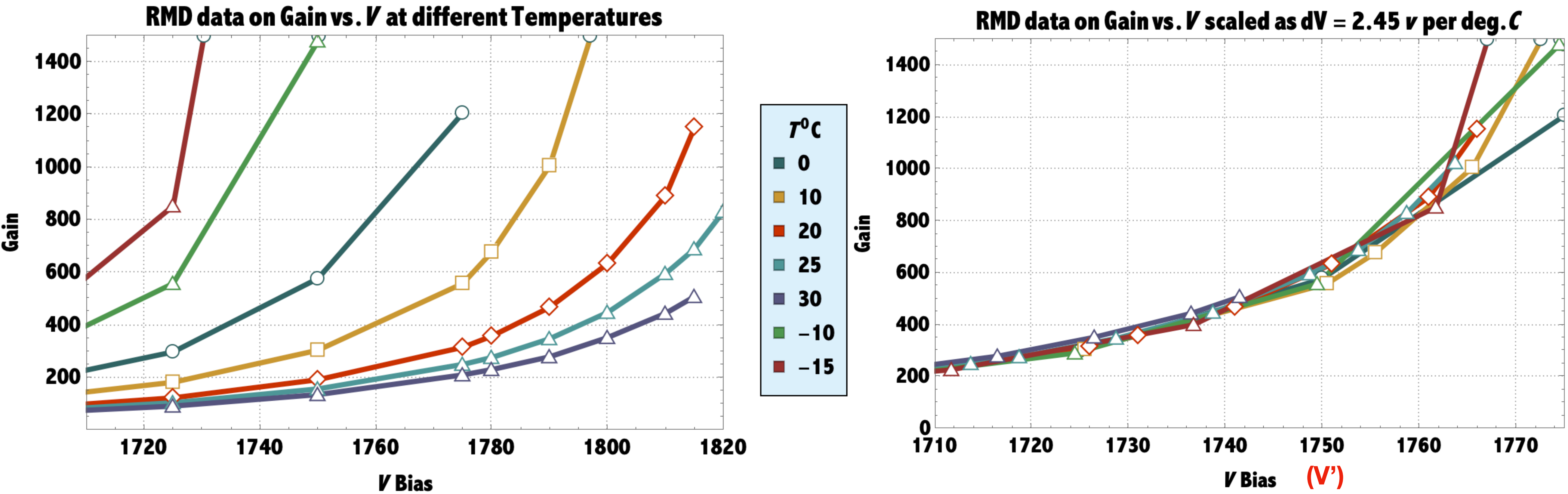
Plots and Text for inclusion

1)RMD Gain Measurement



RMD 8x8mm^2 avalanche diode Gain vs. bias voltage response for 20 nsec(wide ?) 425nm led pulses. Unity gain refers to the amplitude obtained at the ~500V bias where amplitude is roughly V independent.

An attempt was made to parametrize regular trend in V required for a given gain vs. T by an ad hoc re-scaling of V' = V-2.45*T(^{0}C). This parametrization of the pattern up to Gain~1000 may prove useful for discriminating among impact ionization models that appear in the literature and as options in ,eg SILVACO™ for modeling such devices.

