A night sky with a mountain silhouette and a shower of white lines representing cosmic rays. The lines are concentrated in the upper left and fan out towards the right. A bright star is visible in the upper left. The mountains are dark, and some lights are visible in the distance.

Portable cosmic ray telescopes  
based on RPCs  
V. M. Nouvilas and C. Soneira

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- The TRASGO project
- The miniTRASGO system

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# Introduction

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- ▶ **Cosmic Rays:** protons, atomic nuclei, electrons, and positrons.
- ▶ Some of them reach  $E \geq 10^{18}$  eV.
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The miniTRASGO system

# The miniature TRASGO: miniTRASGO

- ▶ Four **multigap** RPC modules.
- ▶ Each RPC module has **two 1 mm gas gaps**.
- ▶ **Three 2 mm thick float glass** electrodes of about  $300 \times 300 \text{ mm}^2$ .
- ▶ HV electrodes (2800 kV/gap) made up of **semi-conductive layer** of  $10 \text{ M}\Omega/\text{cm}^2$  applied with airbrush techniques.

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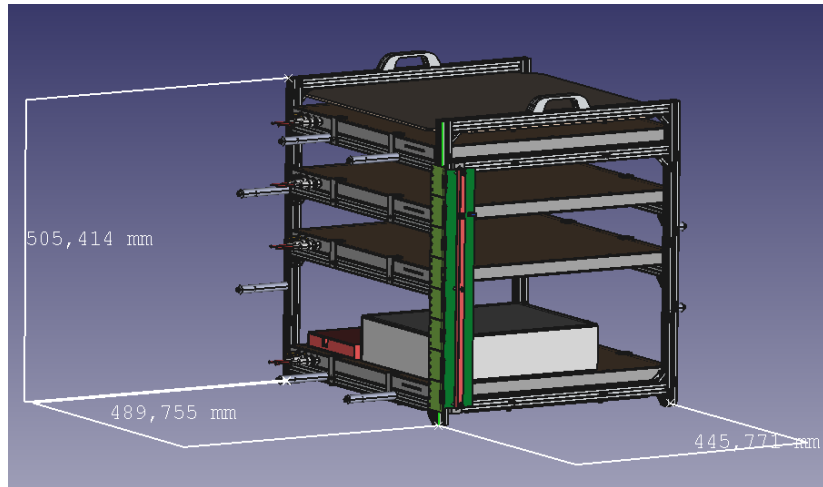
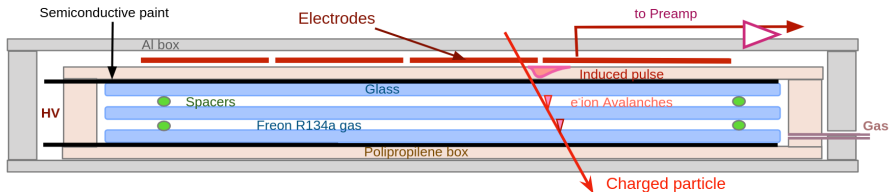


Figure: miniTRASGO design.



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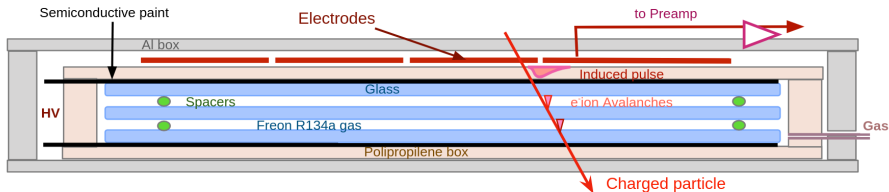
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- ▶ Structure enclosed in an **aluminium box**, provides electromagnetic insulation and rigidity



