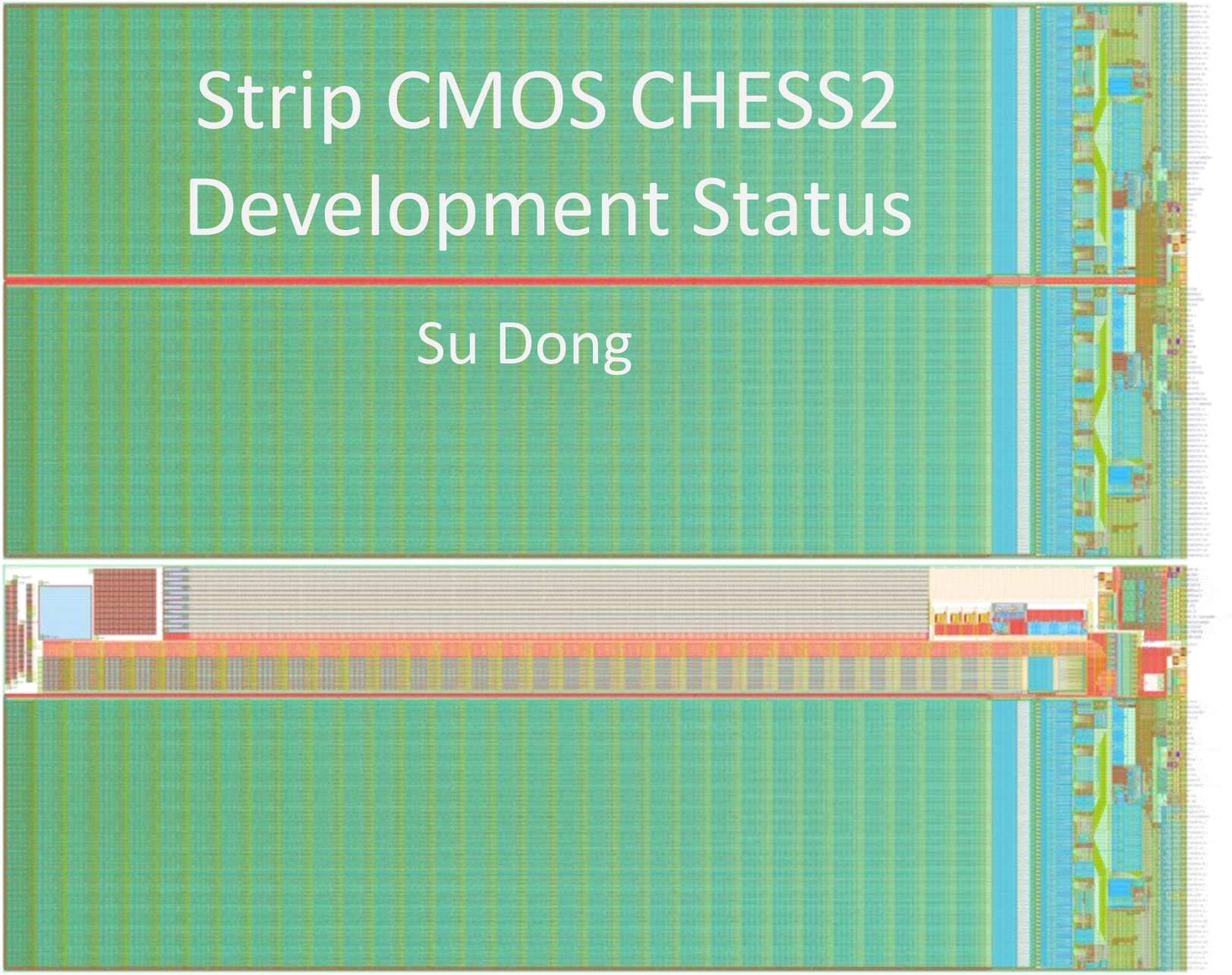
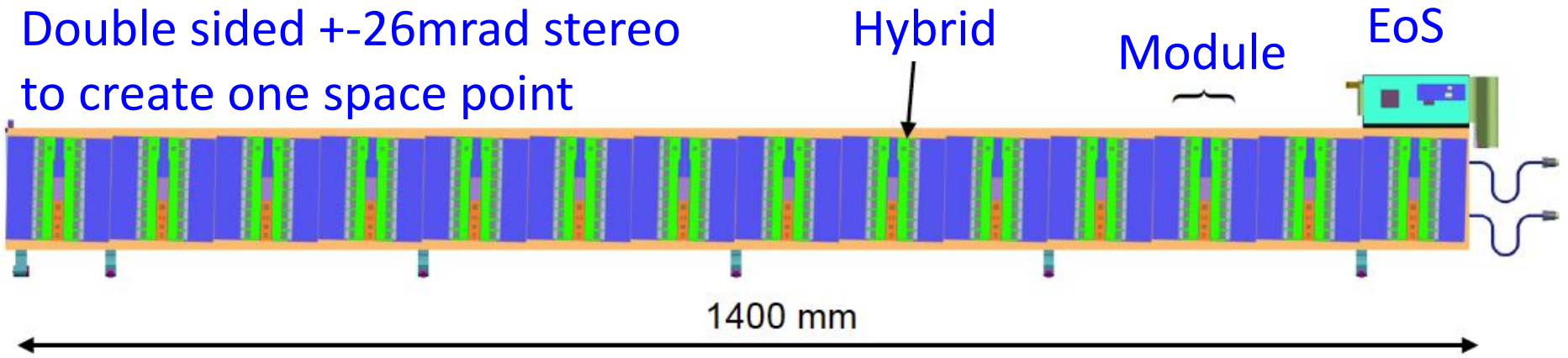
Strip CMOS CHESS2 Development Status

