Optical Light Collection Amount Studies for Dedicated Measurements

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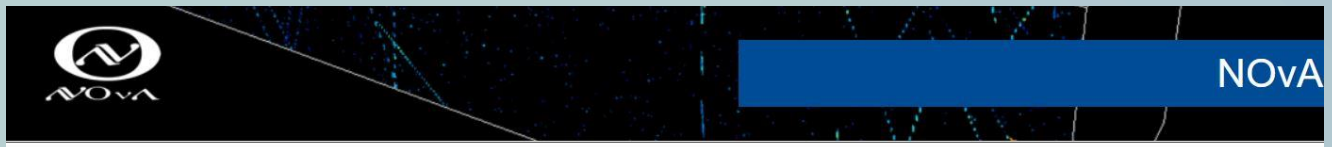
Fermilab

Contents

- Introduction
- LArSoft overview for Photons Detection
- A Fictitious Detector (using PYTHON)
- Light Collection Amount and Implications
- Conclusion
- Acknowledgment

Introduction



About NOvA

- What is a neutrino?
- Research goals
- How does NOvA work?
- Collaboration
- Photos and videos
- Public presentations
- Live NOvA data
- All Things Neutrino

For physicists

- Data releases
- Publications
- Theses

Fermilab's NOvA experiment is helping scientists determine the role that ghostly particles called neutrinos played in the evolution of the cosmos.

The NOvA (NuM
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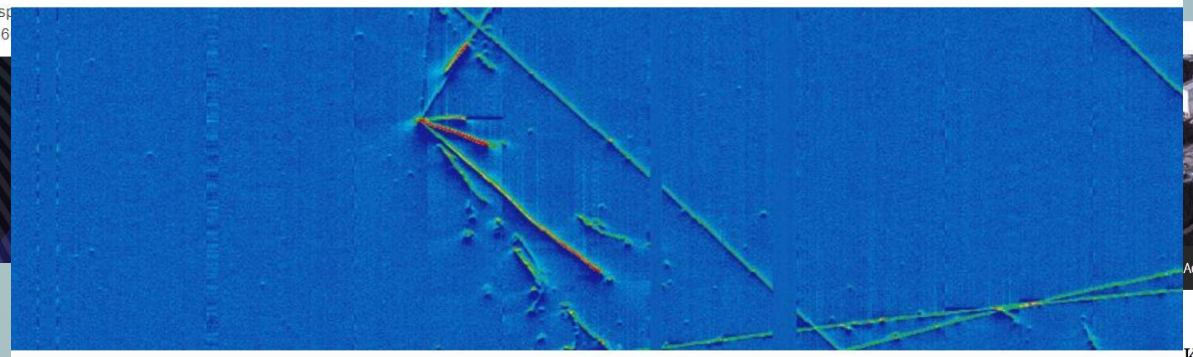
https://www.dunescience.org

DEEP UNDERGROUND NEUTRINO EXPERIMENT

Home | The Collaboration | Why neutrinos? | Neutrino Detectors



An International Experiment for Neutrino Science

The Deep Underground Neutrino Experiment (DUNE) is a leading-edge, international experiment for neutrino science and proton decay studies. Discoveries over the past half-century have put neutrinos, the most abundant matter particles in the universe, in the spotlight for further research into several fundamental questions about the nature of matter and the evolution of the universe — questions that DUNE will seek to answer.

Search...

