A Pixel Detector for MIPP using “BTeV Pixels”

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Context

- BTeV was possible because of two "enabling technologies."
  1. A silicon pixel detector with very high segmentation and very fast, zero suppressed, readout.
  2. A vertex trigger (using pixel hits) capable of accepting data from more than 15 million events per second, selecting events containing measurable b decays, and rejecting backgrounds.

“BTeV” Pixel Detector

- Radiation hard silicon sensors – “moderated p-spray n-in-n devices.”
- 50 micron x 400 micron pixels (~270 microns thick).
- Readout chip developed at Fermilab
  - Each chip reads out a 22 x 128 group of pixels.
    - 9.2mm x 6.4mm of pixels per readout chip
    - One readout cell per pixel.
    - The readout chips are “bump bonded” to the sensors – each pixel is connected to its own amplifier.

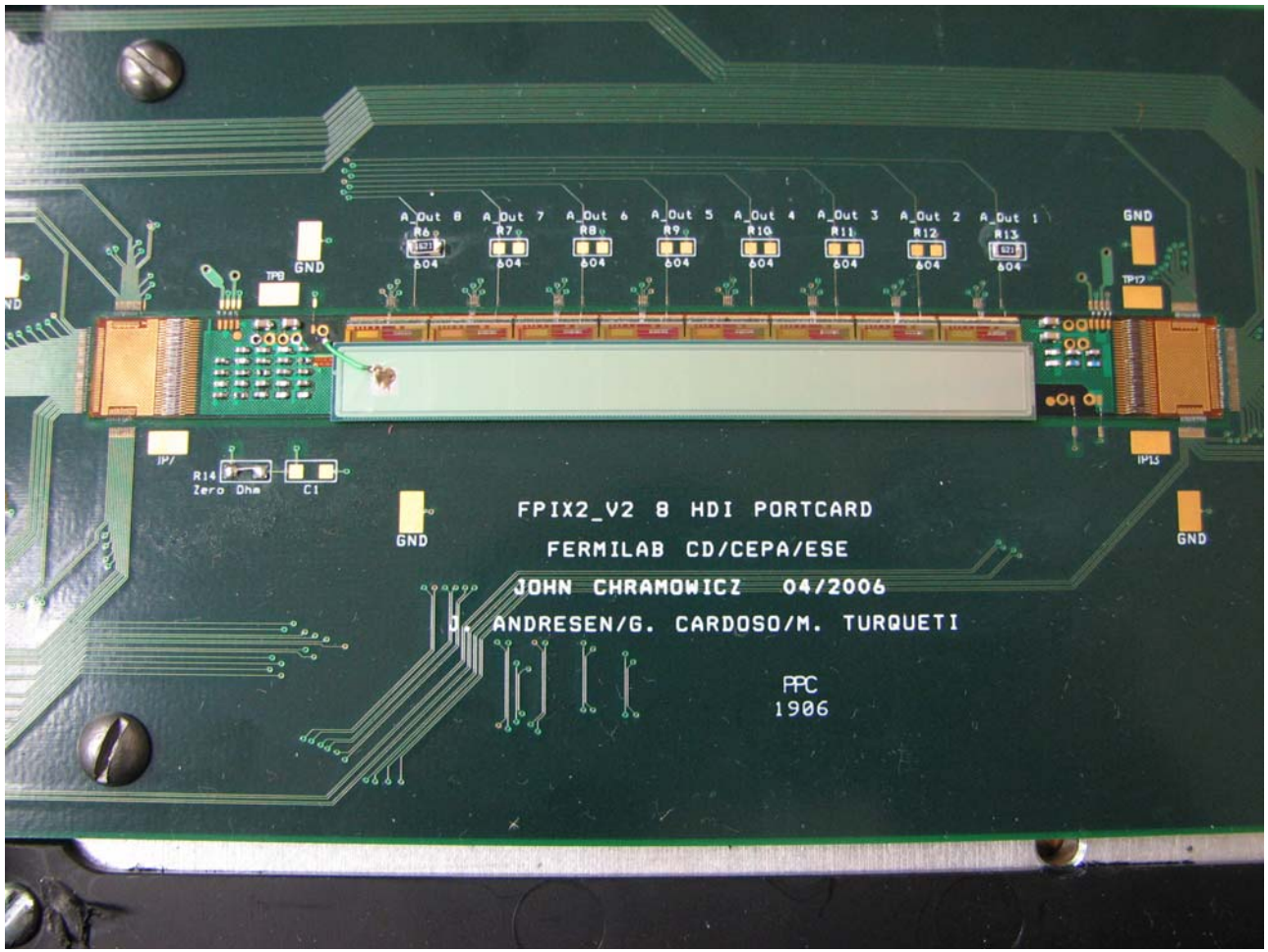
“FPIX2.1” Readout chip

- Fast data-driven readout of zero-suppressed data (time stamp, pixel address & 3-bit pulse height).
- All data is read out (no trigger).
- Chip provides a “Fast OR” whenever 1 or more pixels is hit.

