The MIDAS Personal Active Dosimeter

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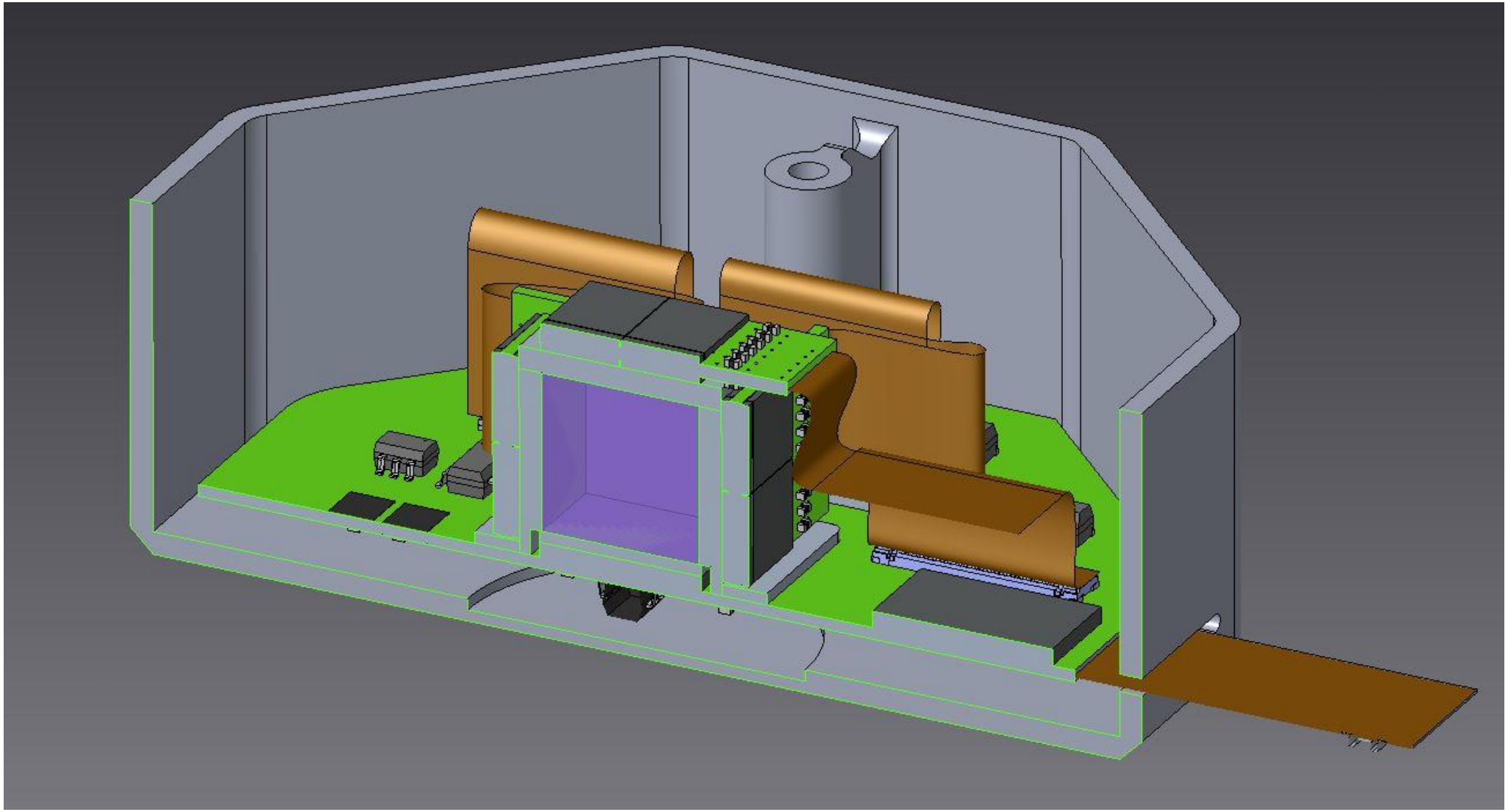
Contents

- Device concept and design
- Silicon pixel sensor
- Simulation and Measurement results

MIDAS is developed under CONTRACT: 4000119598/17/NL/LF
“Highly miniaturized ASIC Radiation Monitor”

The device concept (I)



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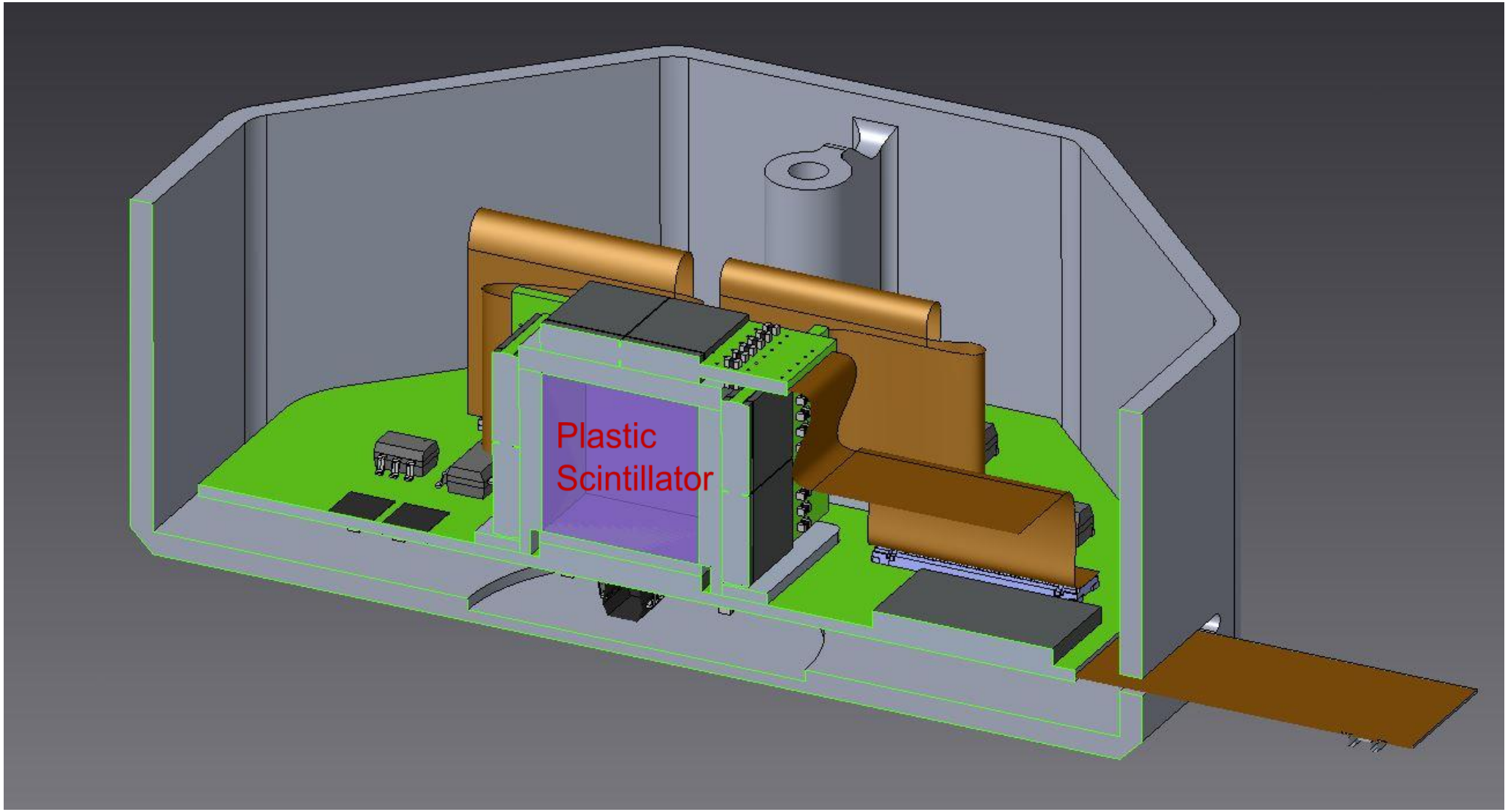

