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CERN Summer Student Sessions
16 August 2011

Towards searching for trapped slepton decays in ATLAS

UNIVERSITY OF ALBERTA
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INSTITUTE OF PARTICLE PHYSICS

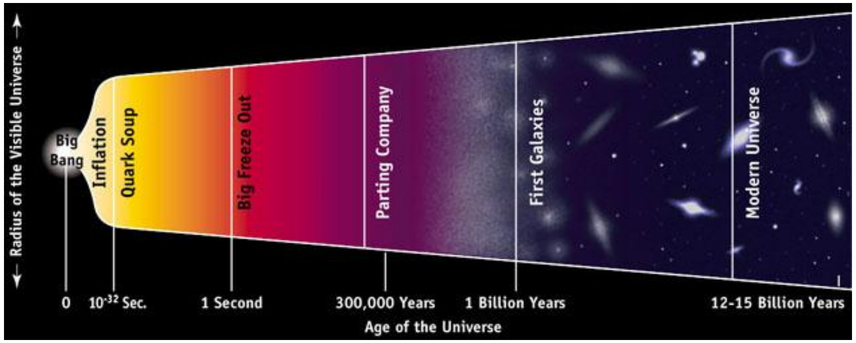
Supergravity

- Supergravity: supersymmetry + general relativity
- Gravitino interacts only gravitationally
- Gravitino lightest supersymmetric particle (LSP): next-lightest supersymmetric particle (NLSP) decays to standard model partner and gravitino in **0.1-1000 days**

J. L. Feng, A. Rajaraman and F. Takayama, Phys. Rev. Lett. **91**, 011302 (2003).

Cosmology

- Late NLSP decays affect cosmology
- Gravitino LSP is superWIMP dark matter
- Charged slepton NLSP favoured, particularly right-handed stau
- NLSP lifetime of a month solves ^7Li abundance anomaly

