An approach to pure scintillator-based detector for *Neu-LAND*

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Introduction
Physical background
Experiment
Results
Conclusions

1. Introduction

1.1 Cave C: What is done there?

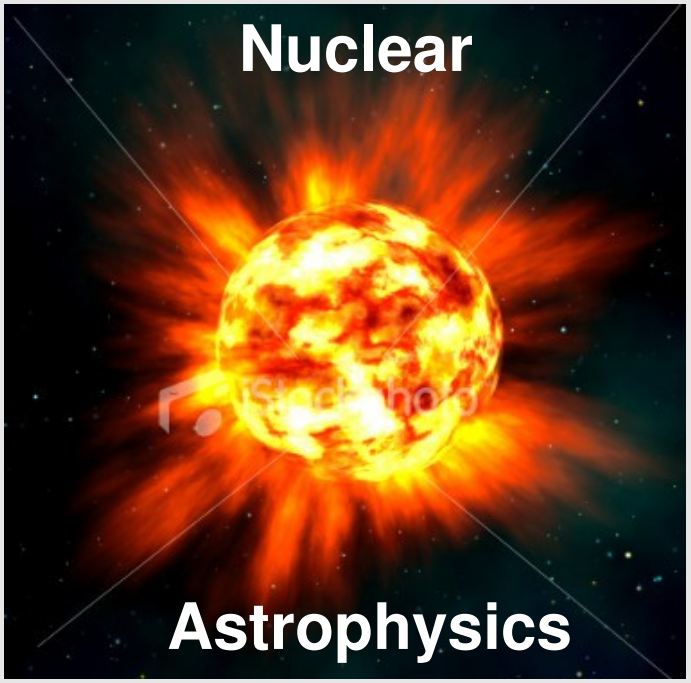
Particle Collisions:

-Multifragmentation

-Collective Flow of Nuclear Matter

-Knock Out

-etc.



1. Introduction

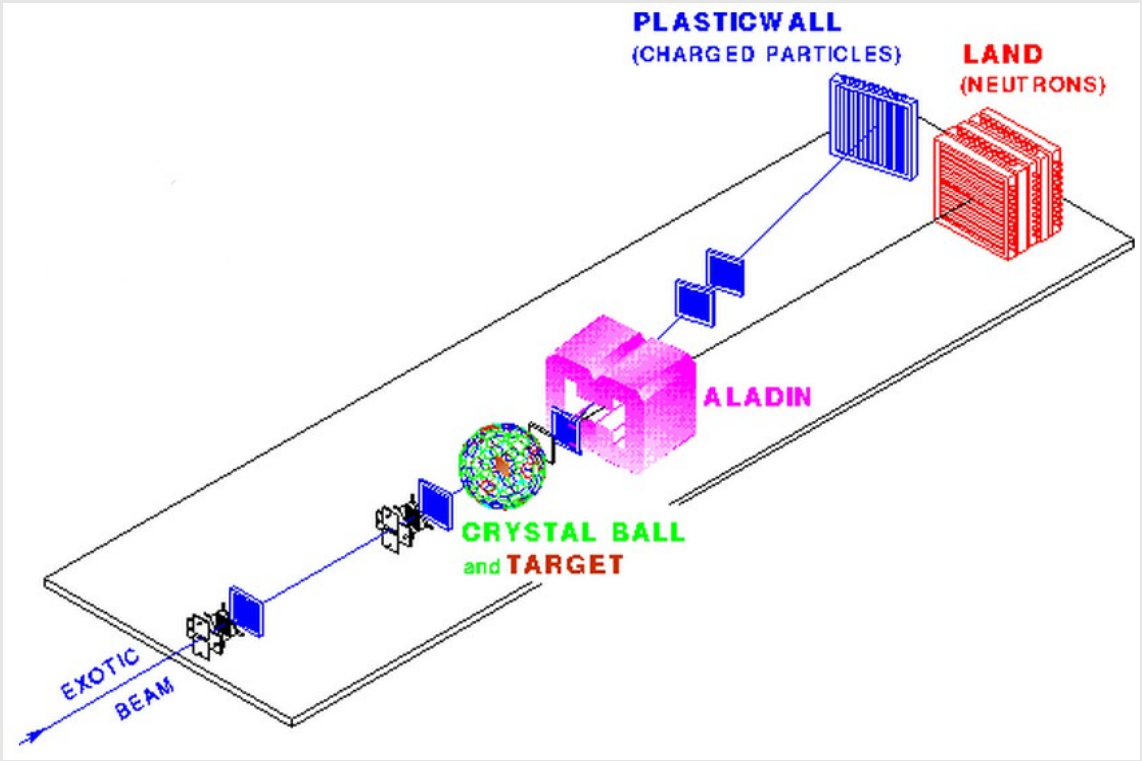
1.2 Large Area Neutron Detector: LAND

LAND mission: detecting neutrons coming from heavy ion collisions.

Trajectory: measure 2 positions.

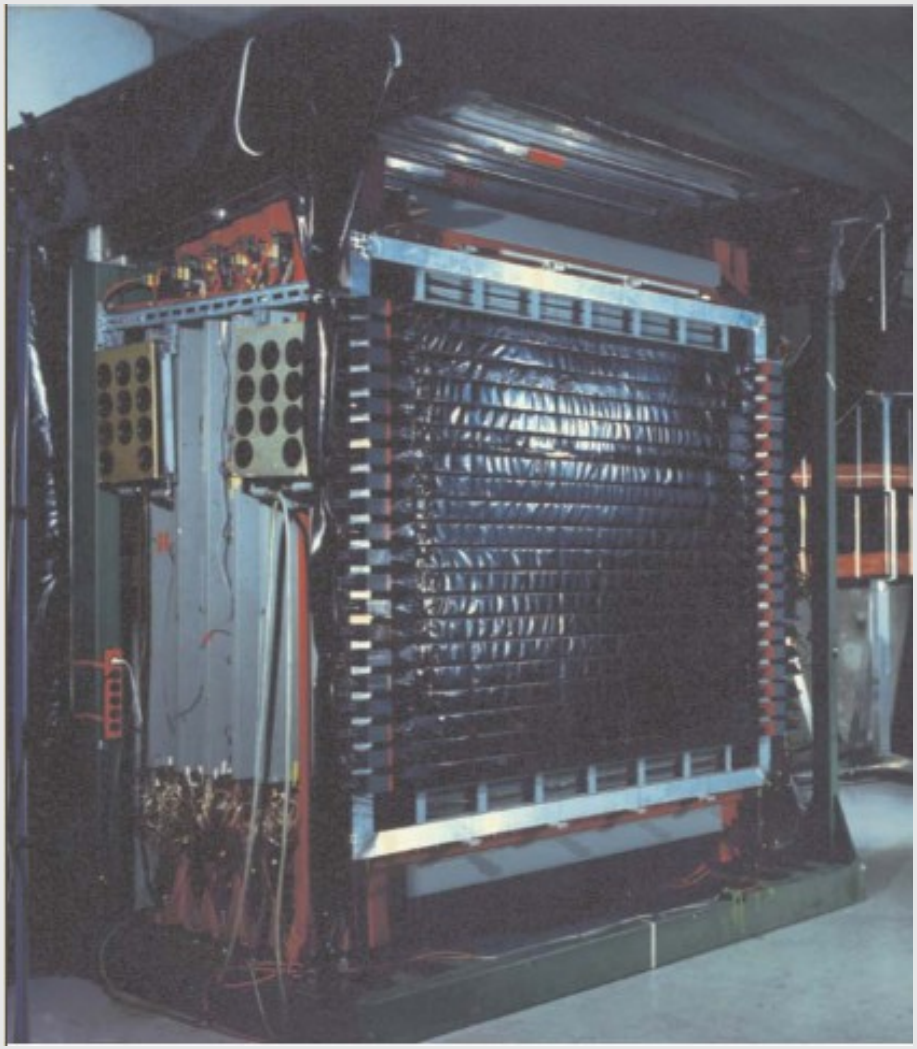
Time of flight between those two positions.

Neutrons momentum.



