# Using Timepix for Neutron Measurements at NTOF

Stuart George*[+], 22nd September 2014
*stuart.george@cern.ch*

Fabrizio Murtas*, Anatoly Rosenfeld^, Marco Silari*

*CERN, Geneva, Switzerland
[+]University of Wollongong, NSW, Australia

This research project has been supported by the Marie Curie Initial Training Network Fellowship of the European Community's Seventh Framework Programme under Grant Agreement PITN-GA-4 2011-289198-ARDENT.

# The Timepix - a quick intro

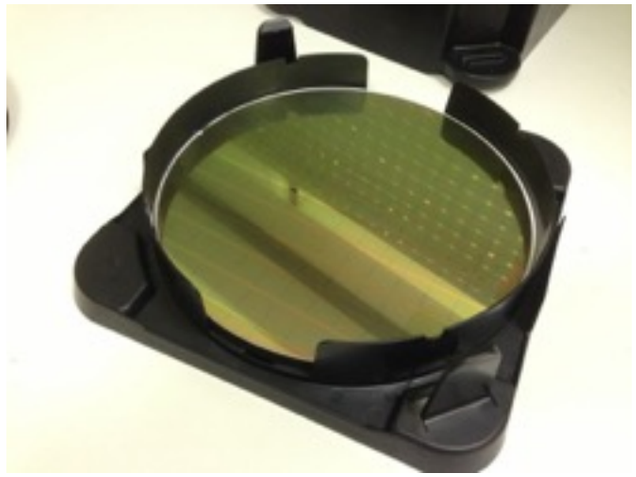
- The timepix consists of 256 x 256 CMOS pixels each measuring 55 x 55 um.

- Each pixel can either measure charge deposited or time of arrival

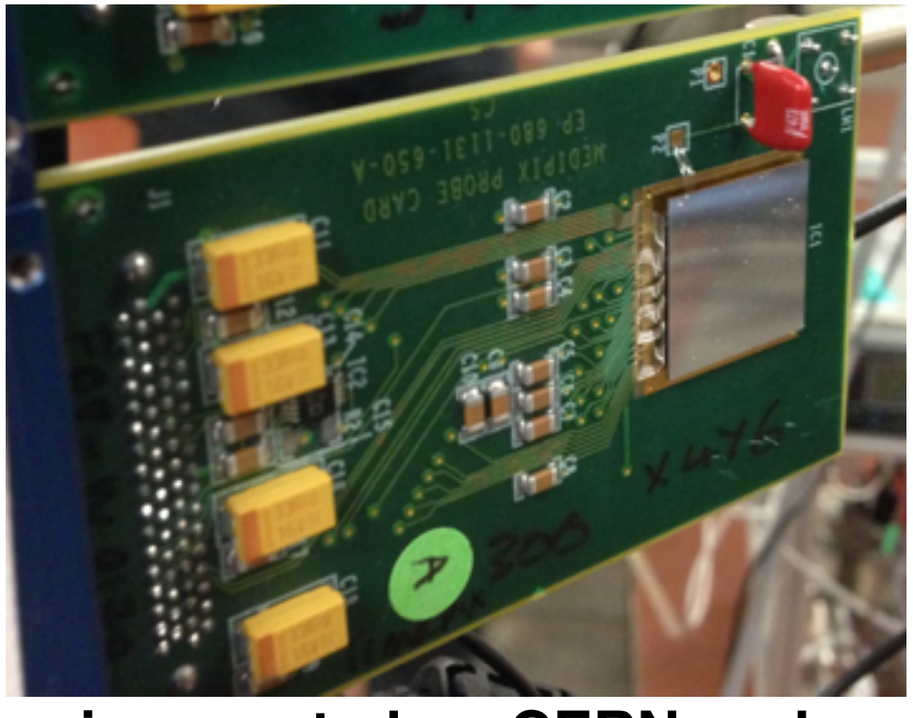
- The detection threshold is about 1000 electrons

