

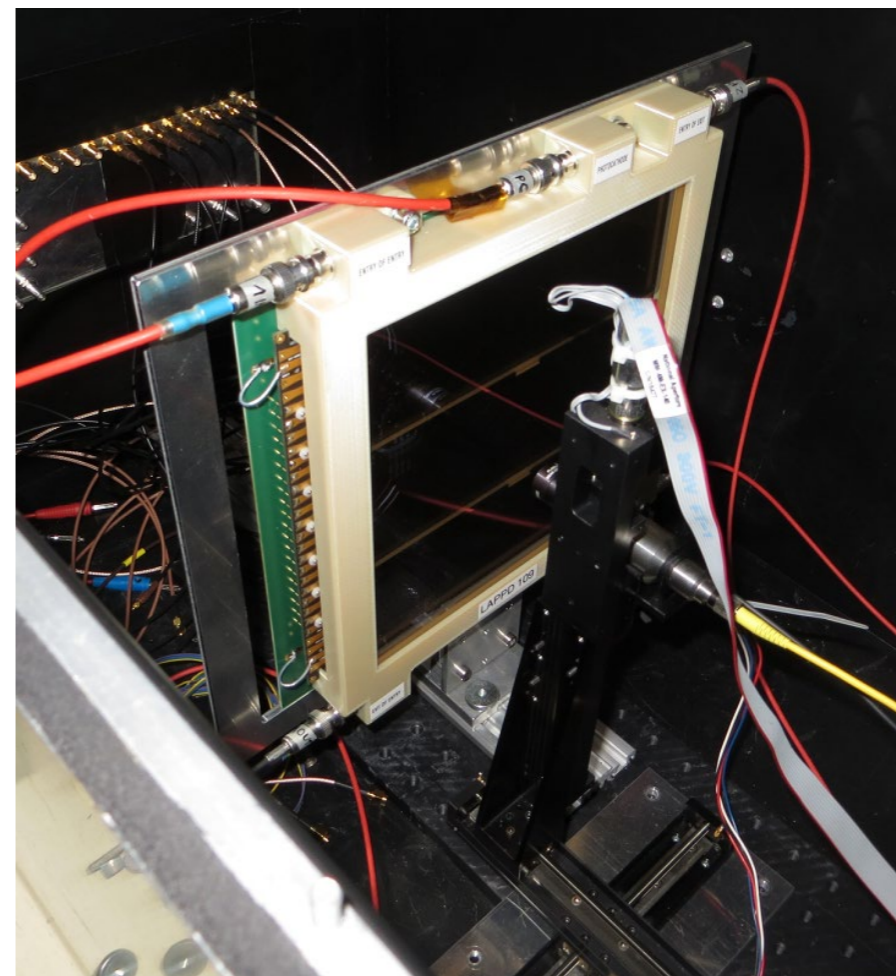
Update on LAPPD R&D at IJS

Samo Korpar et al.

University of Maribor and Jožef Stefan Institute, Ljubljana
LAPPD Workshop, 26 October 2022

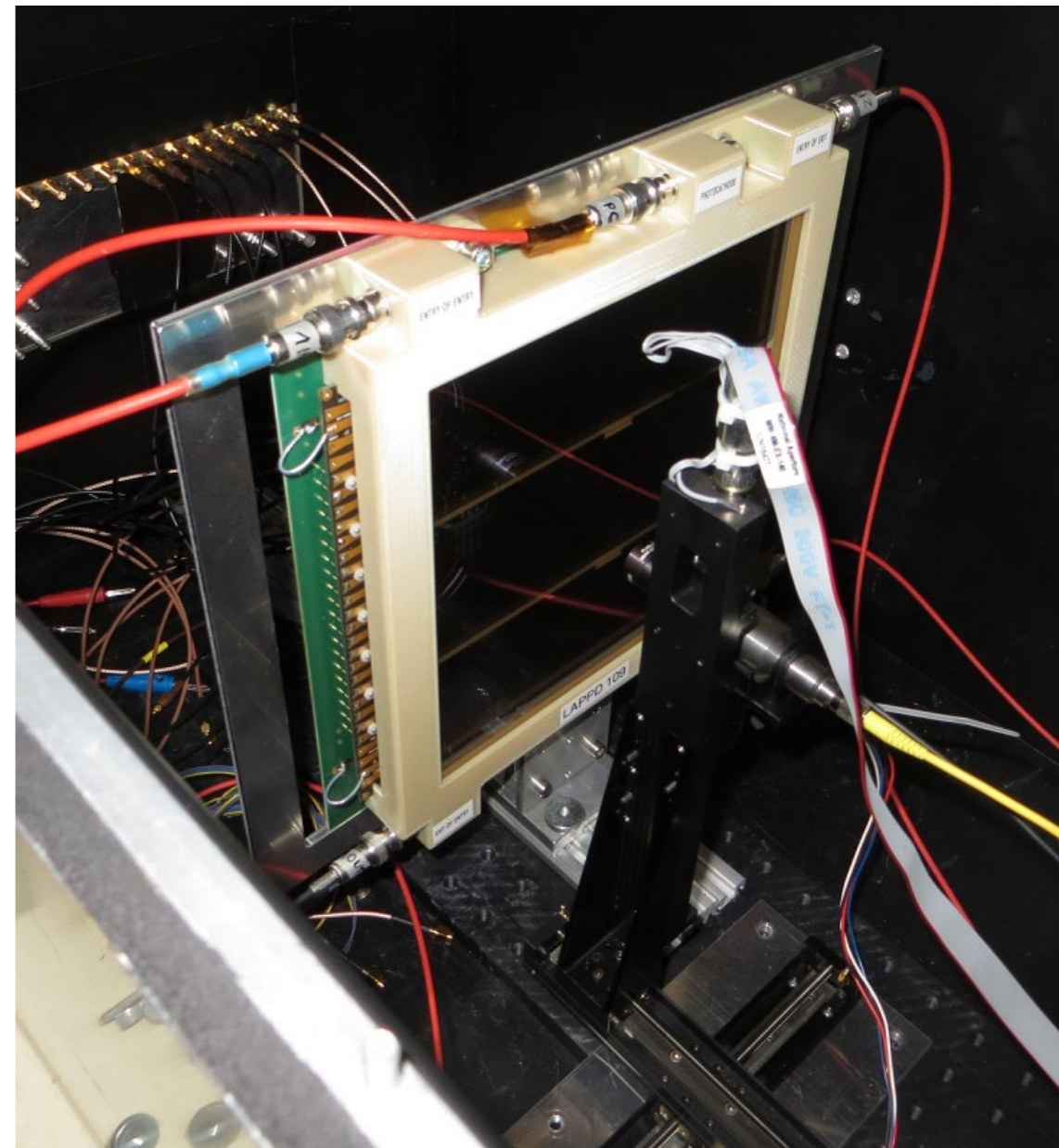
Outline:

- LAPPD tests:
- Timing and charge sharing
- PETsys
- FastIC



LAPPD #109:

- $\approx 200 \times 200 \text{ mm}^2$
- $20 \mu\text{m}$ pores @ $25 \mu\text{m}$ pitch
- resistive anode plane, capacitive coupled readout
- 5 mm thick glass backplate
- 5 HV levels: PC, MCP1in, MCP1out, MCP2in, MCP2out and resistive anode at ground potential
- Standard setup with QDC, TDC, 3D stage ...
- TDC value corrected for time-walk
- ALPHALAS PICOPOWER™-LD Series of Picosecond Diode Lasers – 405 nm
- FWHM $\approx 20 \text{ ps}$
- light spot diameter on the order of $100 \mu\text{m}$
- Preliminary results.



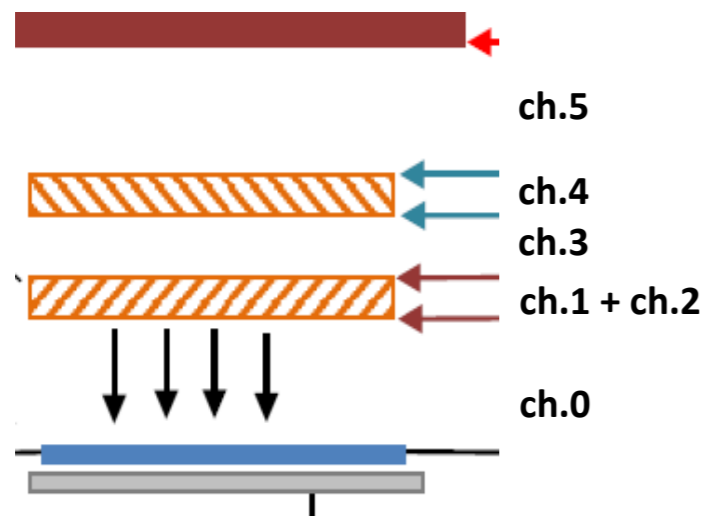
LAPPD - HV supply

CAEN HiVolta (DT1415ET), 8 Ch Reversible 1 kV/1 mA Desktop HV Power Supply – floating channels

- 1 kV/1 mA and 0.6 W(!) per channel
- ch.0 MCP2out – AN
- ch.1+ch.2 MCP2in – MCP2out (2 ch. due to power limit per channel)
- ch.3 MCP1out – MCP2in
- ch.4 MCP1in – MCP1out
- ch.5 PC – MCP1in

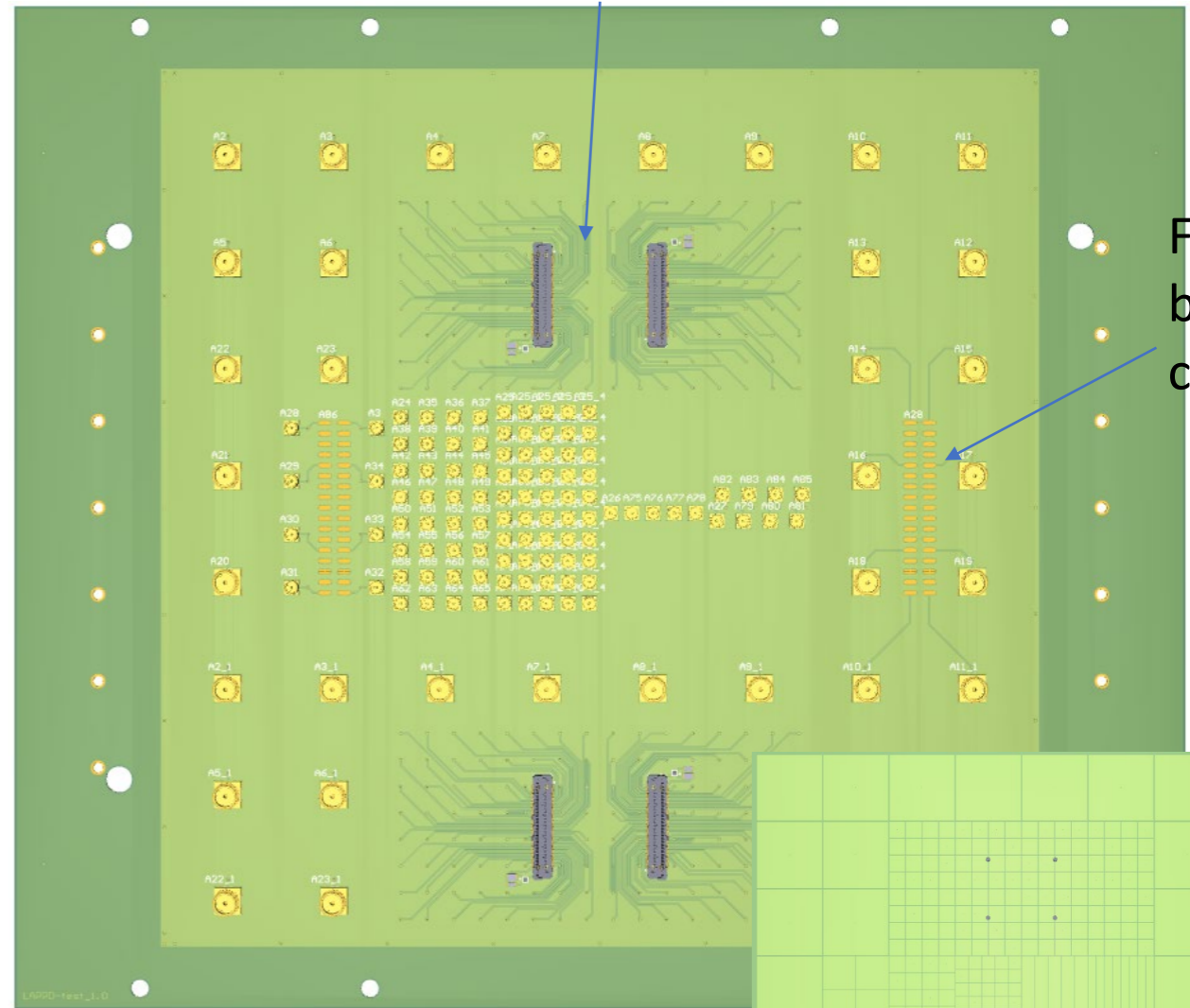
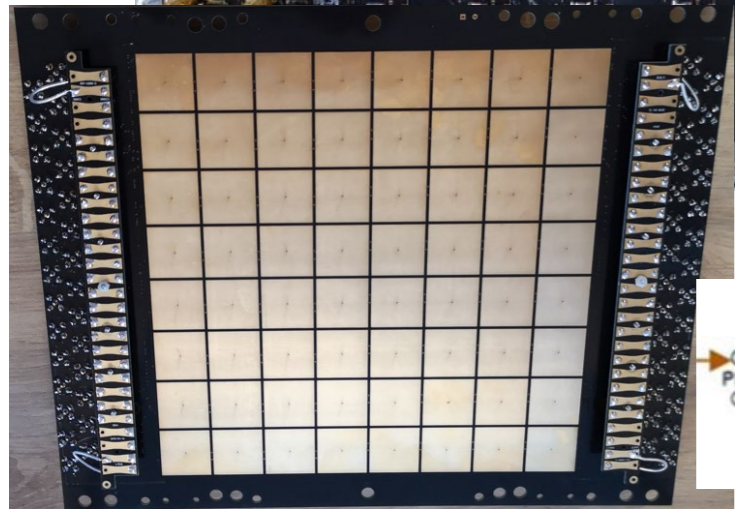
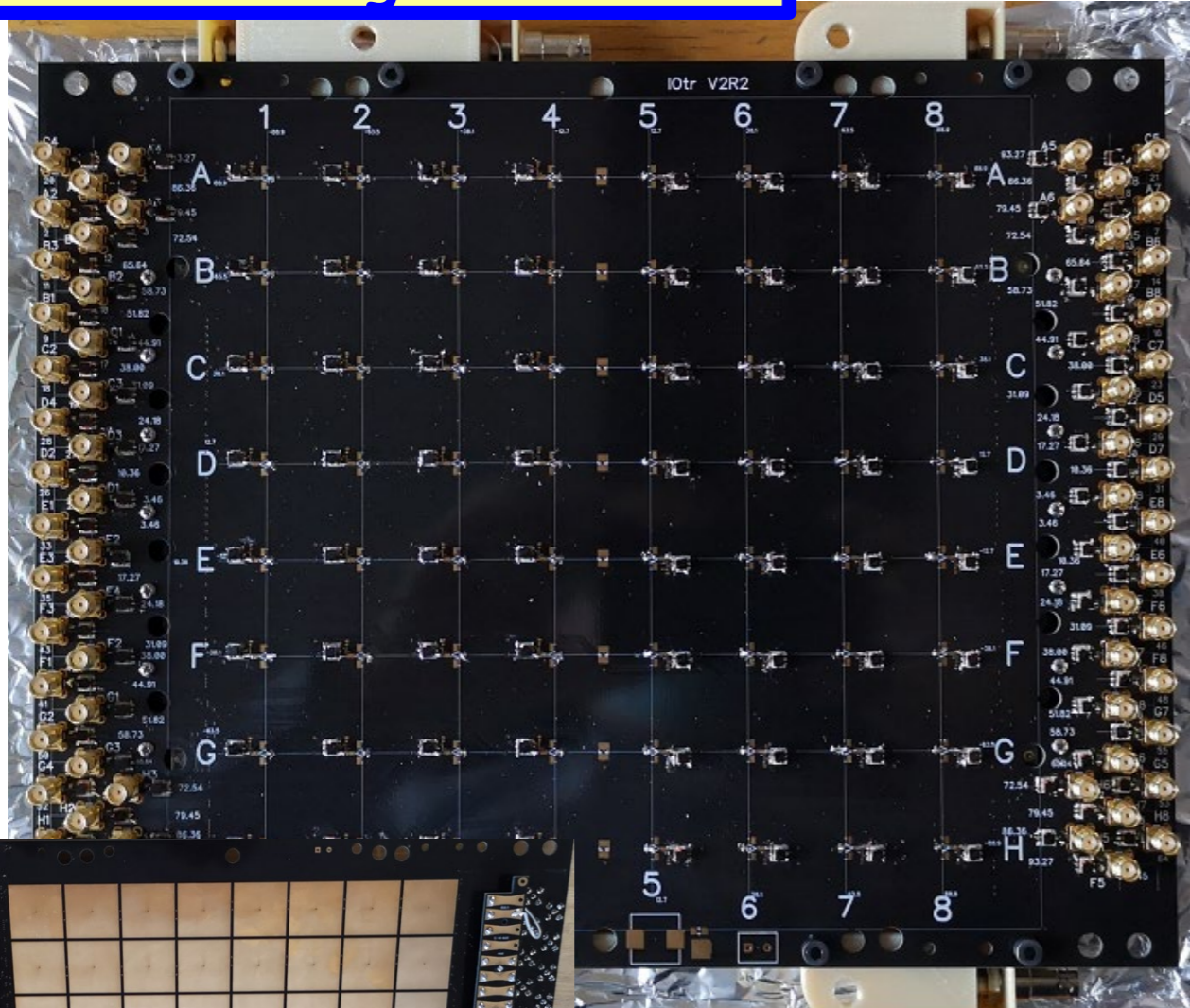


ROP voltages A-PC: 500/825(400+425)/200/825/100 V



Custom	VSet	VMon	IMon	ISet	Pw	Status	SWVmax
00.000	500.00	500.06	3.8730	50.00	On		500
00.001	400.00	400.16	791.5960	900.00	On		400
00.002	425.00	425.30	791.7310	900.00	On		450
00.003	200.00	200.22	15.7010	50.00	On		200
00.004	825.00	825.46	345.5840	450.00	On		850
00.005	100.00	100.20	0.0680	5.00	On		150

LAPPD - sensing electrodes

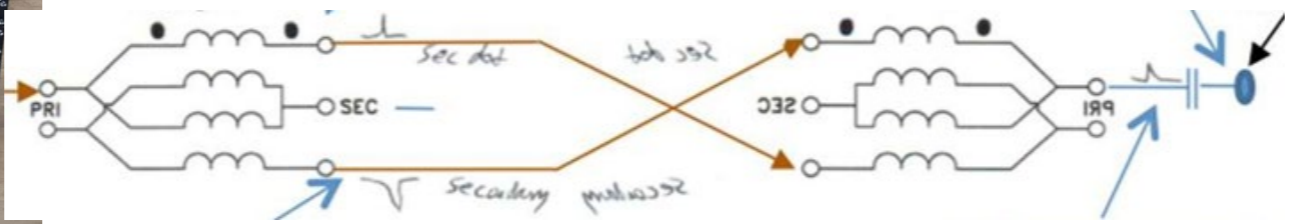


PETSYS conn.