Su Dong



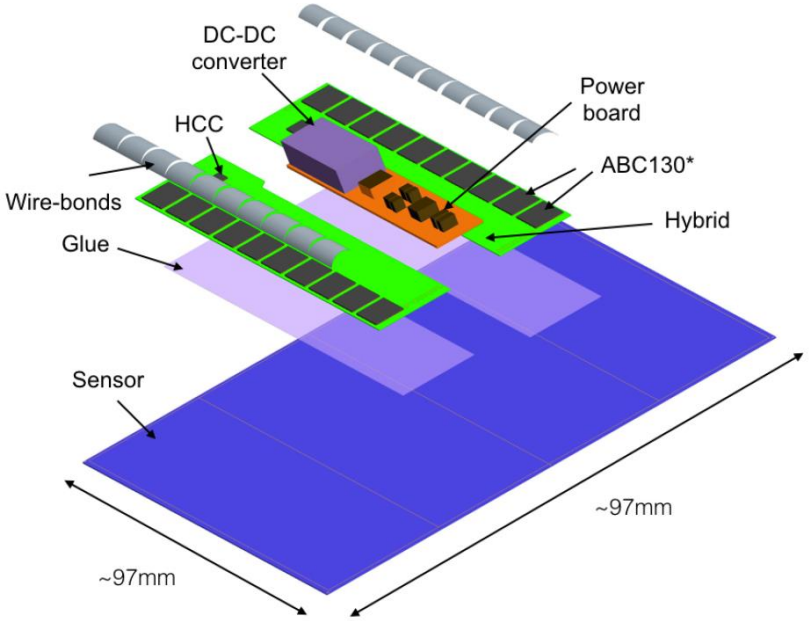
ITk Strip Stave Baseline

Double sided +-26mrad stereo
to create one space point



Short Strip Module:

- 4 sections of 25mm long strips
- 75.5μm strip pitch
- 4x1280=5120 strip channels individually wire bonded to ABC130*
- 2 hybrids of 10 x ABC130* + 1 HCC*

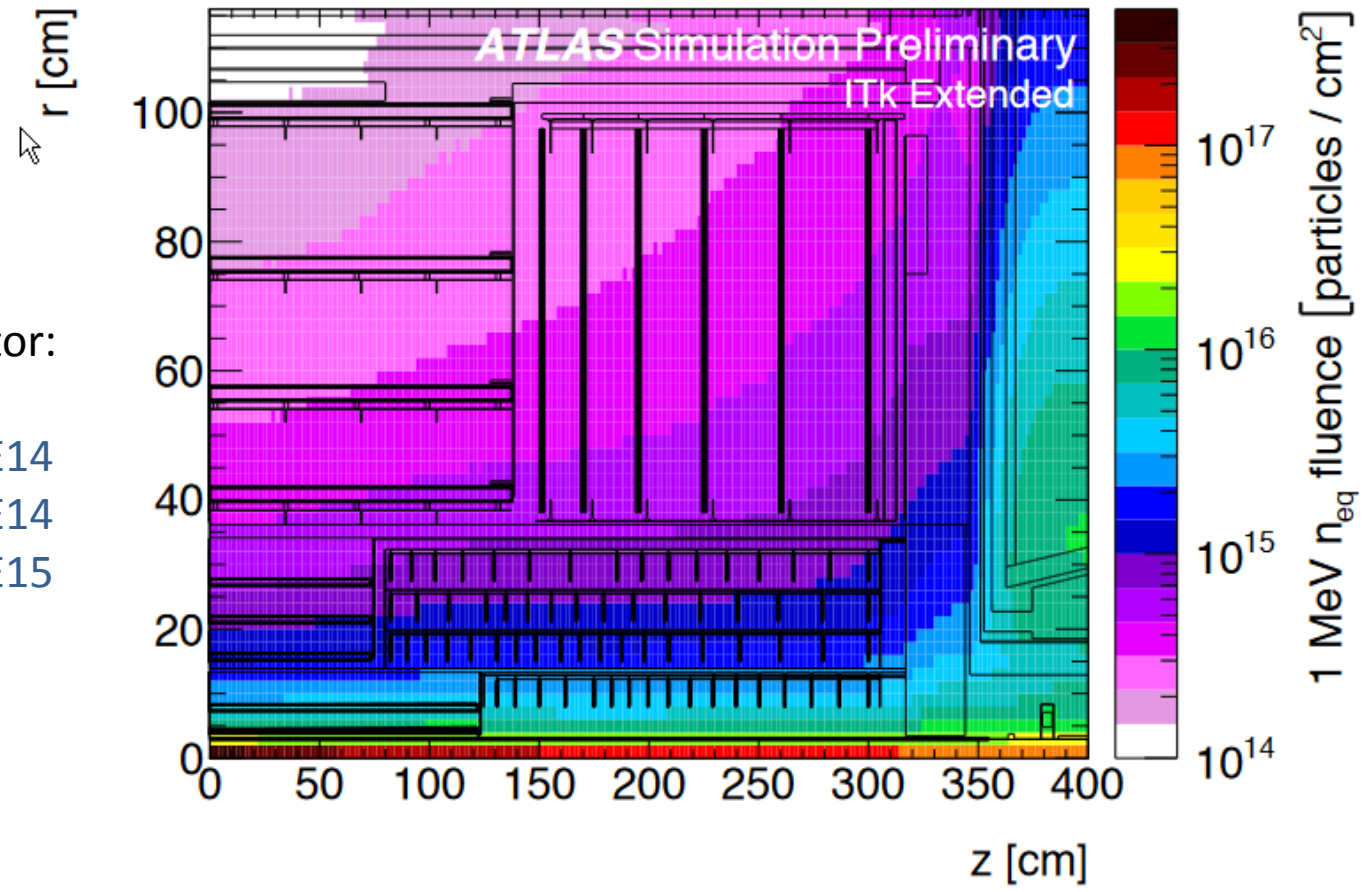


Full ITk strip system is 165 m^2 of strip sensors

ITk Radiation Dose

Strip regions
with 1.5 safety factor:

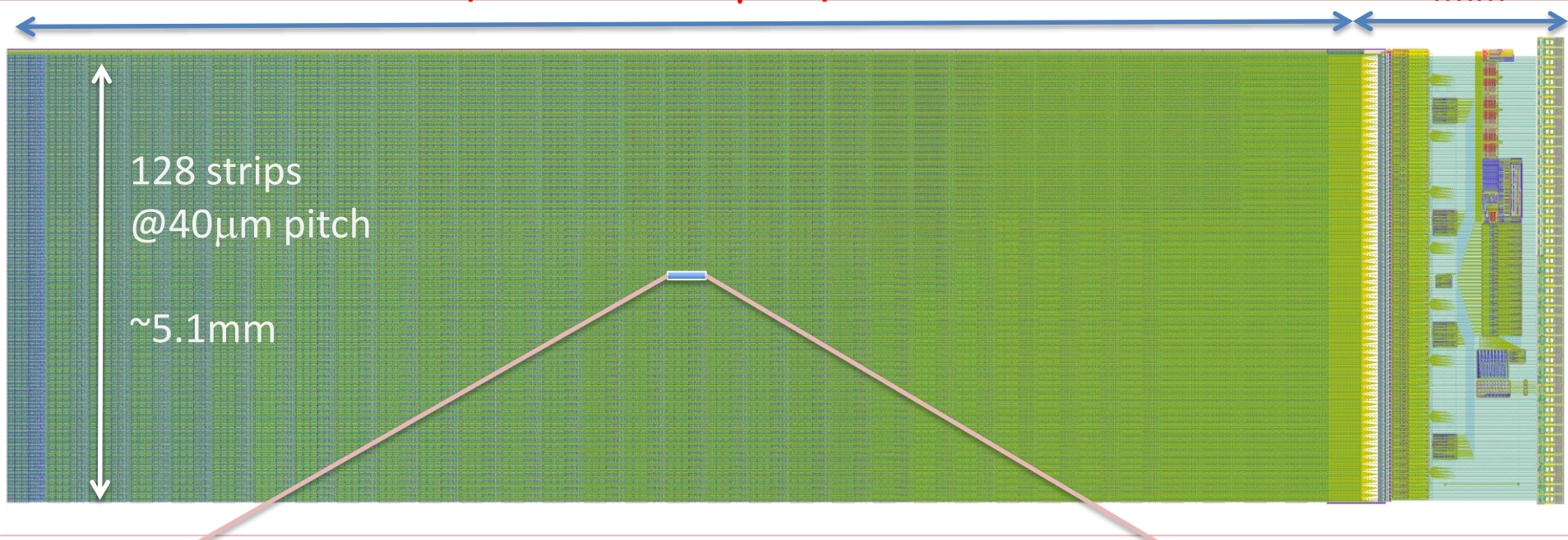
Long strips:	4.2E14
Short strips:	8.1E14
Endcap:	1.2E15



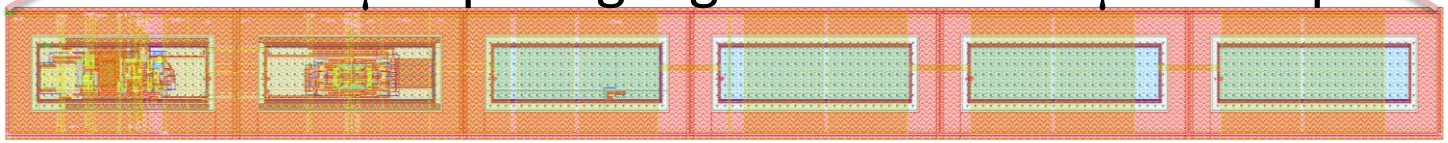
CHESS2 Replacement MAPS

~2cm 'strip' = 32 x 630μm pixels

Digital balcony ~4mm



Individual 40x630μm pixel ganged from 6x105μm sub-pixels:

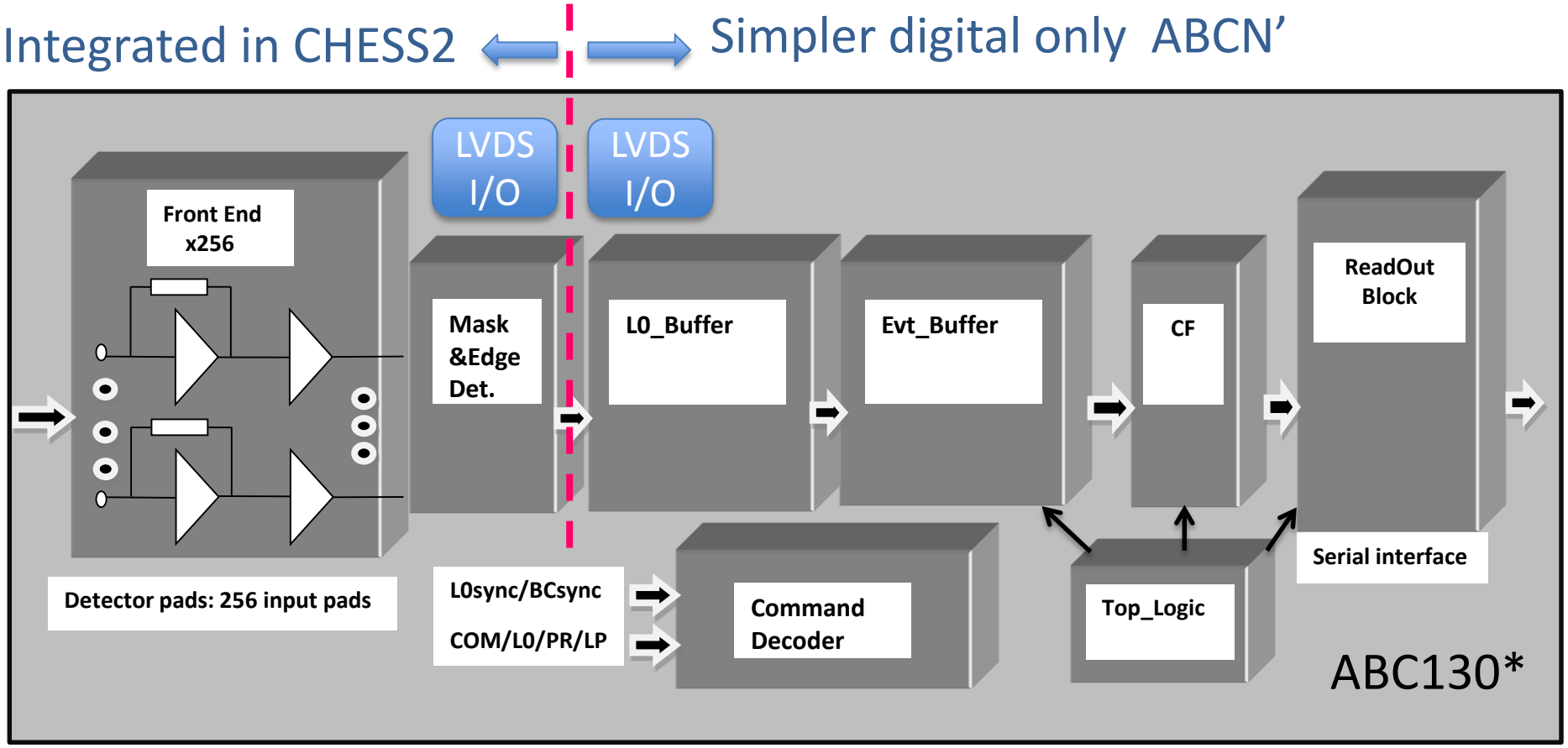


Amplifier, comparator +mem, charge injection, pixel select

Hit encoding
Hit memory
SACI control
LVDS I/O

More CHESS2 design details in Piero Caragiulo's talk at SLAC/Stanford upgrade meeting

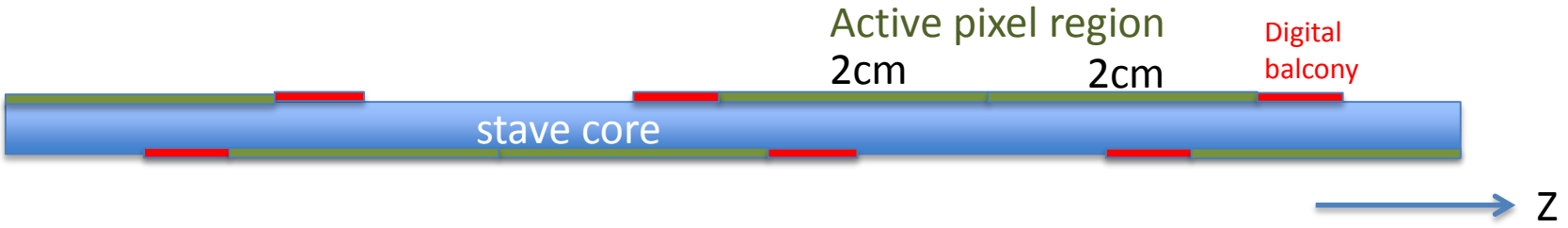
ABC130*->ABCN' Simplification



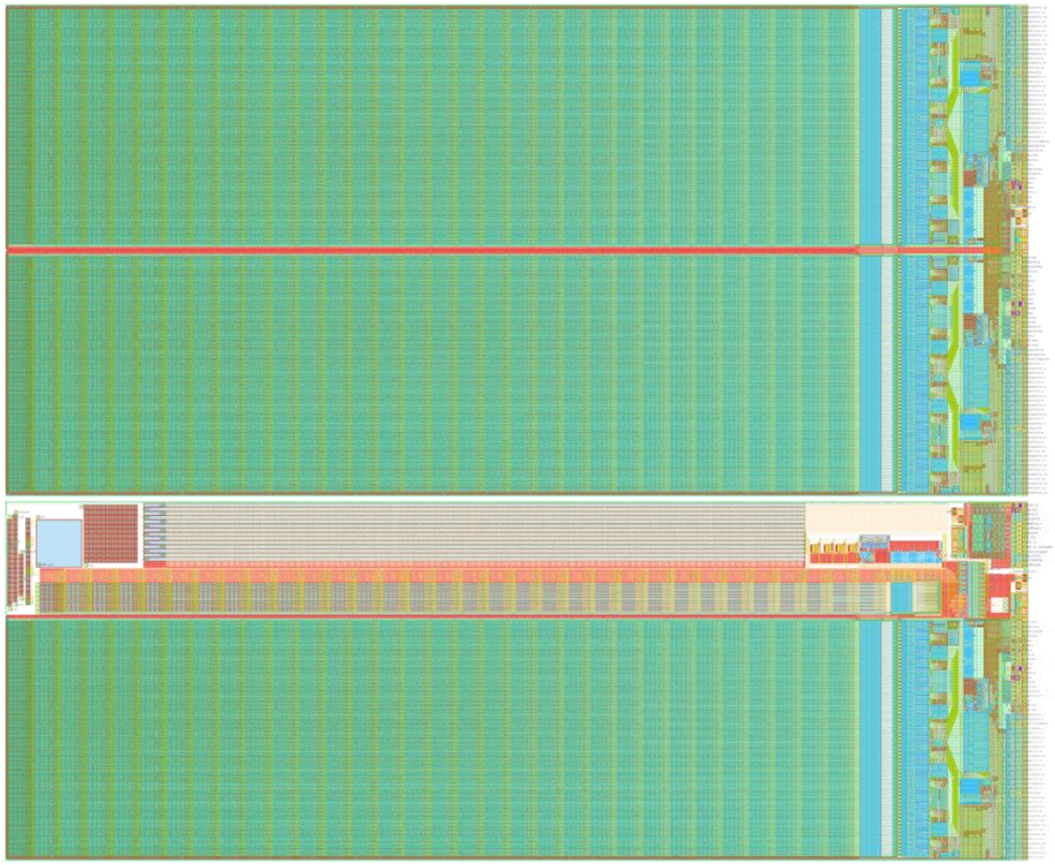
- Eliminating 256 analog strip wire bonds / ABC*
- Adding 2x28 LVDS digital lines at CHESS2->ABCN' interface
- Reuse HCC* and rest of strip readout chain and stave infrastructure