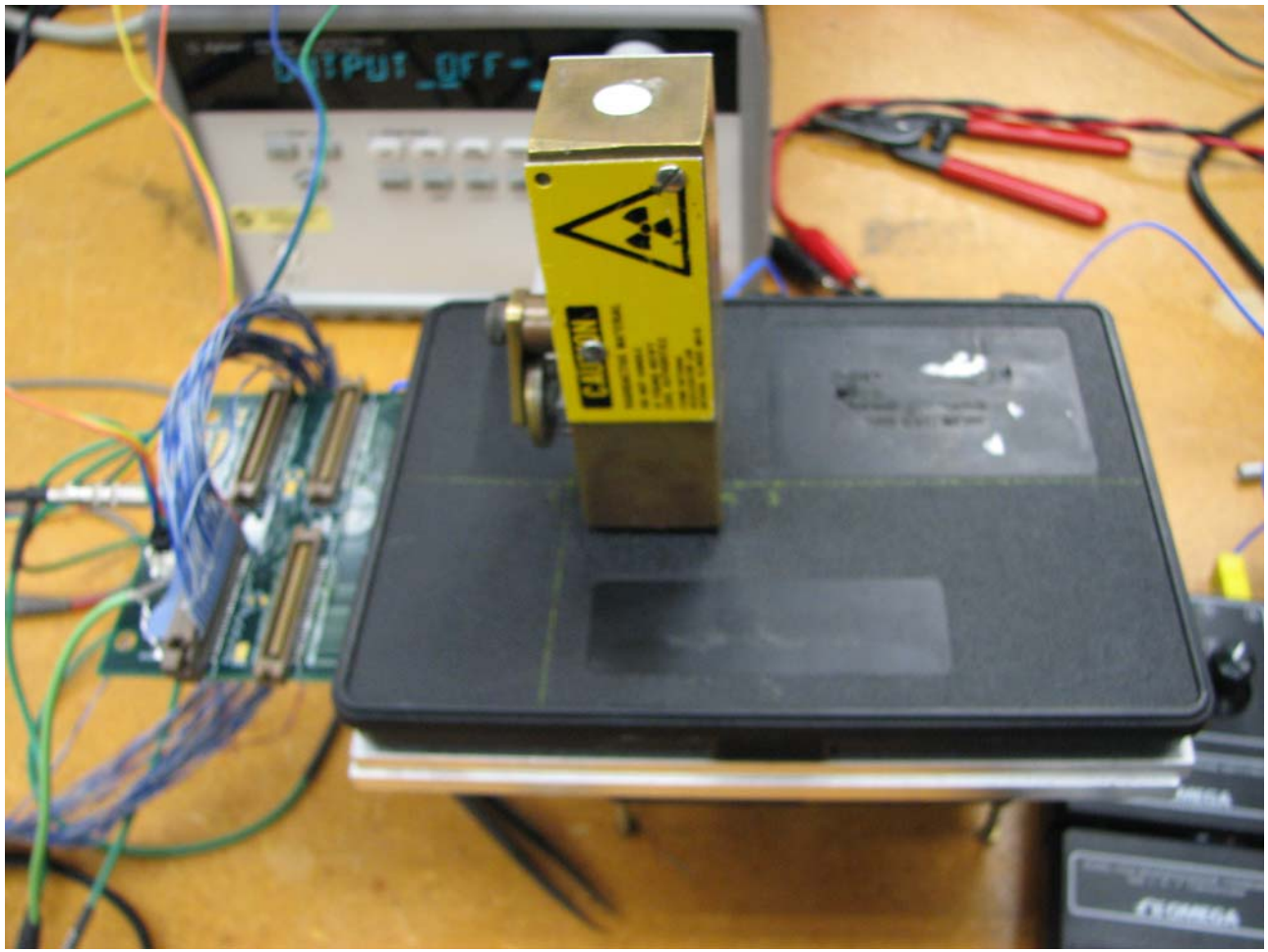
Pixel Detector Description (continued)

- Sensor active area = 73.6mm x 6.4mm.
- 8 readout chips per sensor (1x8).
- Pixels in edge columns of each readout chip are “stretched” to 50x600 microns (no dead space between readout chips).