DUNE and LBNF

- DUNE at LBNF for the public
- DUNE at LBNF Fact Sheet

Aerial photograph of the J-PARC facility

K. Ichikawa from Tohoku
e-elected Spokesperson of the T2K
n

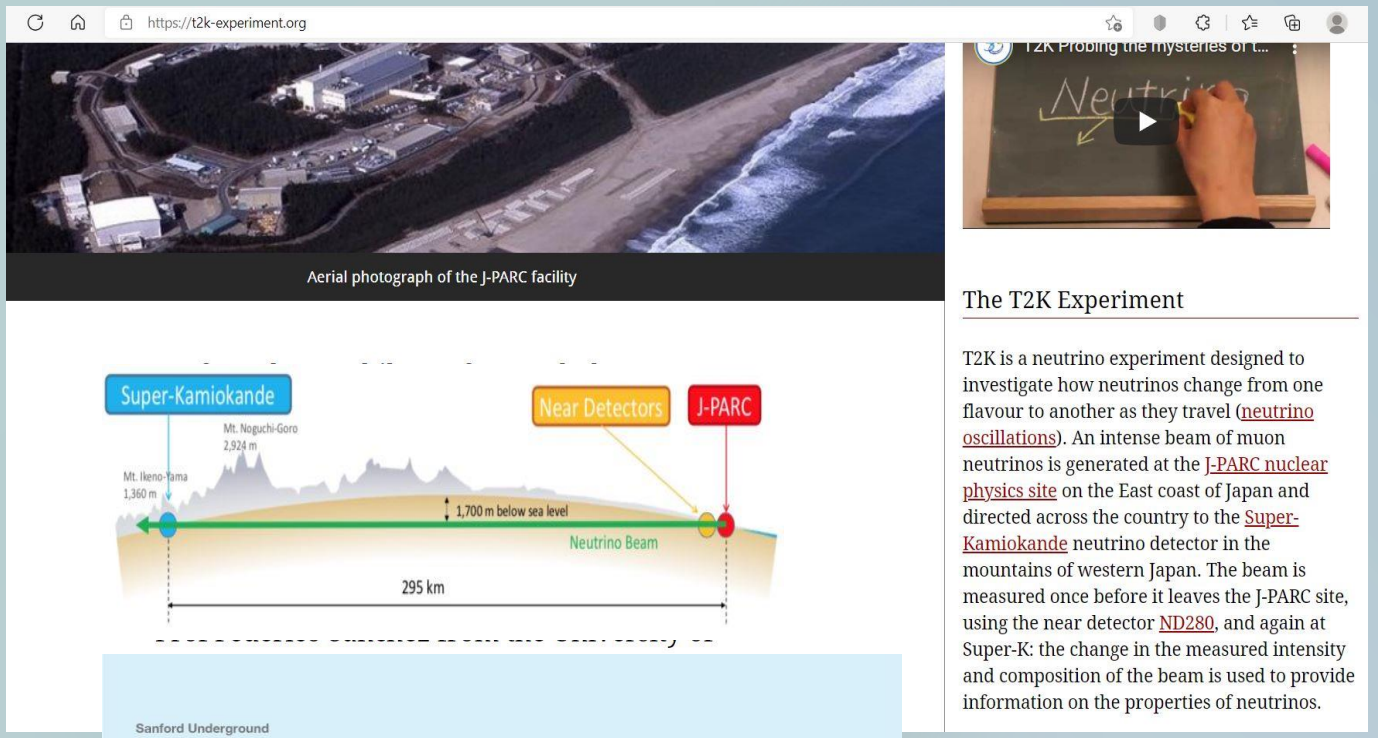
ikawa from Tohoku University was re-elected
e T2K collaboration for a second term.

o Sanchez from the University of Geneva re-elected International Co-Spokesperson of the T2K collaboration

The T2K Experiment

T2K is a neutrino experiment designed to investigate how neutrinos change from one flavour to another as they travel (neutrino oscillations). An intense beam of muon neutrinos is generated at the J-PARC nuclear physics site on the East coast of Japan and directed across the country to the Super-Kamiokande neutrino detector in the mountains of western Japan. The beam is measured once before it leaves the J-PARC site, using the near detector ND280, and again at Super-K: the change in the measured intensity and composition of the beam is used to provide information on the properties of neutrinos.

Long Baseline Neutrino Experiments



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Current	Near Detector Location	L to Travel Km	Far Detector Location
T2K	J-PARC Tokai	295	Super-Kamiokande Kamioka
NO*v*A	Fermilab Illinois	810	Ash River, Minnesota
DUNE	Fermilab Illinois	1300	SURF, South Dakota

In the past: July 06 to Dec 12, ν_μ from CERN to the Gran Sasso National Laboratory, 732 kilometres away to OPERA and ICARUS

Far Detectors and Photons Detection

At the Far detector there is less saturated measurements of Photons compare to the near detector.

The Detector compromise a lot of Volume, so they are built by small pieces called Modules.

For instance, ProtoDUNE is the proven prototype for a Far detector in DUNE. 3.6 m * 2 X 6.1 m X 7.0 m enclosed volume LAr TPC

The Photon Detection (PD) System in ProtoDUNE-SP has 60 modules connected by light-guides (Eljen Technology).

