



SPE and MIP Measurements with Muon Tower

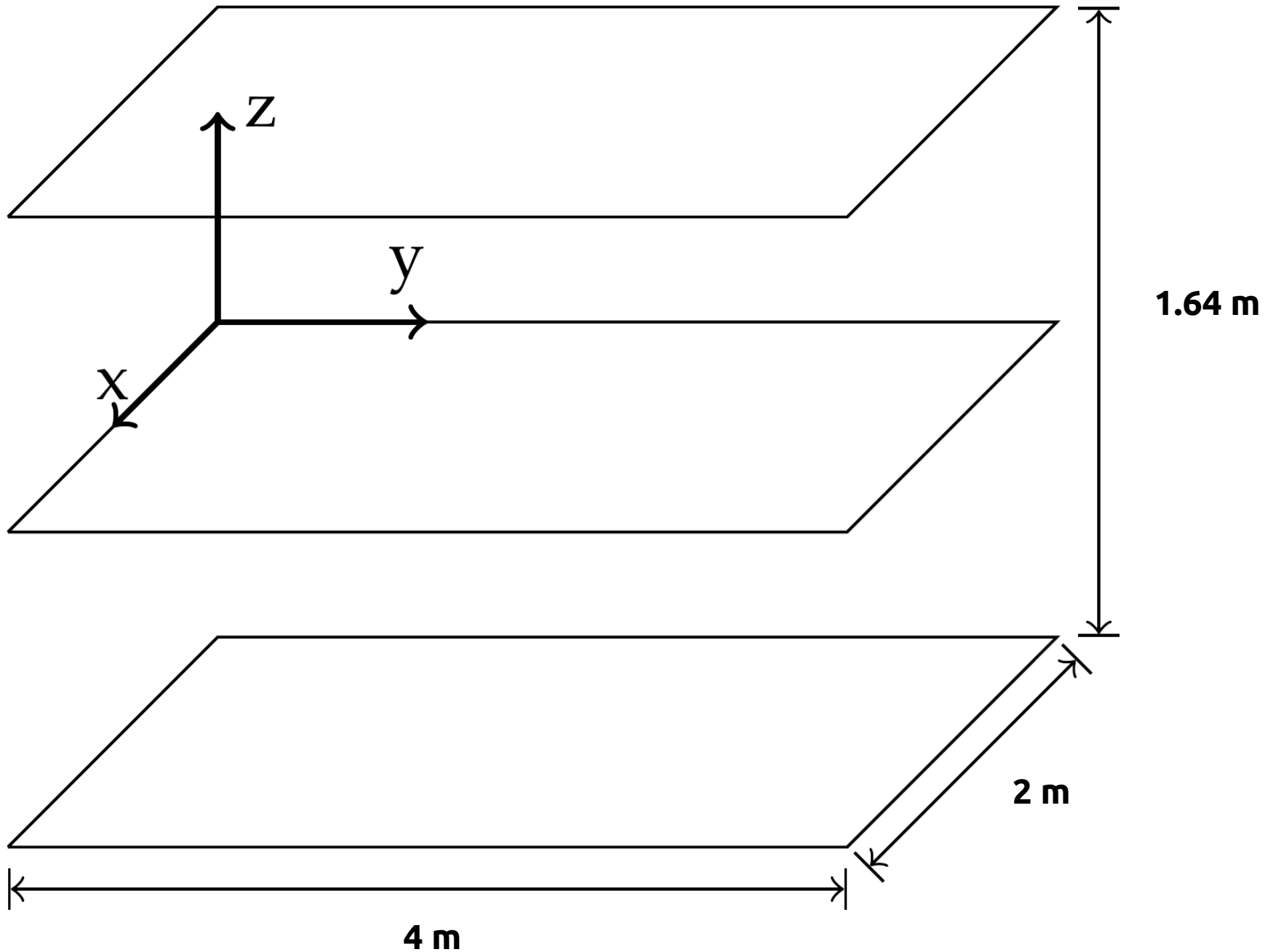
Darko Veberič for the KIT SSD team:

**N. Barenthien, S. Baur, H. Bolz, K. Daumiller, R. Engel, H. Kern, H.-J. Mathes,
M. Riegel, M. Roth, A. Streich, G. Wörner**

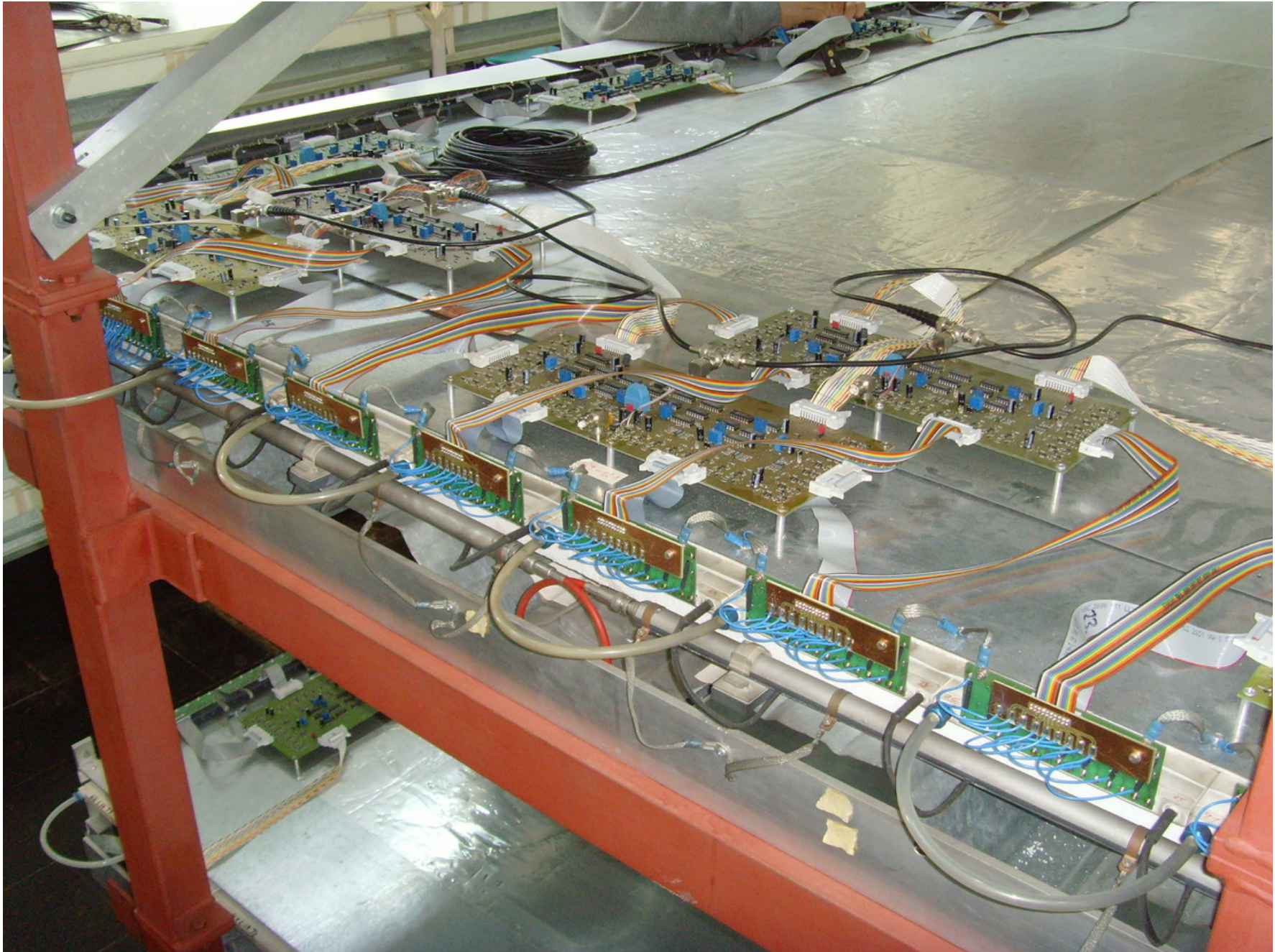
Muon Tower



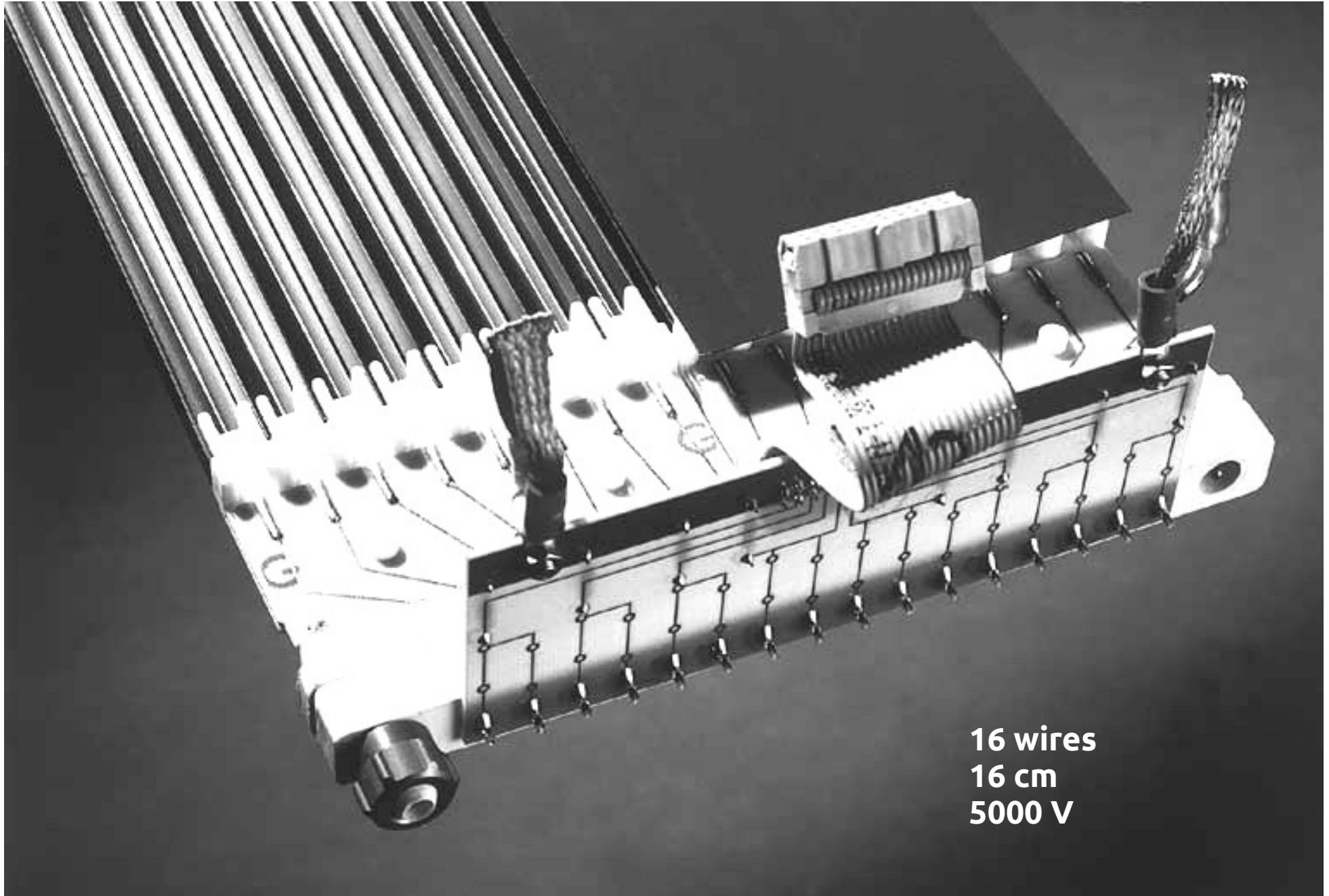
Tower Planes



X-axis: Wire Readouts



Limited Streamer Tubes



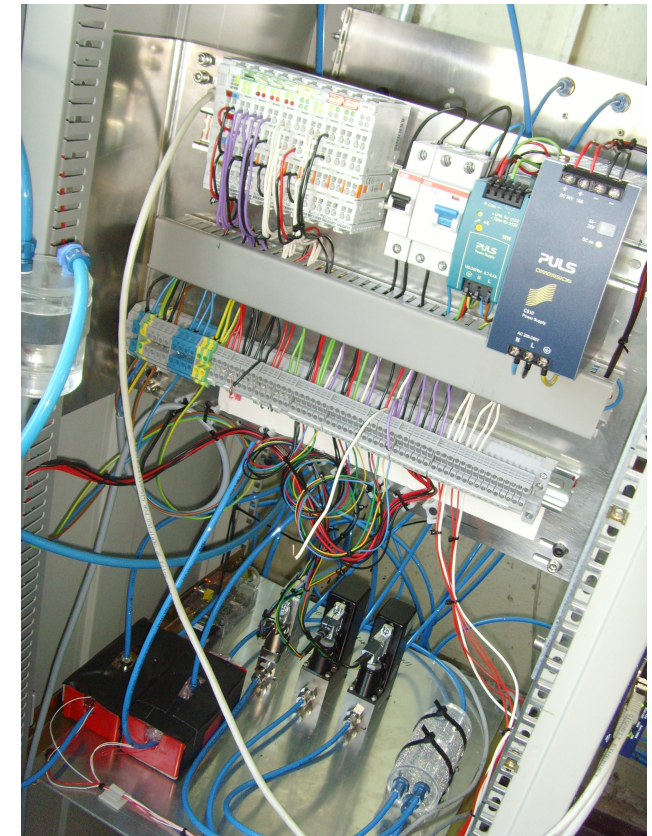
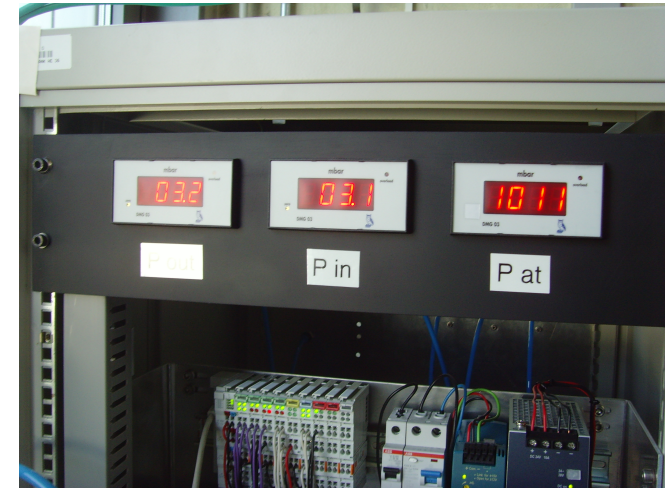
Gas System



