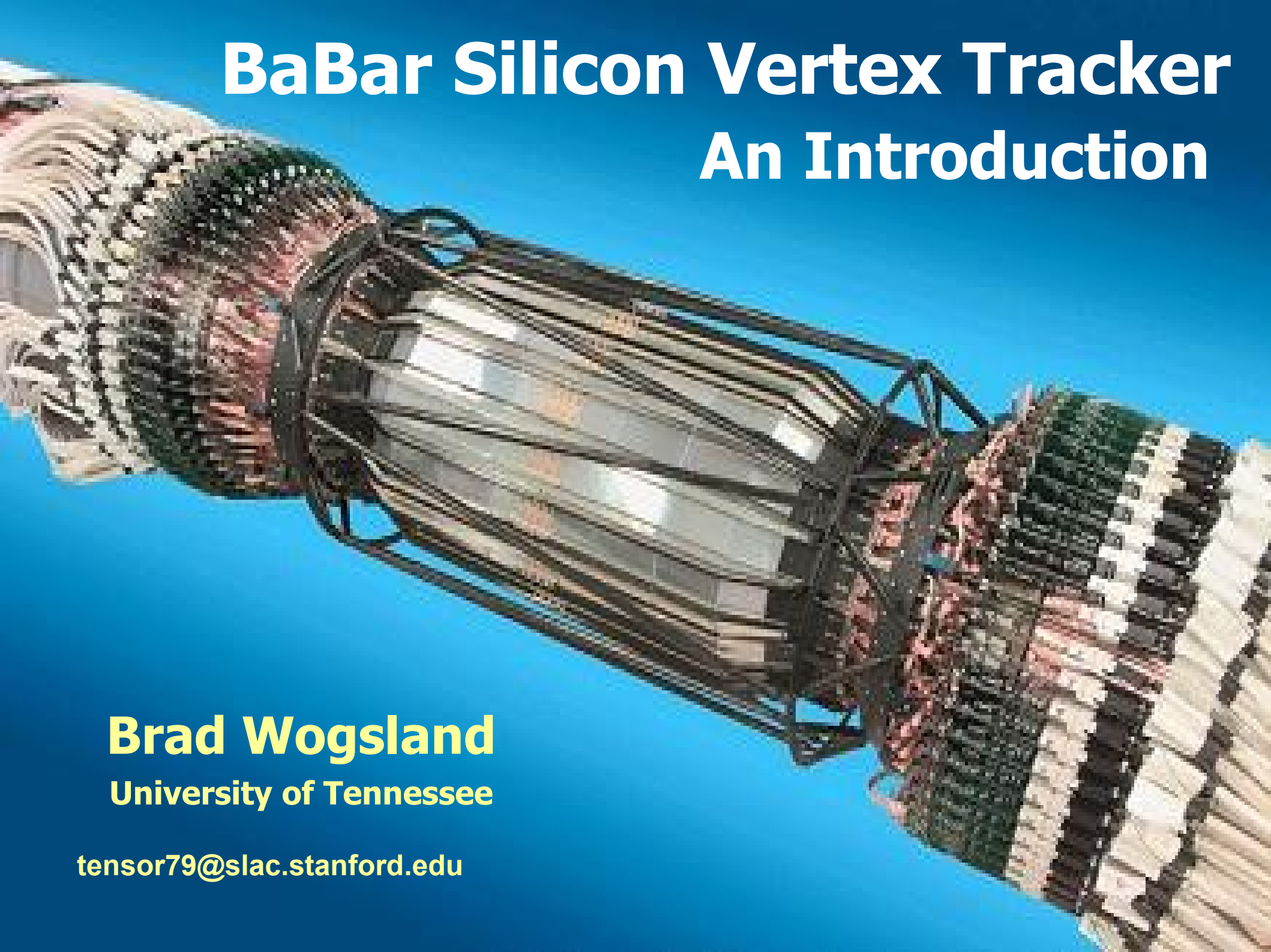
BaBar Silicon Vertex Tracker
An Introduction