- We use a quad configuration of 512x512 pixels for a total of 262144

- ASIC connected to 300 um silicon sensor



**Timepix ASIC Wafer**



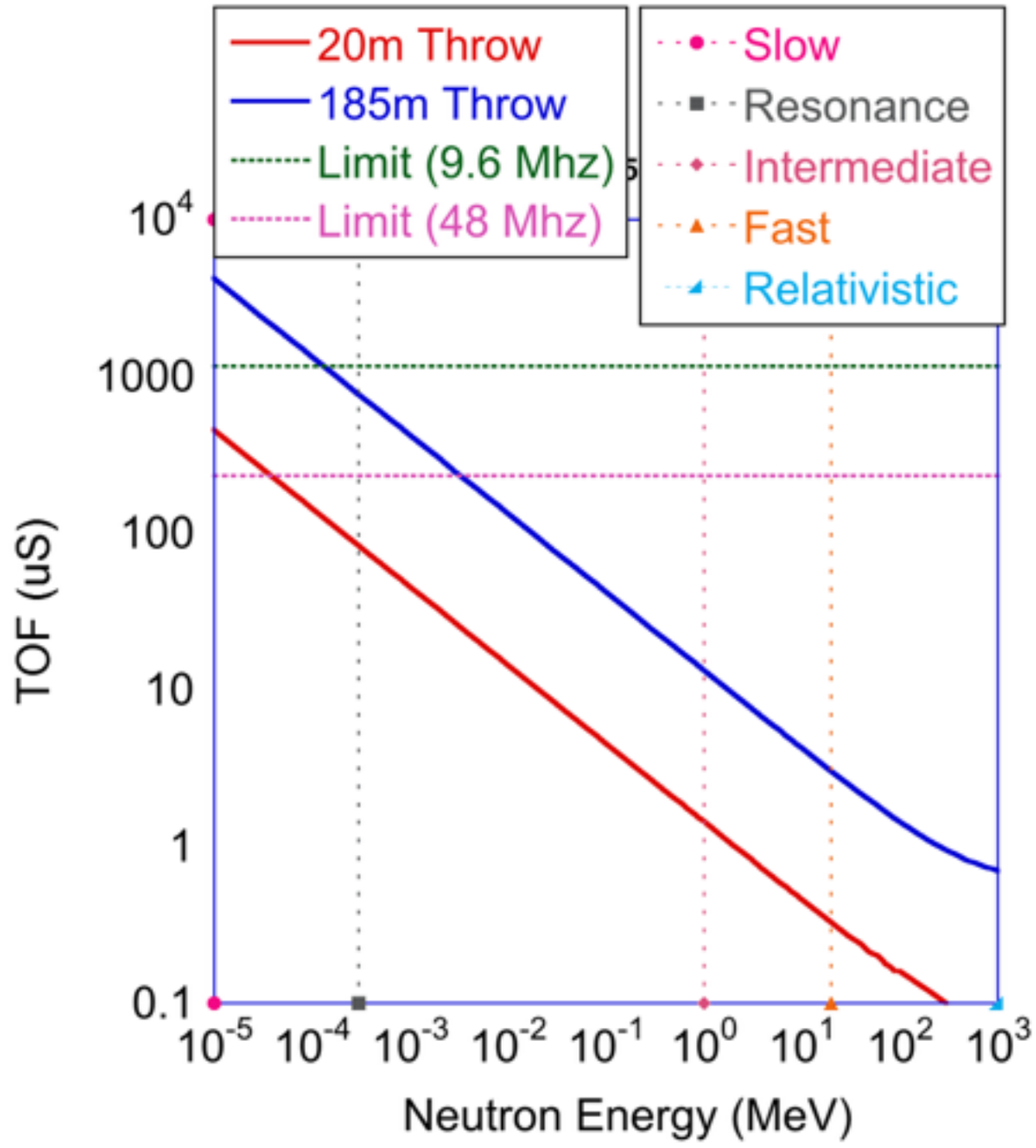
**Timepix mounted on CERN probe card**

# The Timepix - Timing Information

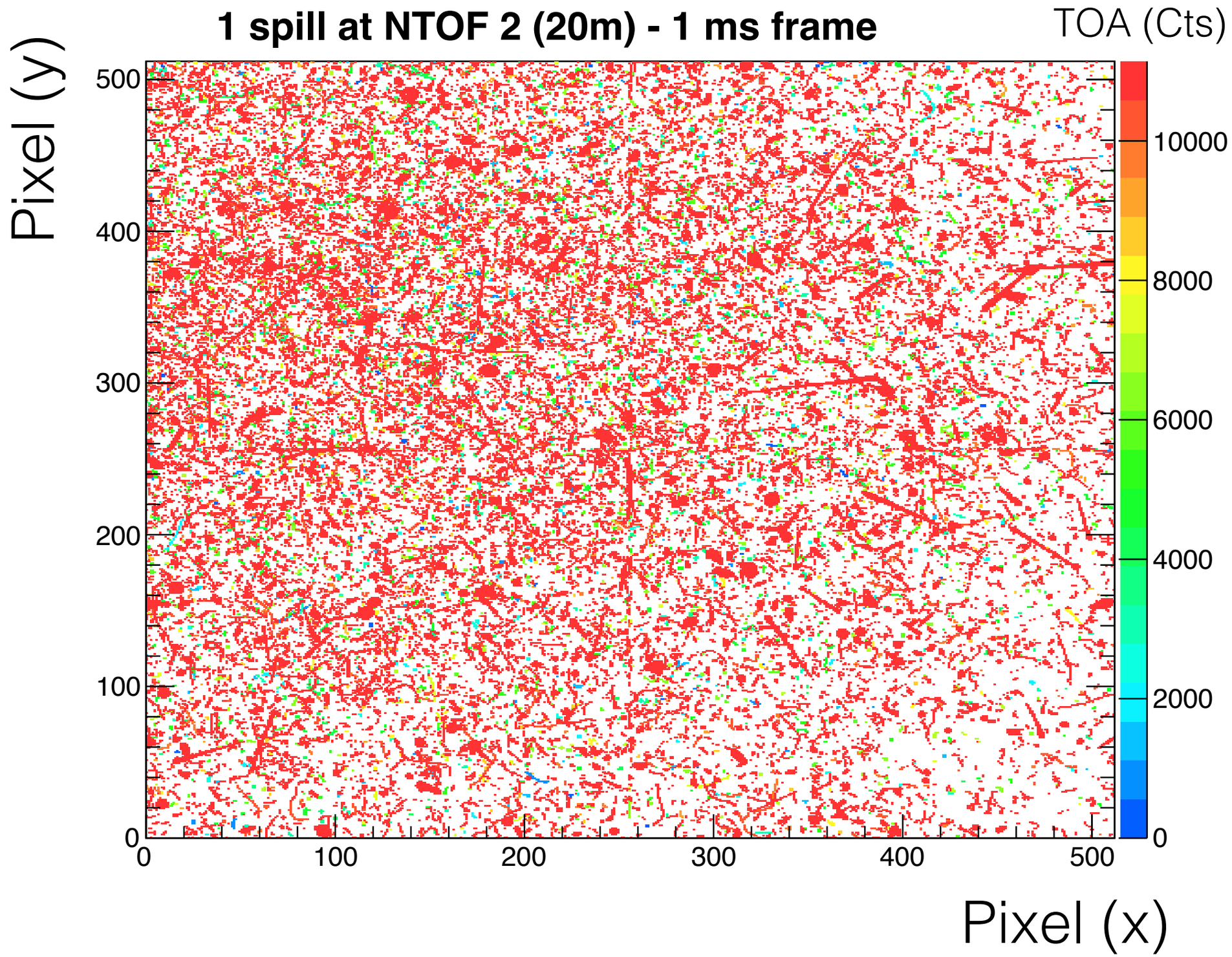
- Clock can run at 1, 10 or 50 Mhz (100 as well, but is unstable) -> 1us, 100ns, 20ns time resolution

- Counter depth is 11810 - places limits on total acq time.

- Readout ~10 mS (**slow**)

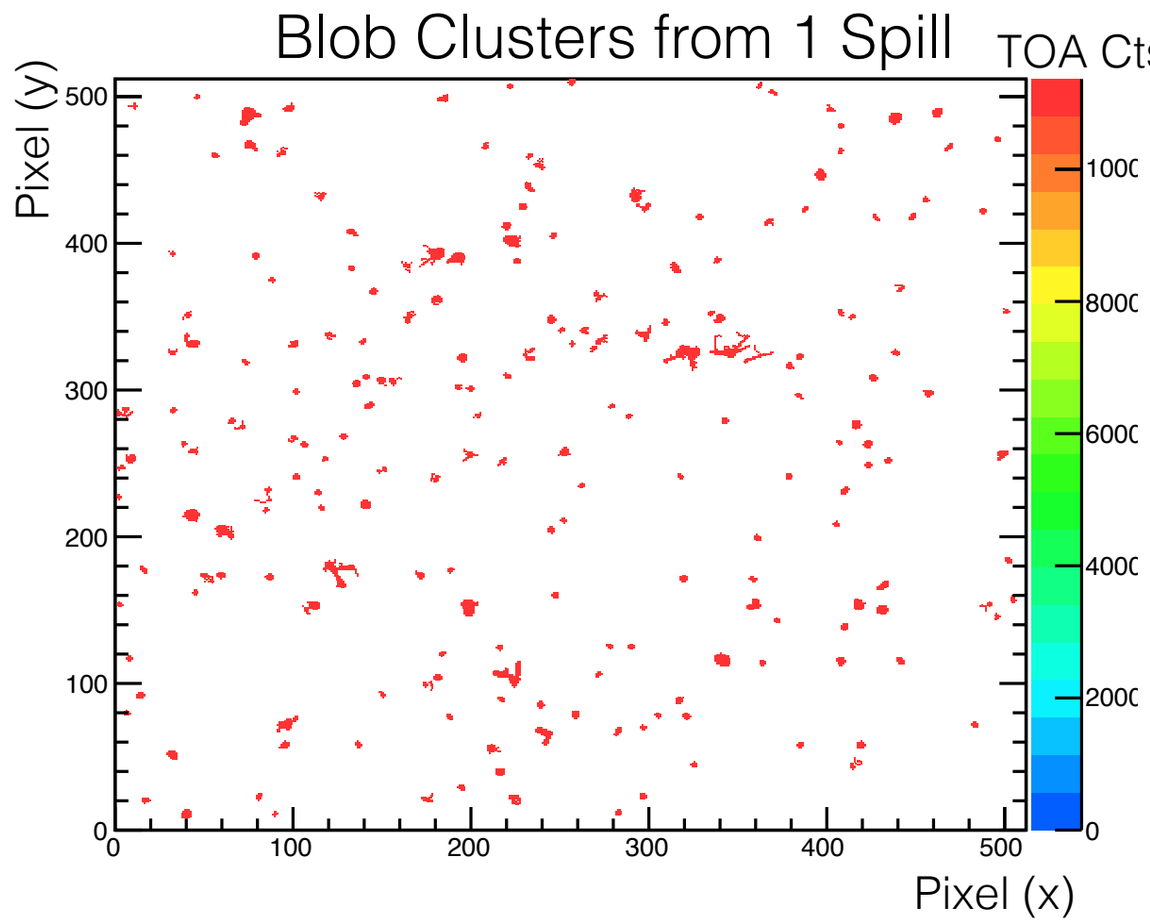


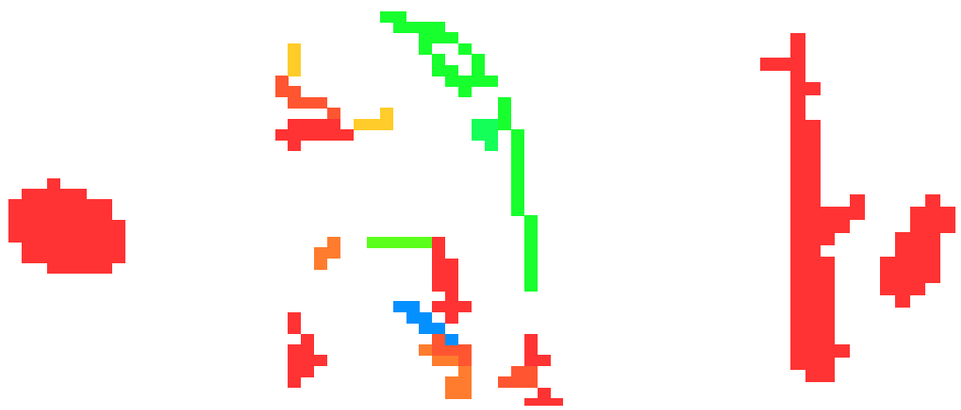
# What do we Measure?



