

# ITkPixV1.1 self trigger source scan

Angira Rastogi, Simone Pagan Griso, Timon Heim

Weekly Instrumentation Meeting

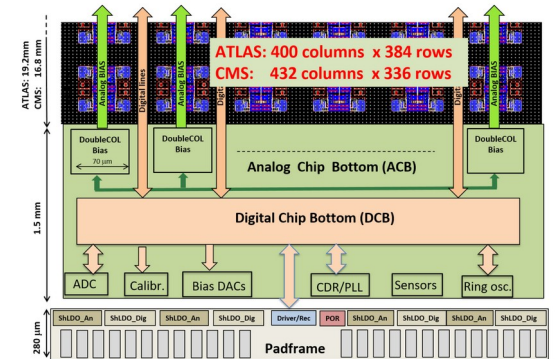
July 8, 2022



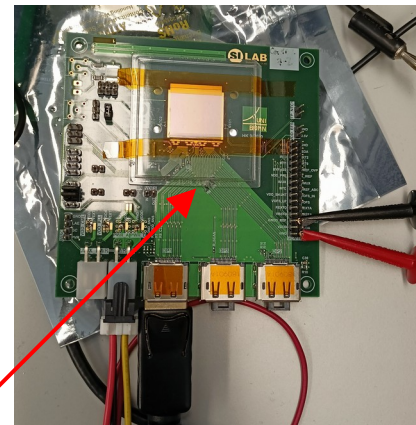
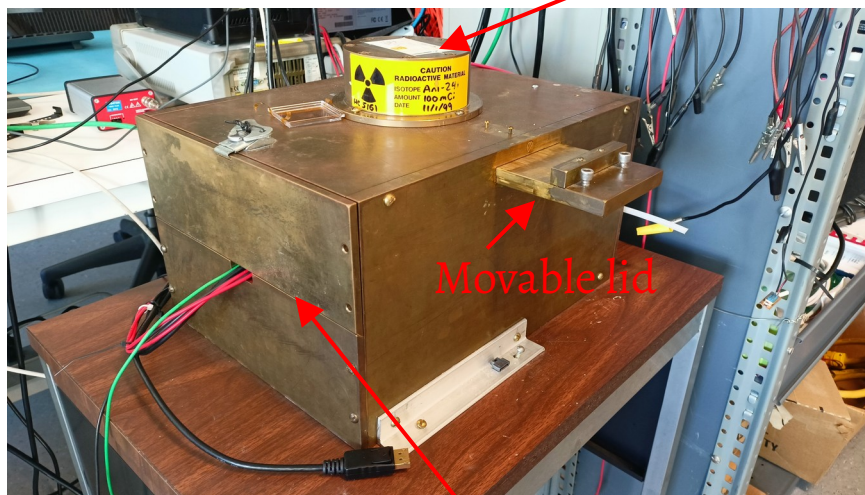
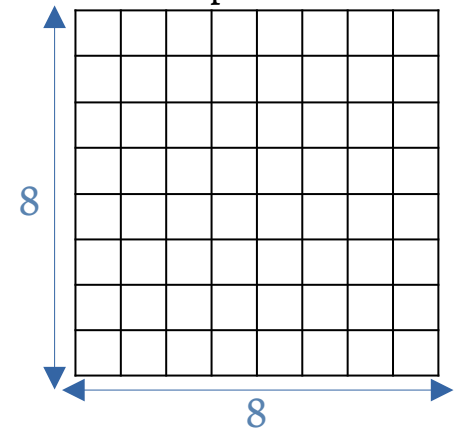
# Introduction

Goal: Irradiating the ITkPixV1.1 chip with Americium-241 and performing the readout (**source scan**).

- Readout from chip happens at a clock/trigger which can be applied externally or internally at a hit instance (**self-triggering**).



8x8 pixel core.

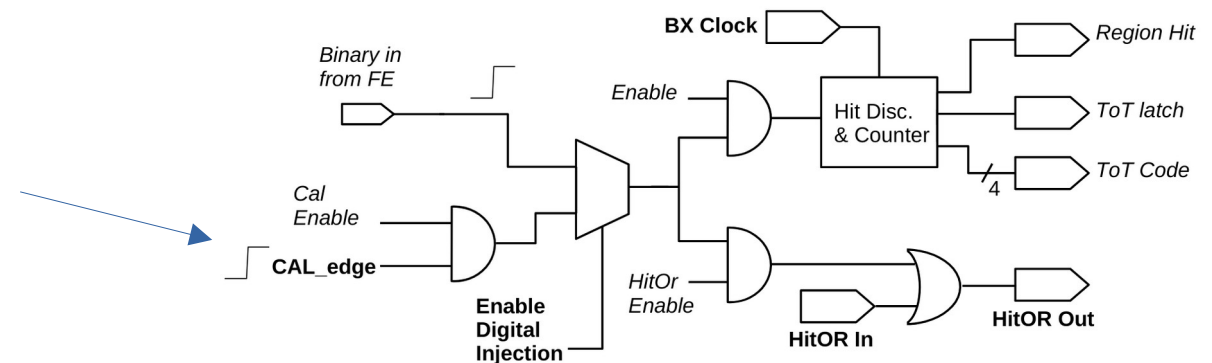


Single chip module inside

# Masking the noisy pixels

- Various sensor capacitors leads to electronic noise in the pixels.
- As a result, the 'noisy' pixels continuously fire becoming 'stuck', and the self-triggering hit logic fails as it is looking for an edge-trigger and not continuous high-level.

Edge trigger for hit processing.

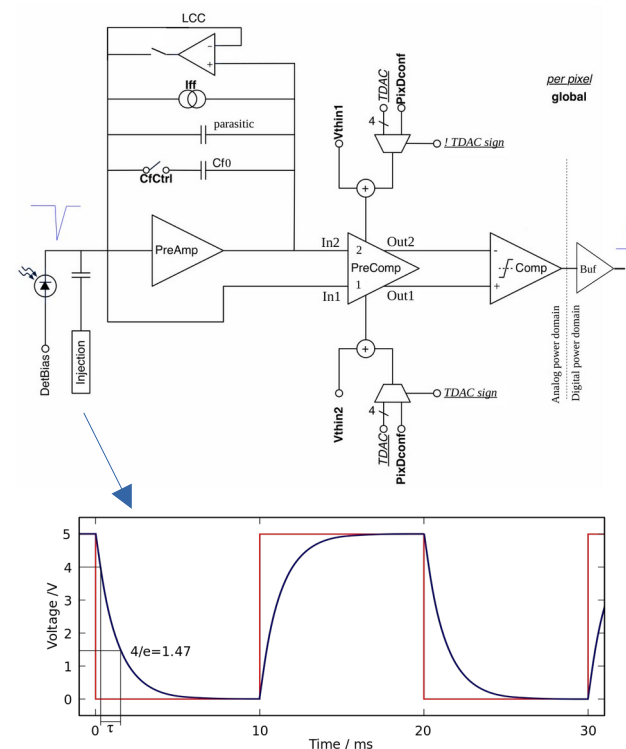


Hence, these pixels needs to be disabled (or masked) from the data-taking operation.