CHESS2 based ‘module’

- 2x20 CHESS2 chips form a 10cm(ϕ)x4cm(z) module
- Each module has 2x2560 strips covered by 10 (?) ABCN’+1 HCC
- One side (2D pixel) establishes 3D space point by itself
- Still double sided stave to stagger modules up and down to give space to digital balcony, but much more relaxed spacing
- spatial resolution:
  - Rϕ: one 40μm pitch space point trading for two strip hits of 75.5μm pitch (/$\sqrt{2}$ ~ 53μm) is still slightly better
  - Z: 630μm pixel much better than 52mrad stereo over 2.5cm.
- Pattern recognition: 40x630μm pixel much more superior



CHESS2 Chips

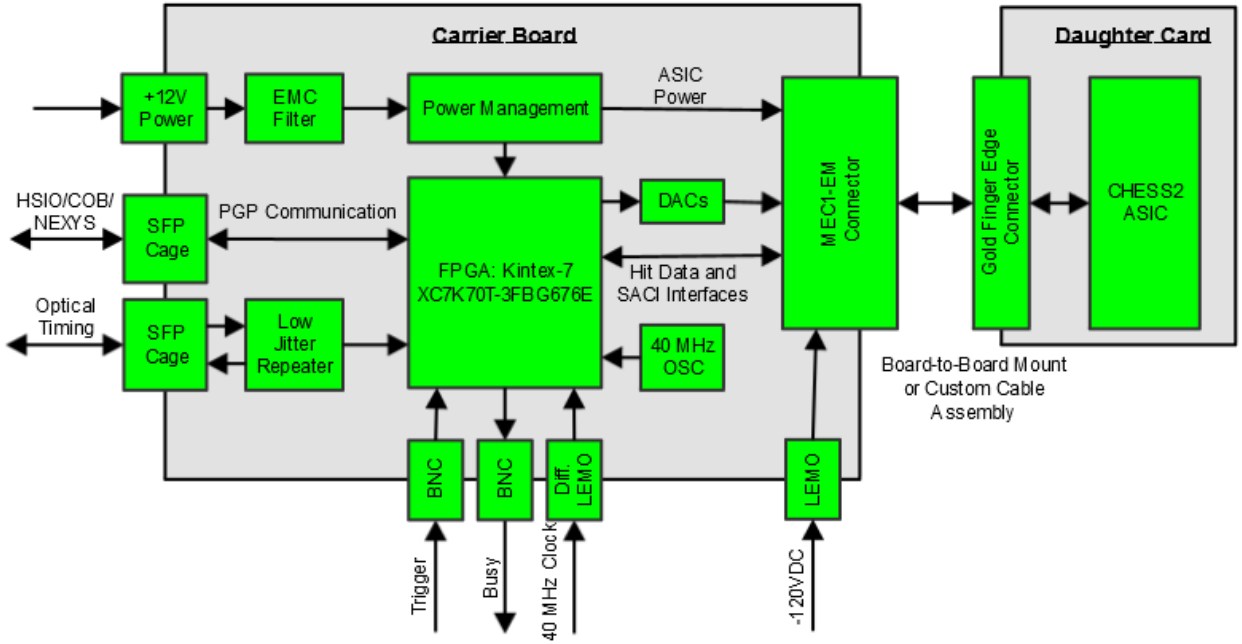


4 types of resistivities:

- 20 Ωcm (standard)
- 50-100, 200-300 Ωcm
- 600-2000 Ωcm

CHESS 2 Test Readout

- Analog test boards on test structures: Oxford
  - Some loaded analog daughter cards already went for irradiation at CERN PS (proton) and Ljubljana (neutron)
- Full digital array readout: SLAC



Documentation collection started at:

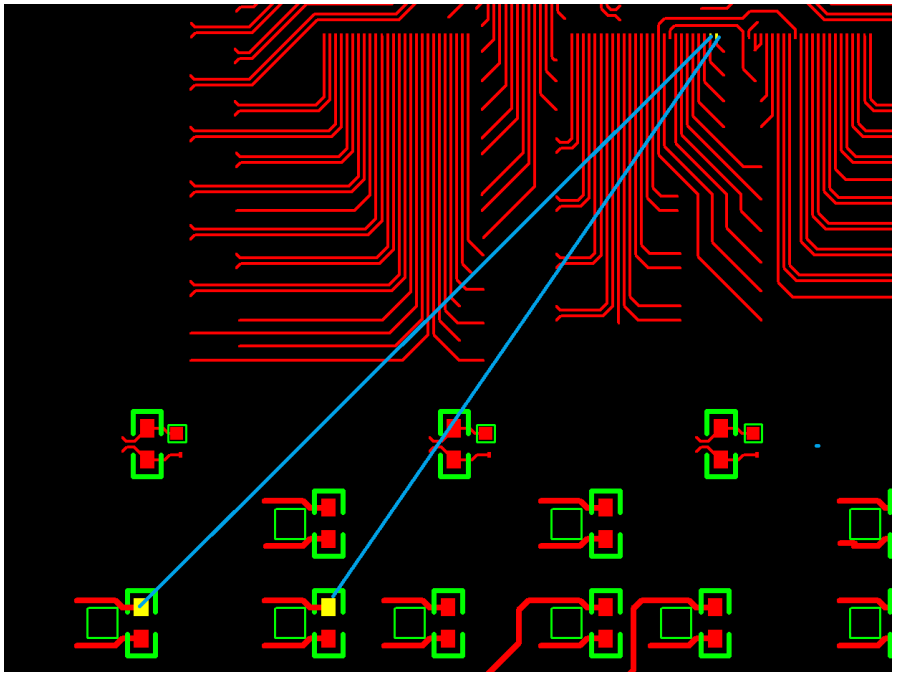
https://twiki.cern.ch/twiki/bin/view/Atlas/CHESSStripTestChip

Digital Test Daughter Boards

- First panel of 10 PCBs at SLAC
- Allow no-soldering option for wire bonds only – no hold up for release after irradiation
- Somewhat trickier layout (10 layers) and more expensive than original expectation due to many fine pitched wire bond pads.