# Particle Signals - Clusters

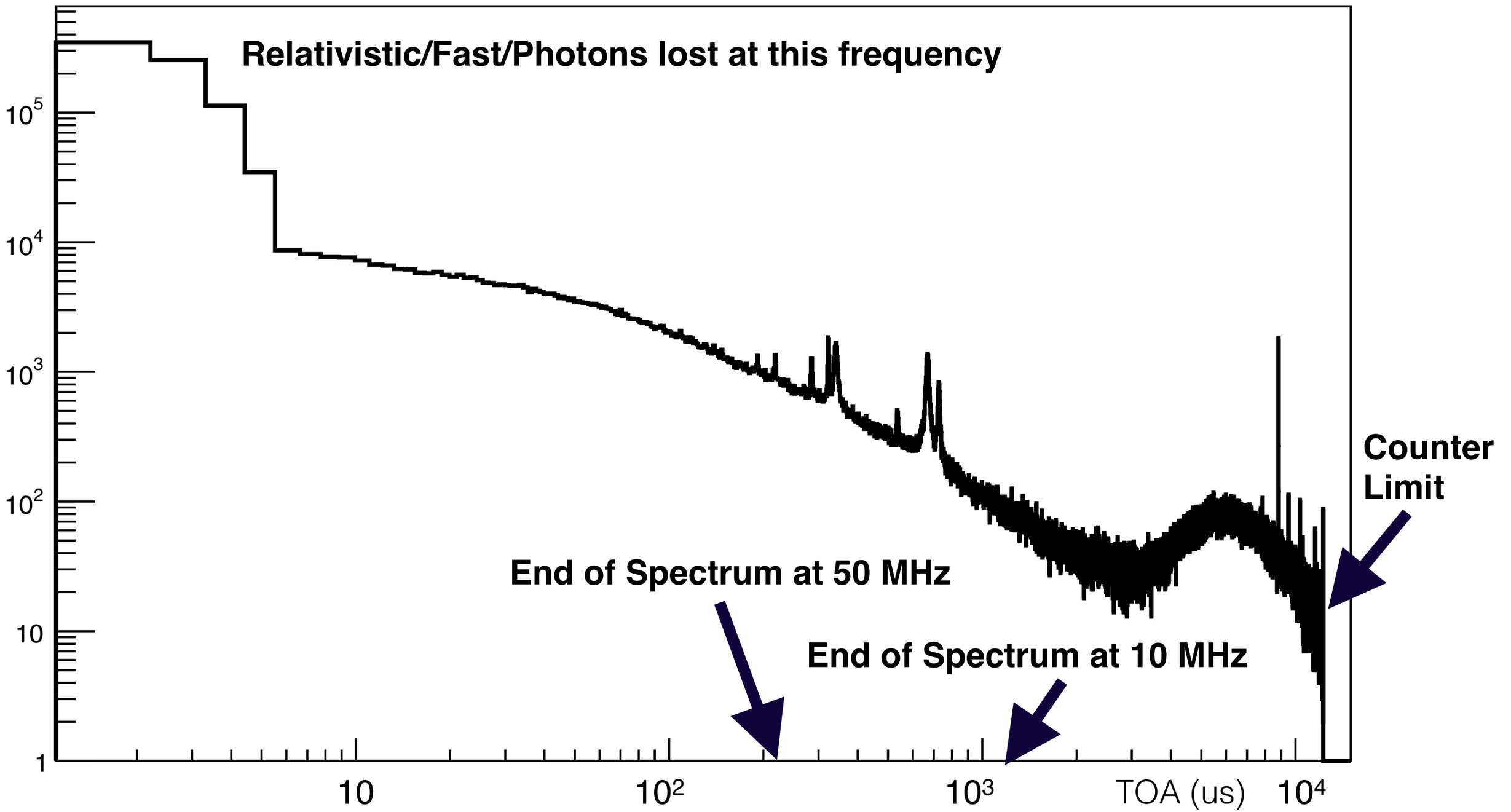
- When particle travels through the sensor it activates a cluster of contiguous pixels
- Signal is convolution of physical track and sensor charge transport
- Clustering done by search for particle contiguous in x,y,TOA