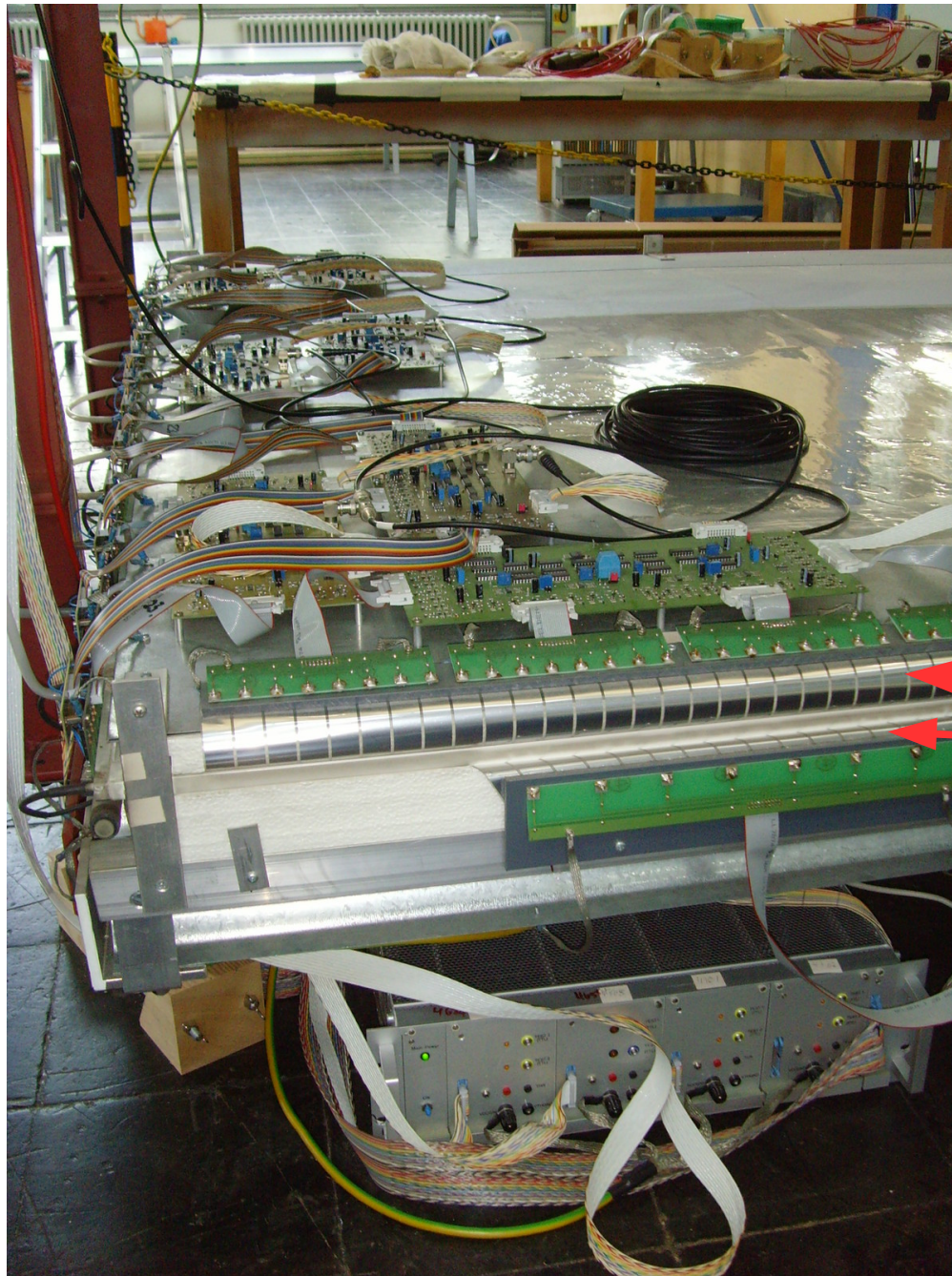
pure CO₂



muon efficiency:
30~40% (per plane)

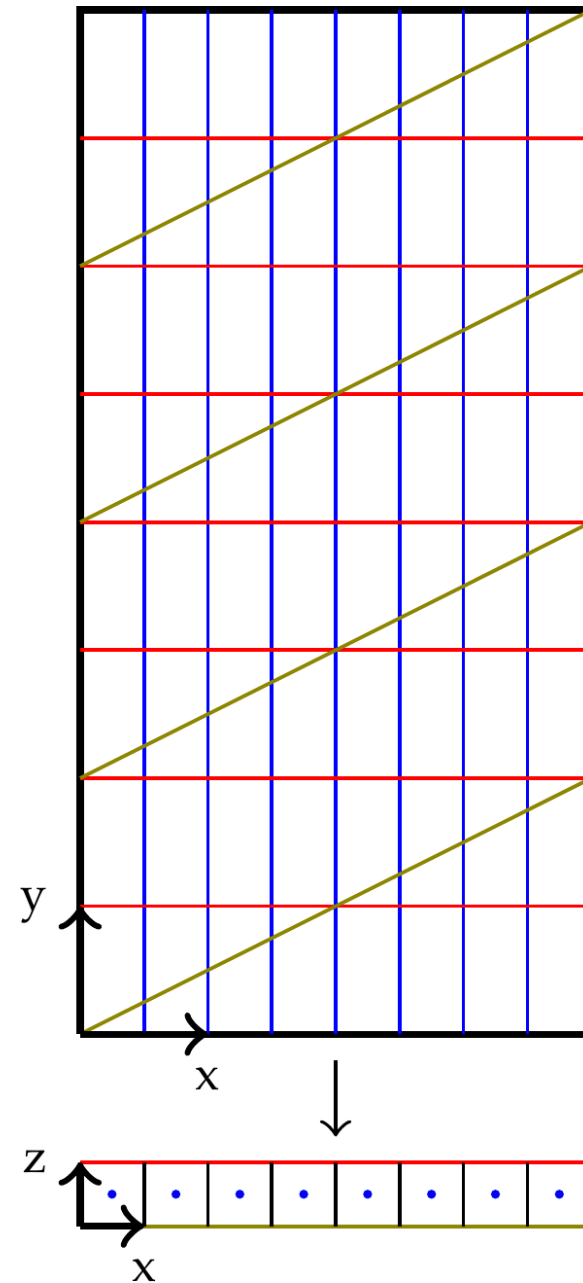


Y-axis: Stripe Readouts



2cm Al stripes:
perp. above
diag. below

Tower Plane

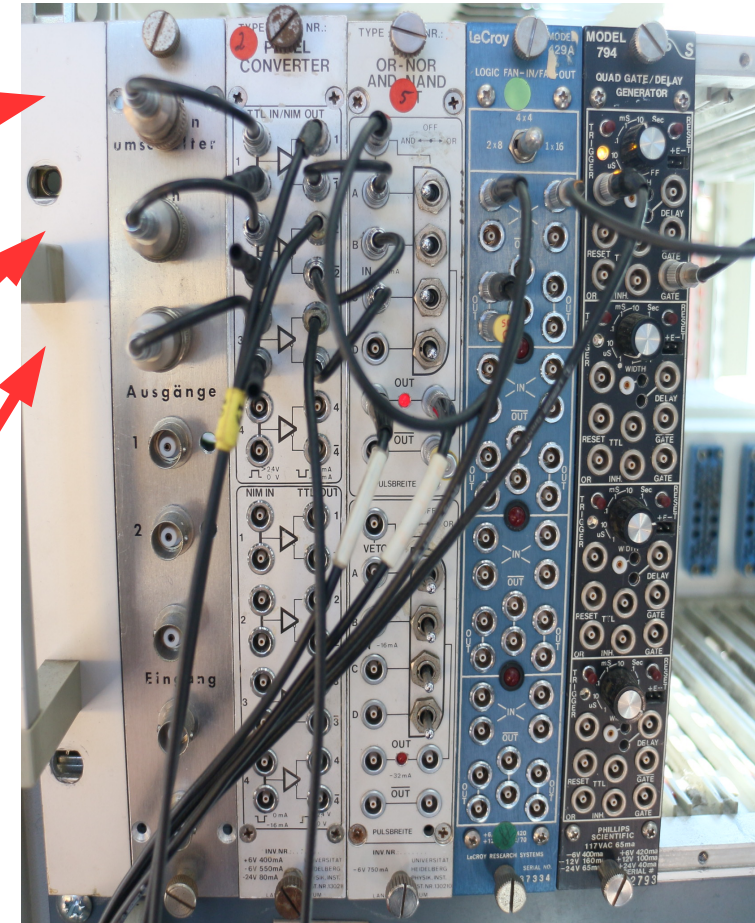


192
perpendicular
stripes: 2cm

96
double diagonal
stripes: 4cm

192
wires: 1cm

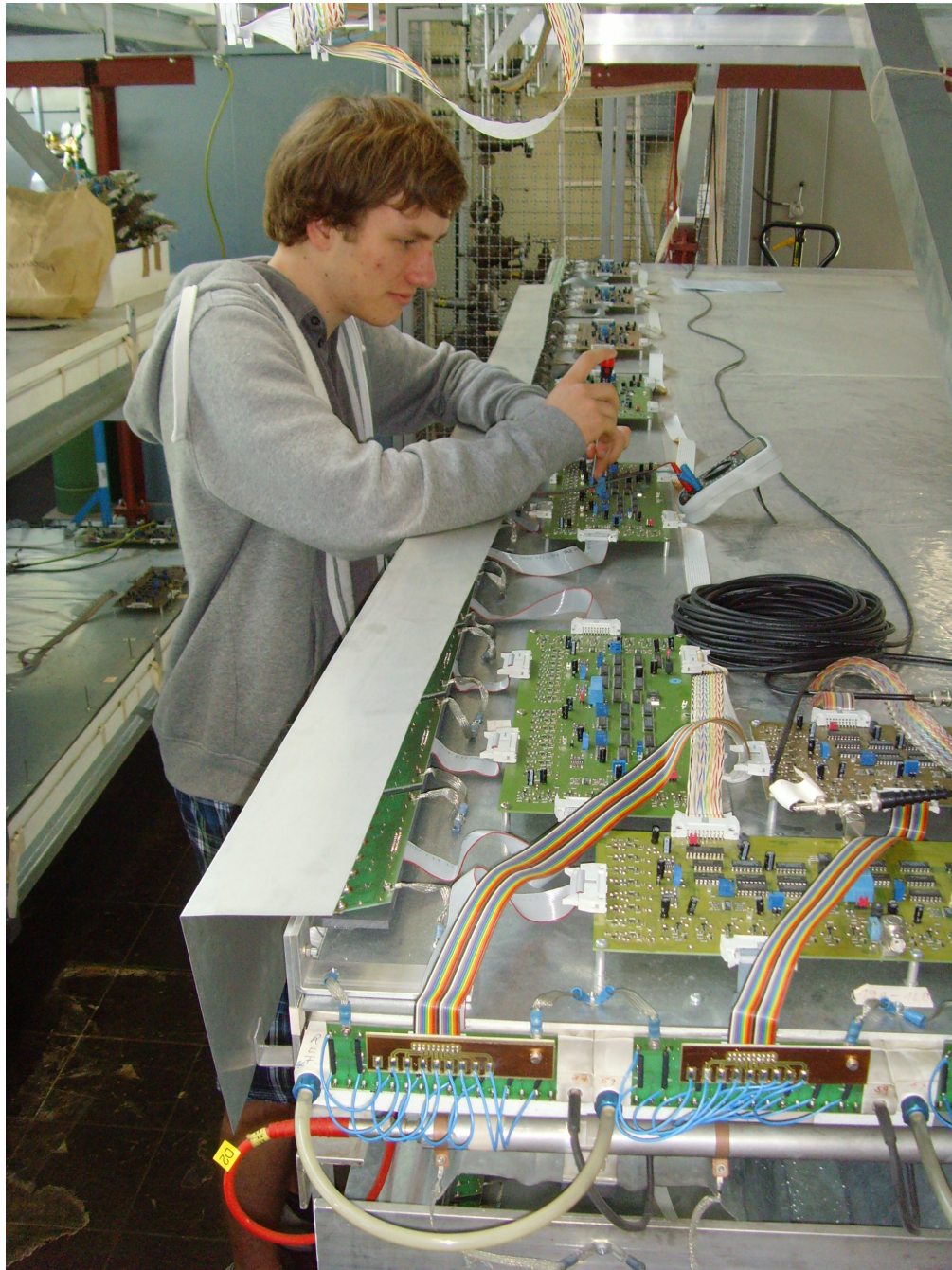
Trigger Logic



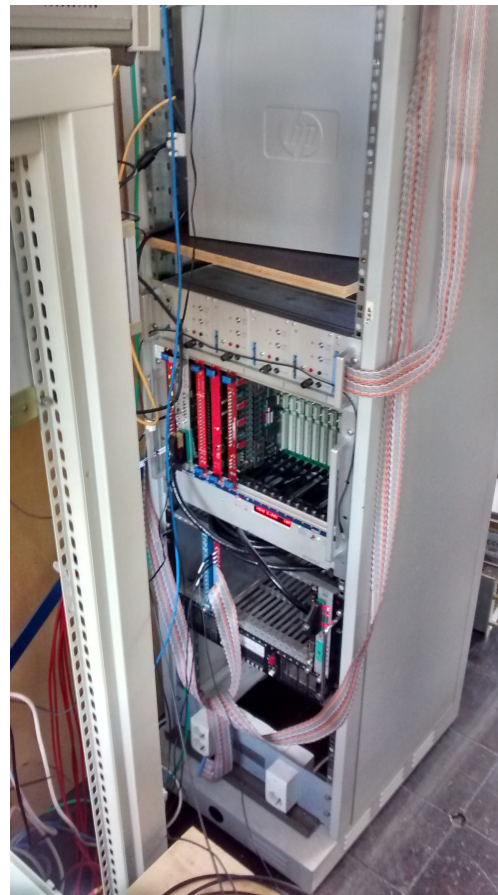
**coincidence pulse
extending, readout veto**