FastIC board conn.

INCOM

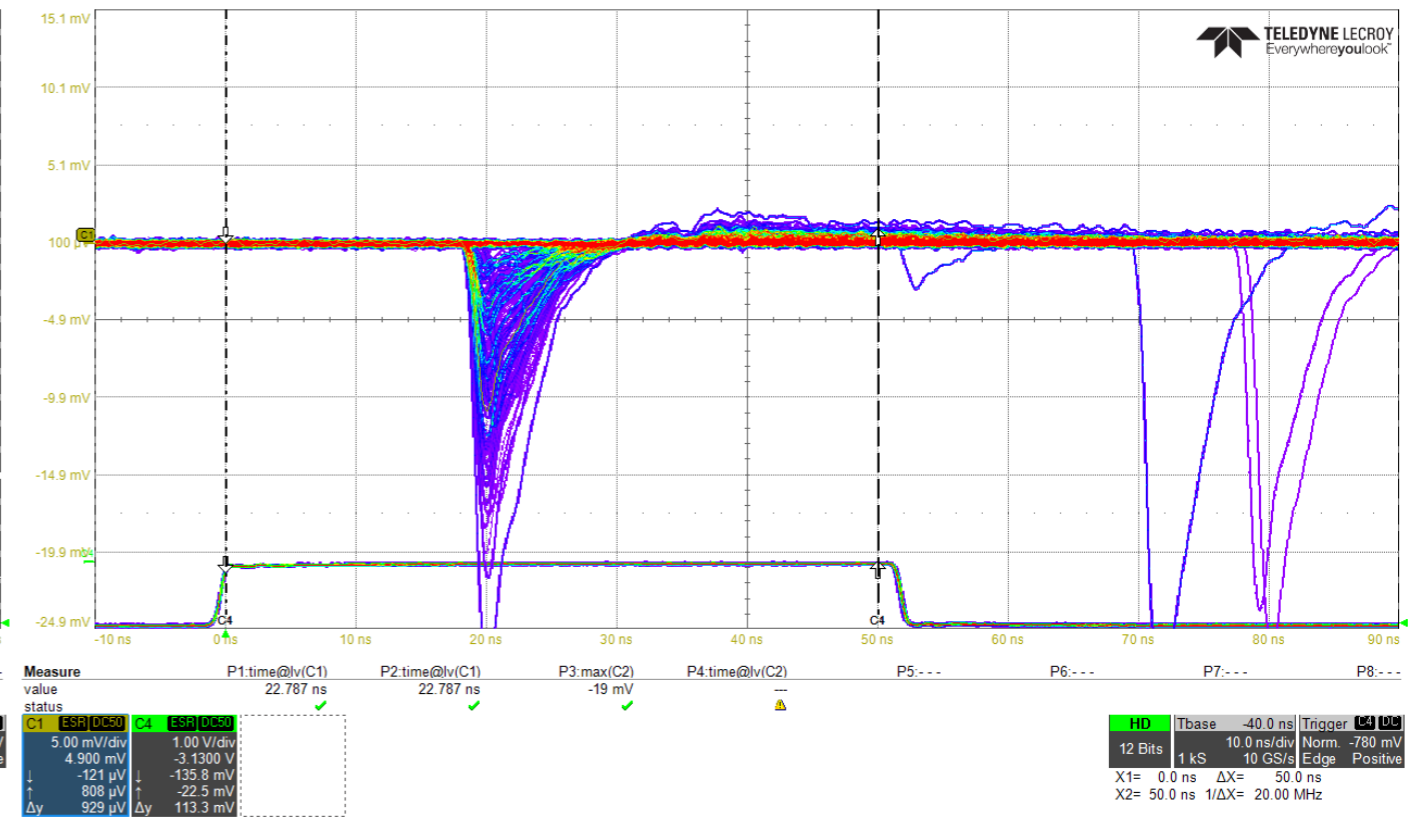
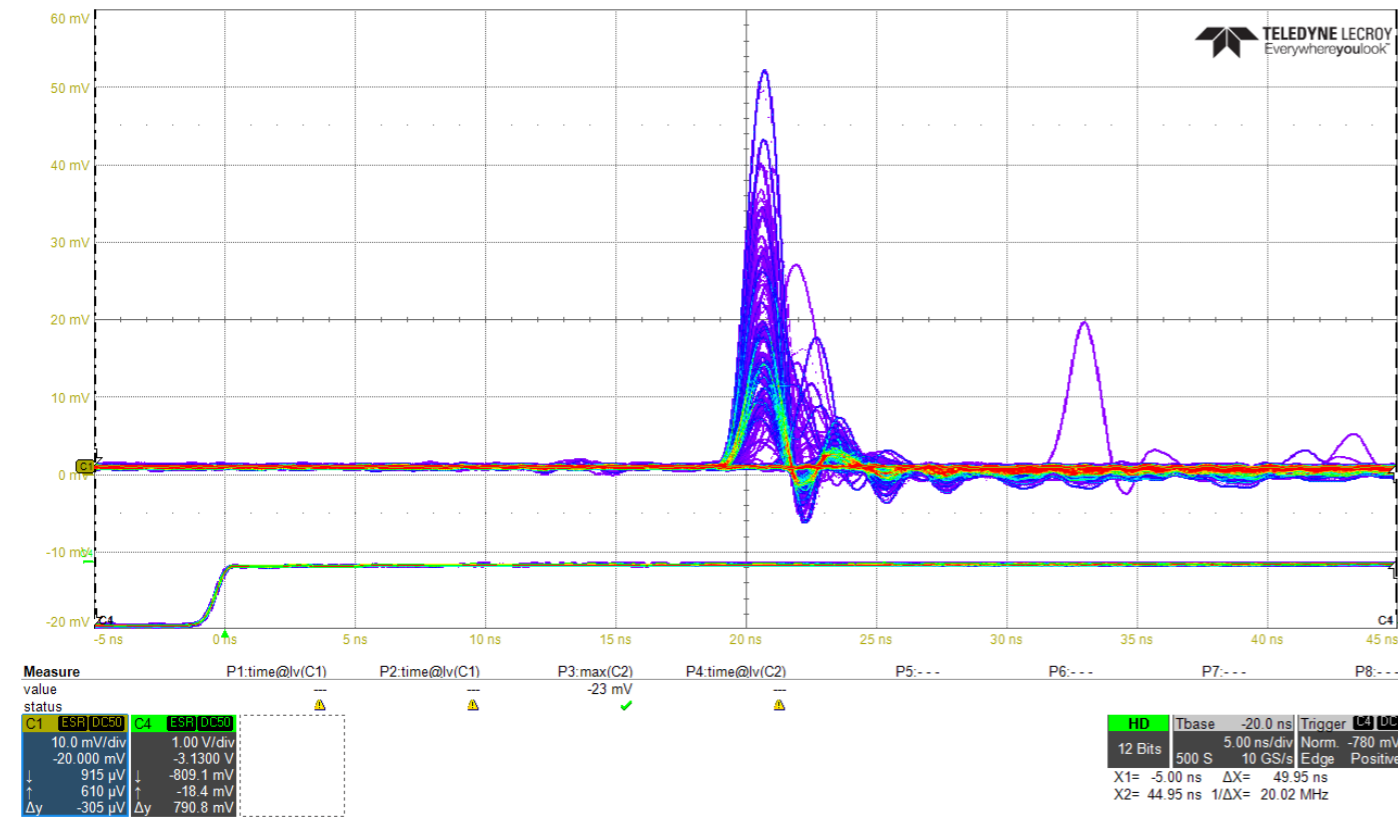
IJS