Clusters Sorted By Morphology

# 0.90 MHz TOA Spectrum

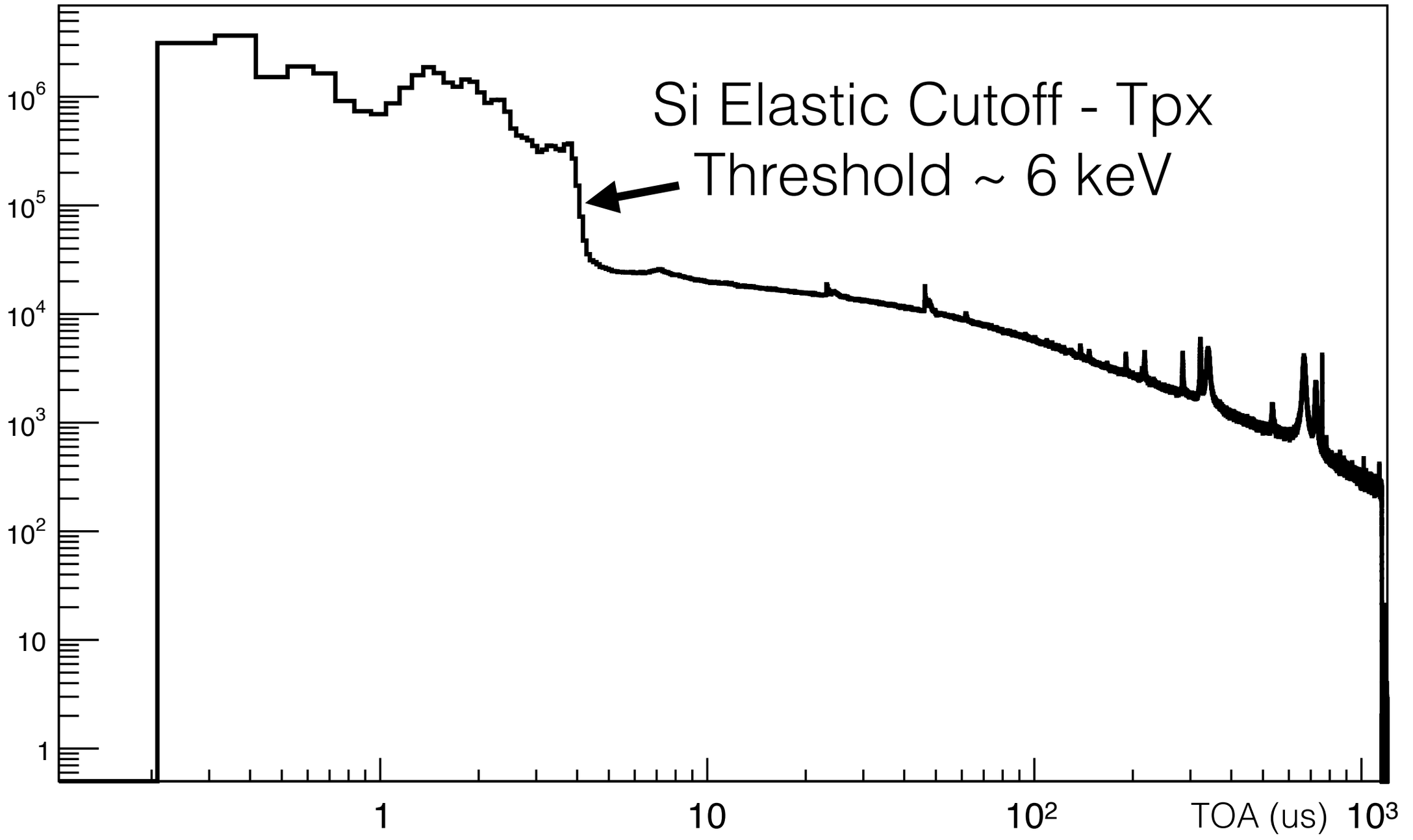



20 keV 200 eV 2 eV 0.02 eV

~100 spills (5 mins), timepix with boron + plastic converter

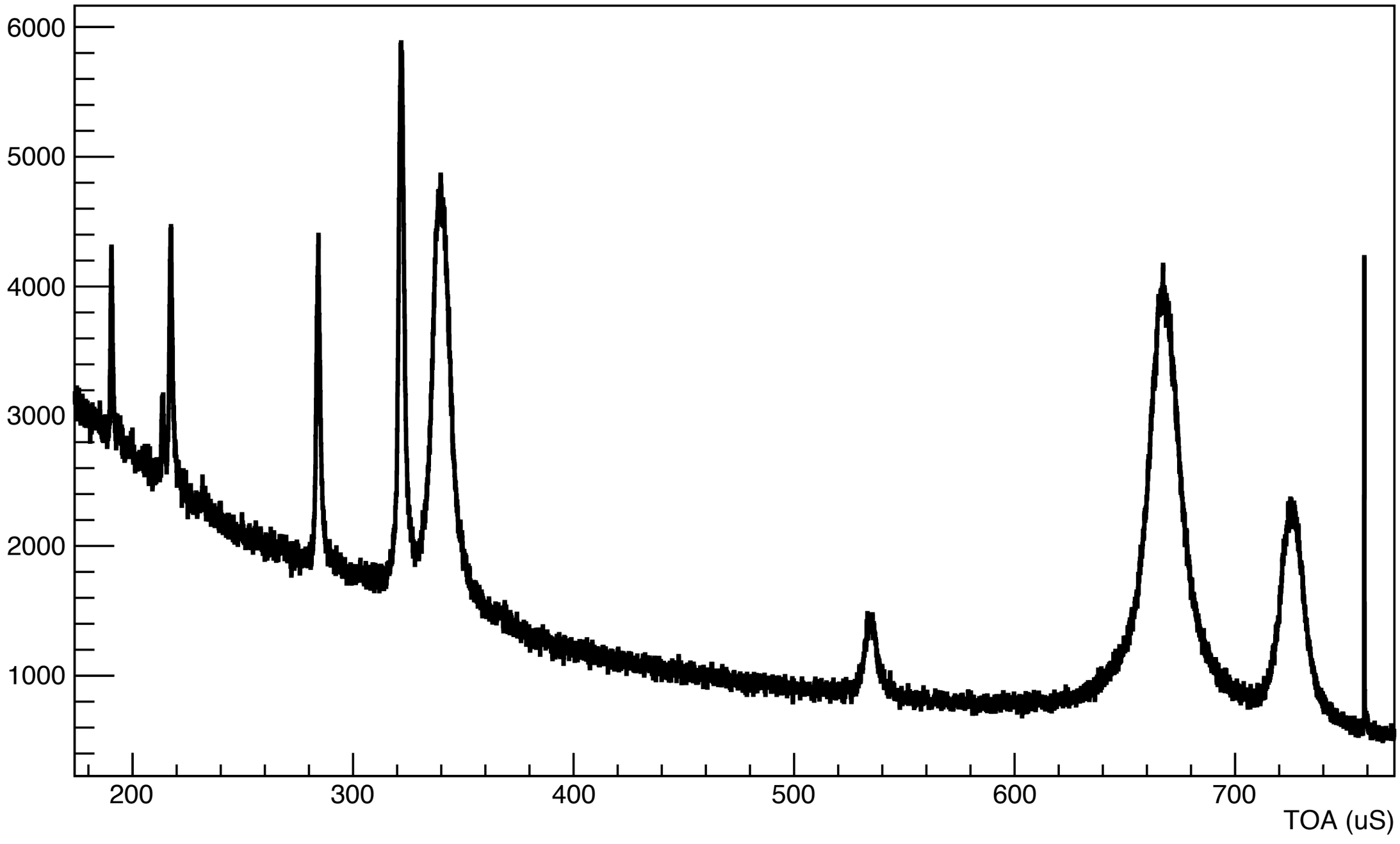
# 9.6 MHz TOA Spectrum

**Text**



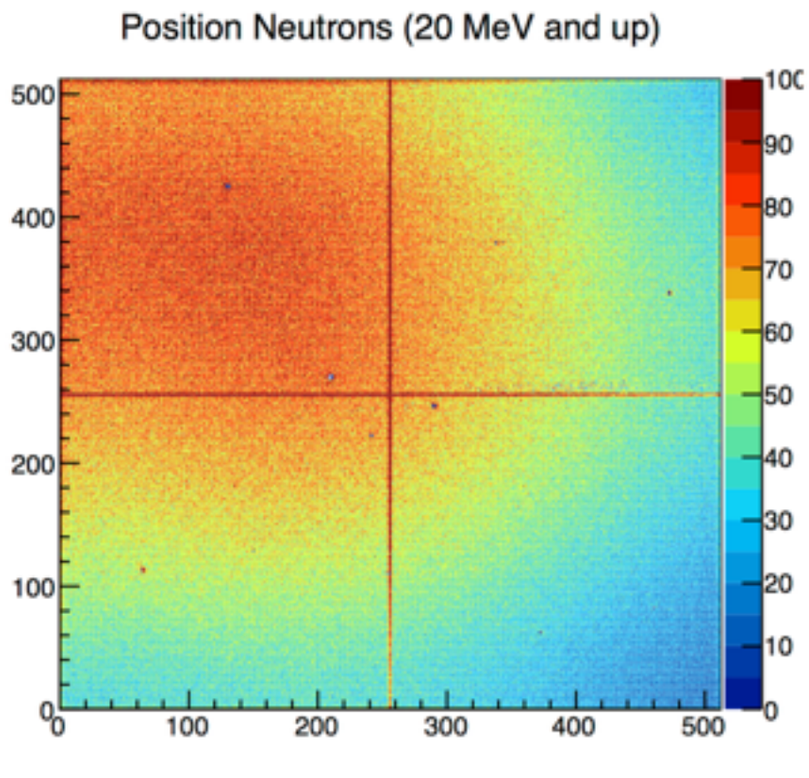