Schematic view of Cave C

1. Introduction:
1.2 LAND



LAND detector

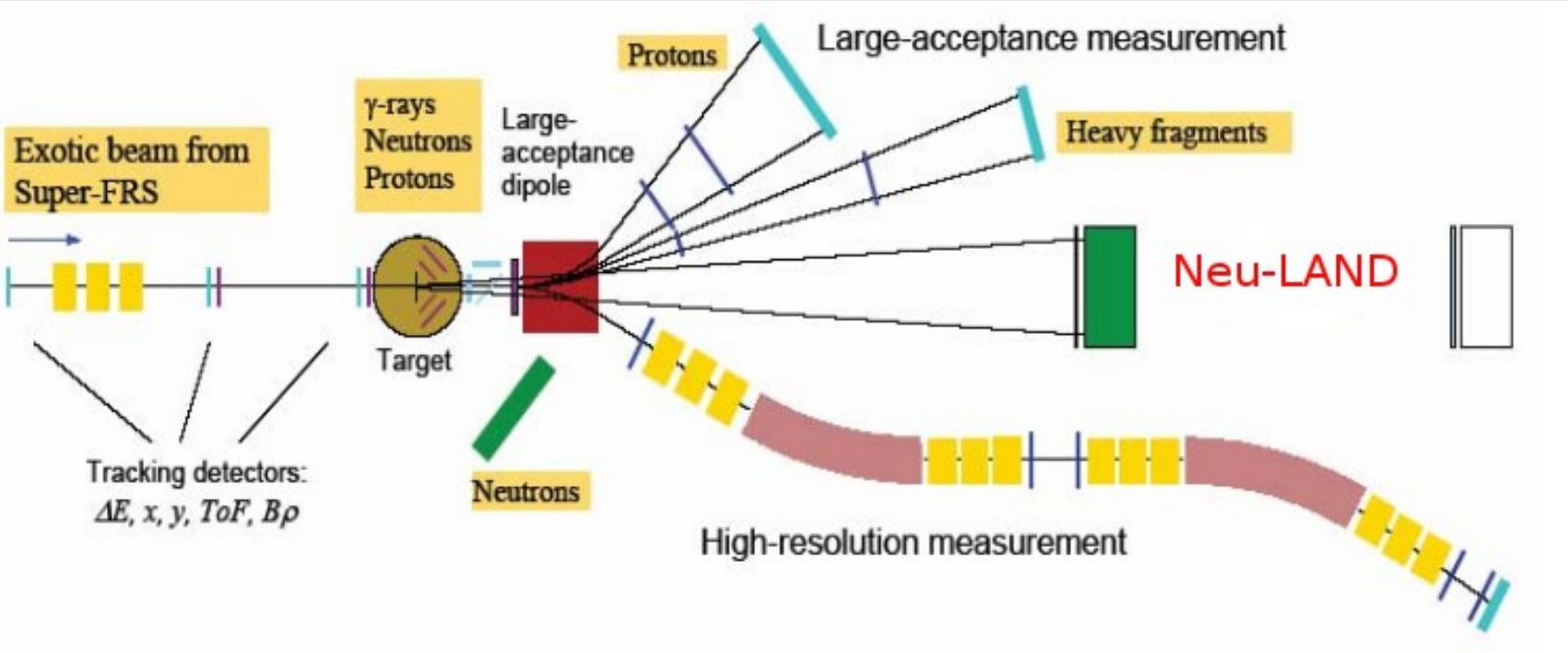
Resolution:

Time: σ = 250 ps

Spatial: σ = 3 cm

1. Introduction

1.3 Neu-LAND for R^3B experiment



Resolution required:

Time: σ ≤ 100 ps

Options for Neu-LAND

- Resistive plate chambers
- Pure plastic

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2. Physics in the experiment

2.1 Neutron detection

Neutrons have no charge ⟶ Only interaction with nuclear matter

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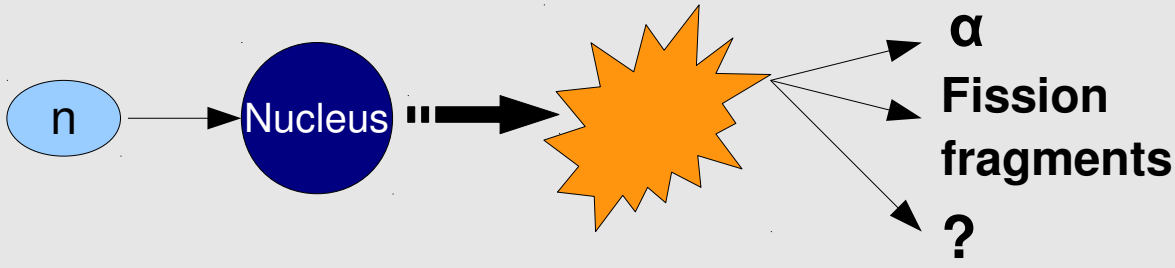
Low energy neutrons:



2. Physics in the experiment

2.1 Neutron detection

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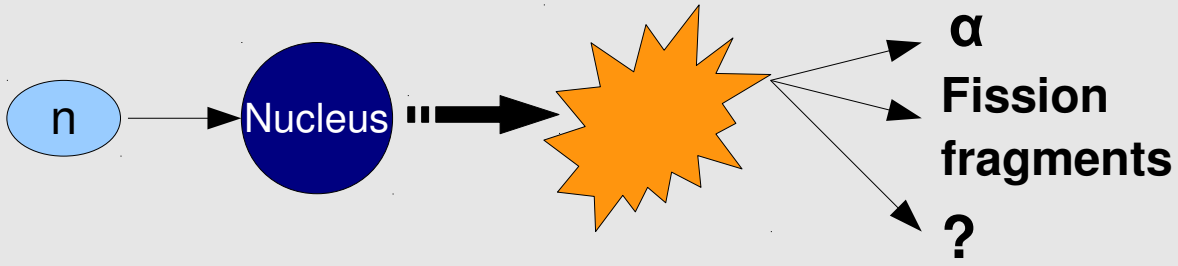
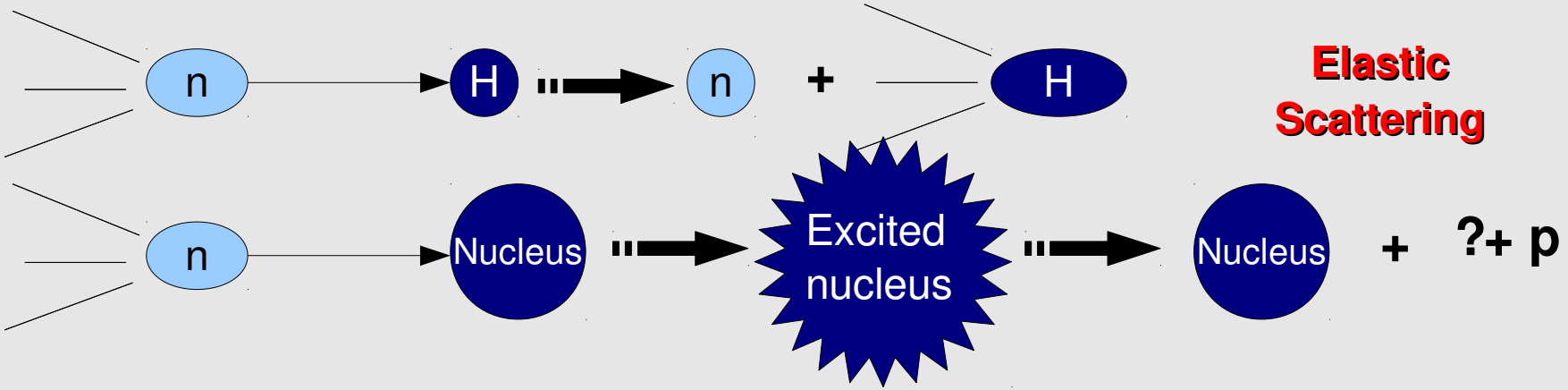
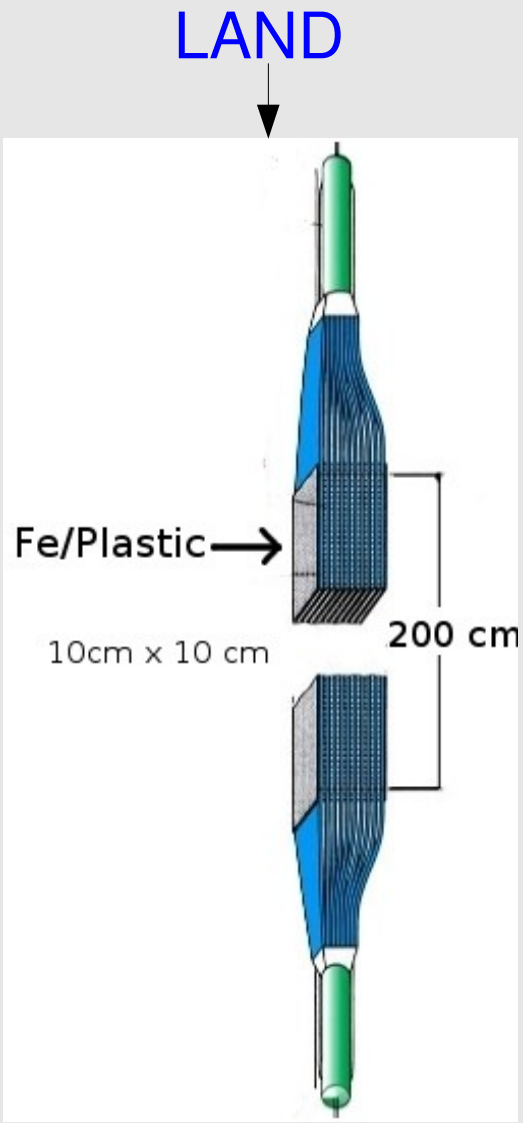