**require triple
coincidence**

Event Readout



wire HV supply: ~5000V



PC Ubuntu: A3818

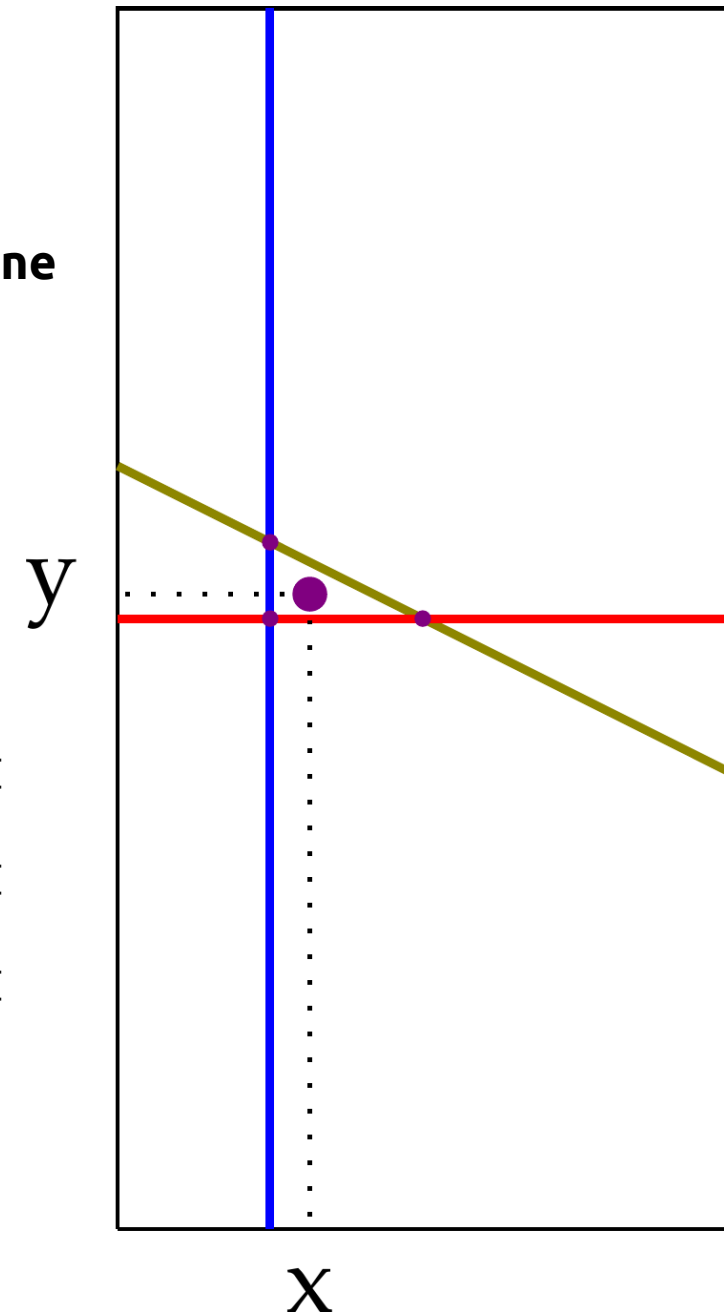
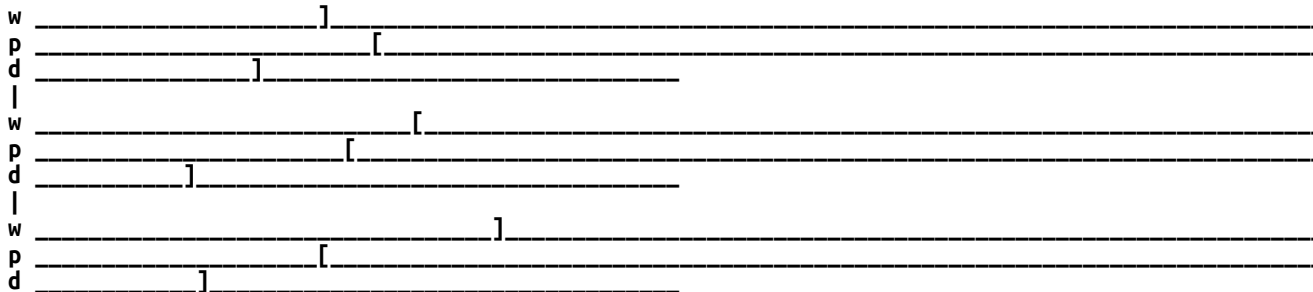
VME: V2718, CBD8210

CAMAC: STAS

Point Reconstruction

within single plane

online event display

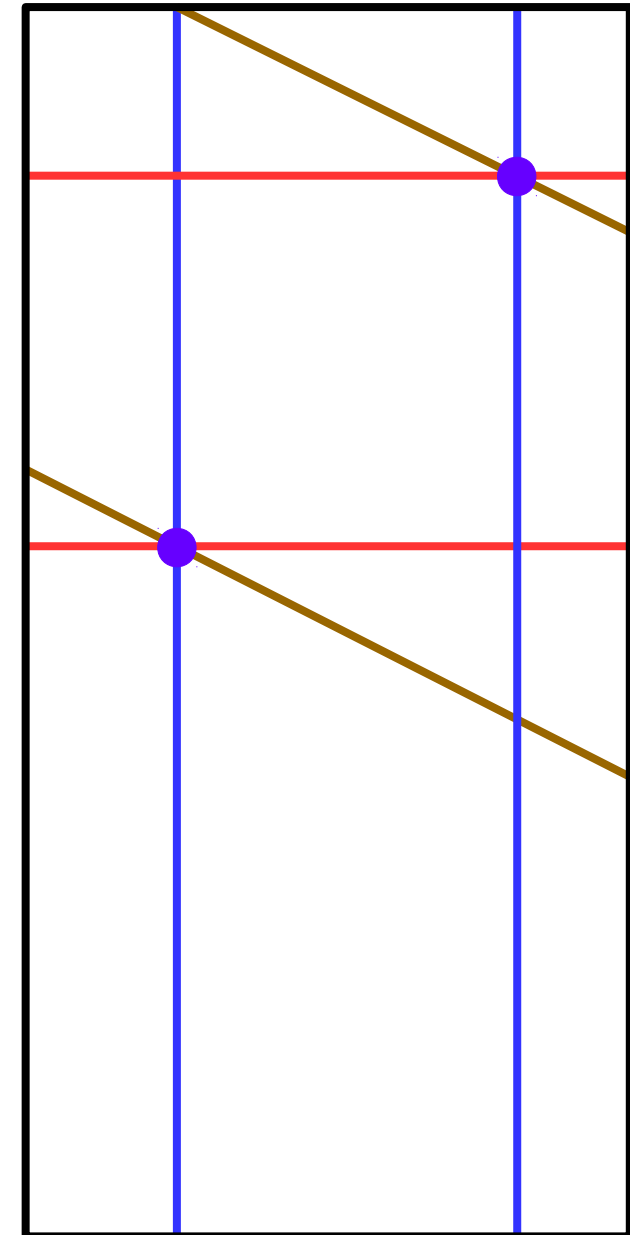


(No) Point Reconstruction

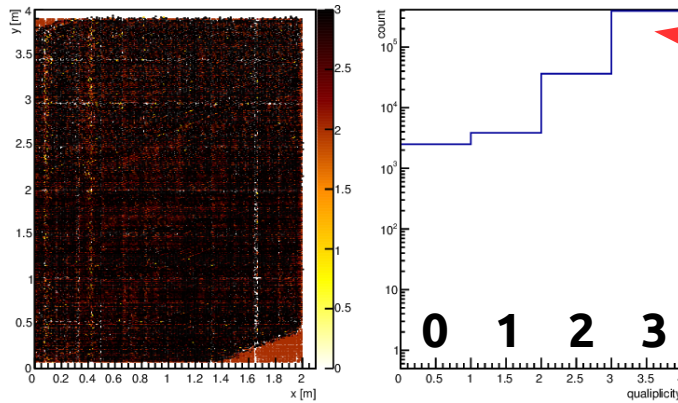
multiple clusters

w _____ HHH[
 p]HHHHHH
 d H[
 |
 w _____ [
 p HH
 d][
 |
 w _____] H[
 p HHH _____ [
 d H _____ H

shower

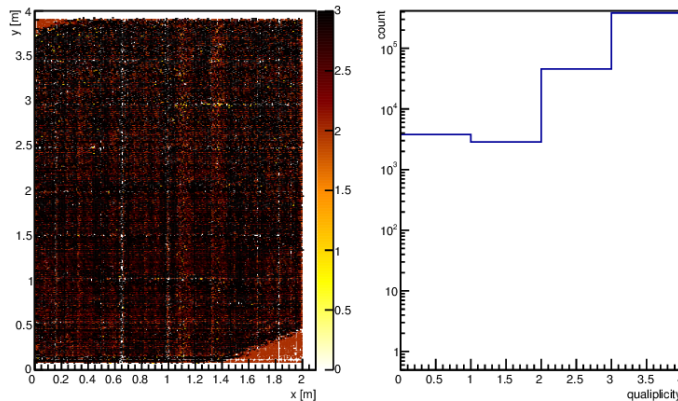
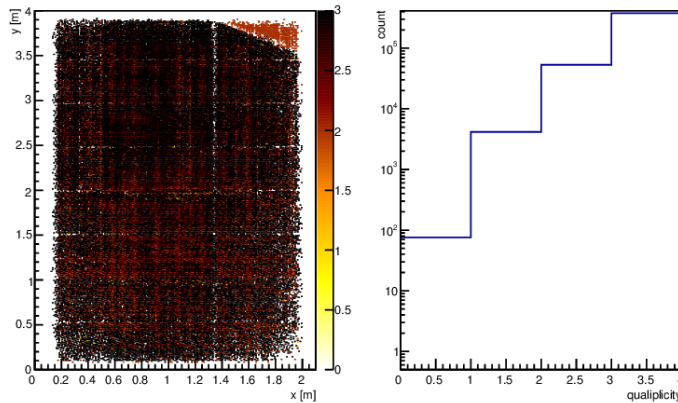
[illegible]

Point Multiplicities

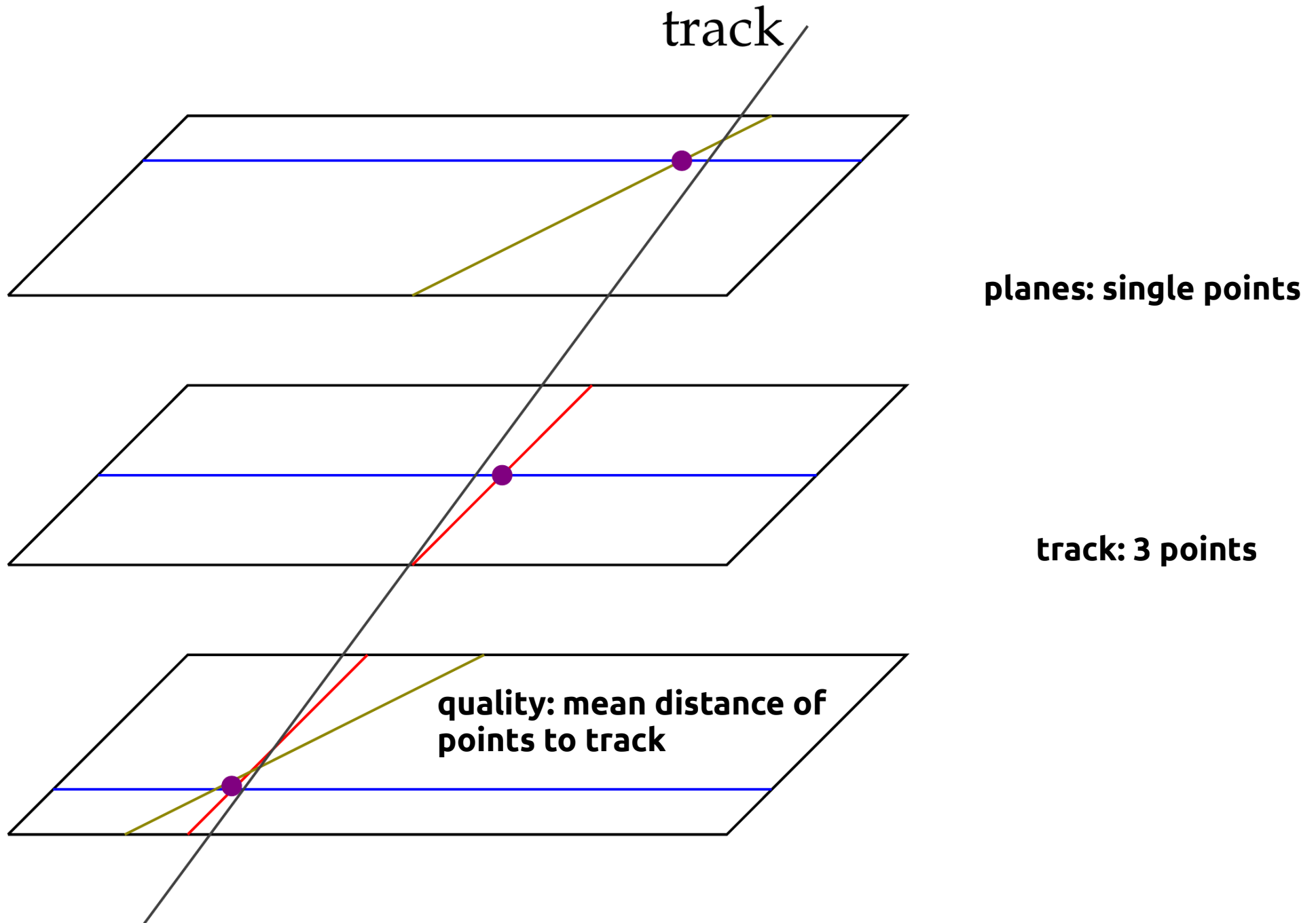


**most of the points
made of all 3
wire/stripe types**

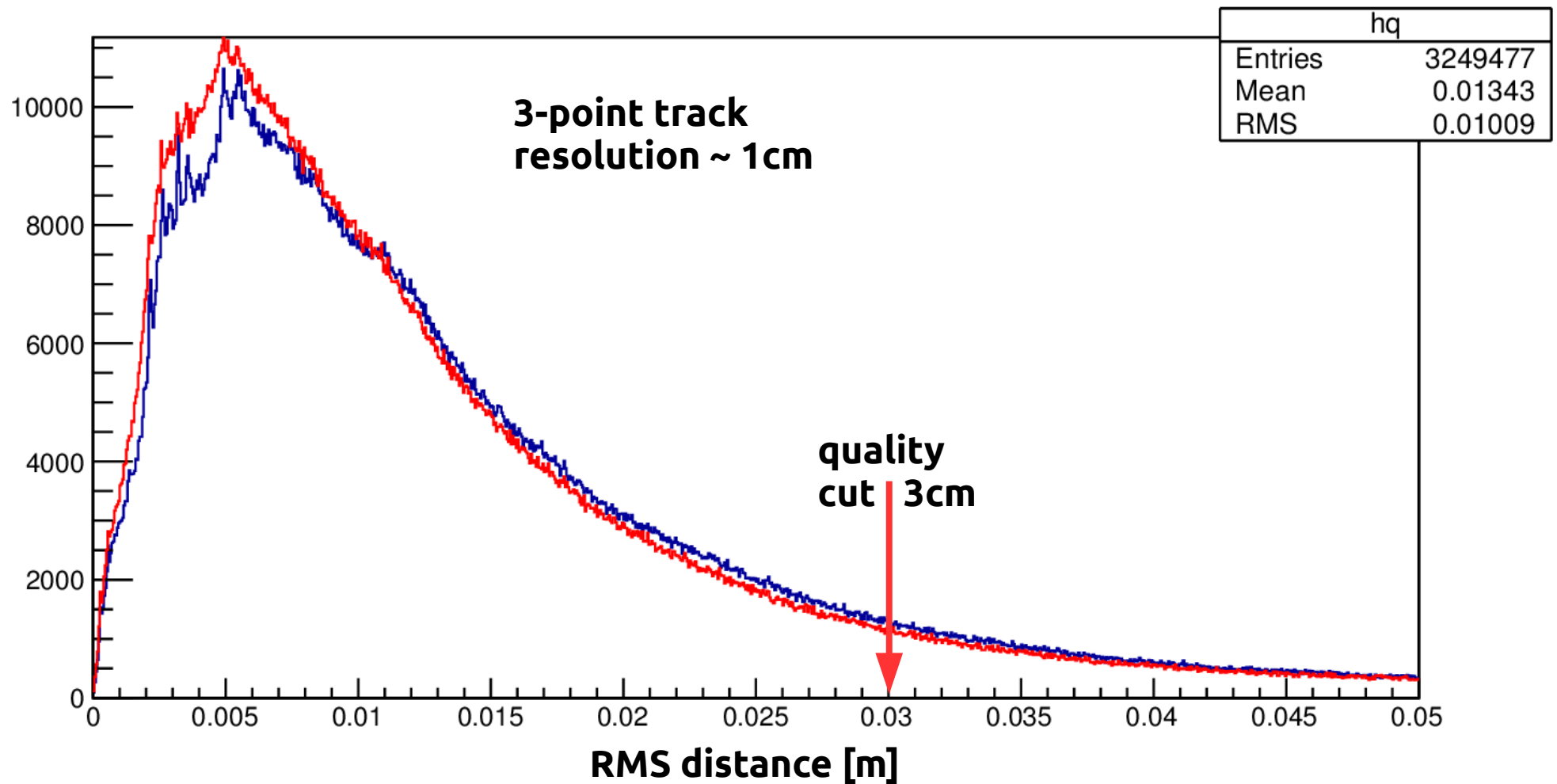
**0: perp+diag
1: wire+diag
2: wire+perp
3: wire+perp+diag**



