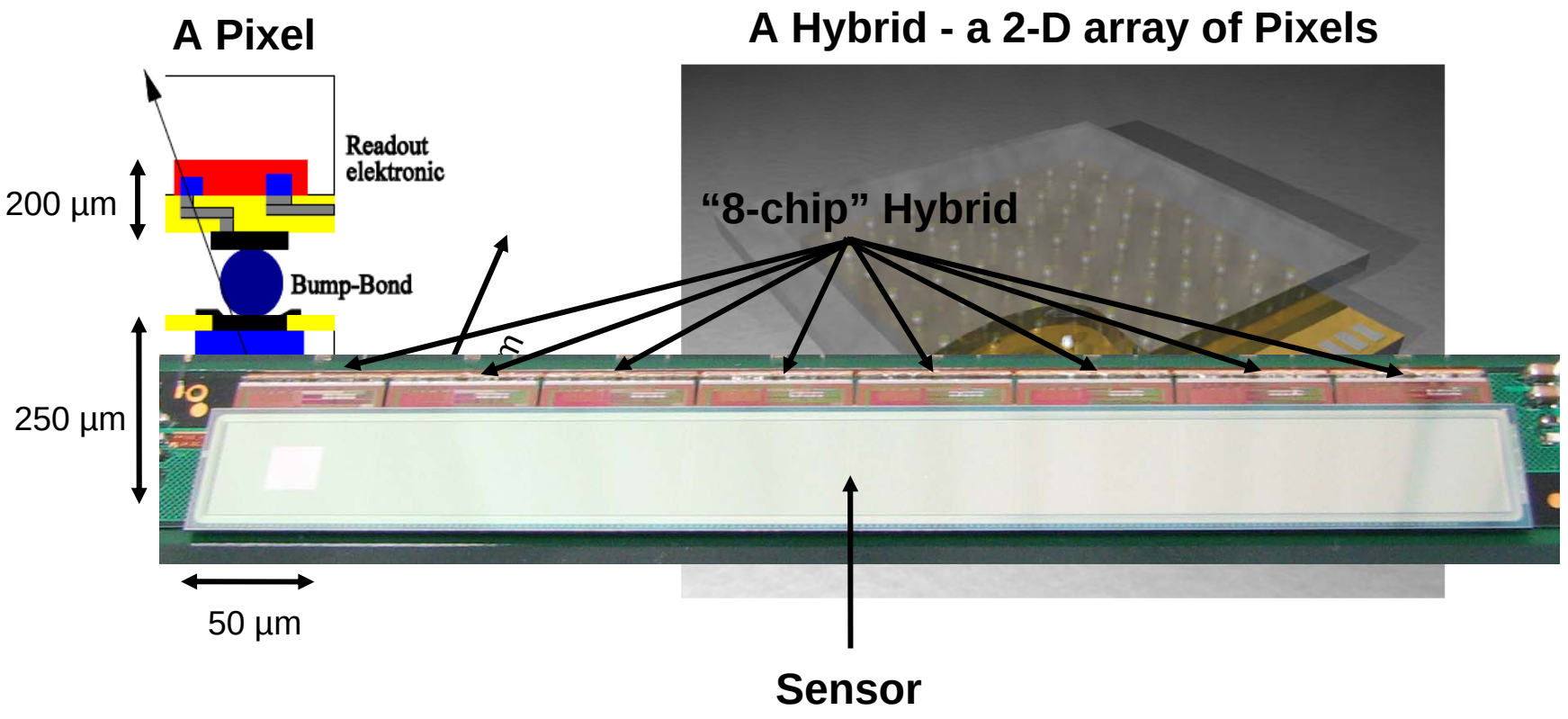
A Pixel Detector for MIPP using “BTeV Pixels”

David Christian

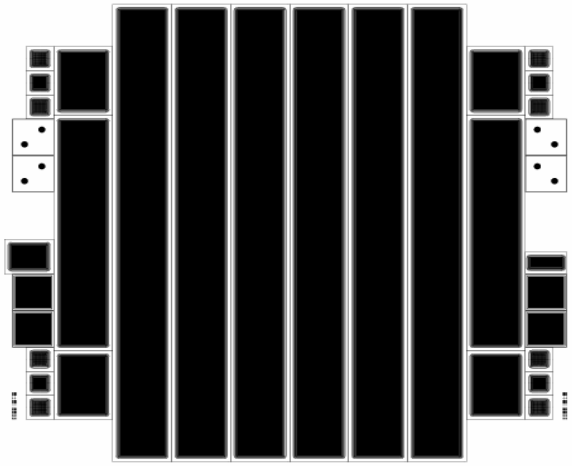
Fermilab

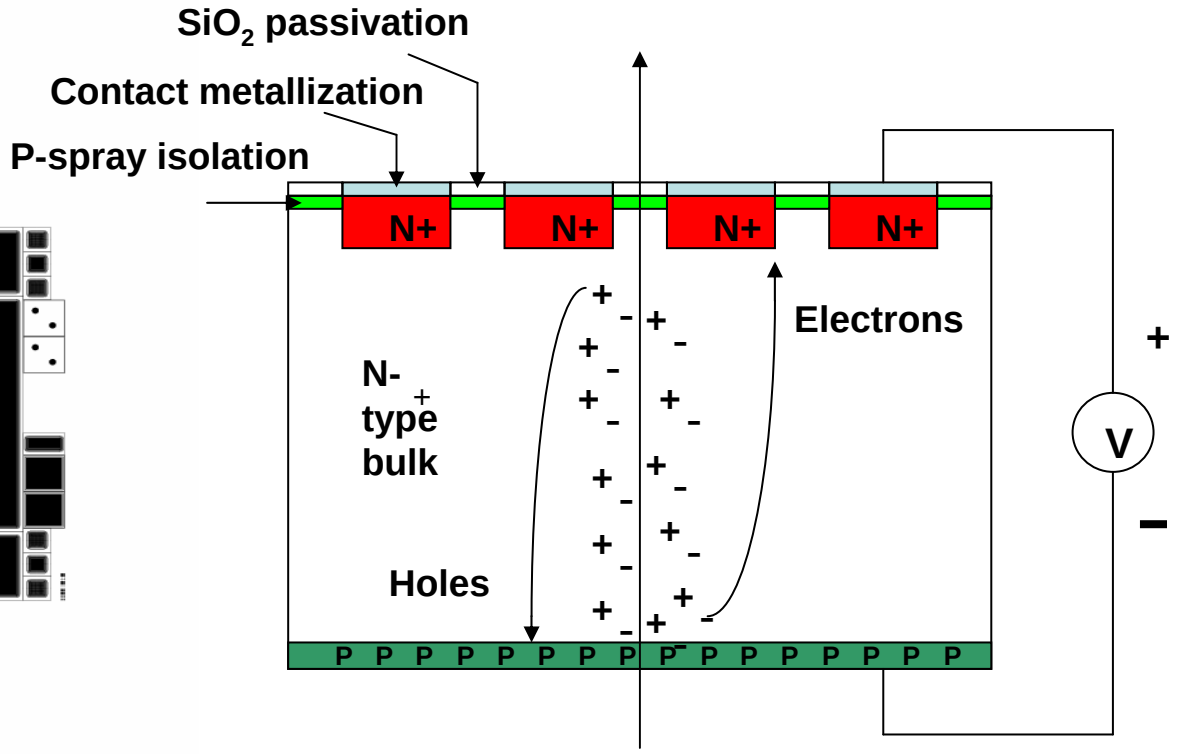
April 27, 2007

What is a Hybrid Pixel Detector?