Design details for daughter + carrier are documented at:
https://confluence.slac.stanford.edu/display/AIRTRACK/ATLAS%3A+CHESS2

Digital Test Daughter Board

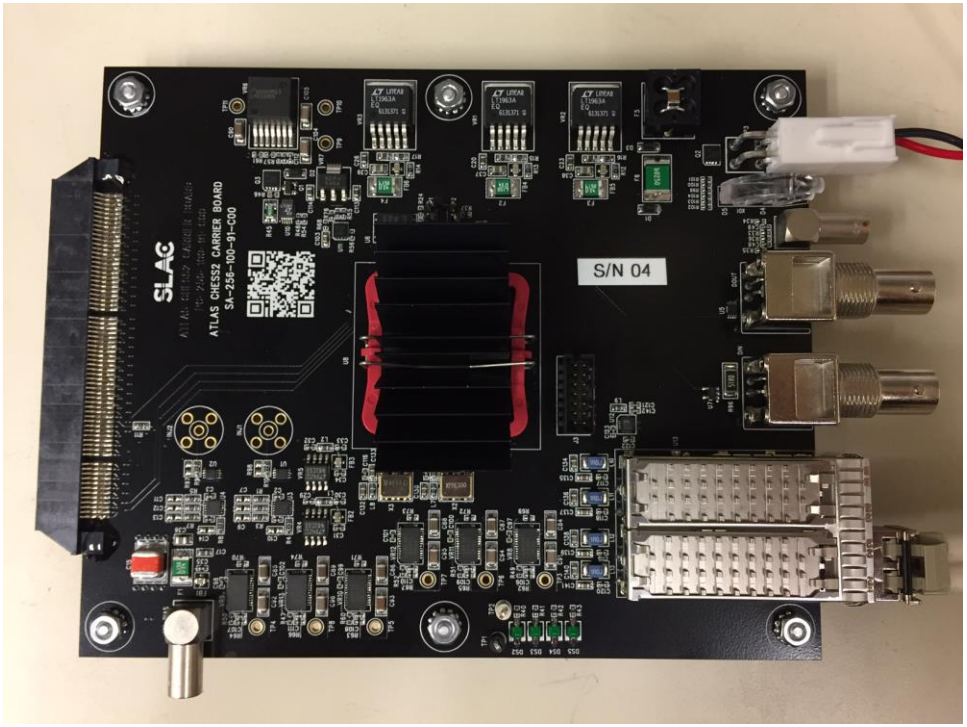


- First panel of 10 at SLAC
- One bug spotted: BL/BLR mislabelled on SamTec connector as BR/BRL caused no connect at layout.
- Two regular wire soldering patch on daughter card
- Carrier board still OK

- 3 patched daughter boards back from wire bonding @ Amtech
- 4 more at UCSC to load for further checks