High energy neutrons:



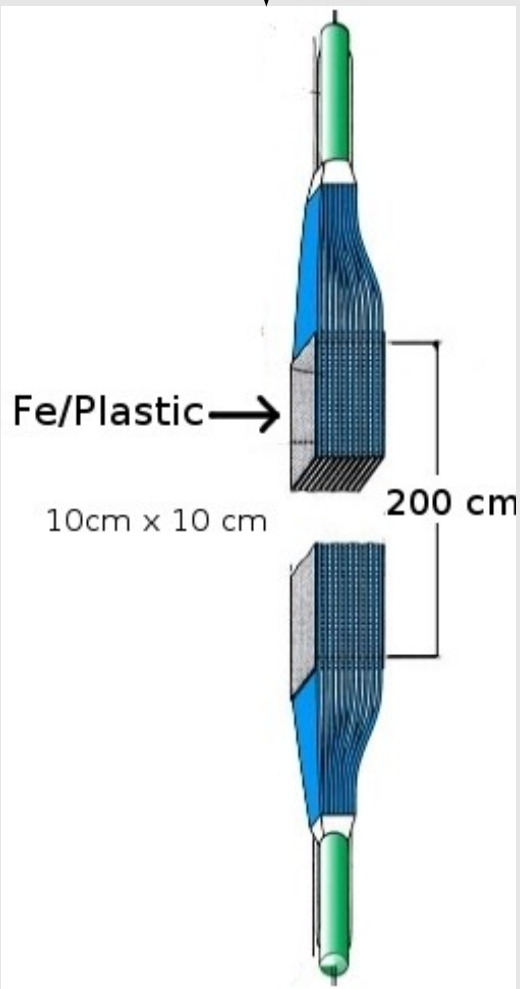
2. Physics in the experiment
2.1 Neutron detection



2. Physics in the experiment

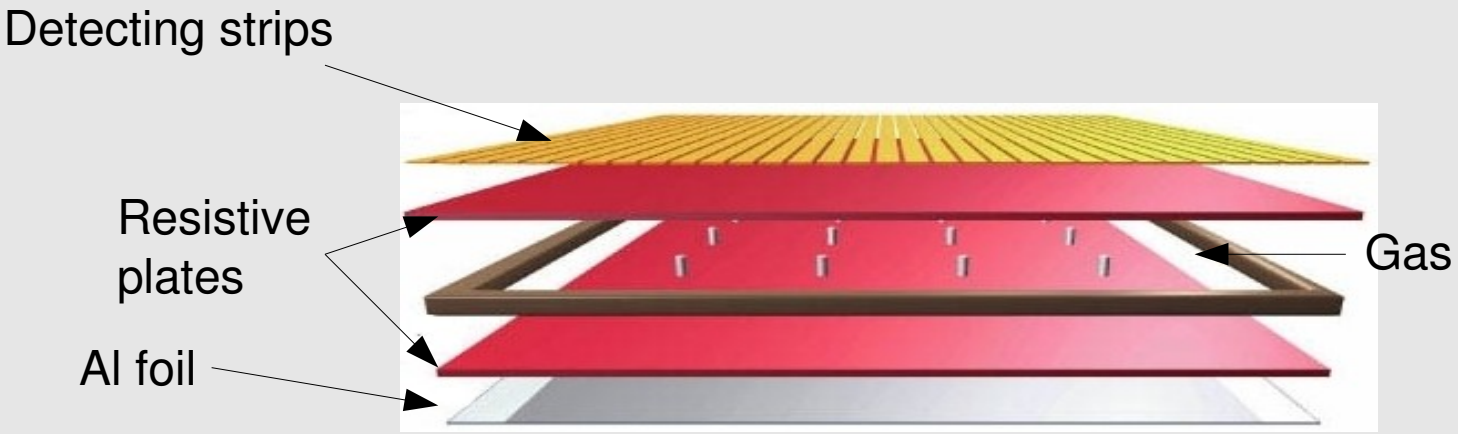
2.1 Neutron detection

LAND



Neu-LAND

Option 1: RPC + 4 mm of passive material

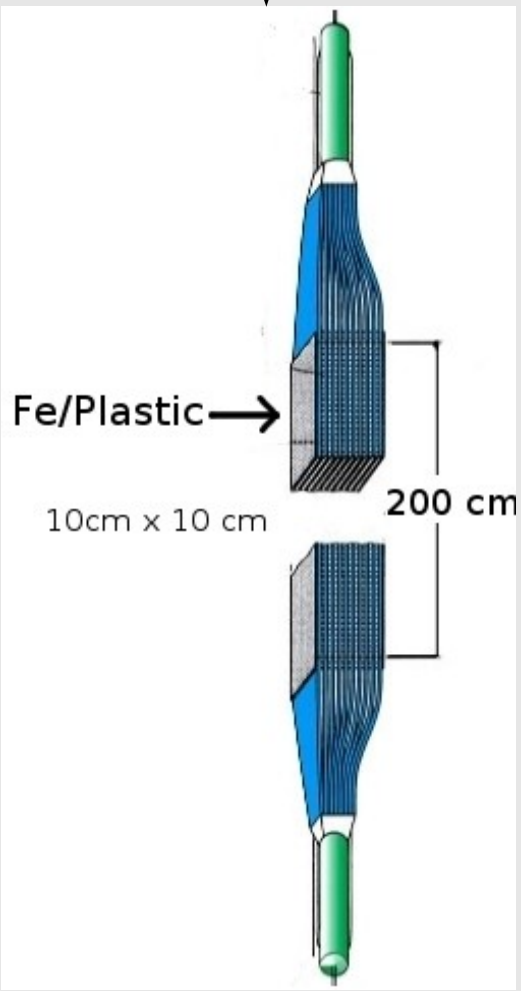


Charged particles --> Ionization of the gas --> Electrons avalanche

2. Physics in the experiment

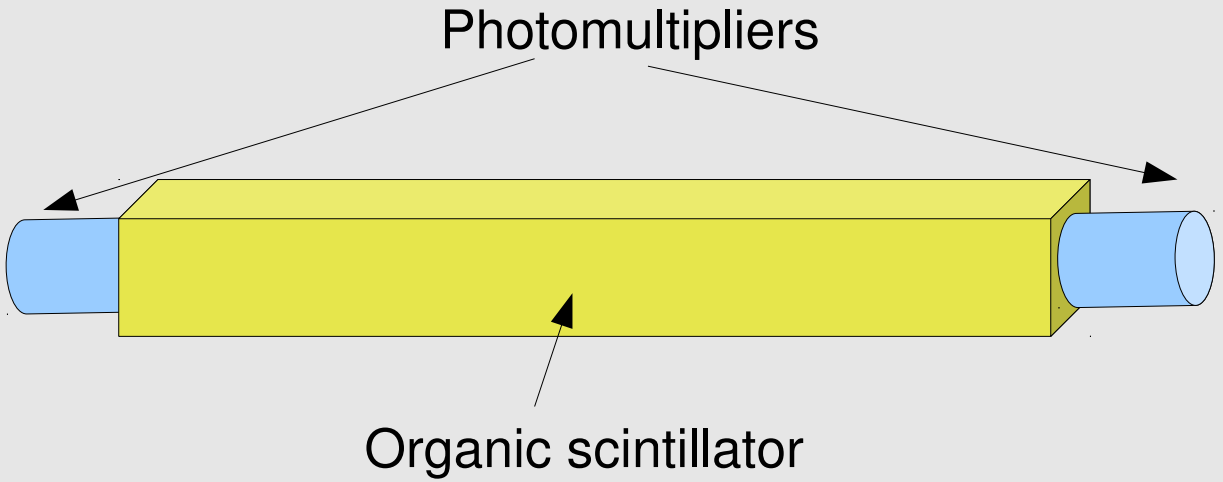
2.1 Neutron detection

LAND



Neu-LAND

Option 2: Pure plastic scintillator



Recoil Hydrogen -->Fluorecense

2. Physics in the experiment

2.2 RPC vs Pure Plastic

2. Physics in the experiment

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RPC:

Fast detector
Cheap

Passive material needed

2. Physics in the experiment

2.2 RPC vs Pure Plastic

RPC:

Fast detector
Cheap

Passive material needed

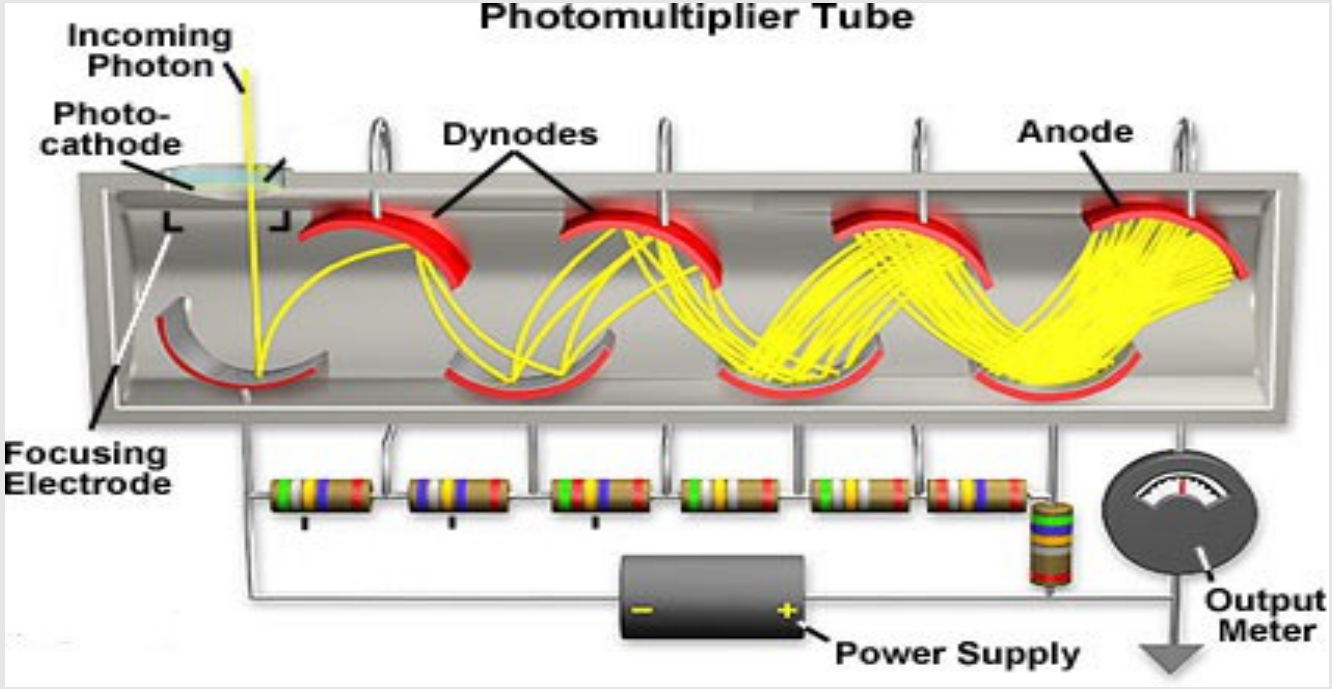
Pure plastic scintillator:

No passive material

More expensive

2. Physics in the experiment

2.3 Photomultipliers



Very important to match the photons wavelength to get maximum Quantum Efficiency

Photoelectric effect

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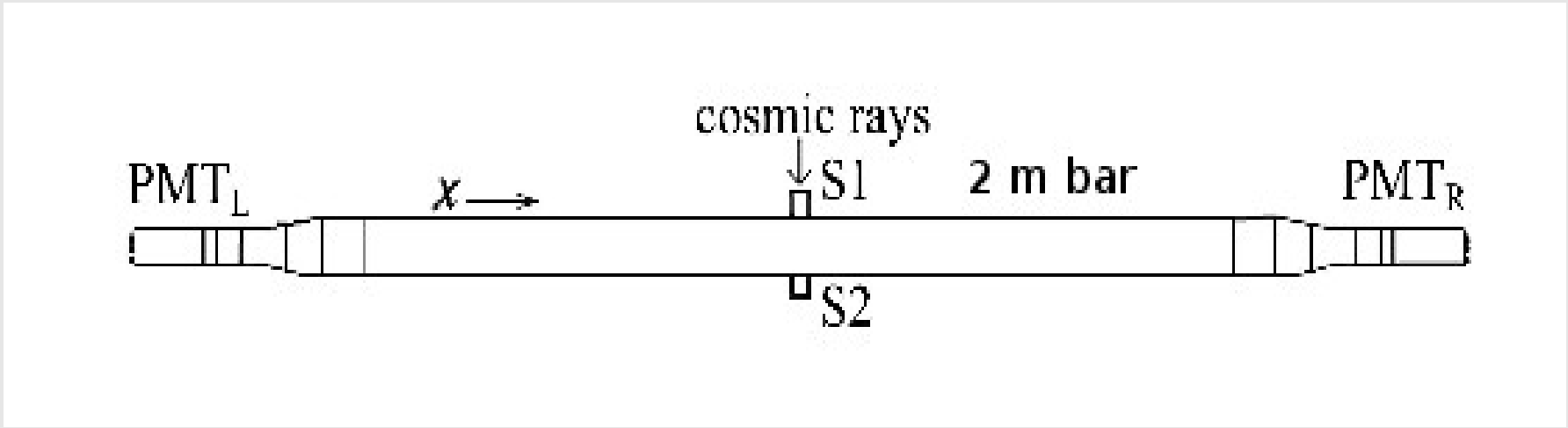
3. Experiment

3.1 Objective and setup

Objective: to estimate the time resolution.

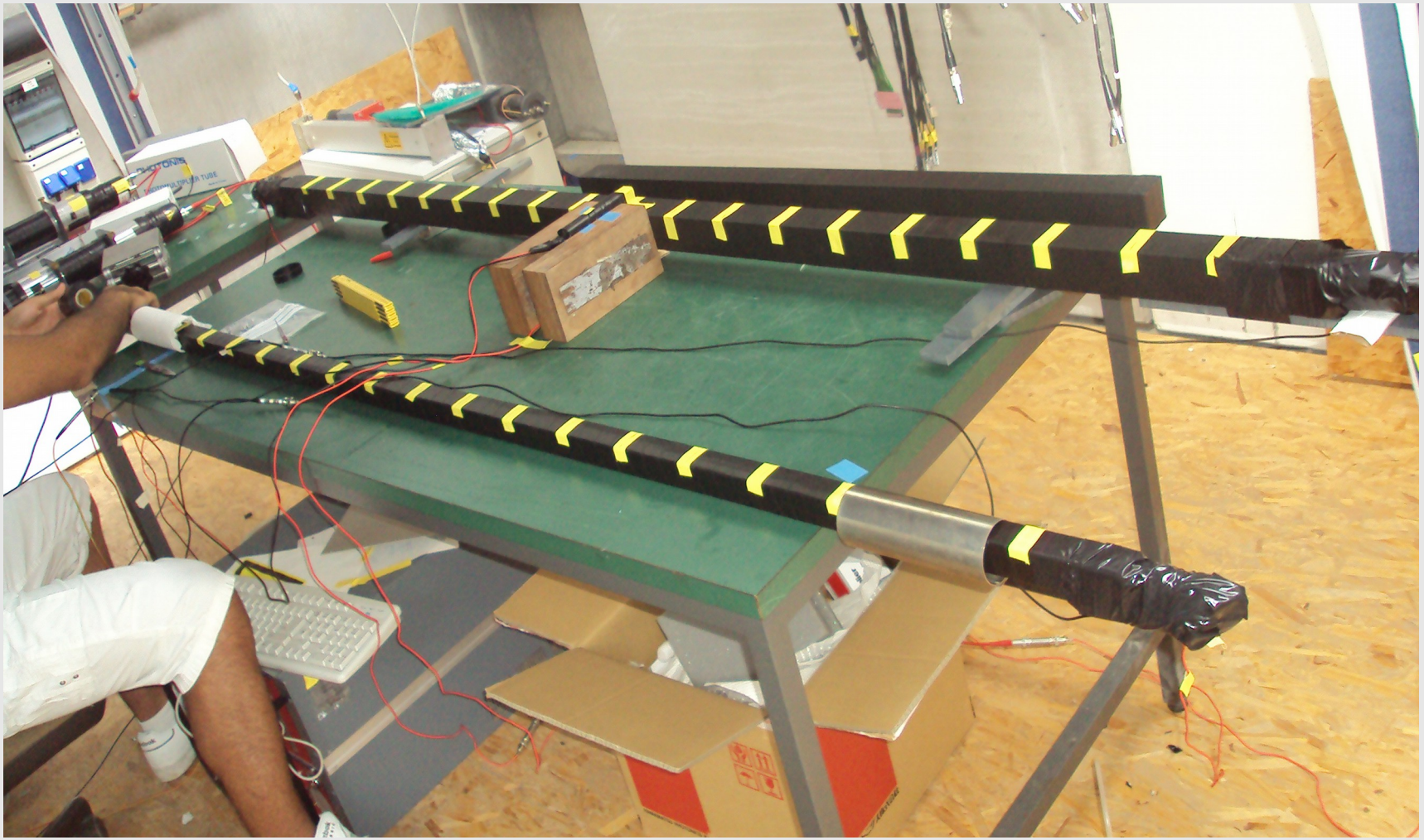
How? Using cosmic rays.



