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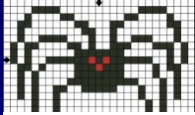


SPiDeR

SPIDER CHERWELL

- SPIDER
- FORTIS
- 4T pixels
- Deep Pwell
- First results
- CHERWELL
- Future plans
- Wishlist

Science & Technology Facilities Council

Imperial College London

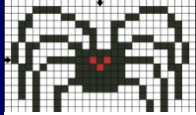
UNIVERSITY OF OXFORD

University of BRISTOL

J.J. Velthuis
for the
SPIDER collaboration

Jaap Velthuis, University of Bristol

University of BRISTOL



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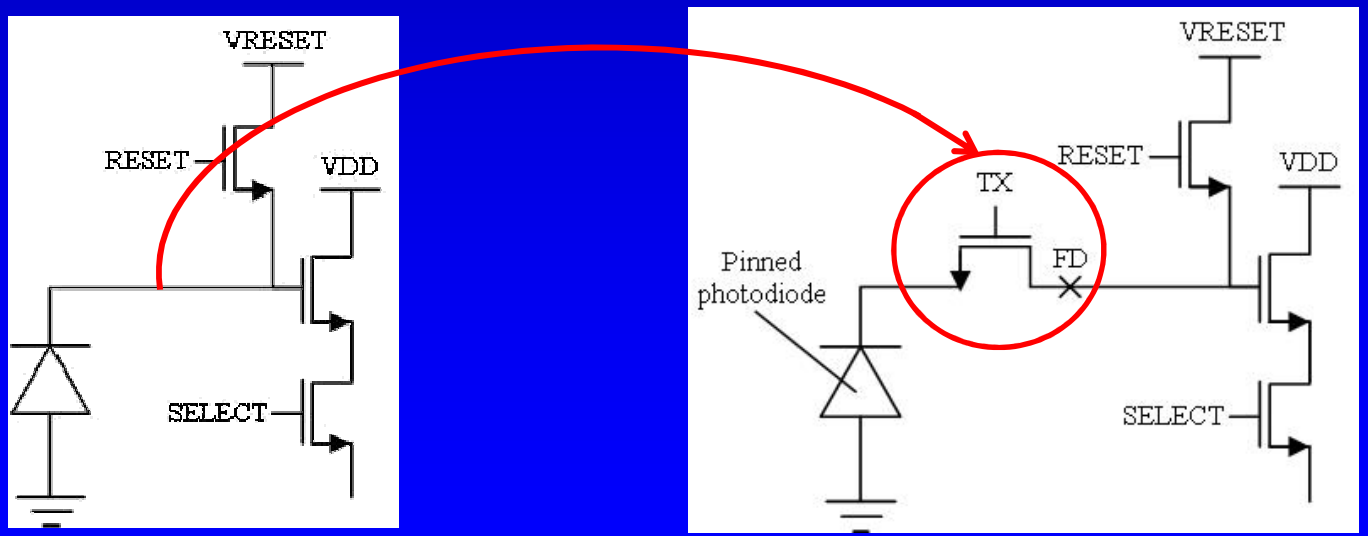
SPIDER

- UK Collaboration working on Silicon Pixel R&D for future colliders.
  - Demonstrate a new improved technique for calorimetry
  - Develop a MAPS sensor with in-pixel data processing for tracking applications
- In principle funded until end of 2012

FORTIS

- FORTIS is the first 4T MAPS for Particle Physics
  - 3T CMOS
    - Simple architecture
    - Readout and charge collection area are the same
  - 4T CMOS
    - Three additional elements
    - Readout and charge collection area are at different points



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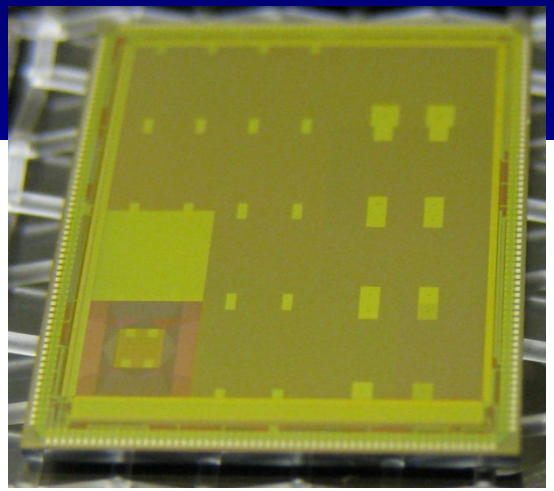
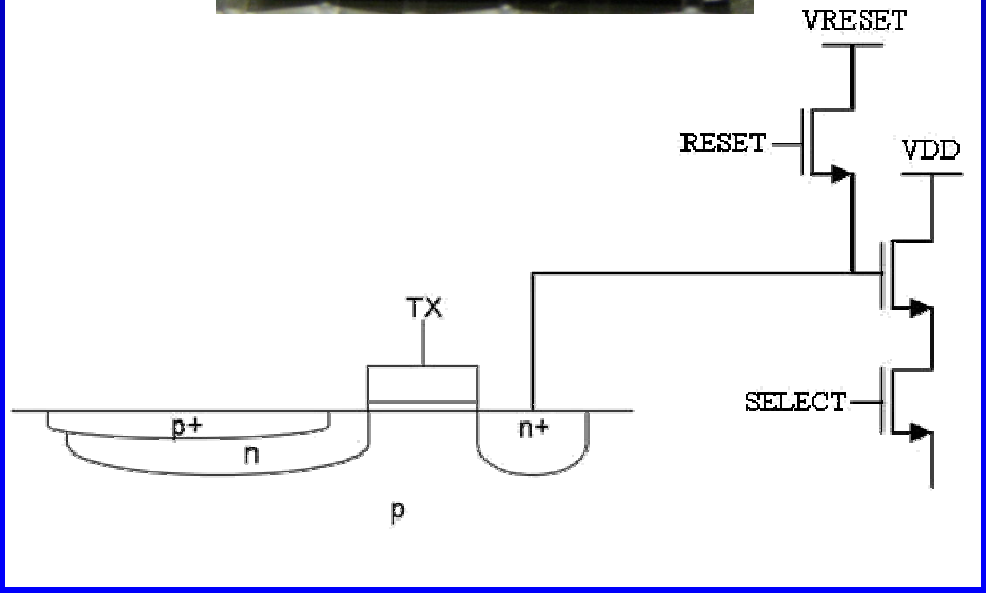
4T Pixel Advantages