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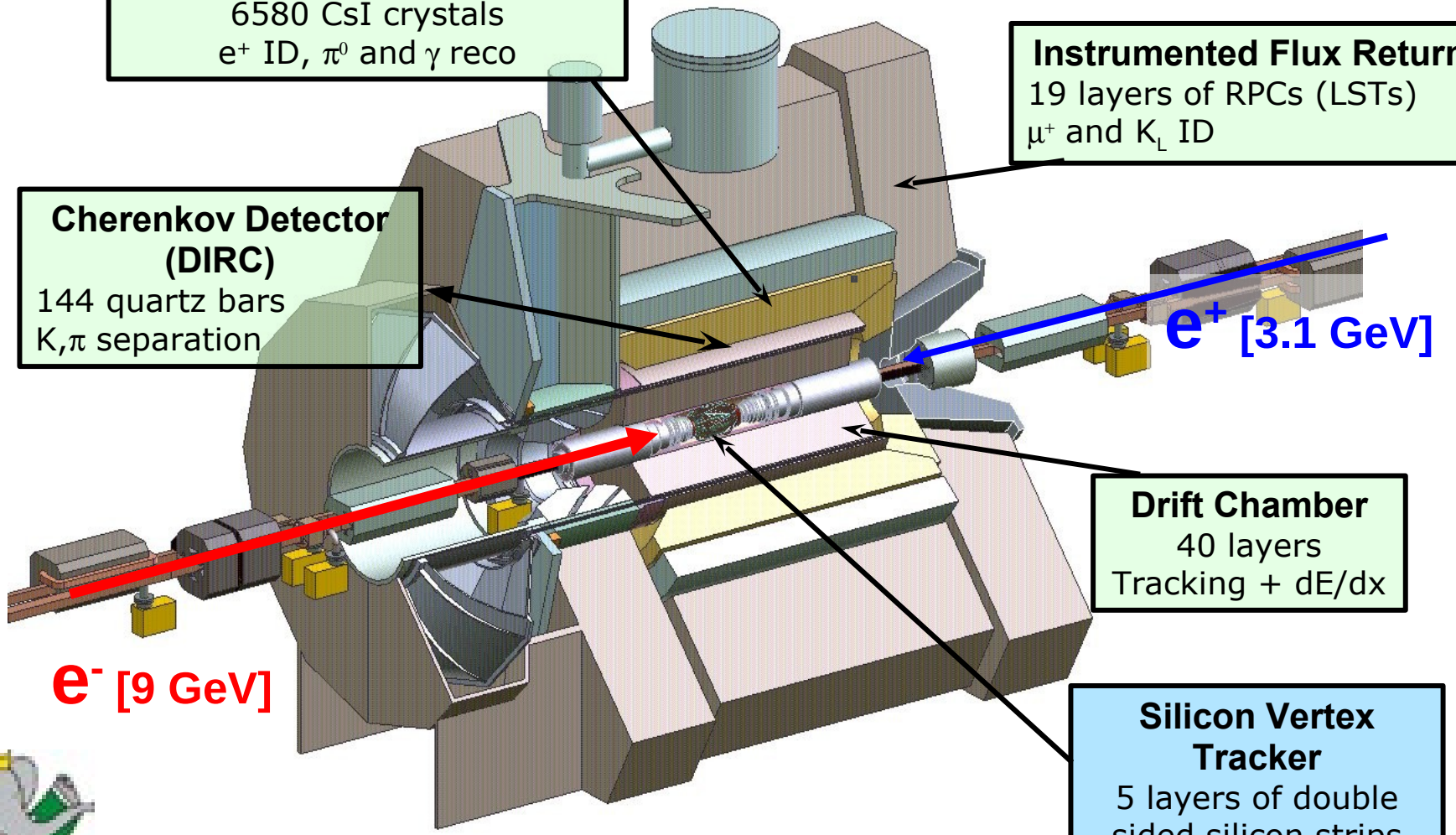
Outline

- The BaBar detector
  - Where the SVT fits in
- Basics of Silicon Detectors
  - Ionization & Signal Collection
- BaBar-specific Details
  - Physics Requirements & Constraints
- Results & Conclusions

The BaBar Detector

The BaBar Detector

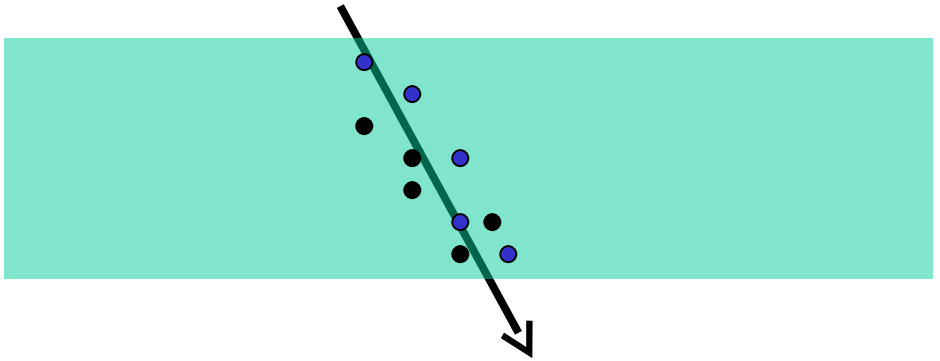


Silicon Radiation Detectors

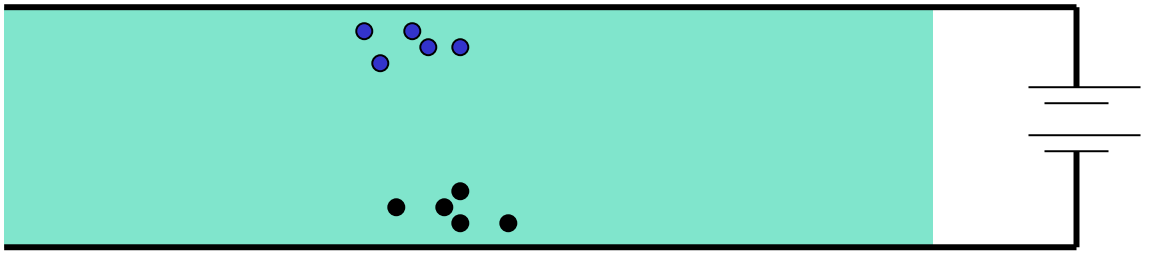
Silicon Radiation Detectors

(Knoll ch. 11)