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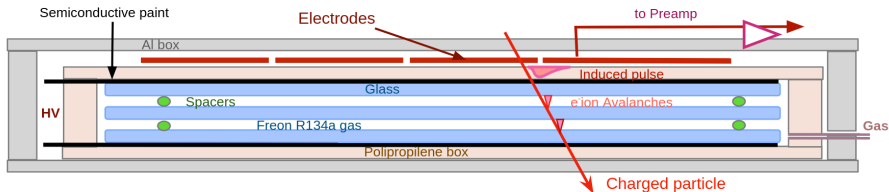
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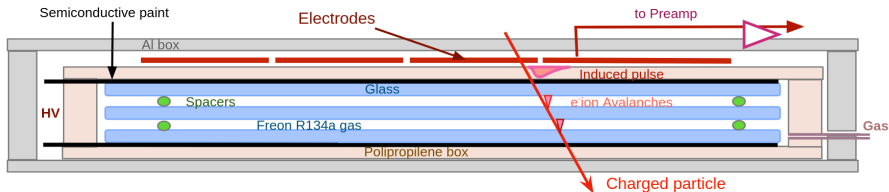
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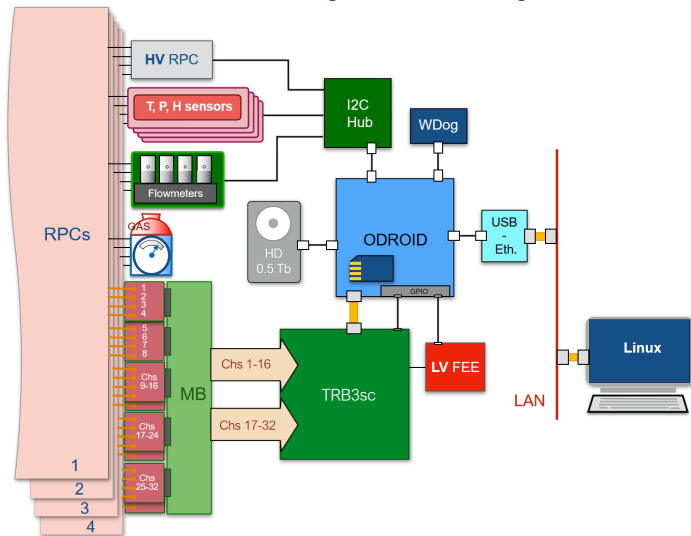
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# The miniTRASGO system: small, but tough

mTrasgo: Data flow and logic



Measuring with miniTRASGO

## The product of the measurement

- ▶ **RPC detection:** any of the four strips that constitute the RPC, on any of both Front ( $F$ ) or Back ( $B$ ) sides, receives a signal.
- ▶ **Trigger:** criteria chosen to register an event. Current trigger: detection in a time window of 200 ns in **three of the four** RPCs.
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- ▶ **Five types** of detections on a miniTRASGO RPC:

- ▶ No strip receives signal
- ▶ only one does (*single*)
- ▶ two (*double*)
- ▶ three (*triple*)
- ▶ up to four (*quadruple*)

Double, triple and quadruple are **multistrip** detections.

- ▶ There could be **crosstalk**: a very small leaking of charge from one strip to another.
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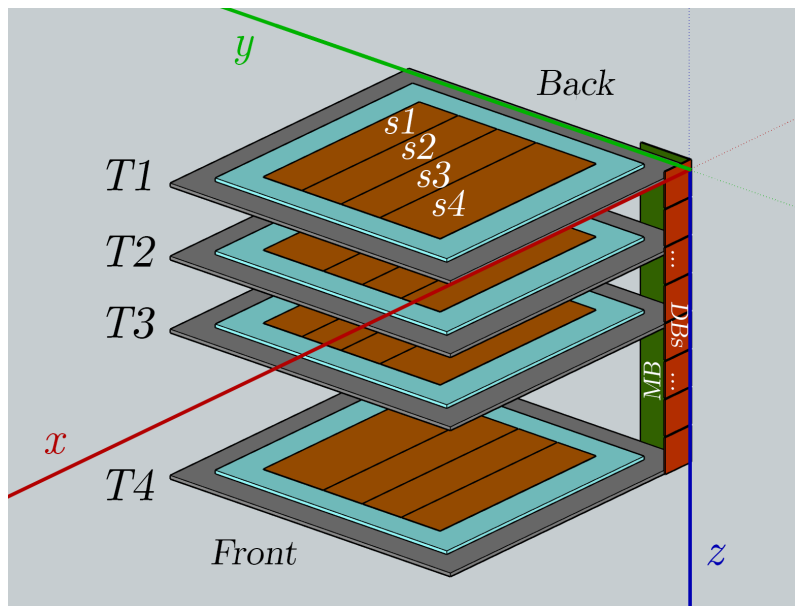
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- ▶ Calculated as follows:

$$Q = \frac{Q_{F,s} + Q_{B,s}}{2} + \epsilon_{T,s}^Q$$

$\epsilon_{T,s}^Q$ : **calibration** parameter for charge in that RPC  $T$  and strip  $s$ :  
**Maximum** of all the values below a certain **quantile**