Ref:
"First results on ProtoDUNESP liquid argon time projection chamber performance from a beam test at the CERN Neutrino Platform". In: *Journal of Instrumentation* (Dec. 2020).
Or
In this conference in session 1B and 1C

LArSoft overview for Photon Detection

https://larsoft.org/larsoft-workshop-june-2019/

pattern recognition in LArTPC experiments, with Pandora being a general purpose, open-source framework for pattern recognition.

For the simulation the propagation of particle is done using Geant4.

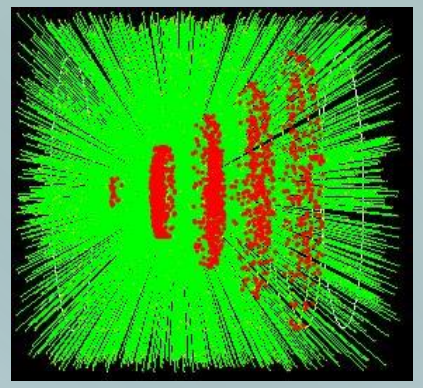
as is in 2020-2021

recob::OpHits_ssprawdecoder_internal_OpDetReco.

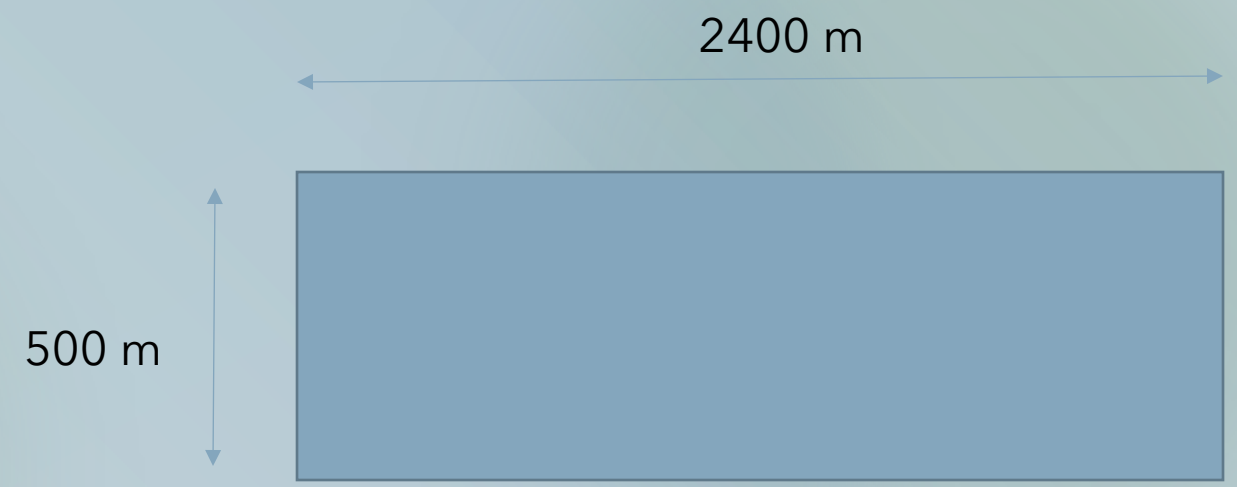
An Analyzer Module can be constructed and to get and save the Total Optical Hits number per Channel for each constructed data set. This to create a TH1D OpHits_OPChannel in a .root file

A Fictitious Detector (using PYTHON)

