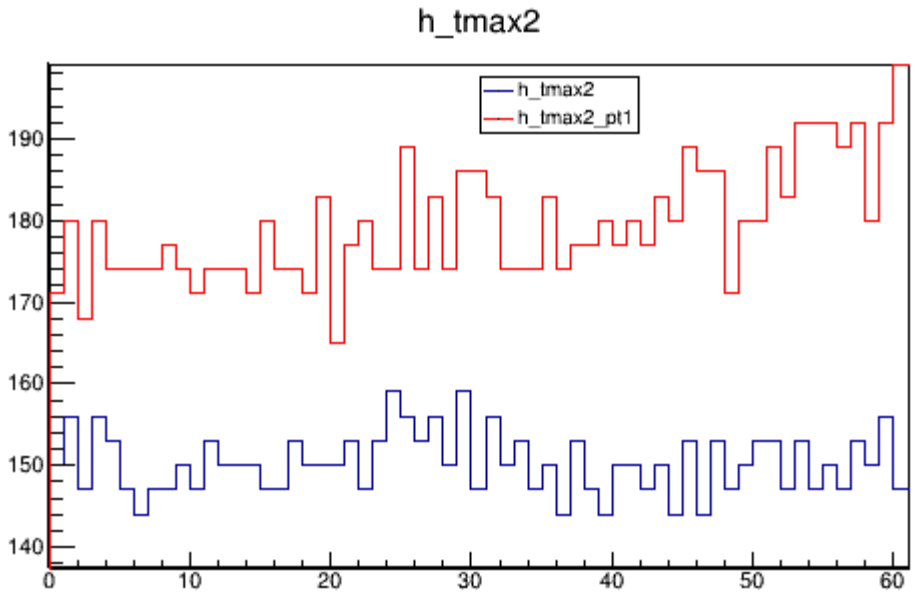


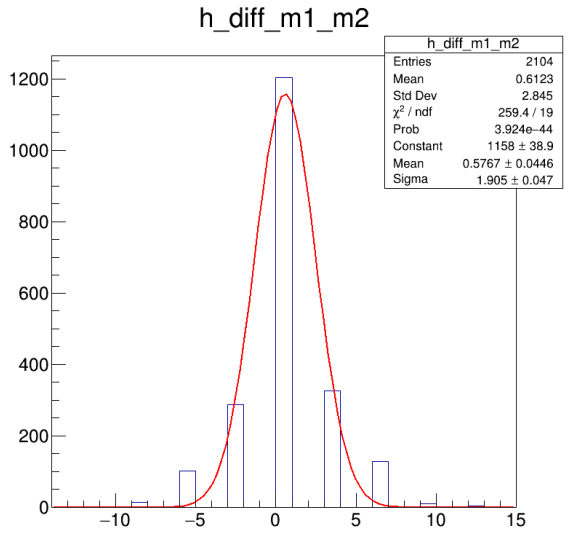


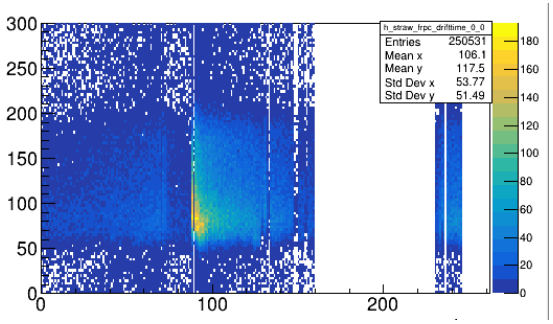


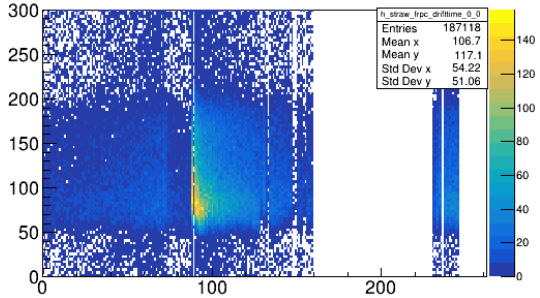
Up to 15 ns variation in time offset correction