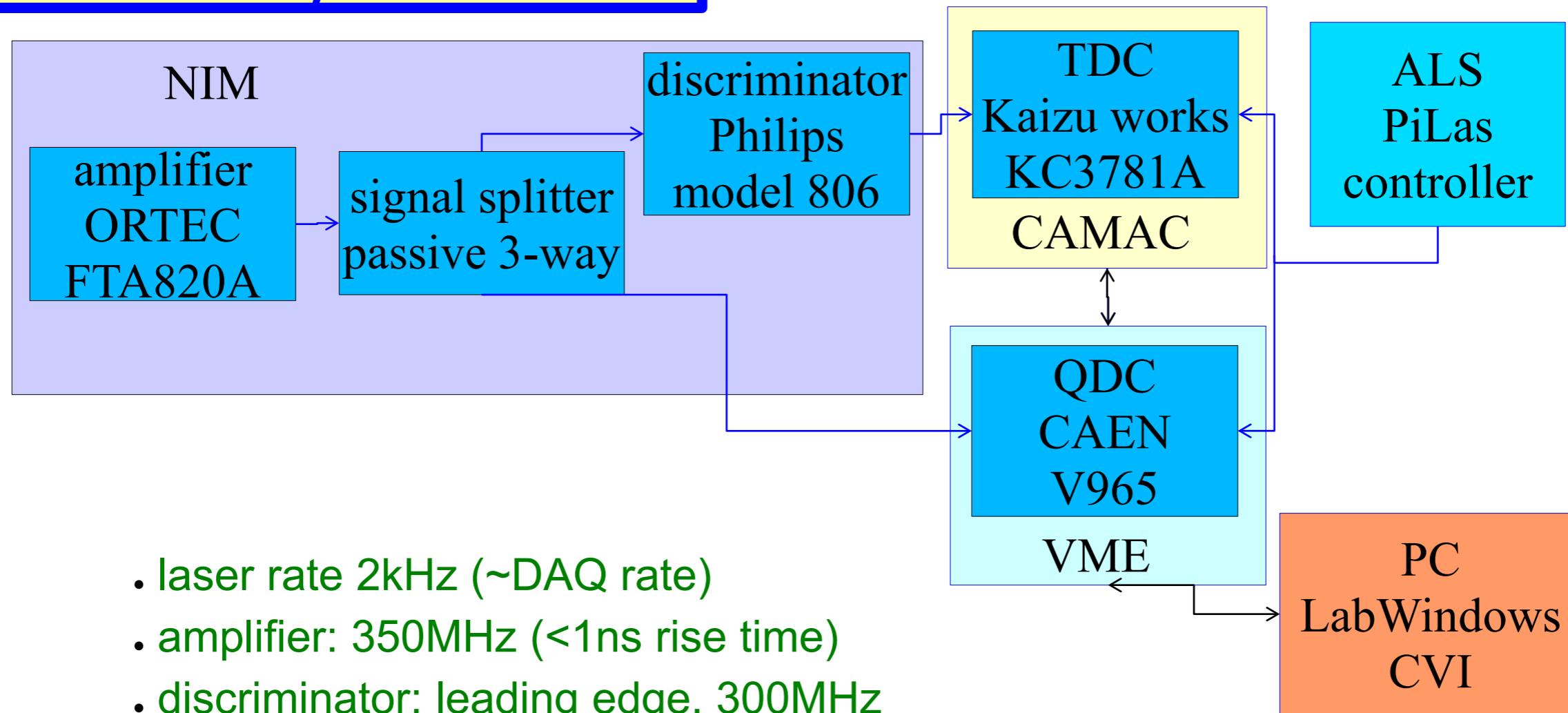
LAPPD - raw signals

- transformed signal

- direct signal



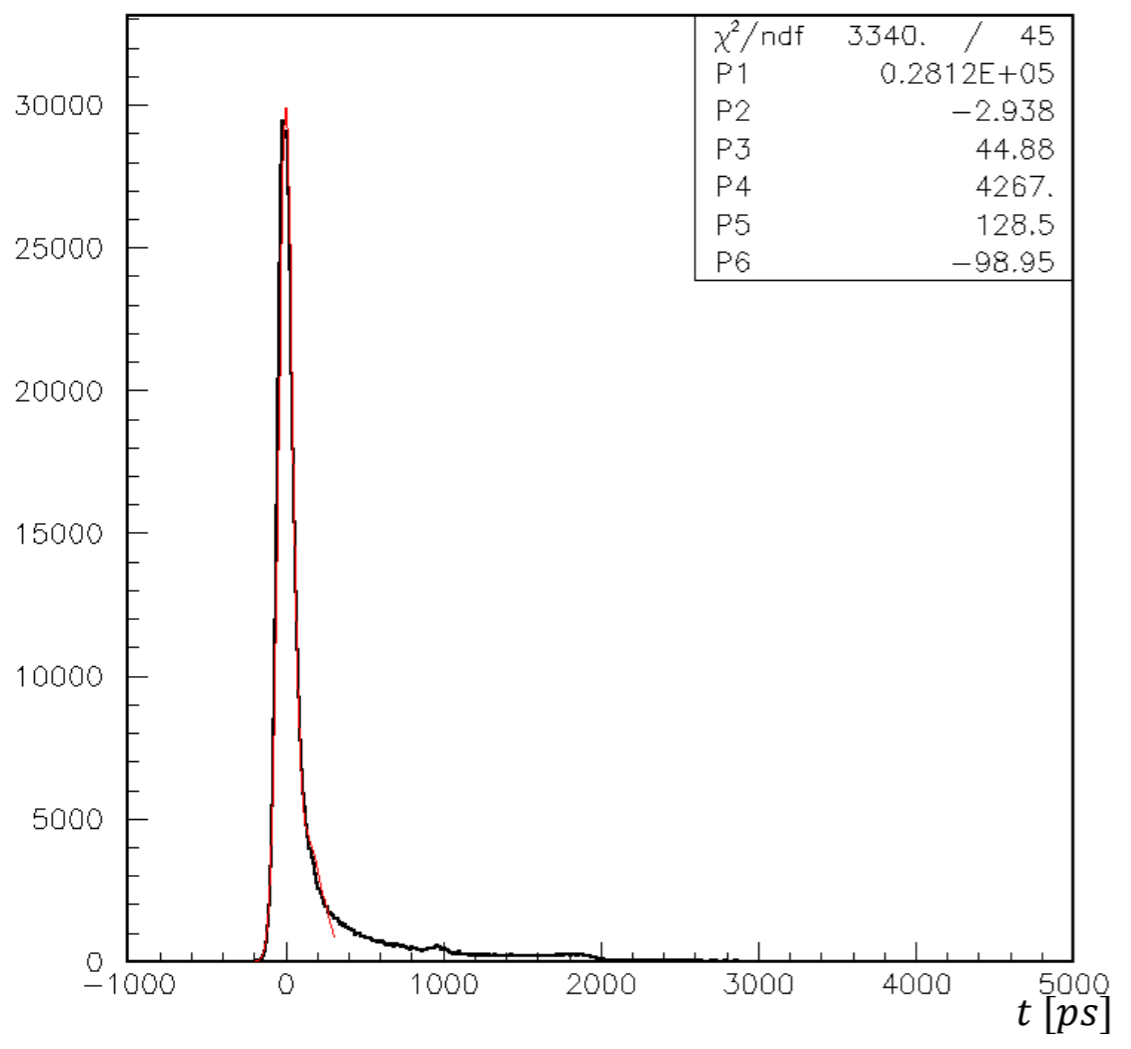
Modular readout system for tests



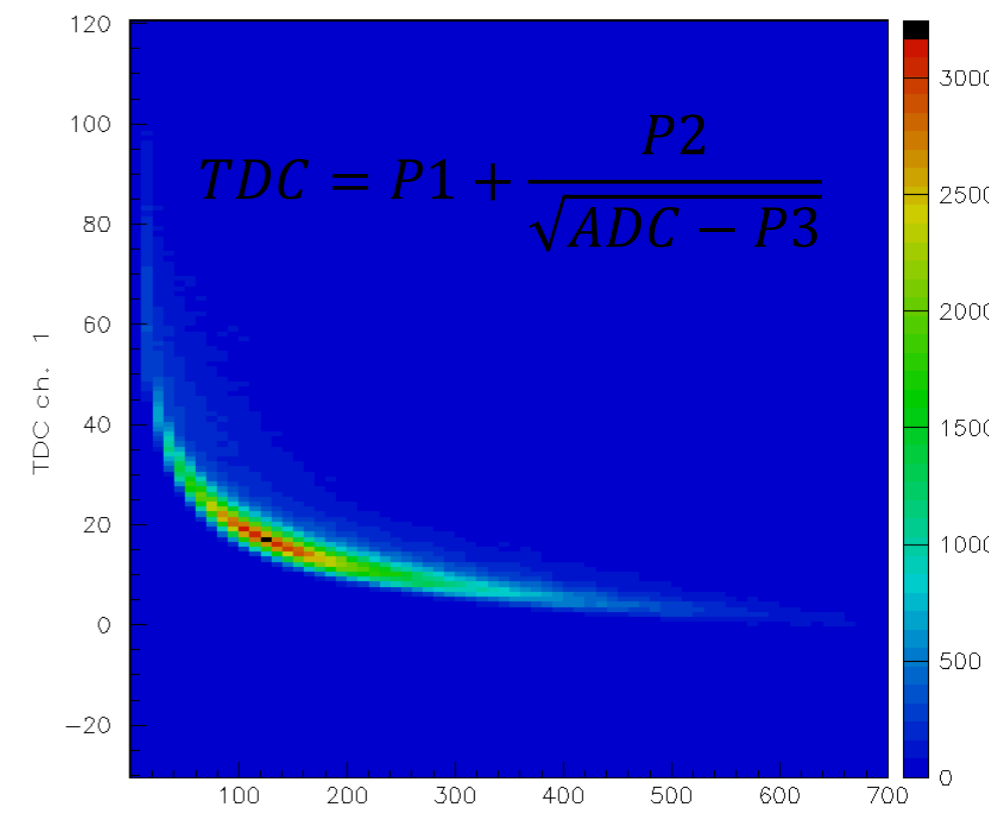
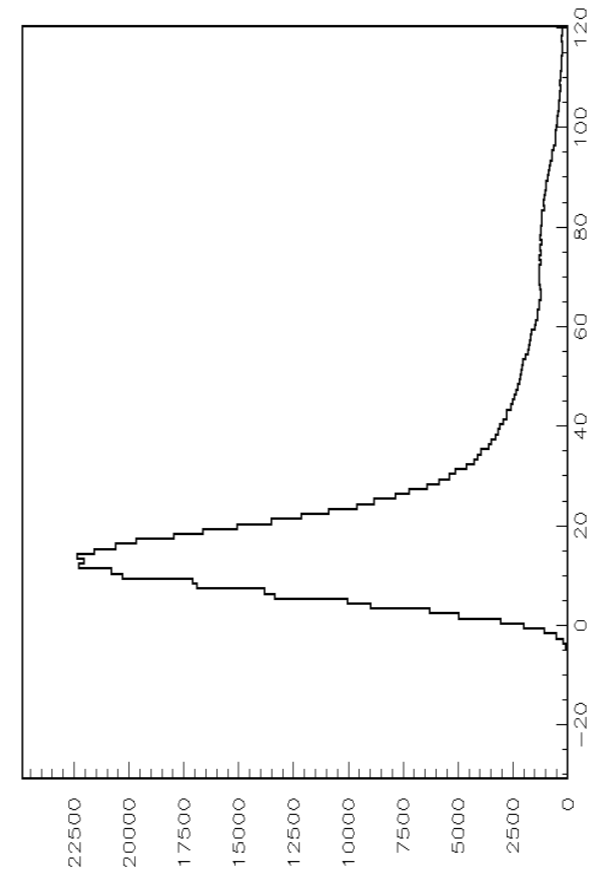
- laser rate 2kHz (~DAQ rate)
- amplifier: 350MHz (<1ns rise time)
- discriminator: leading edge, 300MHz
- TDC: 25ps LSB($\sigma \sim 11$ ps)
- QDC: dual range 800pC, 200pC

LAPPD - time-walk correction

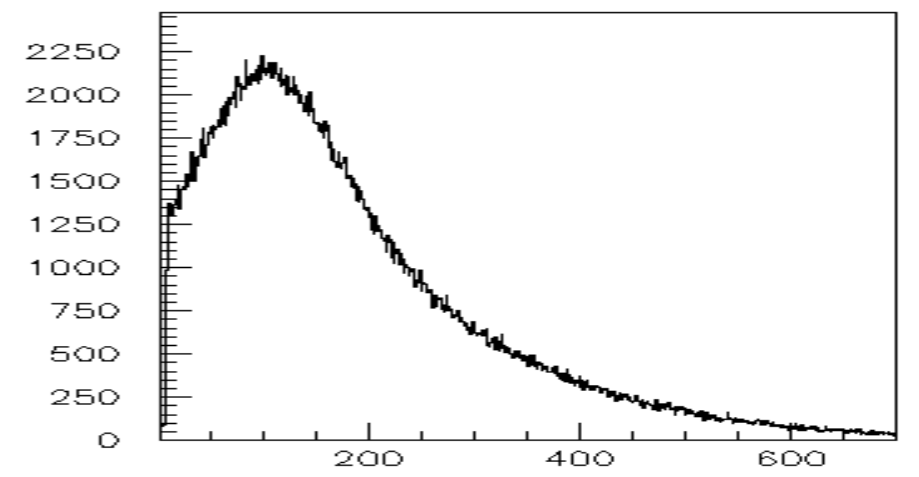
- TDC corrected for time-walk
- timing resolution (prompt peak) $\sigma \approx 40$ ps after time-walk correction



TC center ch. 1



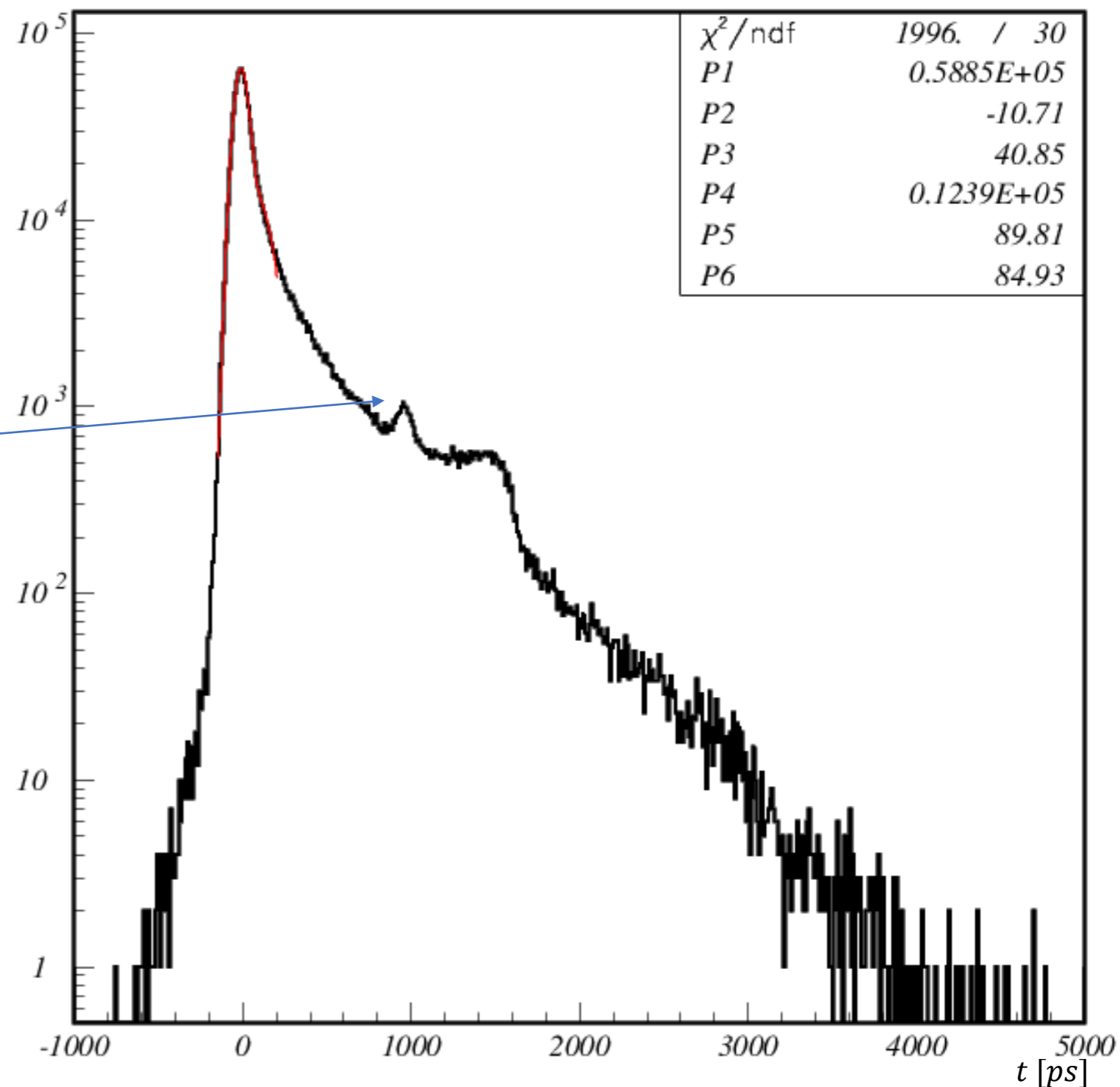
TDC vs. ADC ch. 1



ADC max ch. 1

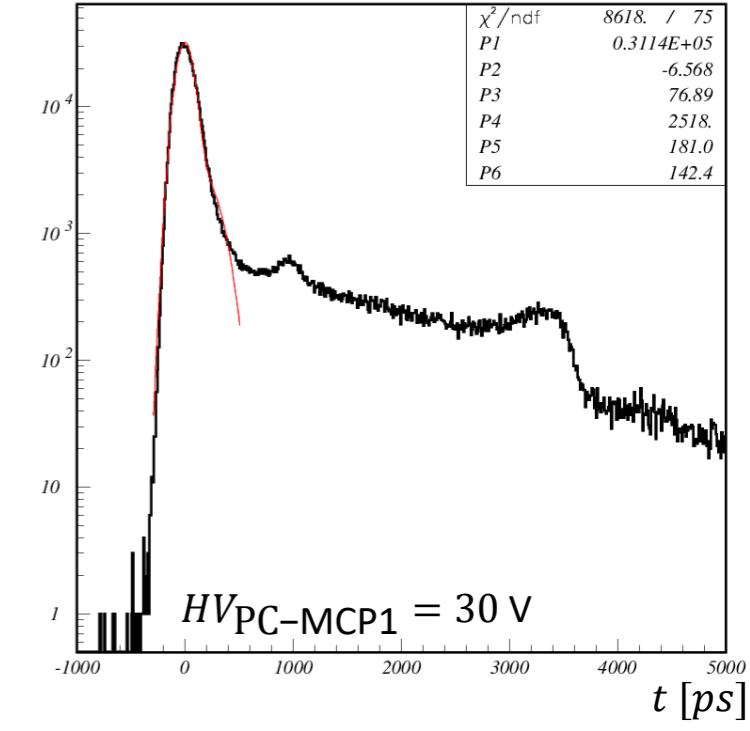
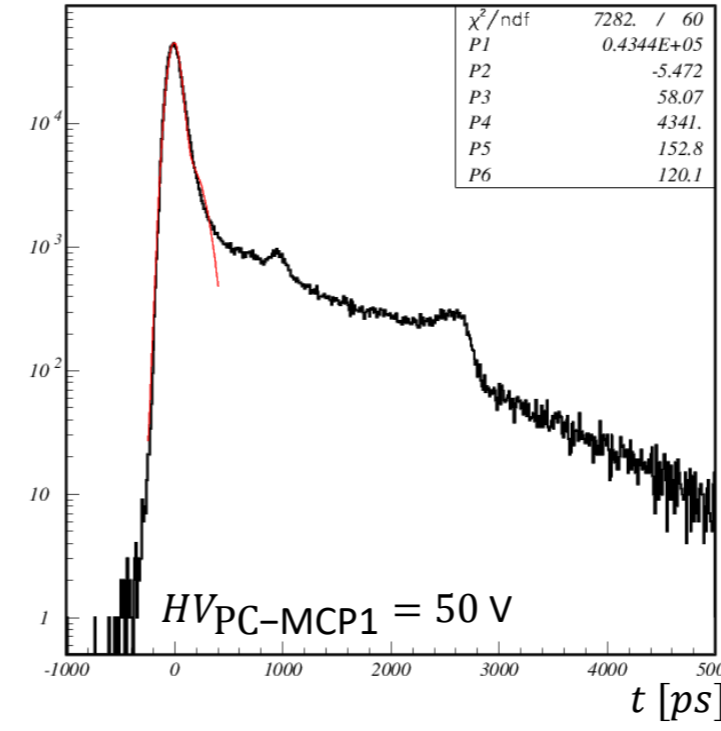
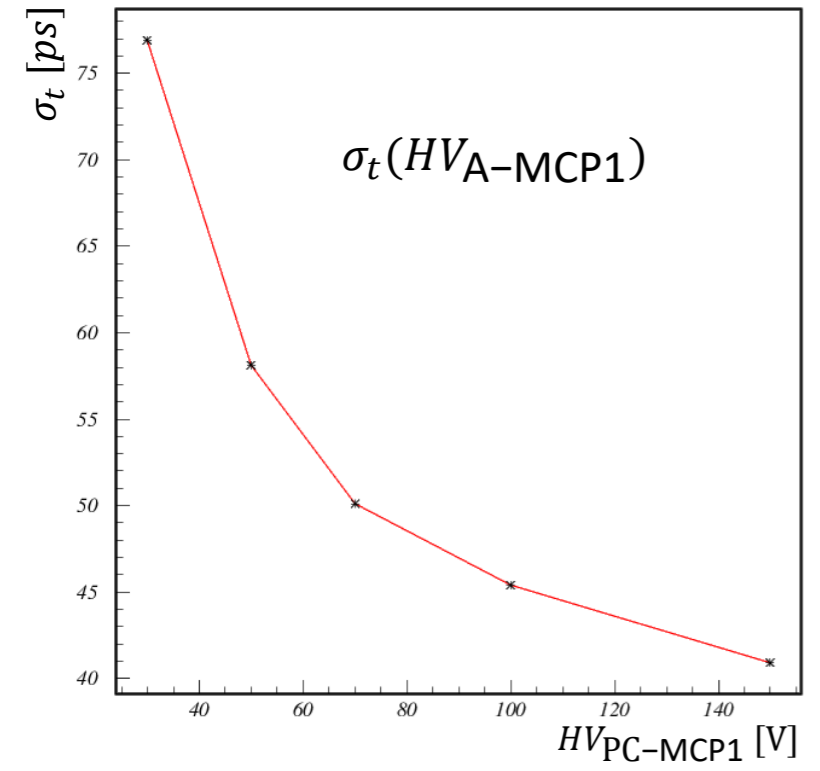
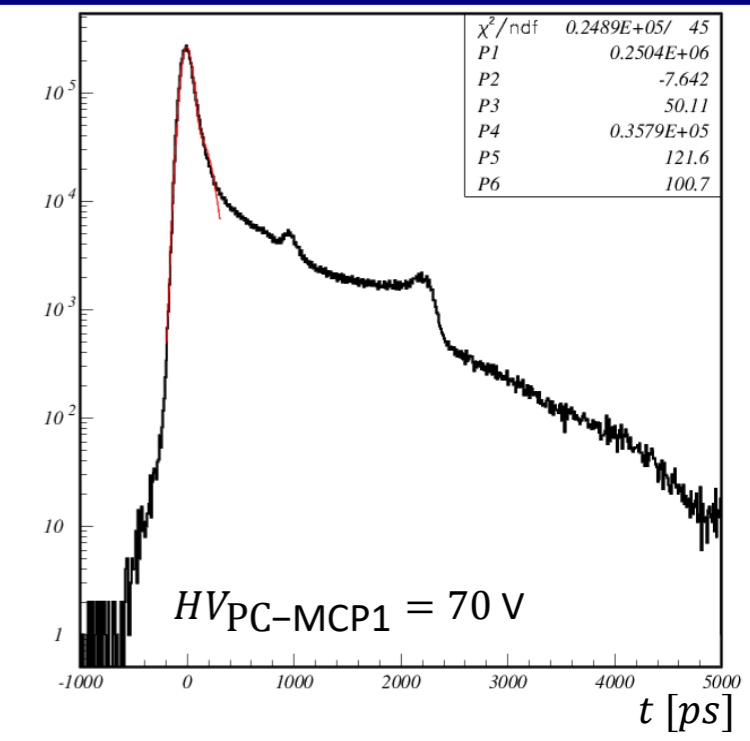
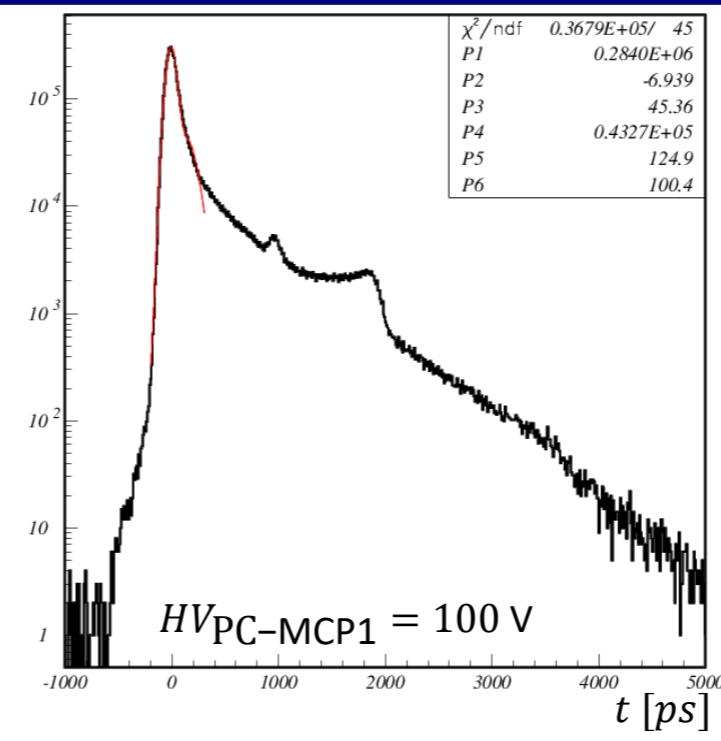
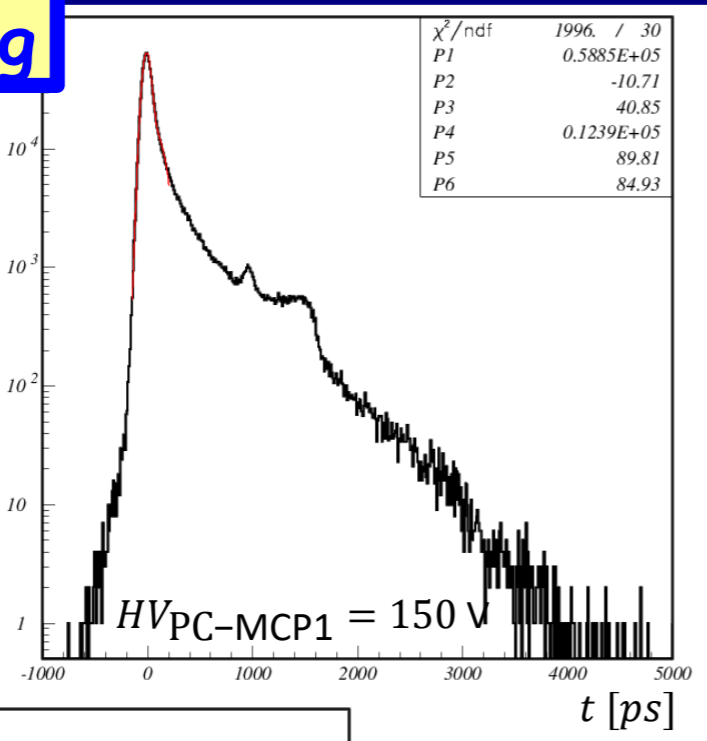
LAPPD - timing distribution