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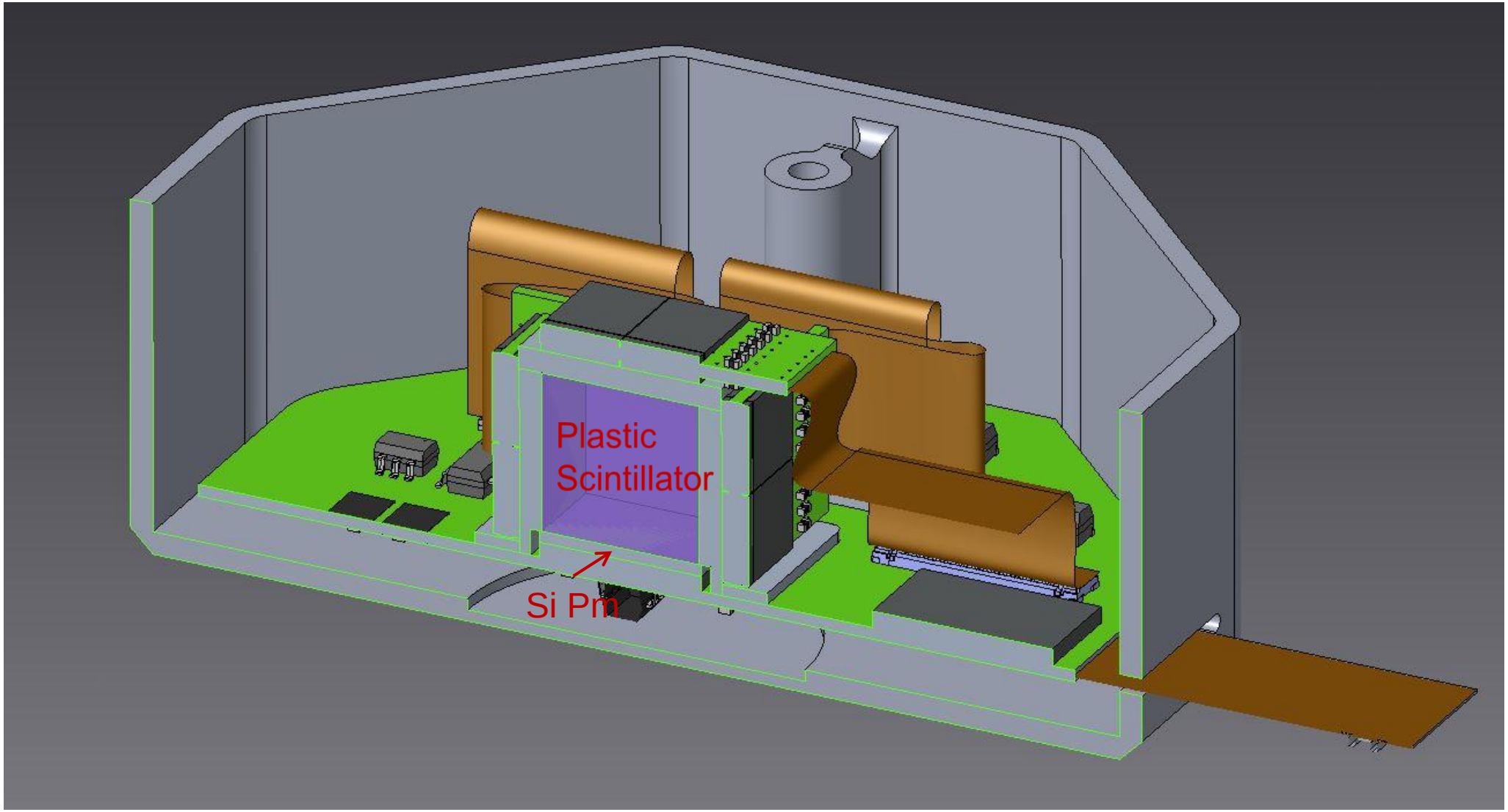

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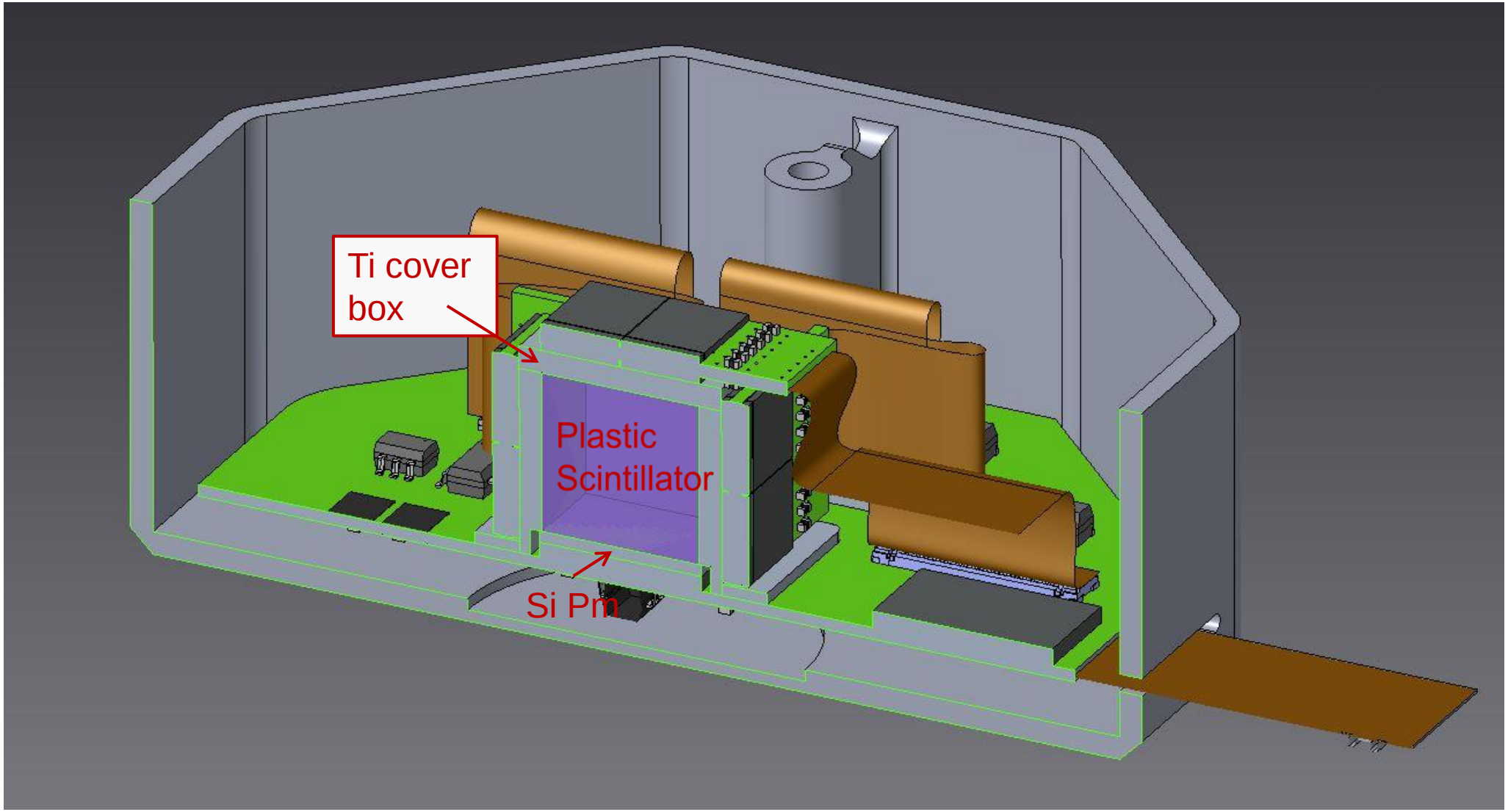