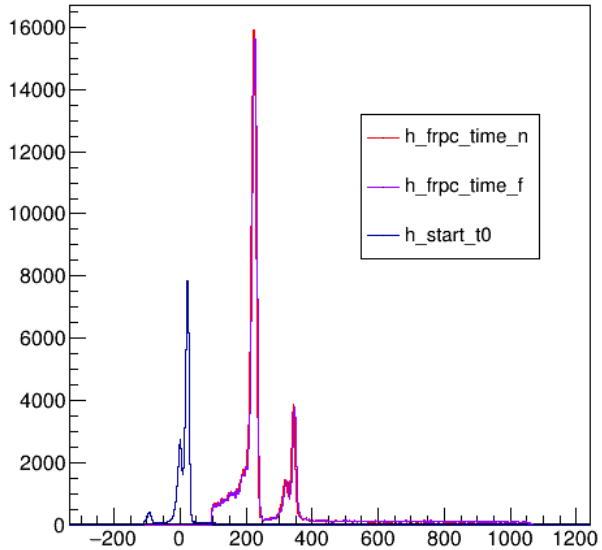


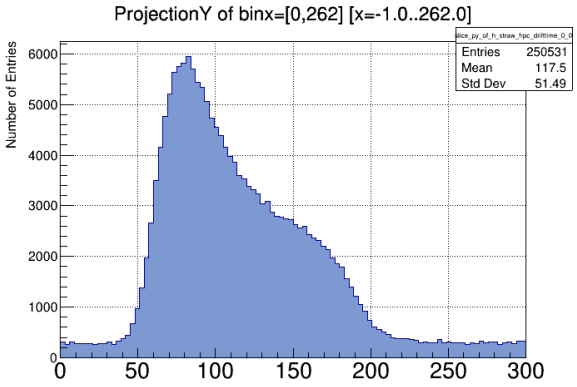

h_tmax2
h_tmax2
h_tmax2_pt1
190
180
170
160
150
140
0
10
20
30
40
50
60


h_diff_m1_m2
h_diff_m1_m2
Entries 2104
Mean 0.6123
Std Dev 2.845
χ² / ndf 259.4 / 19
Prob 3.924e−44
Constant 1158 ± 38.9
Mean 0.5767 ± 0.0446
Sigma 1.905 ± 0.047
1200
1000
800
600
400
200
0
−10
−5
0
5
10
15


h_straw_frpc_drifttime_0_0
Entries 250531
Mean x 106.1
Mean y 117.5
Std Dev x 53.77
Std Dev y 51.49


h_straw_frpc_drifttime_0_0
Entries 187118
Mean x 106.7
Mean y 117.1
Std Dev x 54.22
Std Dev y 51.06


h_frpc_time_n
h_frpc_time_f
h_start_t0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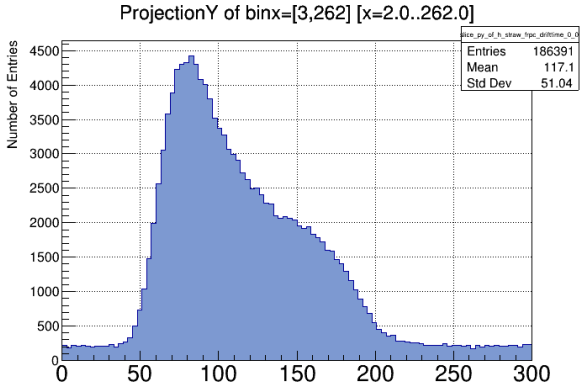
Entries 250531
Mean 117.5
Std Dev 51.49
Number of Entries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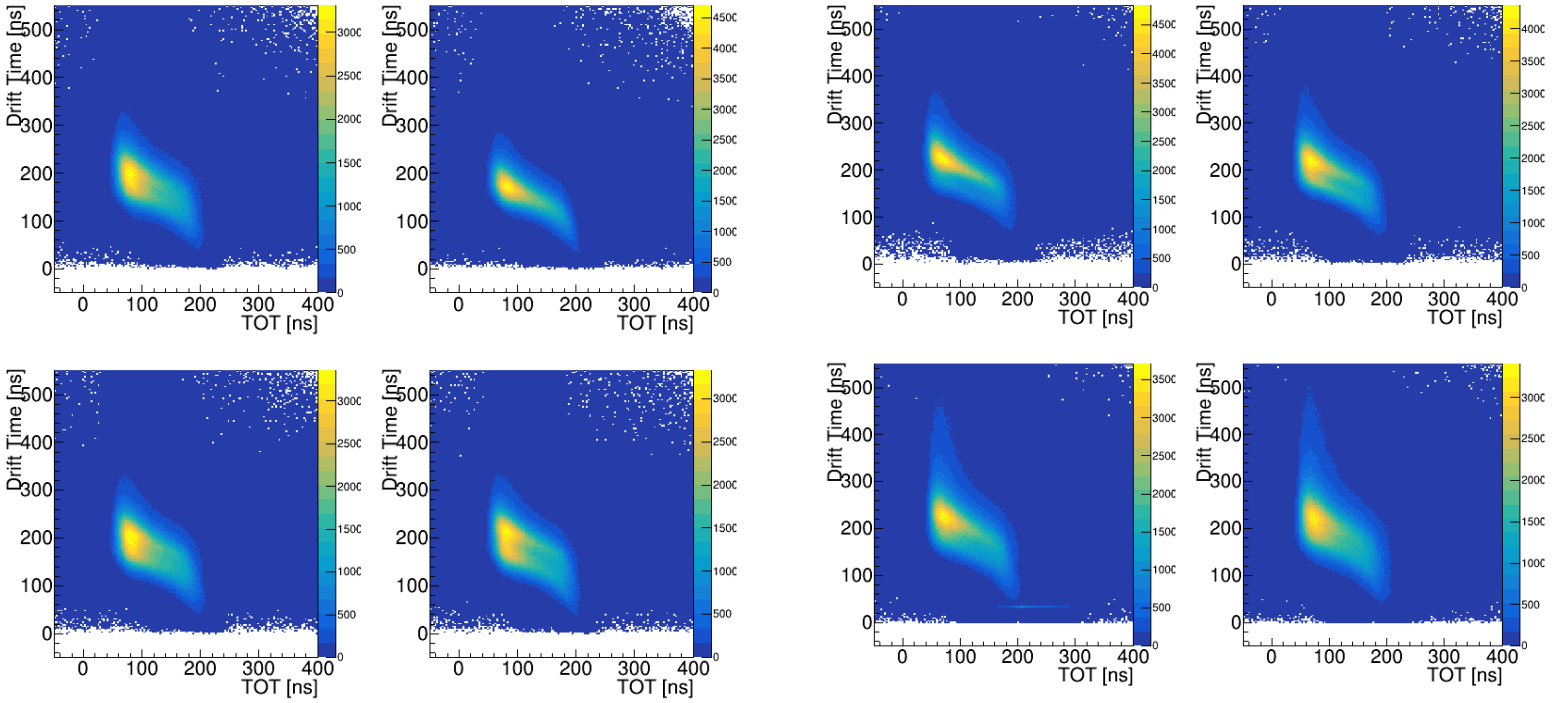
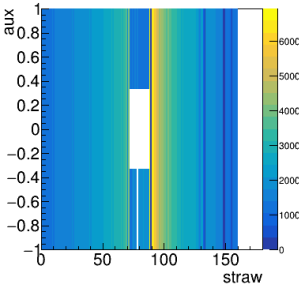
Mean 117.1
Std Dev 51.04
Number of Entries