~3000 spills (~ 5 hrs), timepix with boron + plastic converter

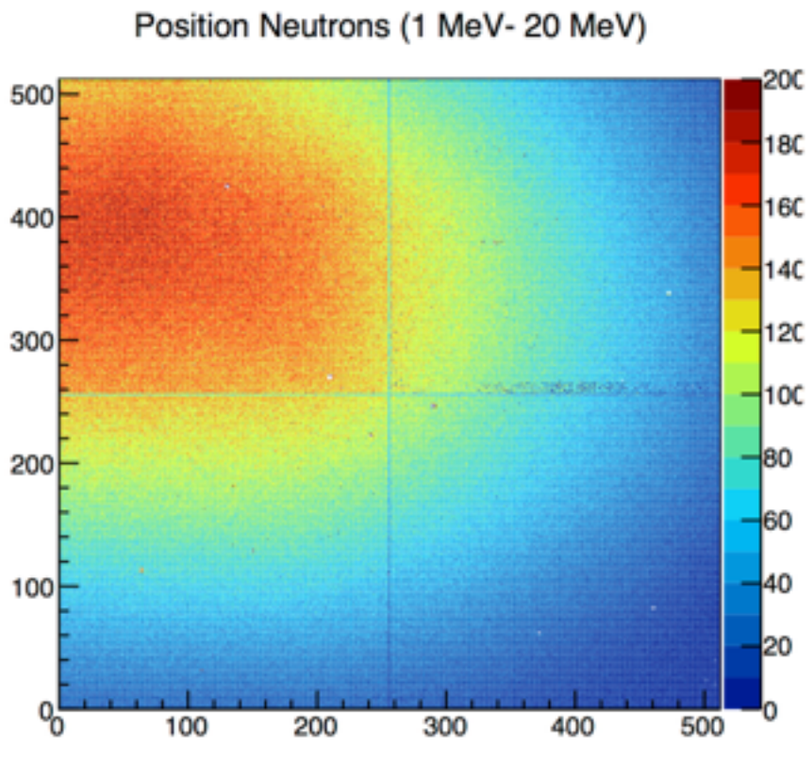
# 9.6 MHz TOA Spectrum

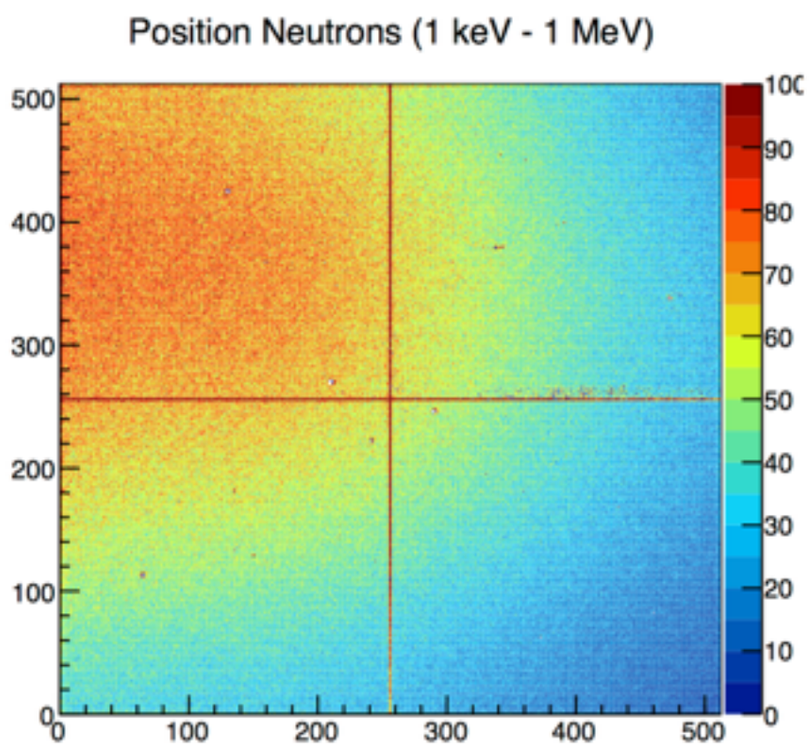


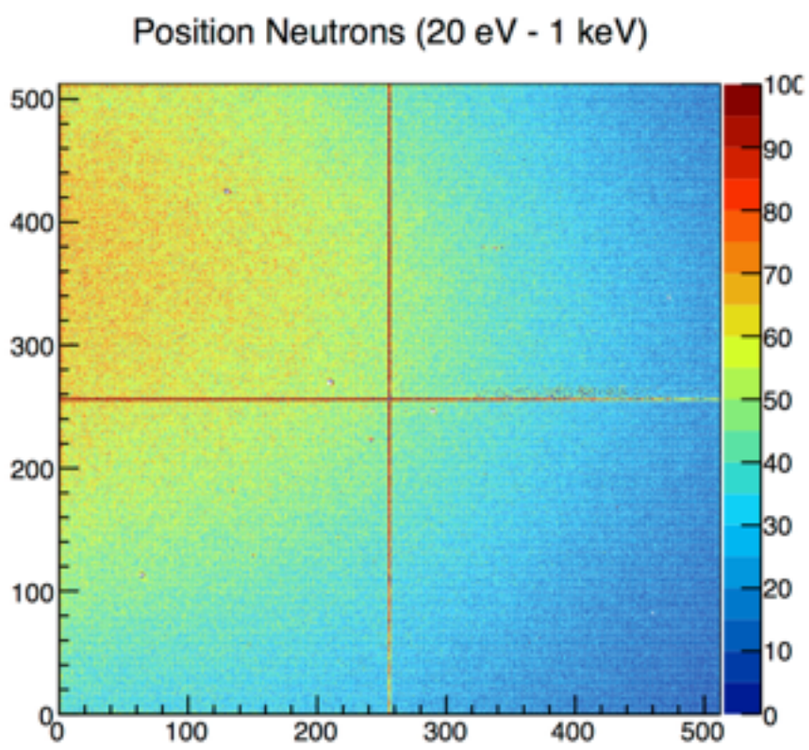

~50 eV ~8 eV ~4 eV