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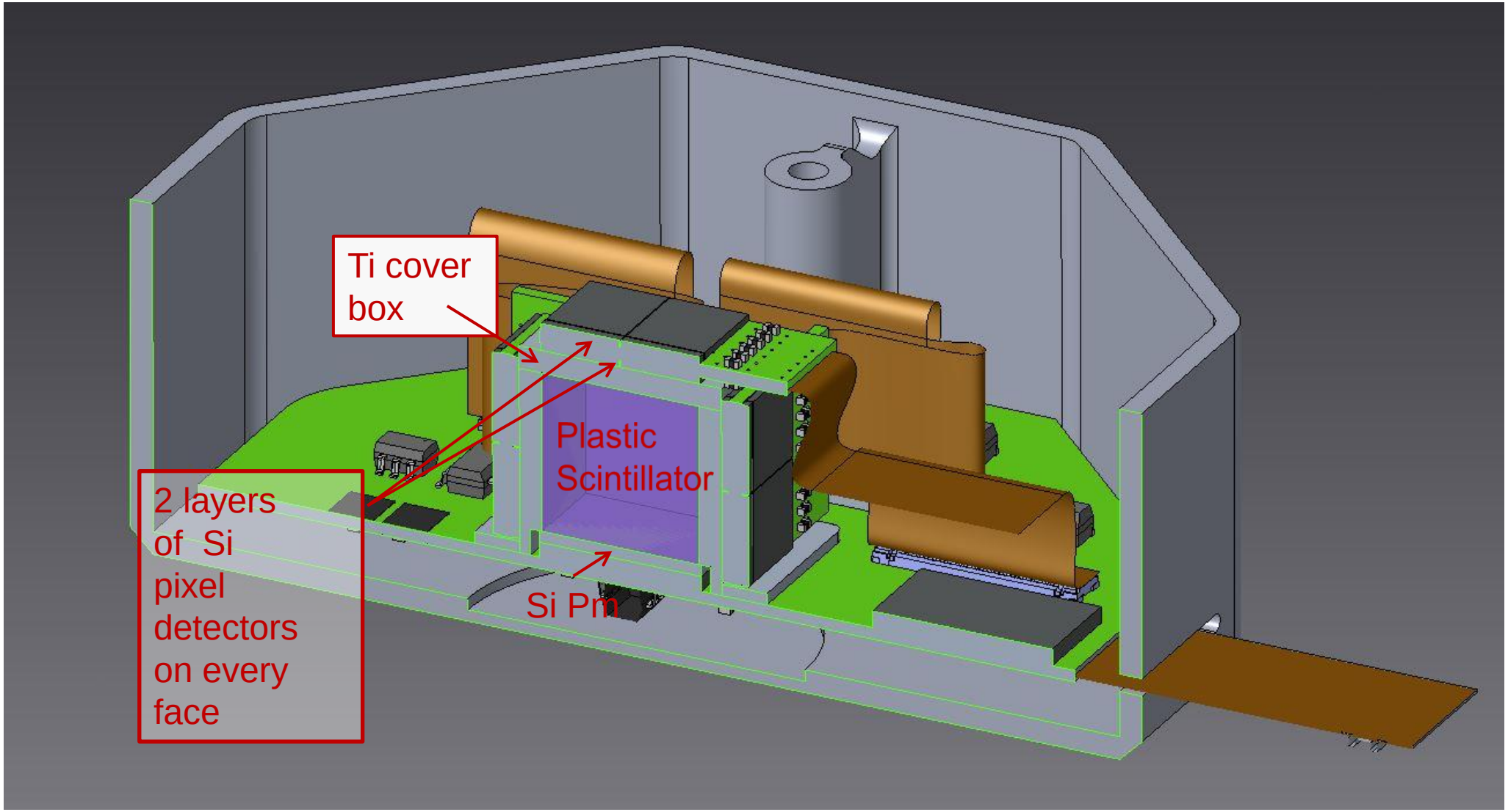
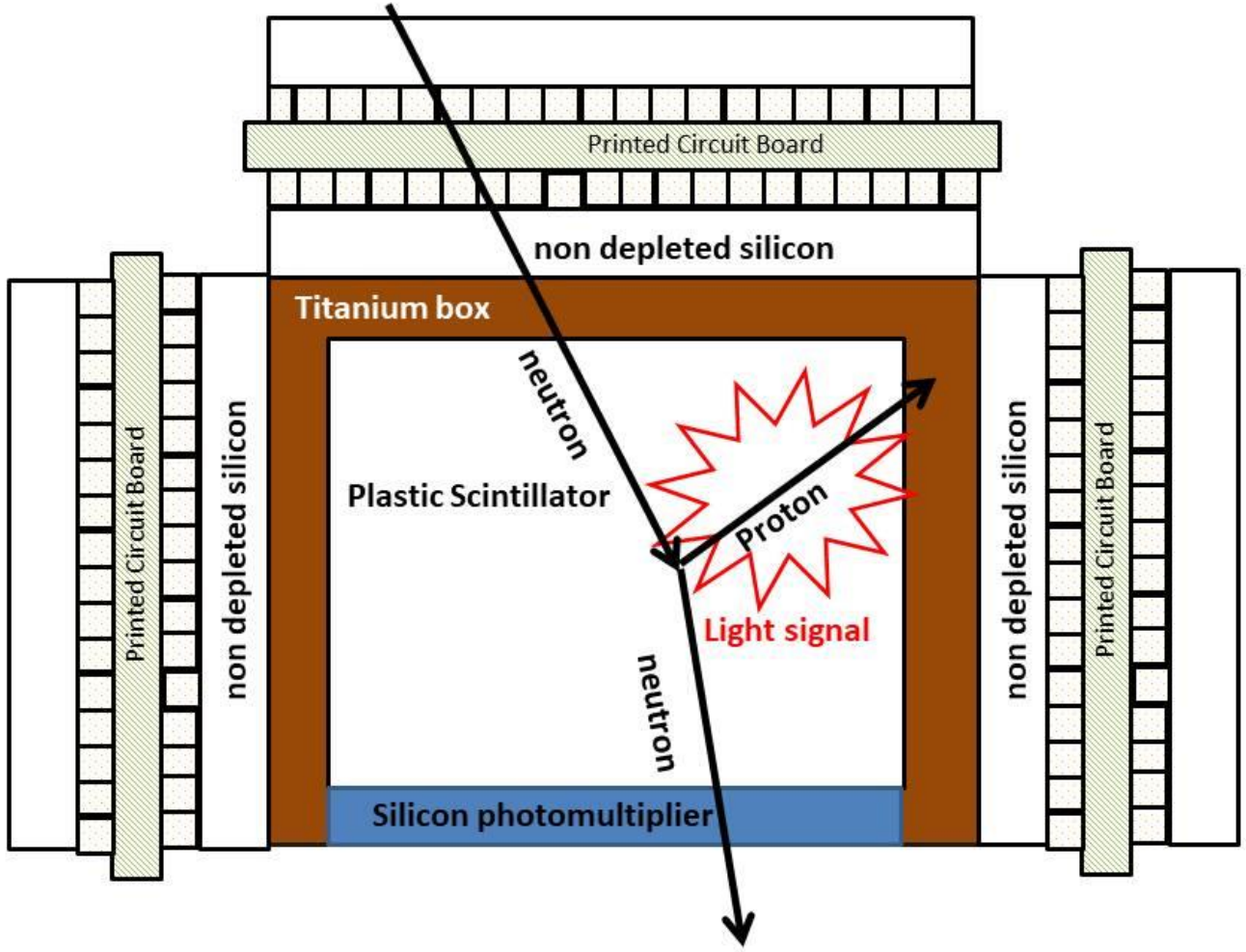
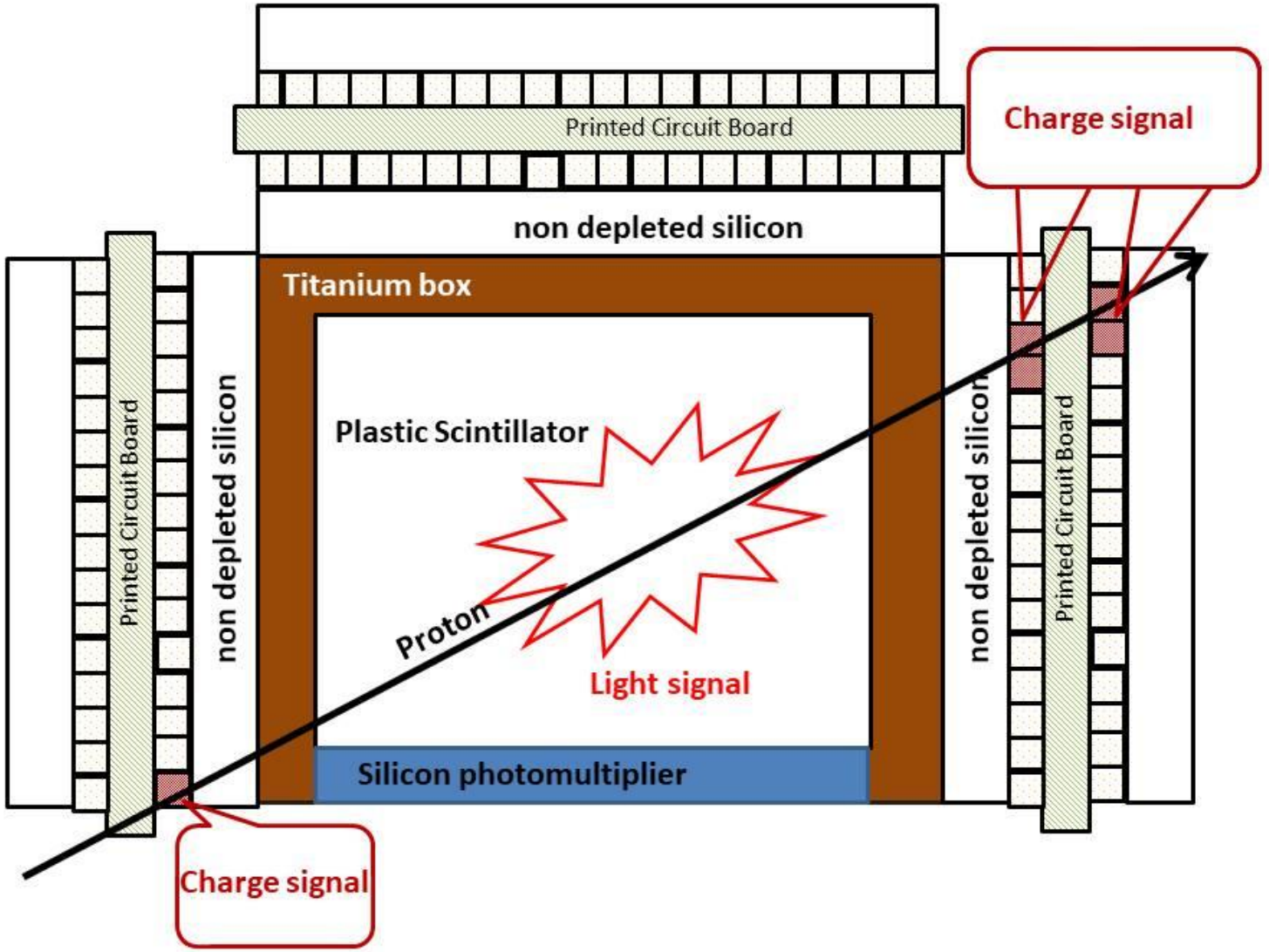


The device concept (II)



The device concept (II)



Monolithic Active Pixel Sensors

Monolithic active pixel sensors for charged particles were applied in space well before the hep community discovers them.

