

Esrang, Sweden  
4  $\frac{1}{2}$  days 2006



Fort Sumner, New Mexico  
1 day 1999



McMurdo Station, Antarctica  
10 days 2003

**TRACER+**

**Patrick Boyle  
McGill University**



# The TRACER Project:

## Transition Radiation Array for Cosmic Energetic Radiation

### *Origin of Galactic Cosmic rays (Supernova Remnants ?)*

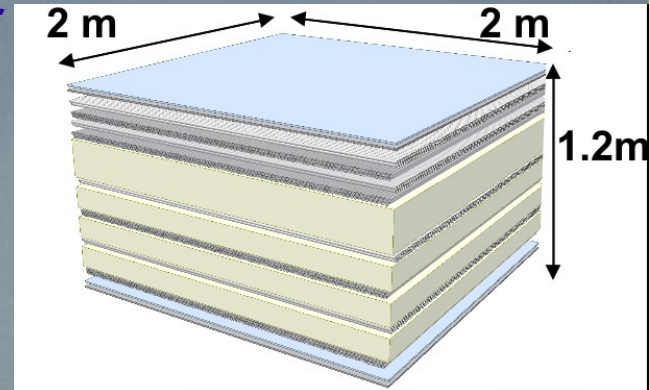
- how are nuclei accelerated ?
- what is the maximum energy via SNR acceleration ?
- how are nuclei injected into the accelerator ?
- how do nuclei propagate through the Galaxy ?

### *Largest cosmic ray detector 5m<sup>2</sup>sr*

#### Single element resolution

#### Energy range 10<sup>9</sup> – 10<sup>15</sup> eV

- Scintillation counters
- Cherenkov counters
- Ionization measurement in gas
- Transition radiation detectors



<i>Flights</i>	<b>1999</b>	Fort Sumner	1 day
	<b>2003</b>	Antarctica	10 days
	<b>2006</b>	Sweden to Canada	4.5 days

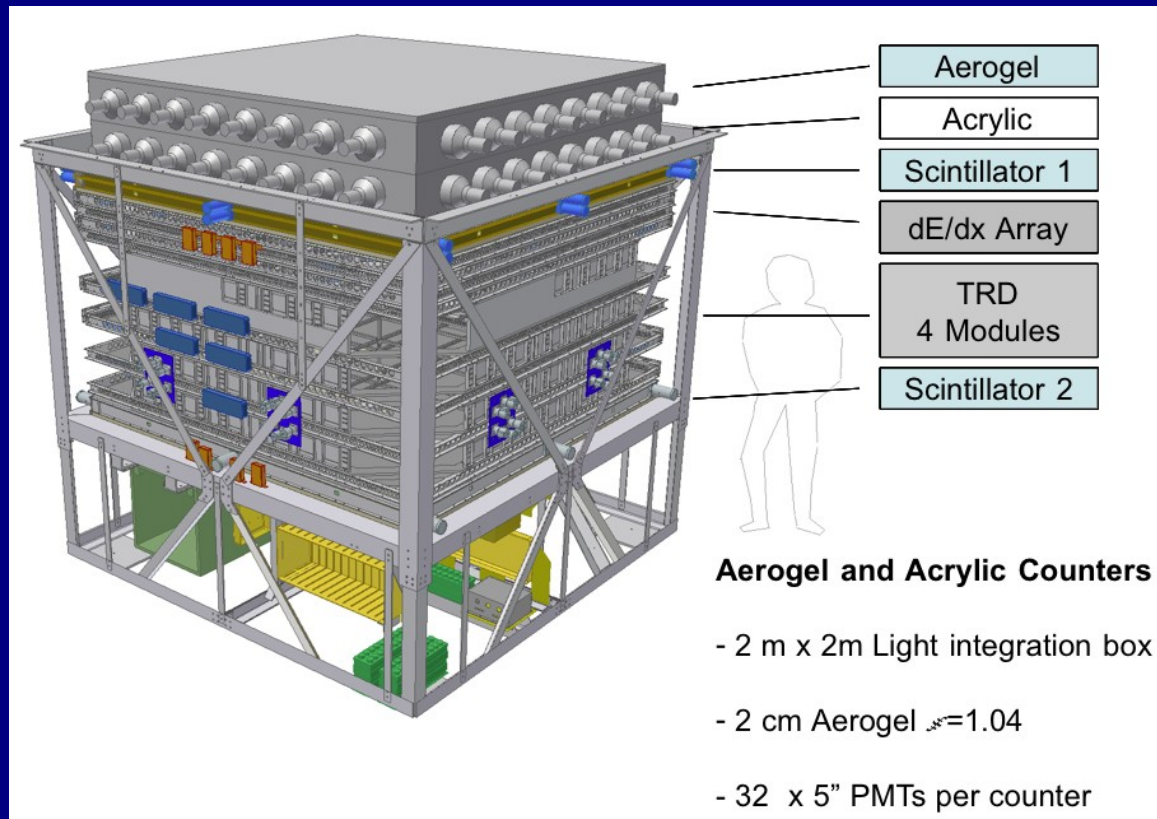
### *Scientific Highlights*

- Most detailed measurements of cosmic-ray nuclei > 10<sup>10</sup> eV.
- First measurement of nuclei > 10<sup>14</sup> eV.
- Common mode of acceleration for all elements.
- Propagation path length decreases with energy 10<sup>9</sup>-10<sup>12</sup> eV.



# TRACER+

Propagation of high-energy cosmic rays in the Galaxy.



Proposed to NASA in 2008/9 – highly recommended.

# TRACER+

## Payload

- 2.5 x 2.5 x 2.5 m<sup>3</sup>
- 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

# TRACER+

## 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 and initial refurbishment of detector system

Data Analysis

# TRACER+

## 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.

# TRACER+

## 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*