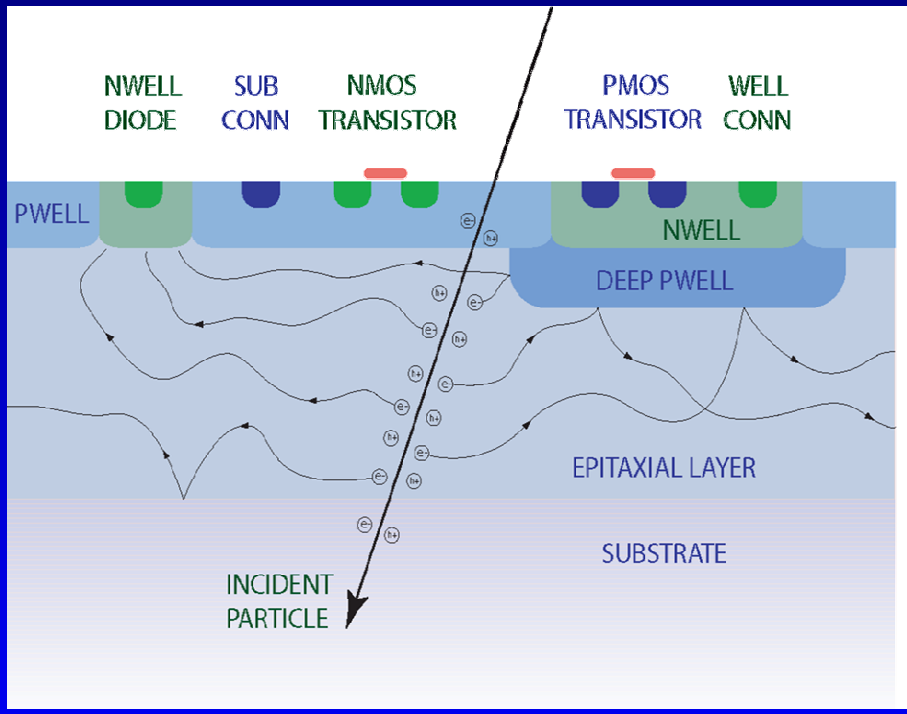
- Low Noise
  - readout node separated from charge collection area
  - The reset noise and fixed pattern noise (FPN) can be removed by in-pixel correlated double sampling (CDS)
- High Conversion Gain
  - Charge is collected on large diode then transferred to the floating diffusion
  - Large C gives fast and complete charge collection
  - Small C yields large gain



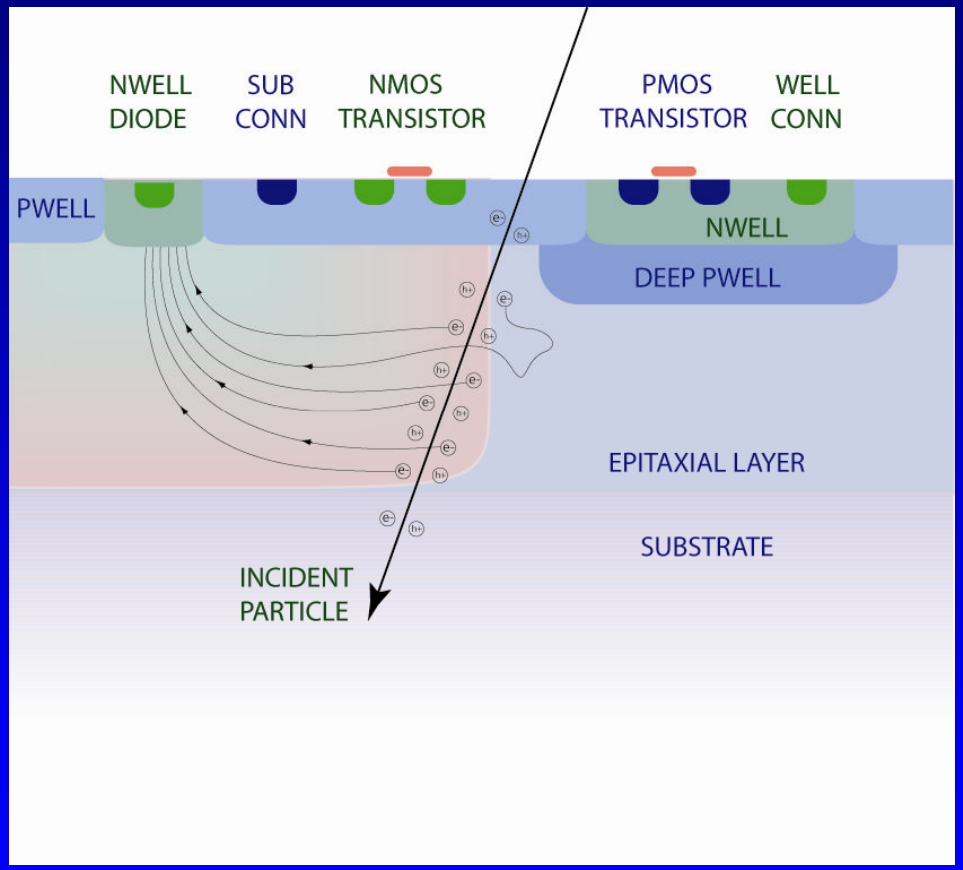


Deep Pwell

- Problem in MAPS:
  - PMOS electronics need Nwell
  - Nwell acts as charge collection diode
  - So can't make PMOS without losing huge amount of Q
- New development: make deep pwell with Nwell inside → can do CMOS
  - Road to data processing in pixel
- Some FORTIS have empty deep pwell to test effect of Q collection



Substrate Resistivity



- High resistivity (intrinsic) silicon enlarges the depletion region to fully occupy the pixel
  - Majority of deposited charge now falls in a depletion region and is collected by electric field
  - Improved charge collection efficiency
  - Faster charge collection (drift vs diffusion)
- Some FORTIS have high res