- Various ways of masking the noisy pixels (through external or self trigger):
  - Noise scan
  - Digital scan
  - Analog scan

# Self trigger analog scan

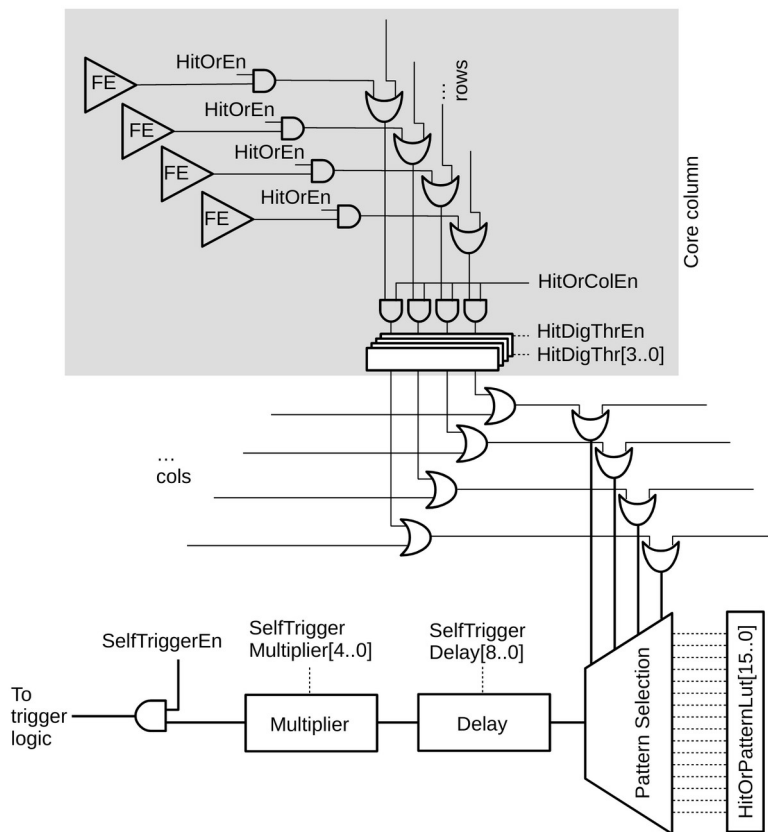
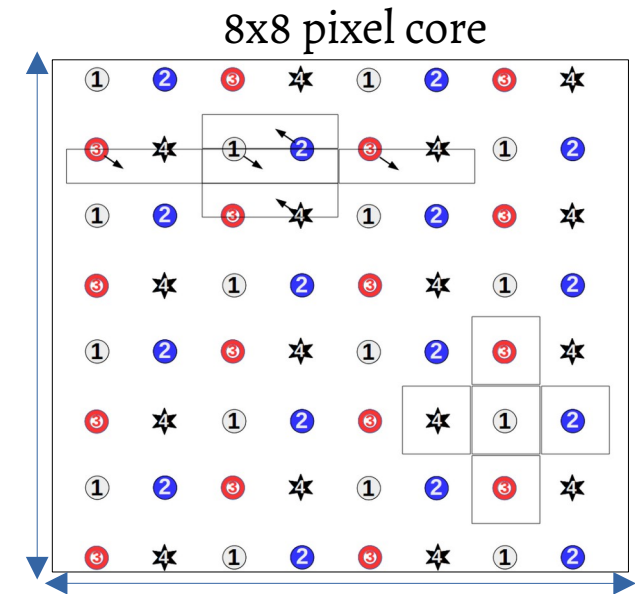
- Performed prior to source scan to set desired pixel mask pattern, disabling the 'dead' and 'noisy' pixels (charge injection  $\neq$  readout).
  - **\*Caveat:** Self-trigger hit logic had the shortcoming of counting each injection twice, once when signal is received (after discharging of the injection capacitor) and then again at the rising edge of charging (as another trigger edge).
  - This resulted in almost all the pixels being masked, since charge injected  $\neq$  hit occupancy.



- **Fix:** Modified the logic to allow hit occupancy per pixel between (injection-10, 2\*injection+10) for qualifying the pixels as 'working'.
  - Will be pushed to YARR git

# HitOR logic

- Within each core column, there are four independent HitOR nets, each one fed by one quarter of the pixels.
- Each net forms the logical OR of all individual pixel outputs that have been enabled by the HitOR mask bit (one bit per pixel).










## HitOR network in a pixel core (4 lanes)

Defines a 16-bit global register: **HitORPatternLUT**

- HitORPatternLUT = 65534 represents OR of all the lanes.
- HitORPatternLUT = 2,4,8,16 enables only one HitOR lane at a time.

# Summary of results

Pixel Mask →	1 pixel/core	2 pixels/core	4 pixels/core	16 pixels/core	32 pixels/core (even)	32 pixels/core (odd)	64 pixels/core
Analog scan							
Source scan	Works	Works	Works	Works	Works	Failed. (HitORPatternLUT =2,4,8,16,65535) (HitORMasks_o/1/2/3 = o/o/o/o and also one CoreCol at a time)	Failed. (HitORPatternLUT =2,4,8,16,65535) (HitORMasks_o/1/2/3 = o/o/o/o and also one CoreCol at a time)