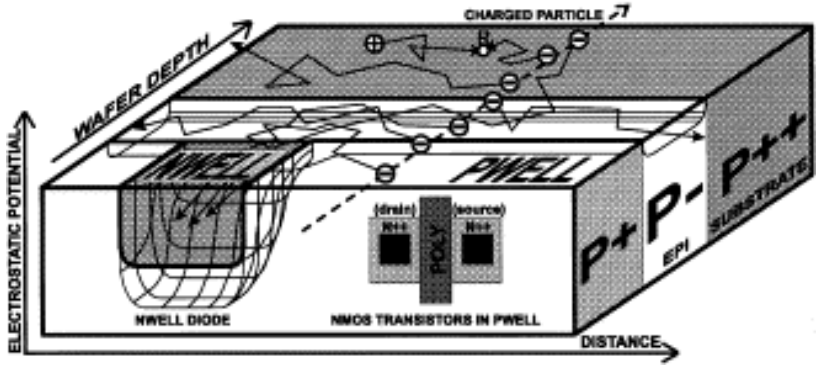
CMOS Charged Particle Spectrometers

G. A. Soli, H. 13. Garrett, and E.R.Fossum

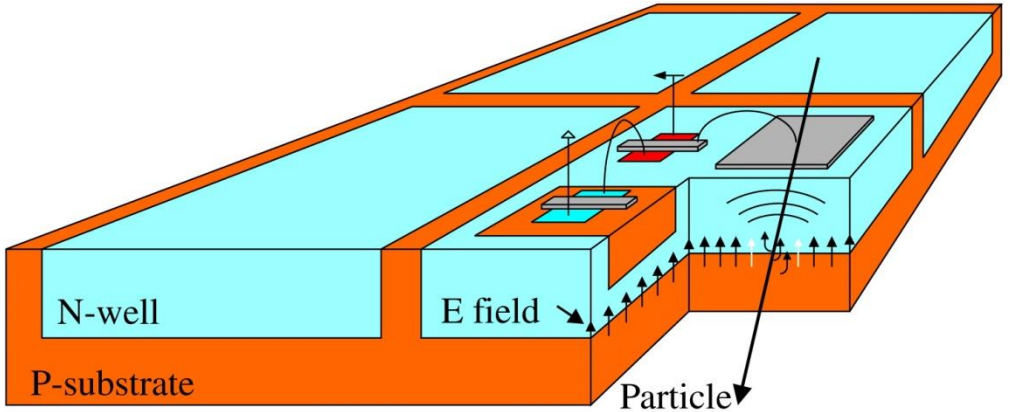
Center for Space Microelectronics Technology
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109

Integrated circuits, manufactured in CMOS technology, have been developed as diffusion -based charged particle spectrometers for space applications. Current designs are single-chip spectrometers capable of uniquely identifying and counting electrons and heavy ions. A four-chip spectrometer designed to count protons and heavier ions was flown on the Clementine spacecraft. The spectrometer proton response is compared to GOES-6 proton data for the 21 February 1994 solar proton event.

G.A. Soli, H.B. Garrett, E.R. Fossum, "CMOS charged particle spectrometers", IEEE Trans. Nuclear Science, vol. 43(3) pp. 1516-1520 (1996)



R Turchetta et al. "A monolithic active pixel sensor for charged particle tracking and imaging using standard VLSI CMOS technology", Nucl. Instr. and Meth. A, 458 (2001)

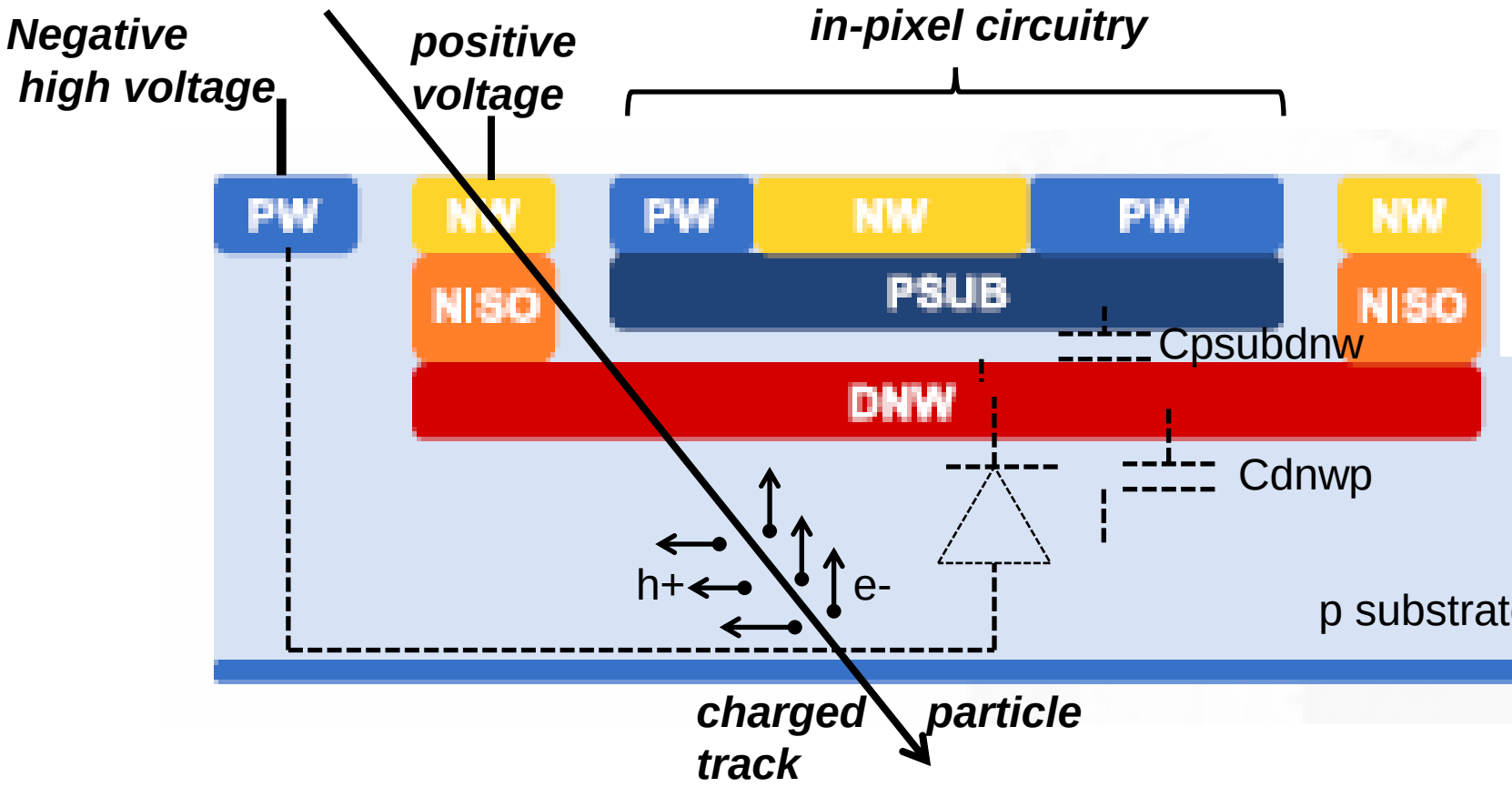


Ivan Peric, "A novel monolithic pixelated particle detector implemented in high-voltage CMOS technology", Nucl. Instr. and Meth. A, 582 (2007)

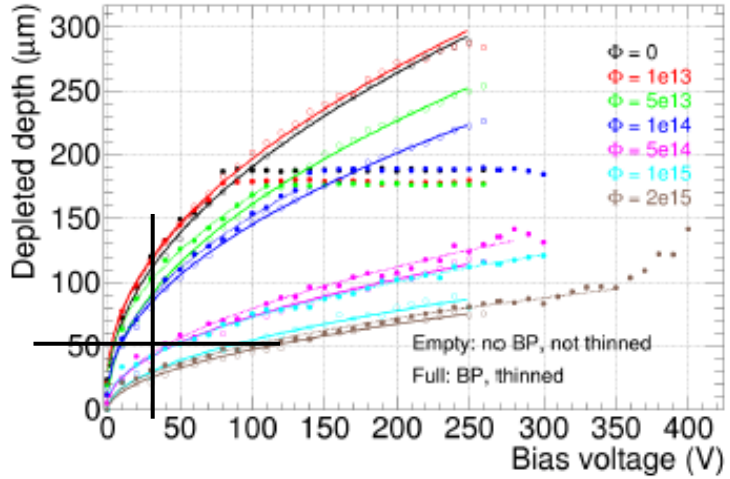
High Voltage CMOS

Principle of operation illustrated

in the manufacturer technology chosen:

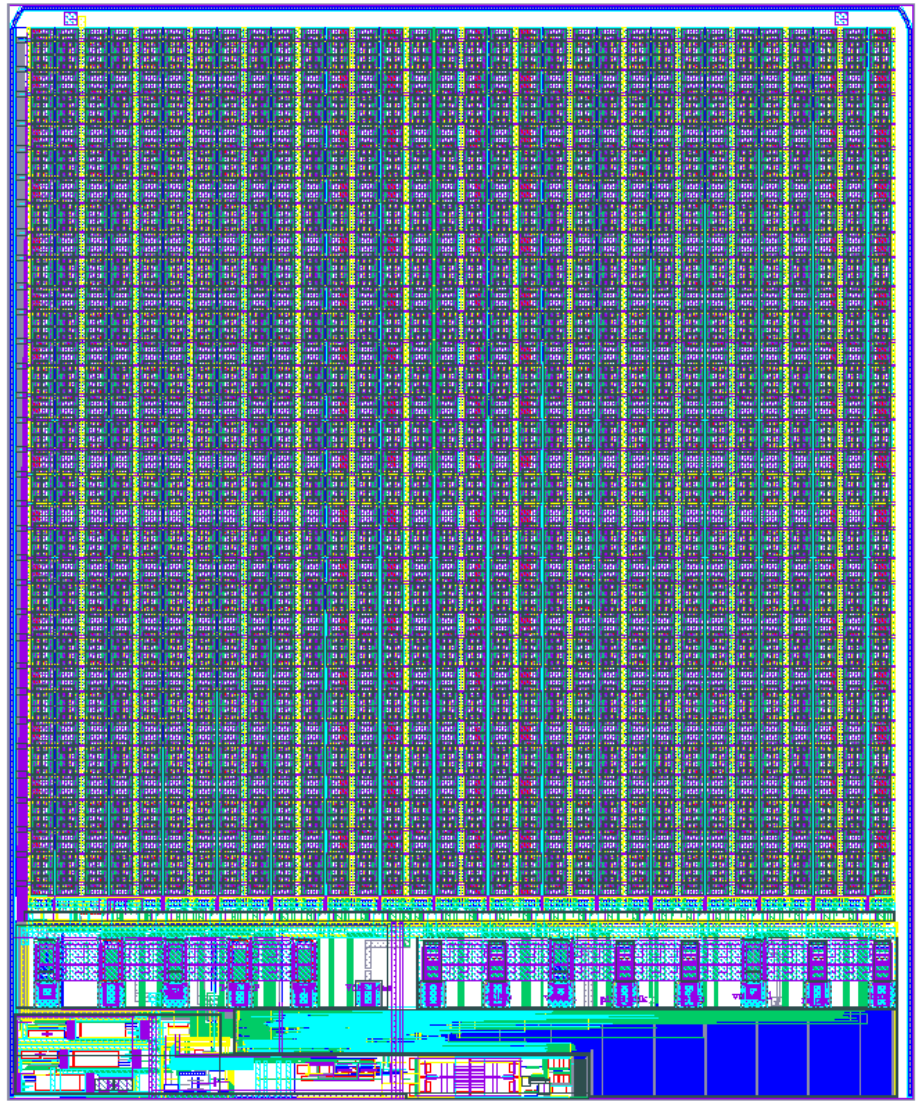


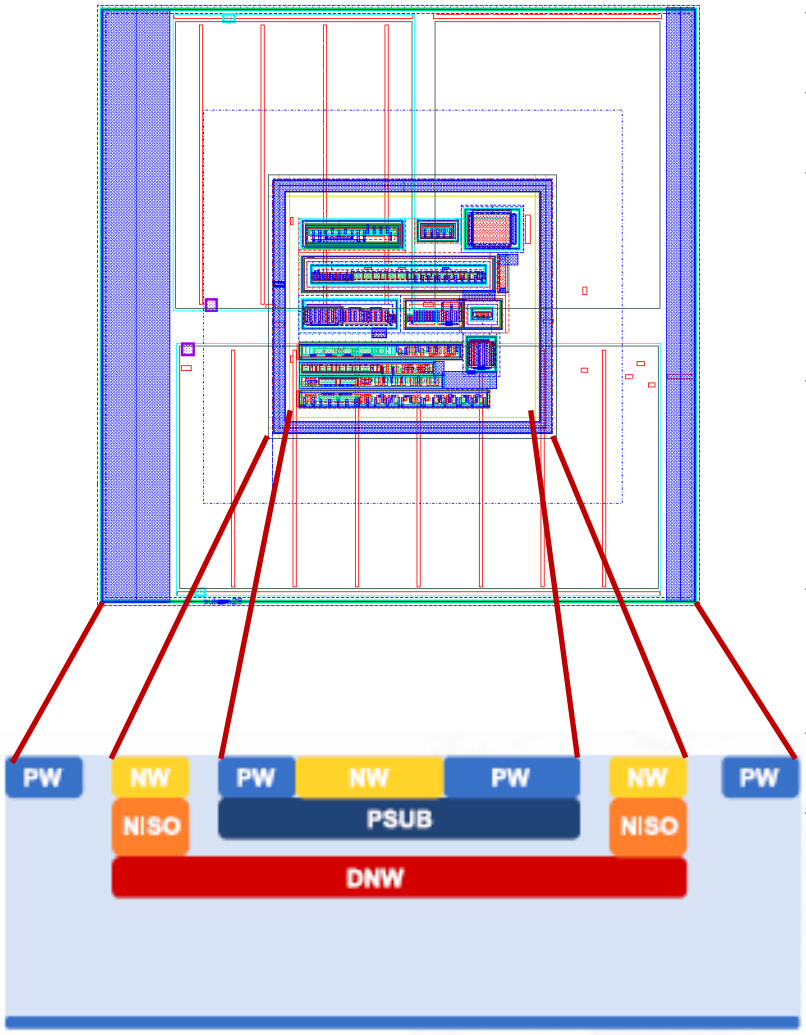
Direct measurement of the depletion depth for substrate with ρ=3 KOhm ·cm



I. Mandic et al. Charge collection properties of irradiated depleted CMOS pixel test structures arXiv:1801.03671v2 [physics.ins-det], 22 Jan 2018

