Radiation damage status of the ATLAS silicon strip detectors (SCT)
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Summary
- ATLAS SCT (~60m²) has been working well over 7 years at LHC.
- Radiation received is now up to 3x10¹³ cm⁻² in 1MeV n-eq fluence.
- Steady increase and annealing of leakage current have been observed in good agreements with two models.
- Part of sensors pass the type inversion point. Detailed studies continue.

Operational status
- 98.7% of the SCT elements are active as of Nov. 2017.

Radiation in 1MeV n-eq Fluence [cm⁻²]
- Accumulated radiation levels at 2017 end can be estimated using the FLUKA simulation [1] and delivered luminosity at LHC Point-1.

Full Depletion Voltage
- Full depletion voltage \( V_{FD} \) depends on the effective doping concentration \( N_{eff} \): \( V_{FD} = \frac{\xi}{N_{eff}} \).
- Radiation \( \phi \) creates acceptors and removes donors and \( N_{eff} \) changes as \( \phi \).
- Type inversion \( n \rightarrow p \) occurs and \( V_{FD} \) gets higher due to the anti-annealing effect.

Noise and Gain
- Noise and gain are stable from 2010(top) to 2017(bottom).
- Anomalous noise increases observed in endcap strips facing to the N₂ gap spaces.

Leakage Current
- Leakage current is proportional to the fluence \( \phi \),
  \[ I_{leak} = a(T) \alpha \cdot V_{FD} \cdot \phi \]
- with temperature-sensitive annealing like
  \[ \alpha(t) = \alpha_0 \exp(\frac{-t}{\tau_0}) + \alpha_1 \exp(\frac{-t}{\tau_1}) + \alpha_2 \exp(\frac{-t}{\tau_2}) + \alpha_3 \exp(\frac{-t}{\tau_3}) + \alpha_4 \exp(\frac{-t}{\tau_4}) \]

Evolution of leakage current of 4 barrel layers and model prediction

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