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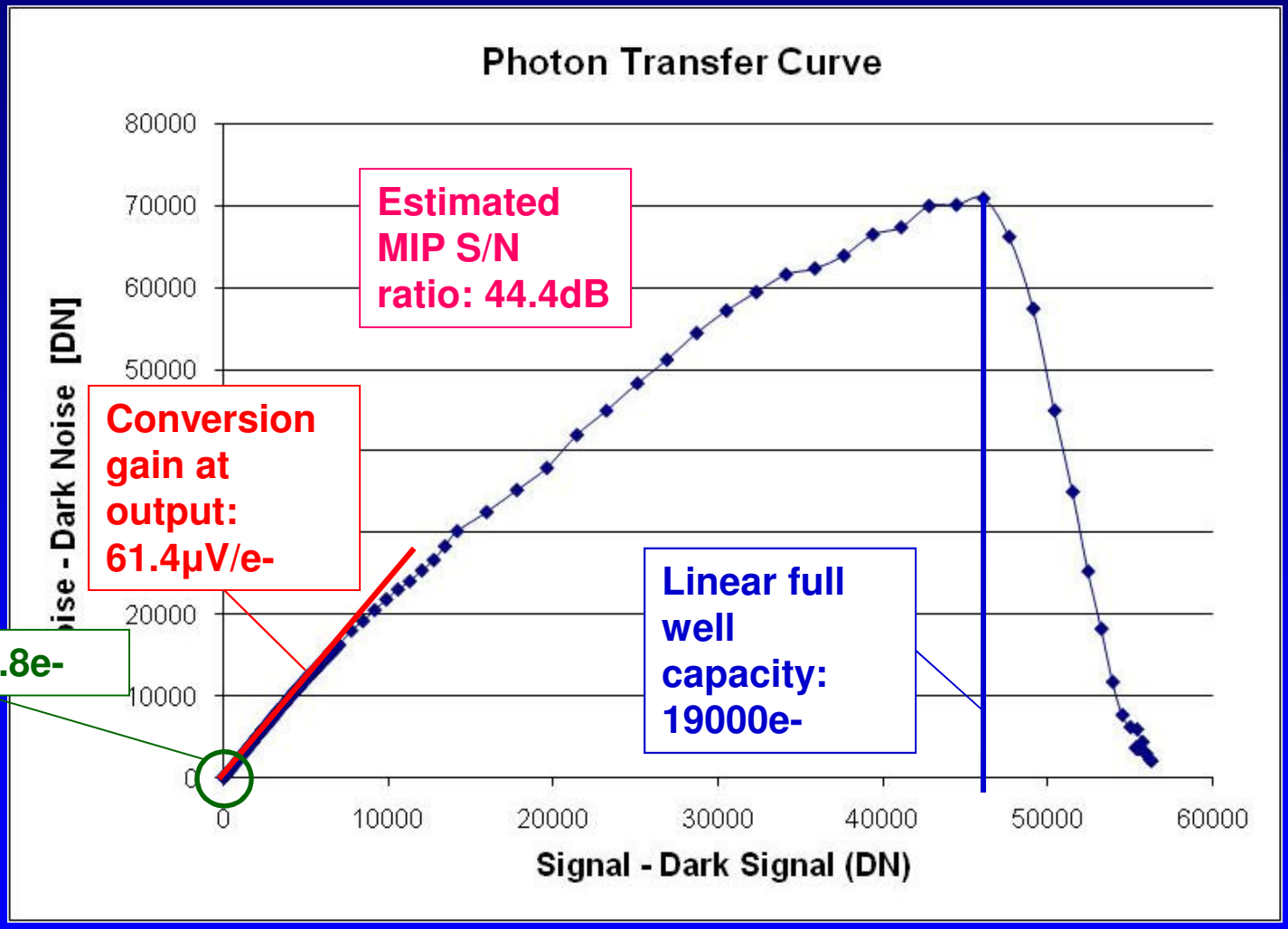
FORTIS Results



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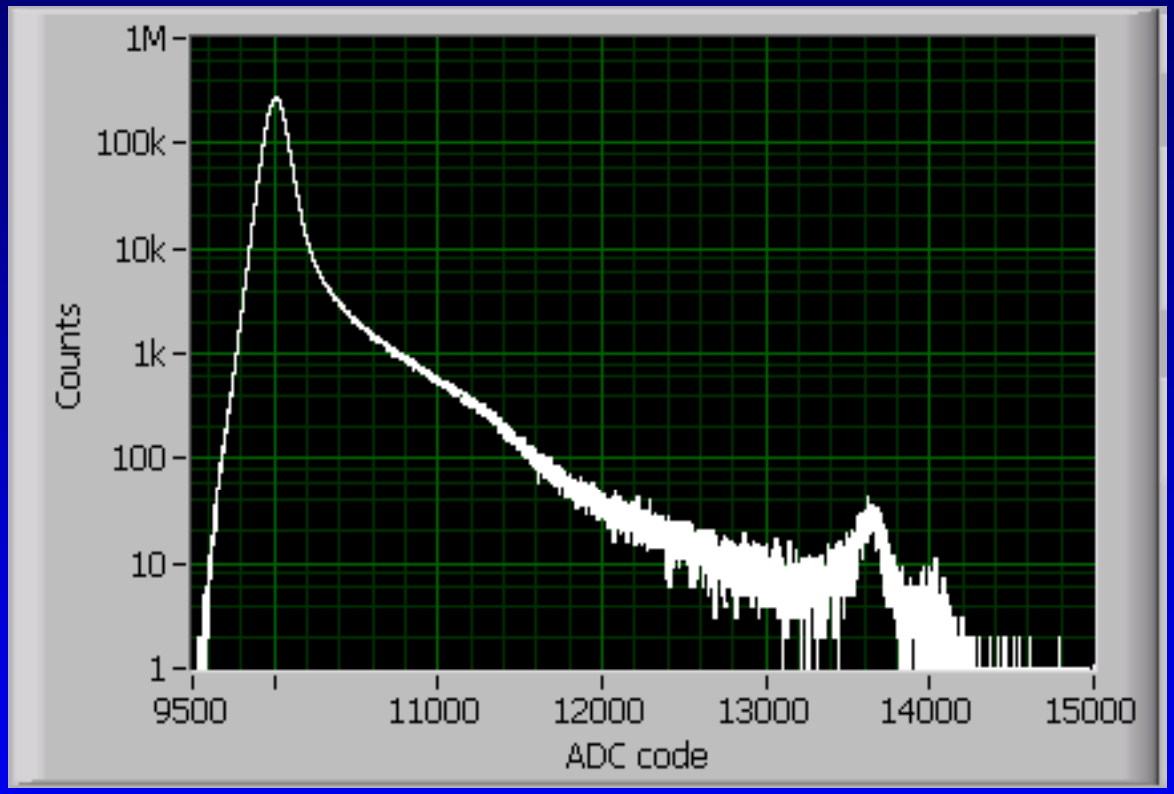
FORTIS results