- Charged particles ionize material

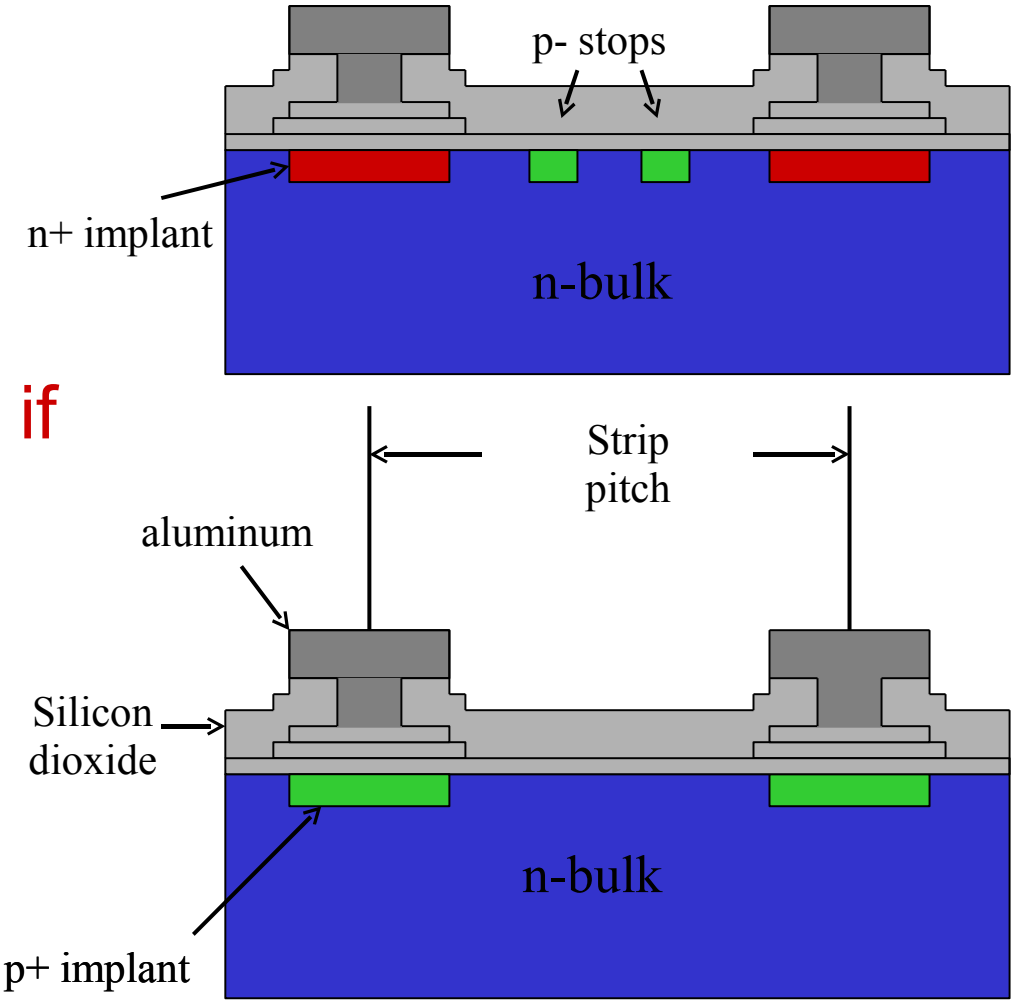


- Reverse bias diode collects electrons, holes



Silicon Radiation Detectors

- Double sided
  - p side collects electrons
    - lower noise
    - works even if not fully depleted
  - n side collects holes

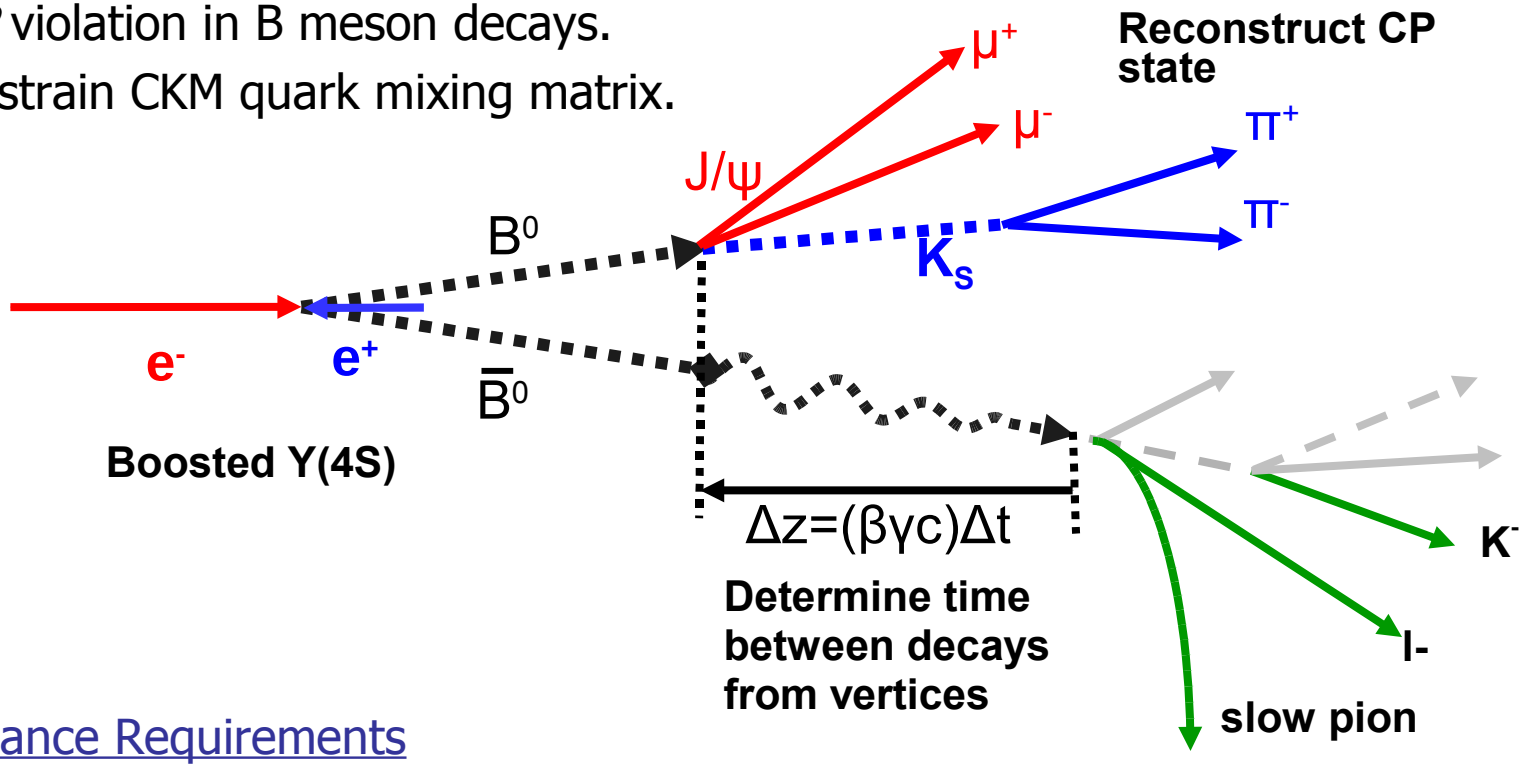


Details of the BaBar SVT

BaBar Requirements

Scientific Objectives of BaBar:

- Study *CP* violation in B meson decays.
- Over-constrain CKM quark mixing matrix.