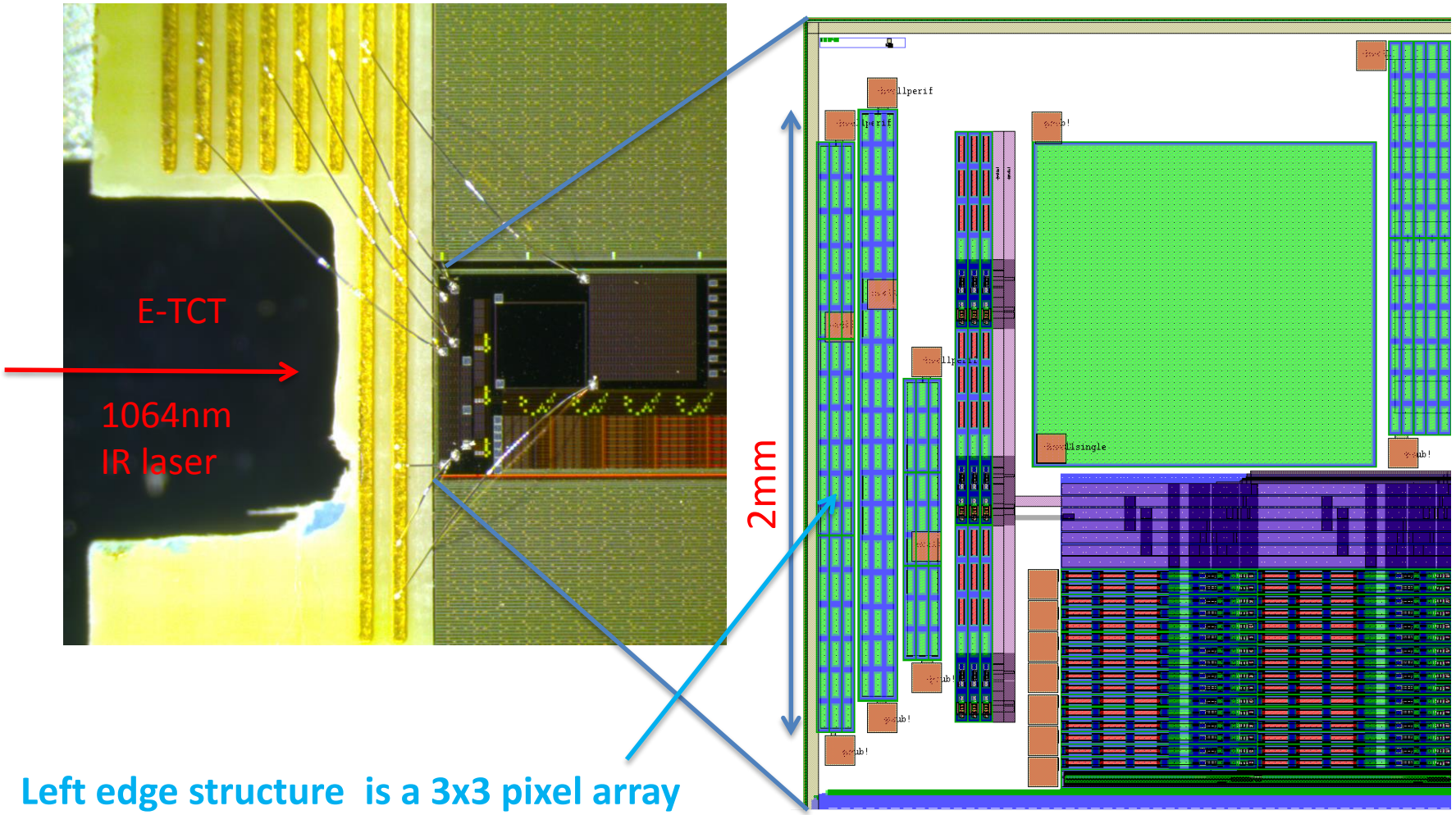
Digital Carrier Board

- First few loaded boards at SLAC
- Checks by Larry so far:
  - Power regulation OK
  - Can program FPGA and PROM with J-tag. PROM booting OK.
  - Can R/W registers via SFP port with PGP link.
- More standalone tests to come:
  - SPI DAC
  - Triggering
  - External clock
  - Data collection



- Further tests next week with loaded daughter board:
  - SACI interface
  - HV bias
  - ASIC's parallel LVDS data tuning
- Martin integrating carrier board with HSIO2 readout