Scheme of the setup.

3. Experiment

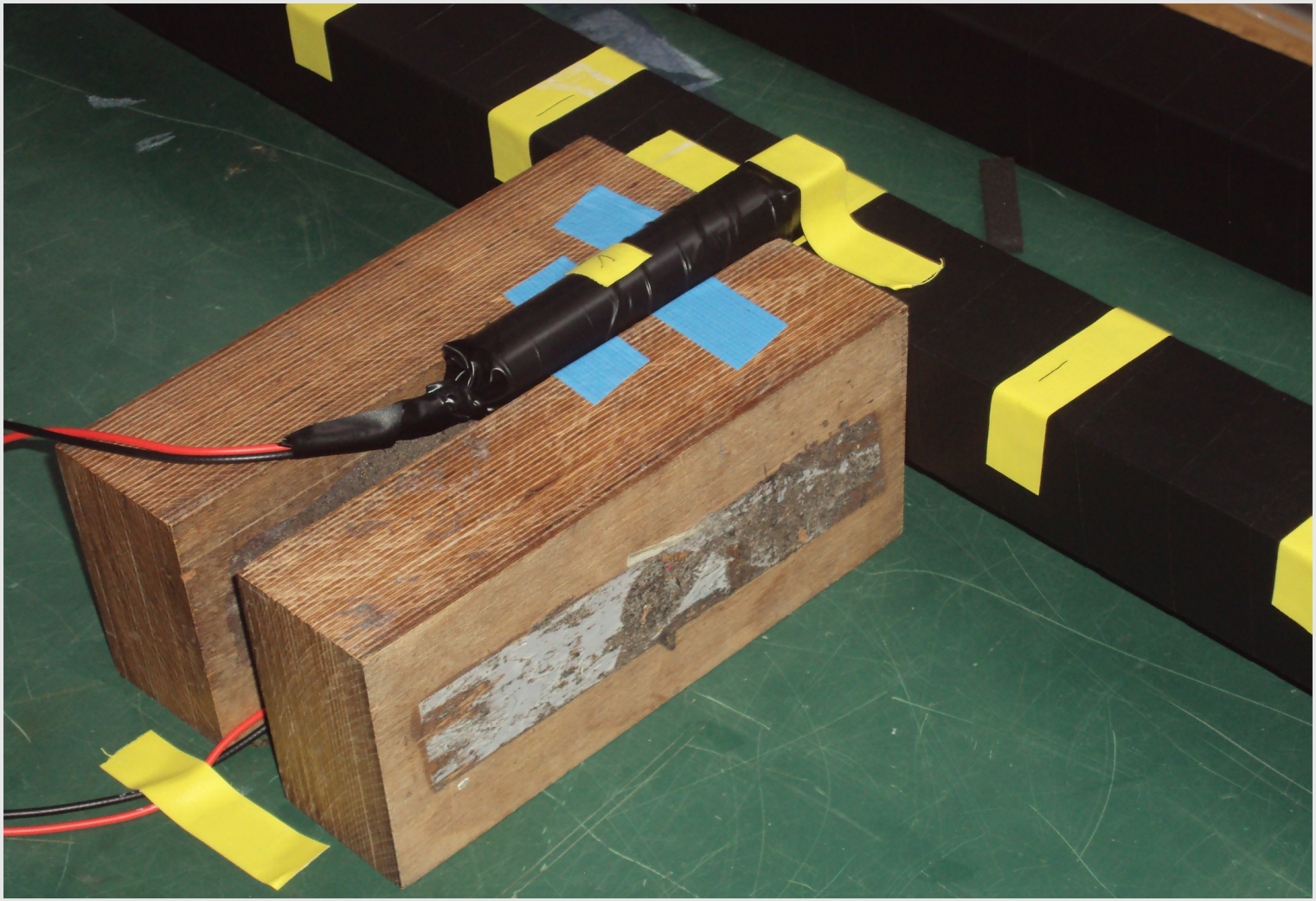
3.1 Objective and setup



Setup.

3. Experiment

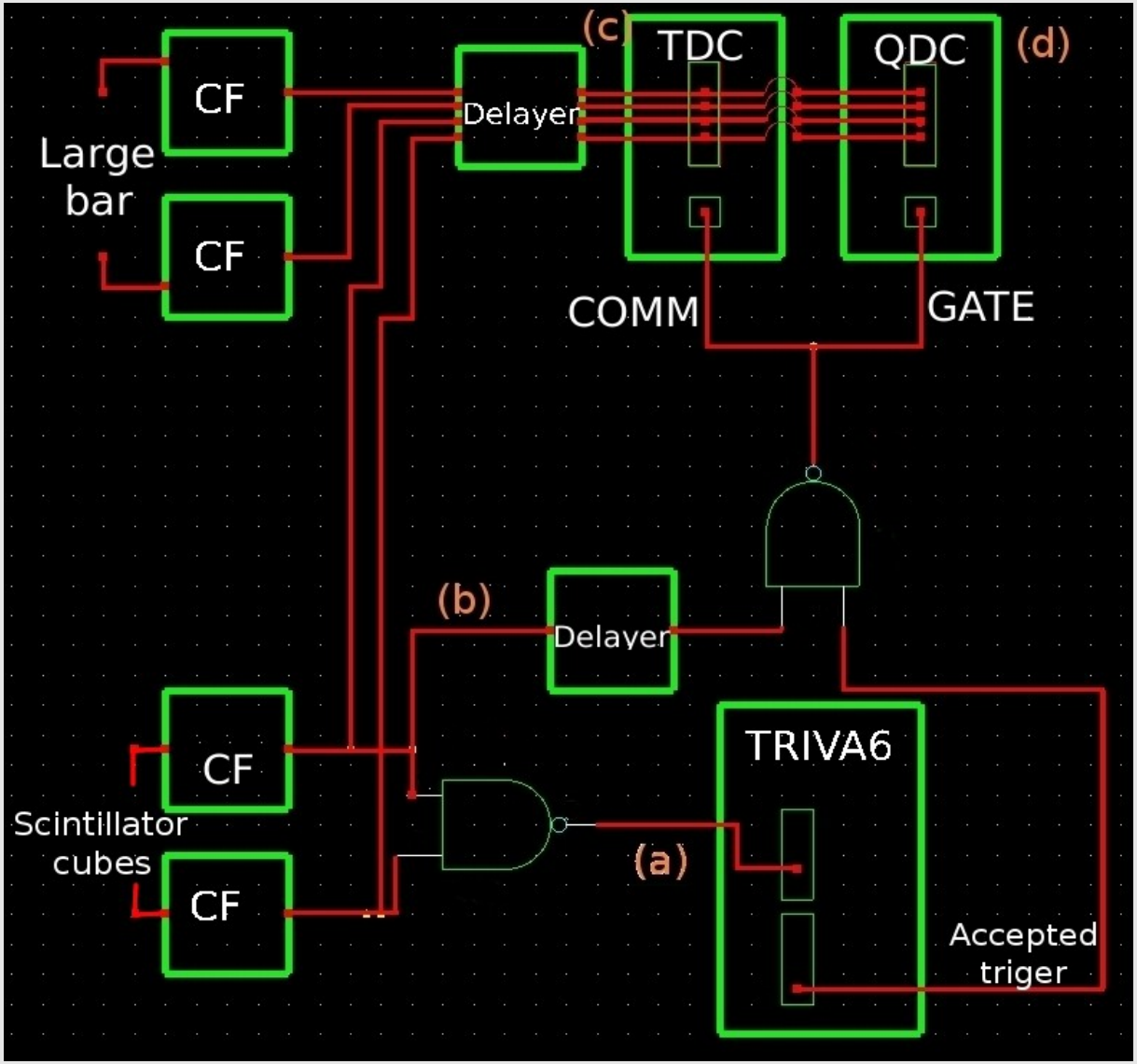
3.1 Objective and setup



Scintillator cubes.