Muon Track Reconstruction



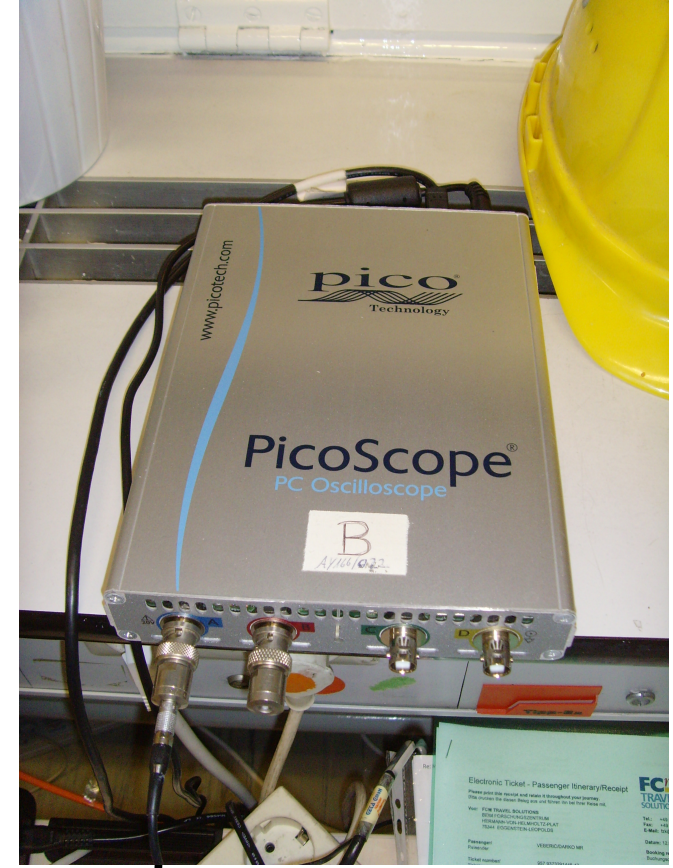
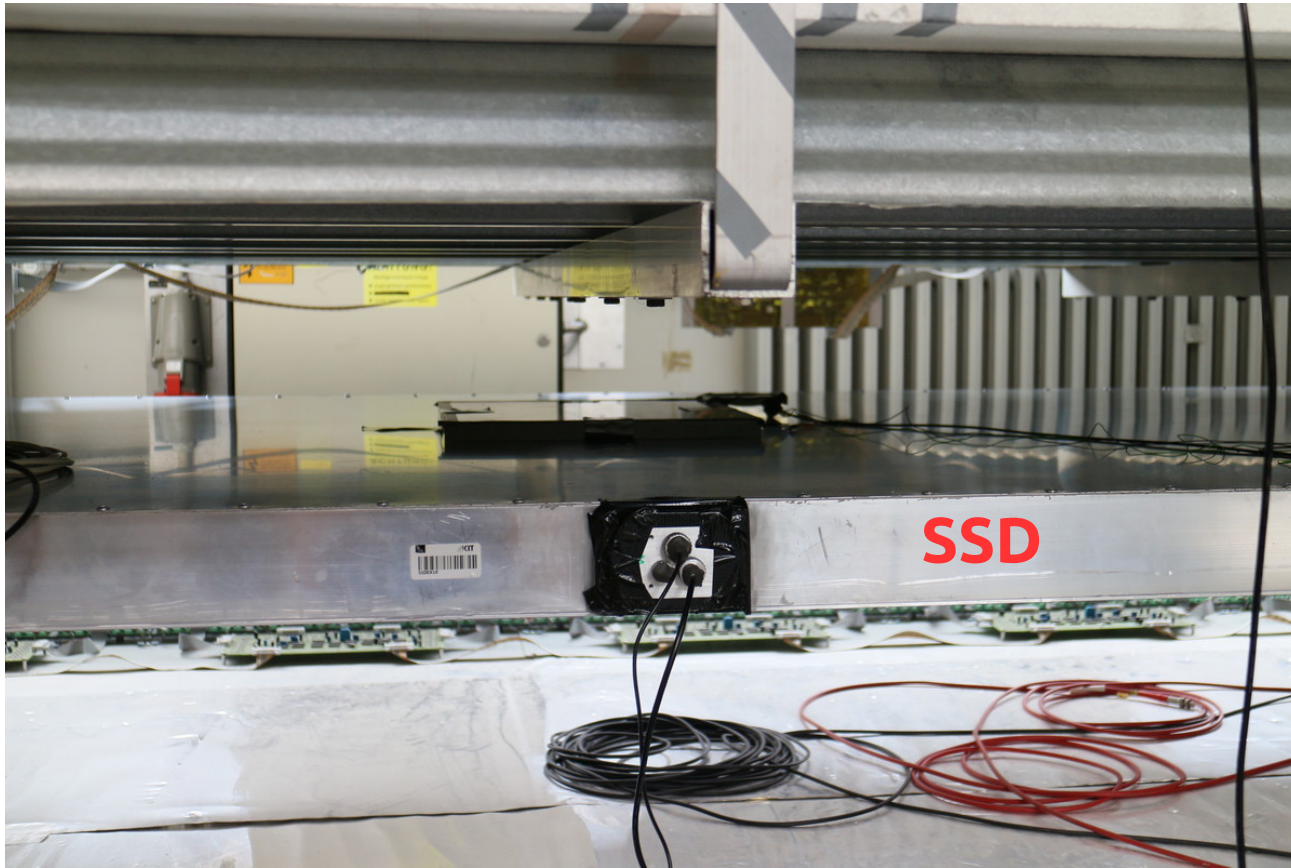
Resolution



SSD Placement



SSD Readout



triggered by tower
3-plane coincidence:
readout bit patterns

SSD PMT readout with PicoScope 6403:
4 μ s trace, 1.6ns sampling, 350 MHz bandwidth

event
→ ROOT files

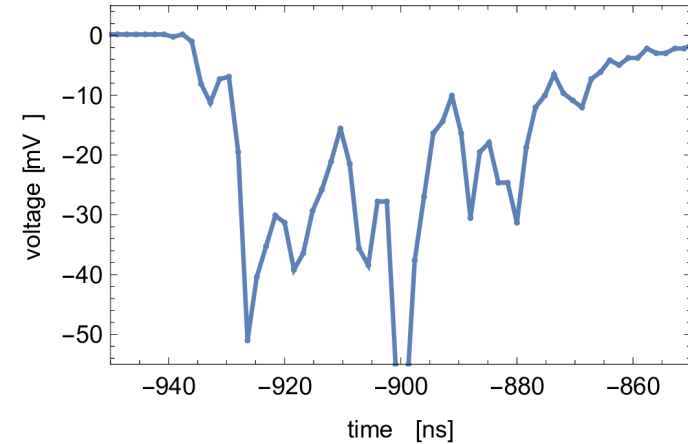
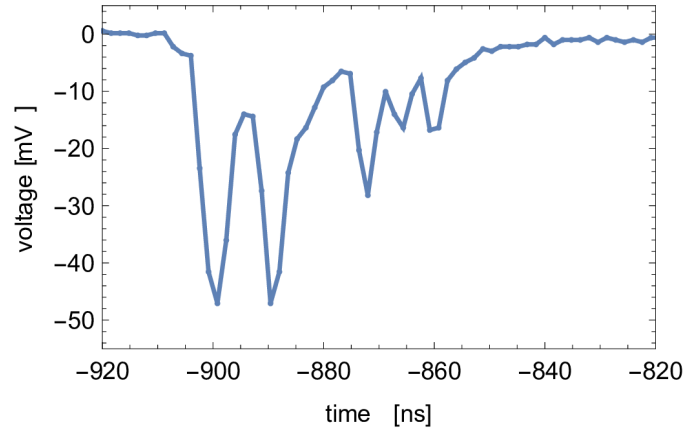
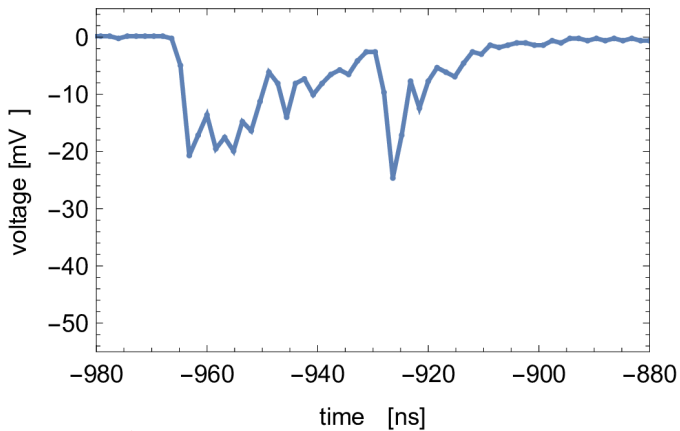
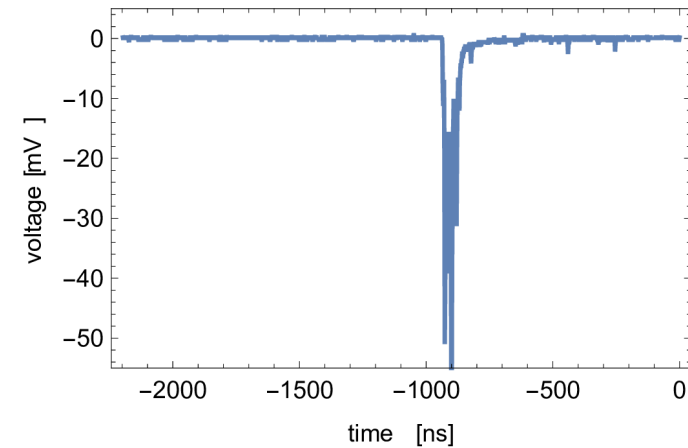
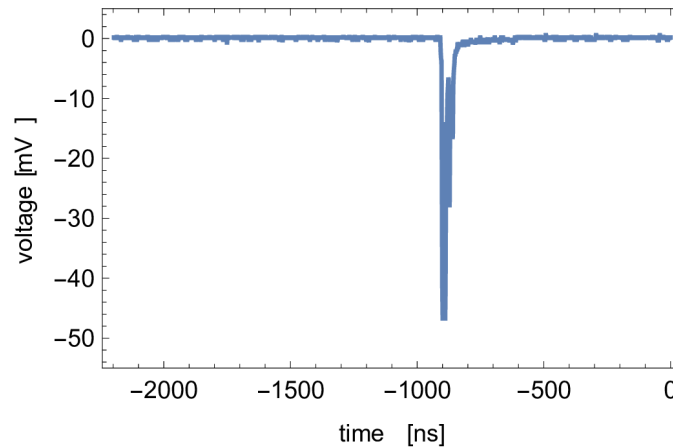
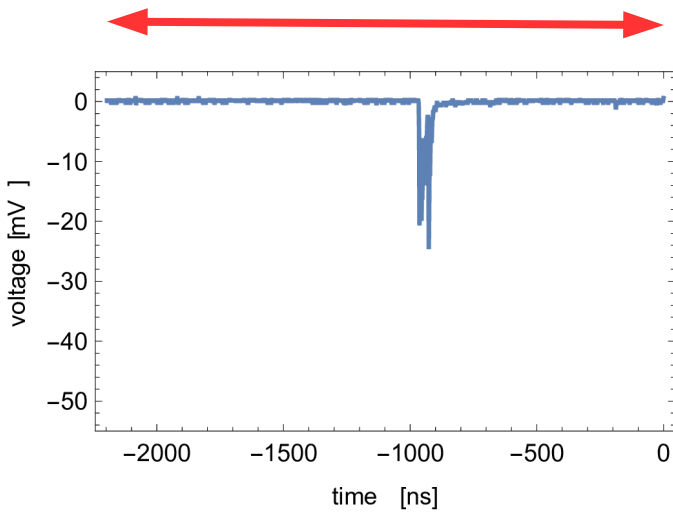
offline track reconstruction