The HVCMOS Si sensor

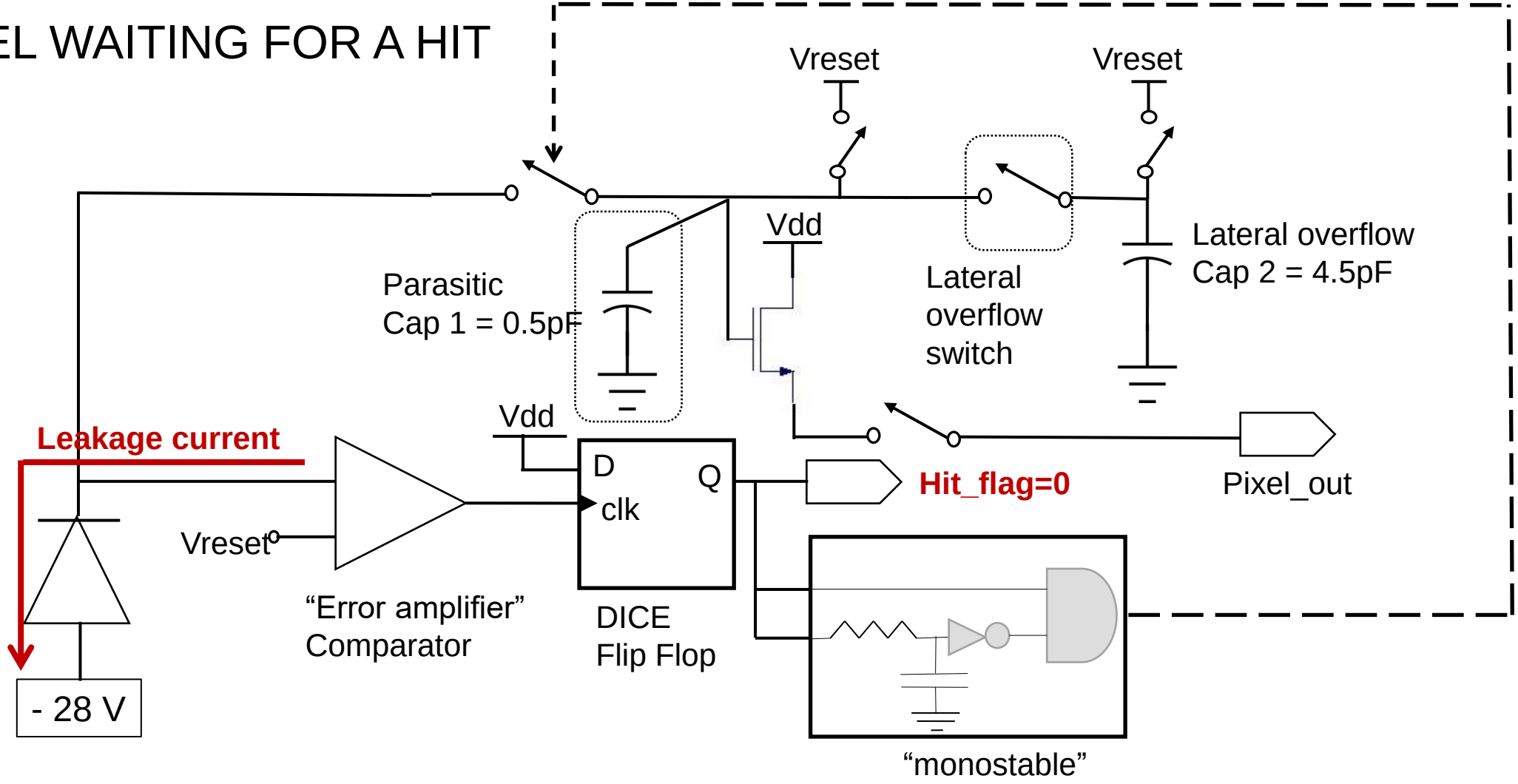




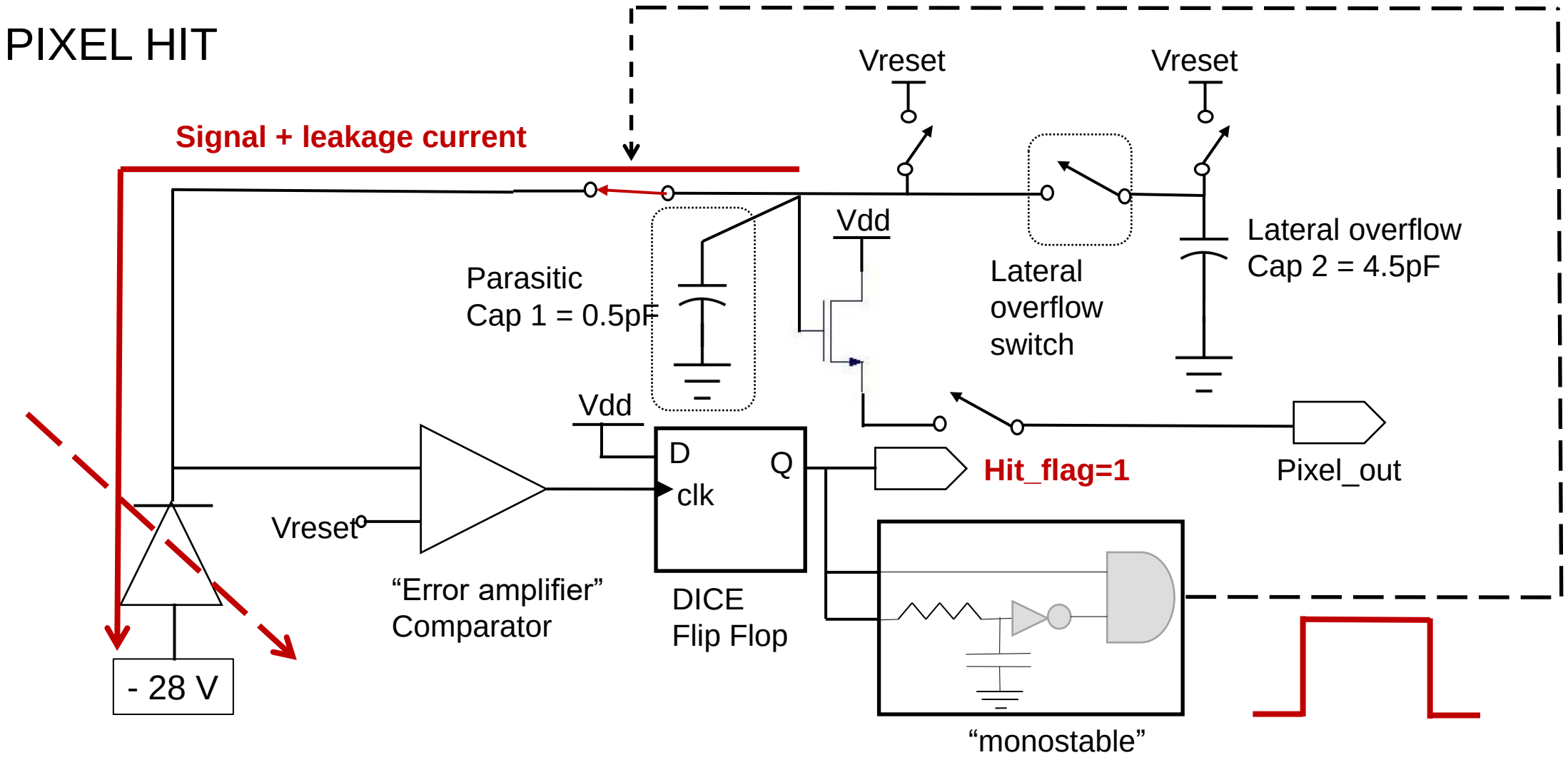
- ✓ 32 rows x 32 columns
- ✓ 105.5 um pixel pitch
- ✓ Charge signal dynamic range: Min:0.5fCb, Max:5 pCb ***(80db)***
- ✓ Pixel static power consumption: <100 nA @ 1.8V
- ✓ Embedded A/D converter (11 bits)
- ✓ Only hit pixels are readout
- ✓ Information output: Hit flag and from pixels hit: Serially, 10 bits address, 22 bits charge signal