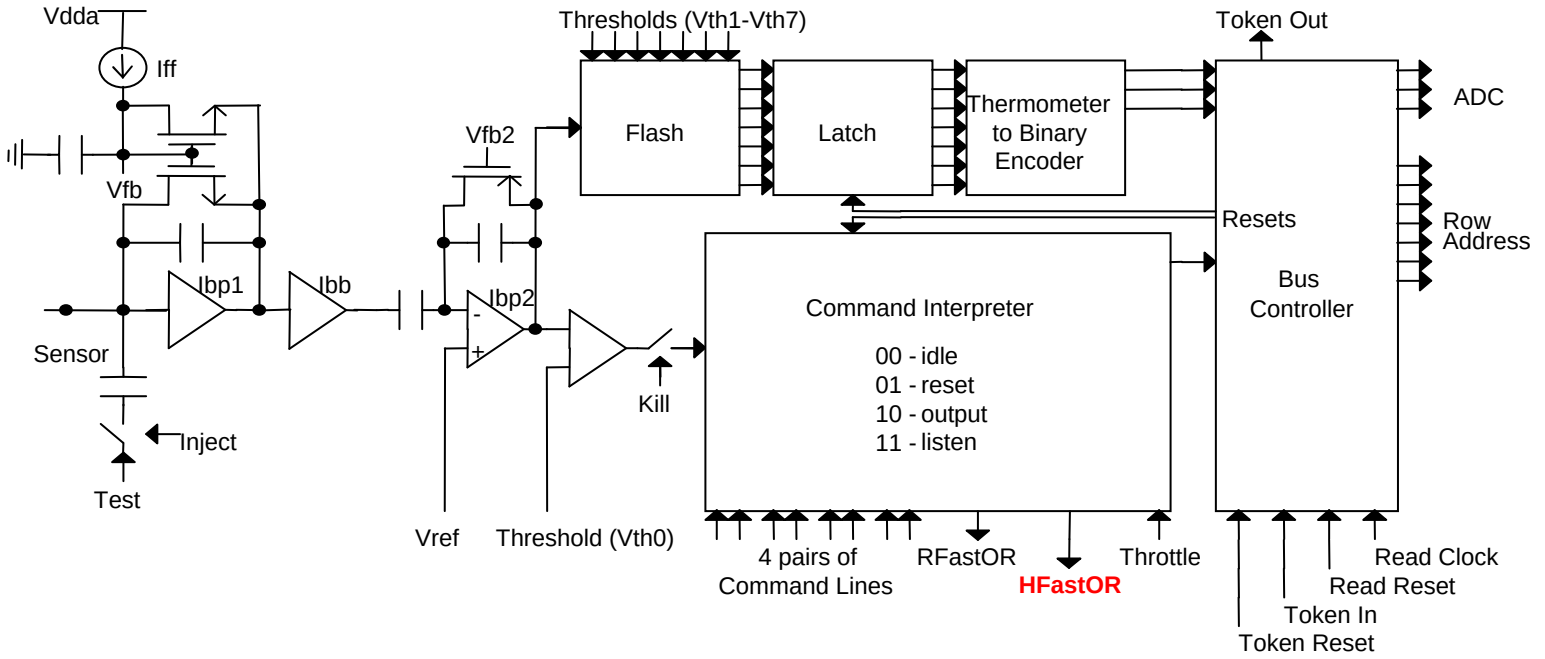


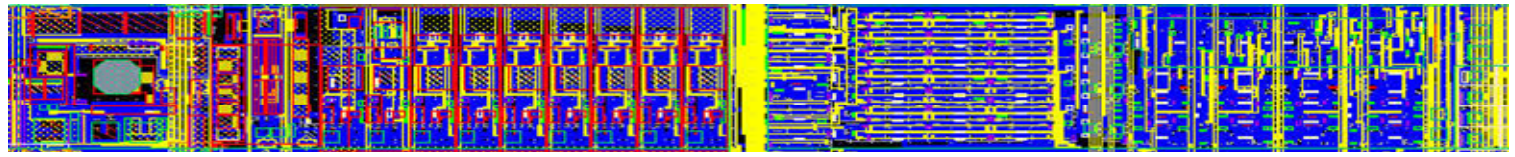
The Sensor




SiO2 passivation
Contact metallization
P-spray isolation
N+
N+
N+
N+
N- type bulk
Electrons
Holes
P
V
+
−

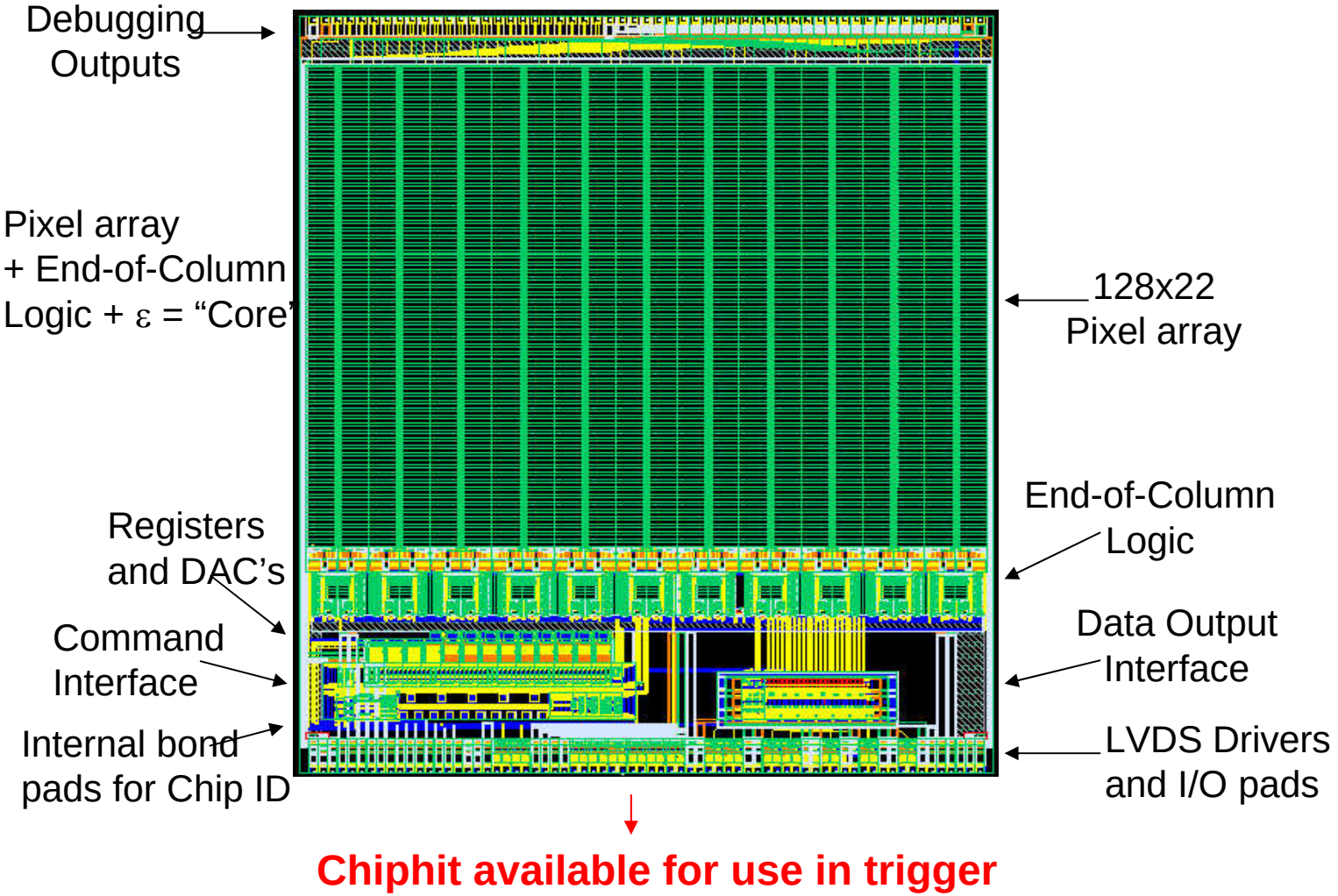
The readout IC





Preamp | 2nd stage +disc | ADC | Kill/ inject | ADC encoder | Digital interface

FPIX2 developed for BTeV

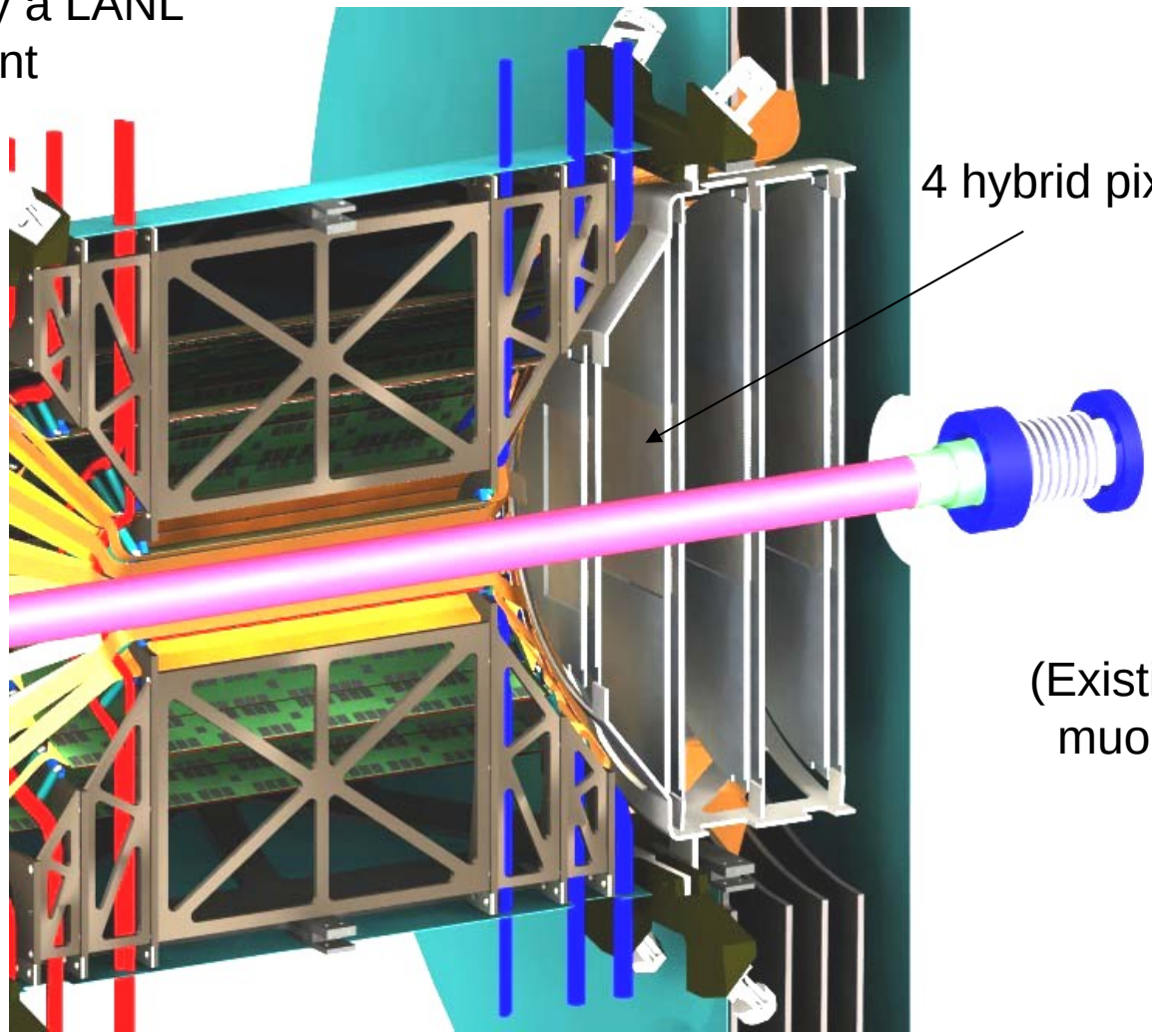


Hybrid Pixel R&D After BTeV

- As of two years ago:
  - FNAL-designed readout chip had two minor fatal flaws.
  - No system demonstration had yet been done.
- An “extended closeout” R&D program was approved
  - 1 more chip submission.
  - R&D refocused on ILC.
  - Two system tests approved:
    - Telescope for the forward direction of PHENIX (at RHIC)
    - Test beam telescope