offline pulse finding

SSD PMT Traces

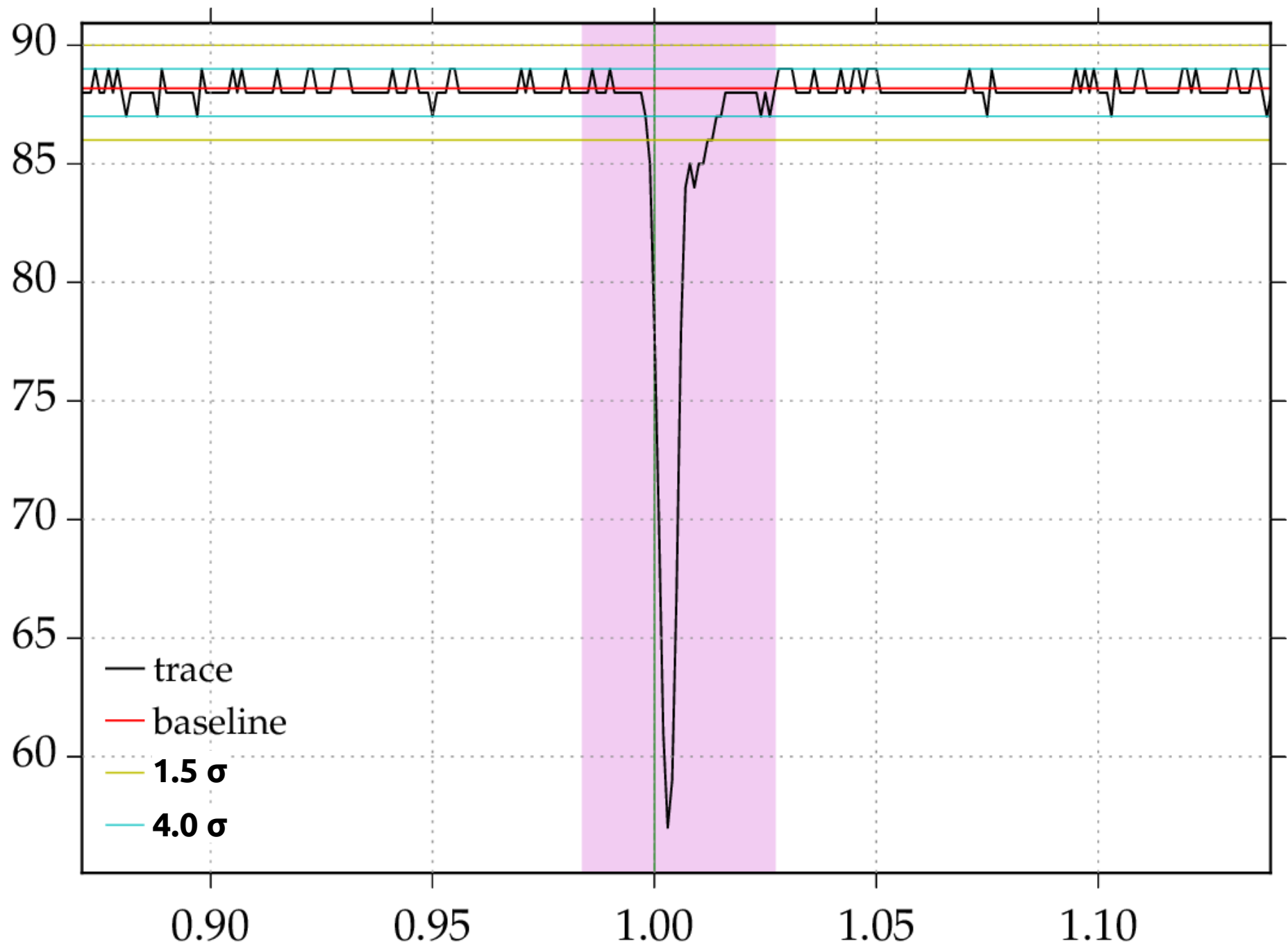
end $t = 0$ at tower trigger
begin $t = -4000$ ns

2.2 μ s

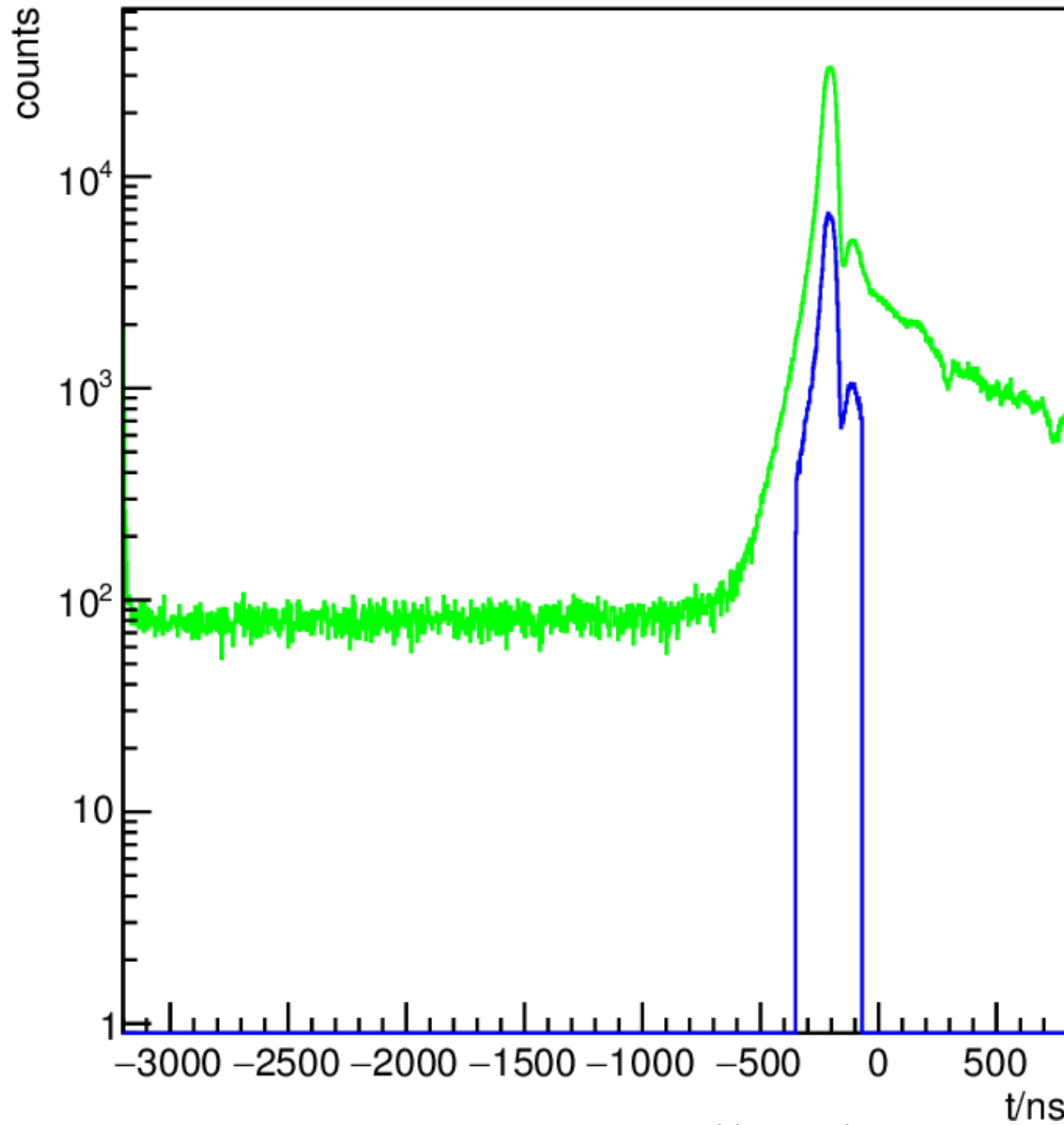


100 ns

Pulse Finder



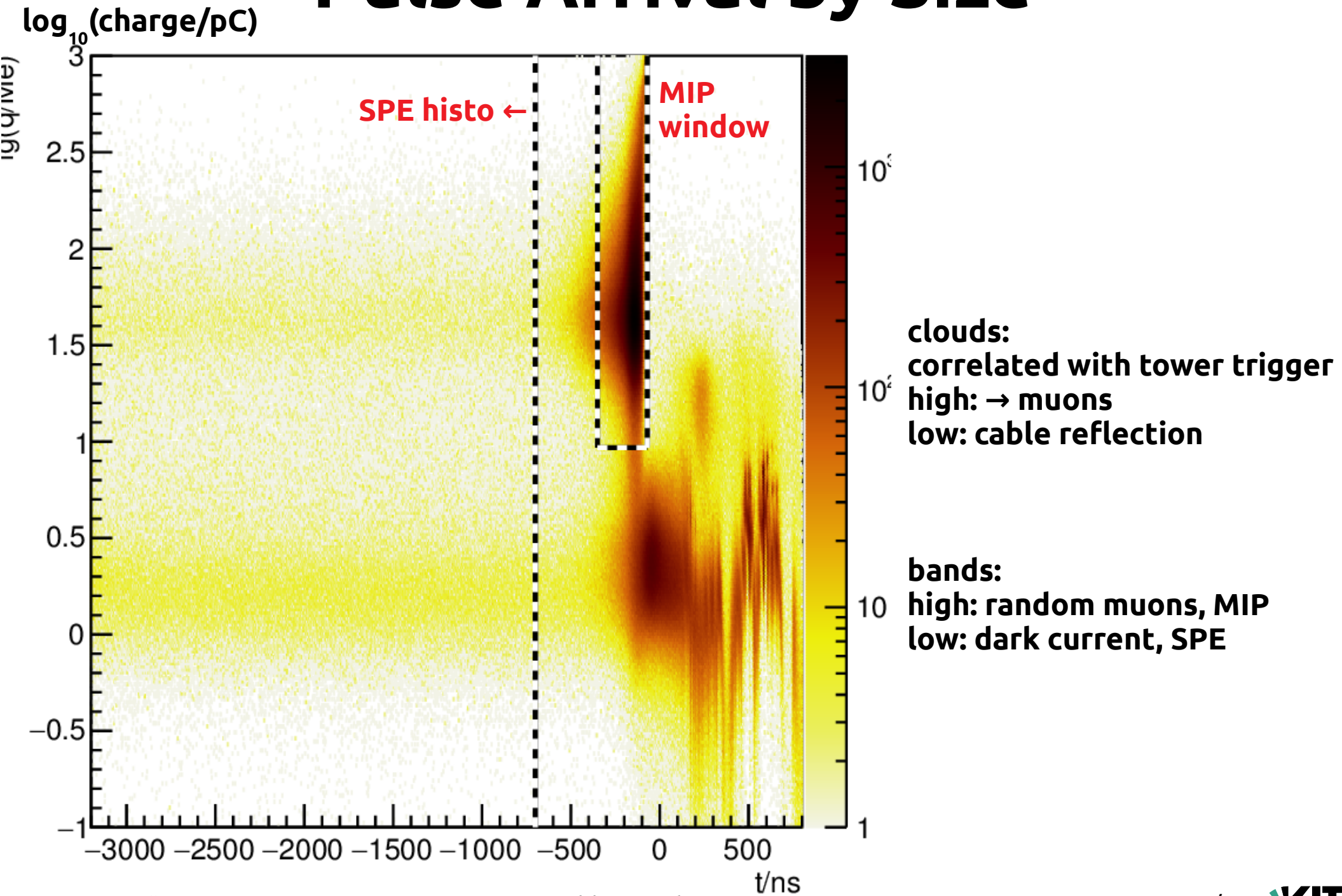
Pulse Arrivals



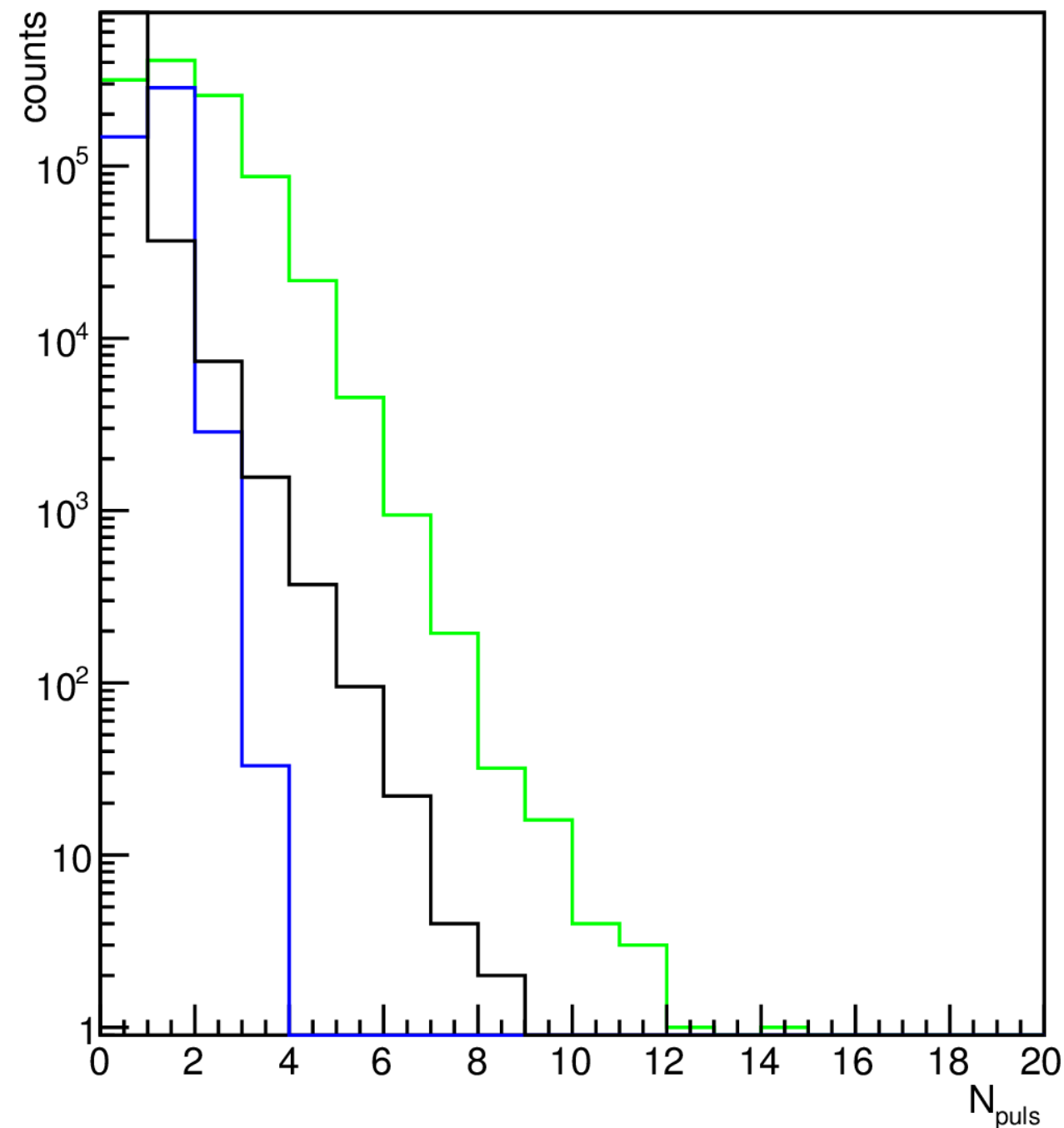
typical pulse density

all
used later for MIP, "light"

