Performance of STAR Silicon Drift Detectors at recent experiments at the AGS and RHIC (Present and future prospects)

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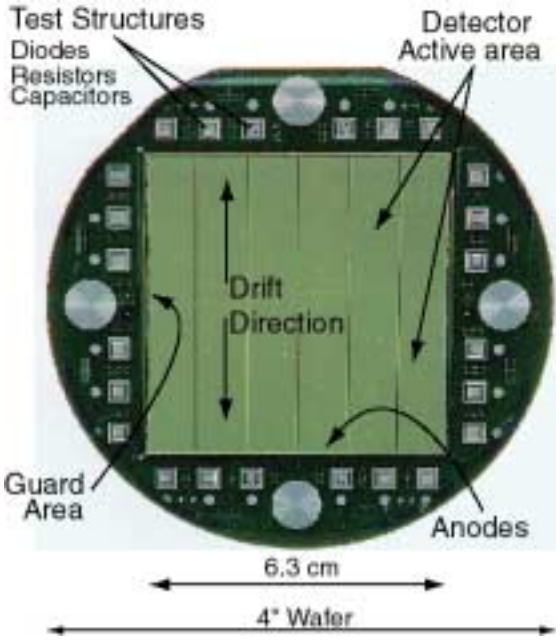
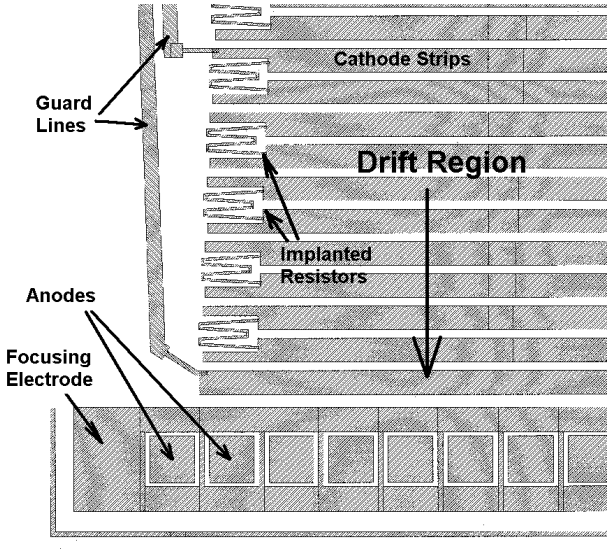
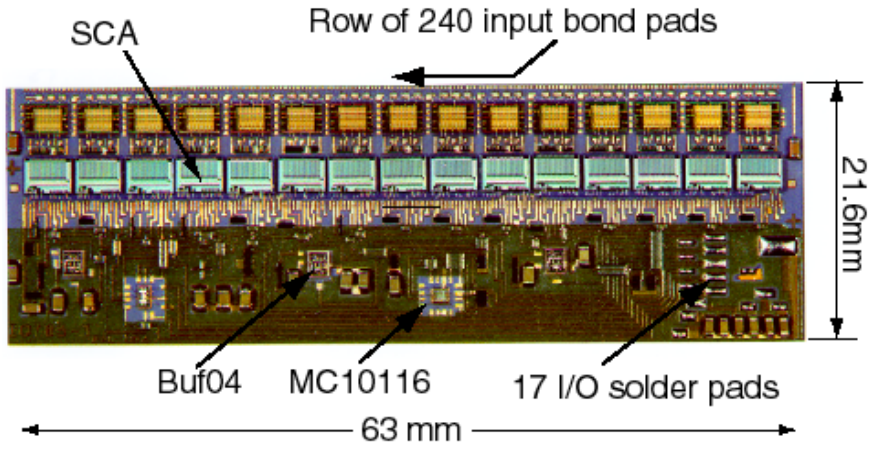
The STAR Silicon Drift Detector:





- $6.3 \times 6.3\ cm^2$, 95% active area.
- 4" NTD type, 300 μm thick, silicon wafer with a resistivity of 3 kΩ cm.
- 2×240 readout anodes, (spacing of 250 μm).
  128 Time buckets, 40 ns each (equivalent to 240 μm).