3. Experiment

3.1 DAQ



Scheme of tha DAQ

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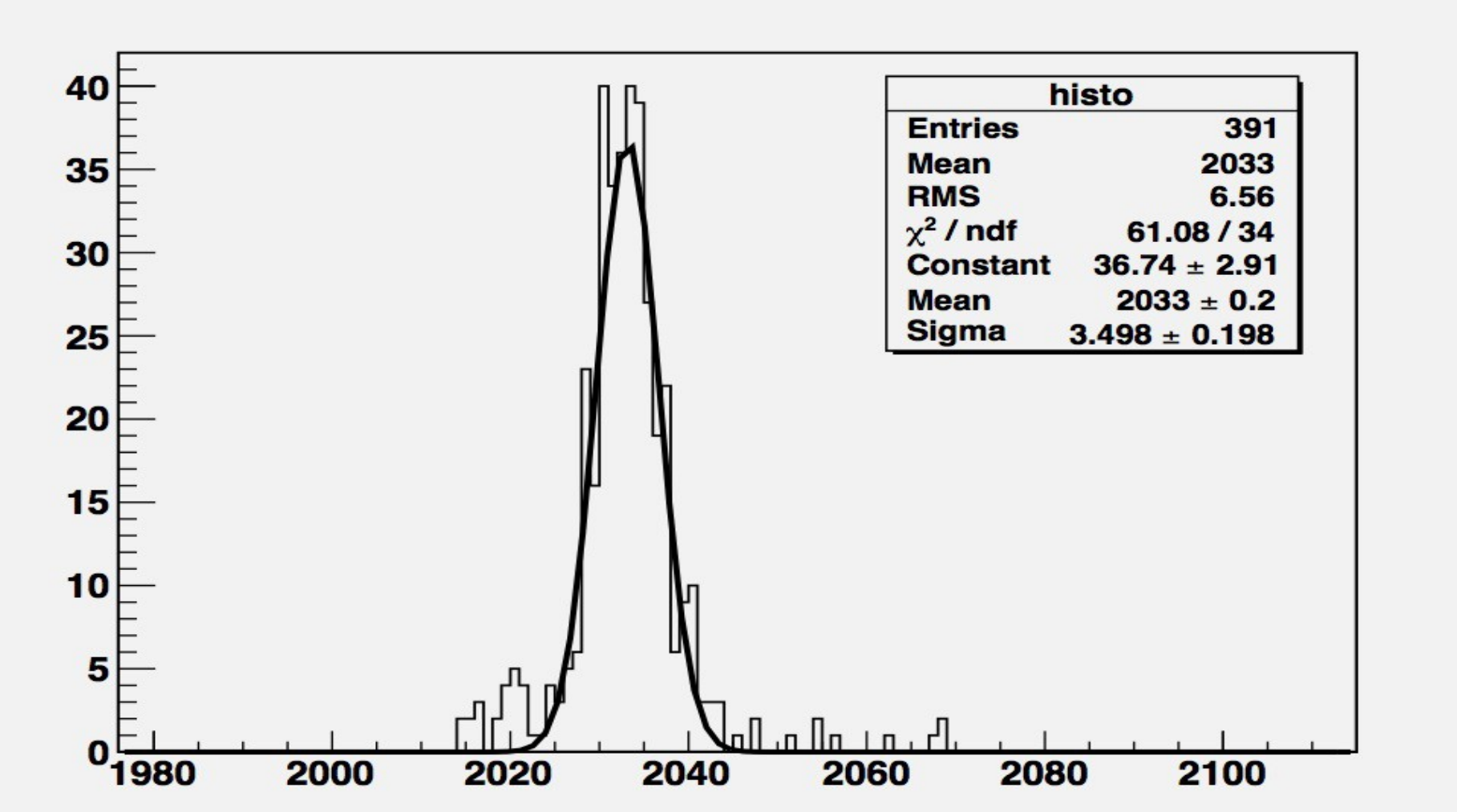
4. Results

4.1 Data obtained



Data from one PMT for x = 120 cm.

4. Results
4.2 Data analysis

Uncertainty sources:

Electronics. → Pulser test: $\sigma = 0{,}721 \pm 0{,}050$ ch.

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Electronics + photomultiplier attached to the scintillator cubes.

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Physical size of scintillator cubes.

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Electronics + photomultiplier attached to the scintillator cubes.

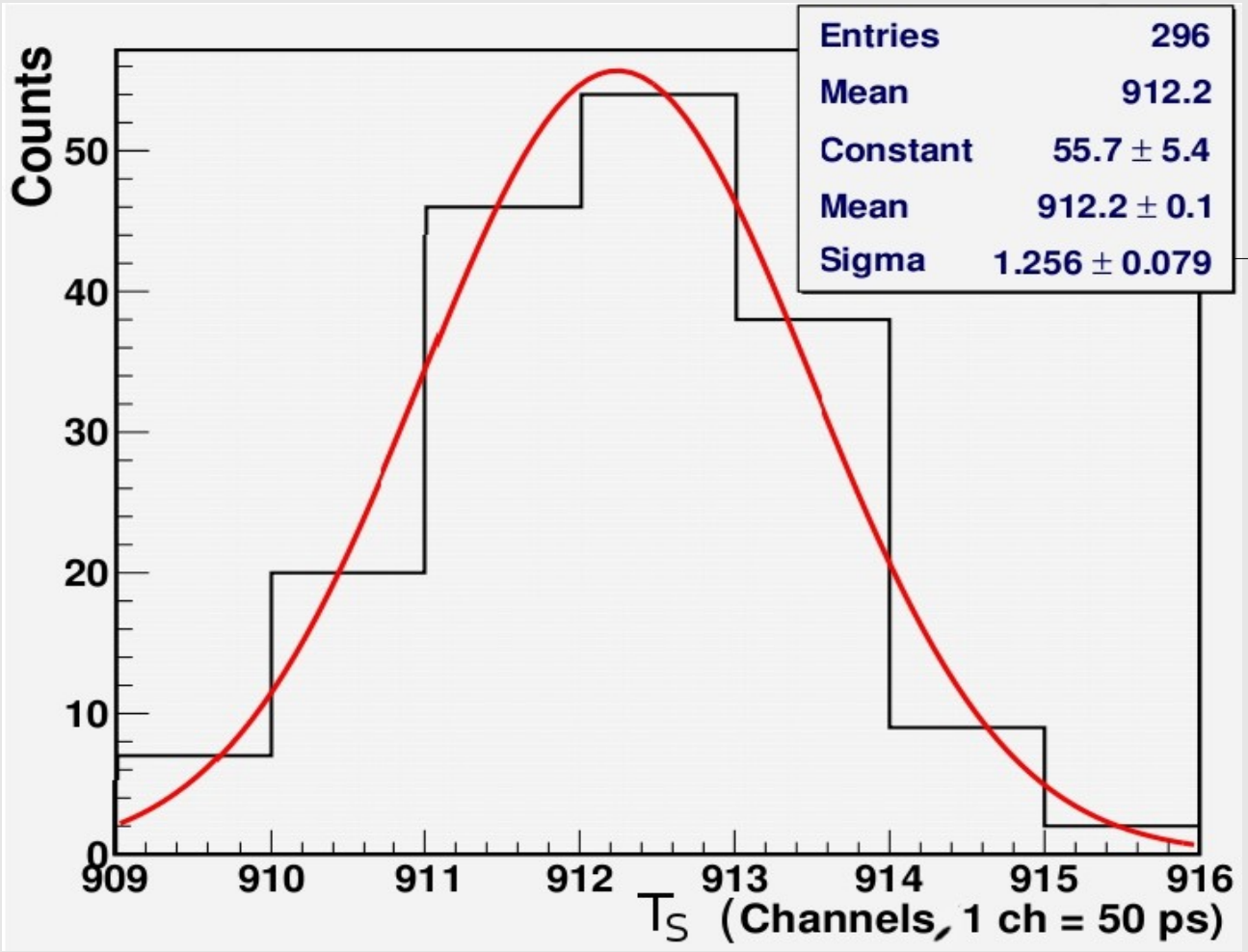
Physical size of scintillator cubes.