Pixel operation explained

PIXEL WAITING FOR A HIT

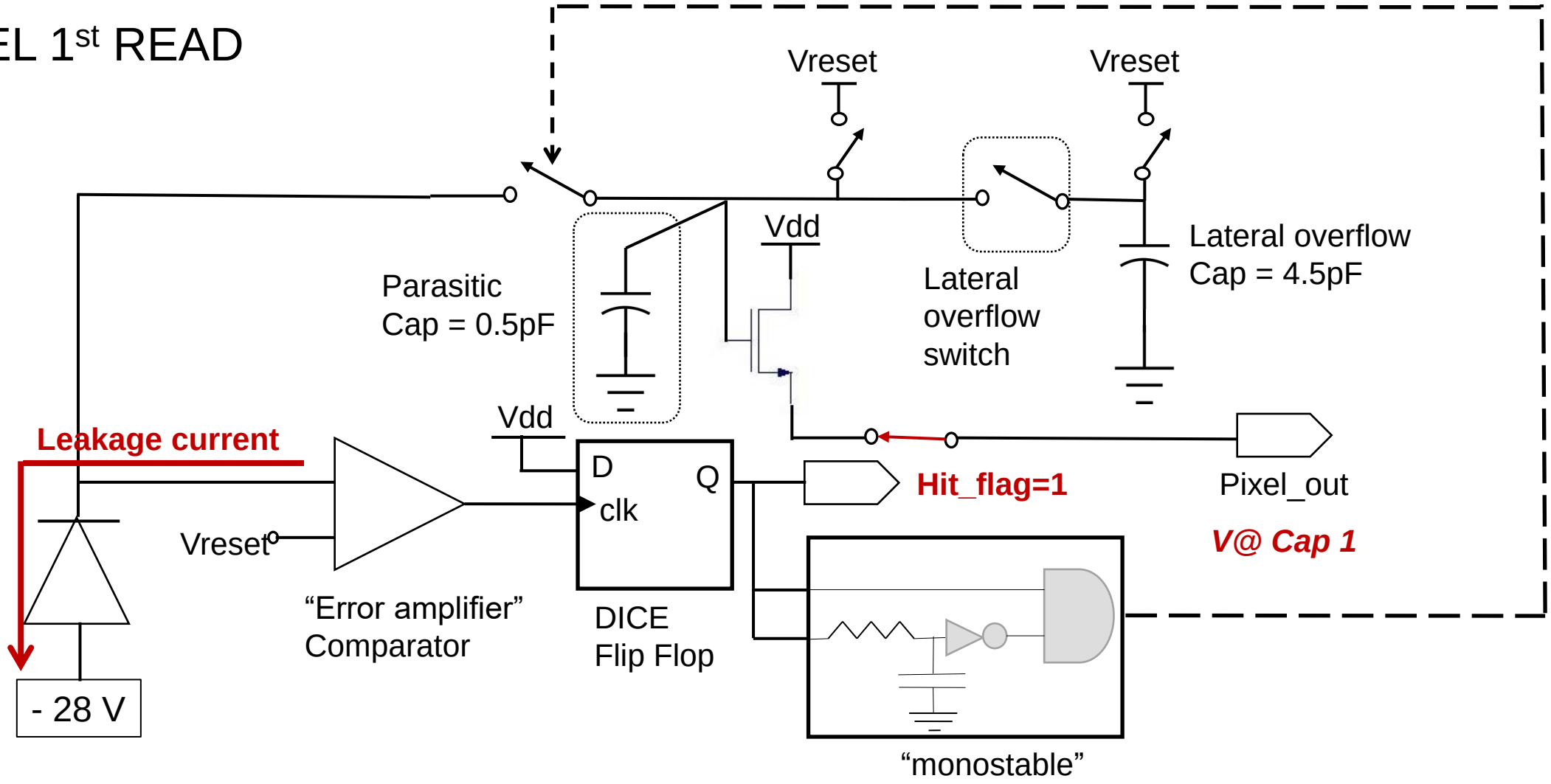


Pixel operation explained



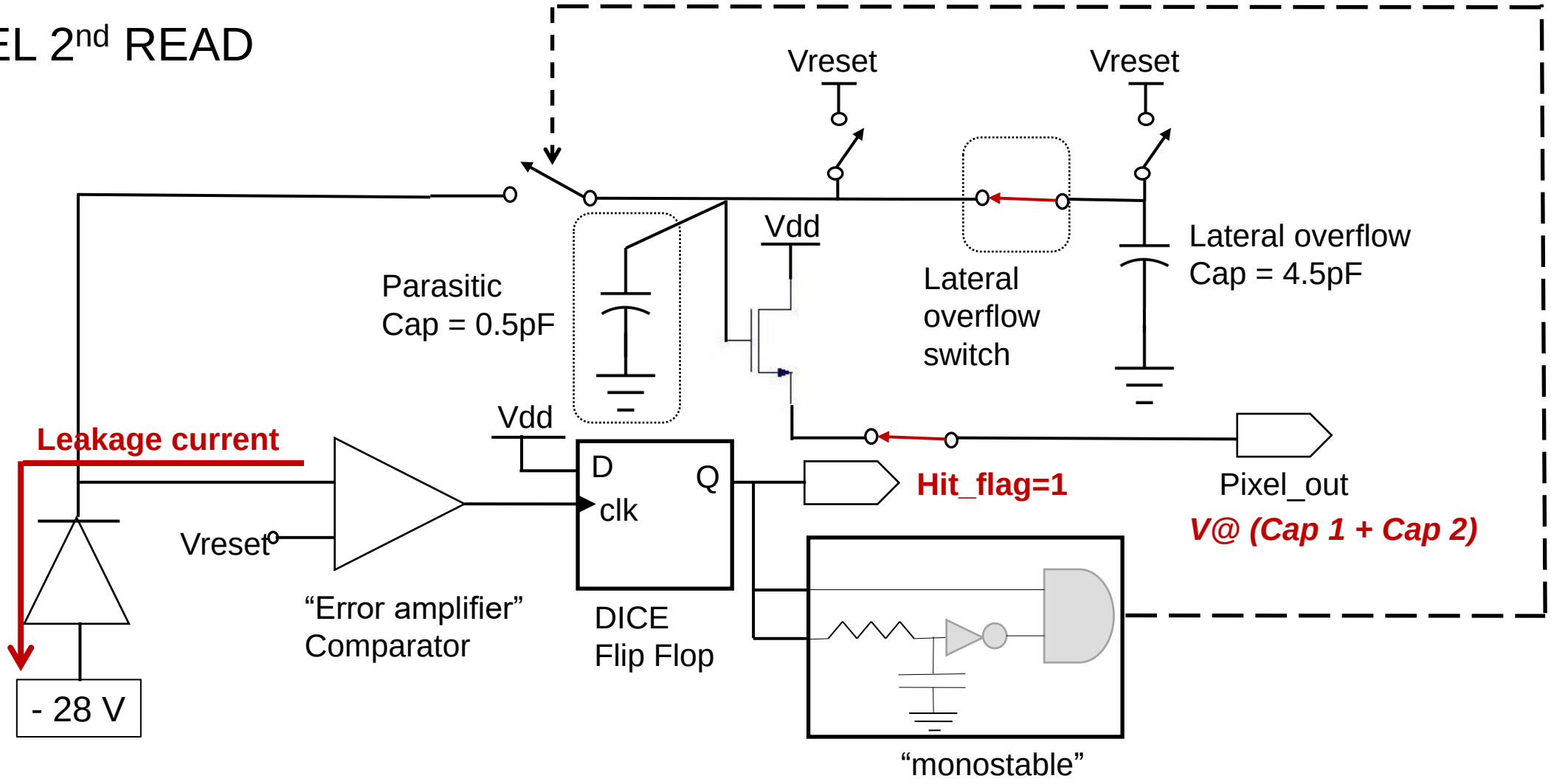
Pixel operation explained

PIXEL 1st READ



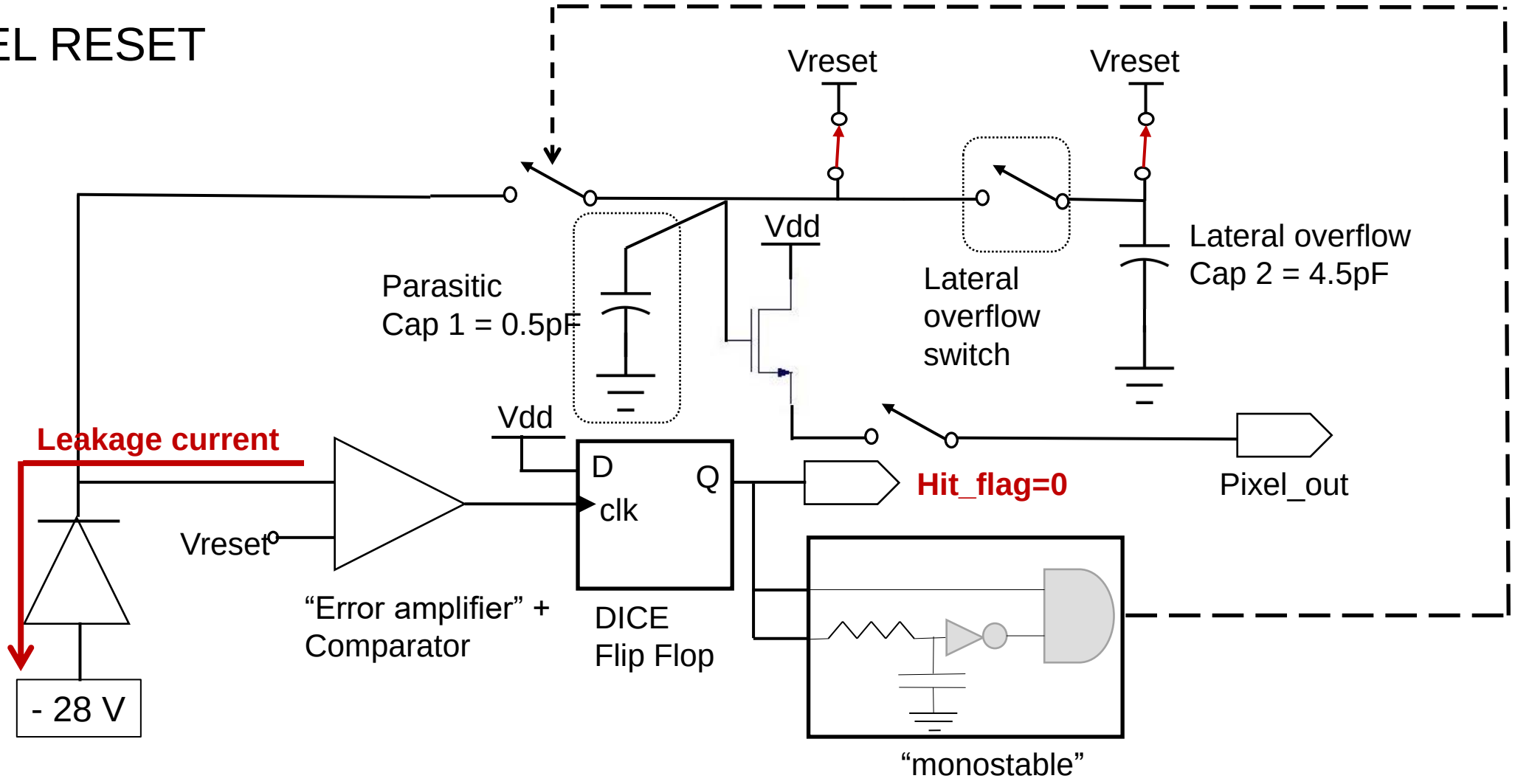
Pixel operation explained

PIXEL 2nd READ

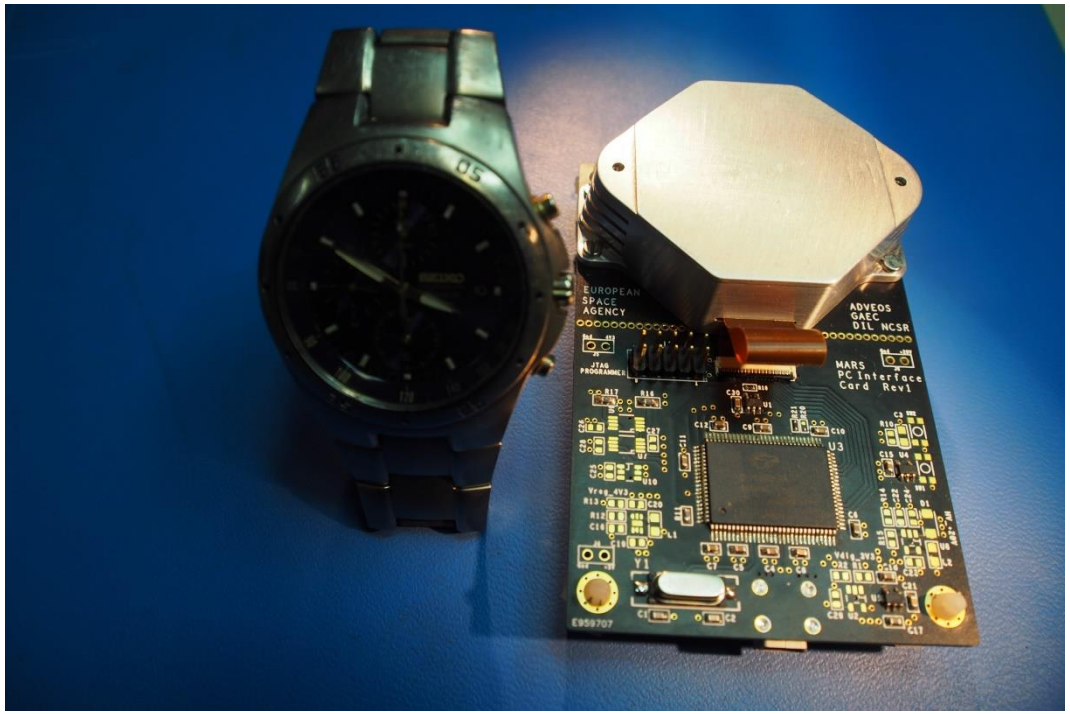


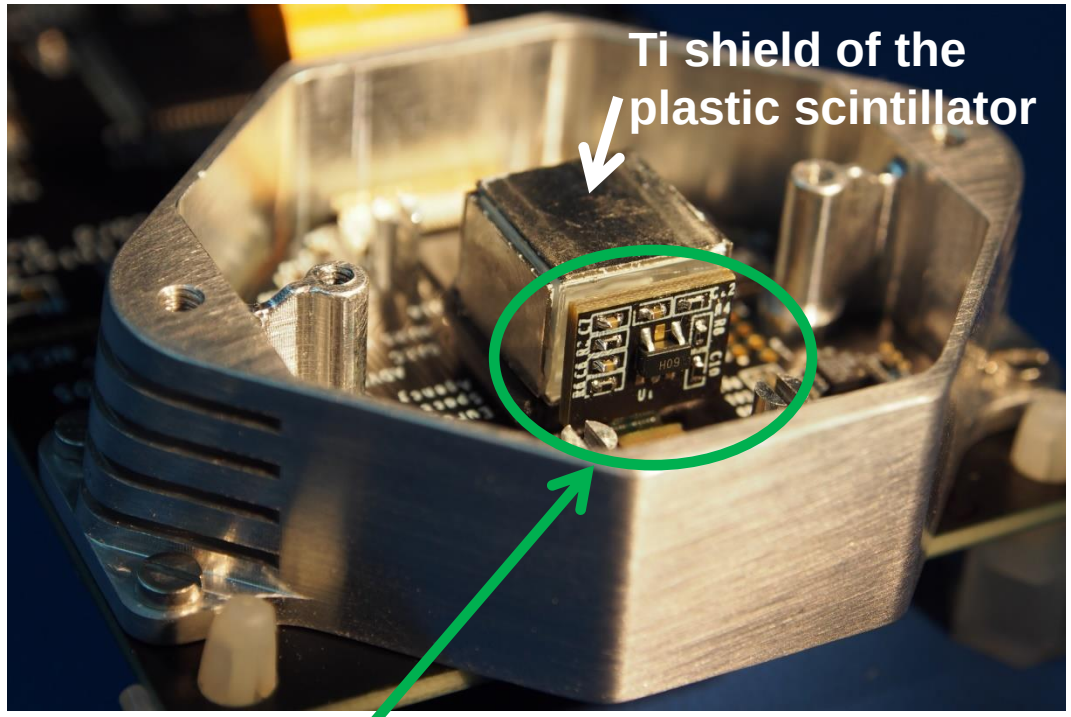
Pixel operation explained

PIXEL RESET



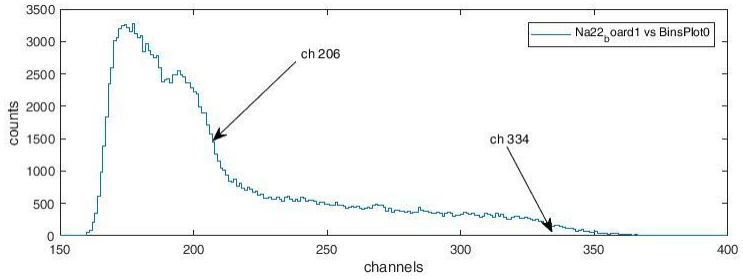
1st prototype