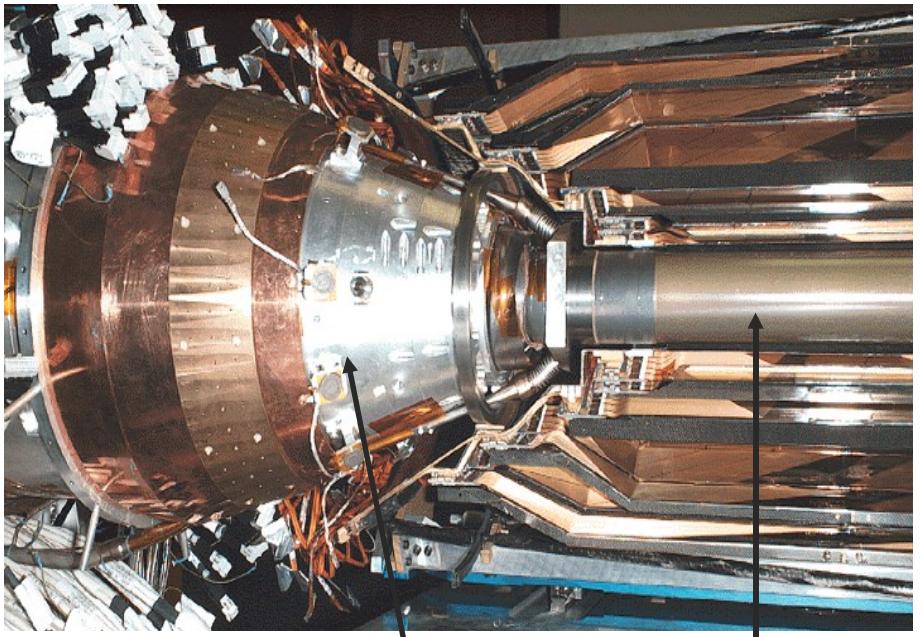


SVT Performance Requirements

- Δz resolution < 130 μm (average Δz for B^0 decays = 280μm).
- Single vertex resolution < 80 μm.
- Stand-alone tracking for p_T < 100 MeV/c with 80-90% efficiency.

The BaBar SVT

- 5 layers of double-sided silicon strips
  - •0.94 m^2 of Si
  - •Φ and z strips
  - • Inner 3: Precision Vertexing
  - • Outer 2: Pattern recognition, Low P_t tracking
- Kevlar/carbon fiber support system