PHENIX: identify charm decays to (forward) muons

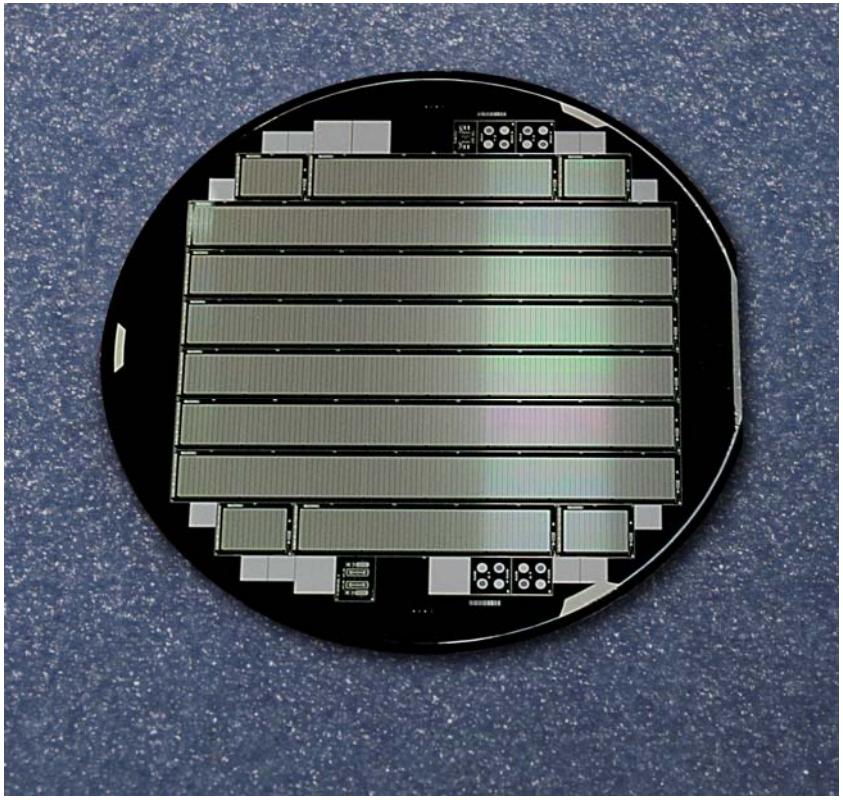
Funded by a LANL LDRD grant



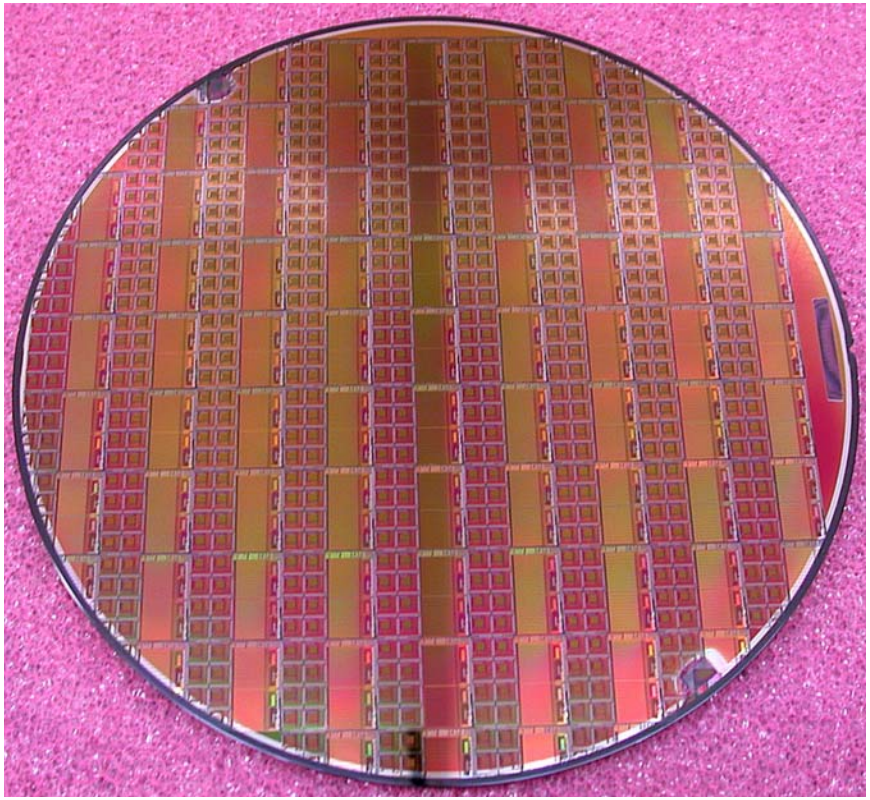
4 hybrid pixel stations

(Existing forward muon system)

Sensor & FPIX2.1 wafers

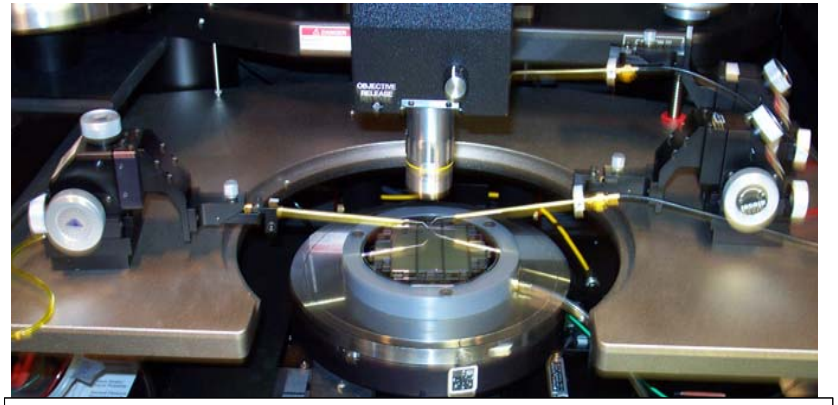


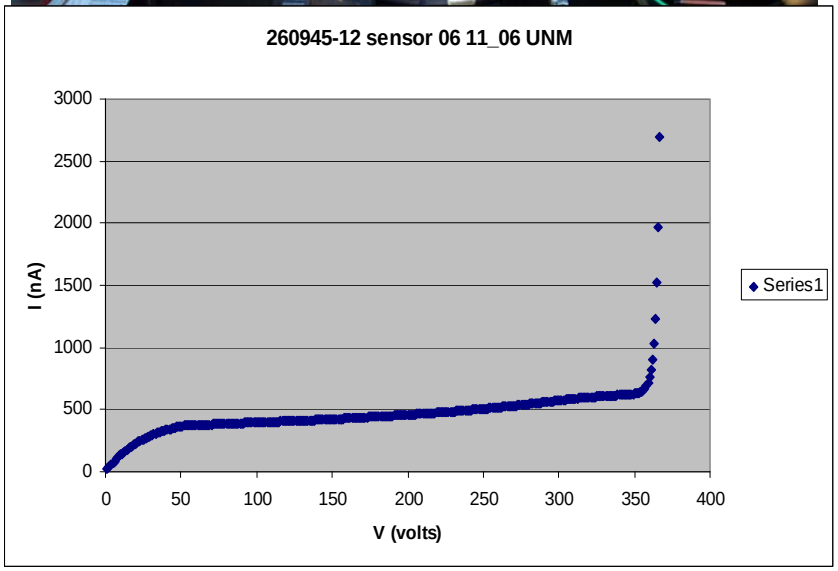
Sensor wafers produced for PHENIX by CiS (enough extras purchase by FNAL for a MIPP detector)



FPIX2.1 fabricated on wafer with “TripT” for D0; fatal flaws fixed; Wafers produced for PHENIX (also enough extras for a MIPP detector)