- Knowing the main behavior of Photons in LAr from Birks´s book



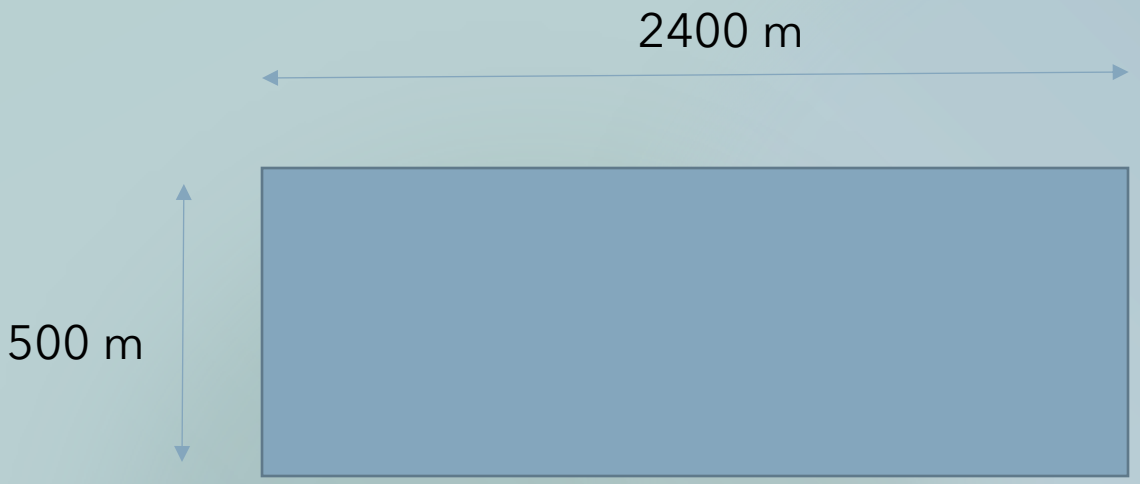
Results using Geant4, example

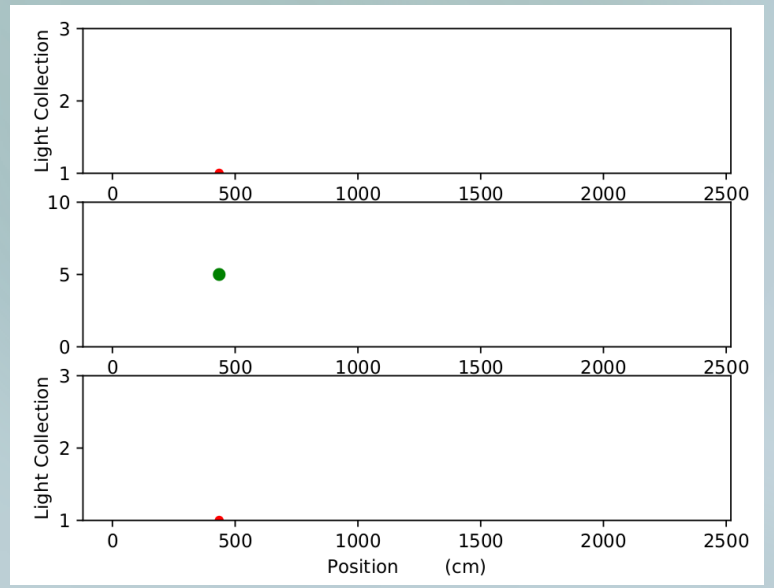


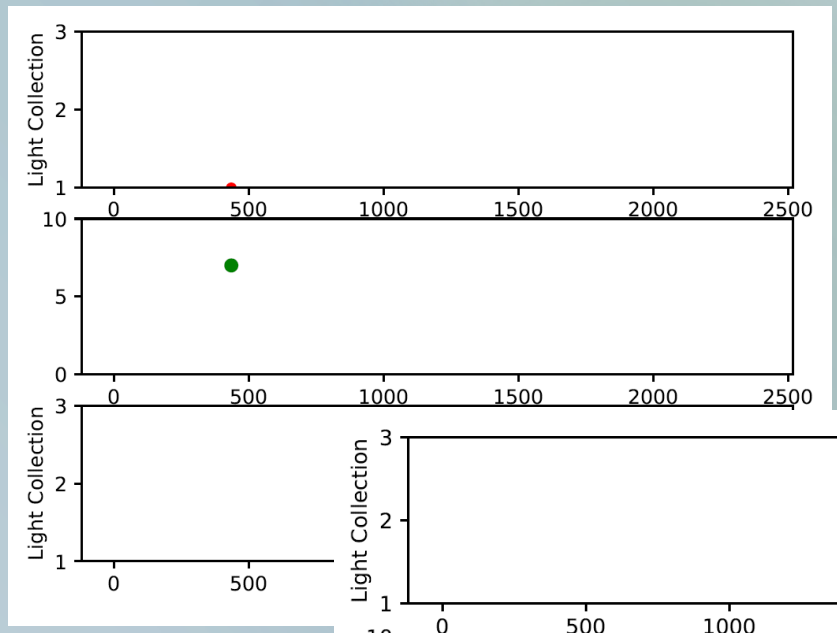
2D – View from the top
or Cross-section View