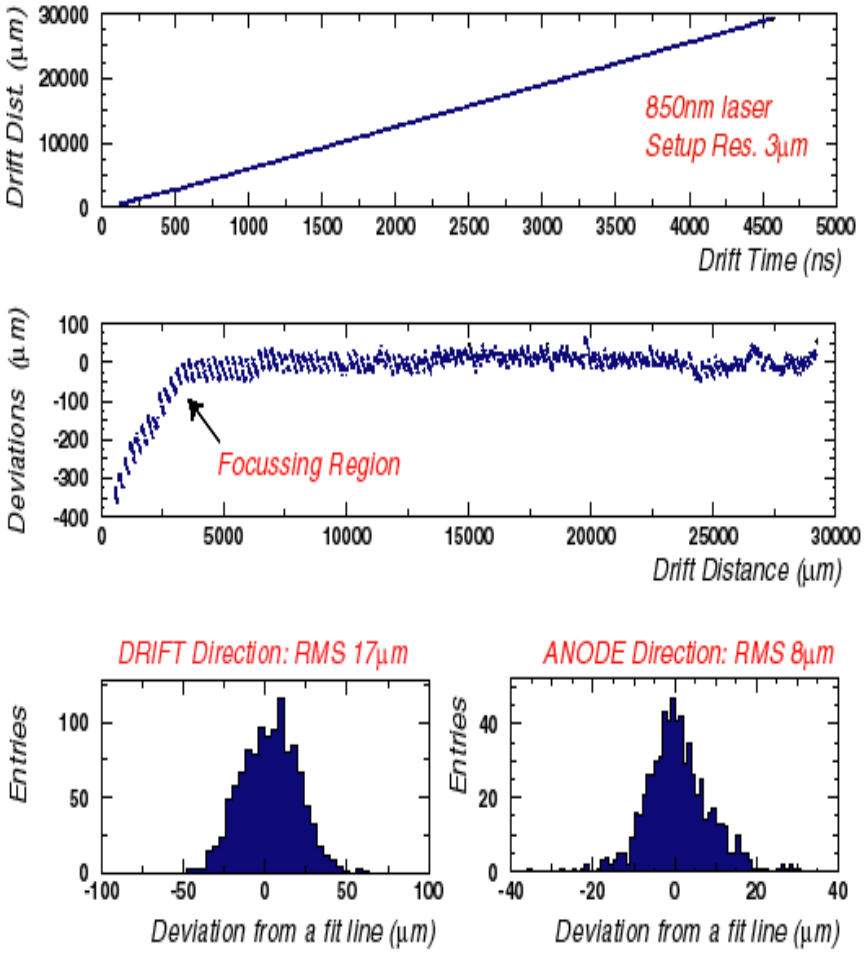
Front End Electronics:



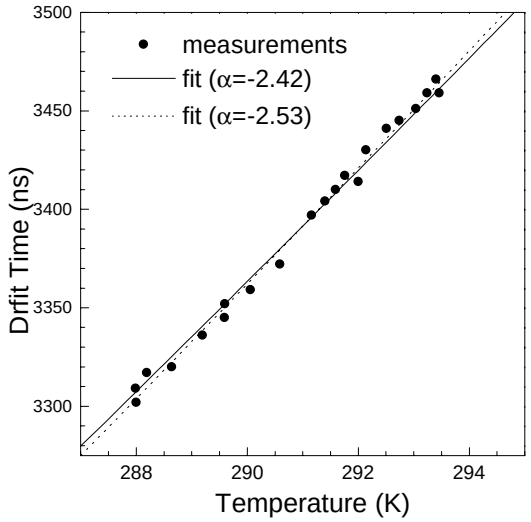
- **Beryllia substrate multi-chip hybrid carrier.**
- **15 PASA chips:**
  Pre-amplifier/Shaper integrated circuit based on bipolar technology
  16 input/output channels with gain factor of 7μV/electron
- **15 SCA chips:**
  Switched capacitor array based on CMOS technology
  Circular buffer with 128 capacitors with clocking frequency of 25 MHz
- **Readout time:** 4 μs drift time, and 5 ms readout of all SVT wafers.