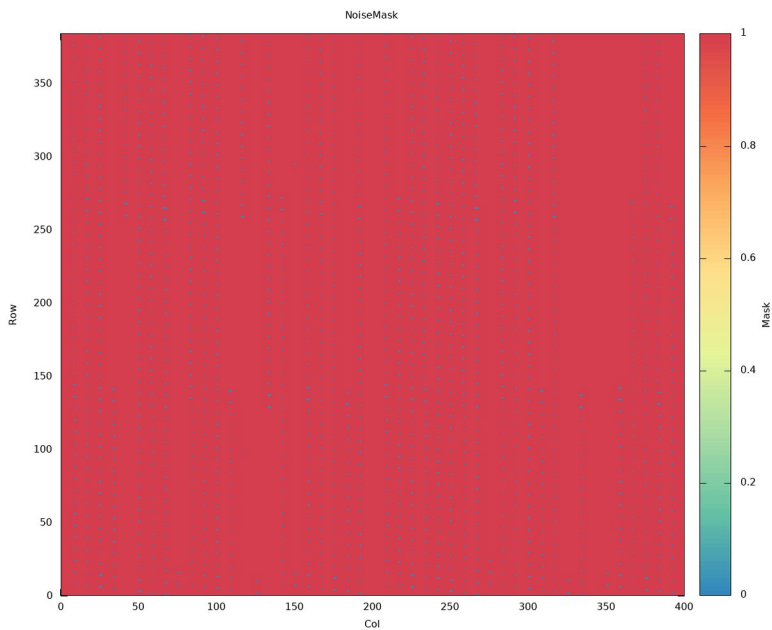
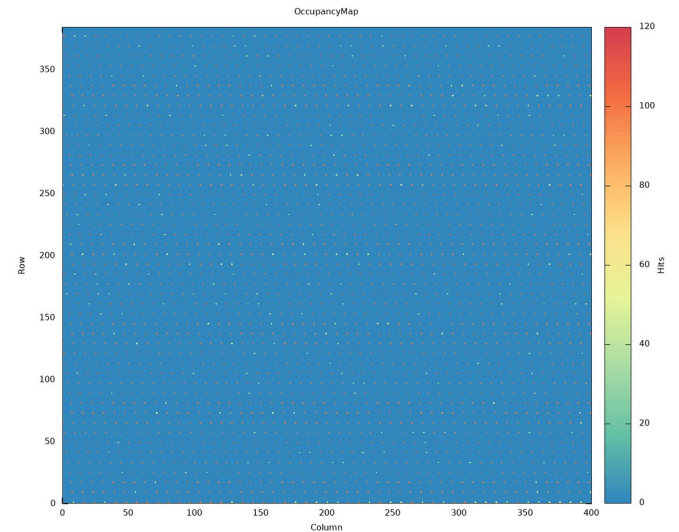
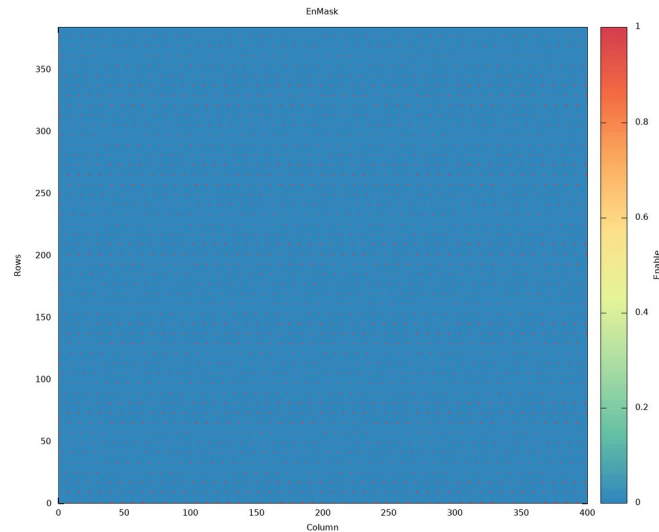
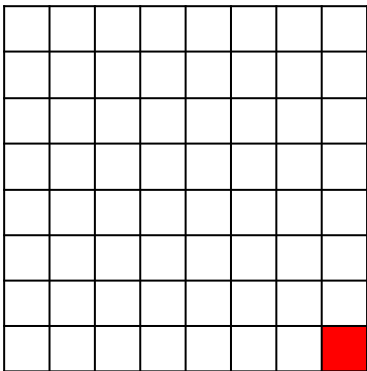
Failed source scan = No triggers received.

HitORMask\_o/1/2/3: Enable/disable for core columns 15:0/31:16/47:32/53:48.

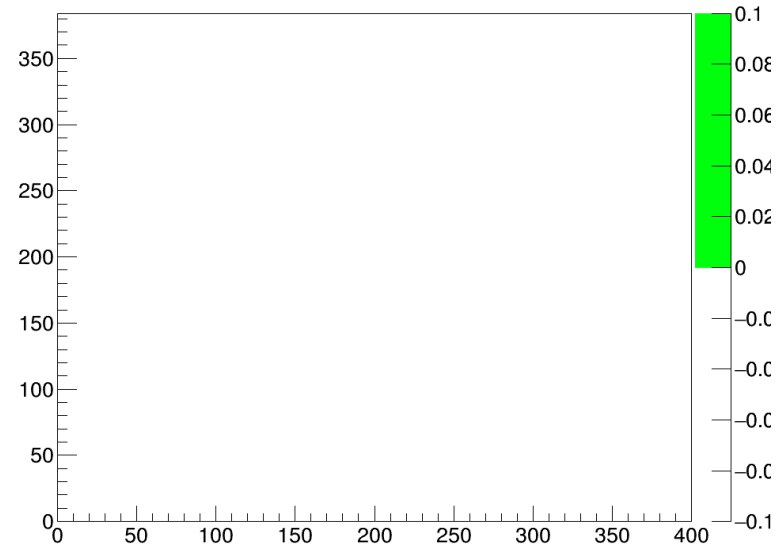
# Results: 1 pixel/core

## Self trigger Analog scan

MaskLoop(64,0,64)