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## The product of the measurement: position

- ▶  $Y$  position determined according to **strip number and RPC**.
- ▶ Position along the strip,  $X$ , **requires**  $T_{F,s}$  and  $T_{B,s}$ . The following equation is used:

$$X = \frac{T_{F,s} - T_{B,s}}{2} \cdot V_{\text{strip}} + \varepsilon_{T,s}^T,$$

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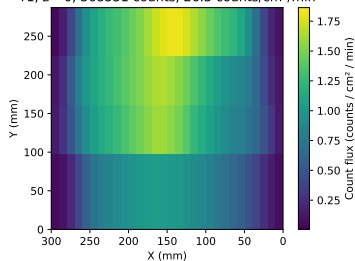
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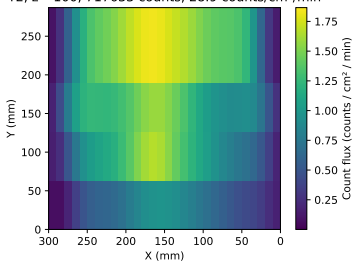
# Position maps

Corrected by efficiency hit position distribution  
from 2023-08-06 00:05:01 to 2023-08-08 00:00:02

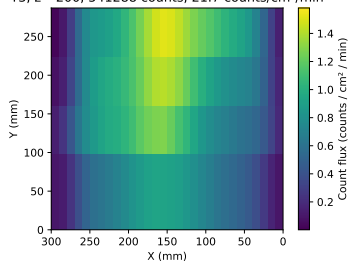
T1, z = 0, 568551 counts, 26.3 counts/cm<sup>2</sup>/min



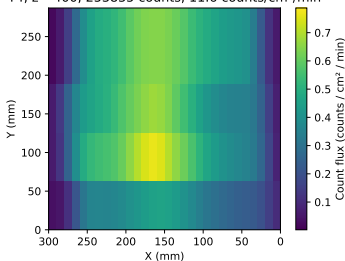
T2, z = 100, 717633 counts, 28.9 counts/cm<sup>2</sup>/min



T3, z = 200, 541288 counts, 21.7 counts/cm<sup>2</sup>/min



T4, z = 400, 253835 counts, 11.6 counts/cm<sup>2</sup>/min

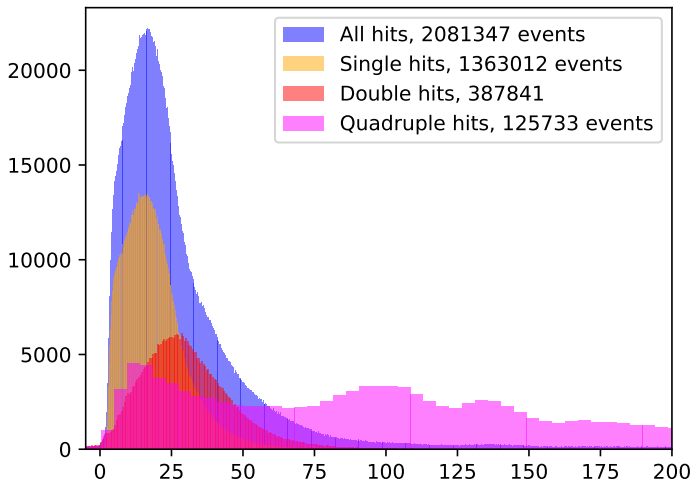


## Charge spectra

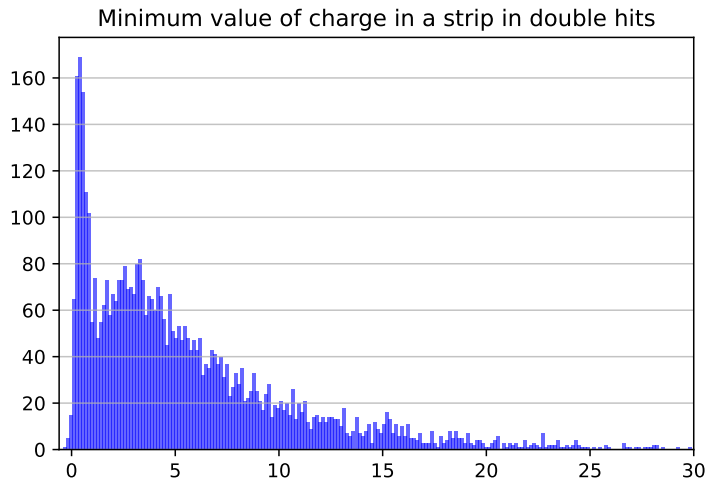
Let's review some data for several **multistrip cases**.