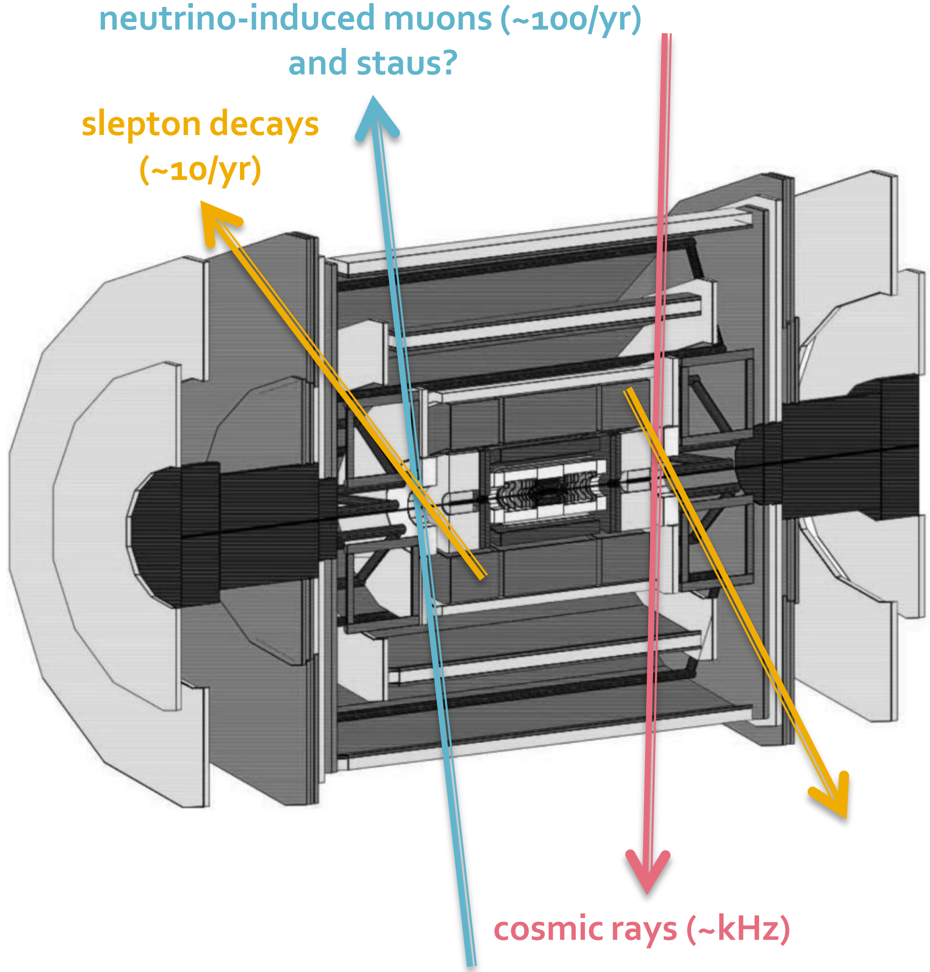


Astronomy Workshop, D. P. Hamilton

J. L. Feng, A. Rajaraman and F. Takayama, Phys. Rev. Lett. **91**, 011302 (2003).

Motivation

- Detectors trap sleptons, observe their late decays in cosmic ray runs
- Eliminate cosmic rays by only considering upward-going muons
- Trapped slepton decay muons will not hit both sides of the outer layers
- Neutrino-induced muons (and staus?) interesting
- **Distinguish upward going muons using timing**



J. L. Pinfold and L. Sibley, Phys. Rev. D **83**, 035021 (2011).

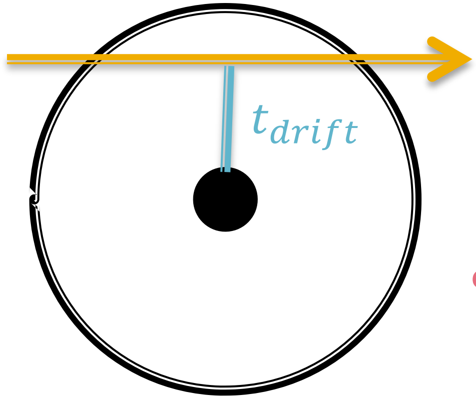
Software Chain

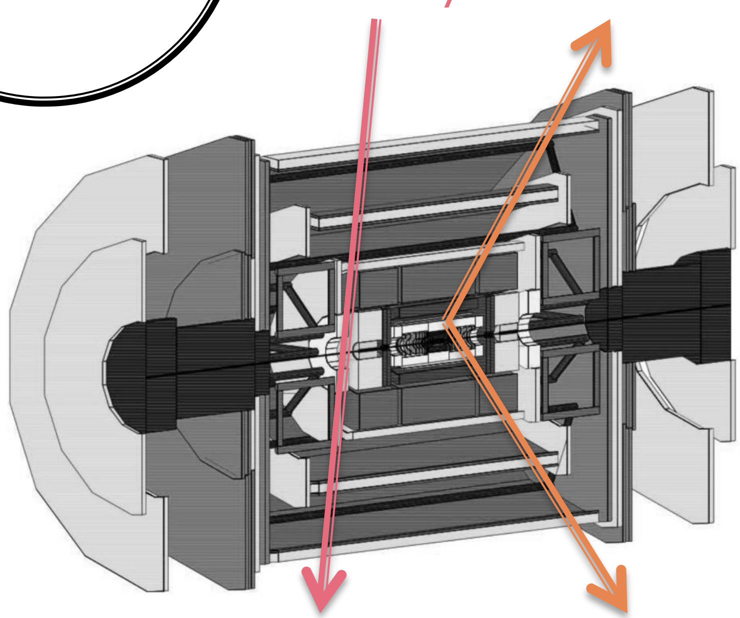
- Monitored drift tube (MDT) timings in event summary data (ESD) with full reconstruction output
- Athena framework to write C++ programs accessing ESDs and outputting ROOT files
- Ganga to run Athena programs on the Grid to access entire runs of data
- ROOT to do final analysis

MDT Timing

$$t_{measured} = t_{drift} + t_{flight} + t_{propagation} + t_0$$

- Drift time determines distance of hit from wire
- Drift time offset by time of flight, cable propagation, electronics
- t_{flight} calibration assumption
  - $t_{flight,collision}$ muon originates from interaction point in time with bunch crossing
  - Cosmics have $t_{jitter} \mp t_{flight,collision}$ in top and bottom of detector





R. Aben, M. S. thesis, Universiteit van Amsterdam, 2010.

t_o Correction

- Muon reconstruction determines $t_{0,refit}$ to best fit segment, correction recorded
- Taking difference in correction in different layers removes jitter
- Can differentiate between $(0,2)\Delta t_{flight}$

expected for collision muons

$$t_{measured} = t_{drift} + t_{flight,collision} + t_{propogation} + t_{0,calibration}$$

reality for cosmic muons

$$t_{measured} = t_{drift} + t_{jitter} \pm t_{flight,collision} + t_{propogation} + t_{0,calibration}$$

$$t_{0,refit} = t_{measured} - t_{drift} - t_{propogation} - t_{flight,collision} = t_{jitter} - (0,2)t_{flight,collision} + t_{0,calibration}$$