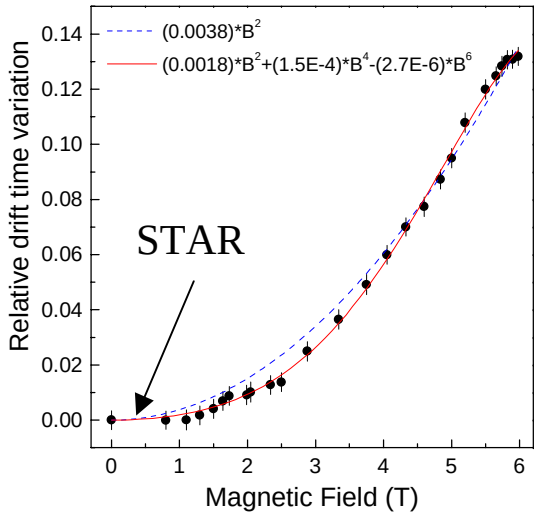
Performance of the STAR Silicon Drift Detector:

- Drift Velocity: **~6 μm/ns**
- Single hit resolution:
  - Anode Direction: **10 μm**
  - Drift Direction: **20 μm**
- Double hit resolution: **400 μm**
  (can be improved by software)
- Noise: **530e$^-$**
- No charge loss observed.



Temperature and Magnetic field dependence:





- **Temperature**

  Detectors run in room temperature, tested up to 60°C.

  1°C variation in temp. ≈ 1% in drift velocity.

  Charge injection lines calibrate drift velocity.

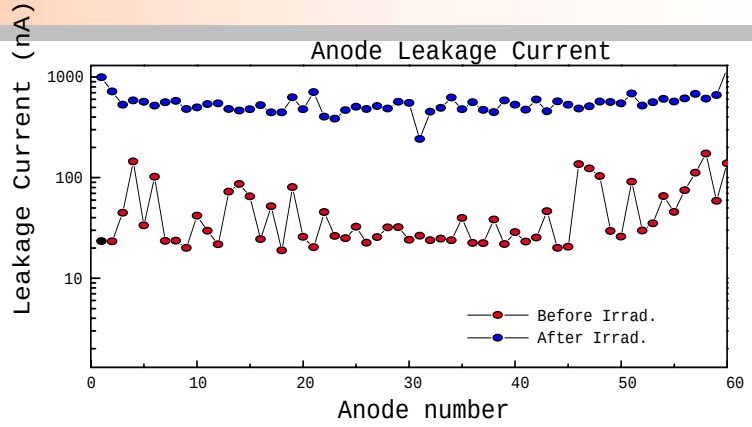
- **Magnetic field**

  Detector works well in high magnetic field environment , tested up to 6.4T.

Radiation Hardness of STAR/SDD:

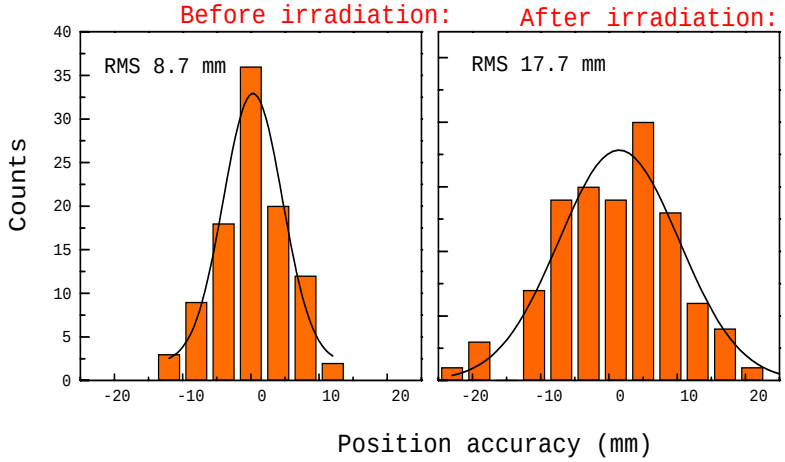
Irradiation:

- Both detector and Front End electronics were irradiated.
- neutron-radiation: **10^{12} n/cm^2**
- γ-radiation: **23 Krads**