Edge TCT analog tests @Ljubljana

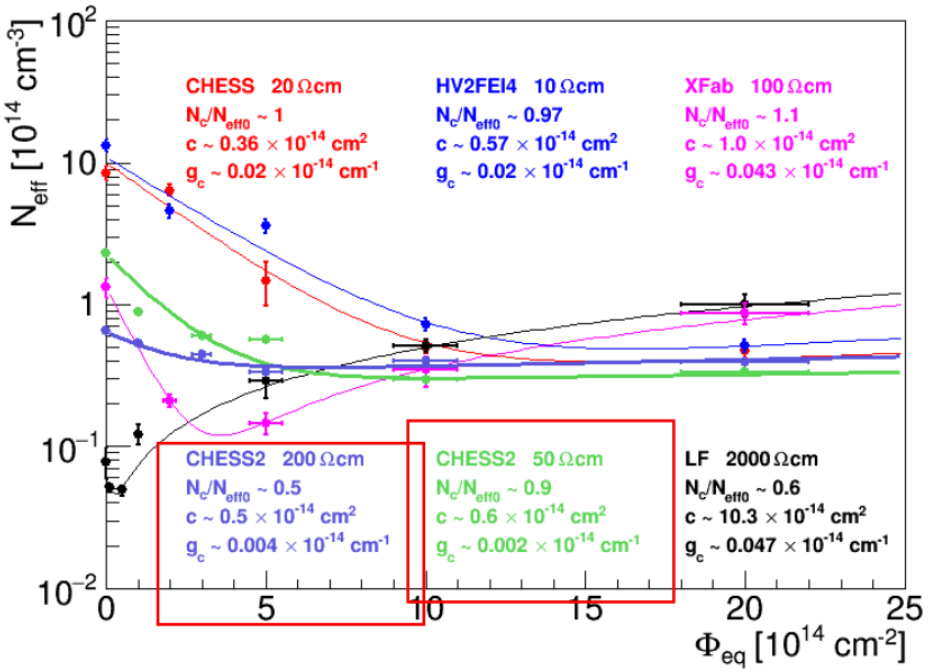


Left edge structure is a 3x3 pixel array

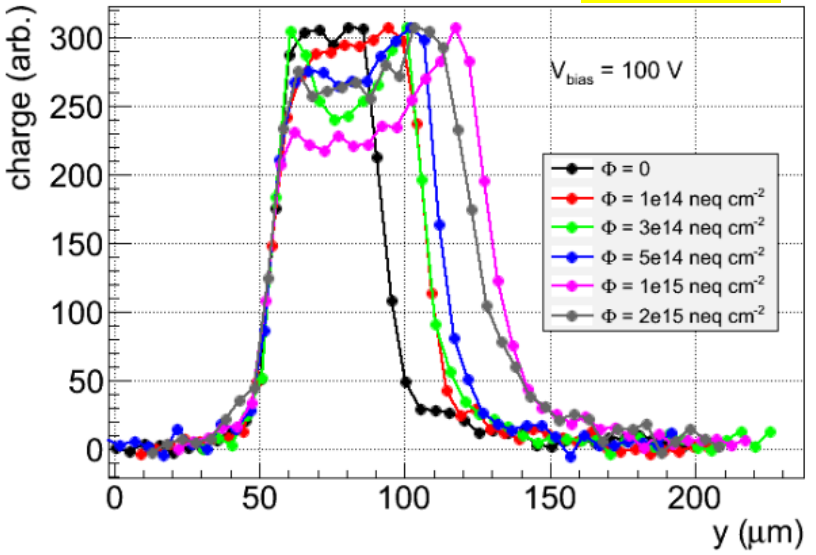
Edge TCT analog tests @Ljubljana

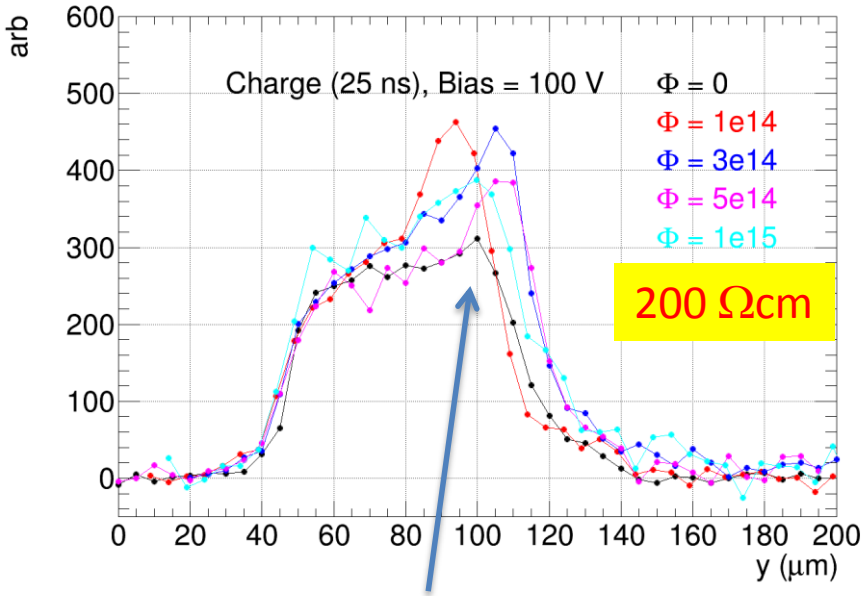
50 Ωcm

Edge-TCT charge profile
for central pixel in the 3x3 structure



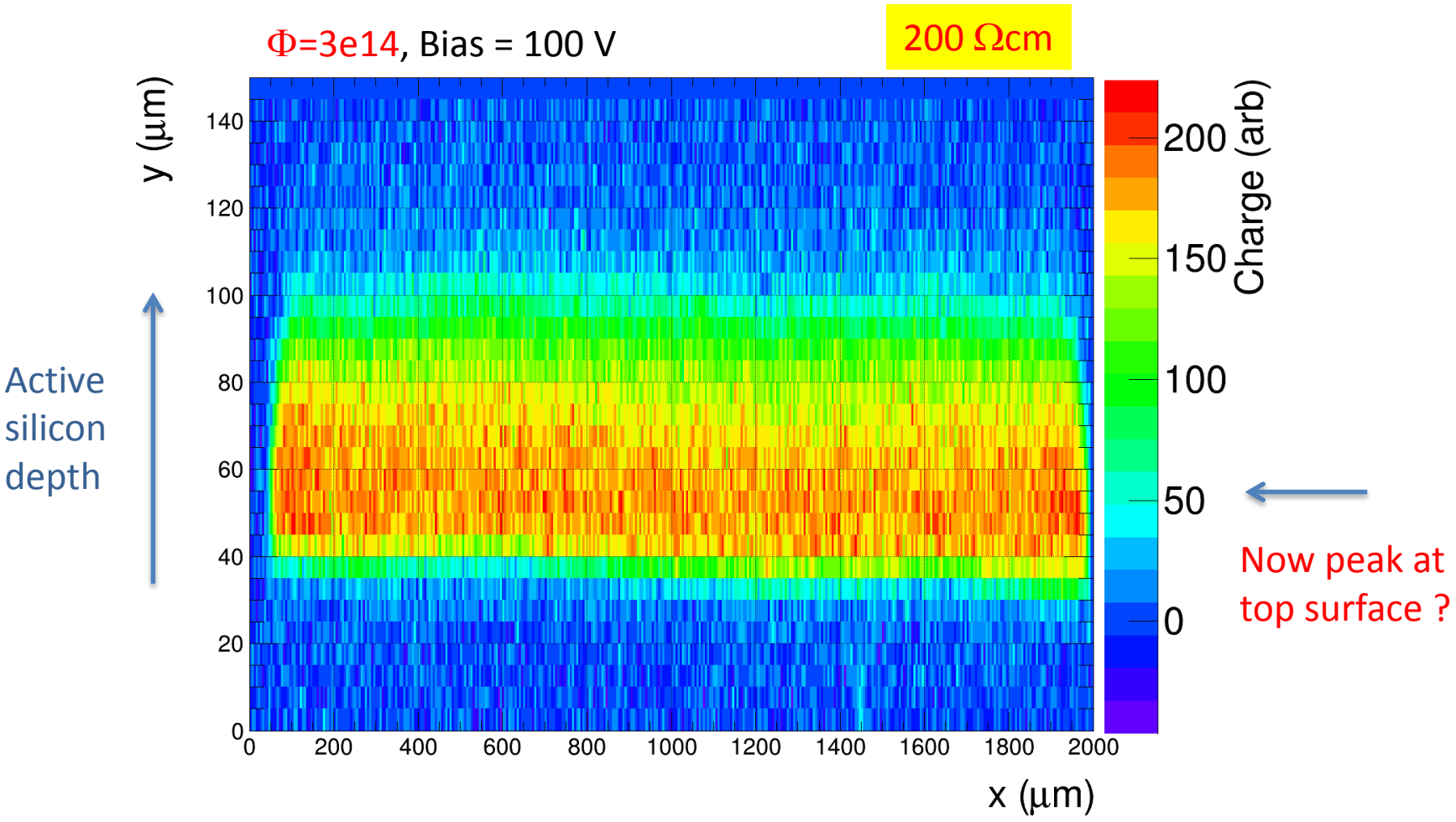
All neutron irradiation only





? back peak

E-TCT



scan across 3 x 3 pixels => no gaps between pixels

Summary

- Testing for CHESS2 started in earnest
- Many puzzling effects to understand on behavior after irradiation
- All teste activities has local components:
  - SLAC designed the digital test system
  - Edge-TCT in group C Labs going online after laser safety certification
  - Cosmic telescope next and test beam later

Welcome more participants !