Pulse Arrival by Size



Pulse Counts



typical number of pulses per trace

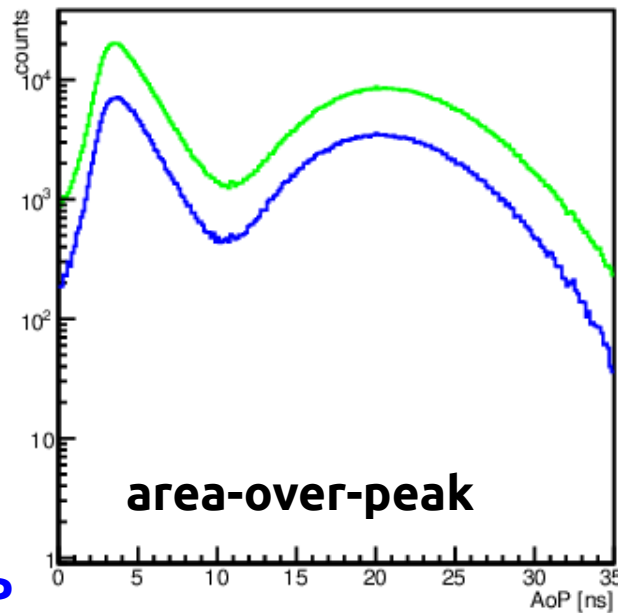
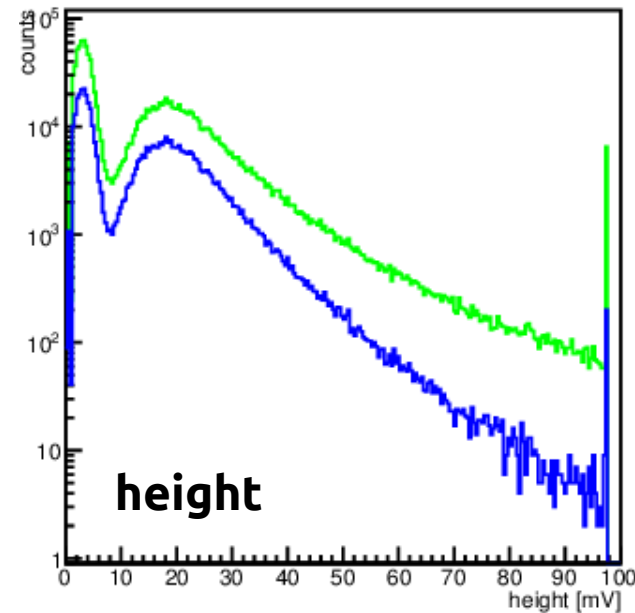
all

SPE/trace histo

MIP/trace histo

we can use SPE/trace count-statistics (mode, mean, std) to determine potential light leakage

Signal



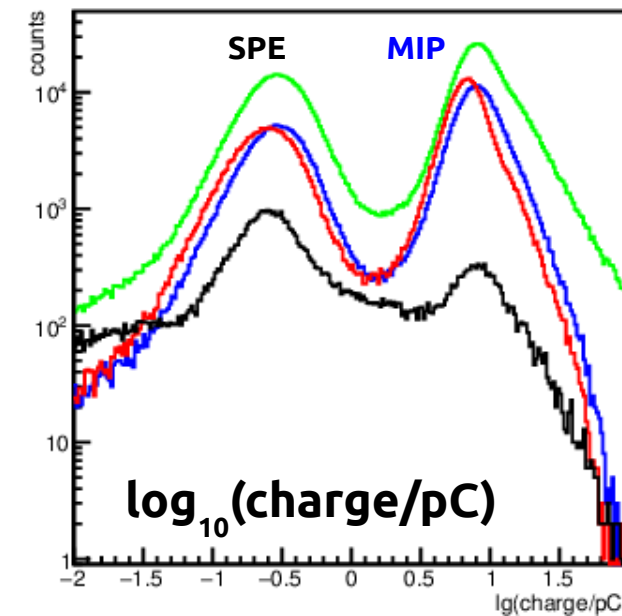
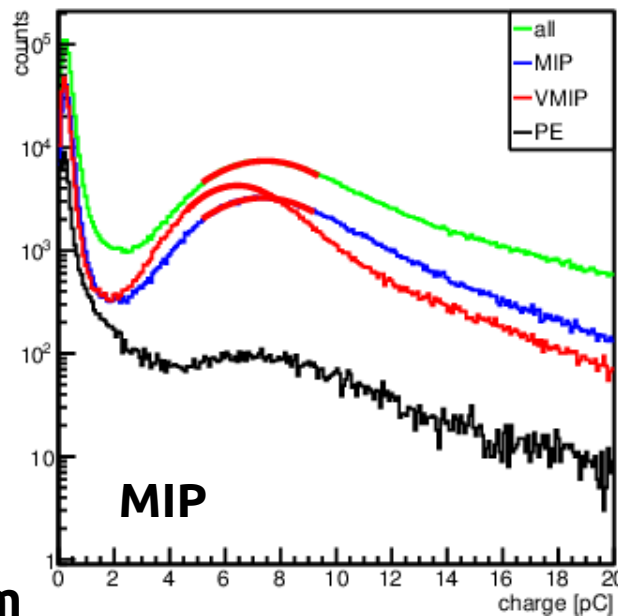
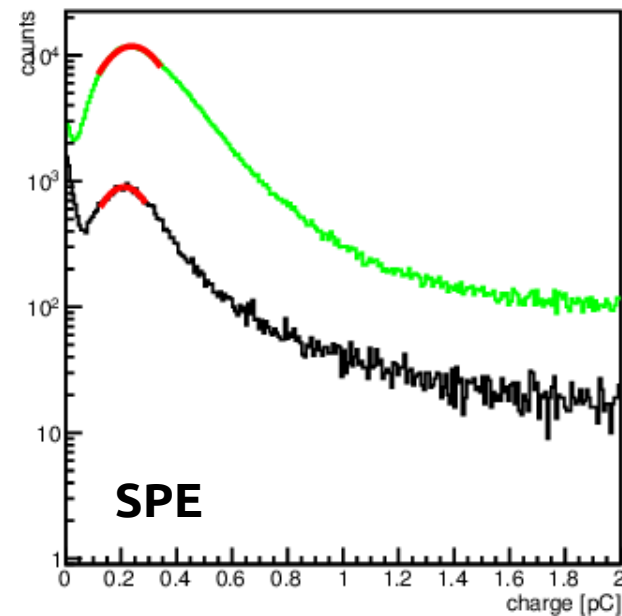
PE/pC	MIP/pC
0.2388	7.4489
	7.3737
	6.4449
0.2118	