- measured timing distribution typical for MCP-PMT
- main prompt peak with some inelastic and elastic backscattering contribution
- additional small peak at about 1 ns delay probably due to some reflection (light?), delay not affected by PC-MCP1 voltage
- plot is for the PC-MCP1 voltage of 150 V and ROP for others



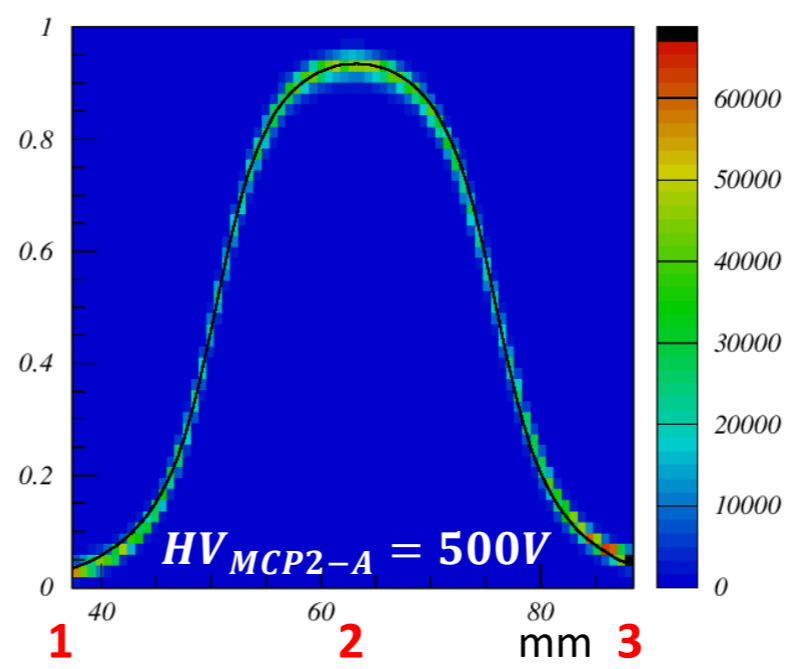
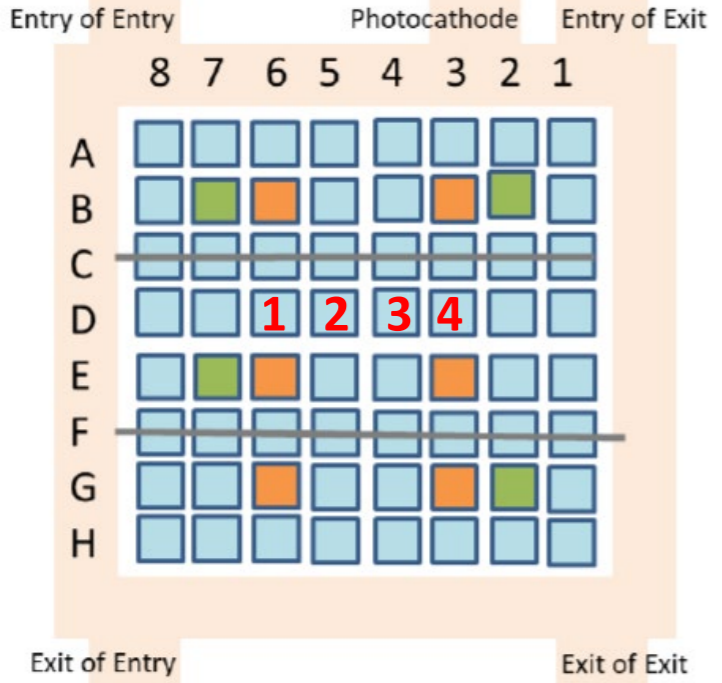
LAPPD - timing

- corrected TDCs for several PC-MCP1 voltages
- time resolution vs PC-MCP1 voltage

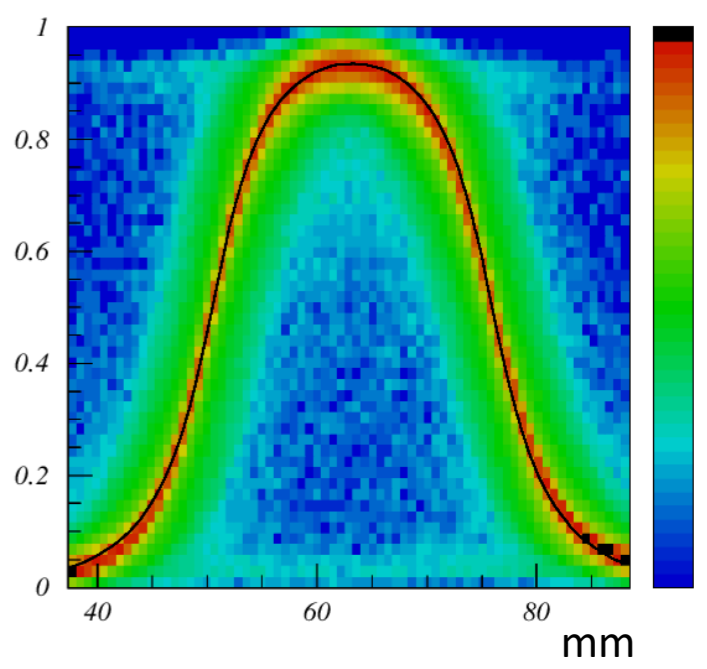


LAPPD - induced charge fraction

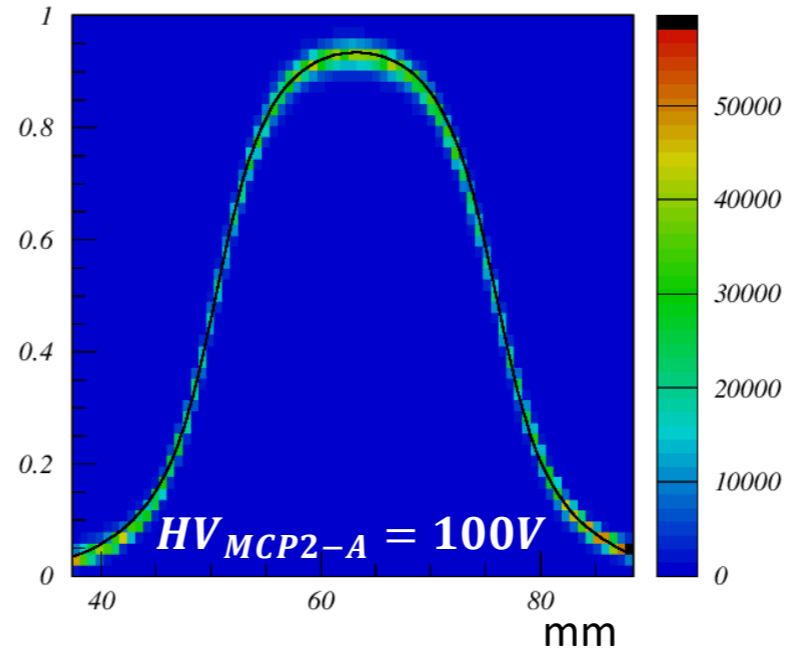
- fraction of the signal on ch. 2 vs laser spot x position: $f(x) = \frac{q_2}{\sum_i q_i}$
- green band (log scale) indicates the range of a backscattered photoelectrons – twice the PC-MC1 distance (on each side)
- ROP for upper plots and 100 V between MCP2 and A for lower ones
- Signal spread not mainly from electron spread but induced charge spread on coupled electrode



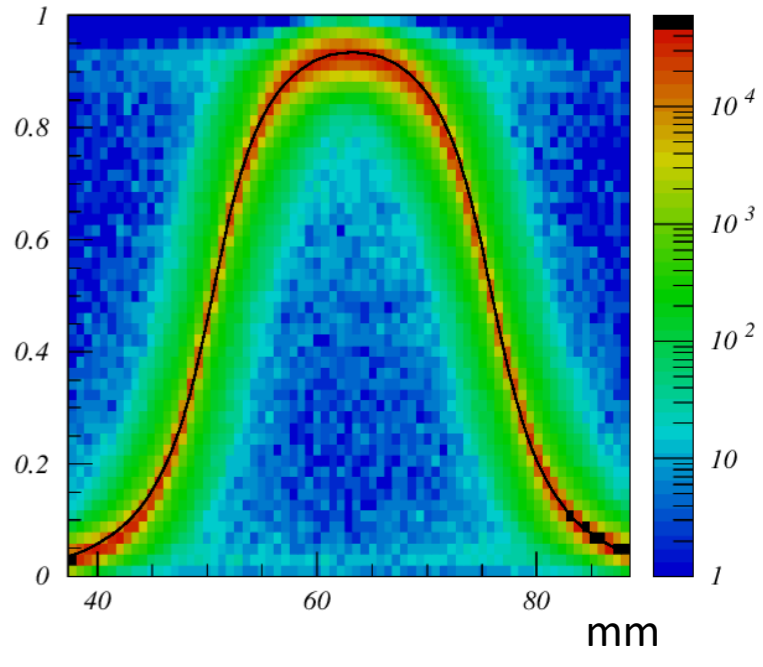
ADC2/(1+2+3+4) vs. X



ADC2/(1+2+3+4) vs. X



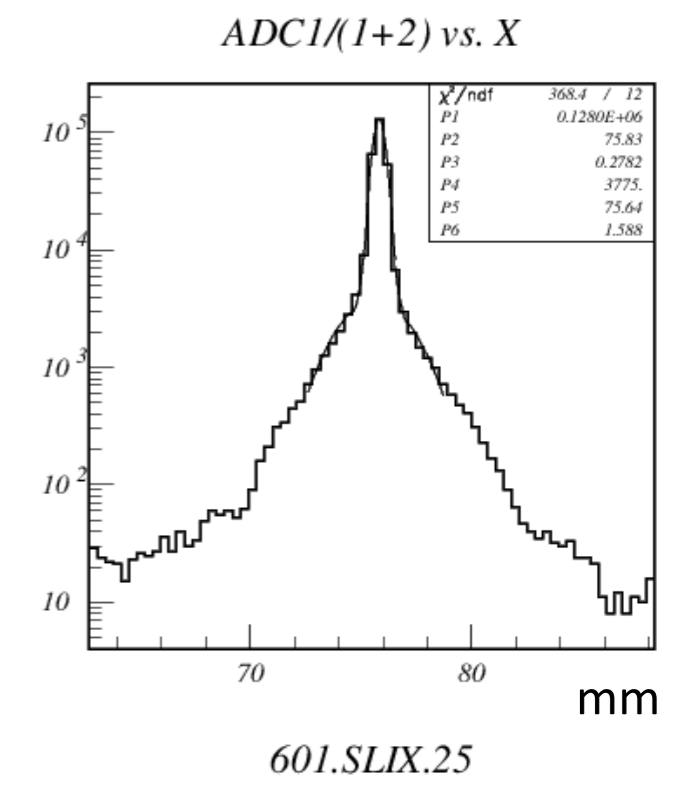
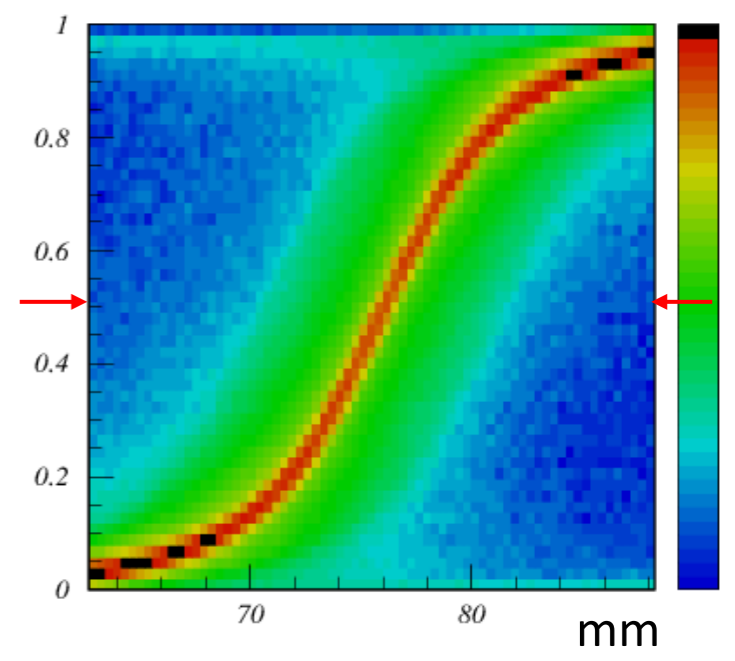
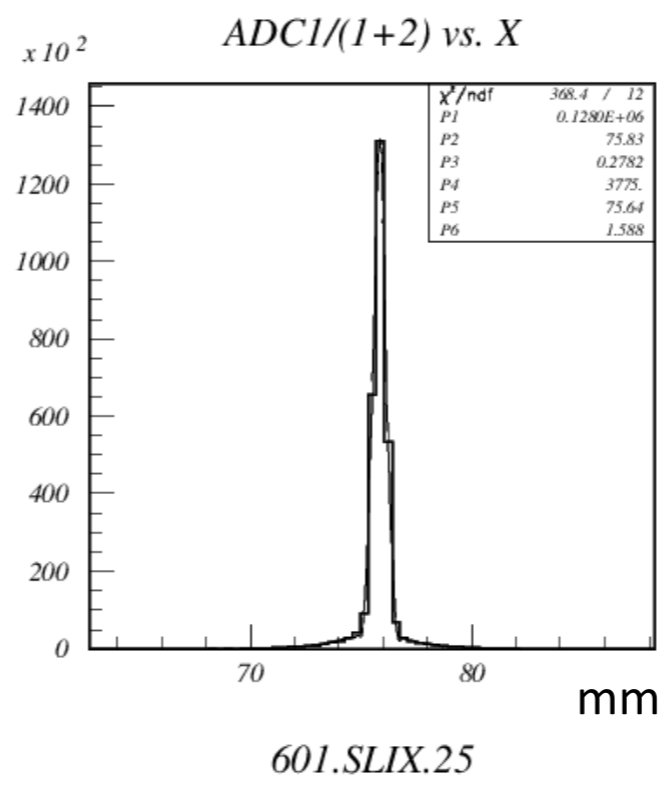
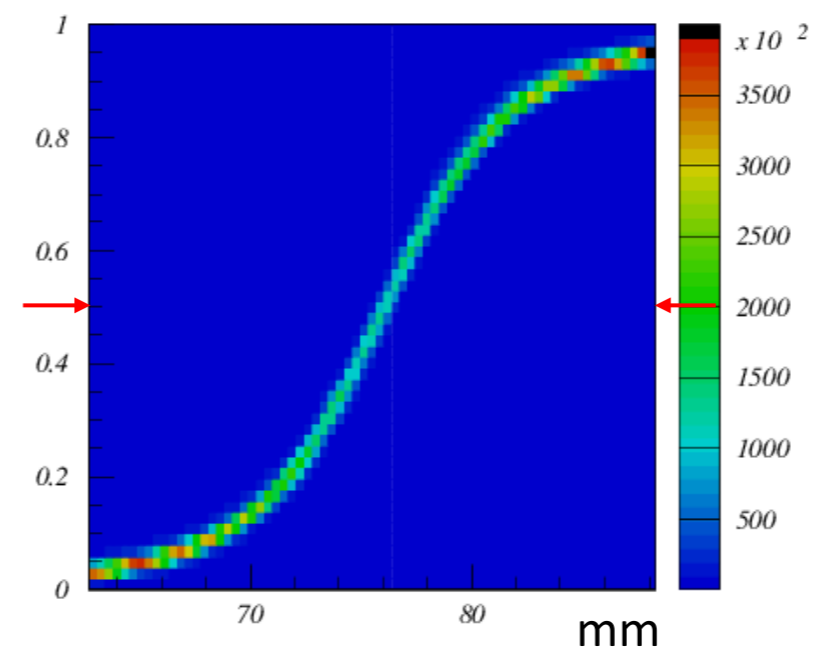
ADC2/(1+2+3+4) vs. X