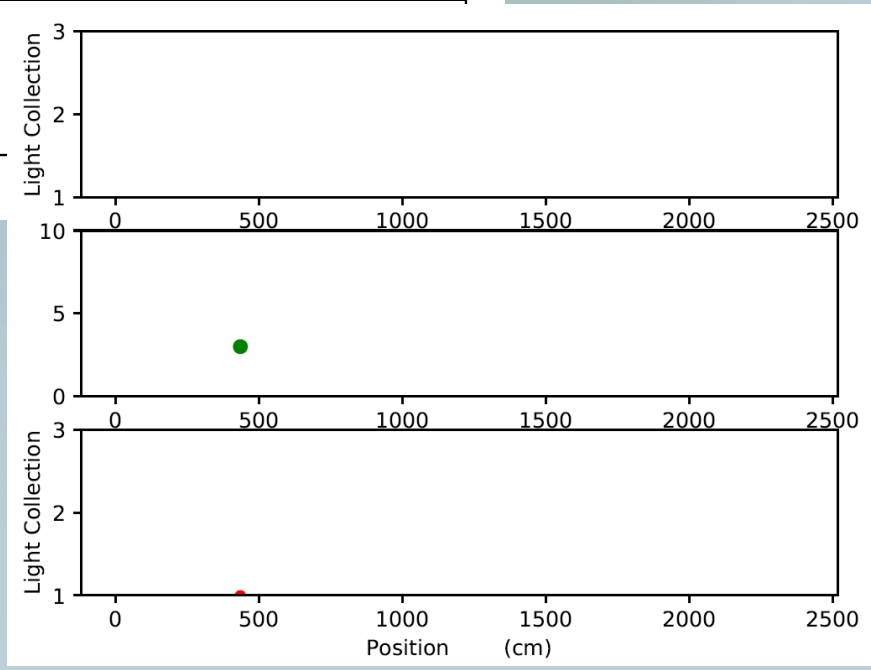
Photon Module´s size of 50 cm
At the North and at the South ----> 4800

A Fictitious Detector (using PYTHON)