Occupancy without noise distribution



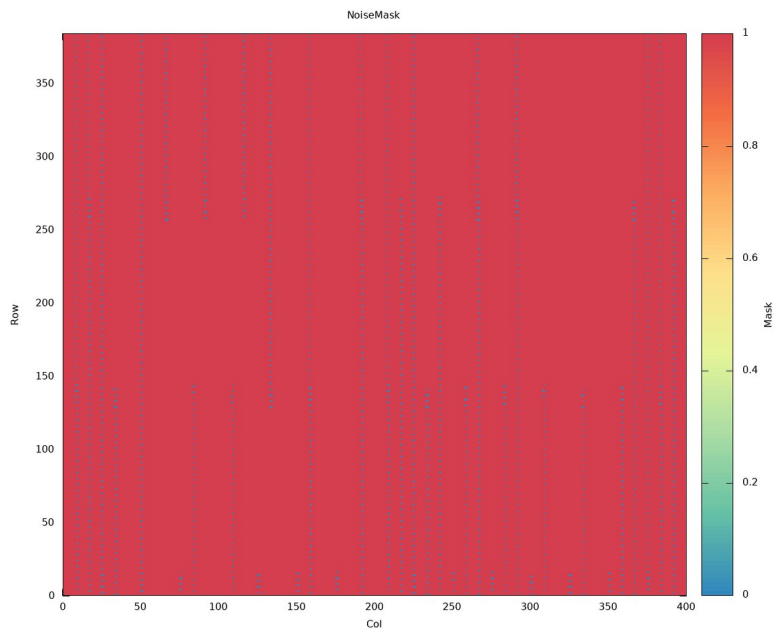
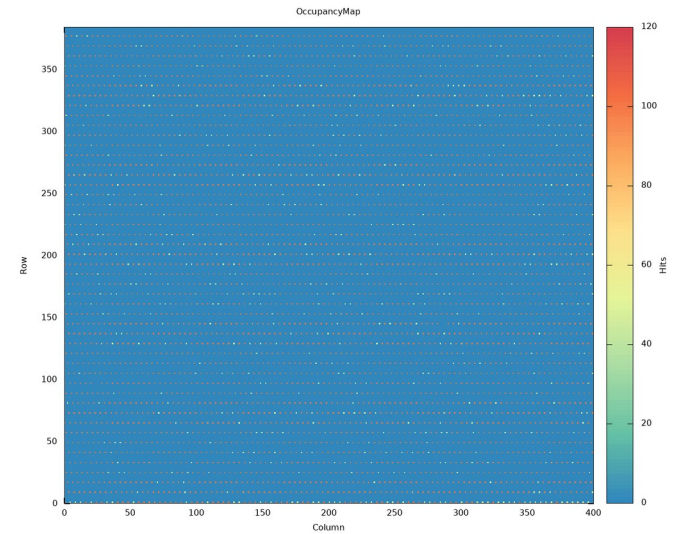
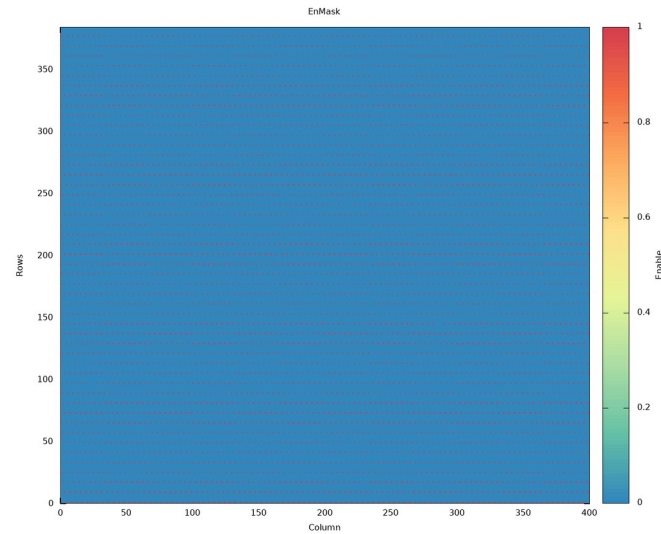
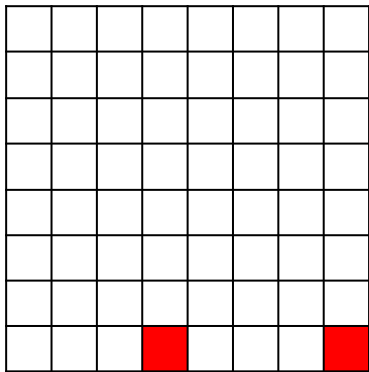
## Source scan Works!

- HitOrPatternLUT = 65534 (OR of all lanes)
- HitORMasks\_o/1/2/3 = o/o/o/o (all enabled)
- Total time = 300s

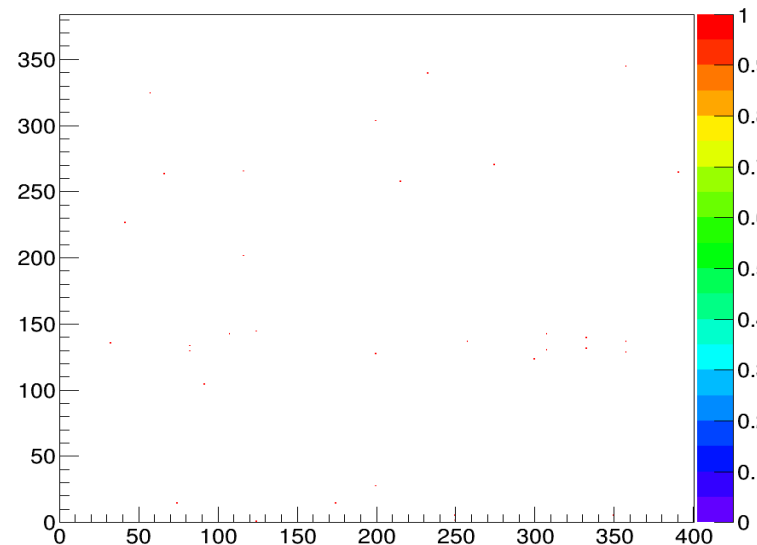
# Results: 2 pixels/core

## Self trigger Analog scan

MaskLoop(64,0,32)