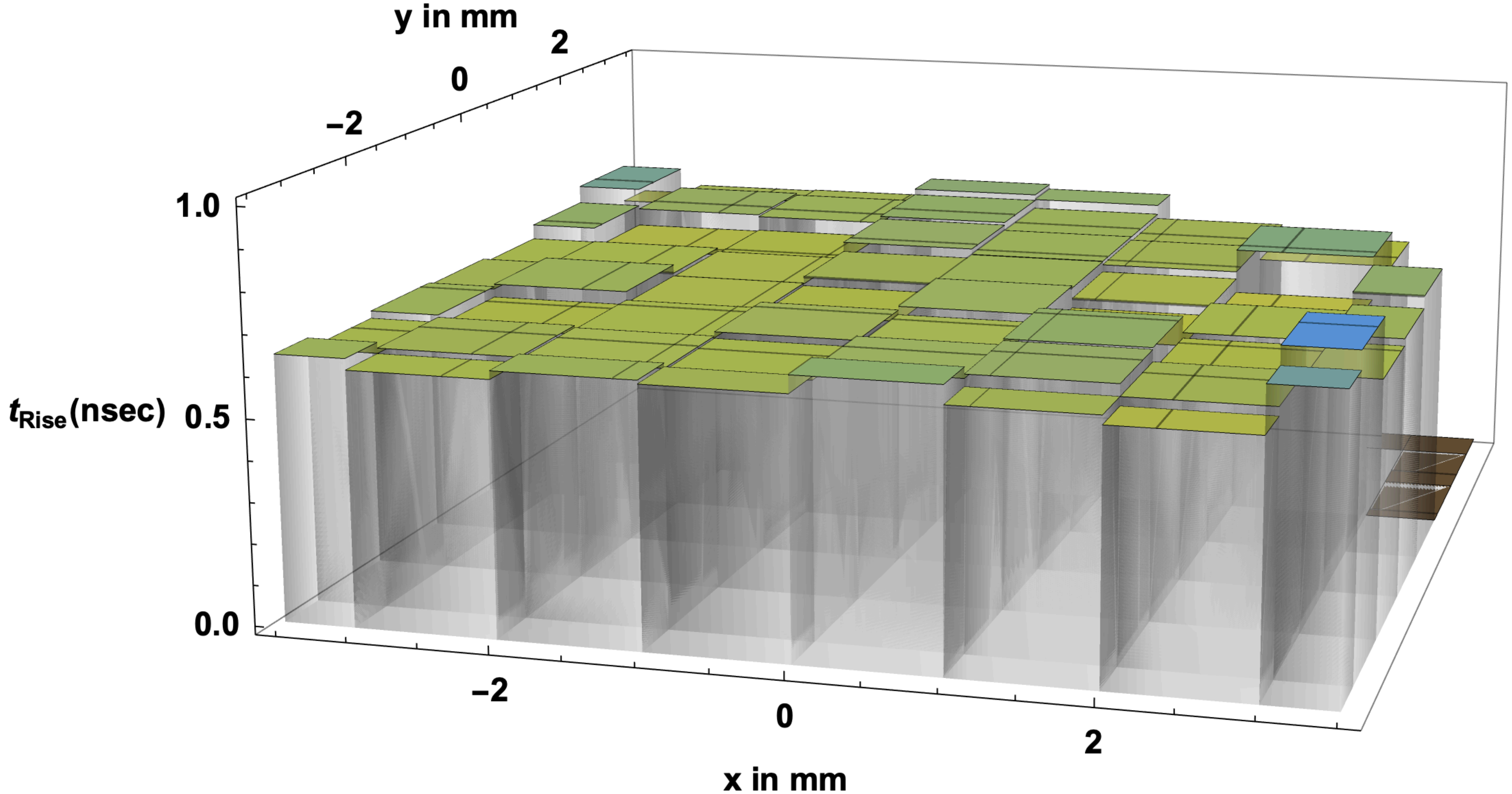
It should be noted that this particular definition of gain, as it applies to visible light photo-detection in an APD, will likely differ from the response to minimum ionizing particles (or the IR laser model used) since, in the former case all photoelectrons traverse the region where impact ionization occurs.