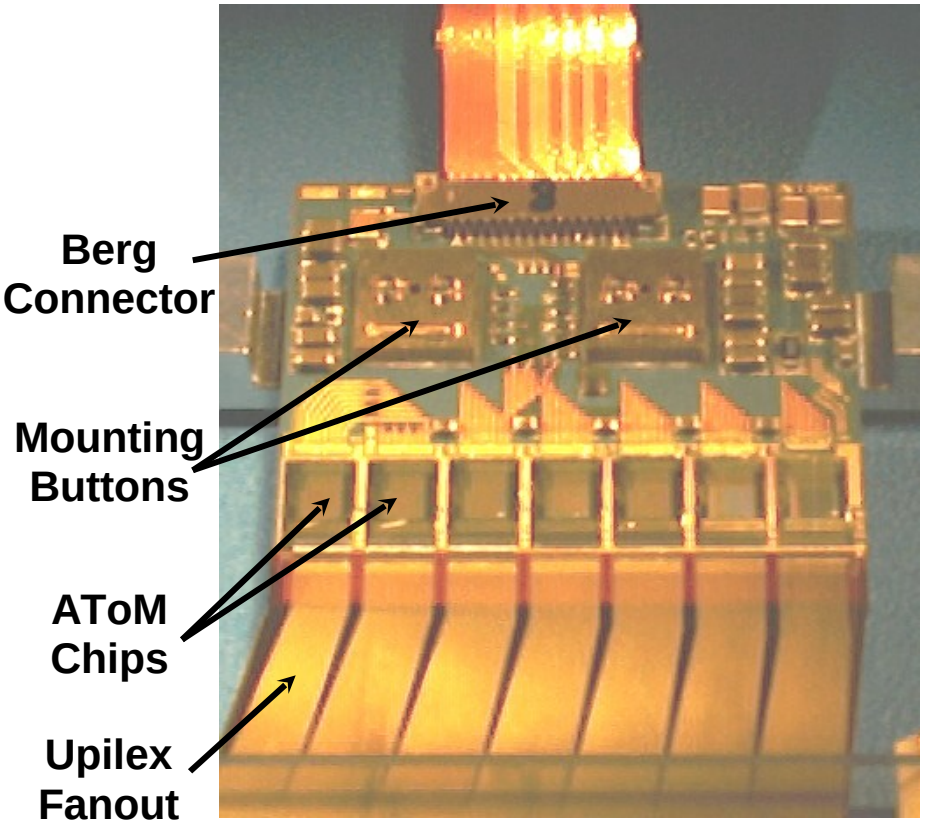


SVT Readout

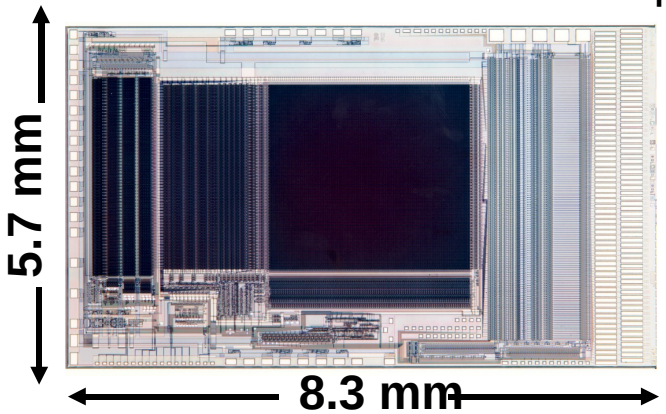
AToM Chip

- Radiation hard
- 128 Channels per chip
- Simultaneous
  - Acquisition
  - Digitization
  - Read-out