# Beam Spot - NTOF 2

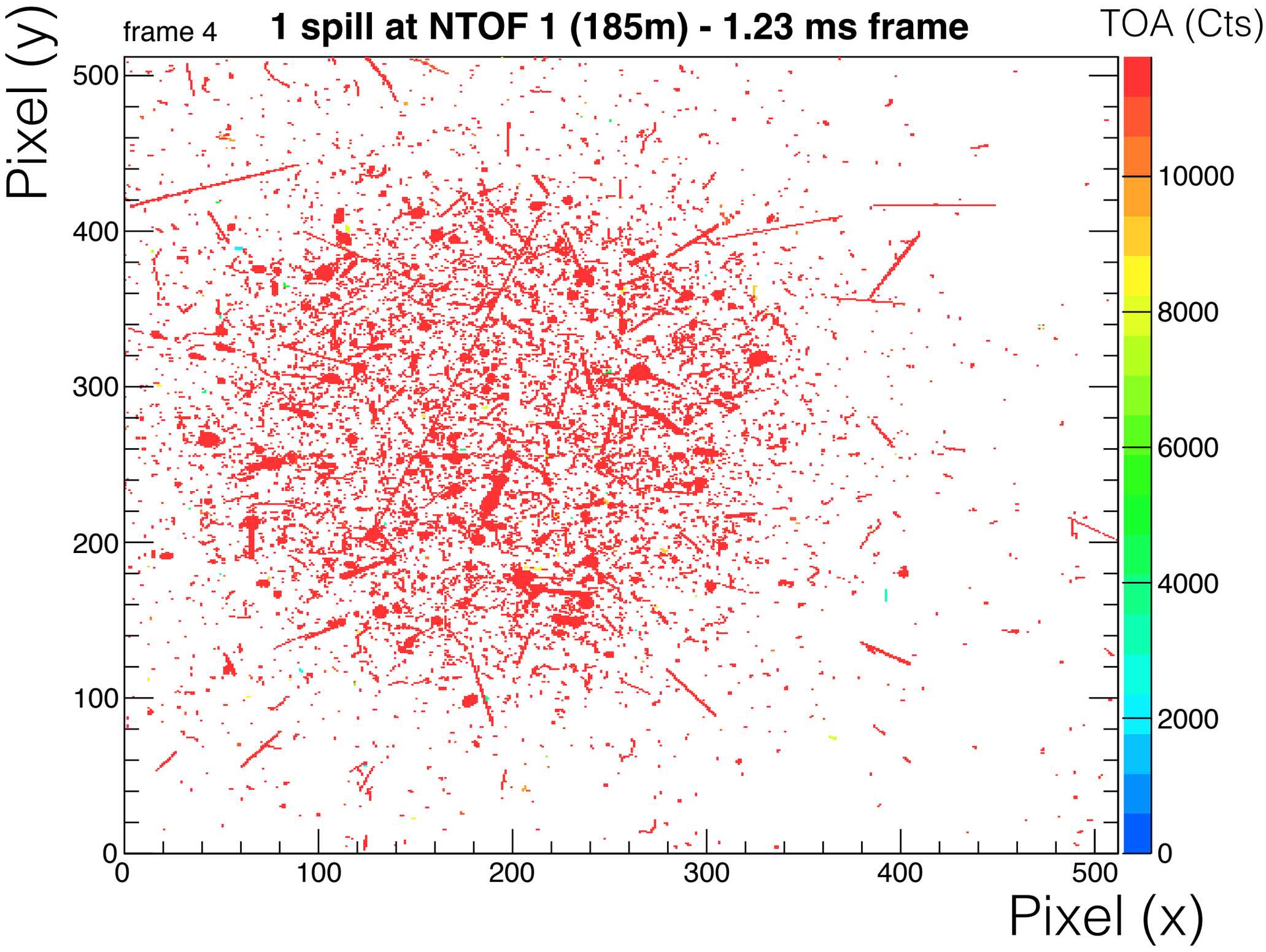


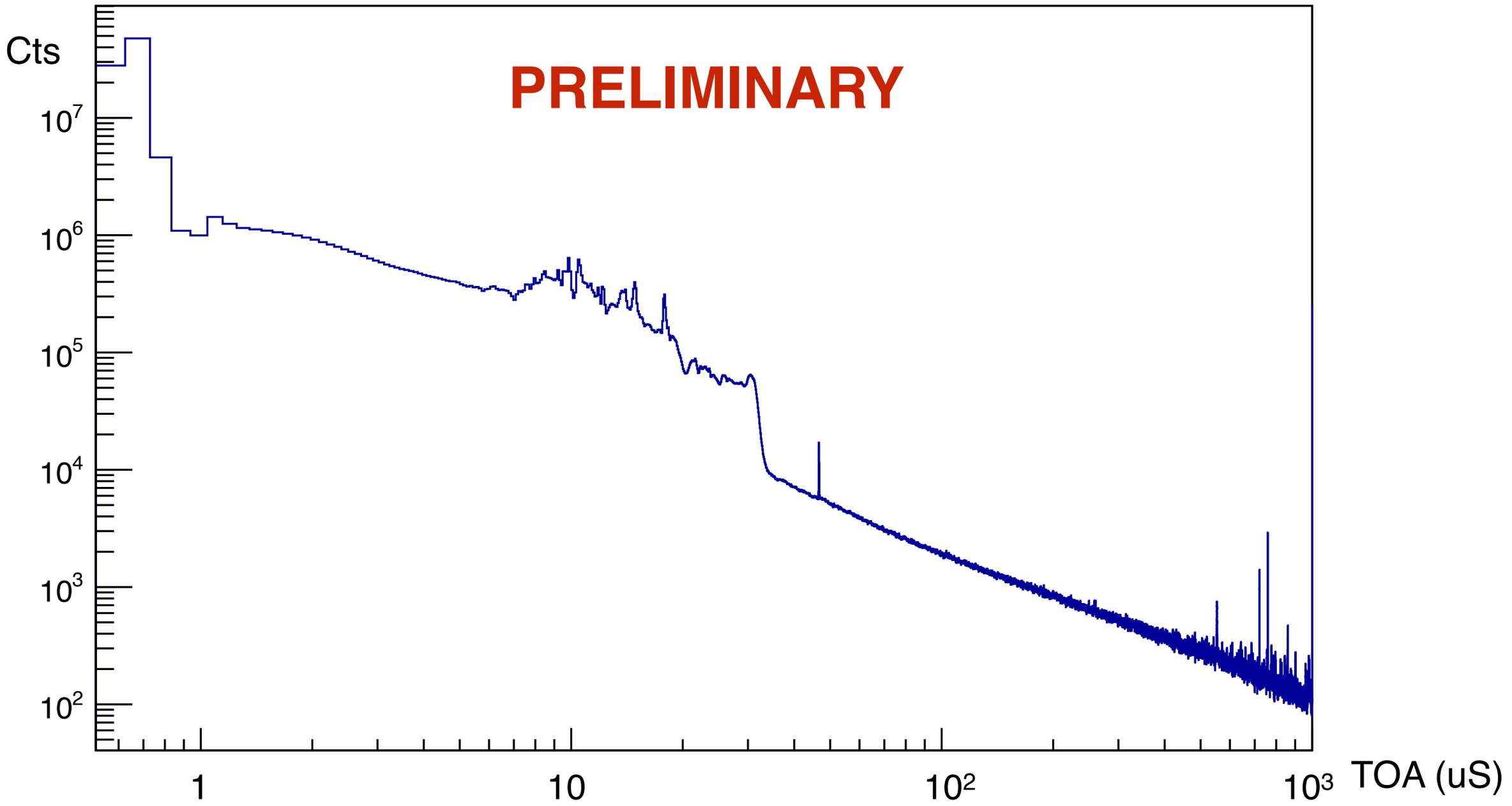



# Measurements NTOF 1



# Measurements NTOF 1

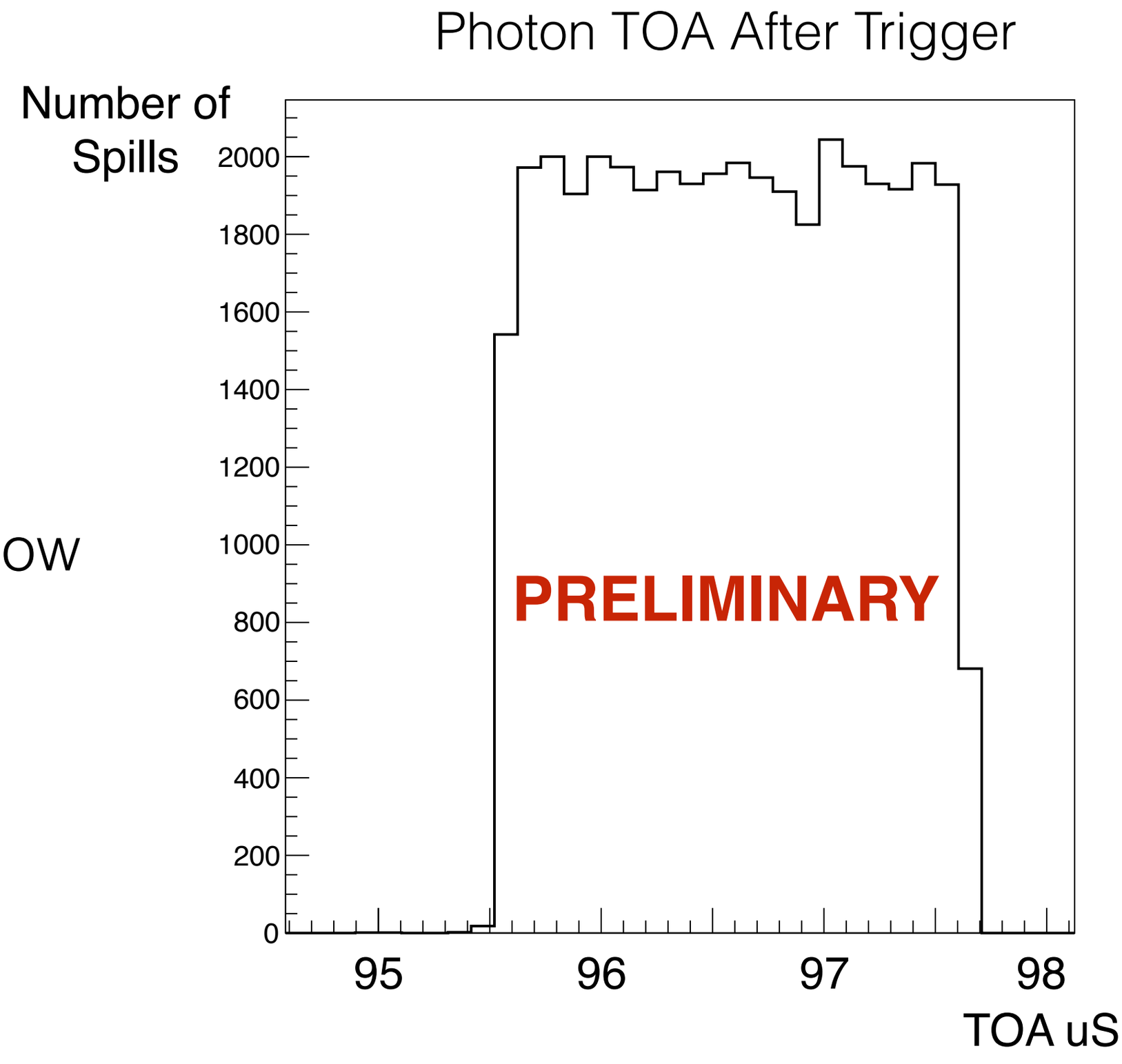
TOF Spectrum - NTOF 1 (185 m) - 9.6 Mhz Clock
Silicon sensor (.3mm) + Boron on Plastic Converter