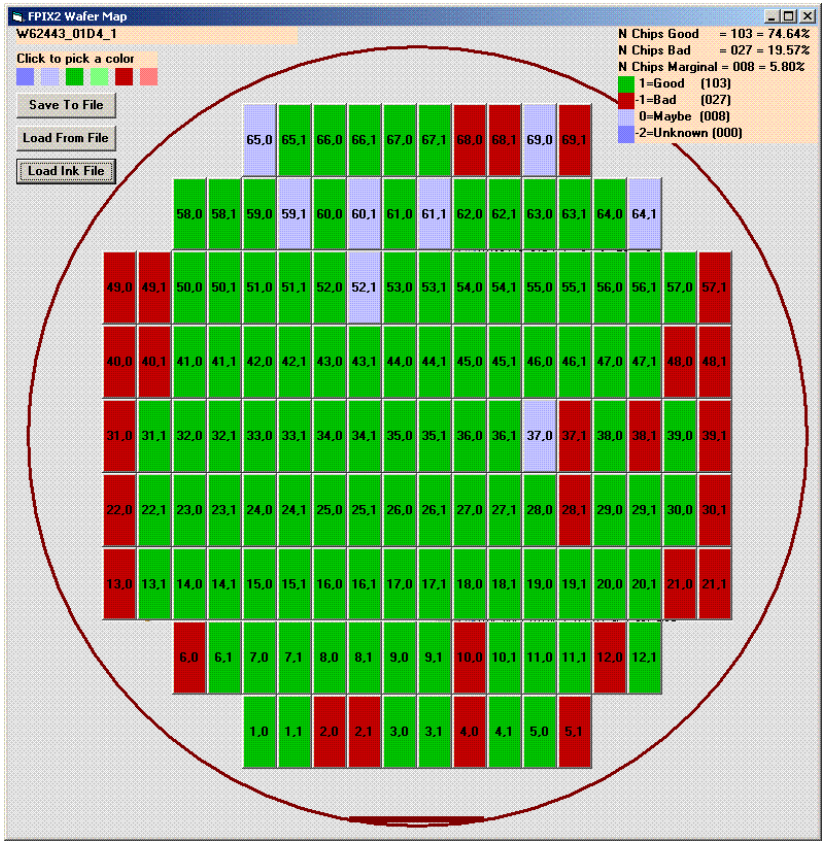
Sensors & ROCs probed – yield is high



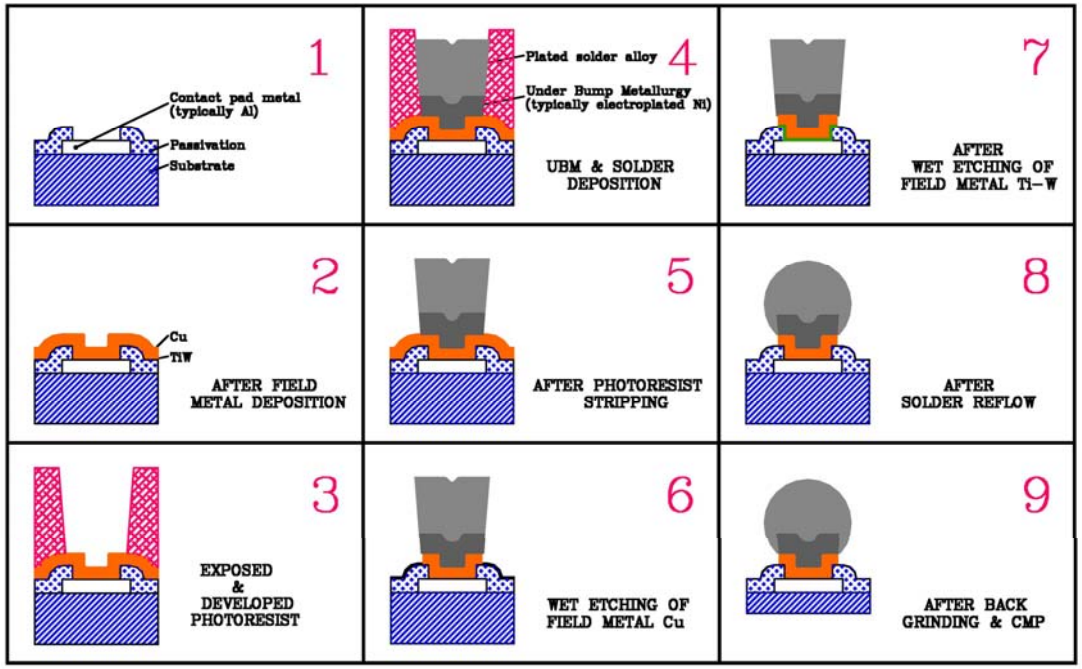


Typical sensor IV curve

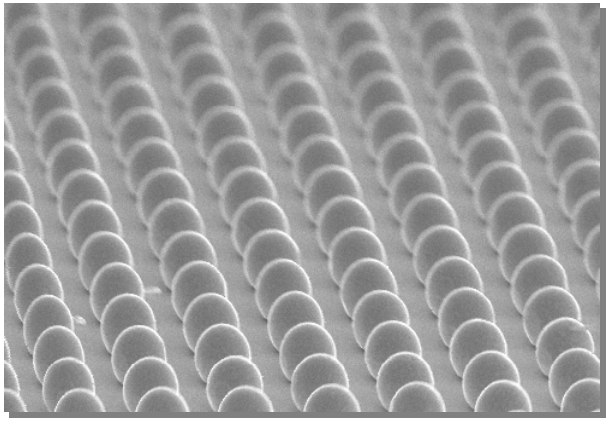
Typical FPIX2.1 wafer map



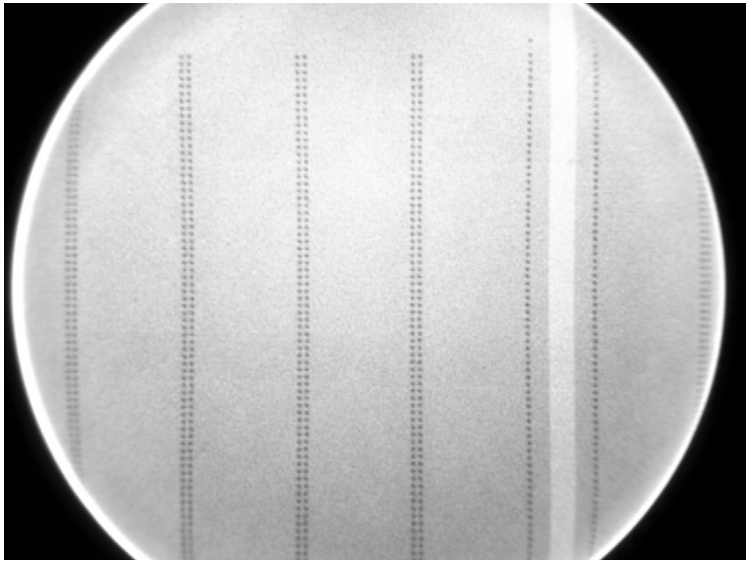
Hybridization – solder bump bonding done by VTT (Finland)