- ^{55}Fe Photons (preliminary)
  - Conversion gain = 56 μ V/e$^-$
  - Noise (from dark fwhm) = 7.7e$^-$

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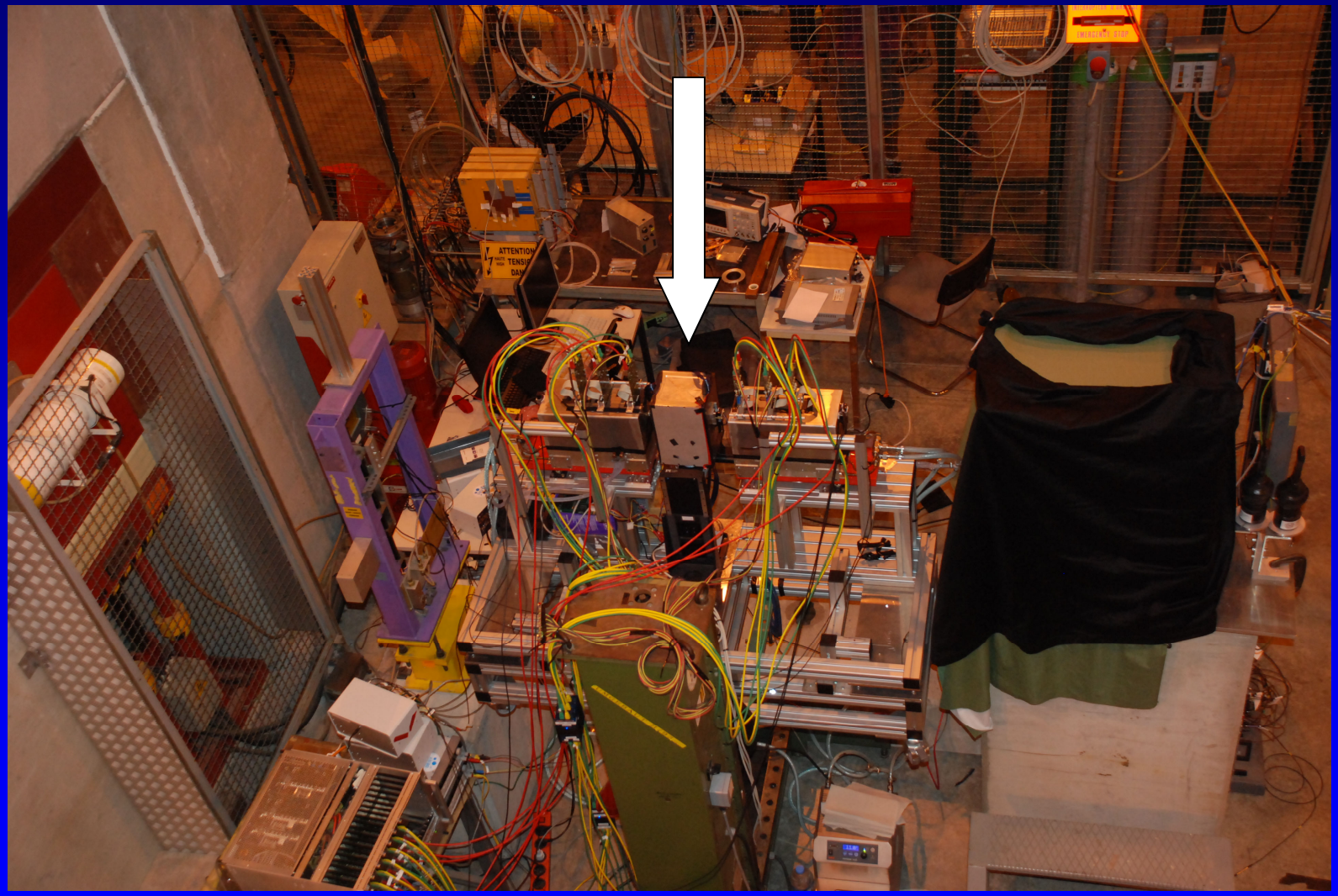
Some test beam pictures



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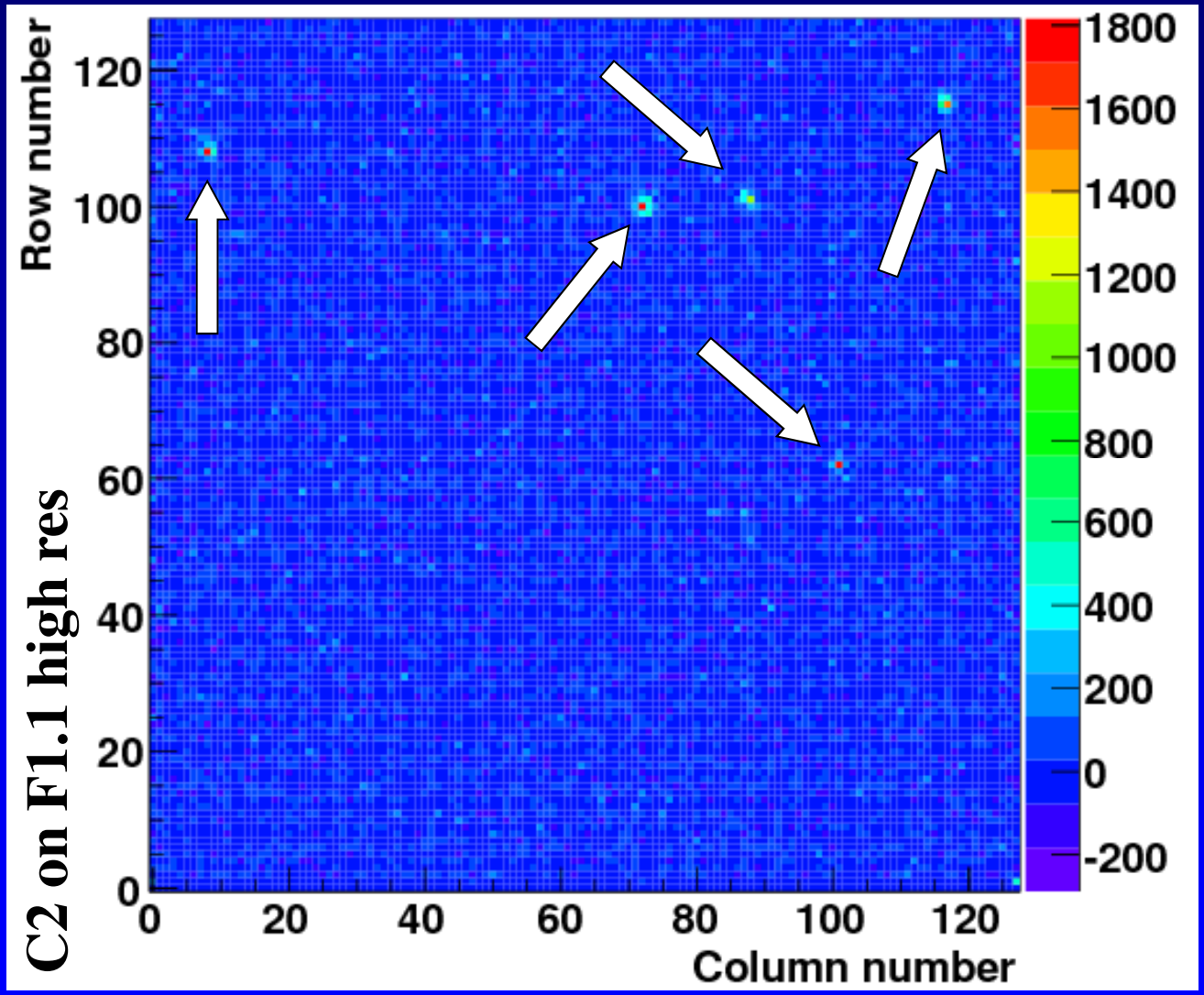
We see hits…