ADC2/(1+2+3+4) vs. X

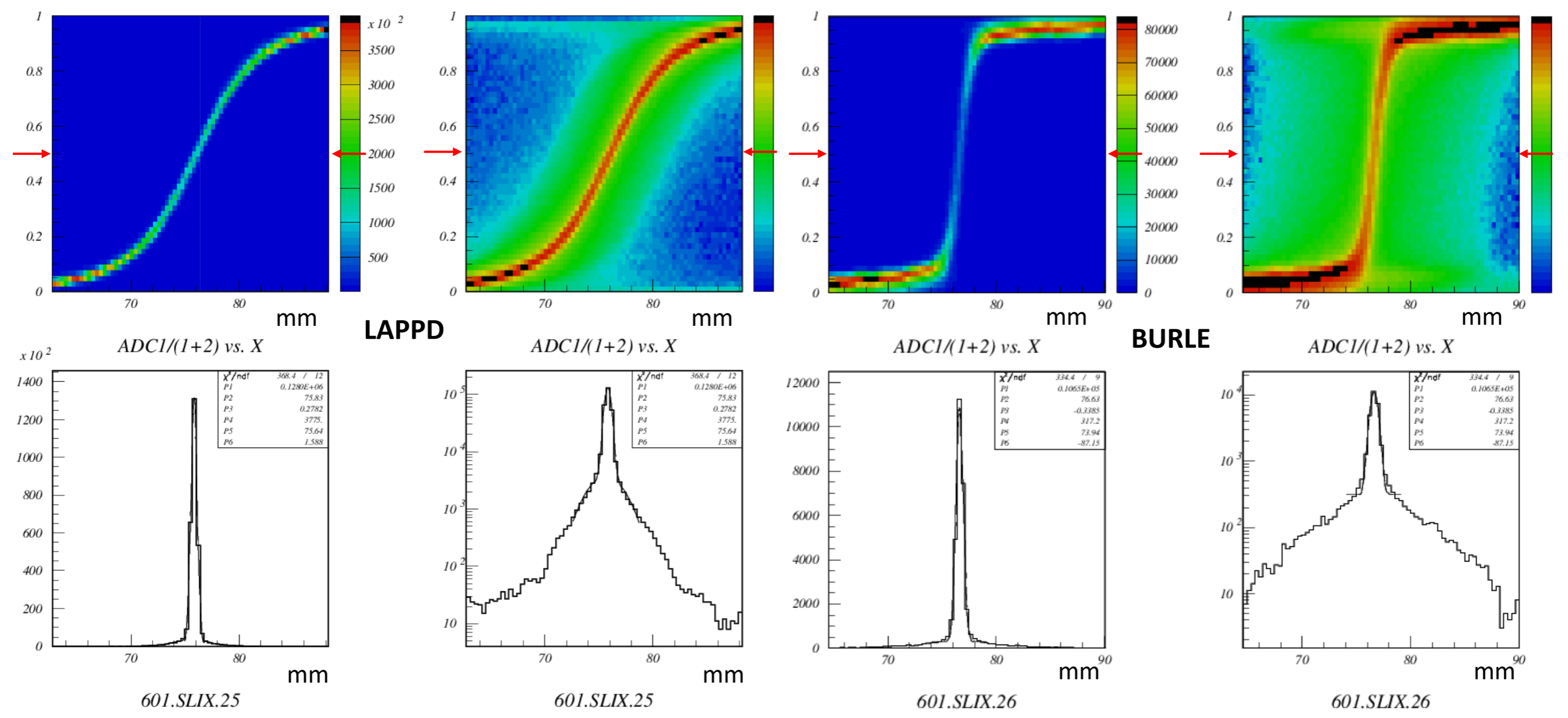
LAPPD - charge sharing

- more detailed scan between the centres of adjacent pads (top)
- central slice where signal is equally split between the pads (bottom)
- narrow peak is due to the light spot size and photoelectron spread
- longer tail from photoelectron backscattering - ≈ 6 mm on each side $\rightarrow \approx 3$ mm PC - MCP1 distance



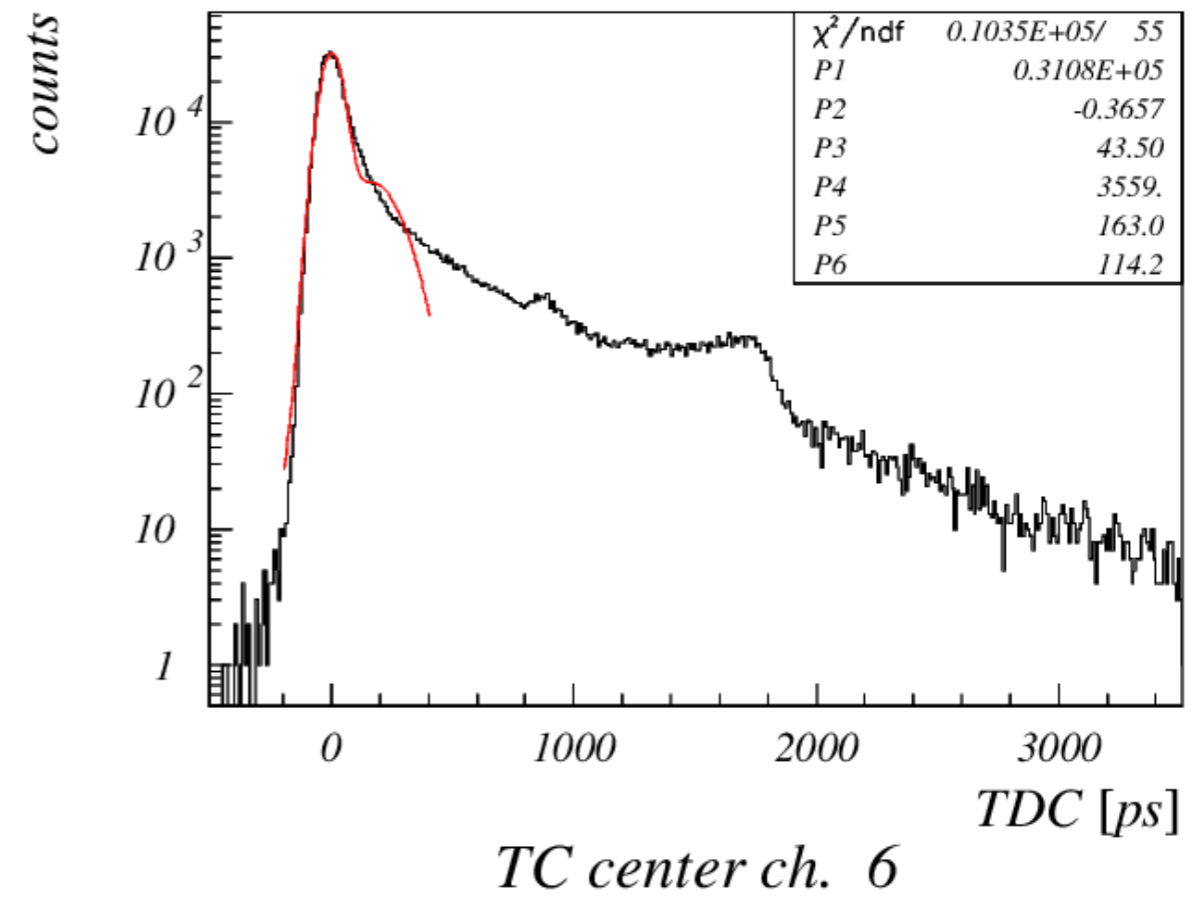
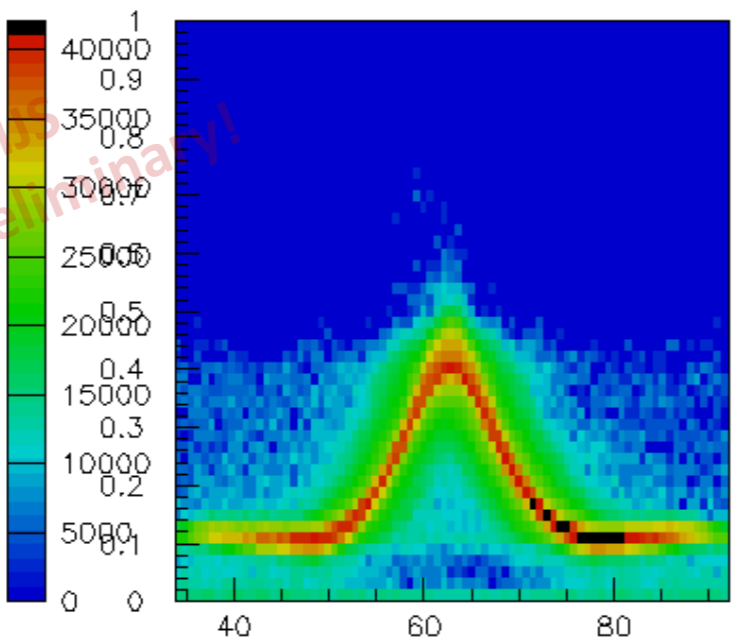
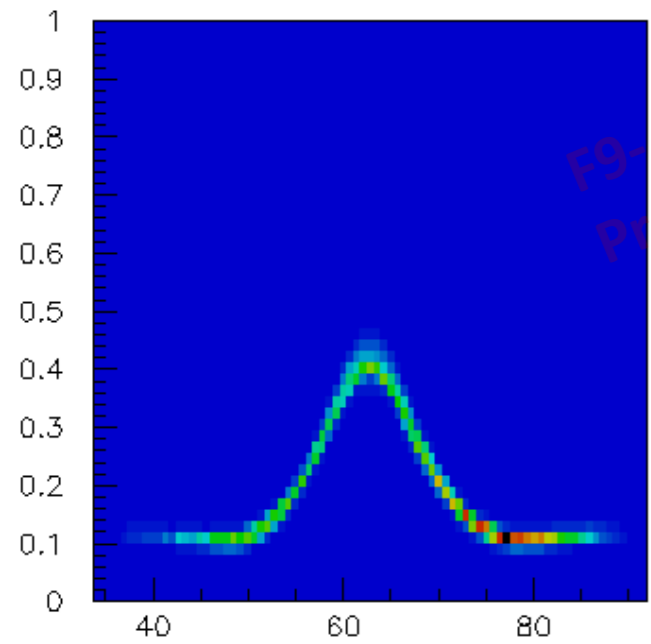
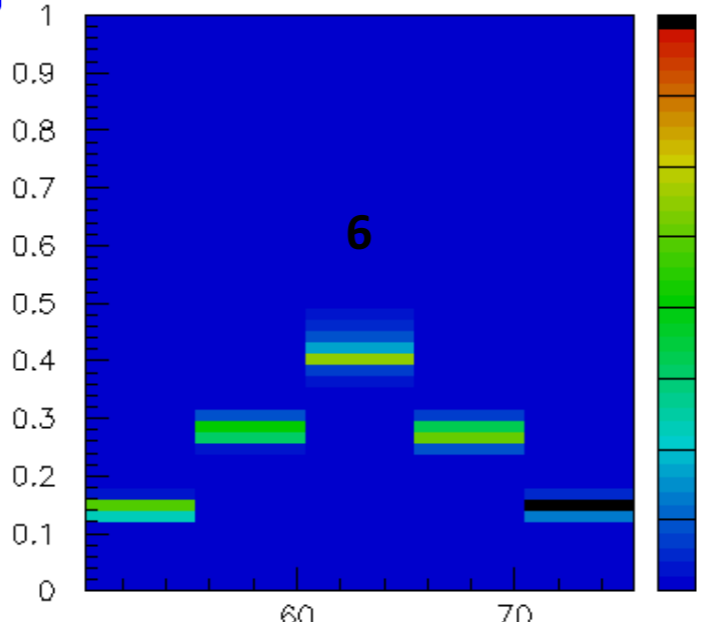
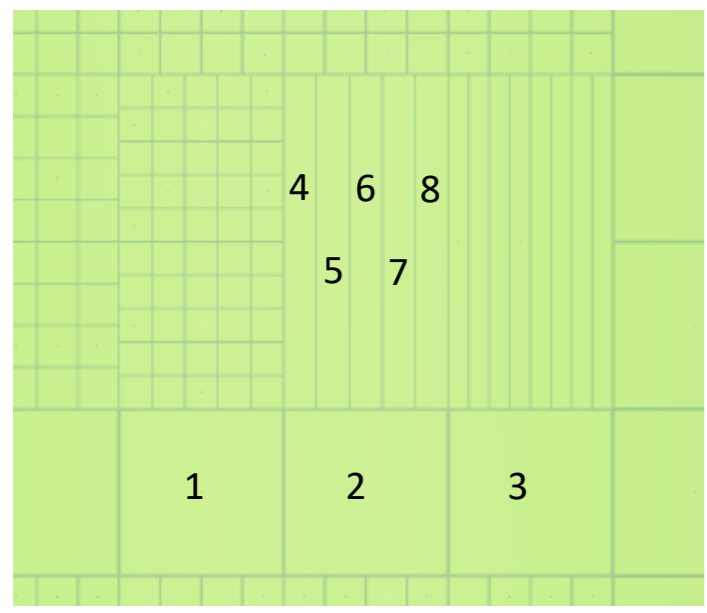
LAPPD - PLANCON

LAPPD (capacitive coupling) – BURLE PLANACON (internal anodes) signal spread comparison – same pad size, same range