Occupancy without noise distribution



## Source scan Works!

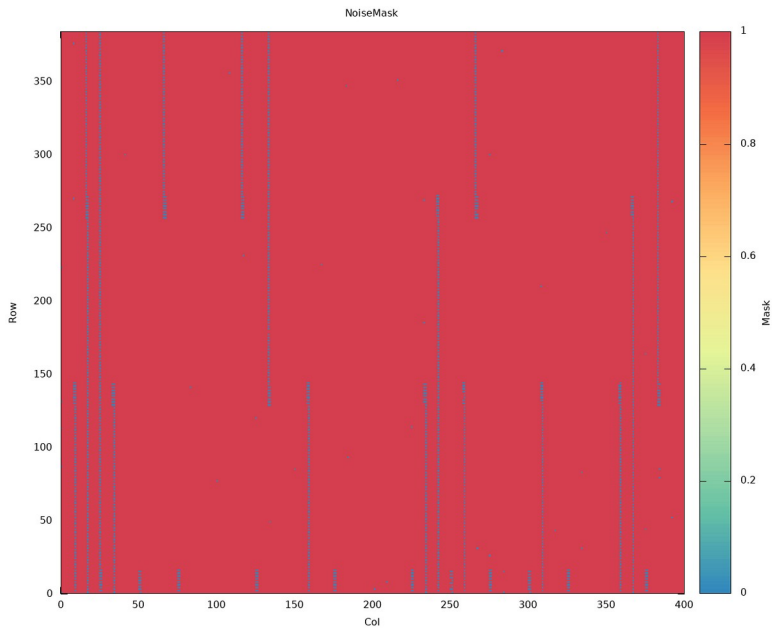
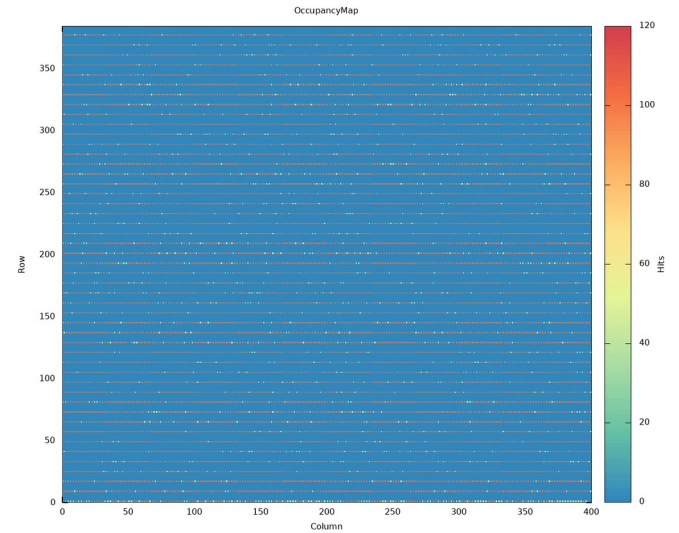
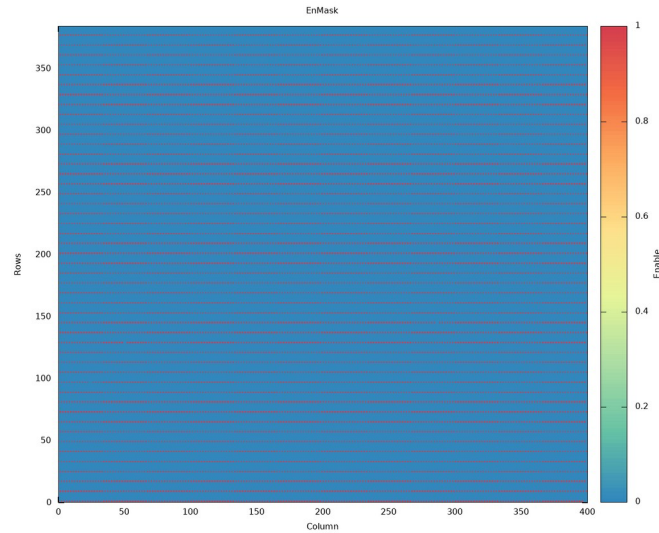
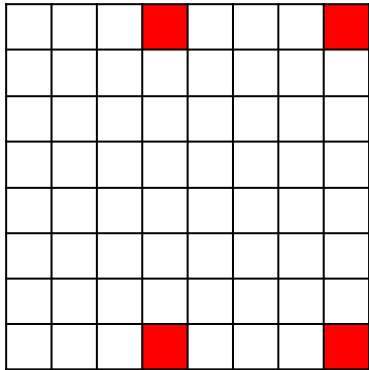
- HitOrPatternLUT = 65534 (OR of all lanes)
- HitORMasks\_o/1/2/3 = o/o/o/o (all enabled)
- Total time = 300s



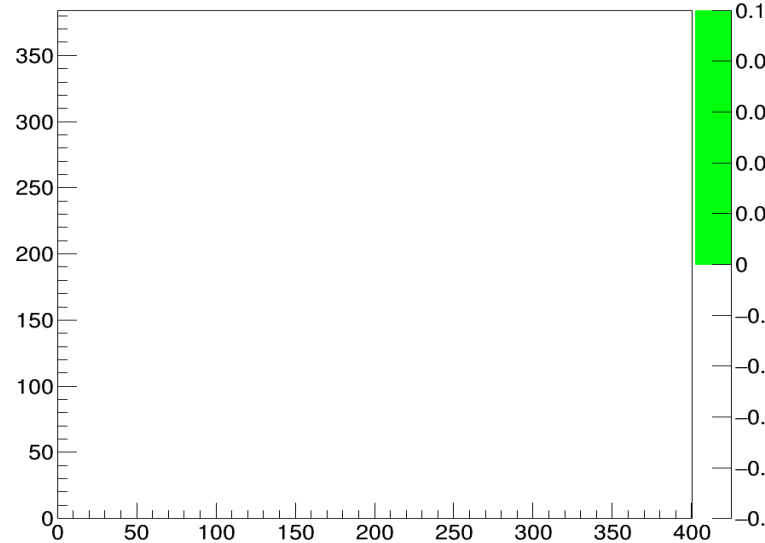
# Results: 4 pixels/core

## Self trigger Analog scan

MaskLoop(64,0,16)



Occupancy without noise distribution



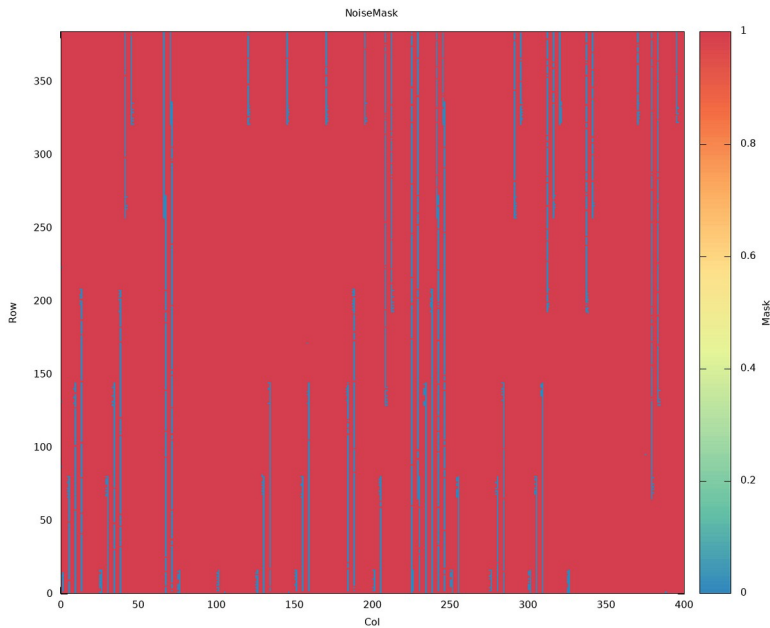
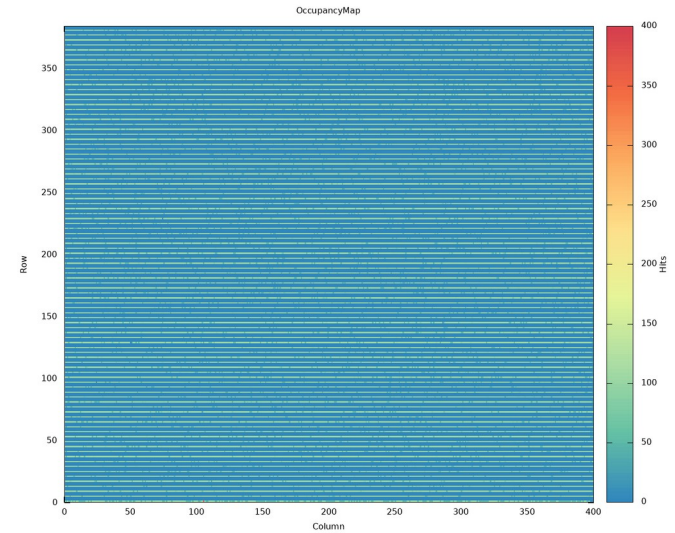
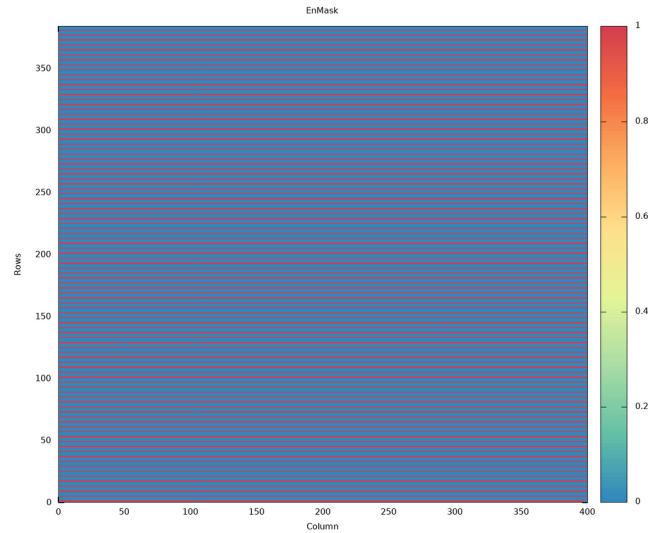
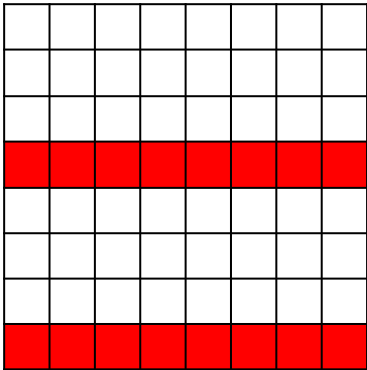
## Source scan Works!