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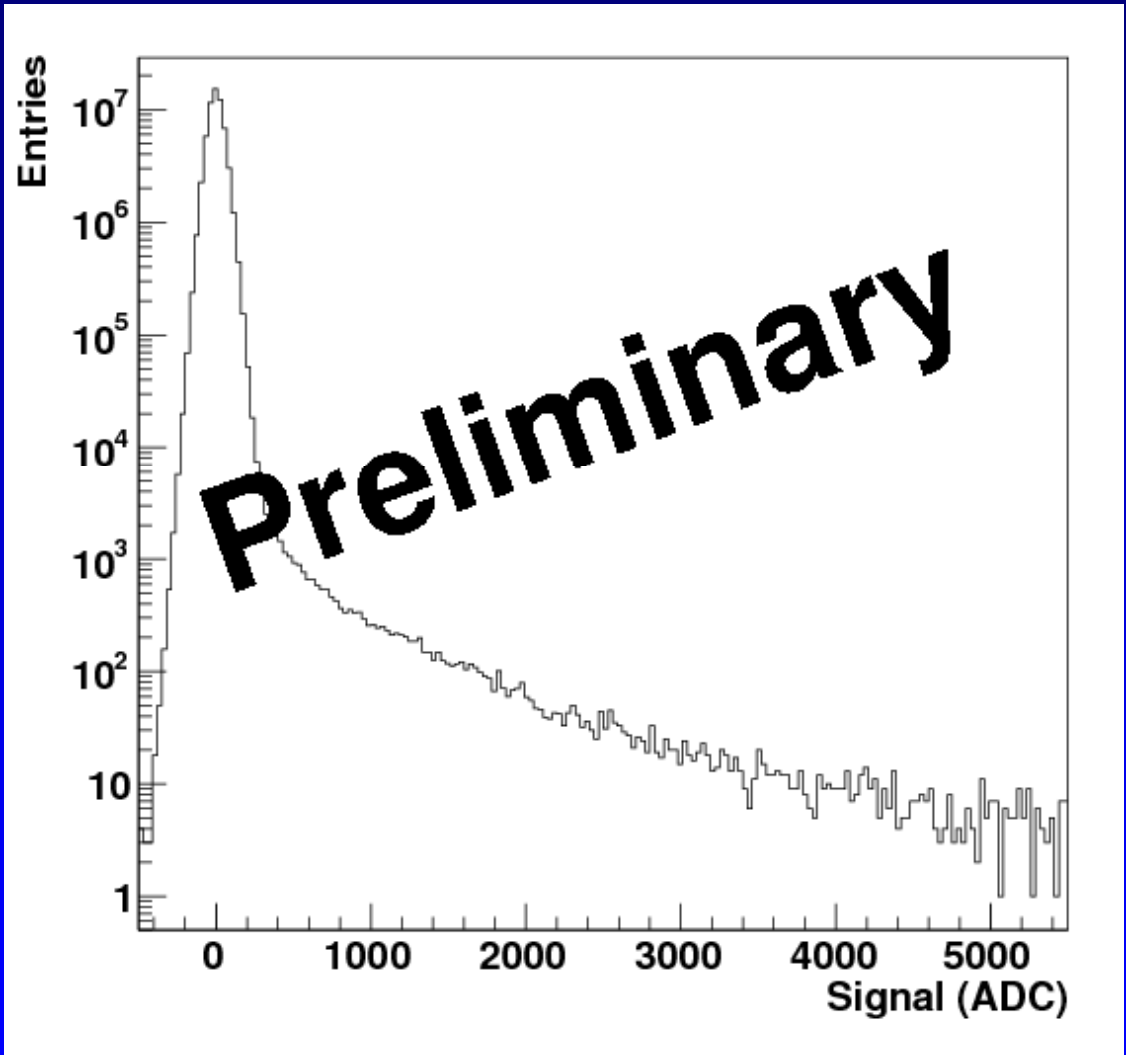
Raw signals