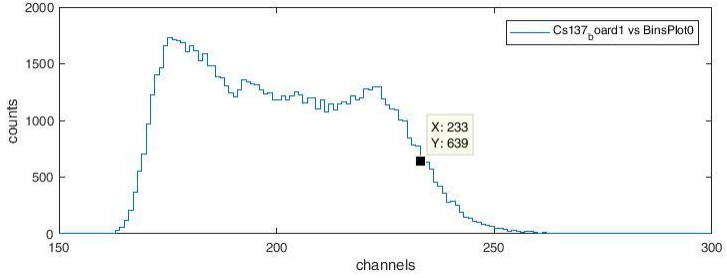


The silicon photomultiplier readout electronics

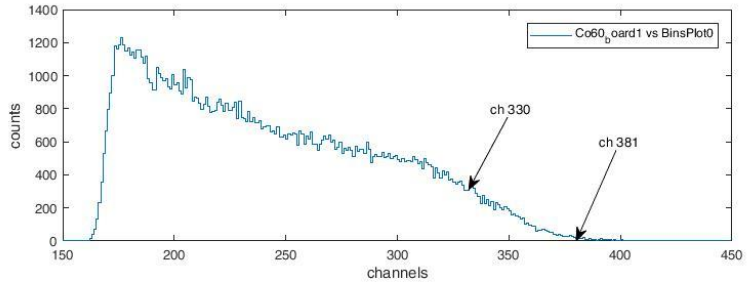
Measurements with n/γ (very preliminary)



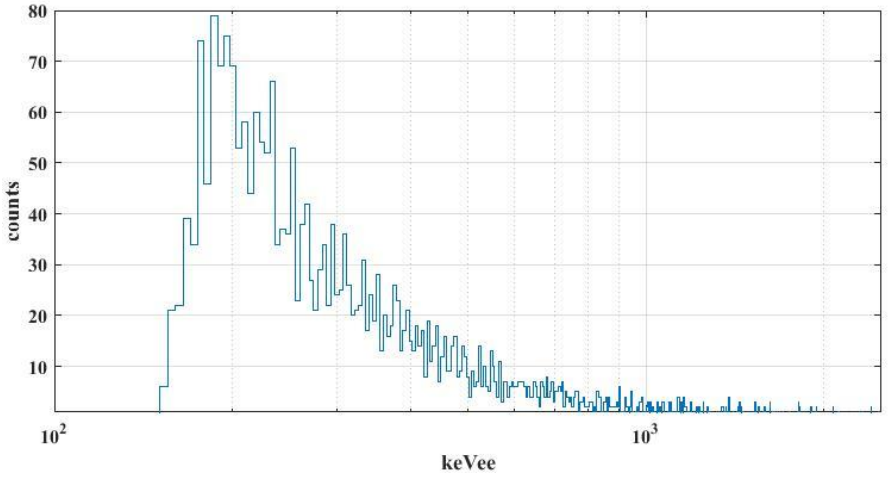
Na22



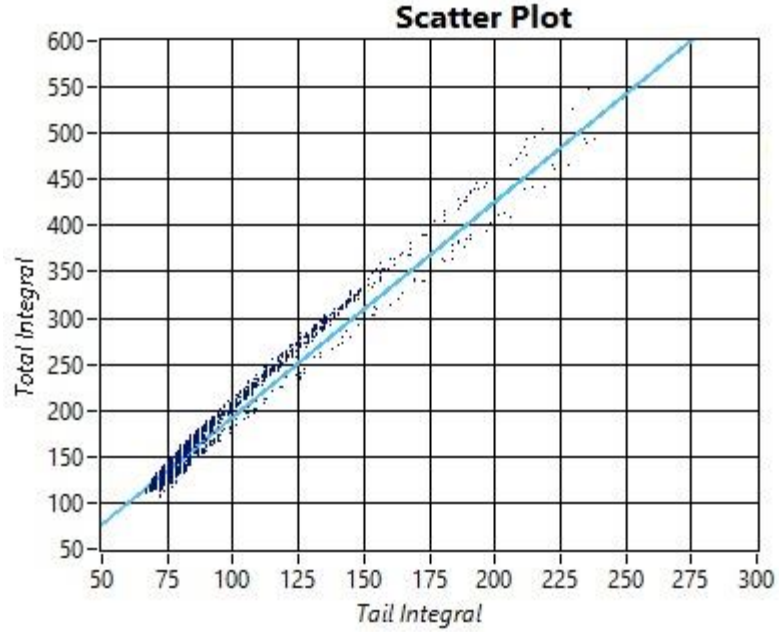
Cs137



Co60



Cf252



16.5 MeV
Neutron beam

What is next:

- Analysis of first neutron beam measurements
- Measurement at CERF facility @ CERN
- Preparation for the silicon sensor tests
- Continue simulations