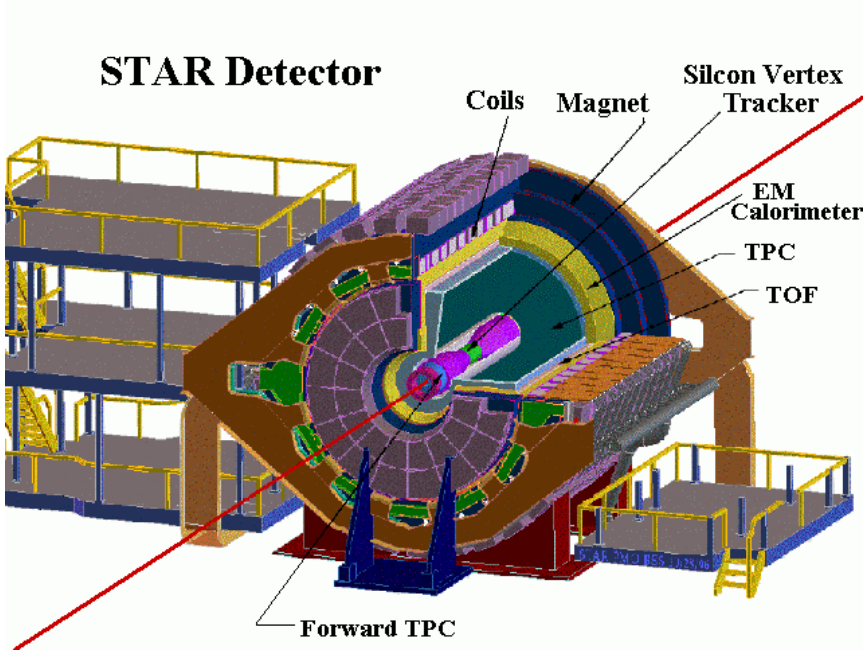
Effects:

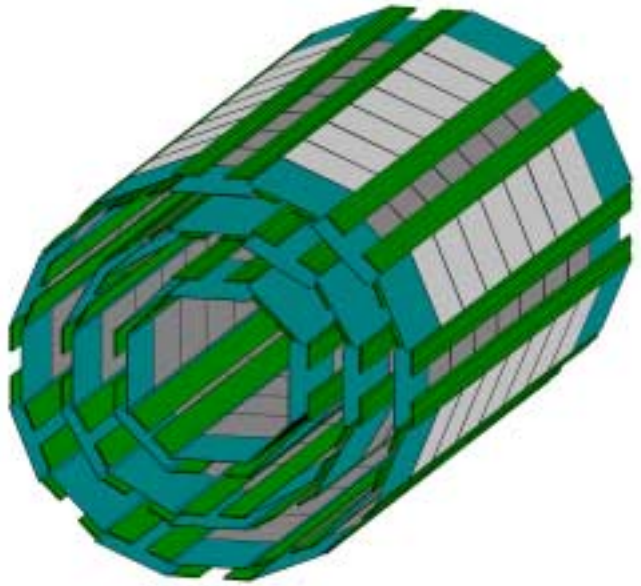
- Increase of leakage current ~**200 nA**
- Noise increase **20%**.
- Position resolution degradation



- For the radiation levels of RHIC (1Krad per year & 5×10^9 fast neutrons/cm^2), SDD and associated FEE is sufficiently radiation hard to withstand 10 years operation!!!

The STAR - Silicon Vertex Tracker:





- 216 Silicon Drift Detectors
- 36 detector ladders, mounted in 3 concentric barrels, at radius of 6.6 cm, 10.6 cm and 14.5 cm, total area of 0.7 mm^2.
- Estimated maximum hit occupancy: 78 hits/wafer ≈ 3%.

Status of the SVT assembly:

- **SDD Wafers (Completed)**
  - Total of 250 good wafers, production yield was ~70%.
  - Passive probe testing for selection criteria and quality control.
  - Laser cutting, with precision of **5 μm**.
- **Front End Electronics (In progress)**
  - PASA & SCA production complete, yield of 85%.
  - Hybrid assembly and bonding in progress.
- **SVT Ladders (In progress)**
  - Detector placement on ladder done with accuracy better than **10 μm**.
  - Relative ladder placement done with accuracy better than **100μm**.
  - Each ladder is calibrated with Laser injection on a XY stage test station, position resolution known to a precision of **10-20 μm**.
- **Completion and installation ready for RHIC year-2 running.**