The TRACER Project:
Transition Radiation Array for Cosmic Energetic Radiation

**Origin of Galactic Cosmic rays (Supernova Remnants ?)**
- how are nuclei accelerated?
- what is the maximum energy via SNR acceleration?
- how are nuclei injected into the accelerator?
- how do nuclei propagate through the Galaxy?

**Largest cosmic ray detector** 5m²sr
Single element resolution
Energy range $10^9$ – $10^{15}$ eV
→ Scintillation counters
→ Cherenkov counters
→ Ionization measurement in gas
→ Transition radiation detectors

<table>
<thead>
<tr>
<th>Flights</th>
<th>Year</th>
<th>Location</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td></td>
<td>Fort Sumner</td>
<td>1 day</td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td>Antarctica</td>
<td>10 days</td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td>Sweden to Canada</td>
<td>4.5 days</td>
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</tbody>
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**Scientific Highlights**
- Most detailed measurements of cosmic-ray nuclei $> 10^{10}$ eV.
- First measurement of nuclei $> 10^{14}$ eV.
- Common mode of acceleration for all elements.
- Propagation path length decreases with energy $10^9$-$10^{12}$ eV.
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Propagation of high-energy cosmic rays in the Galaxy.

Proposed to NASA in 2008/9 – highly recommended.
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Payload
- 2.5 x 2.5 x 2.5 m³
- 6000 lbs

Balloon
- 40 M cubic foot balloon

Flight Characteristics
- 120,000+ feet
- 14+ day flight

Launch
- Antarctica
- Sweden (Russian overflight)

Telemetry
- LOS 1 Mbit
- TDRSS

Program
- 4 years

Collaboration
- McGill
- UChicago
- NASA GSFC
- Penn State

Budget
- $5 M (total)

Possible Funding
- NASA
- CSA
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Program Schedule

Year 1
Refurbishment of TRD system.
Testing and procurement of Aerogel.
Design of front end electronics, DAQ and scintillator system.

Year 2
Construction of scintillation, Cerenkov and power systems.
Construction of front end electronics and DAQ.

Year 3
Integration of detector system
Vacuum test of instrument
Flight readiness review
Balloon flight in polar region

Year 4
Recovery an initial refurbishment of detector system
Data Analysis
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Responsibilities

McGill / UChicago  TRD, Gas systems, DAQ, Integration, Power.

NASA GSFC  Cerenkov, Front-end electronics.

Penn State  Scintillator systems.

Proposed Canadian Contribution

Operating costs
~ 100 k per year (post-doc & graduate student(s) + undergrads)

Lab space
suitable work area with 3.5 m overhead crane for years 1 - 3.

- Modest cost for Canadian led international balloon mission.
- Excellent opportunity for training HQP's.
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Summary

- TRACER+ can continue cutting edge cosmic-ray measurements.
- Depends on funding in both Canada and USA.
- Canada could play a lead role for modest cost.
- Opportunity to train HQP's.

Long Term

Space mission with TRACER technology.

Technologies are proven and development could begin anytime.

Proposal ranked highly in NASA Space based small Initiatives Program