- HitOrPatternLUT = 65534 (OR of all lanes)
- HitORMasks\_o/1/2/3 = o/o/o/o (all enabled)
- Total time = 300s

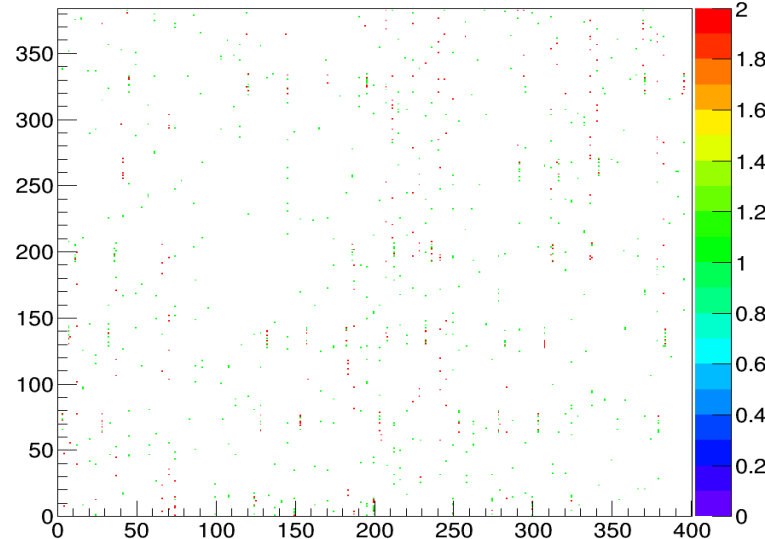
# Results: 16 pixels/core

## Self trigger Analog scan

MaskLoop(64,0,4)



## Occupancy without noise distribution



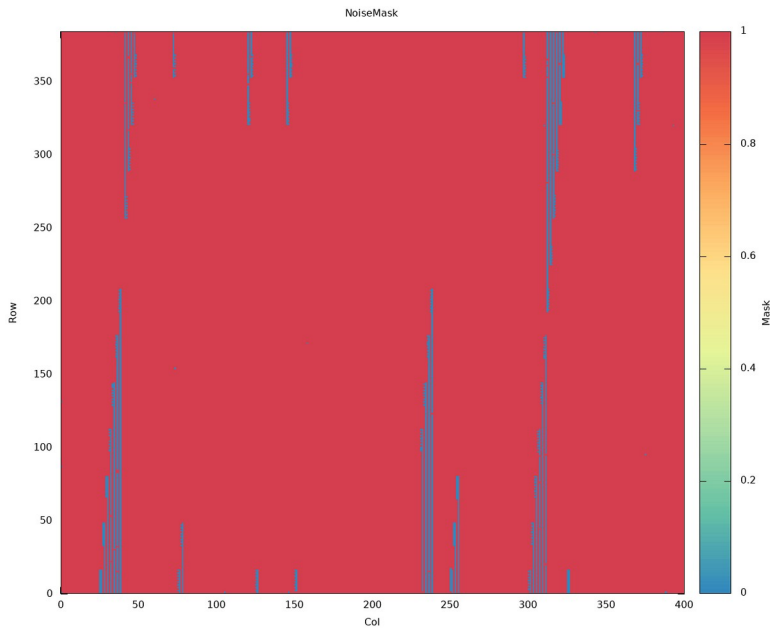
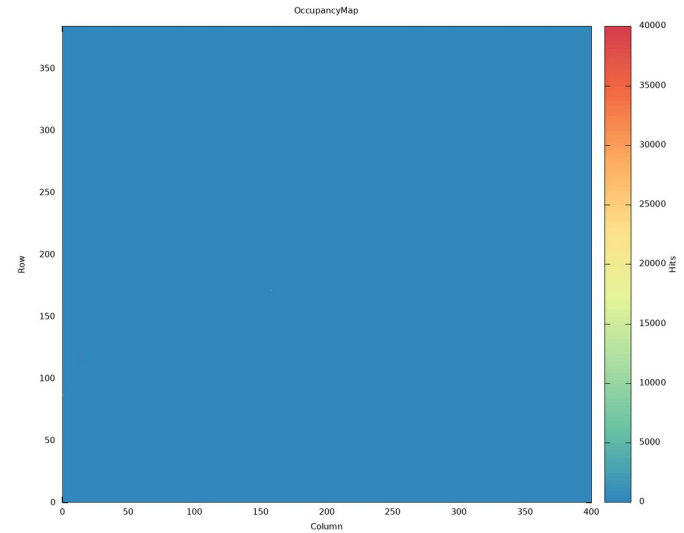
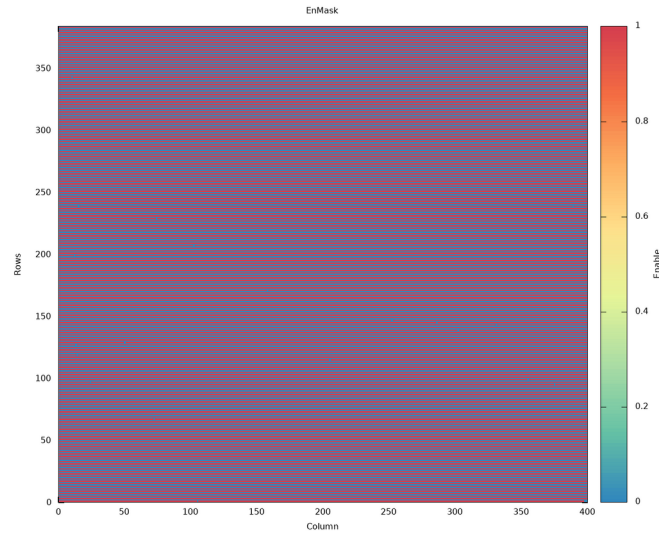
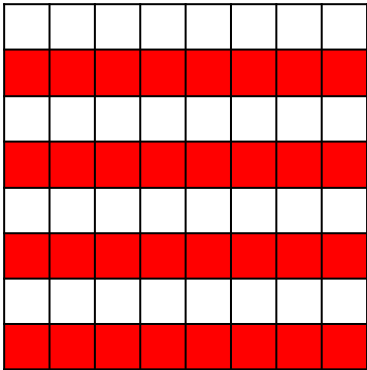
## Source scan Works!