MIP/PE = 34.814

VMIP/PE = 30.429

all
MIP

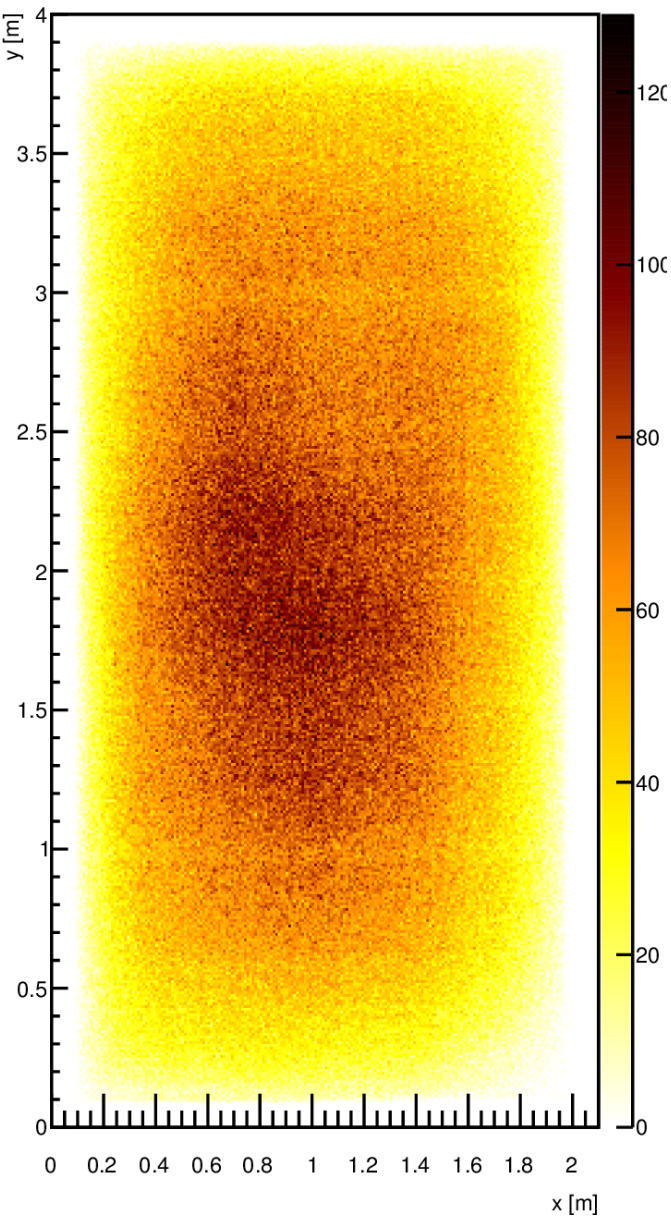
vertical equivalent MIP
SPE



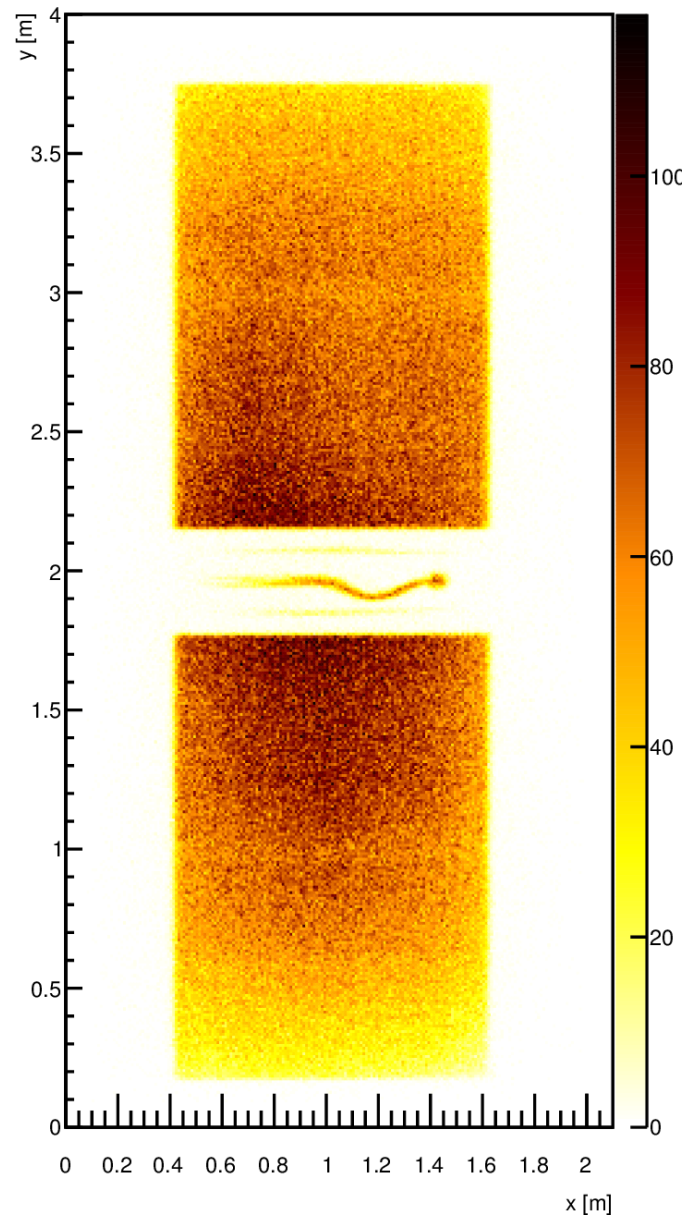
←
zoom

SSD Efficiency

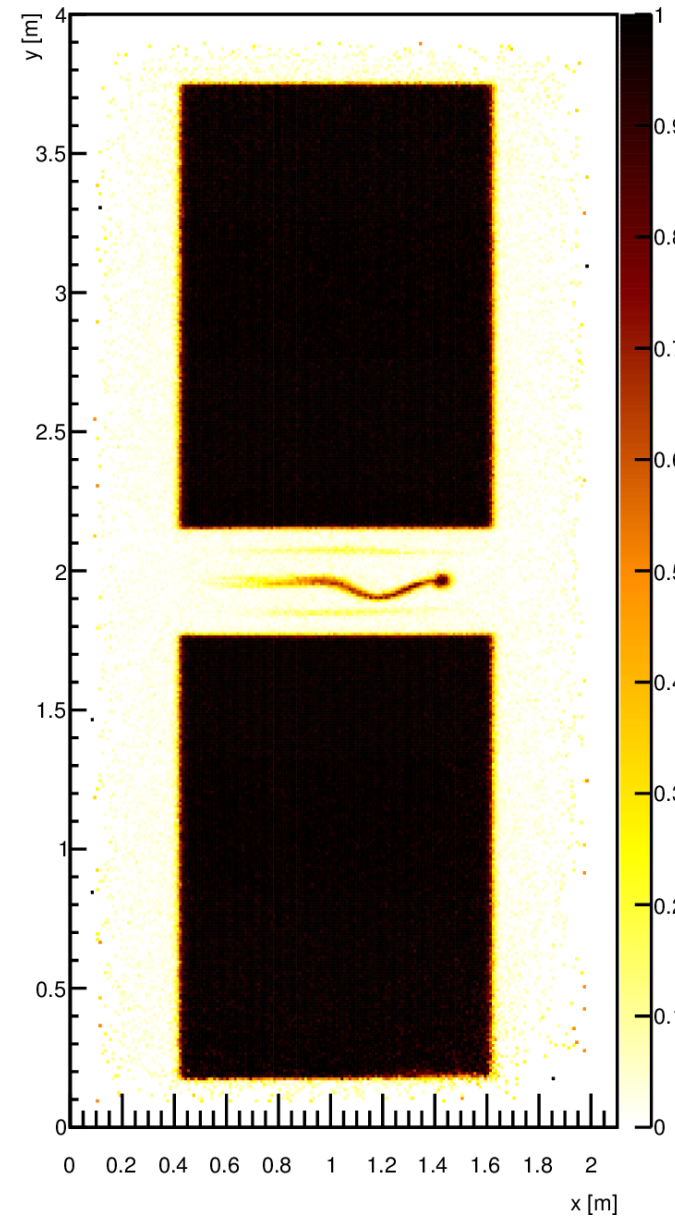
muon hits



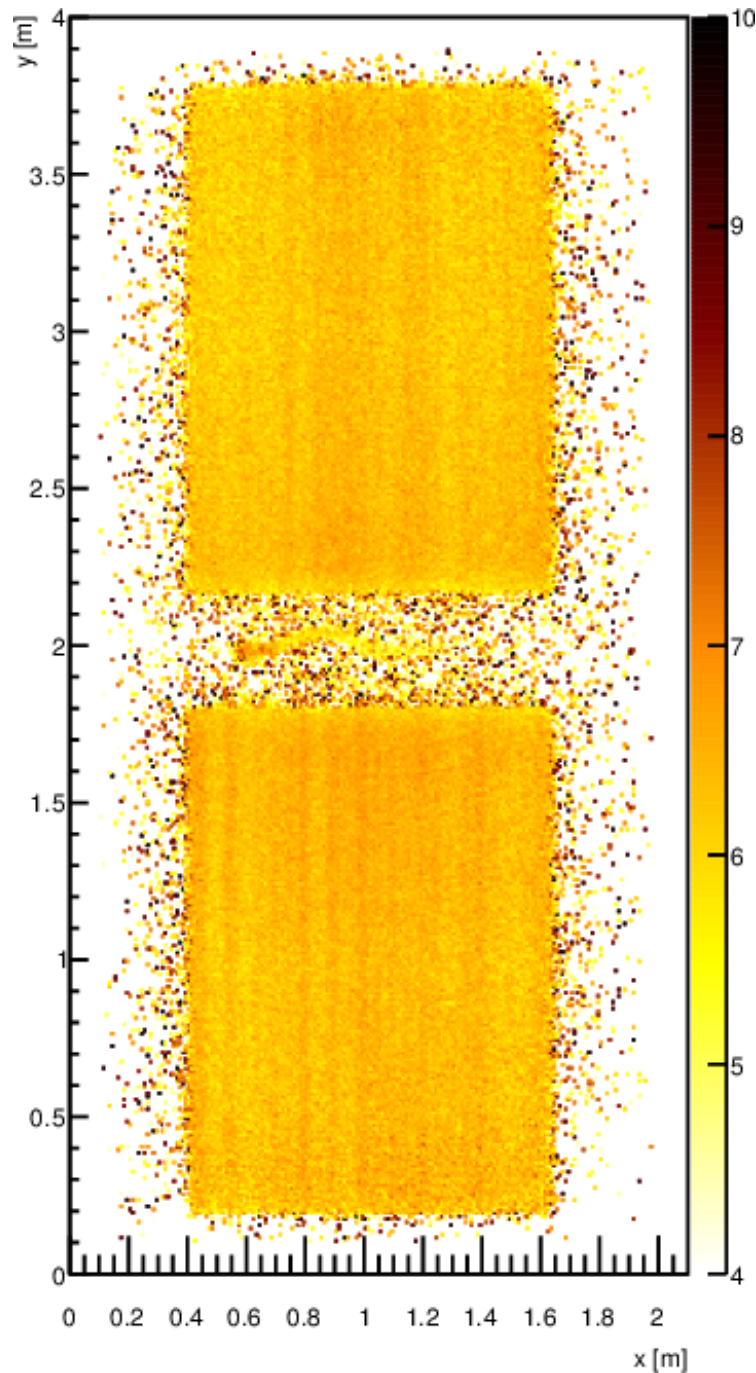
MIP



efficiency



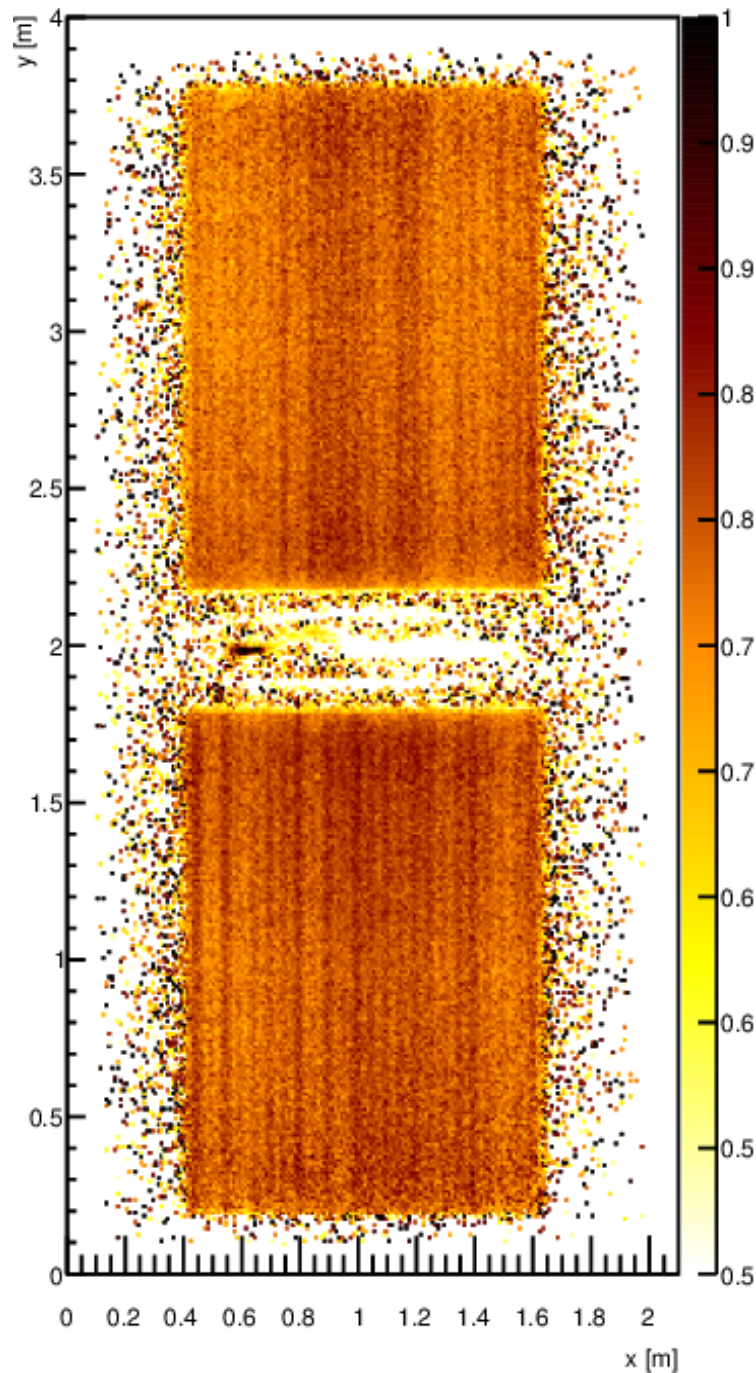
Uniformity



**uniformity of $\langle \text{charge} \rangle$
in 1cm x 1cm bins**

fibers/bars visible

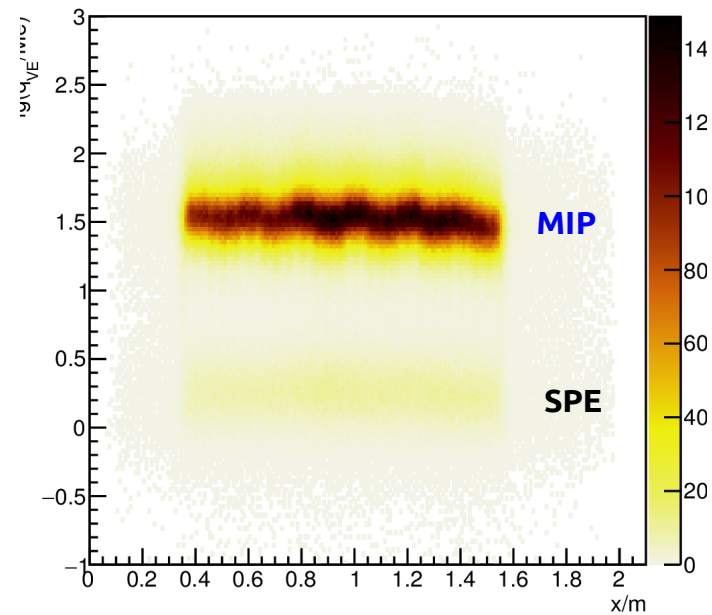
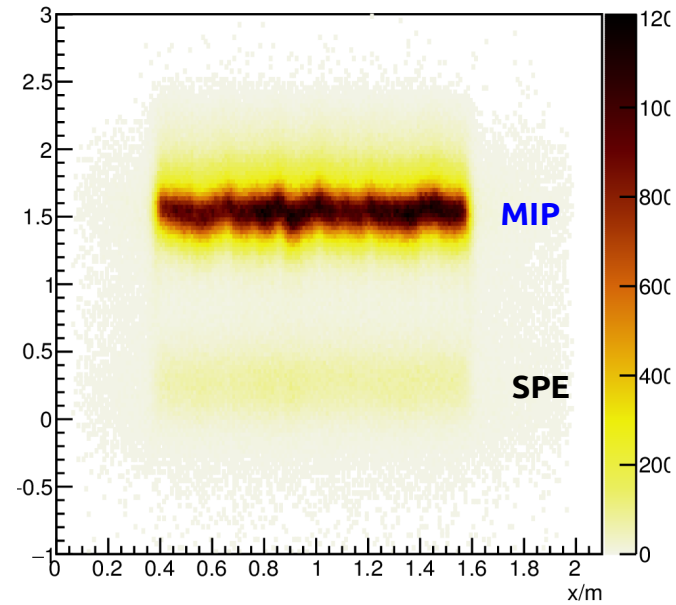
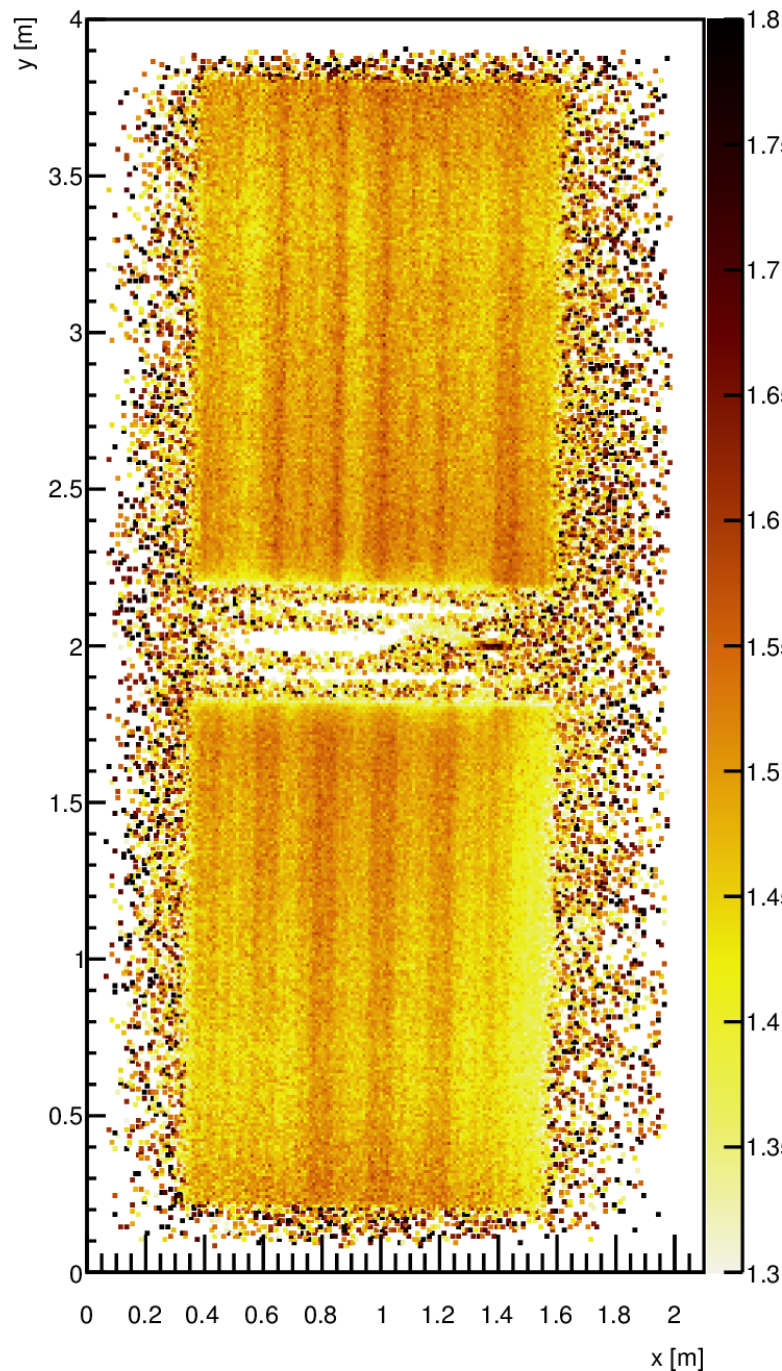
Uniformity