High Density Interconnect (HDI) Board

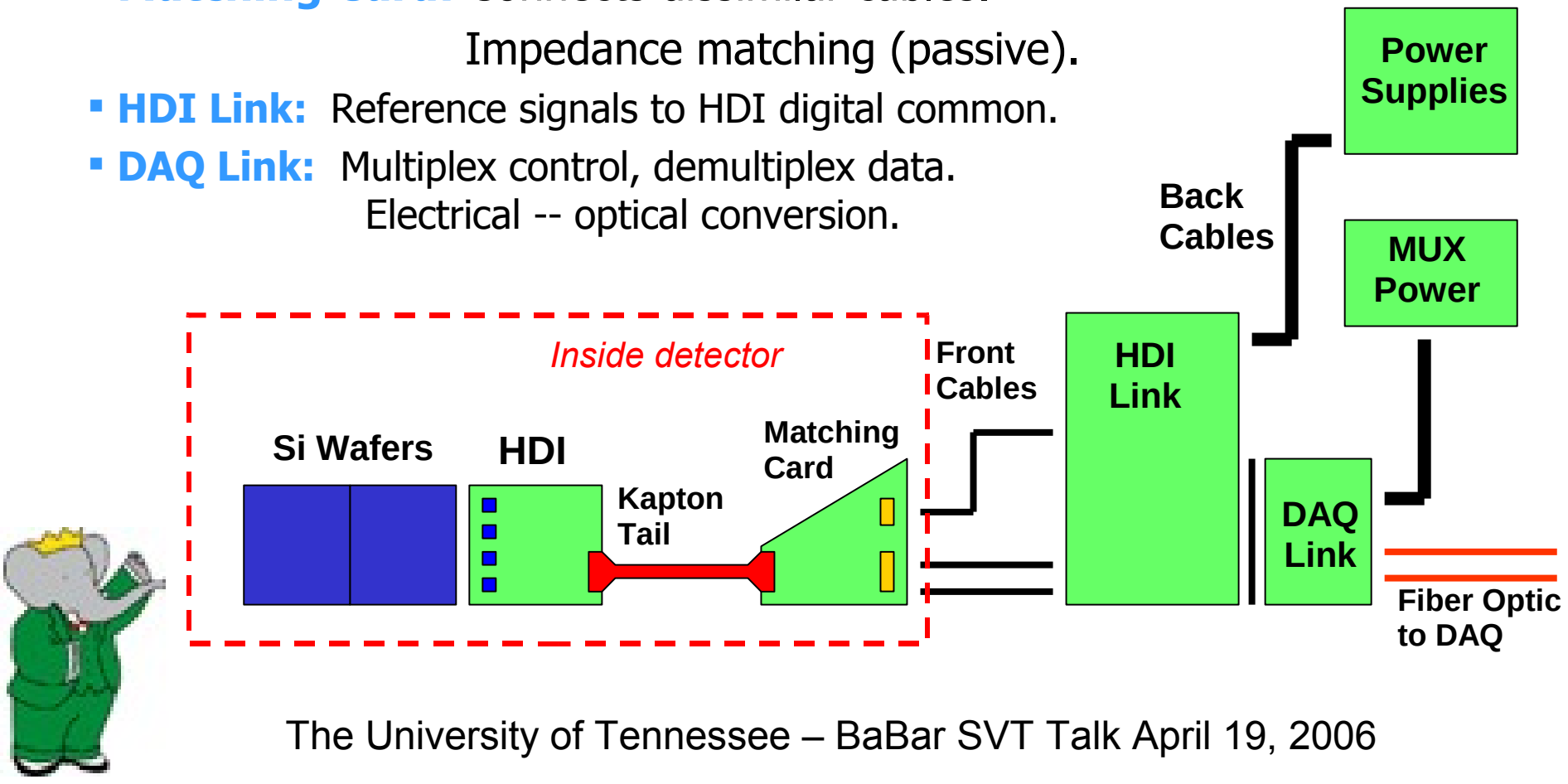


AToM Chip



SVT Readout

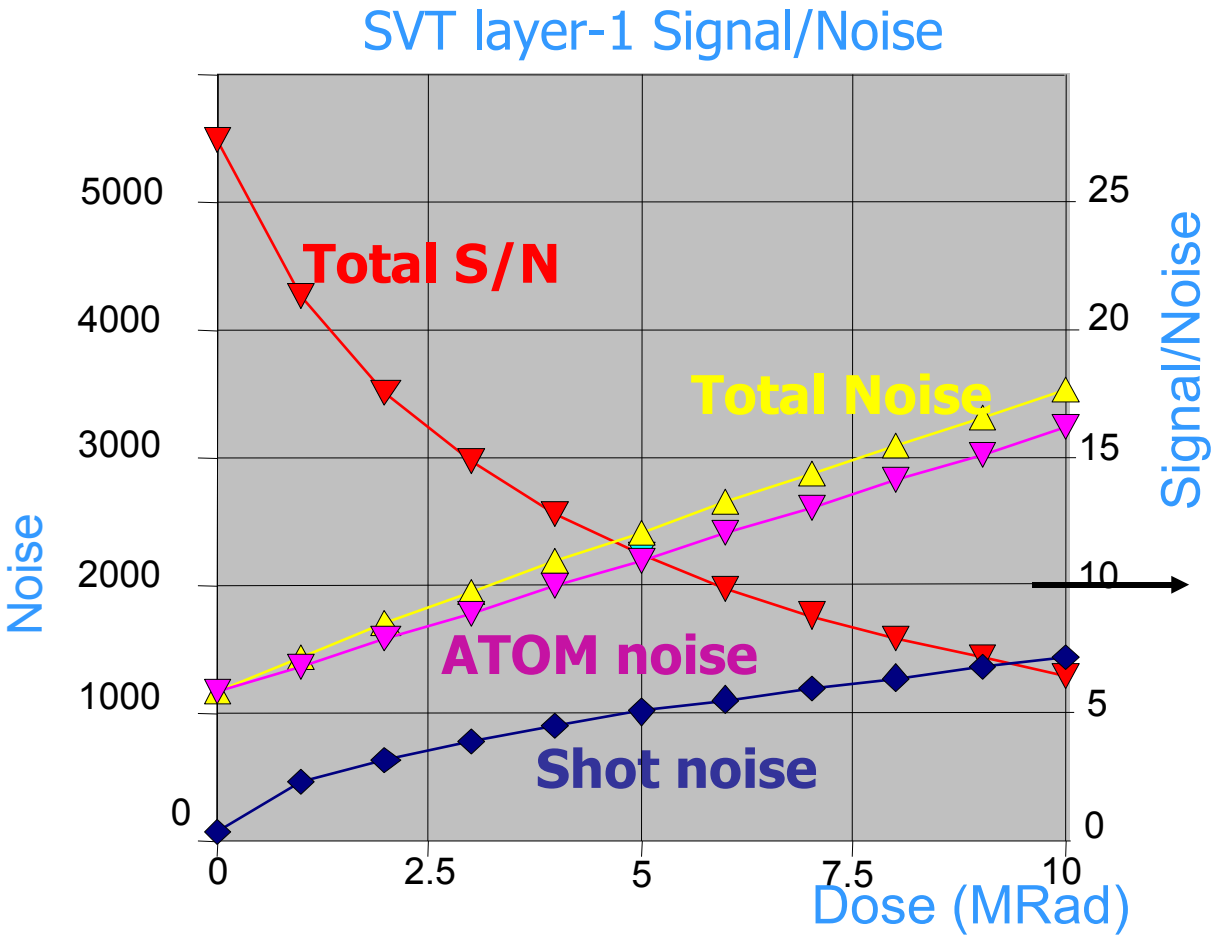
- **HDI:** High Density Interconnect.
  Mounting fixture and cooling for readout ICs.
- **Kapton Tail:** Flexible multi-layer circuit.
  Power, clock, commands, and data.
- **Matching Card:** Connects dissimilar cables.
  Impedance matching (passive).
- **HDI Link:** Reference signals to HDI digital common.
- **DAQ Link:** Multiplex control, demultiplex data.
  Electrical -- optical conversion.



Radiation Dosage

- Expected dosage of 2 MRad over 10 years in design
- SVTRAD measures dose rate to accuracy <.5 mRad/s
- Based on 2001 testing of the AToM chip with a Co^{60} source an upper limit of 5 MRad was set
- Dosage of the SVT budgeted to avoid this limit