Response vs. Position of mesh readout 8x8mm2 ADs

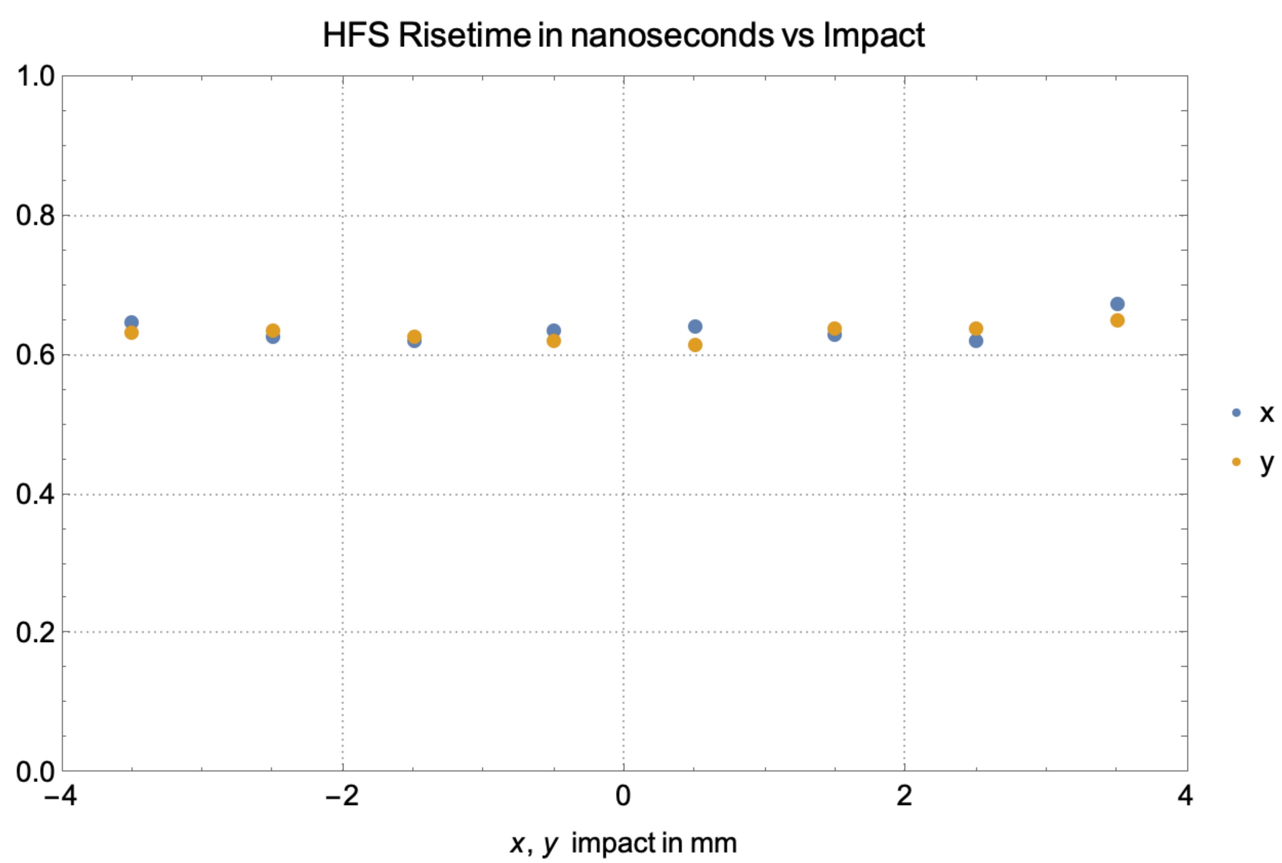
Several mesh readout 8x8 mm2 devices have been characterized in terms of their uniformity of response in a 150 GeV muon beam in the H4 beam line at the CERN SPS. For the measurements described below we used a fast transimpedence amplifier with roughly 10 ohm effective input impedance(ref. suggestion from Mitch) and bandwidth of 1 GHz. The measurements were carried out within the infrastructure of PICOSEC(\bibitem{NIMpico} J.Bortfeldt et al, "PICOSEC: Charged particle timing at sub-25 picosecond precision with a Micromegas based detector" Nucl. Instrum. Methods A903. 2018; 317-325.). In particular, the PICOSEC setup provided tracking precision of 40 microns and a t0 reference based on a Hamamatsu MCP PMT which detected charged particles by the Cerenkov light produced in the quartz entrance window (ref. Lukas Elba proceedings) providing a ref time jitter of <10 picoseconds.

Pulse shape vs. Position

Using the above setup and a 2.5 GHz 20GSa/s digital oscilloscope to record the waveforms the timing measurements of HFS were derived using a 20% constant fraction algorithm (to define the signal time of arrival). To ensure the consistency of this timing measurement the dependence of waveform characteristics (particularly the rise time) on impact position of muons was studied using the H4 beam data. For this particular study a sample of ~1000 events were recorded with HFS operated at a bias of 1750V resulting in a most probable amplitude (MIP peak) of 65 mV at the scope input. The typical pulse rise time (measured at 20-80% levels) was 630 picoseconds with an rms spread of ~160 picoseconds. As seen from the plots below this aspect of the signal is essential independent of the point of impact.