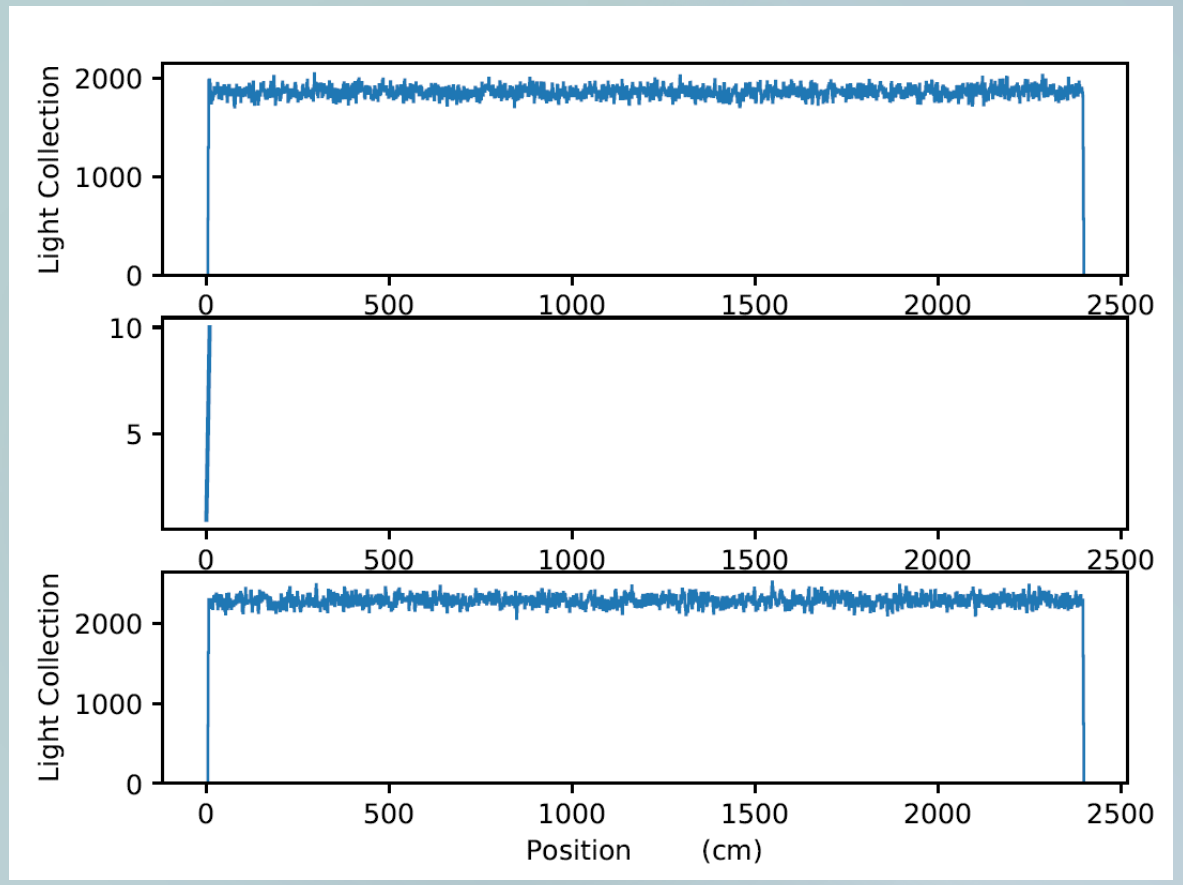




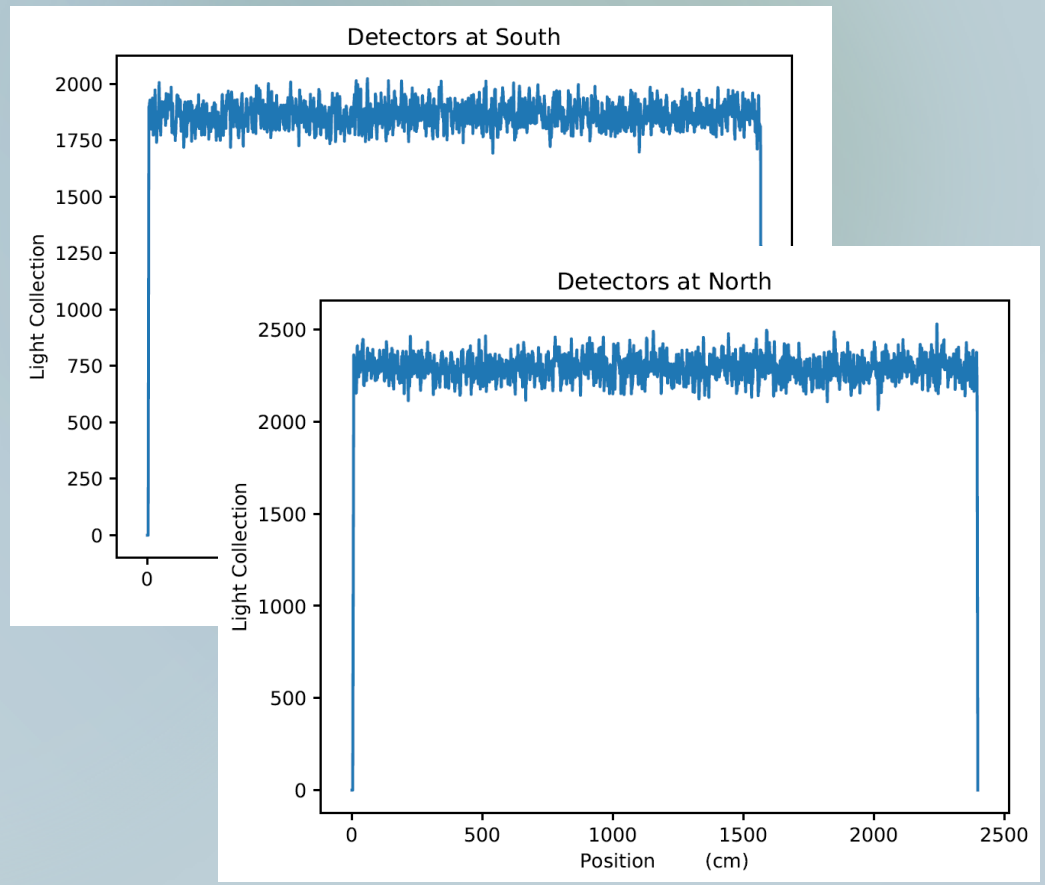




A Fictitious Detector, Results in Python