LAPPD - 5mm strips

- charge sharing for 5 mm strips

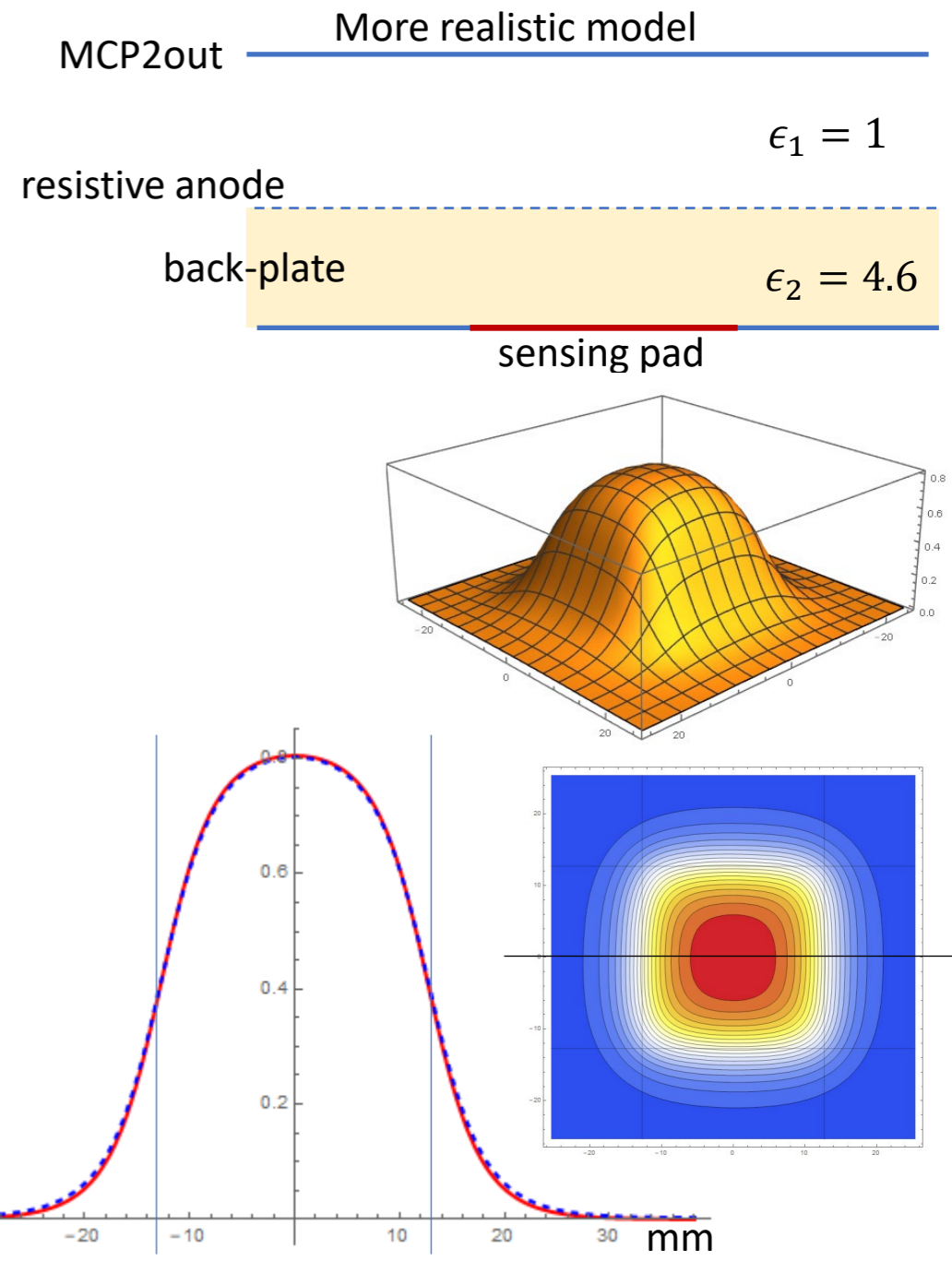
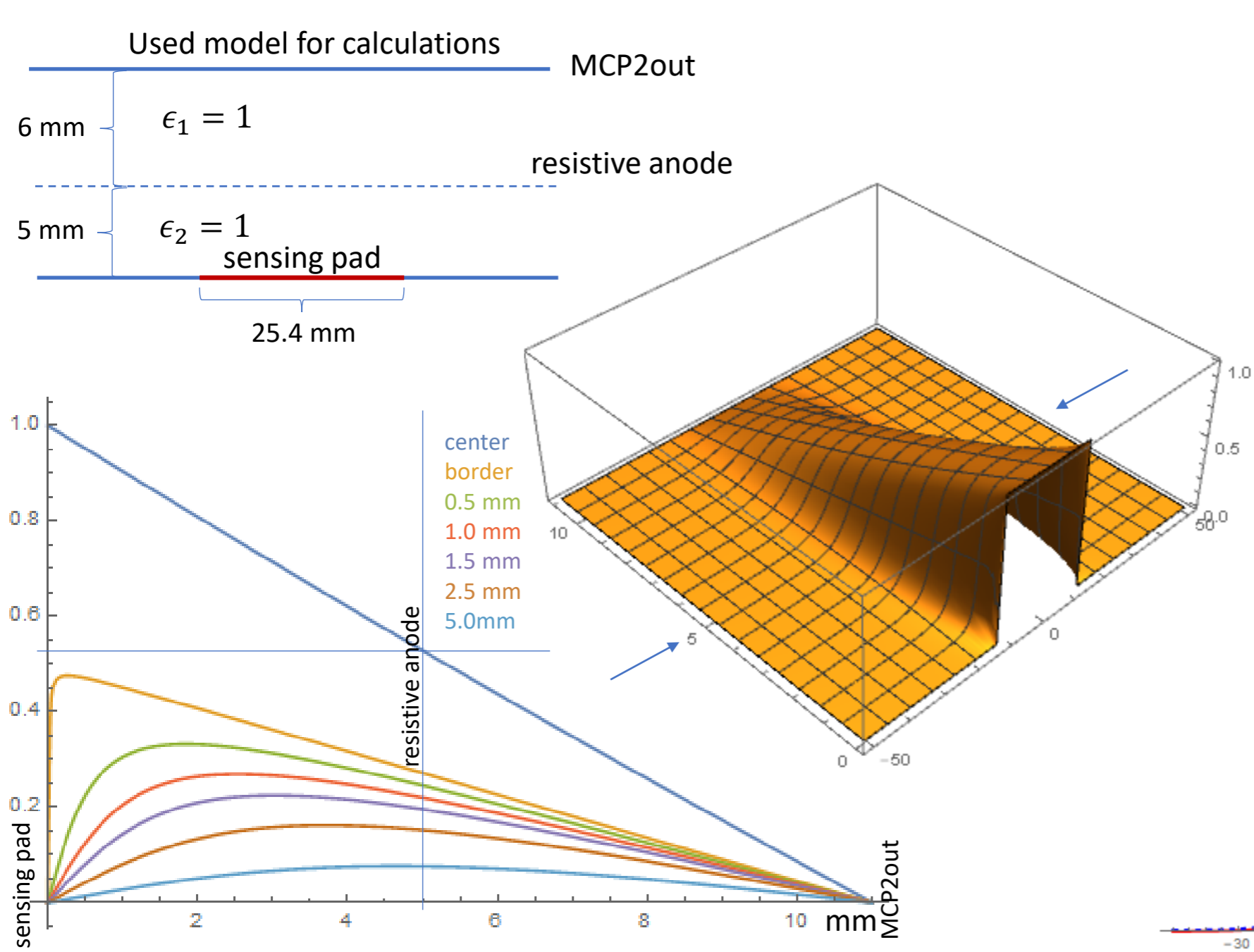


6
ADC(I)/ADC vs. X

ADC(I)/ADC vs. X

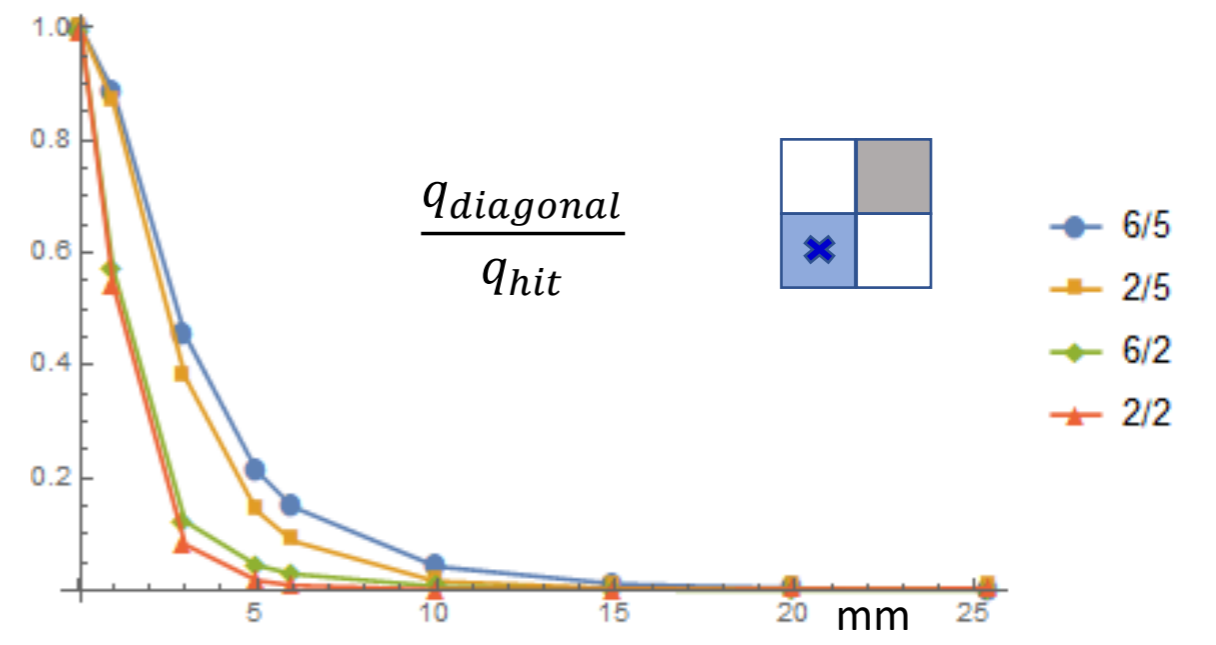
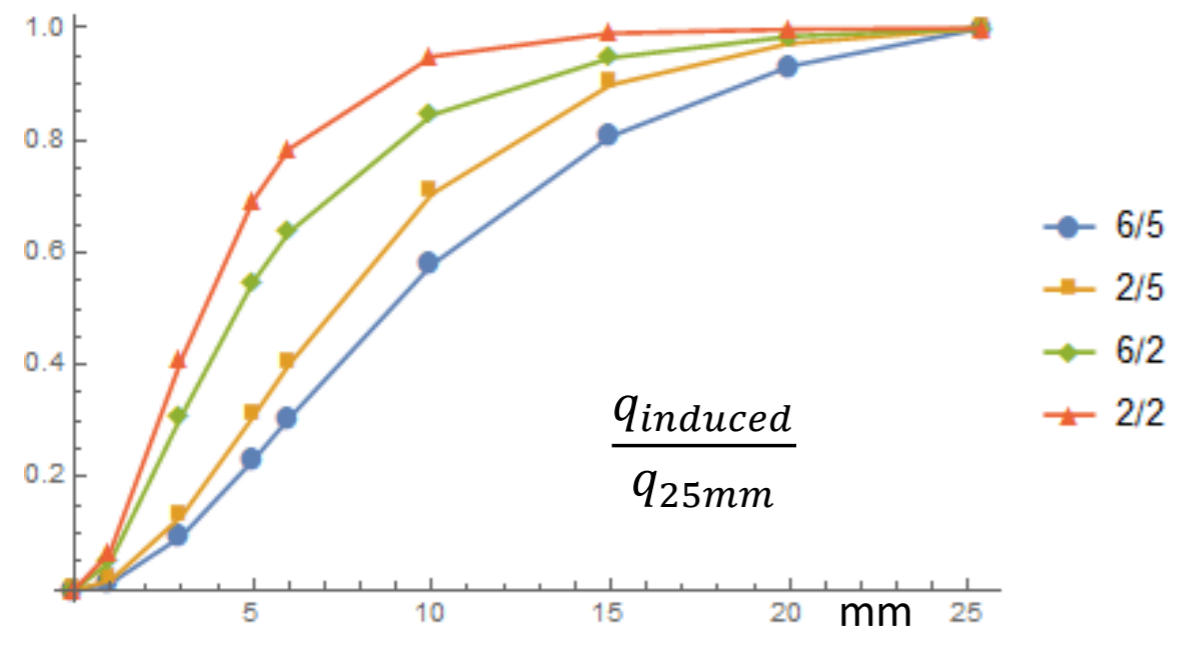
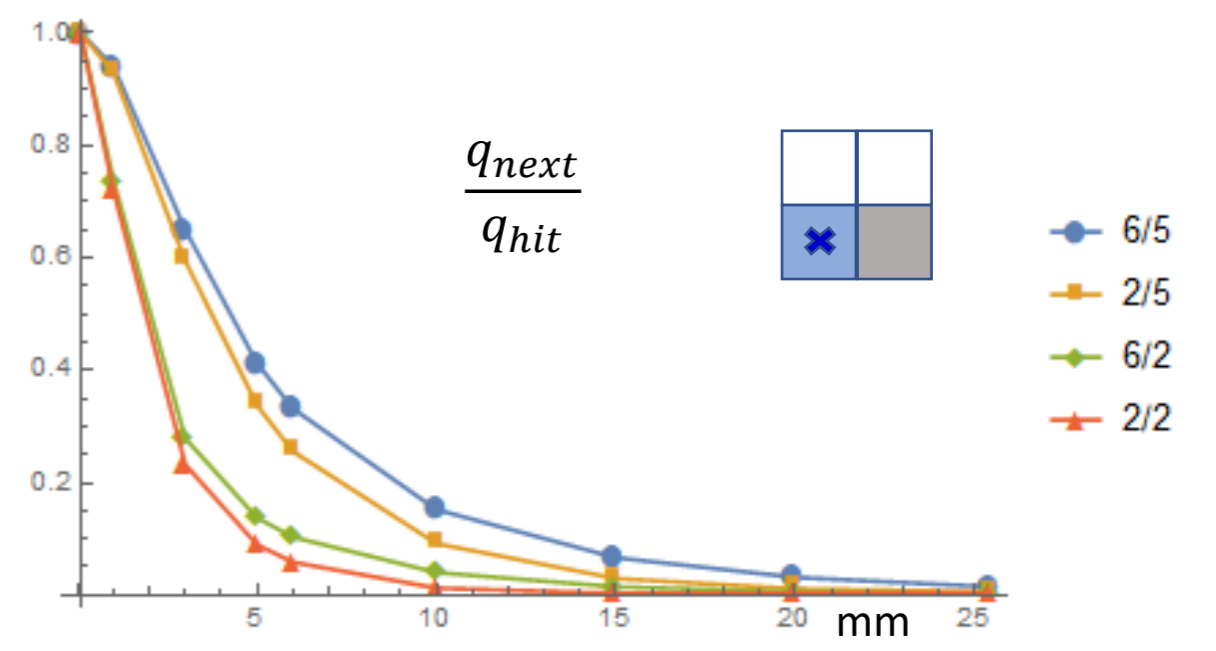
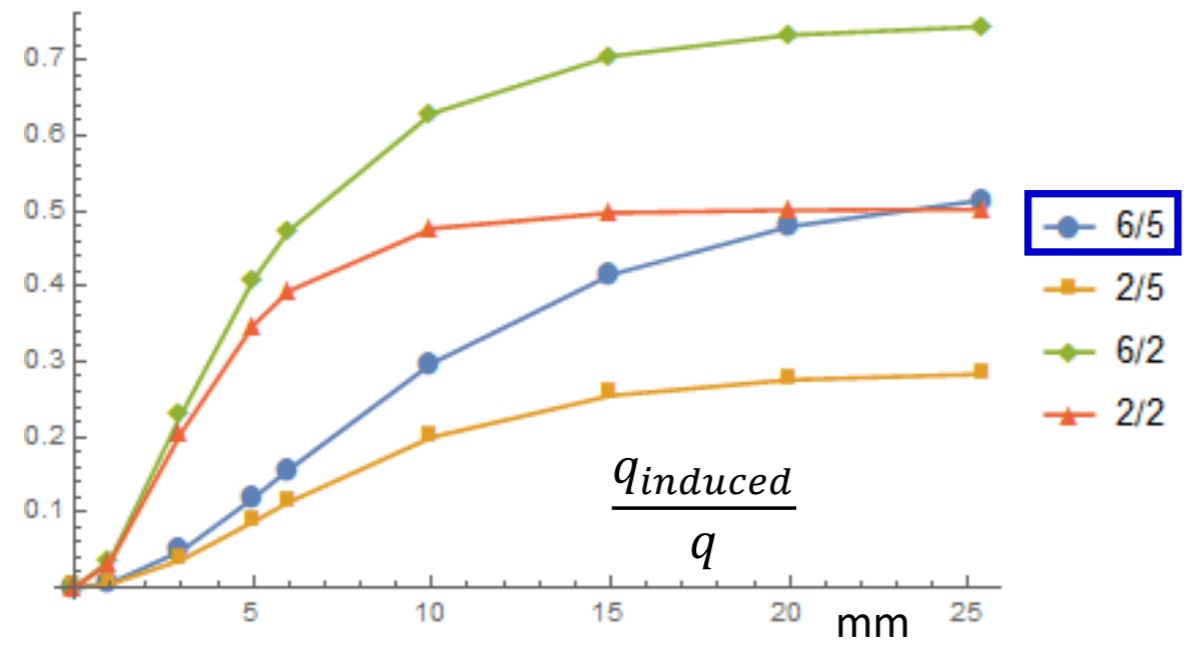
TC center ch. 6