Scintillator bar plus photomultipliers attached.

4. Results

4.3 Detailed plots

Gaussian fit for self-triggering signal for x = 120 cm.

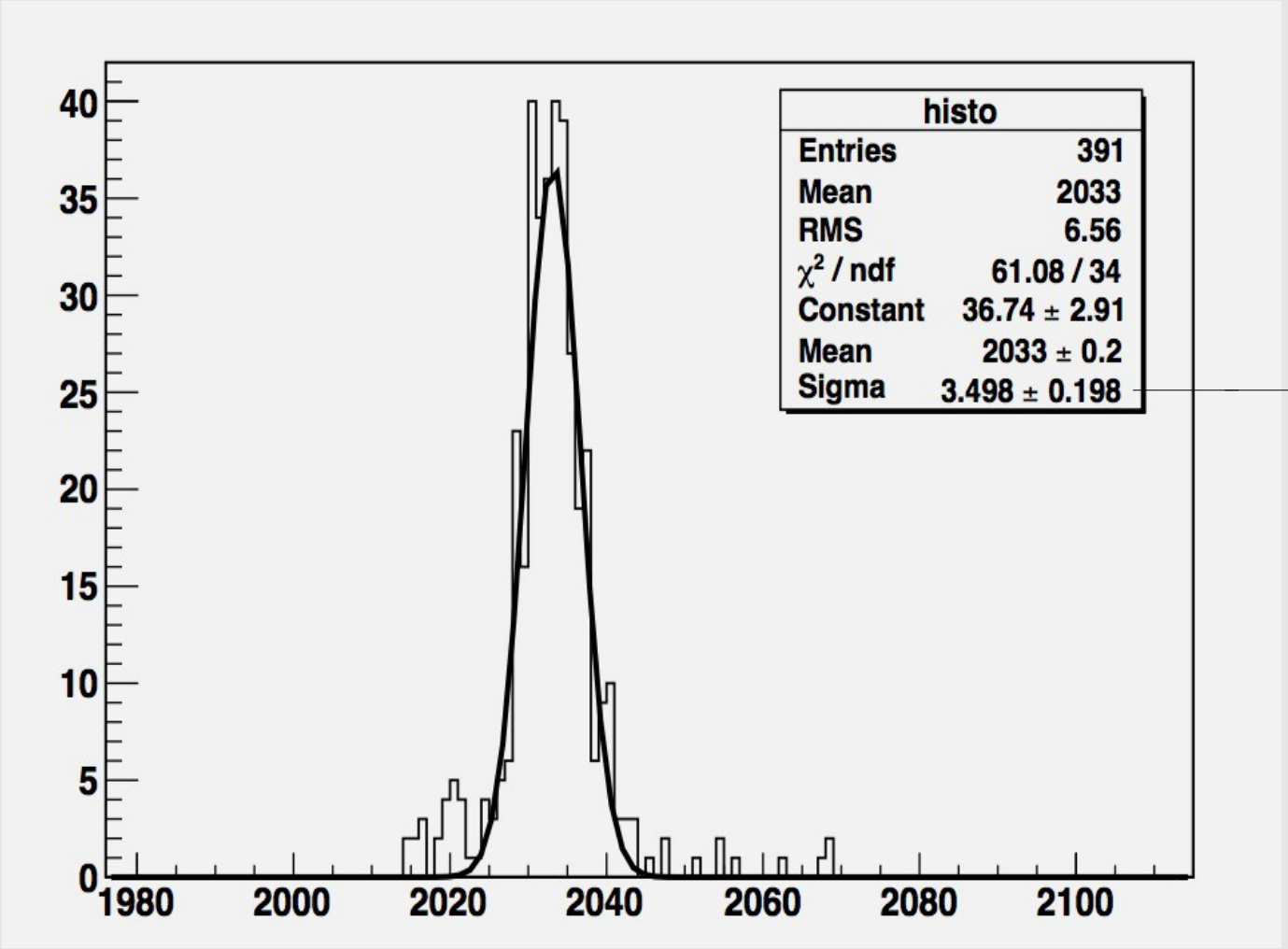


It gives the electronics plus the PMTs attached to the scintillator cubes.

4. Results

4.3 Detailed plots

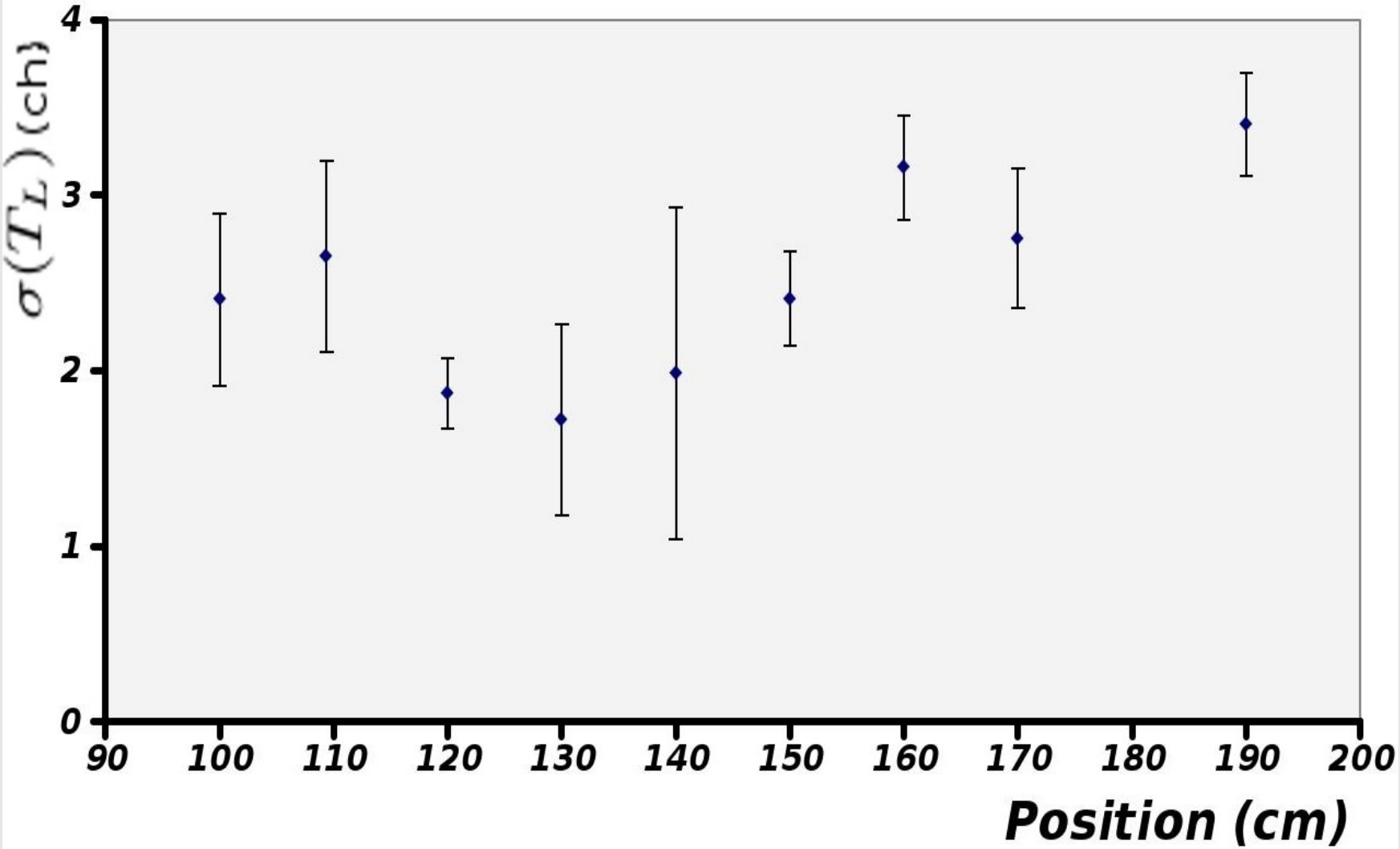
Gaussian fit for one photomultiplier for x = 120 cm.