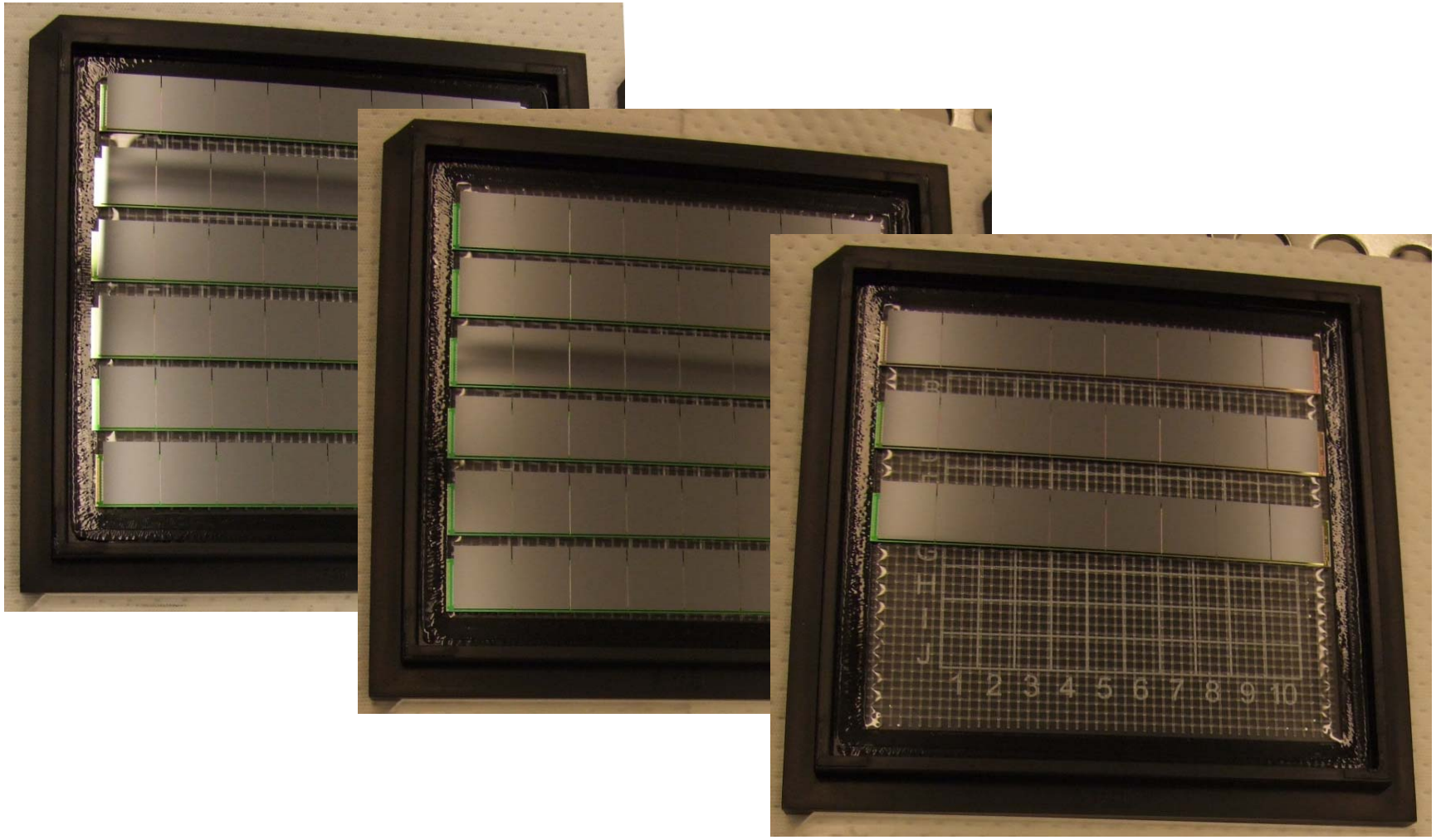
VTT bump-deposition process flow



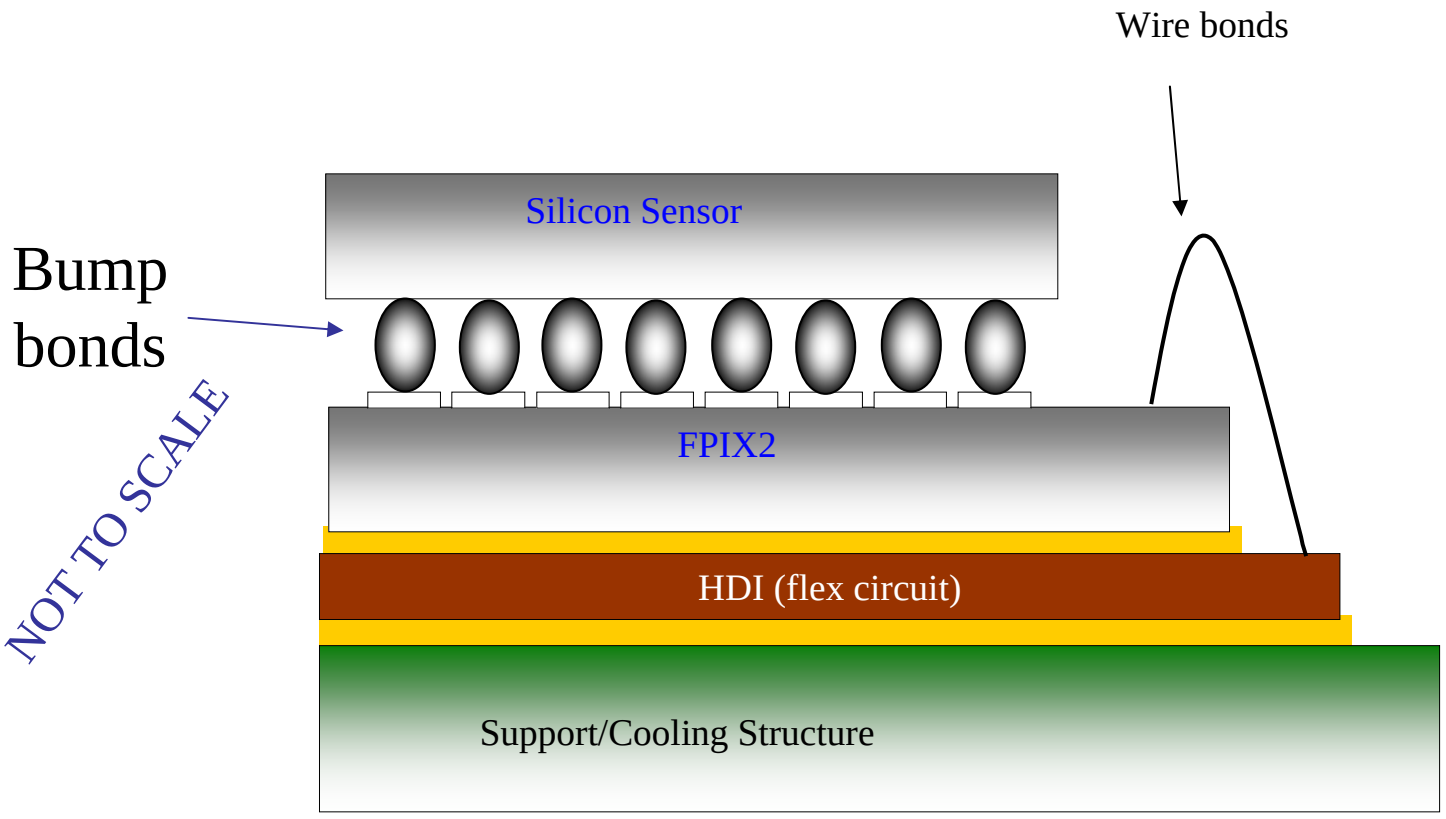
X-ray made at FCC



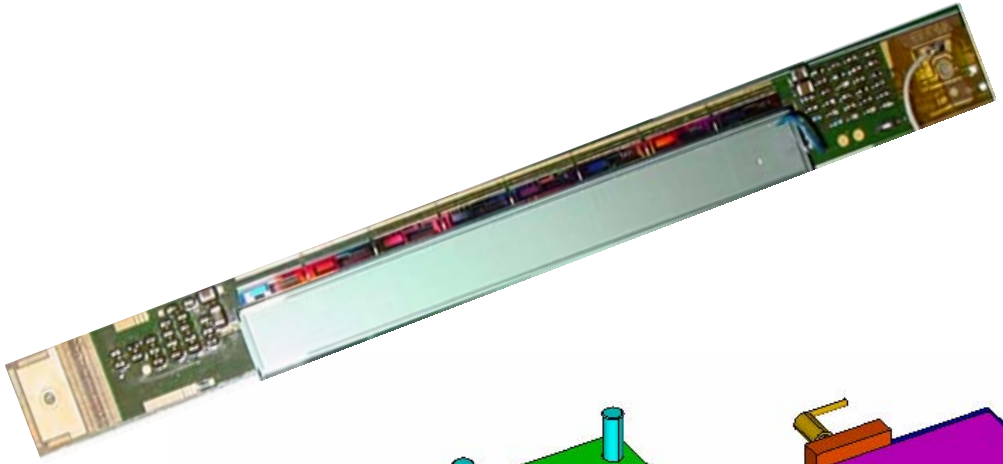
15 Pre-production PHENIX hybrids delivered 12 April 2007