# Multistrip hits and crosstalk characterization

Event distribution according to the number of strips activated from 2023-08-06 00:05:01 to 2023-08-08 00:00:02



# Multistrip hits and crosstalk characterization



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When a double hit can be considered an interstrip hit:

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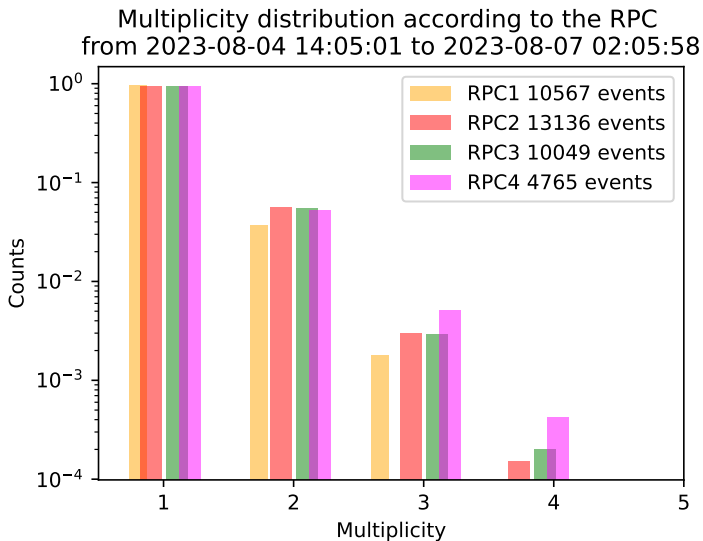
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- ▶ The new miniTRASGO system has been introduced.
- ▶ Time and charge measurements are simple but powerful tools.
- ▶ Some derivations, such as multiplicity, were presented.
- ▶ **This telescope is just born... A lot of work is yet to be done!**

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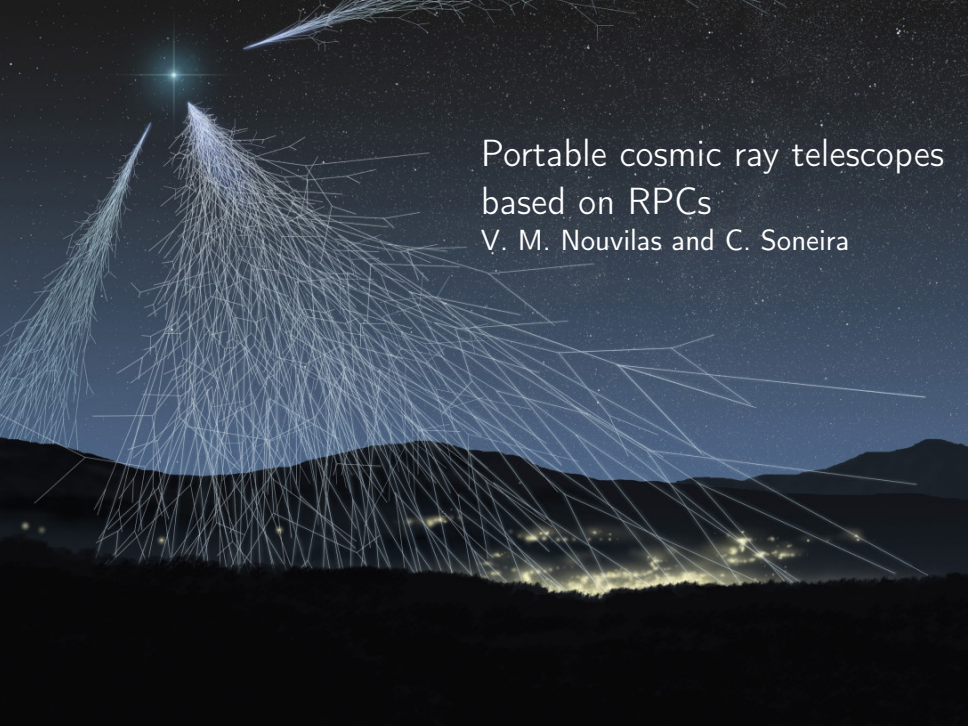
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