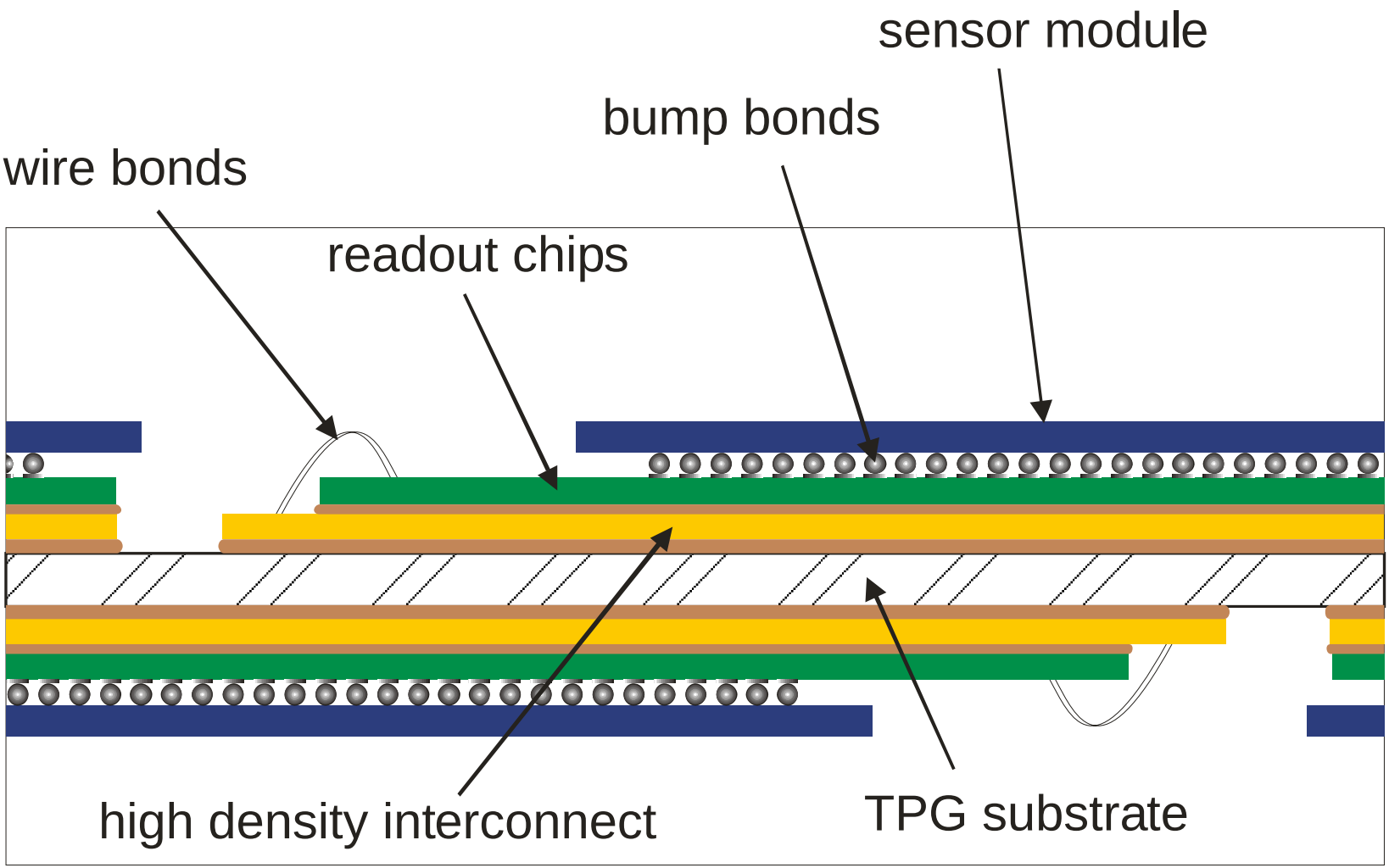
1x8 module on test card



Module under test at FCC



BTeV Pixel Detector



Pixel R&D after BTeV

- BTeV was cancelled early in 2005.
- Development of “BTeV pixel detector” continued at a very reduced rate, now in the context of a new ILC vertex detector R&D effort.
  - Planning to replace the existing BTeV pixel telescope in MTest with a larger aperture telecope.
  - Also planning a “system test” with a telescope in the forward direction of PHENIX (to identify semileptonic charm decays to muons).

Pixel R&D after BTeV (continued)

- Collaborating with LANL & Columbia U (Nevis) on PHENIX pixel detector.
  - Developing simpler (wrt BTeV) plane structure.
  - Developing simpler readout system.
  - Will be implemented first in MTest (summer – fall 2006).

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 PHENIX-style planes and readout system.
  - Need to understand how to merge data stream with the rest of MIPP data.
- Use pixel “fast or” signals in MIPP trigger.

Current Status

- Sensor design finished; 2 vendors established (CiS and ON Semi).
  - PHENIX production begun; 1st batch rec'd; very good yield.
- Readout chip works as designed.
  - PHENIX production finished; 1st measurements of yield also good (~75%).
- 1st versions of "High Density Interconnect" were too dificult to manufacture (very low yield) – "KISS" HDI due in ~1 week.
- Development of simplified plane in progress.

Help Needed!

- Design not yet optimized:
  - Placement
  - 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.