It gives the uncertainty of the one PMT attached to the big bar .

4. Results

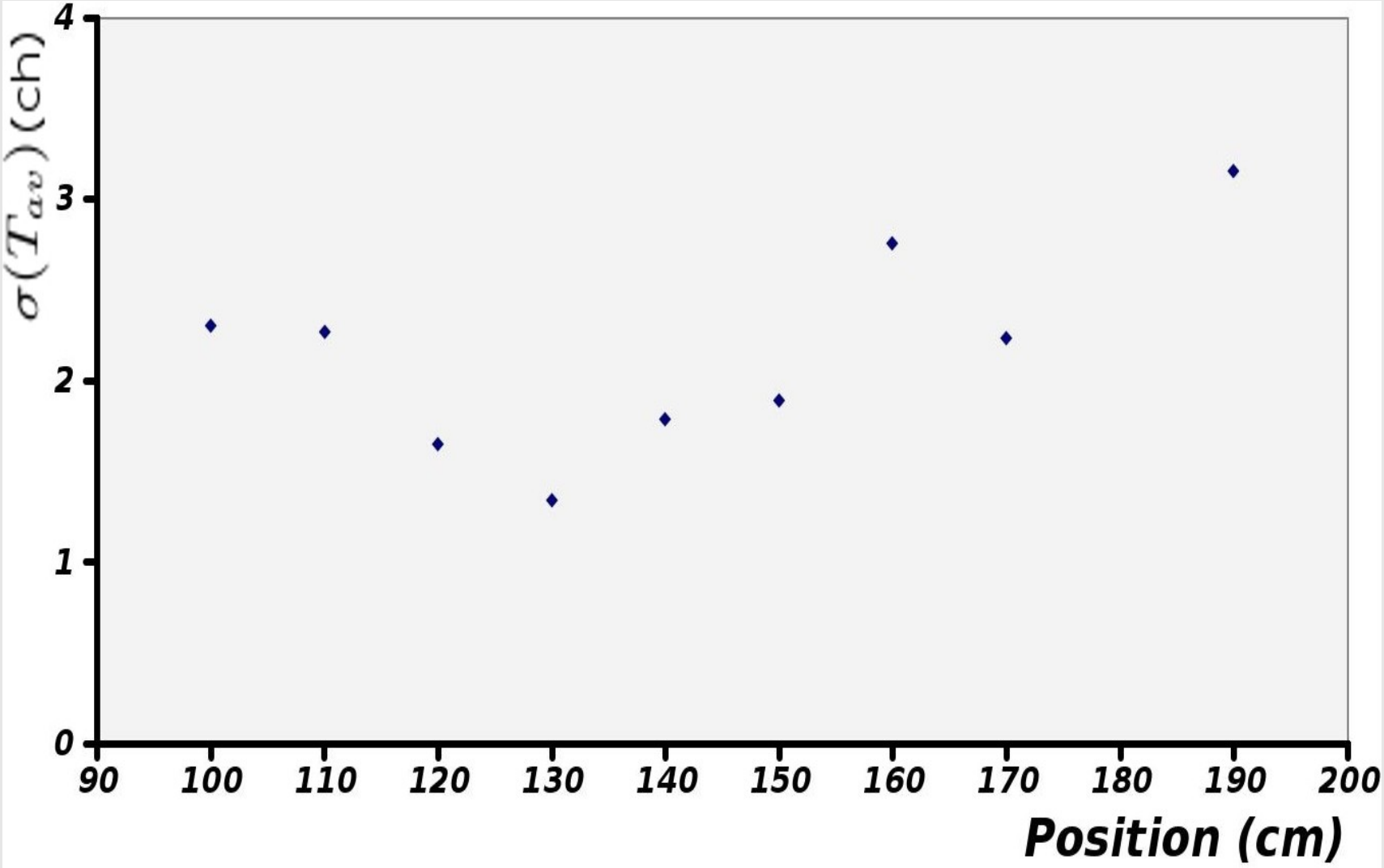
4.4 Time resolution



Left PMT time resolution.

4. Results

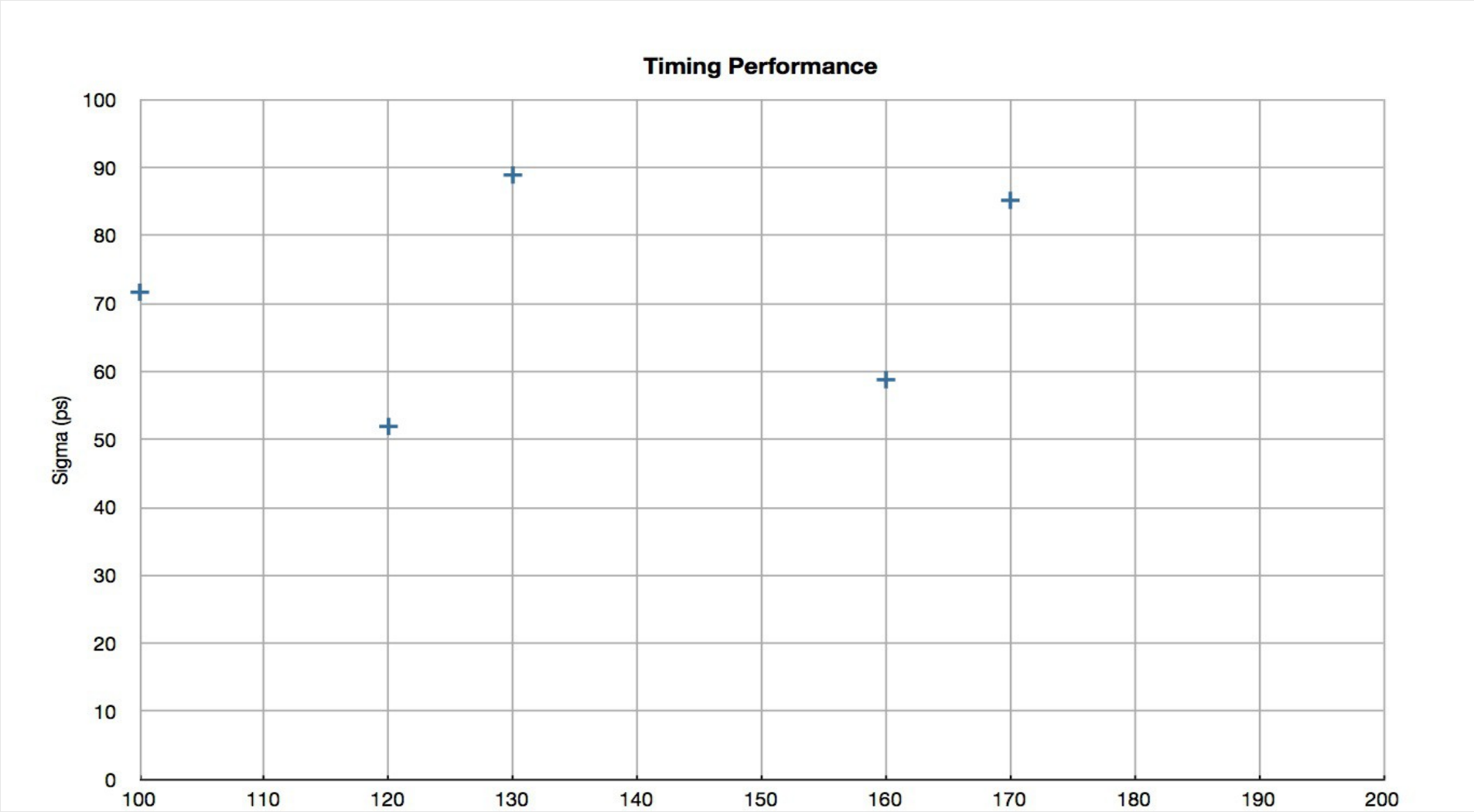
4.4 Time resolution



Total time resolution.

4. Results

4.4 Time resolution



Total time resolution.

5. Conclusions

From the work and analysis done we can conlude that:

Organic Scintillators can be implemented in Neu-LAND.

We have established an upper limit of the time resolution ≈ 100 ps.

The real time resolution can only be better since:

The size of the scintillator cubes used to create the trigger has not been taken into account.

It is expected for neutrons to produce more photons in the scintillator bar since they are more energetic.