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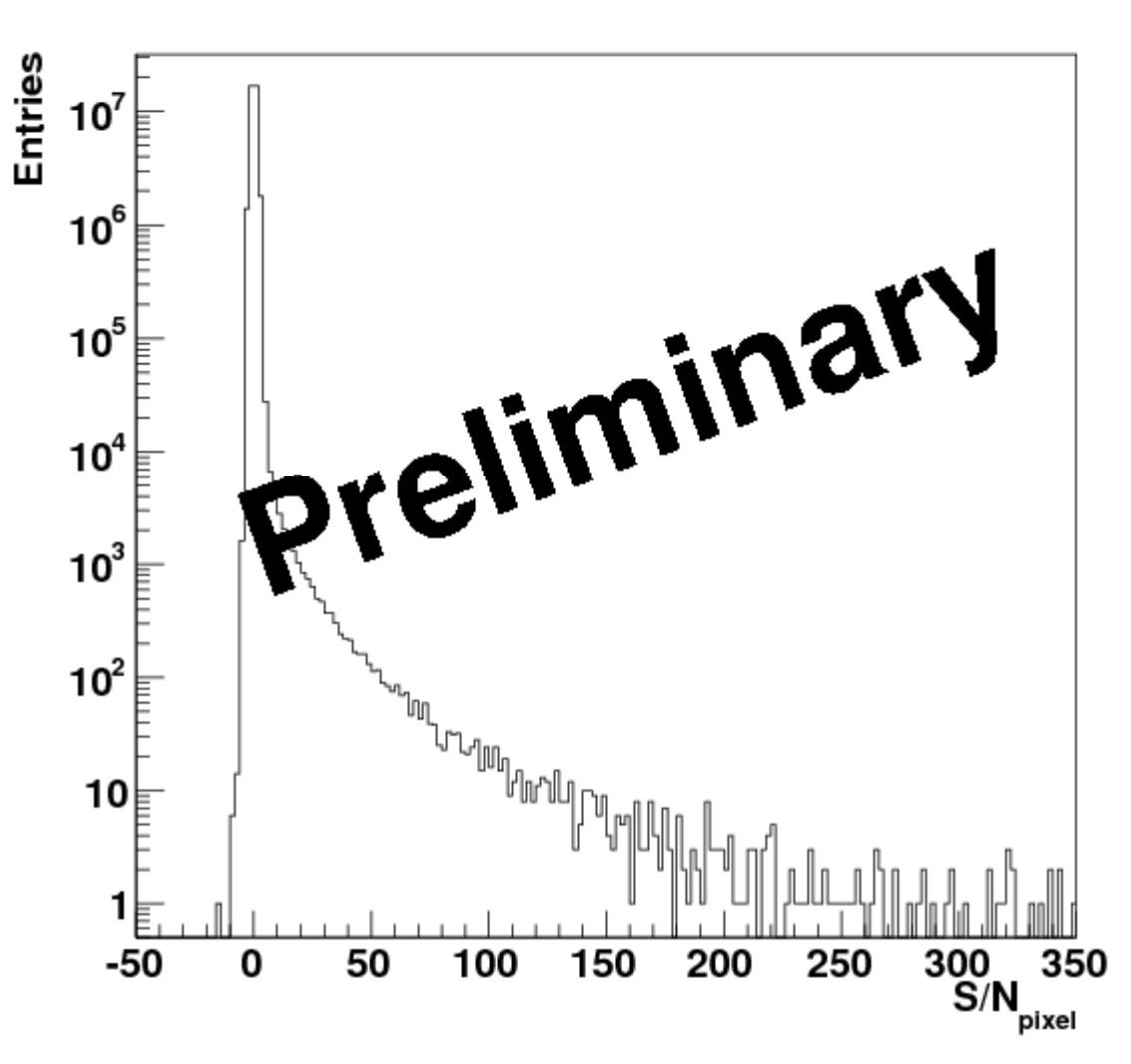
Raw S/N for each pixel



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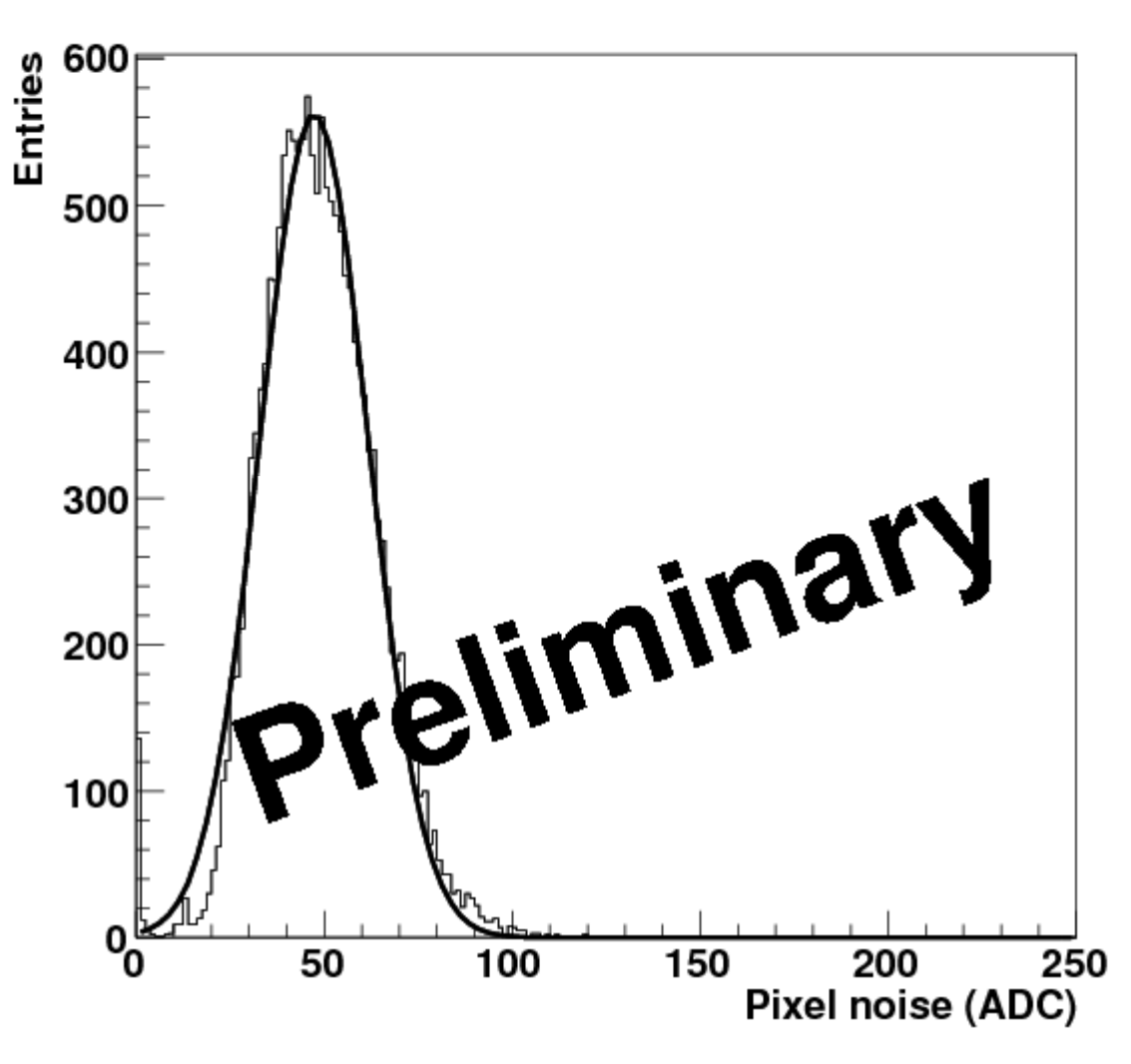
Pixel Noise