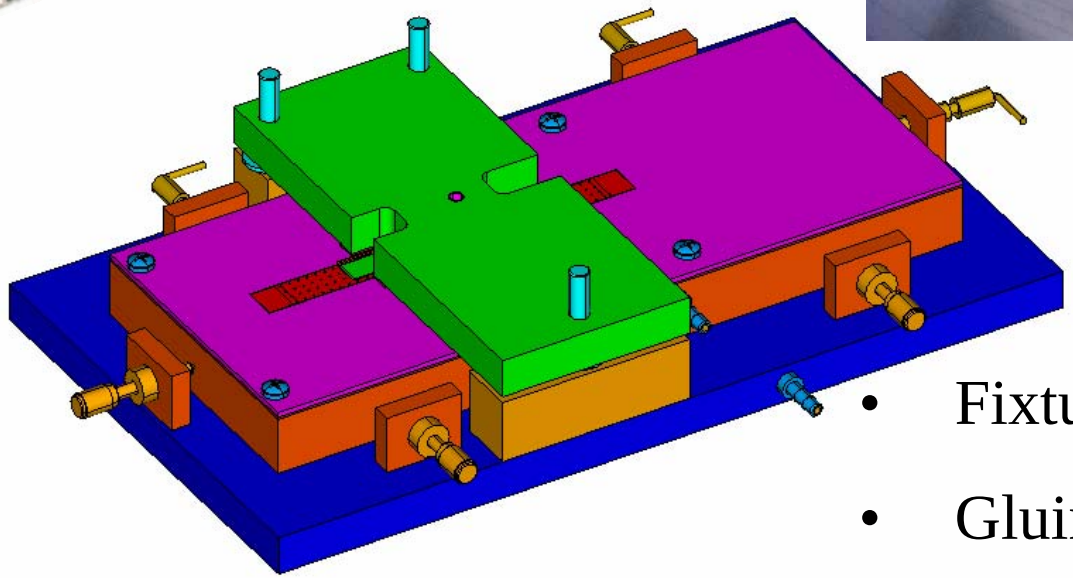


Pixel Module = Hybrid on High Density Interconnect



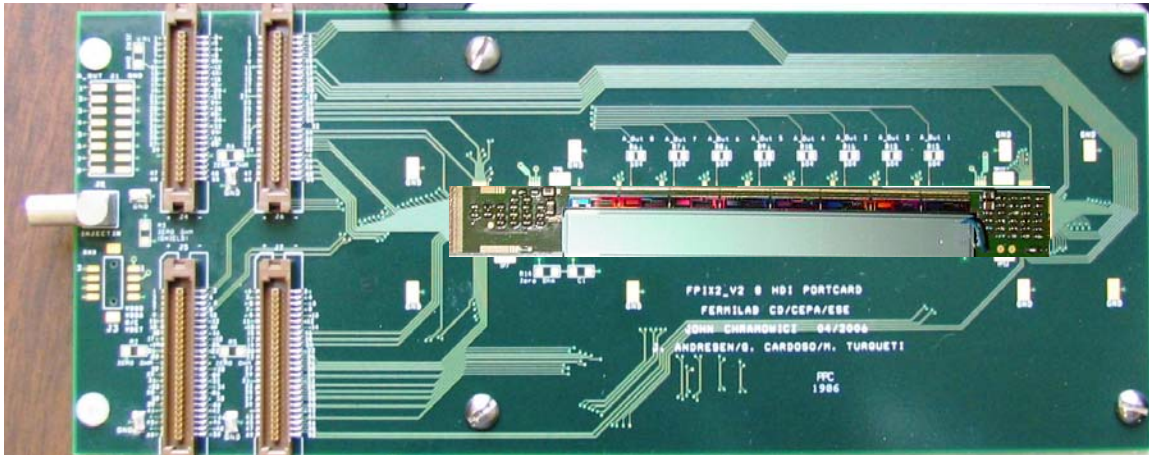
Pixel Module Assembly



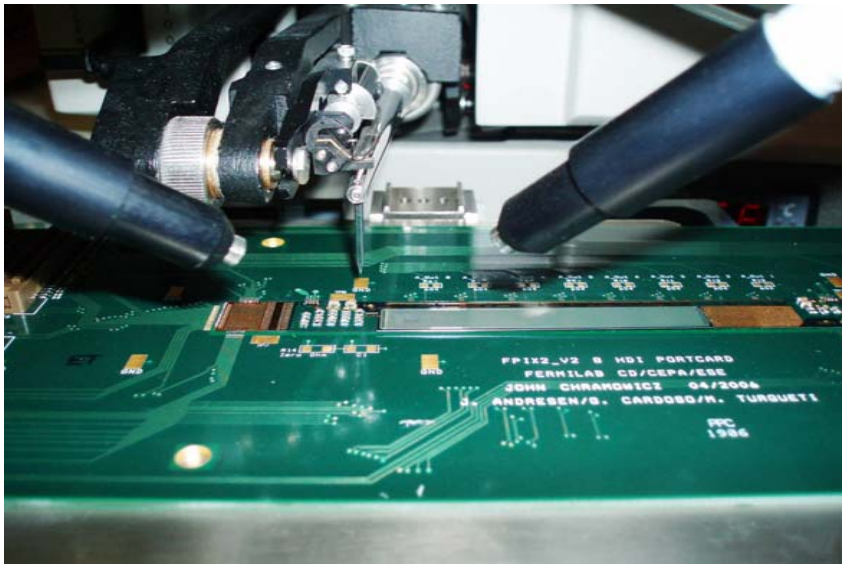


- Fixture with Vaccum Chuck
- Gluing of FPIX to HDI

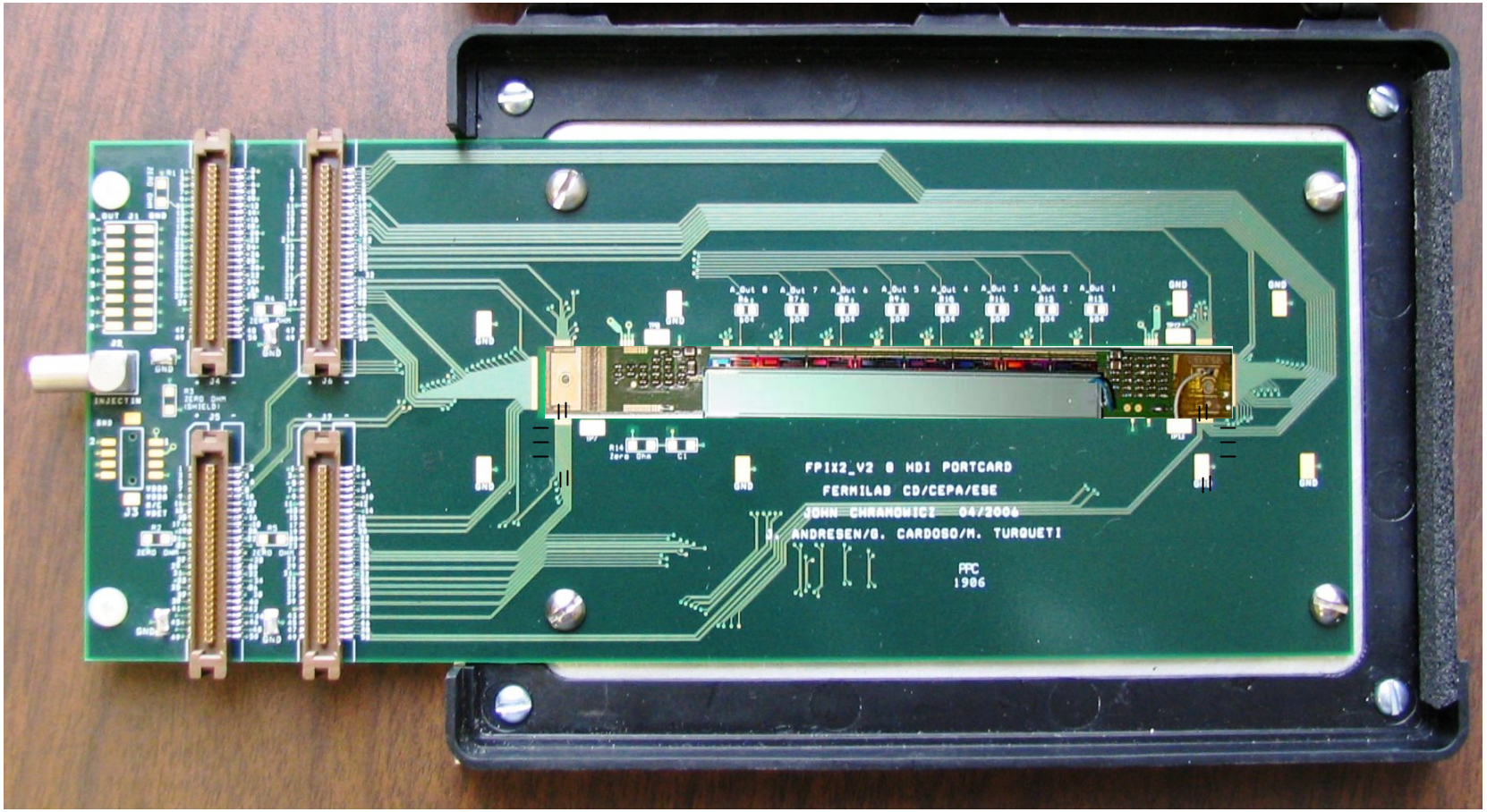
Testcard and Wire Bonding



- Testcard for each module
- Gluing of module to card
- Wirebonding of HDI to card

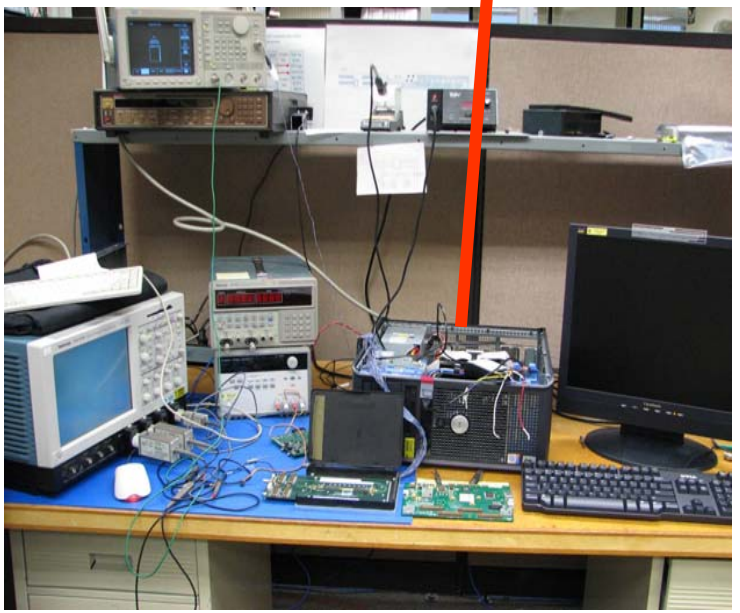


Ready Test Card

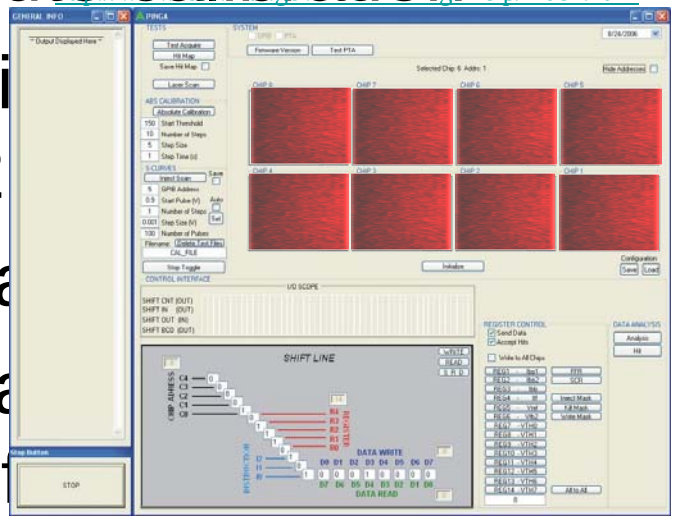


Bench Tests

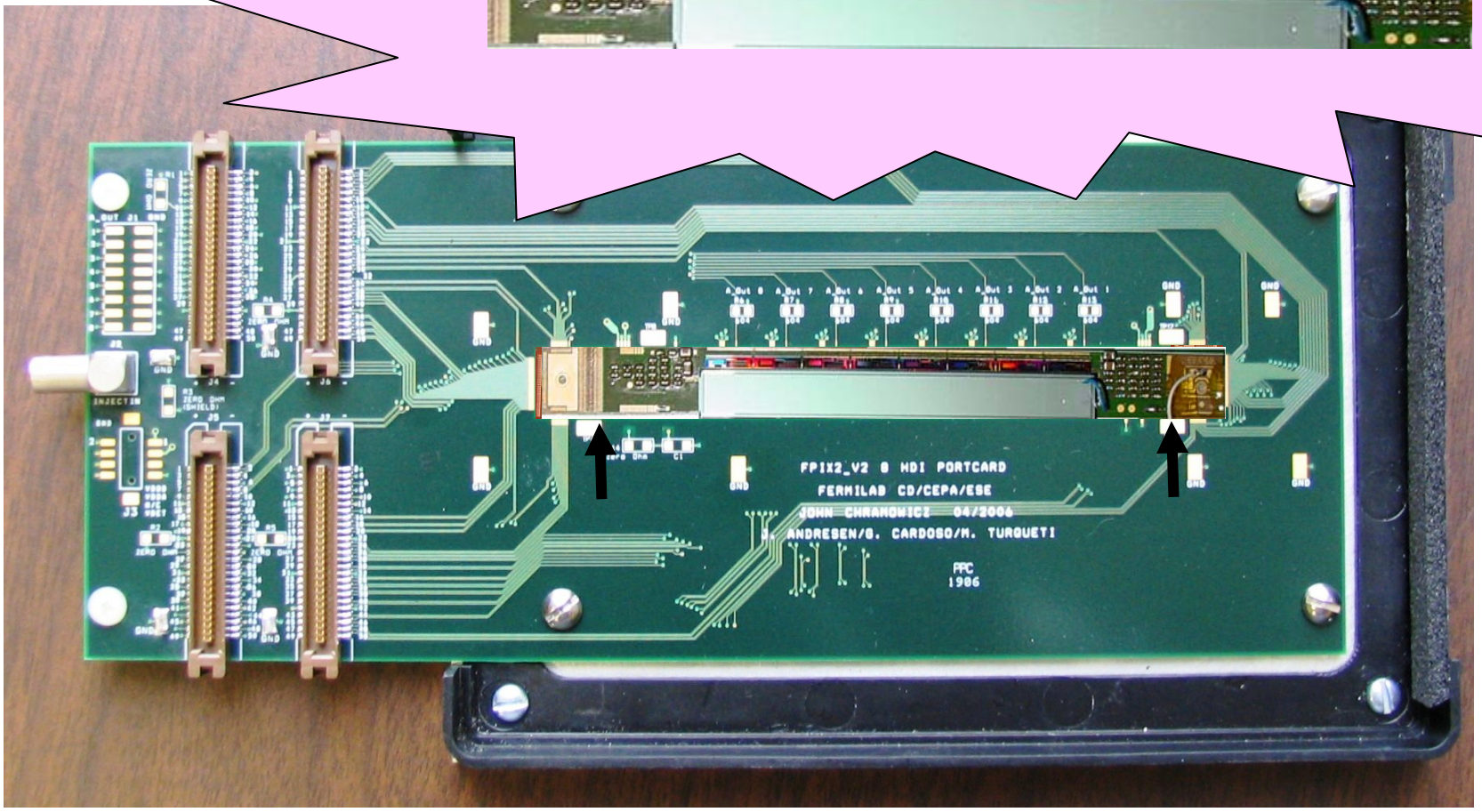
- Perform module test
  - ‘PINGA’ test software
  - Initial characterization with inject pulser
  - Hit map
  - Absolute calibration
  - Burn-i
  - 2
  - Repea
  - Q&A a
    classi