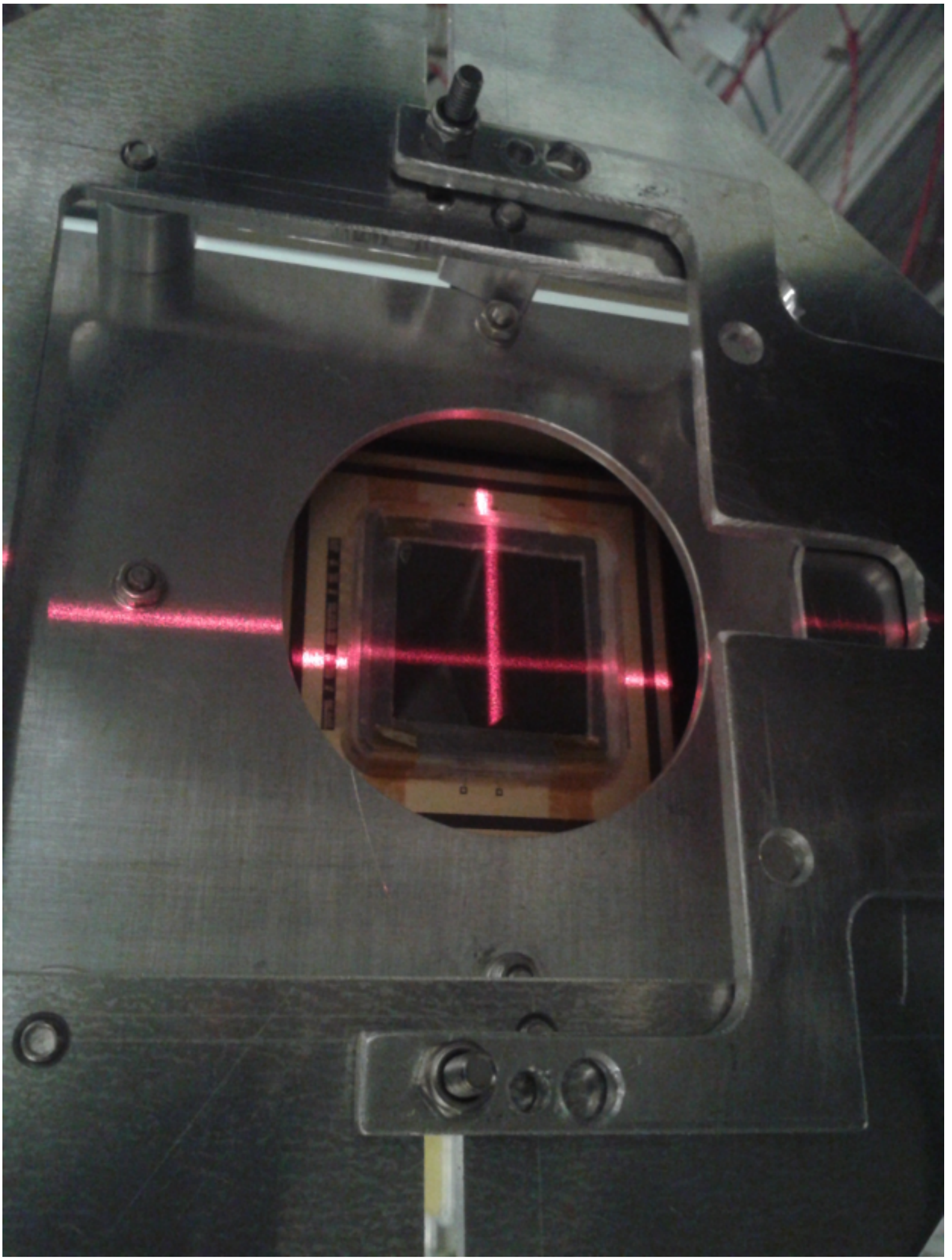



~200 MeV ~2 MeV ~20 keV ~200 eV

# NTOF 1 Trigger Jitter

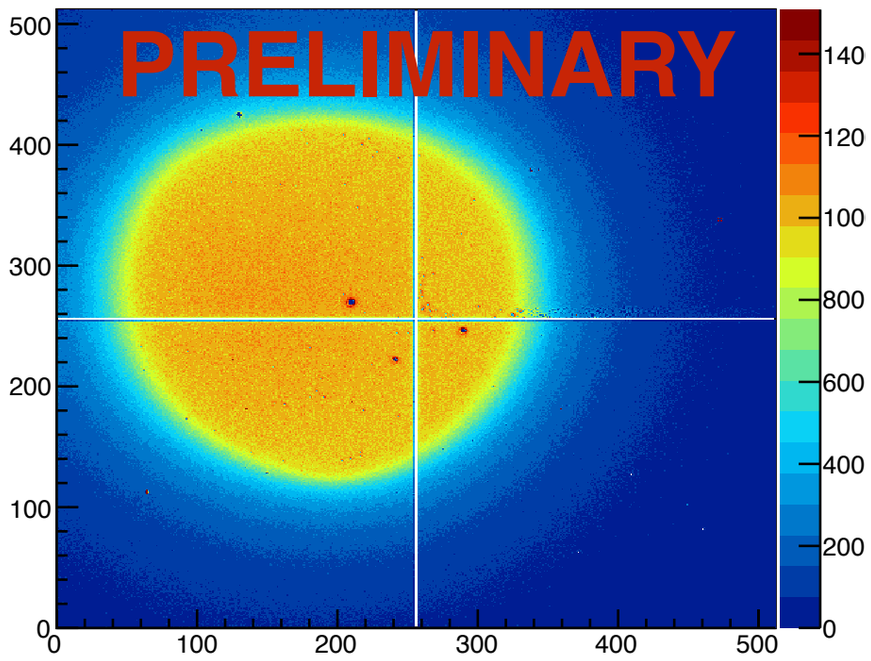
- Search for first photons in each frame
- 100 nS time window



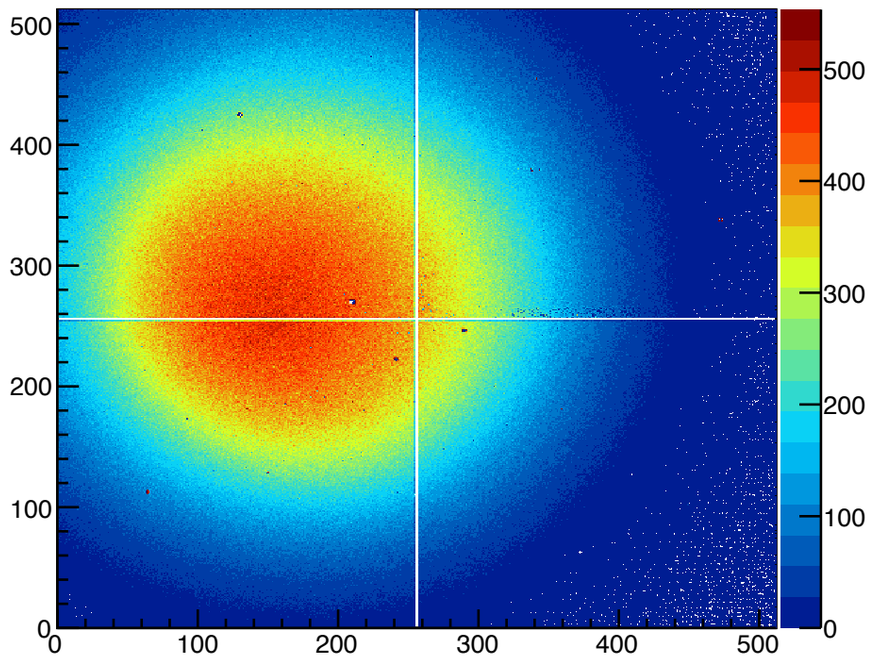


# Beam Profiles - NTOF 1

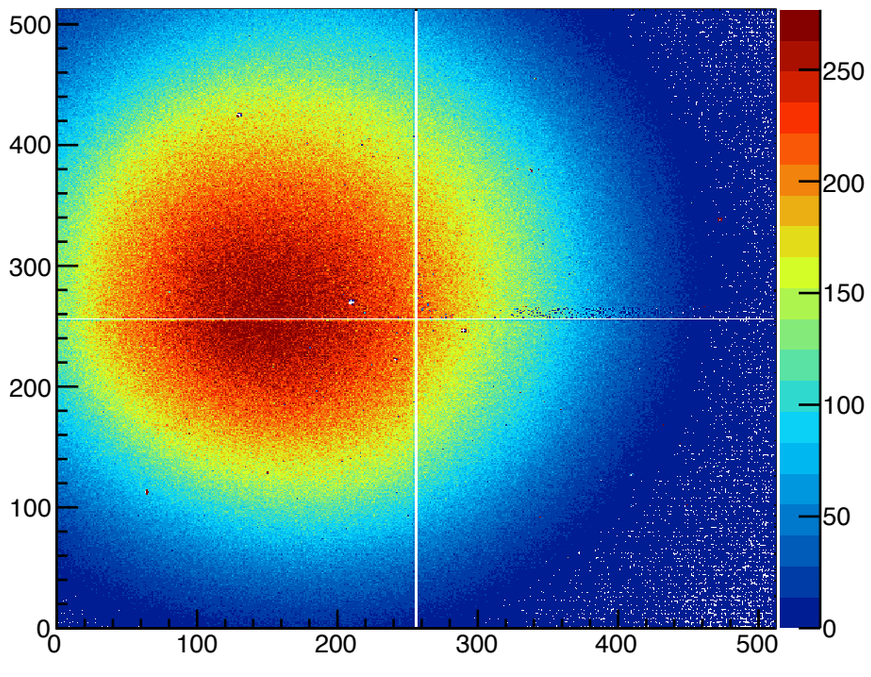
Position Neutrons (20 MeV and up)



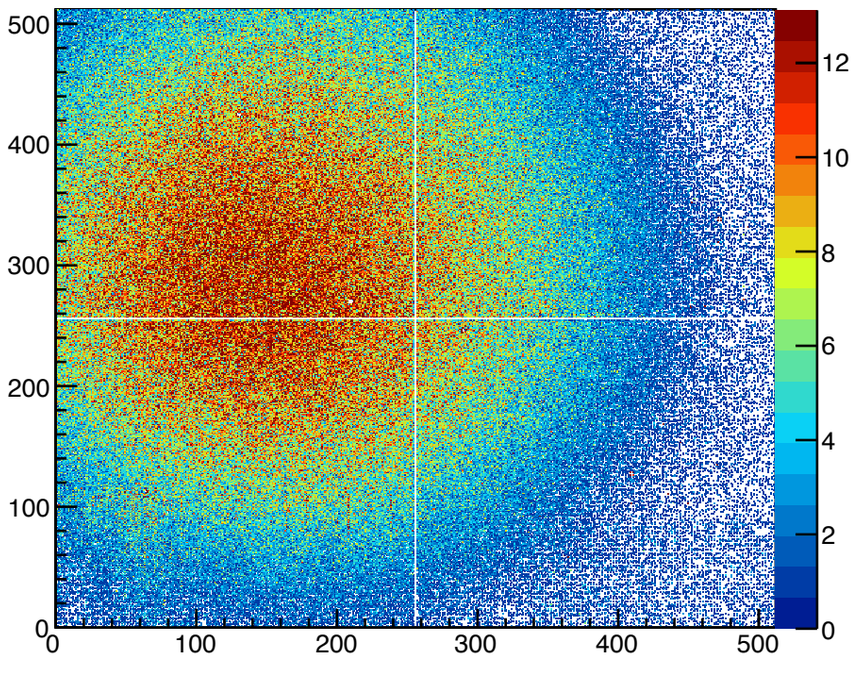

Position Neutrons (1 MeV- 20 MeV)