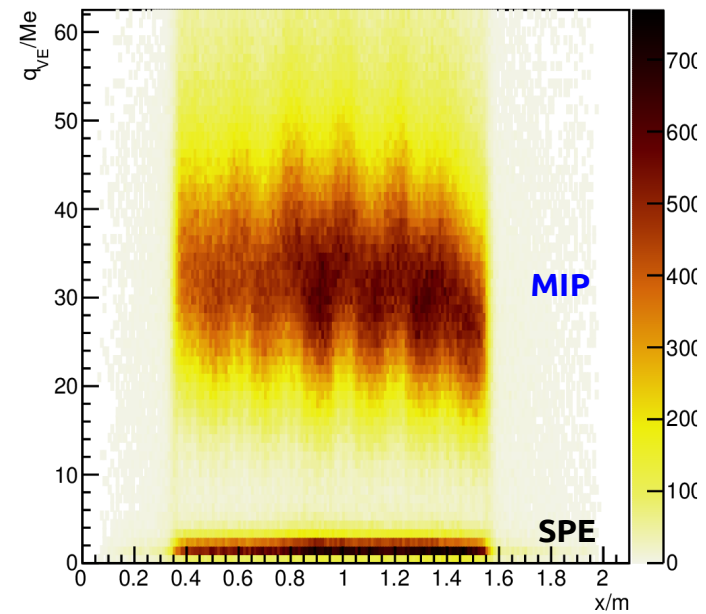
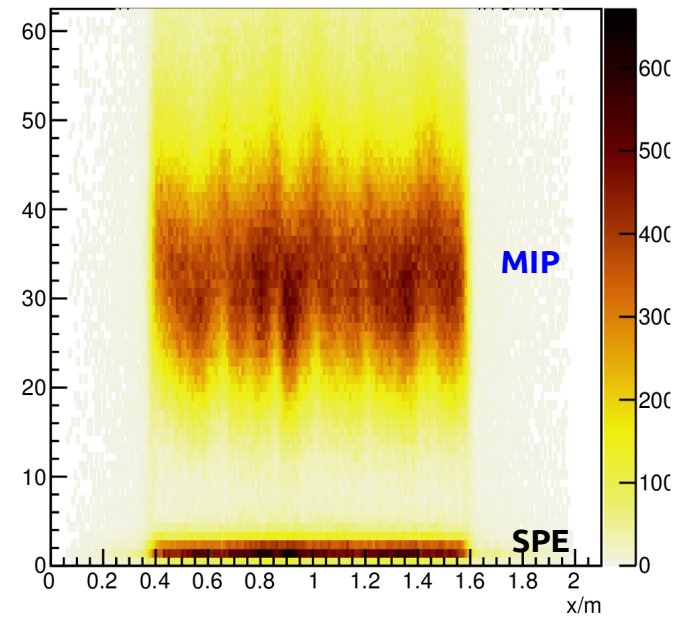
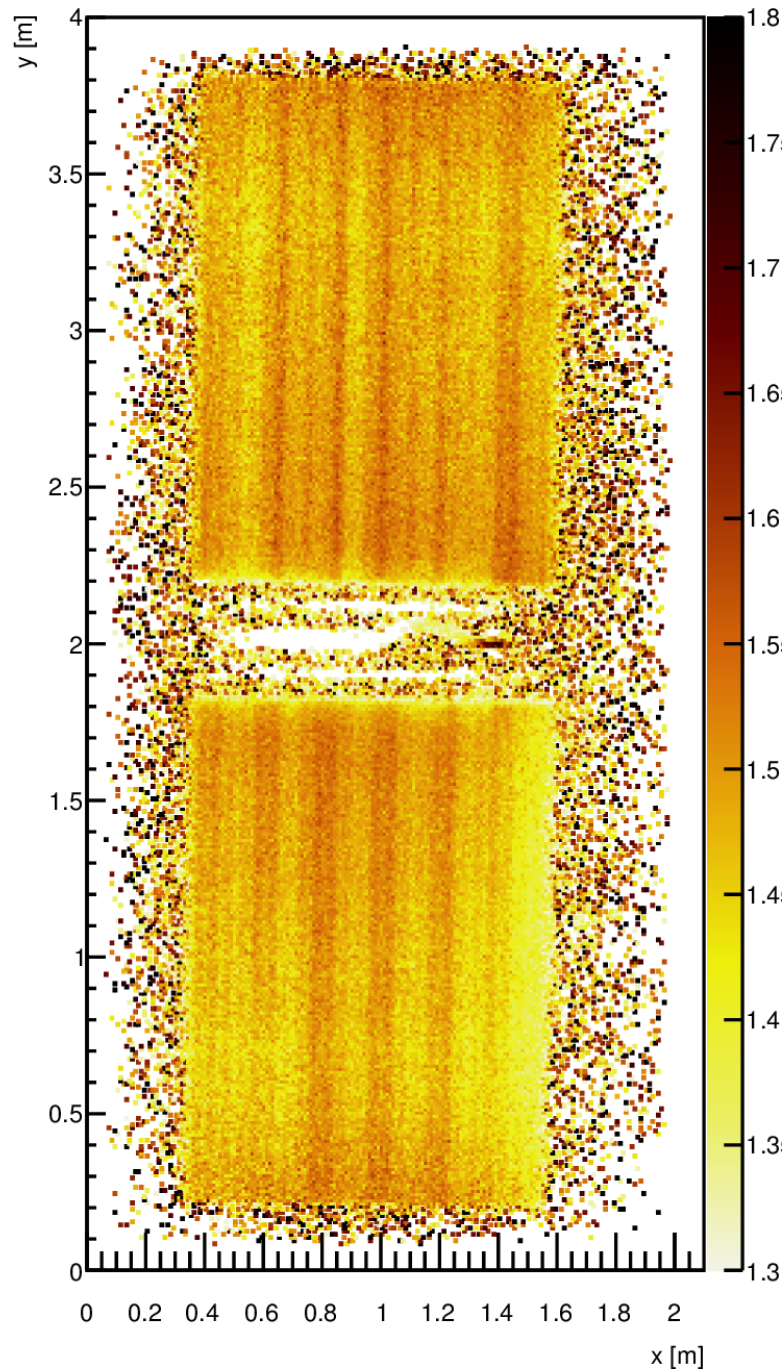
uniformity of $\langle \log_{10}(\text{vcharge}/\text{pC}) \rangle$

more contrast

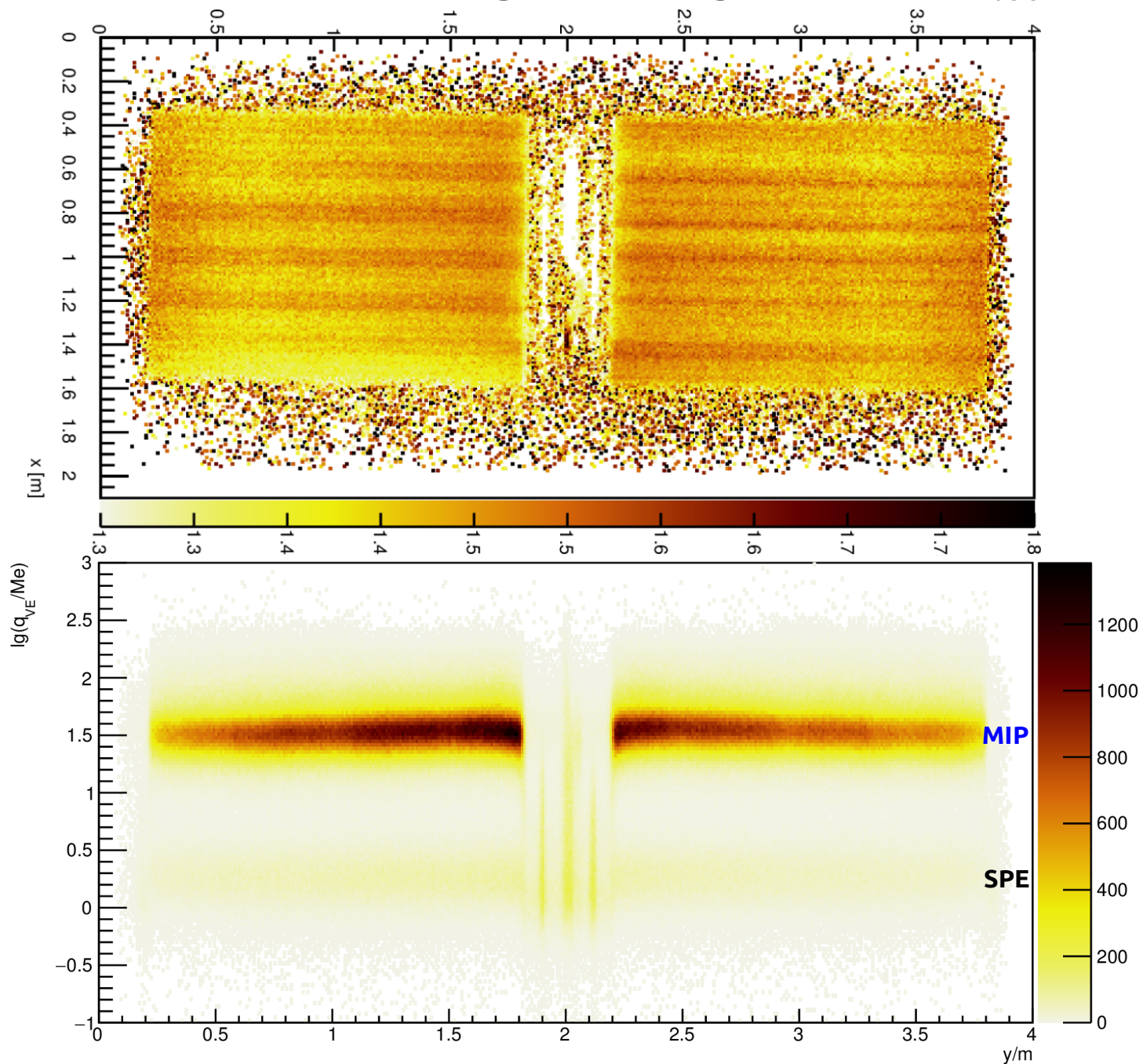
Uniformity Projections



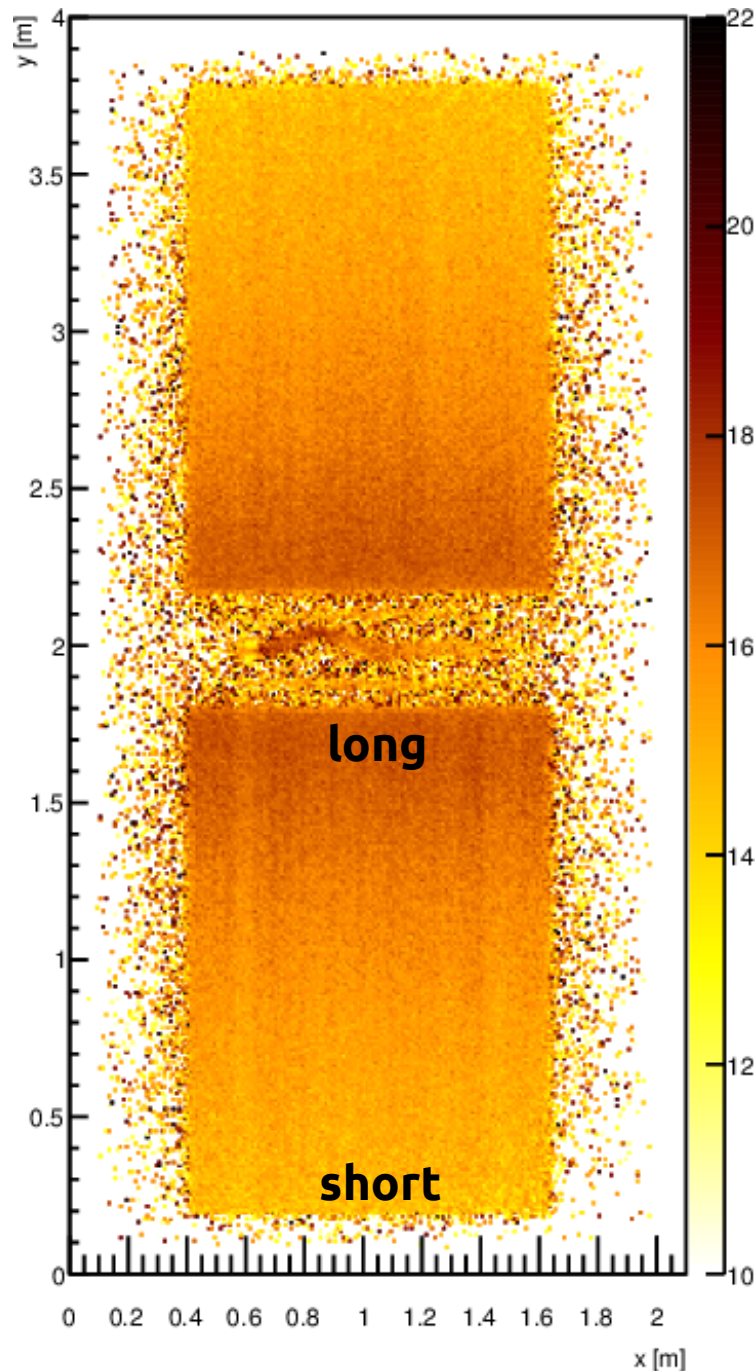
Uniformity Projections



Uniformity Projections



Signal Width



uniformity of signal width

short: far from PMT

long: near PMT

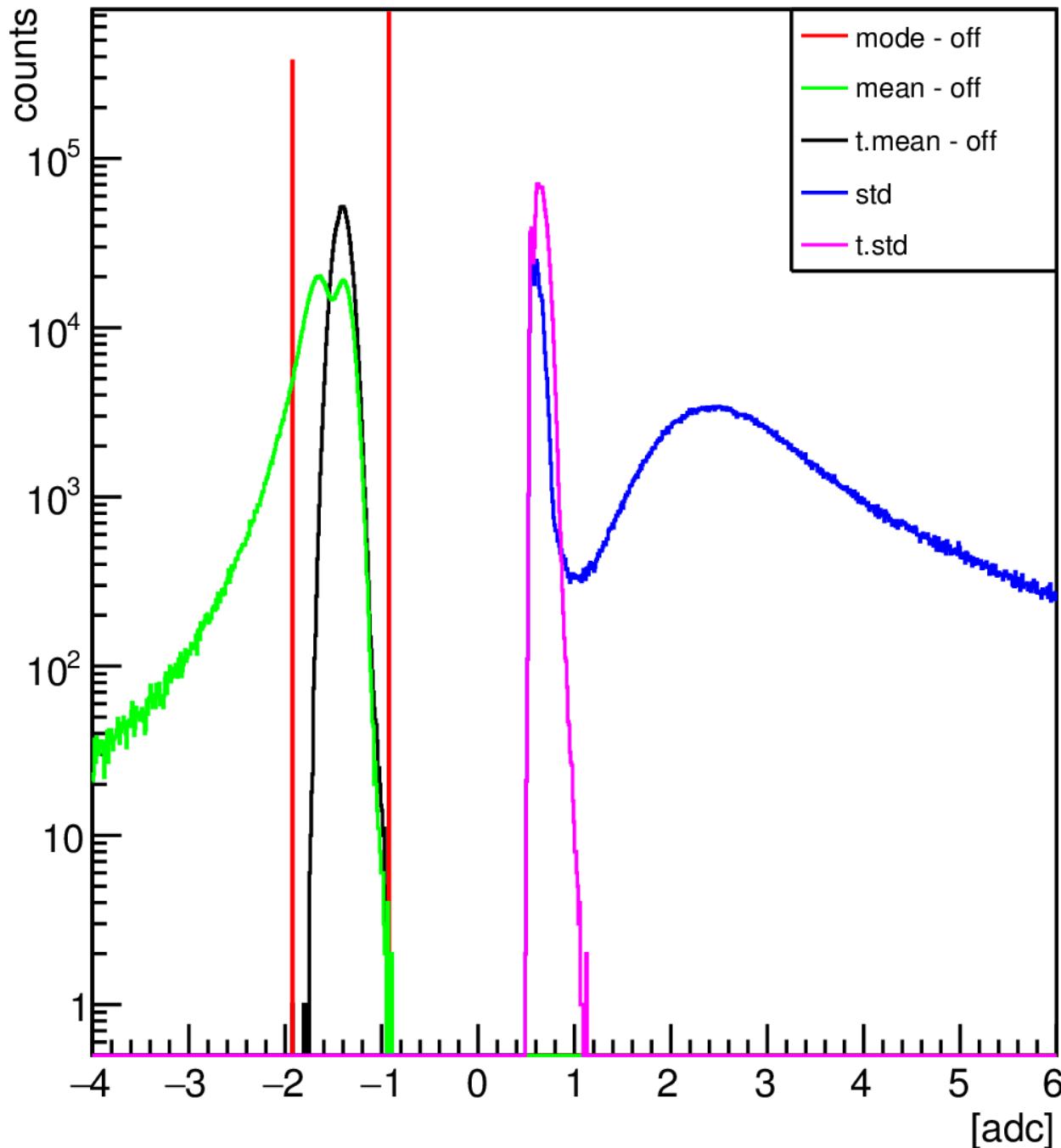
U-routing → two photon bunches



Thank you!

Backup

Pulse Finder



(robust baseline fit)
truncation = mode ± 5 adc
baseline = truncated mean
baseline noise = truncated σ

pulse finder:

* trigger: 3.5σ

* duration: until below 1.5σ
for 7+ time bins

pulse integral \rightarrow charge

Empty