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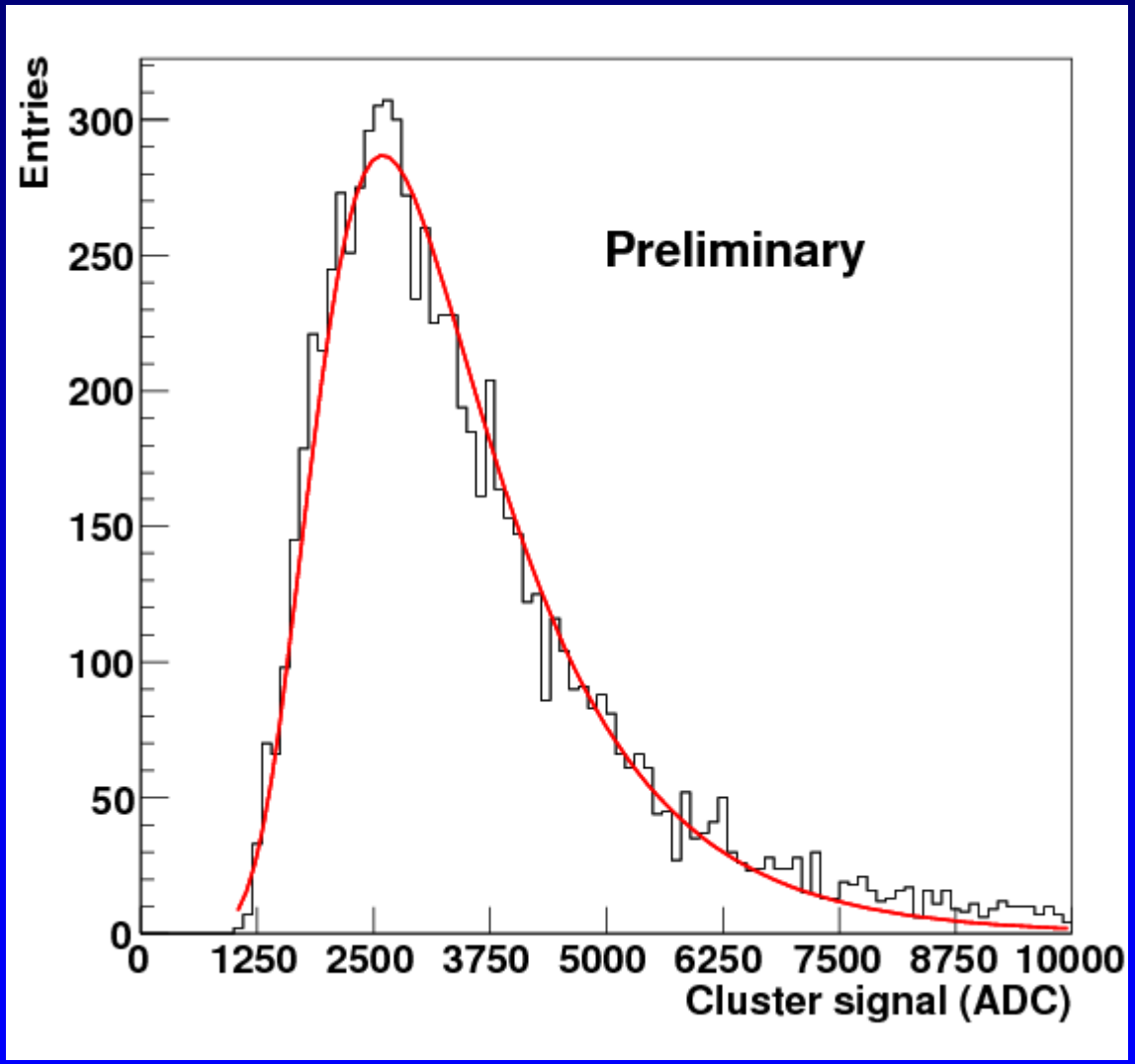
Cluster signal



- Corresponds to S/N~50
- Data analysis just started
- Still need to match up with telescope

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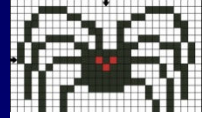
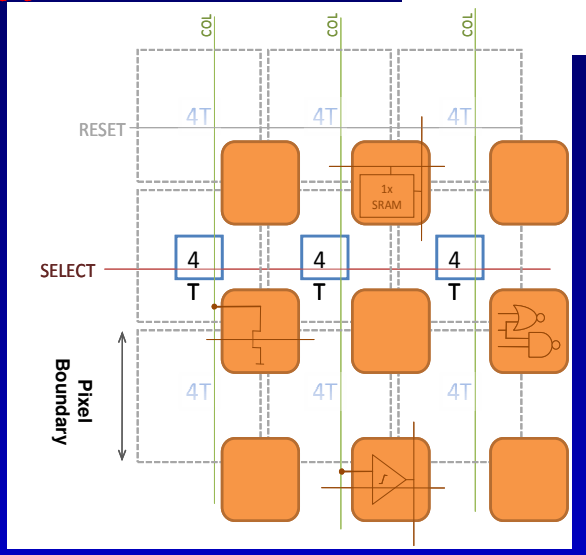
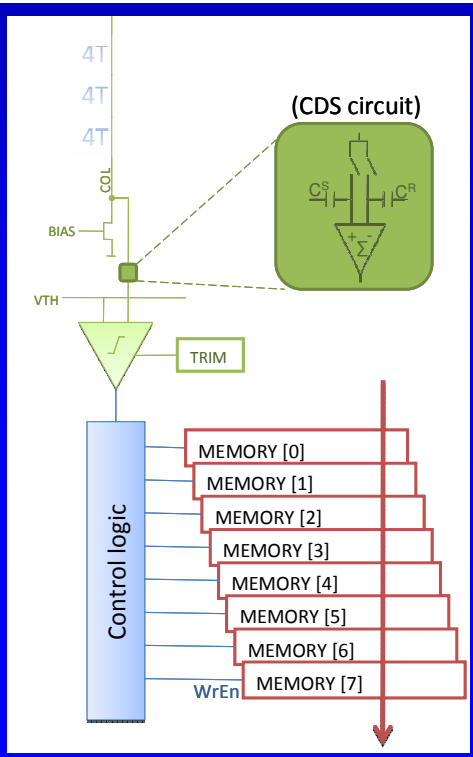
The future: Cherwell