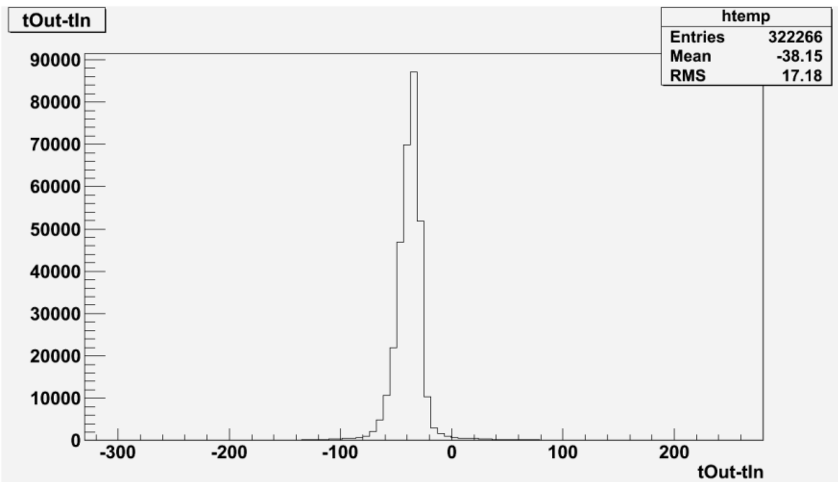
$$t_{0\ correction} = t_{0,refit} - t_{0,calibration}$$

$$\Delta t_{0\ correction} = (0,2)\Delta t_{flight}$$

N. Benekos, J. Coggeshall and T. M. Liss (unpublished).

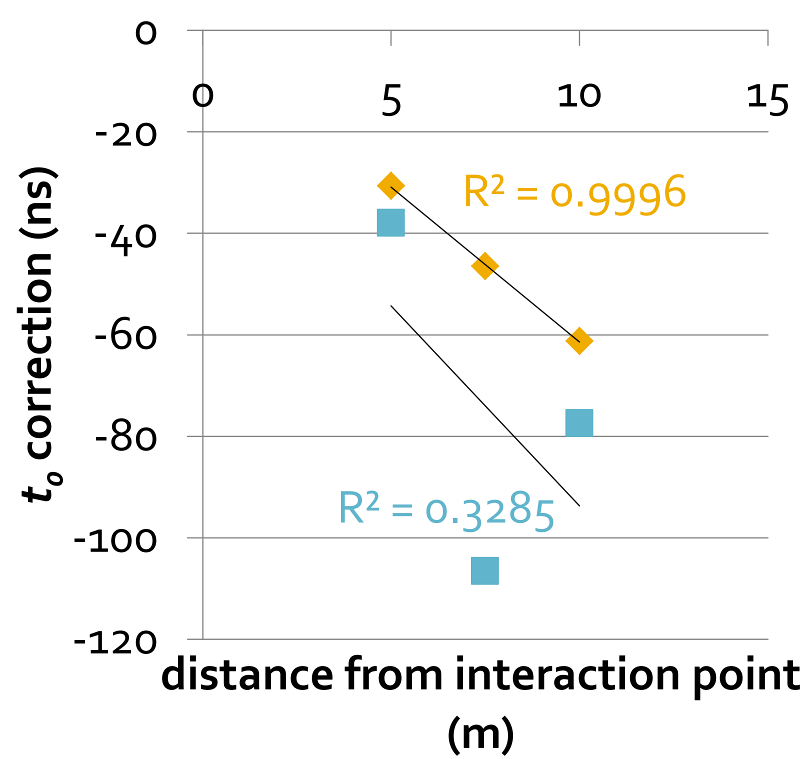
Cleaning the t_0 Correction

$\Delta t_{0\ correction}$ (ns)
cosmic rays in upper half of detector



μ corresponds to 11.44 m
3 hours of cosmic data

Cosmic ray tracks in upper half of detector



Conclusion

- More research needed to use t_o correction to find upward muons in cosmic ray runs
- Current triggers will be replaced with triggers involving timing and pointing requirements
  - Will reduce cosmic ray background, but also need to be careful sleptons aren't filtered out too
- Technique could be used to research neutrino-induced muons, neutrino-induced staus as well as slepton decays