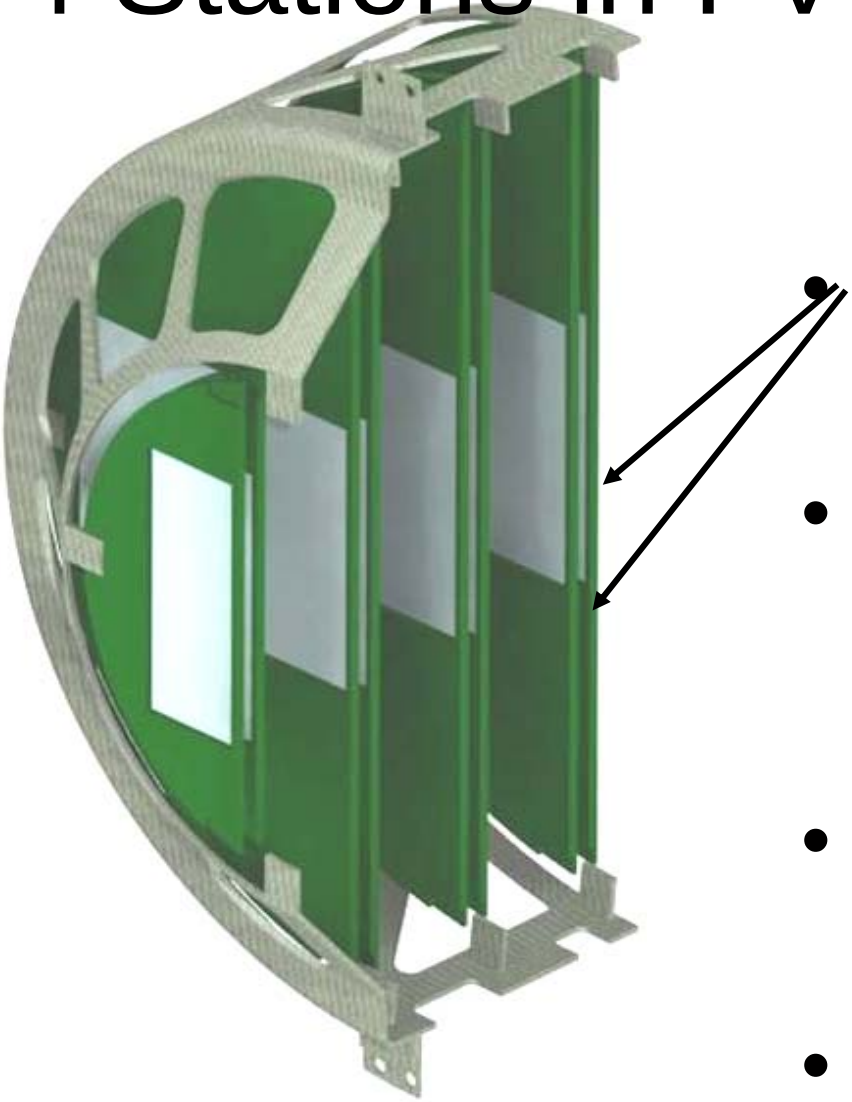
http://www.ssc.fnal.gov/Phenix/PingaHelp/index.html