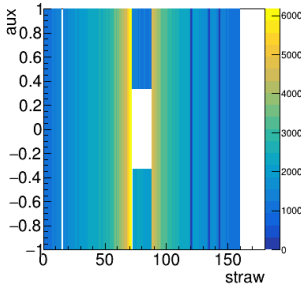


STS calibration

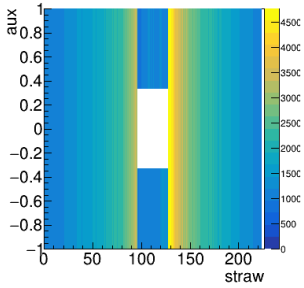
STS1.1



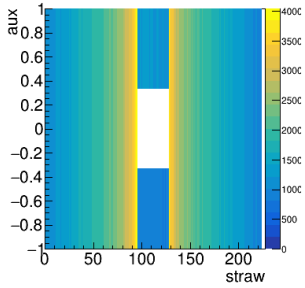
STS1.2

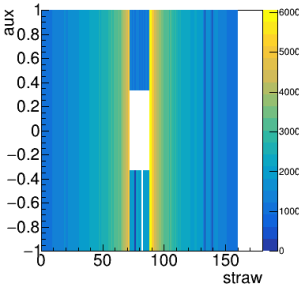


STS2.1

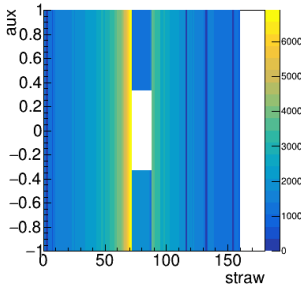


STS2.2

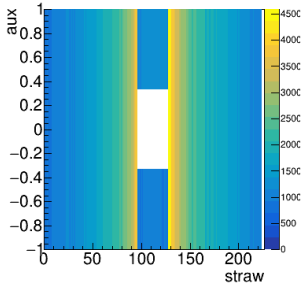




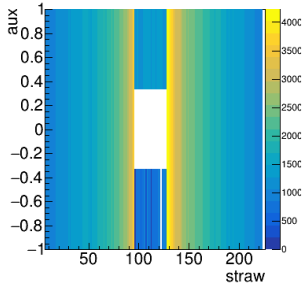
STS1.3



STS1.4



STS2.3



STS2.4