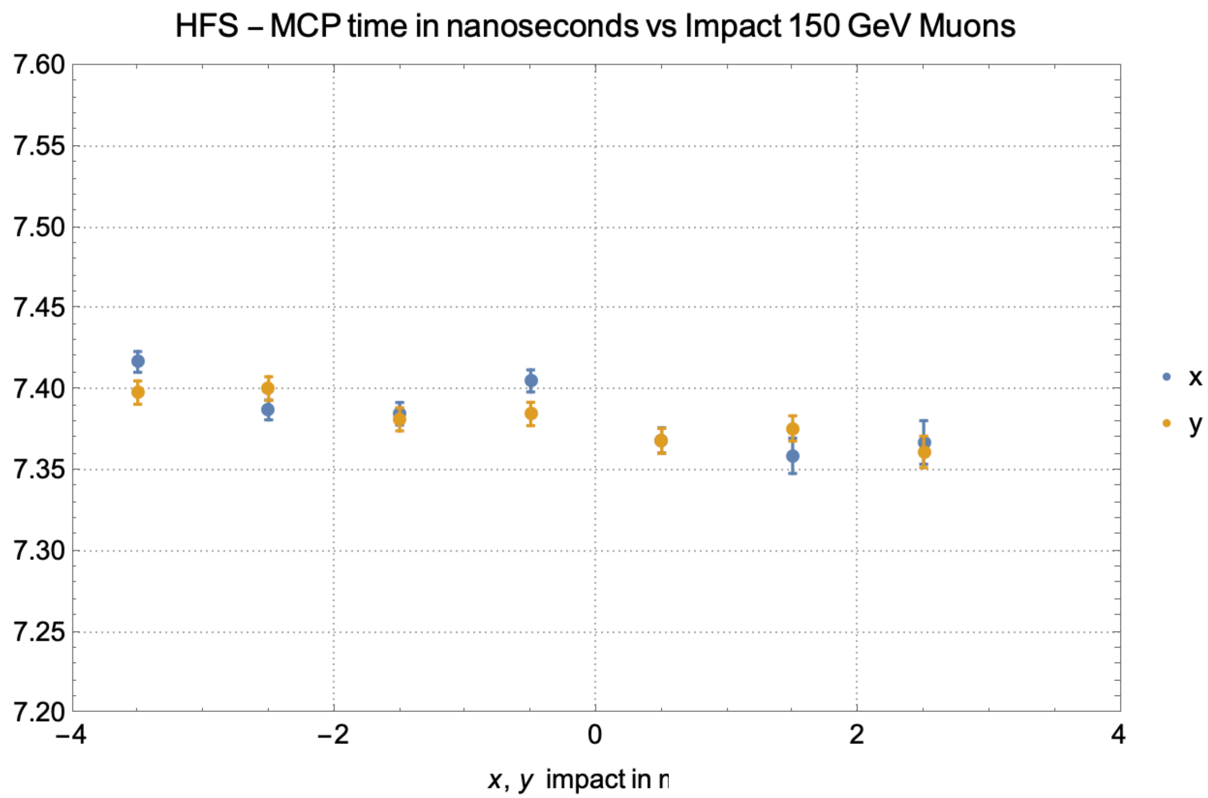


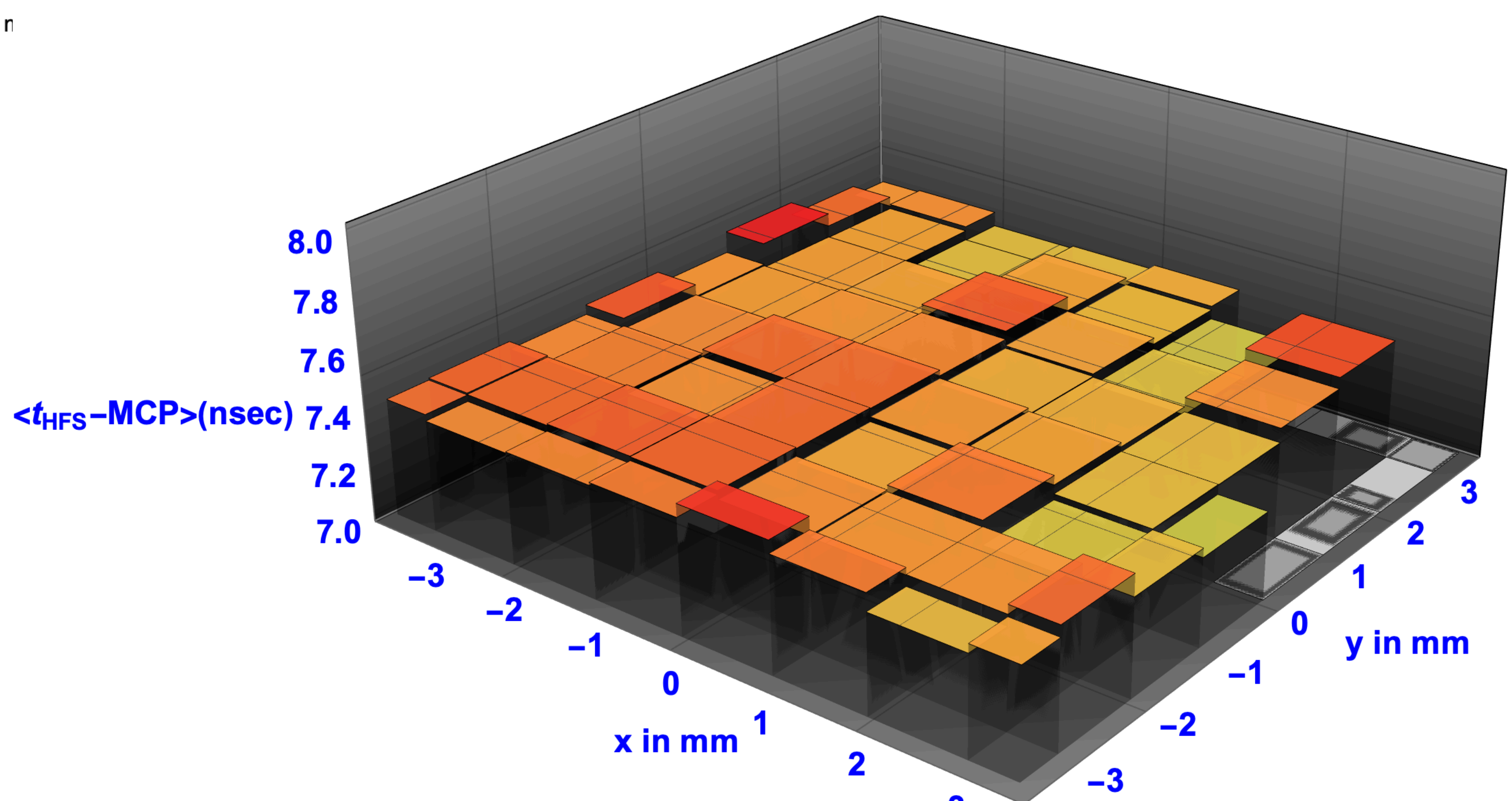
y in mm
2
0
−2
1.0
t_{Rise}(nsec)
0.5
0.0
−2
0
2
x in mm



HFS Risetime in nanoseconds vs Impact
1.0
0.8
0.6
0.4
0.2
0.0
−4
−2
0
2
4
x, y impact in mm
x
y

similarly, the time of arrival (as defined above) shows only small dependence on impact position as shown below:





In the following we present the signal amplitude (ie peak of the fast waveform) dependence on impact position. In general the amplitude (defined as the median of the Landau distribution) shows small variation of the detector active area and a precipitous (within ~200micron fall off at the detector edges (~4.5mm from the center). (the below figure is just a placeholder and I am working on a usable version).

I also propose we include a figure/photo- ie the one used in Matteo RD50 talk- of the HFS/TIA integration.