Module Removal for Plane Ass[illegible]bly

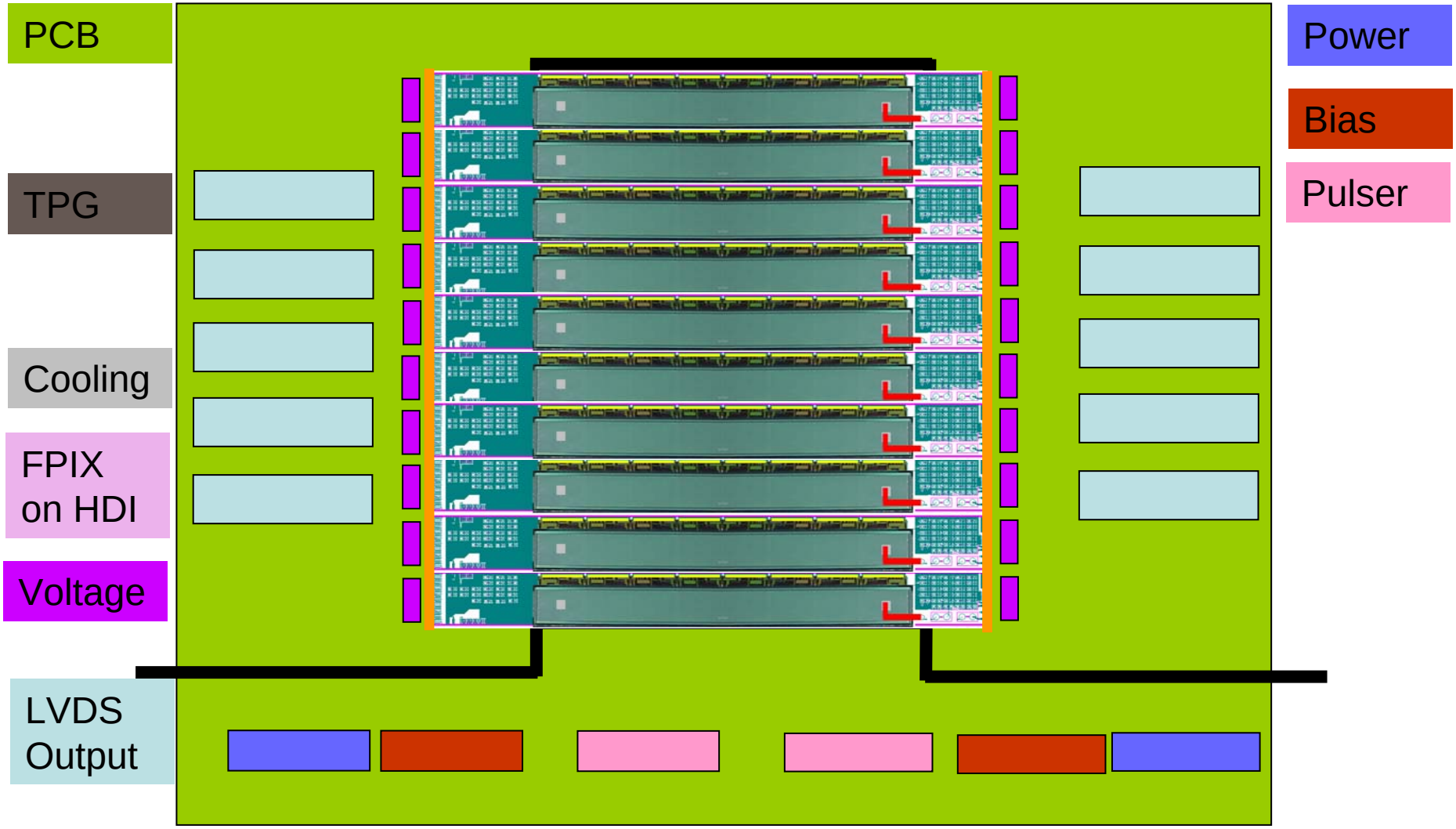


4 Stations in FVTX Frame

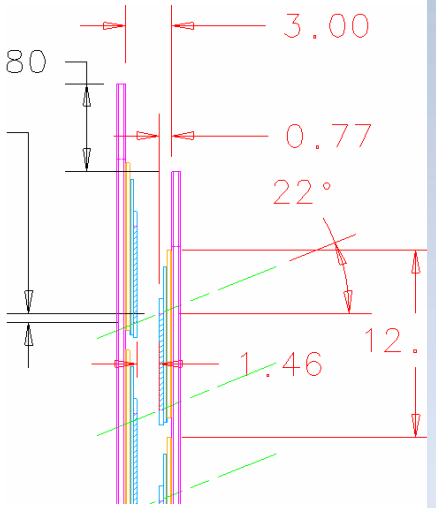


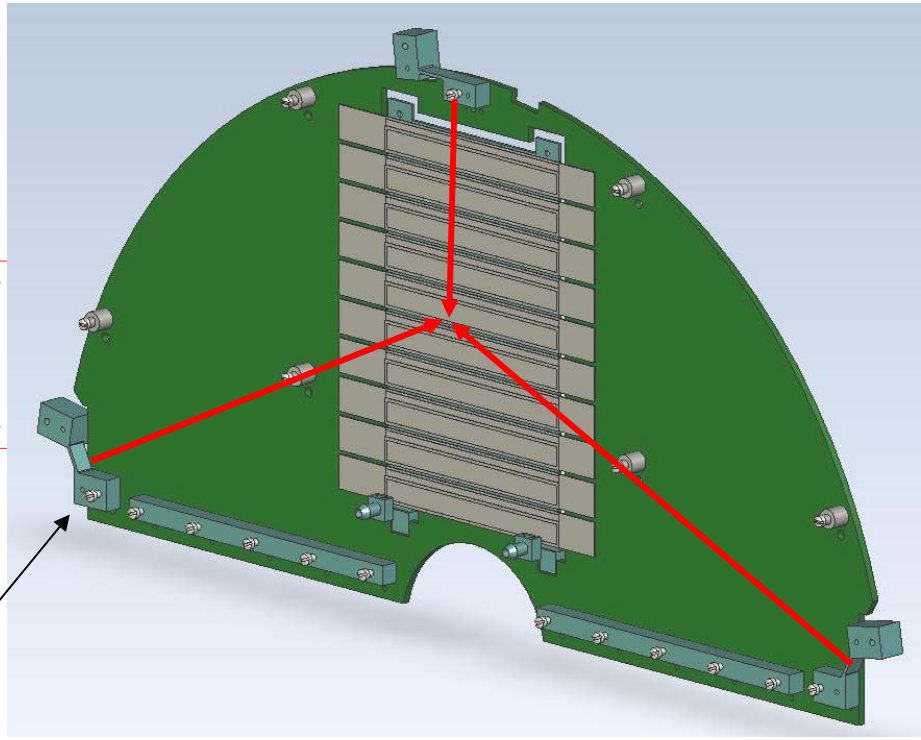
- 2 Planes per Station
- 6 Identical Planes for Stations 2,3,4
- Smaller Plane for Station 1
- Room Temperature

The Layout of a Plane



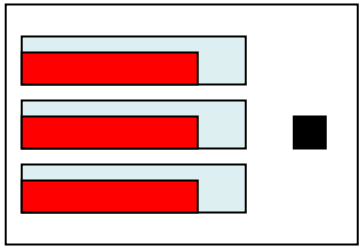
The Actual Plane and Stations



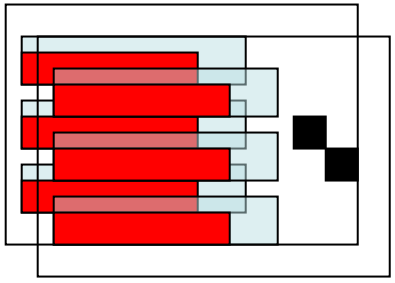


- Flex Blades (Temperature compensation)
- Two Planes Sandwich to get Station
  - Modules Inside
  - Connectors Outside

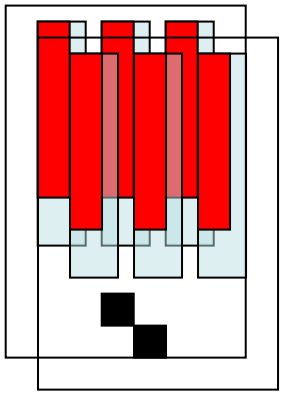
New test beam telescope



Half-plane = three 1x4 modules
read out by 1 FPGA
(collaboration with Columbia U.)

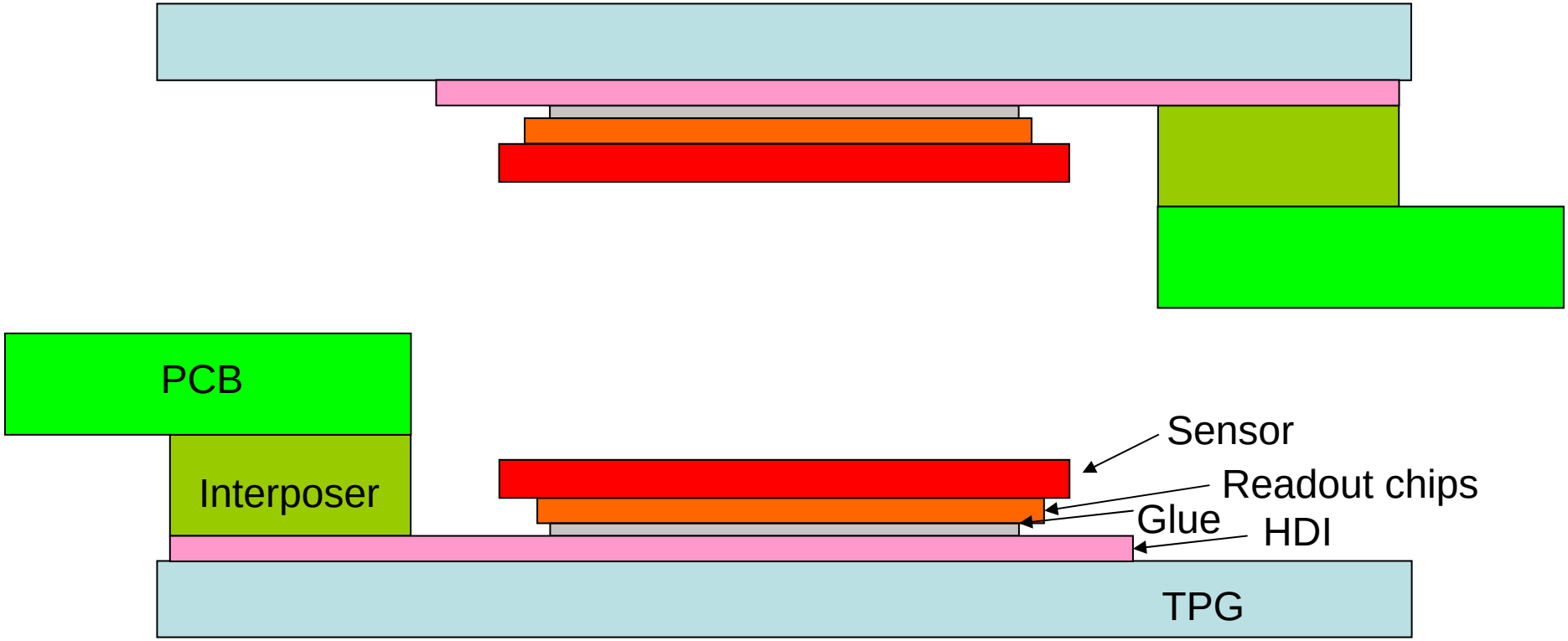


Station = two half-planes
offset by active area of sensor

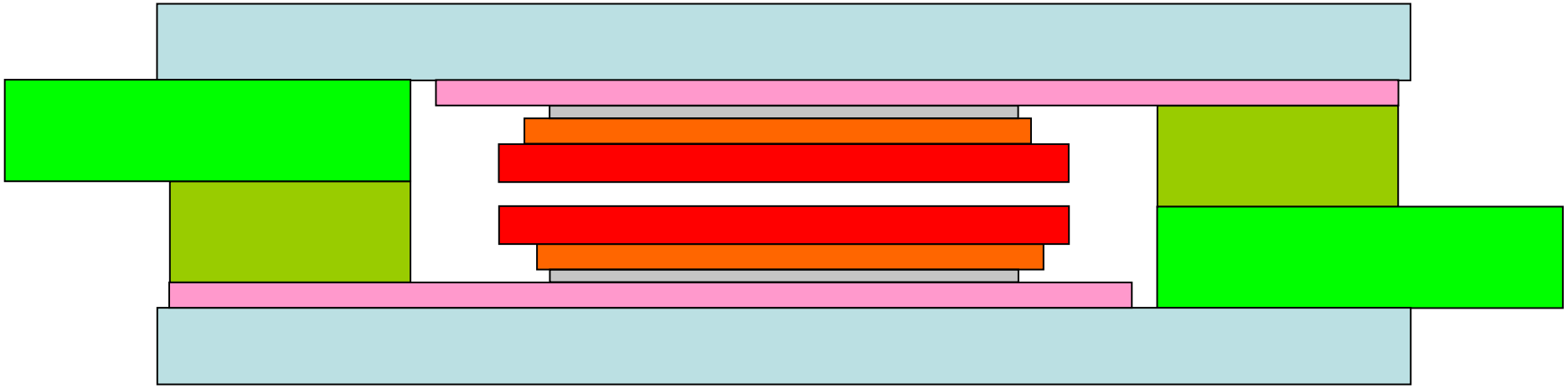


2 stations upstream of
DUT & 2-4 downstream
(precision x & precision y)

Concept for pixel plane



More compact than PHENIX layout; still maybe too much material close to active area for MIPP?



Many fewer wire bonds, much less material outside active area, many fewer cables.

Proposal for MIPP

- Build a 3-station detector (1 before target and 2 after; all pixels in one orientation).
  - Provide a “bulls eye” trigger.
  - Measure charm decay vertices?
- Use Testbeam-style readout system.
  - Need to understand how to merge data stream with the rest of MIPP data.
- Use pixel “fast or” signals in MIPP trigger.

Help Needed!

- Design not yet optimized:
  - Station design/location
  - Aperture
- No one yet working on trigger.
- Will also need to assemble a team to build the detector.
  - Test modules at each stage of construction.
  - Test subsystems.
  - Integrate system into MIPP.