LAPPD - induced charge calculations



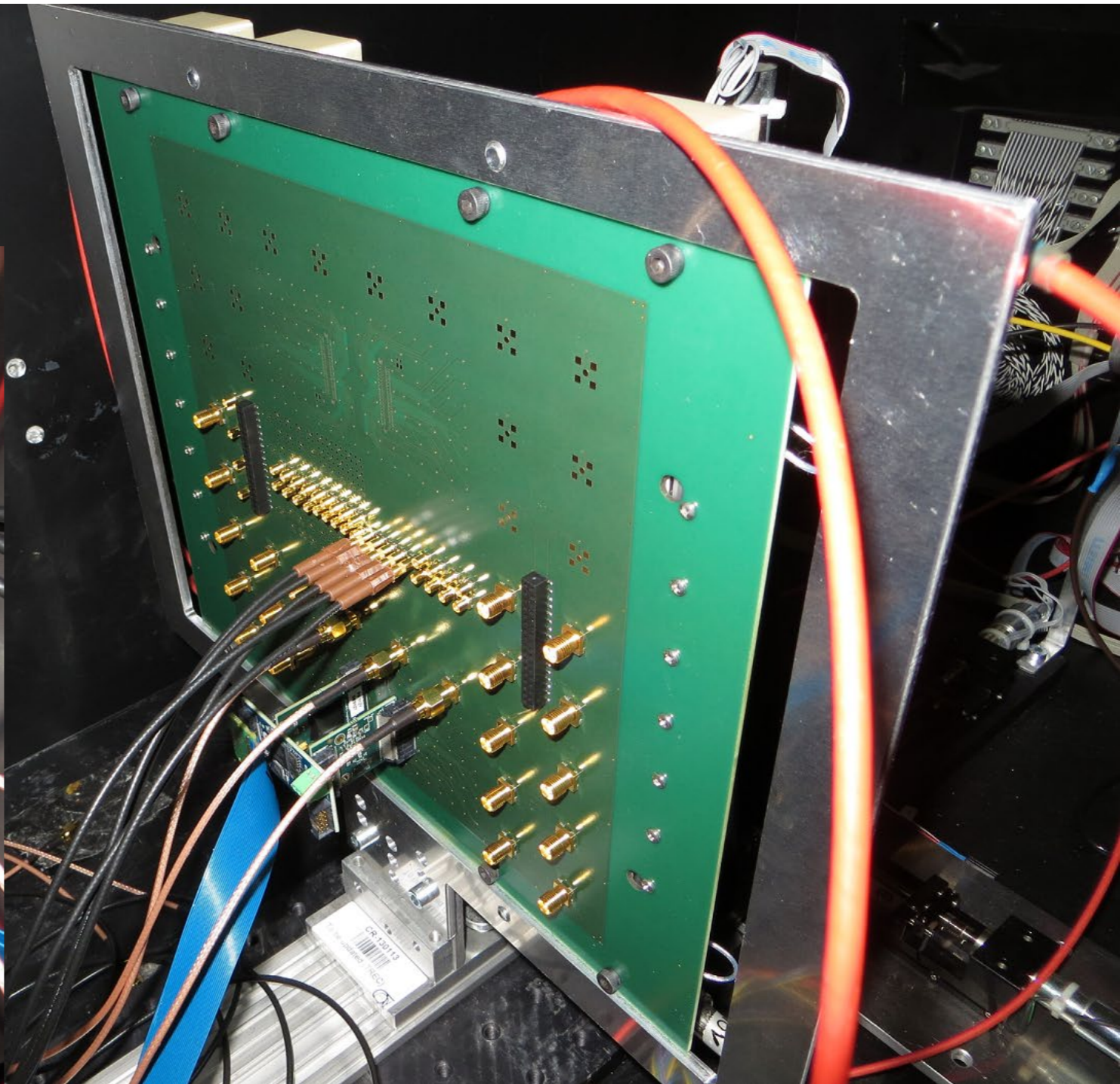
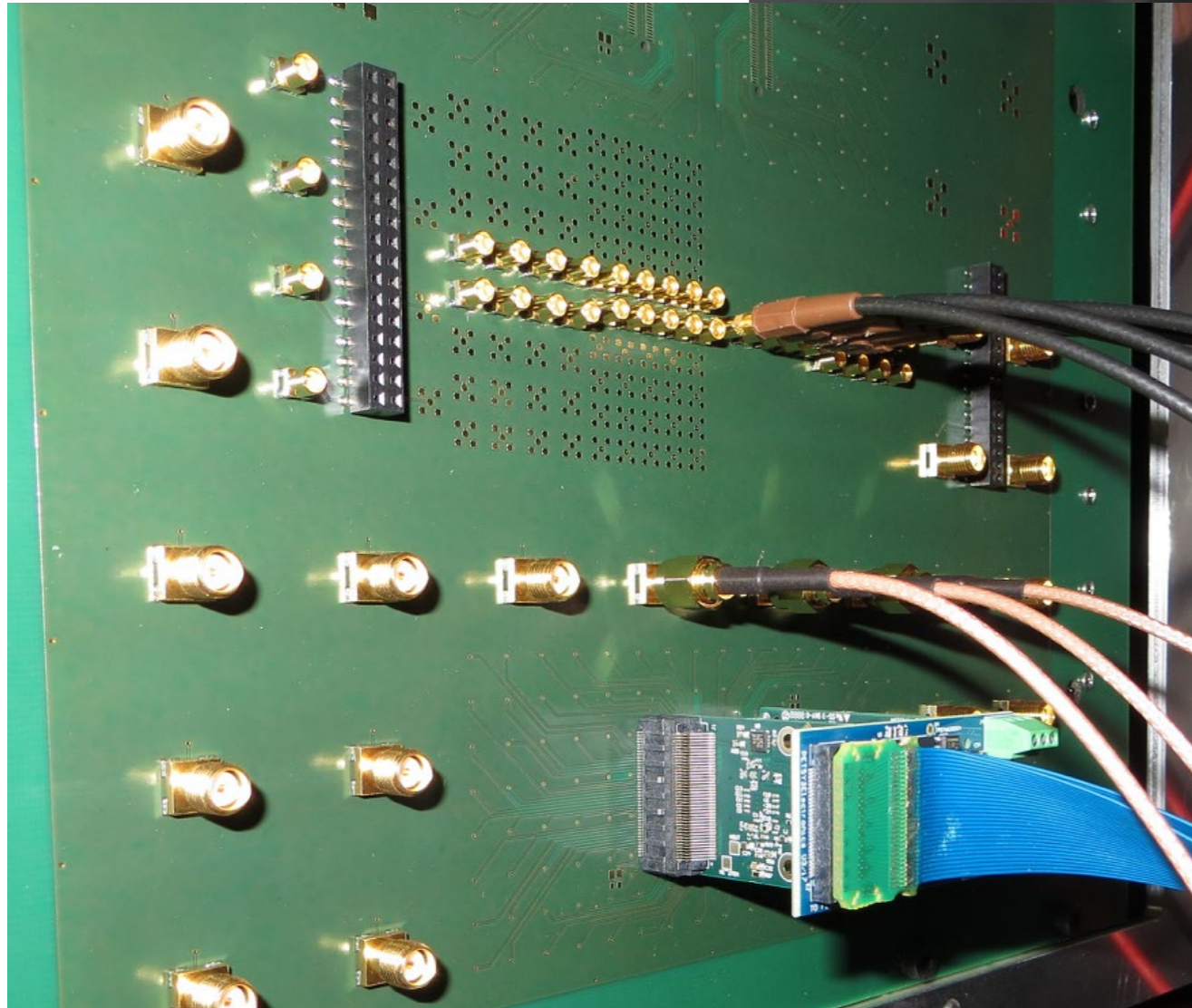
LAPPD - induced charge estimates

Collected charge by pads of different size and for different (MCP2out-A)/(A-pad) distances. ϵ not included.



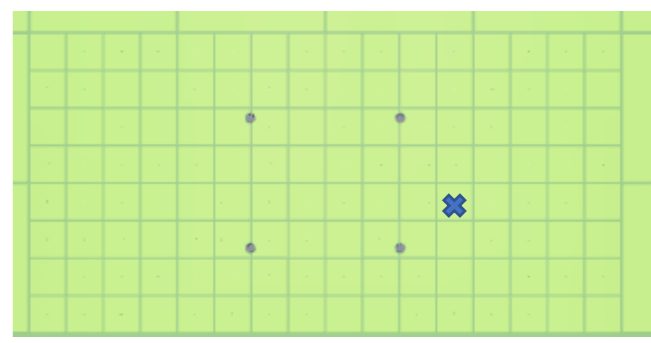
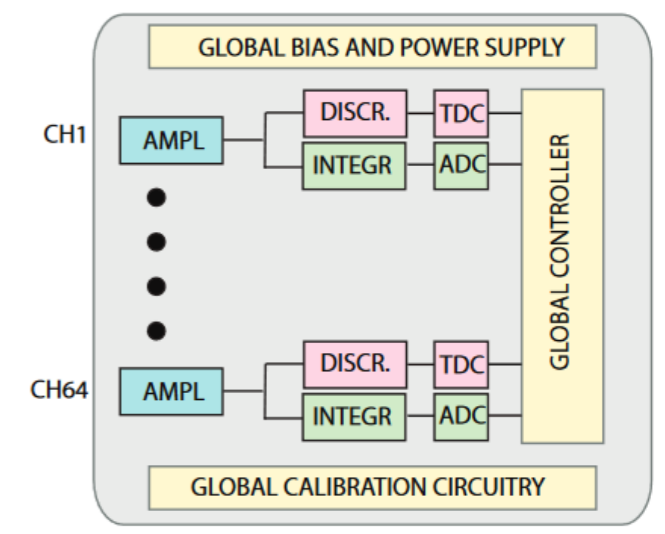
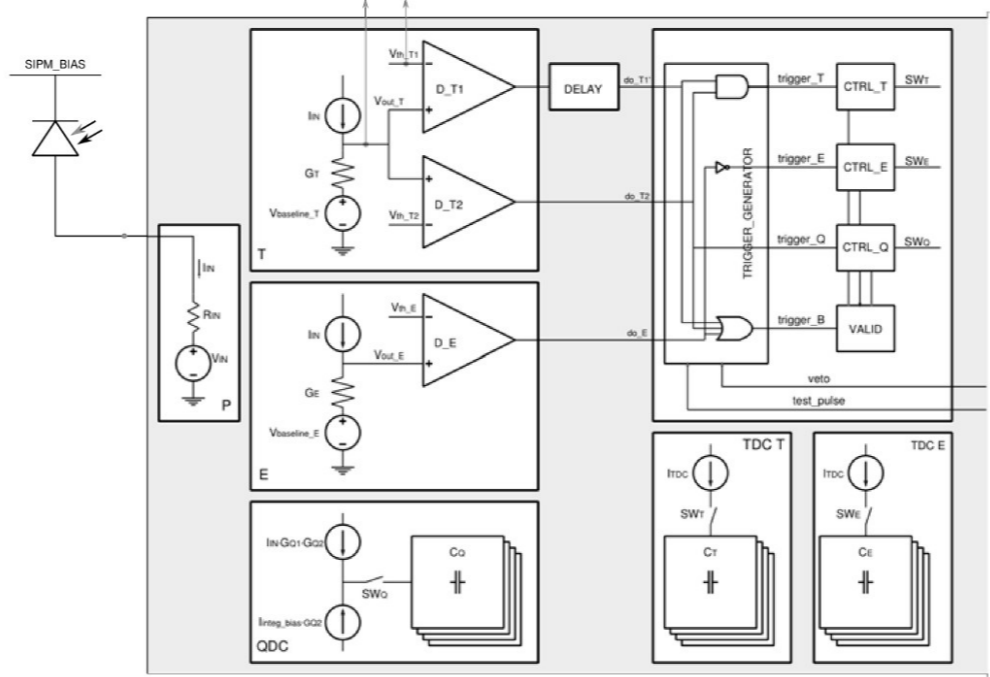
LAPPD + PETSYS

- $\frac{1}{4}$ " pads
- 128 channels (16 x 8)



LAPPD + PETSYS

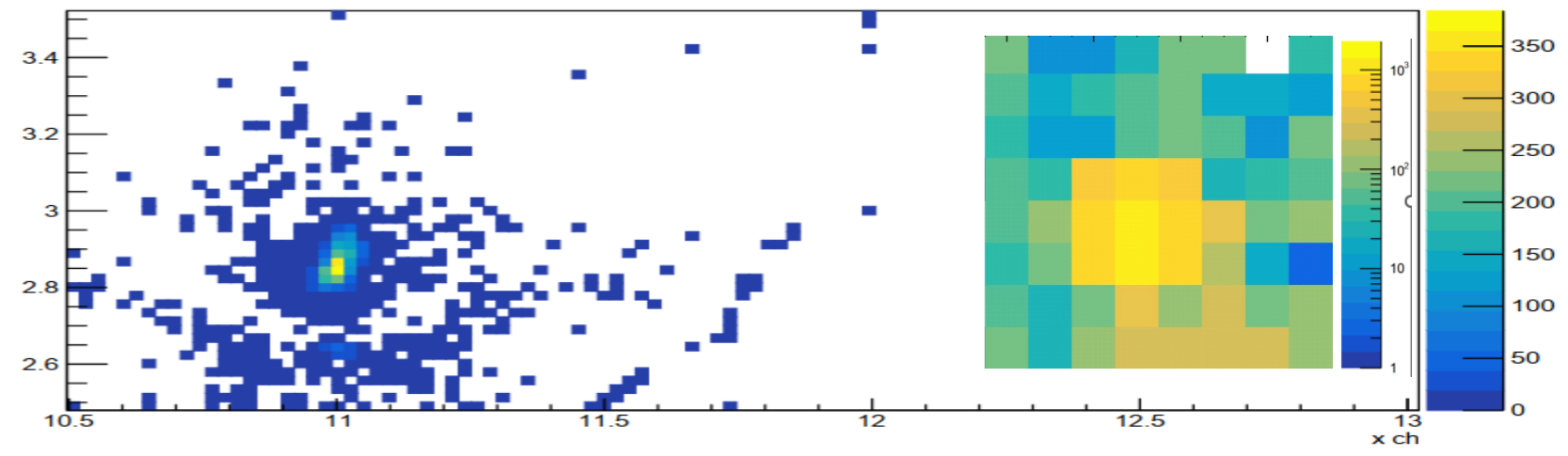
- Signal amplification and discrimination
- Gain adjustment per channel: 1, 1/2, 1/4, 1/8
- Dual branch quad-buffered analogue interpolation TDCs for each channel
- Quad-buffered charge integration for each channel
- Dynamic range: 1500 pC
- TDC time binning: 30 ps
- positive input signal polarity
- Max channel hit rate: 600 kHz
- Configurable timing, trigger and ToT thresholds
- Fully digital output



- Center of gravity with ToT

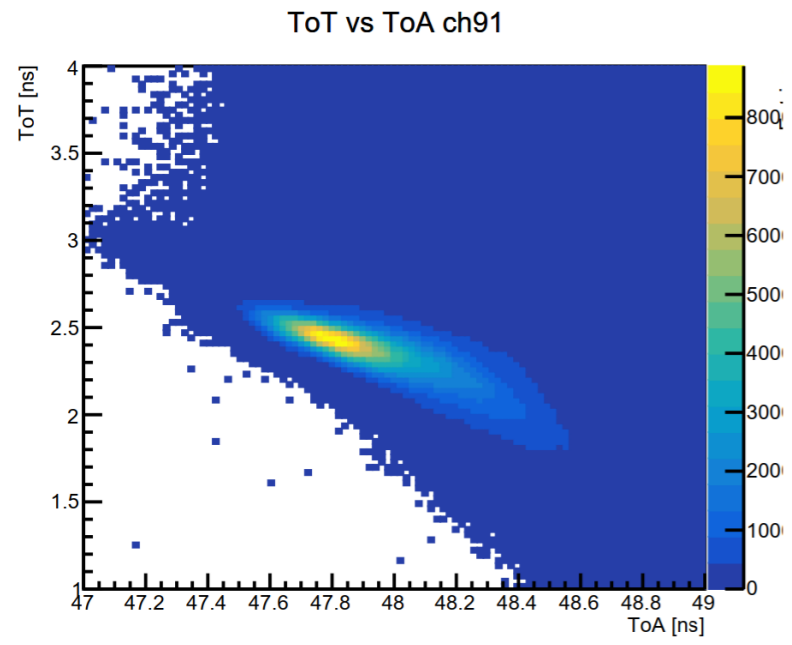


Location of energy weighted hits (ROI)

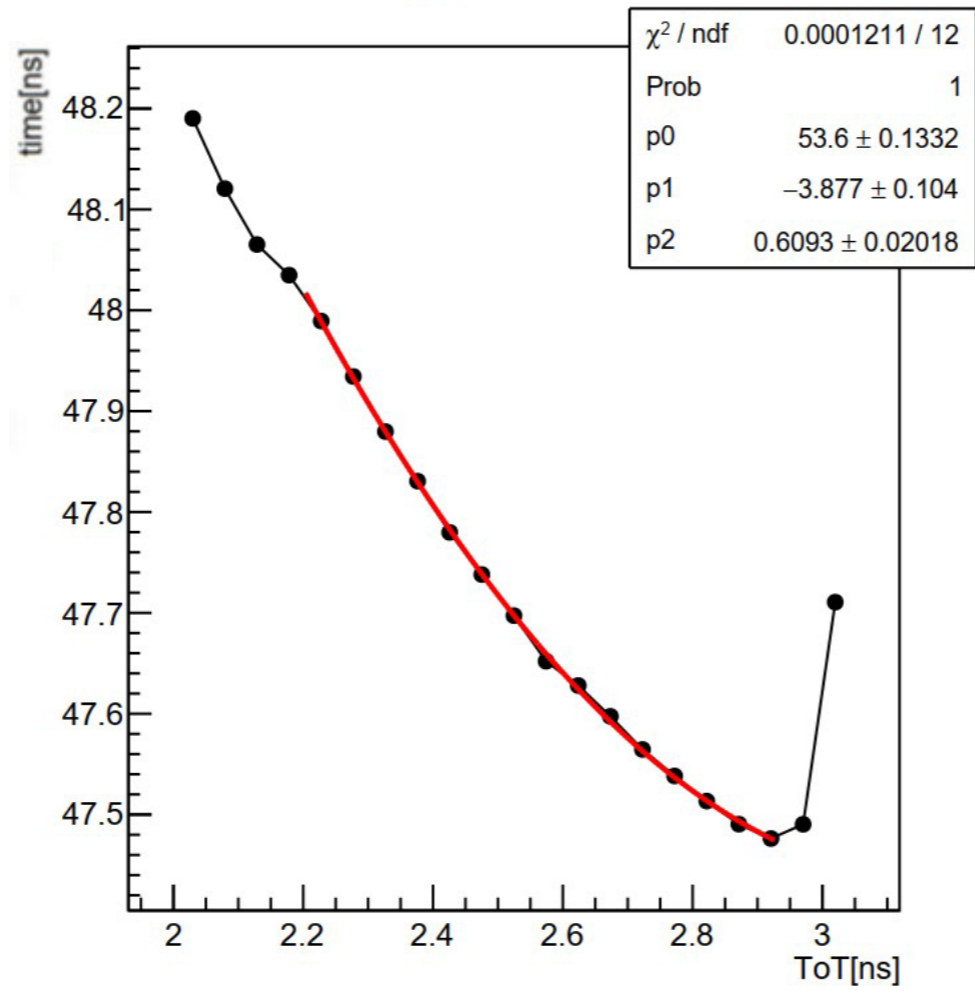


LAPPD + PETSYS: timing

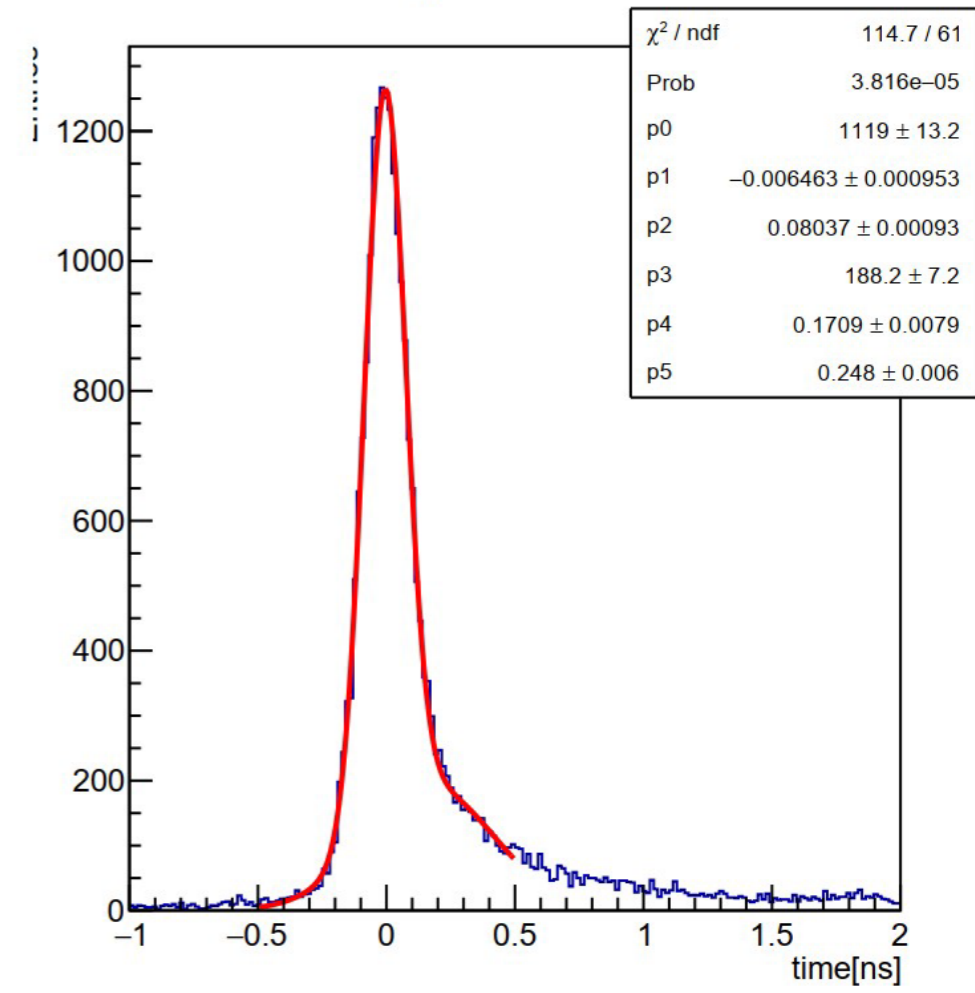
- Time-walk correction based on ToT
- Main peak $\sigma \approx 80$ ps