- HitOrPatternLUT = 65534 (OR of all lanes)
- HitORMasks\_o/1/2/3 = o/o/o/o (all enabled)
- Total time = 300s

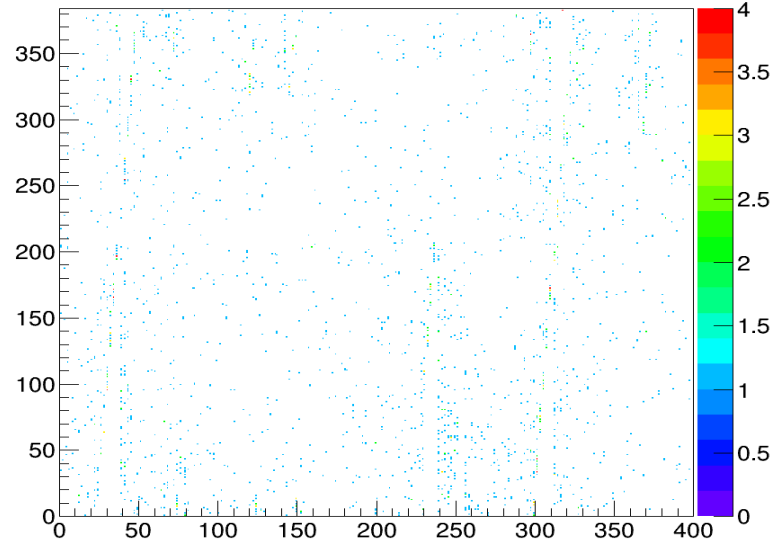
# Results: 32 pixels/core

## Self trigger Analog scan

MaskLoop(64,0,2)



## Occupancy without noise distribution



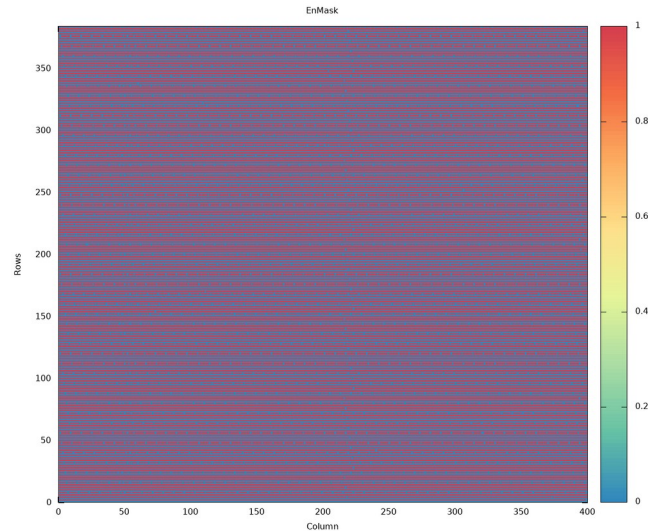
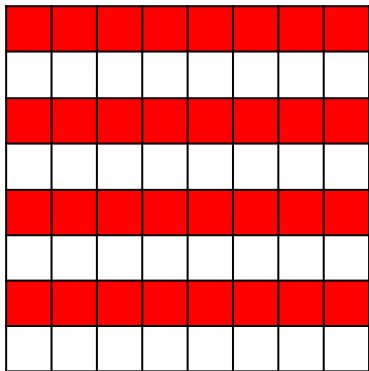
## Source scan Works!

- HitOrPatternLUT = 65534 (OR of all lanes)
- HitORMasks\_o/1/2/3 = o/o/o/o (all enabled)
- Total time = 1200s

# Failed source scans

## Self trigger Analog scan

MaskLoop(64,1,2)

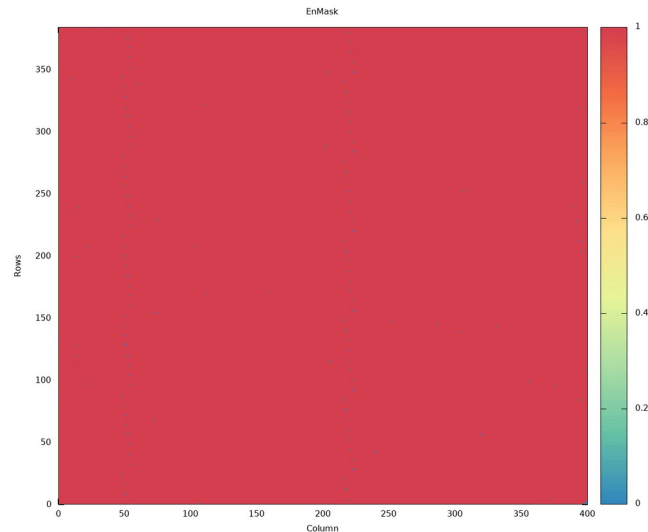
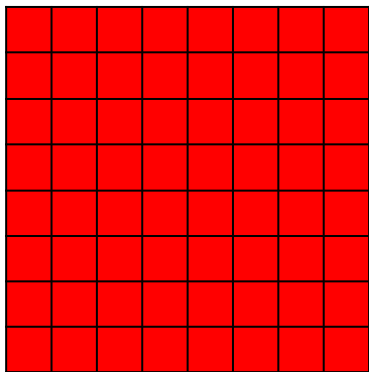


## Source scan Failed.

- Tested various configurations for HitORPatternLUT (2/4/8/16/65534).
- Also changing HitORMasks 0/1/2/3 (enabling one core column only at a time).