- Uses INMAPS plus 4T to achieve
  - 100% fill factor with integrated sensor and readout electronics
    - Incorporation of complex logic within a pixel
    - Investigation of data reduction/clustering
  - Low noise using transfer gate, CDS and in-pixel amplification
  - Low power using rolling shutter readout
  - Combine 128 pixels in 1 strixel





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Future plans

- Cherwell1 will be submitted in spring
  - Tests using sources & laser; no beam test
- Cherwell2 will be submitted beginning 2012
  - Cherwell2 will be extensively tested
  - 3 week beam test at CERN with high momentum pions

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Our needs/wishes

- Beam time!
- Need telescope
  - Really like EUDET concept:
    - Know the TLU; no big interfacing problems to be solved onsite
    - Tracking and alignment software provided
    - Essentially get the tracks
- Would like patch panels (bnc and fiber optic) between hut and area
  - Cabling is pain
- Would like large XY-stage
- Would like cooling option
- If possible could arrange many user beam tests
  - Remote shifts; saves lots of travel money

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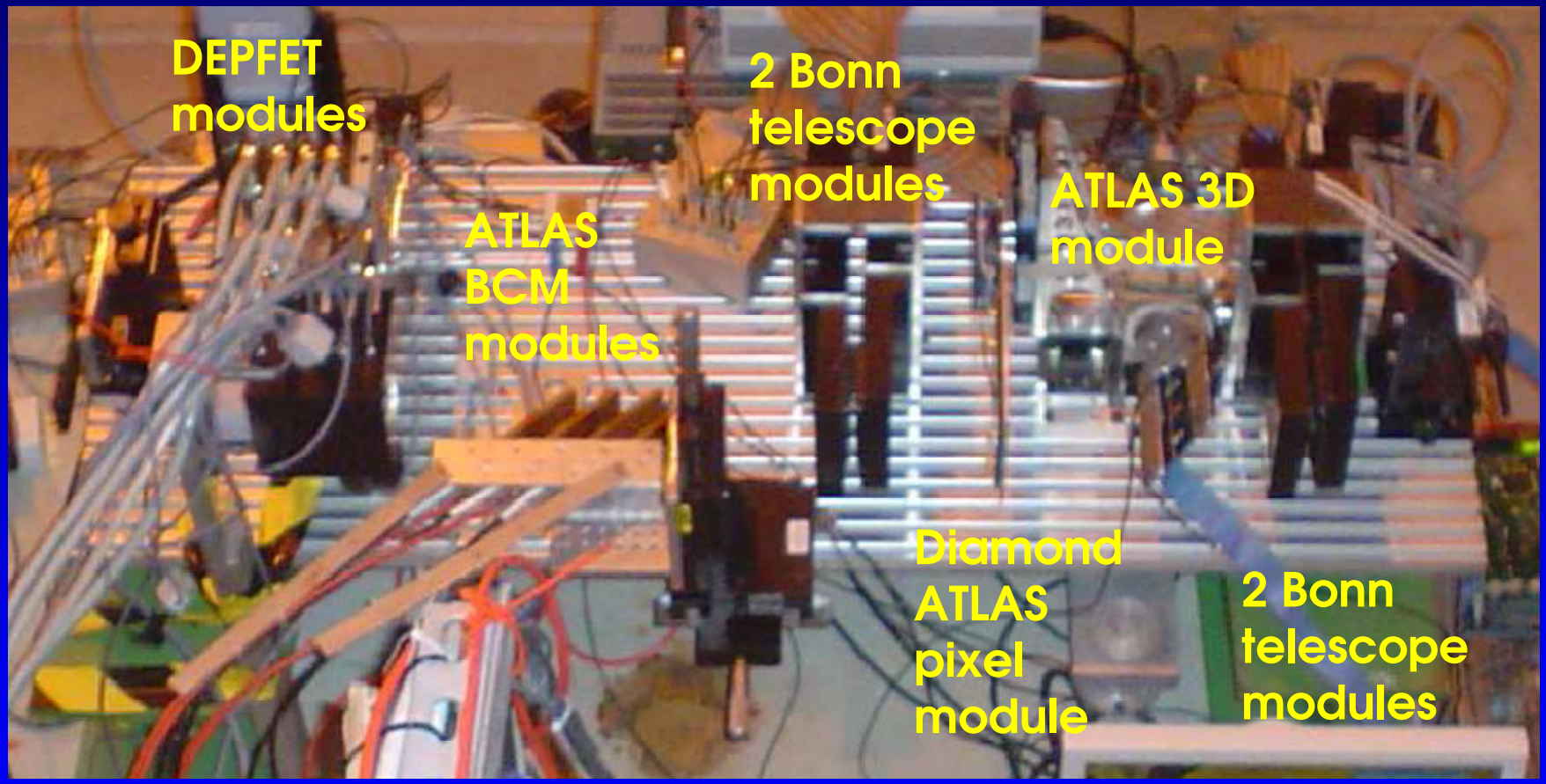
Nice example



- Tested 4 different devices at the same time
  - Currently only possible because 1 institute + friendly colleagues

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Summary

- SPIDER is developing a novel tracking device based on MAPS with in-pixel data processing
- Two iterations. Final chip will be delivered in summer 2012.
- Would be great to have common infrastructure: patch panels, large XY stage, cooling & TLU
- Very interested in collaborating with many other users