Radiation degradation of S/N ratio



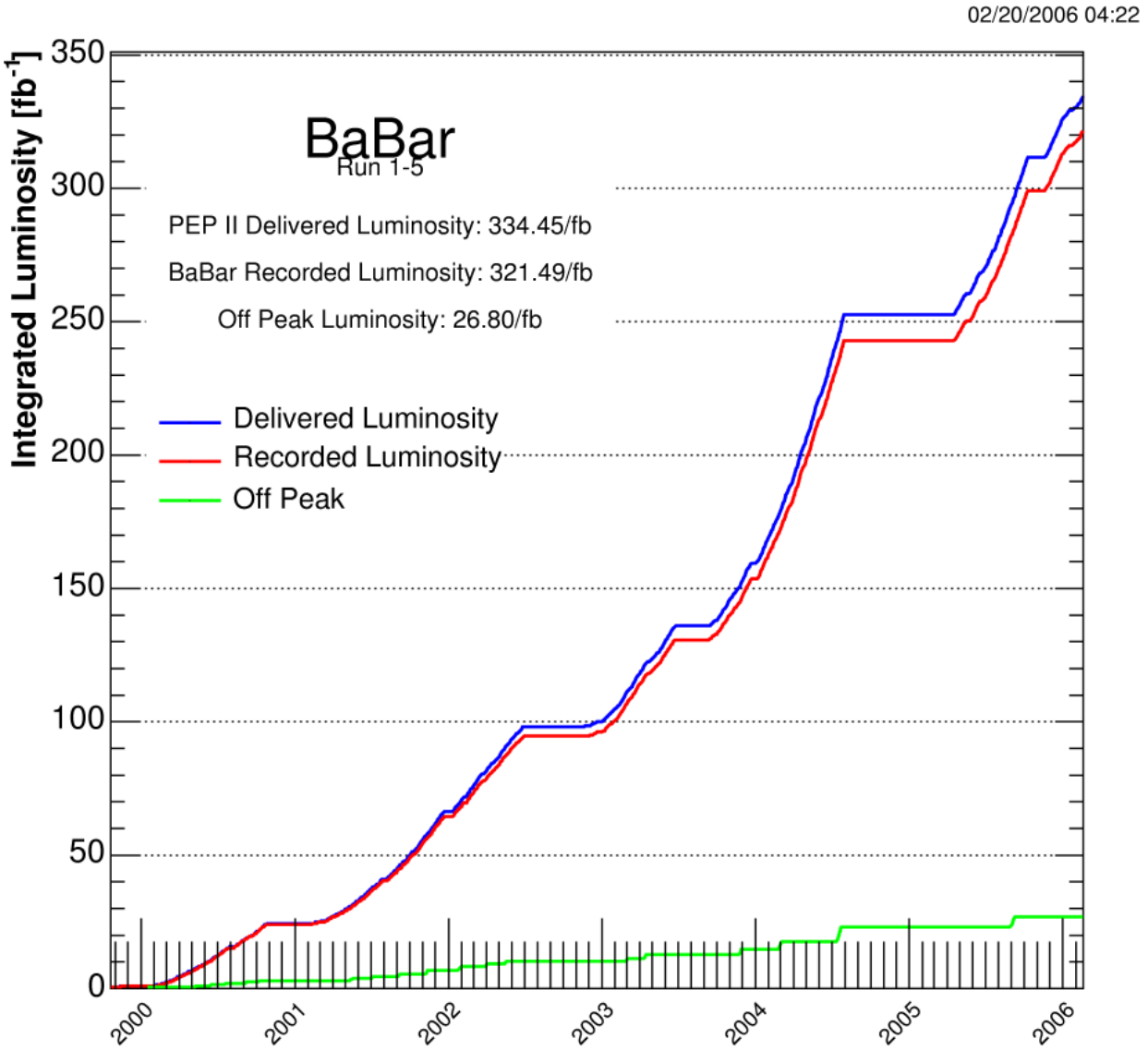
Limit: S/N=10

S/N Limit of 10 ⇒

Radiation budget: 5 MRad

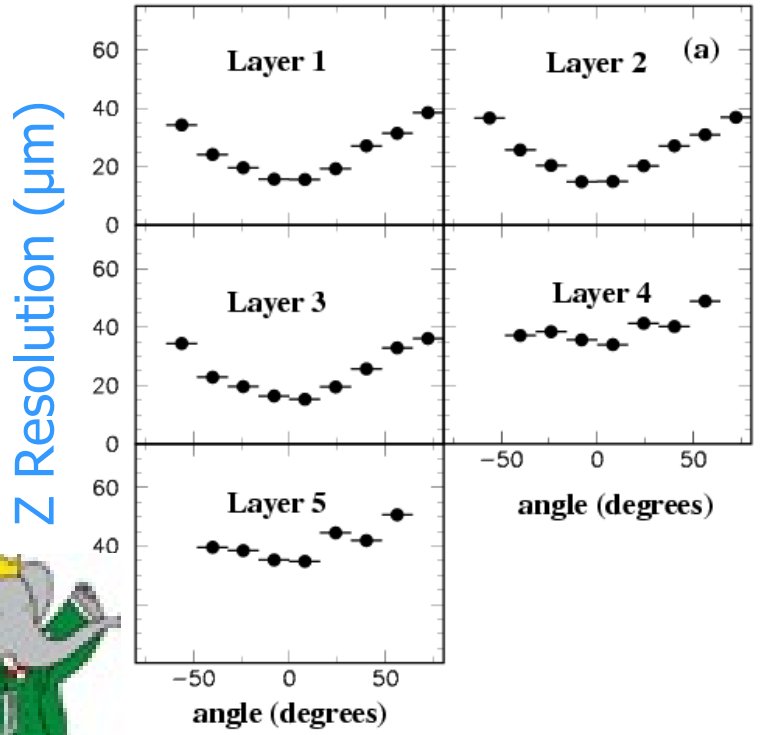
Results & Conclusions

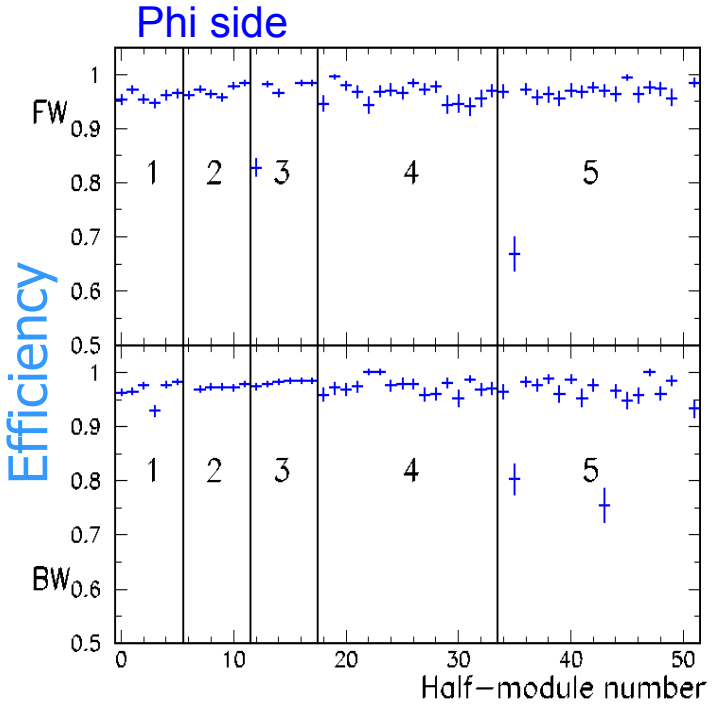
BaBar Data so far

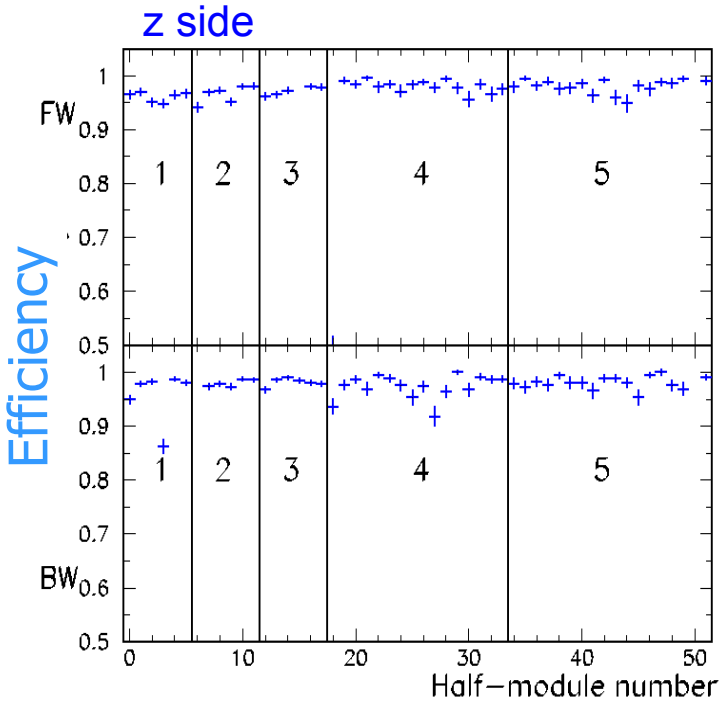


SVT Performance

- Average hit efficiency 97%
- Slow pion efficiency 70% for P_T>50 MeV
- Average z hit resolution 10 - 40 μm
  - Much less than required