## Self trigger Analog scan

MaskLoop(64,0,1)



## Source scan Failed.

- Tested various configurations for HitORPatternLUT (2/4/8/16/65534).
- Also changing HitORMasks 0/1/2/3 (enabling one core column only at a time).
- Also tried enabling one HitOR lane (HitORPatternLUT=2) with one core column at a time (HitORMasks 0/1/2/3).

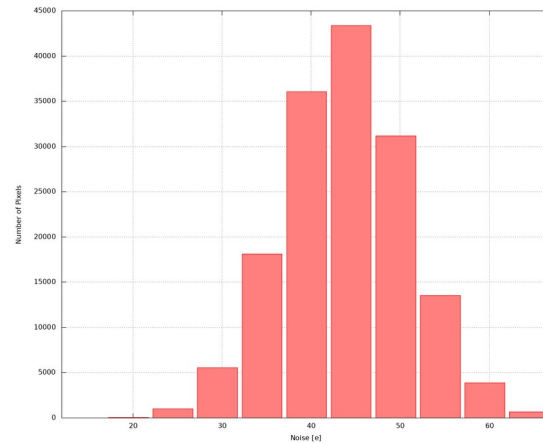
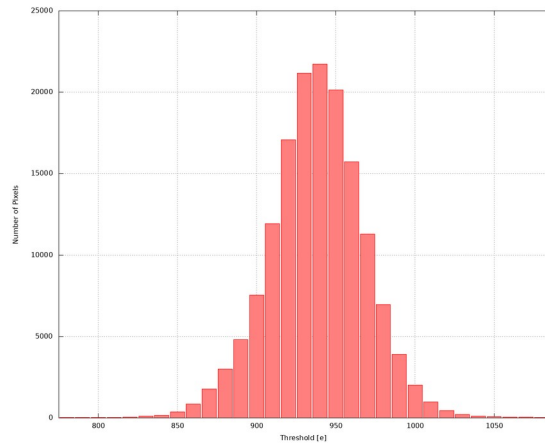
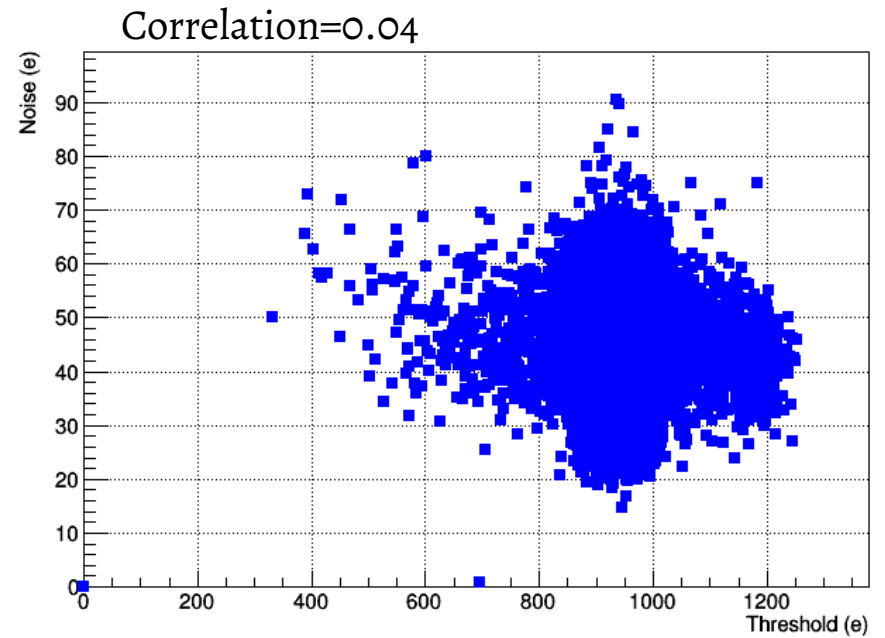
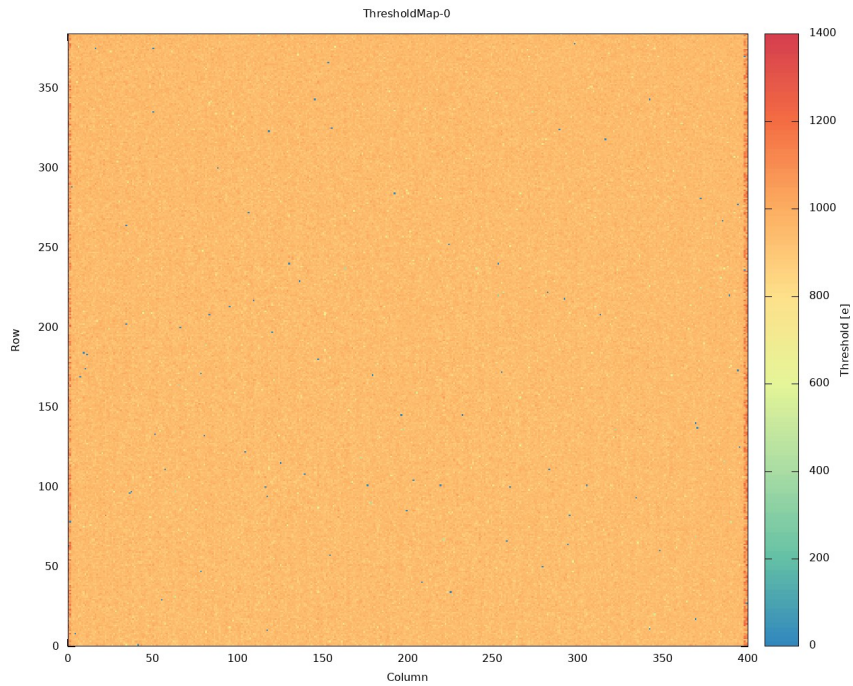
Failed source scan = No triggers received.

# Conclusion

- Self-trigger analog scan in place for ITkPixV1.1.
- Self trigger source scan works as expected for up to 16 pixels per core.
- For higher pixel masking, such as 32 pixels per core, source scan works for even enabled-pixels but fails for odd enabled-pixels. Thus, source scan also fails for fully enabled pixel core (64 pixels).
  - Fails for different enabled configuration of HitOR lanes and Core columns.

# Extra

# Threshold scan (bare chip)



# Threshold scan (sensor+chip)