Timing position vs ToT

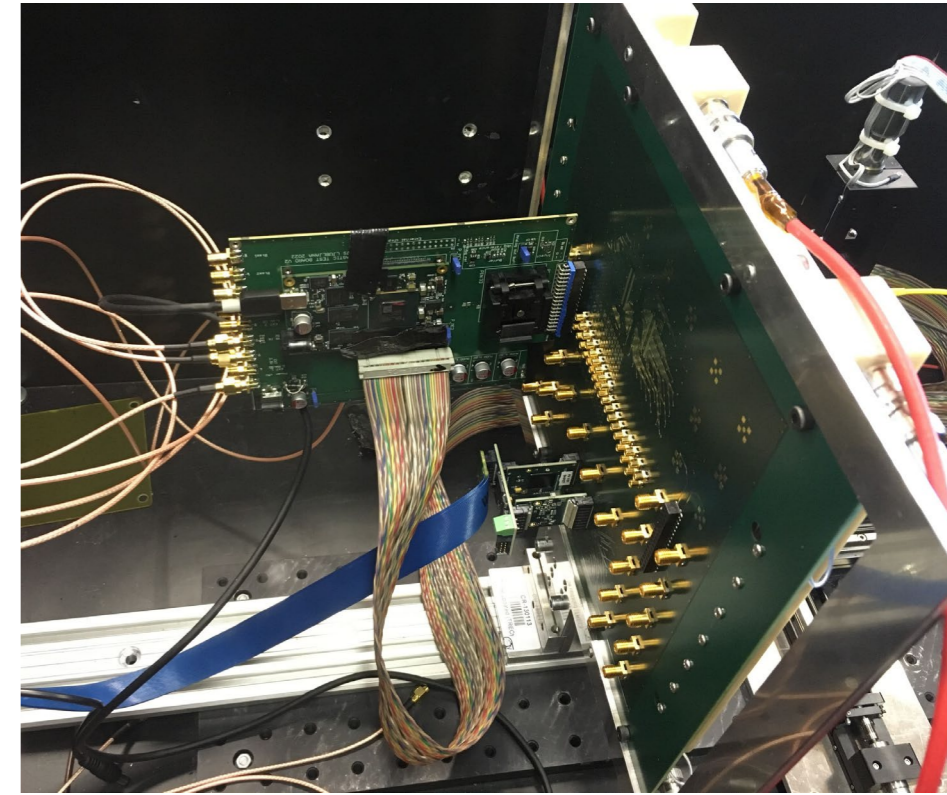
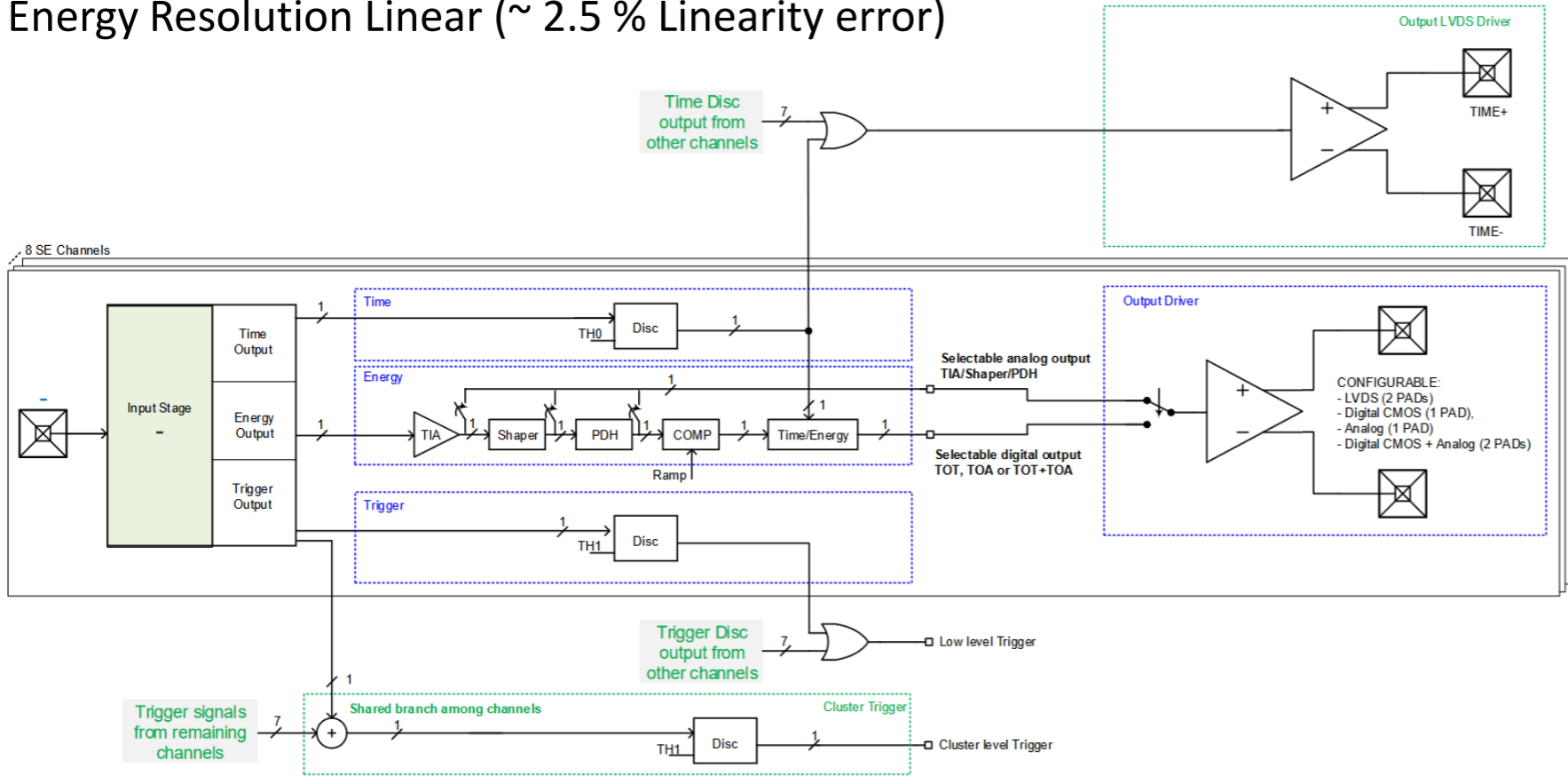


Hit timings ch:91 after corr.

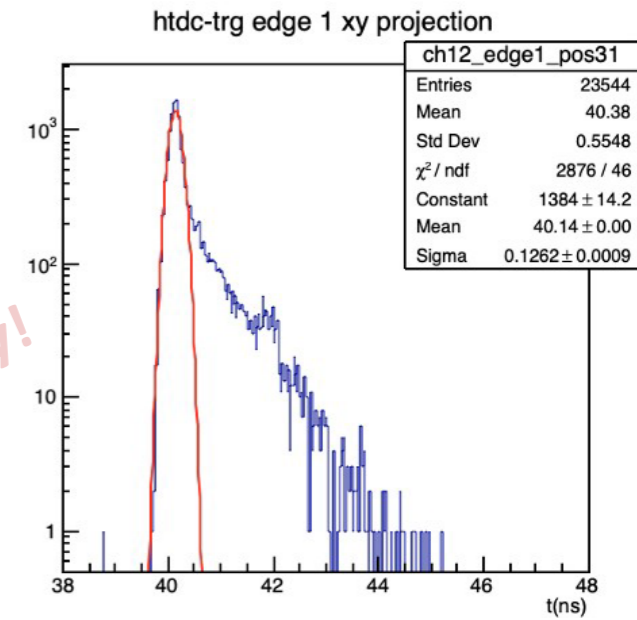
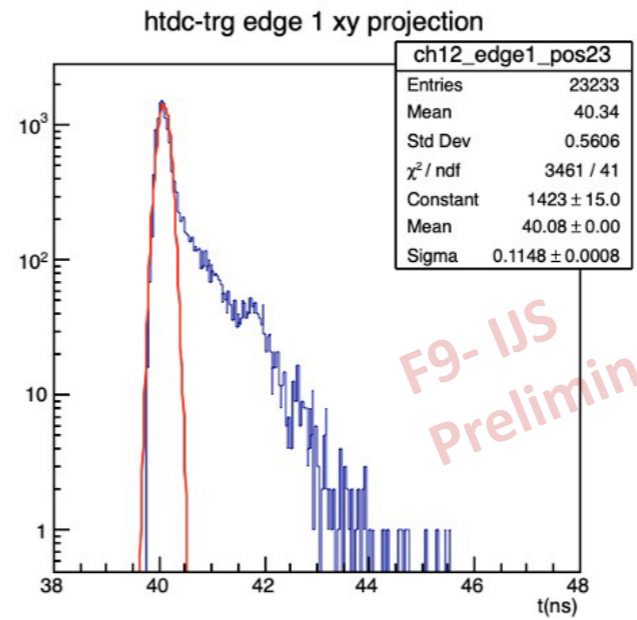
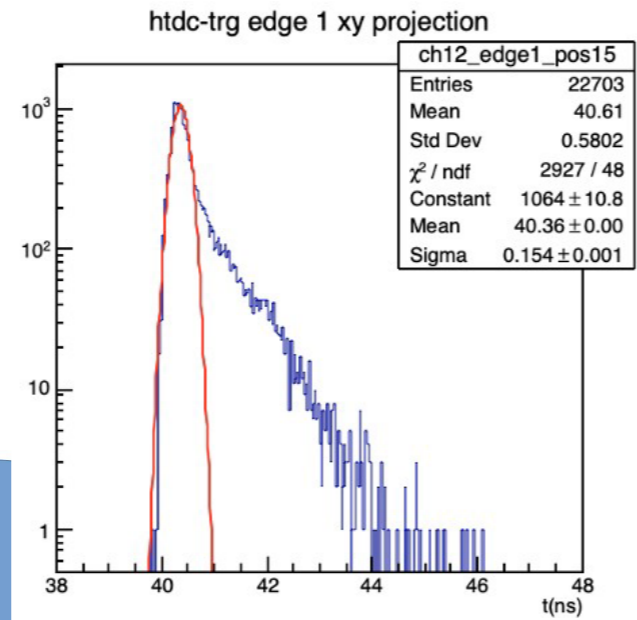
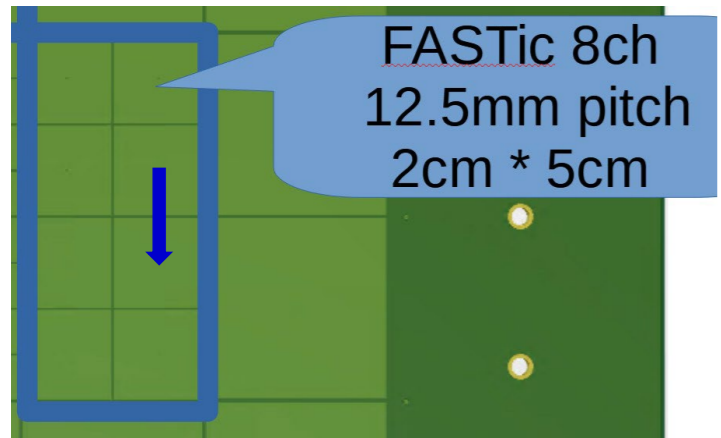


LAPPD + FASTIC

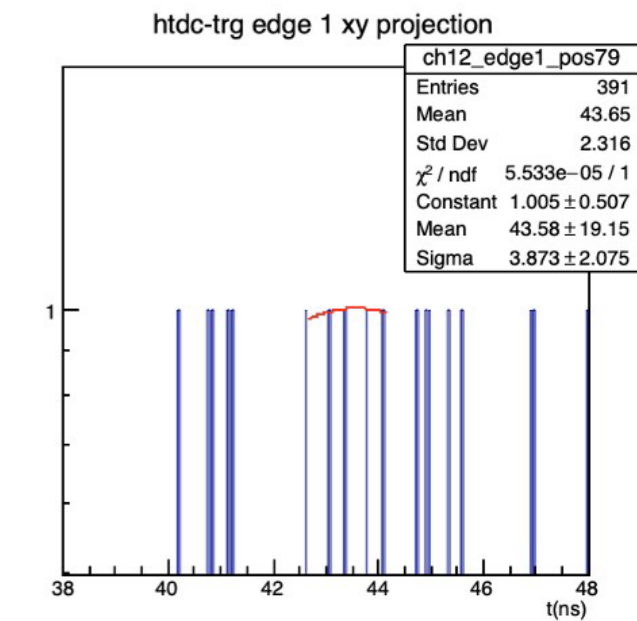
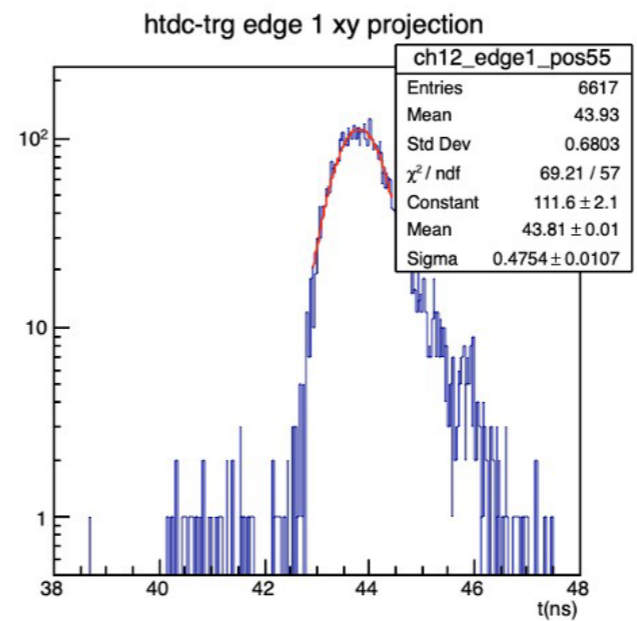
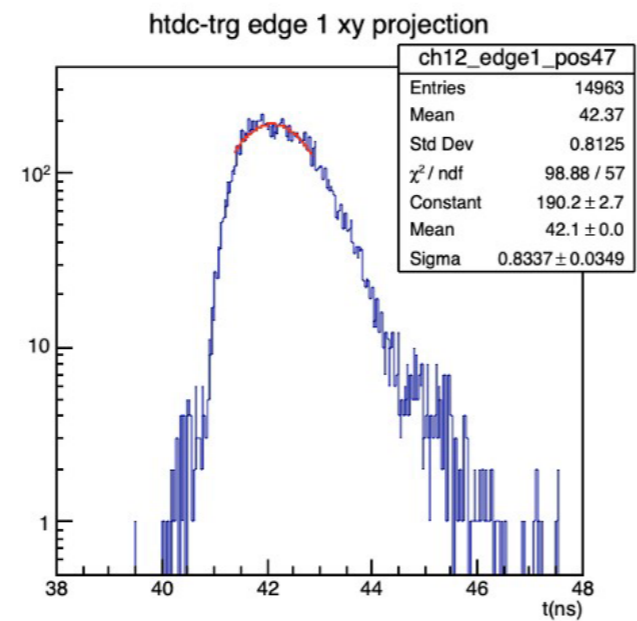
- 8 CH ASIC
- Technology 65 nm CMOS
- ~ 6 mW/ch
- Number of channels: 8 SE / 4 DIFF
- Connection Type Configurable SE (Pos/Neg polarity)DIFF, Sum of 4 (Pos/Neg polarity)
- Electronics Time Jitter ~ 25 ps rms
- Energy Resolution Linear (~ 2.5 % Linearity error)



- Timing resolution at different positions of laser spot ≈ 115 ps – no time-walk correction



F9- IJS
Preliminary!



BACKUP SLIDES