- No radiation-induced change in performance observed so far (2005).

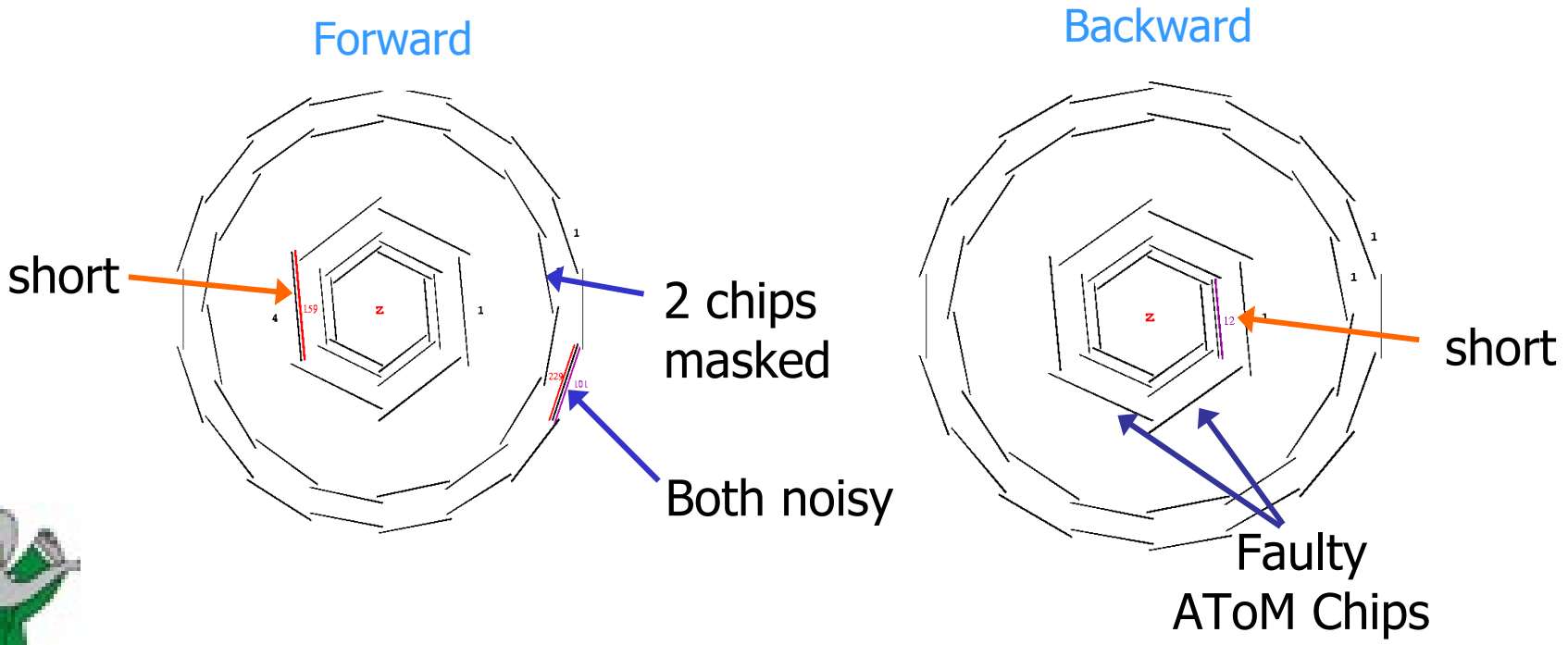






How the SVT's held up

- **<u>95% of detector is still fully functional:</u>**
  - 6 out of 208 readout sections not working
  - 300 p-stop shorts/pinholes (mainly from before 2001)
  - 2% unbonded or otherwise dead channels
  - Redundancy has proven to be sufficient



Questions?

Backup Slides

The AToM Chip

Digitization pipeline of single channel