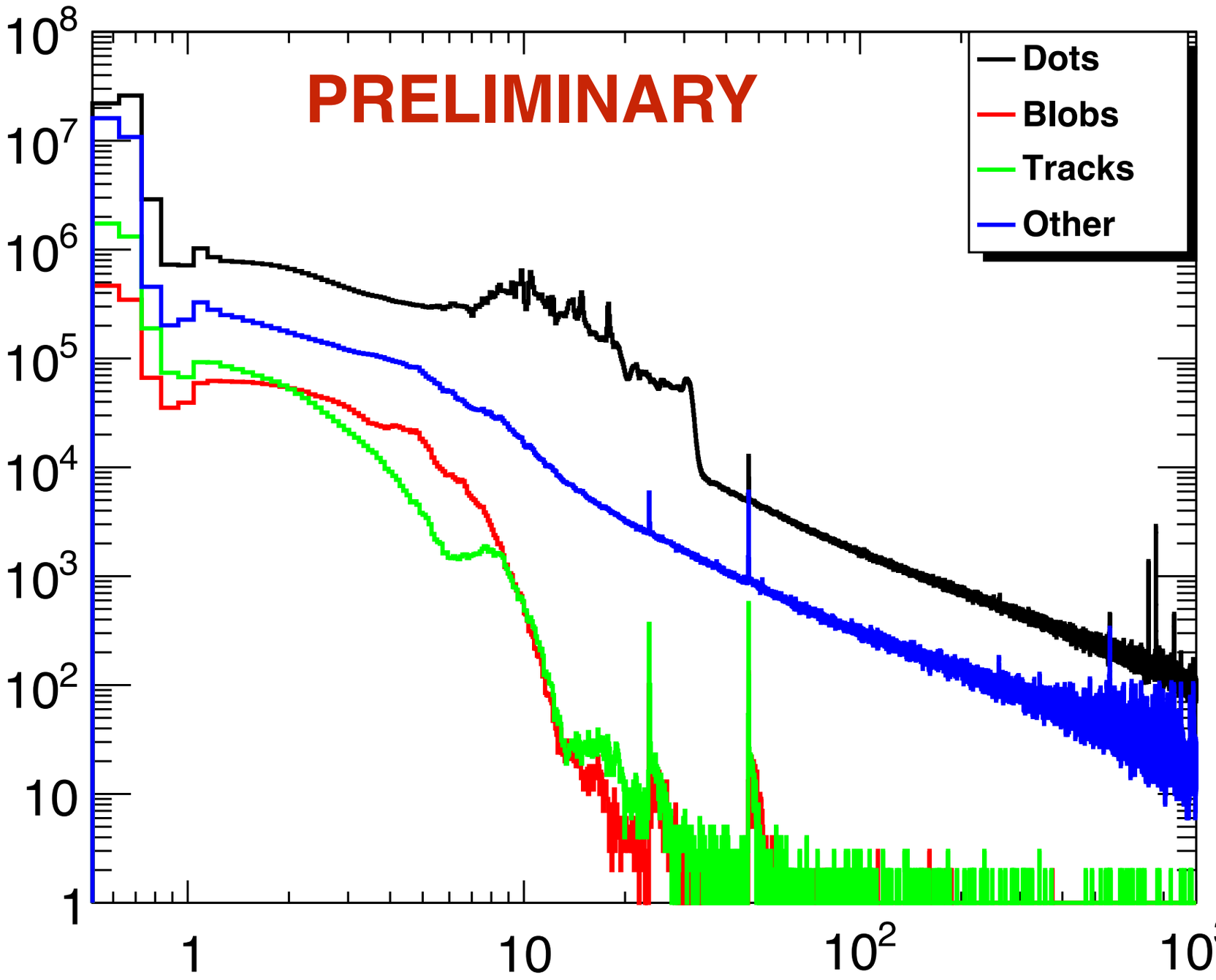

Position Neutrons (1 keV - 1 MeV)




Position Neutrons (20 eV - 1 keV)



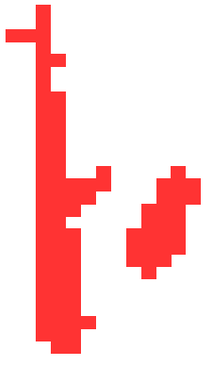
# Clustering Results



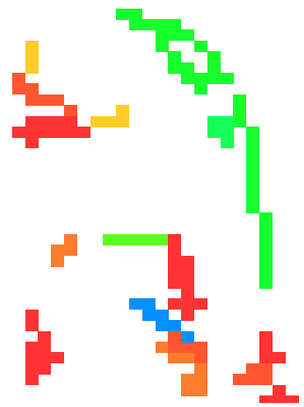

Dots

Blobs

Tracks



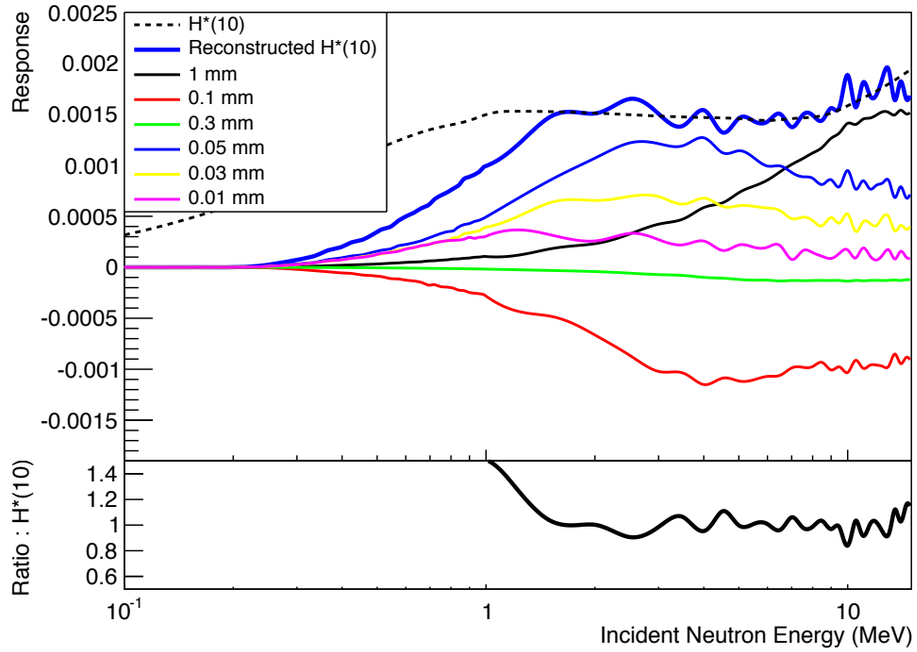
Other

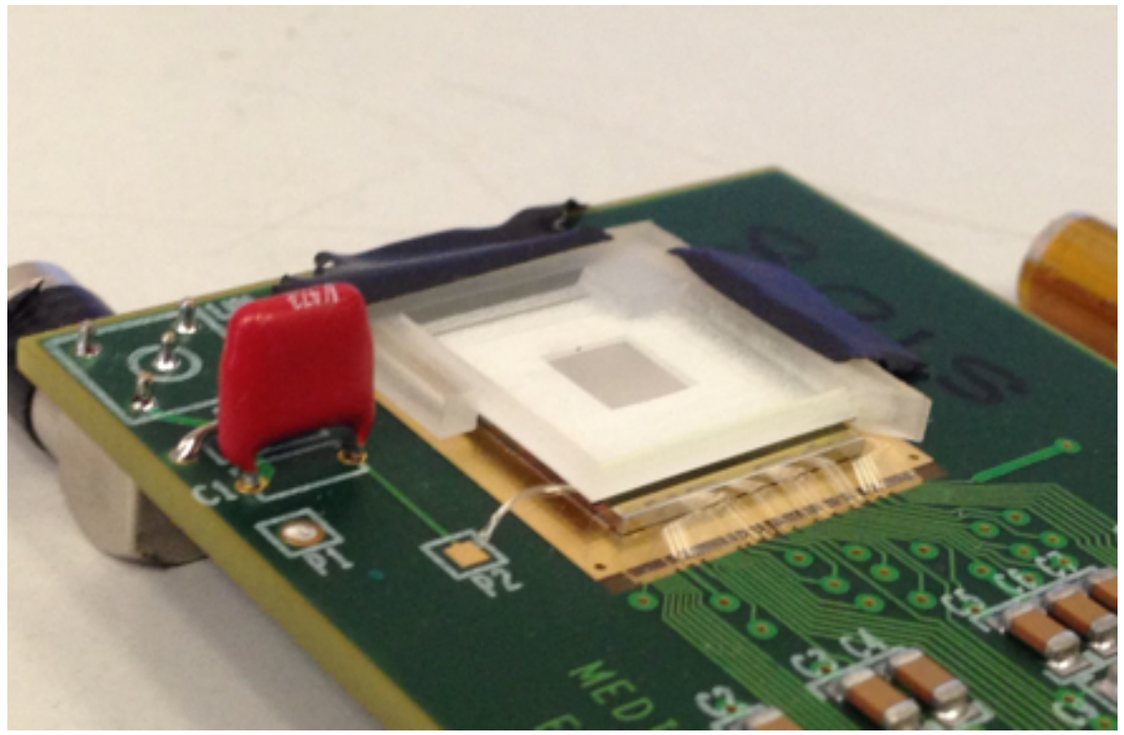


# Our Research Application

- Multilayer plastic converters should be able to provide an energy independent response for fast neutron dosimitery

- Experimental evaluation of 3d printed prototypes over fast energy range



# Technology Limitations and the Future (Final Slide)

- Timepix -> Frame based readout (~1000 fps with new systems, 100 typical), clock unto 100 MHz (10, 50 more used), counter depth = 11.5 bits

- Timepix 3 (first chips May 2013, sensor/readout supply limited) -> Data driven readout (*85 MHits/sec*), simultaneous TOT/TOA (1.5 nS resolution), 24 bit counters

- Timepix 2 (design phase) -> Many of the bug fixes and advantages from Tpx3, frame driven readout, 24 bit counters