Another case



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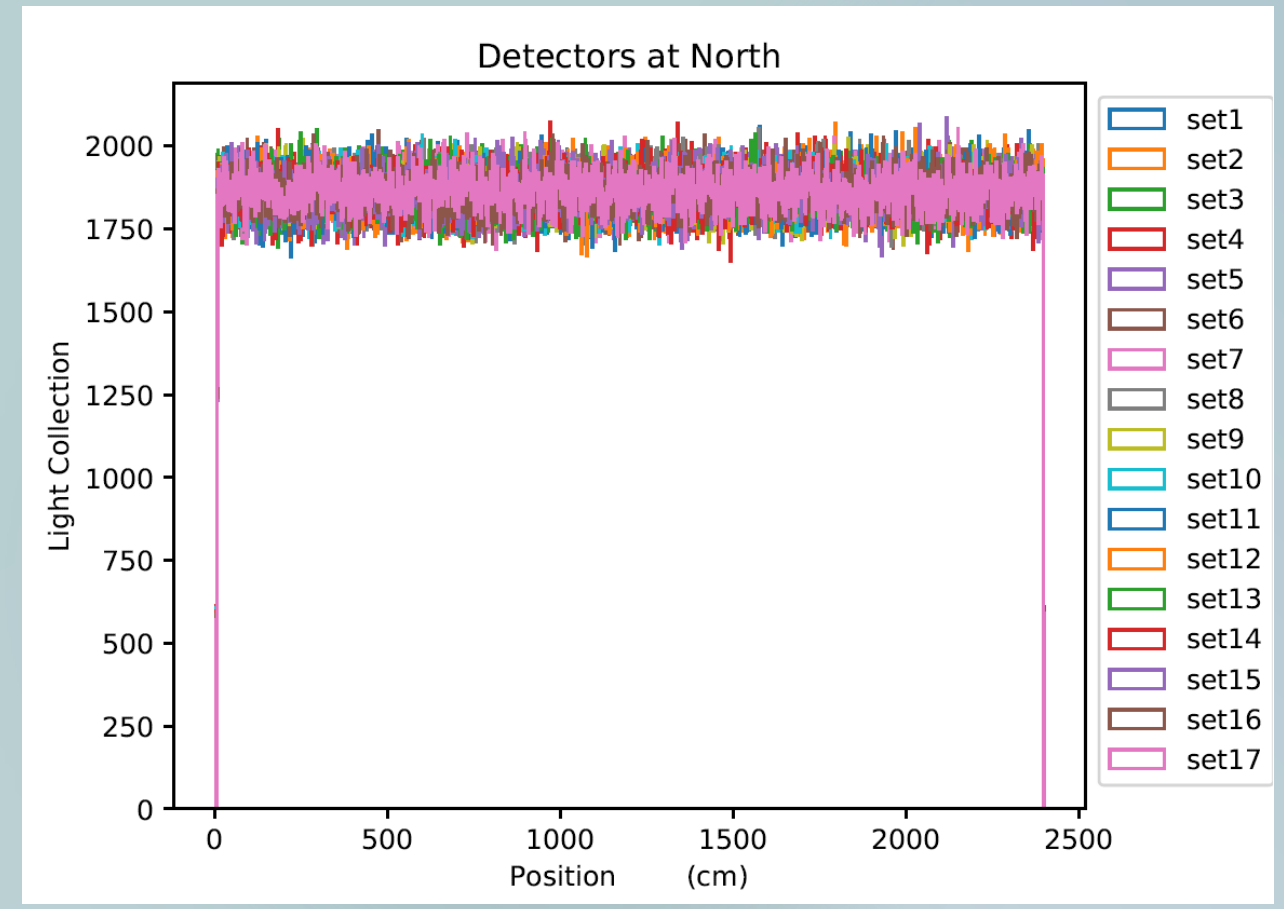
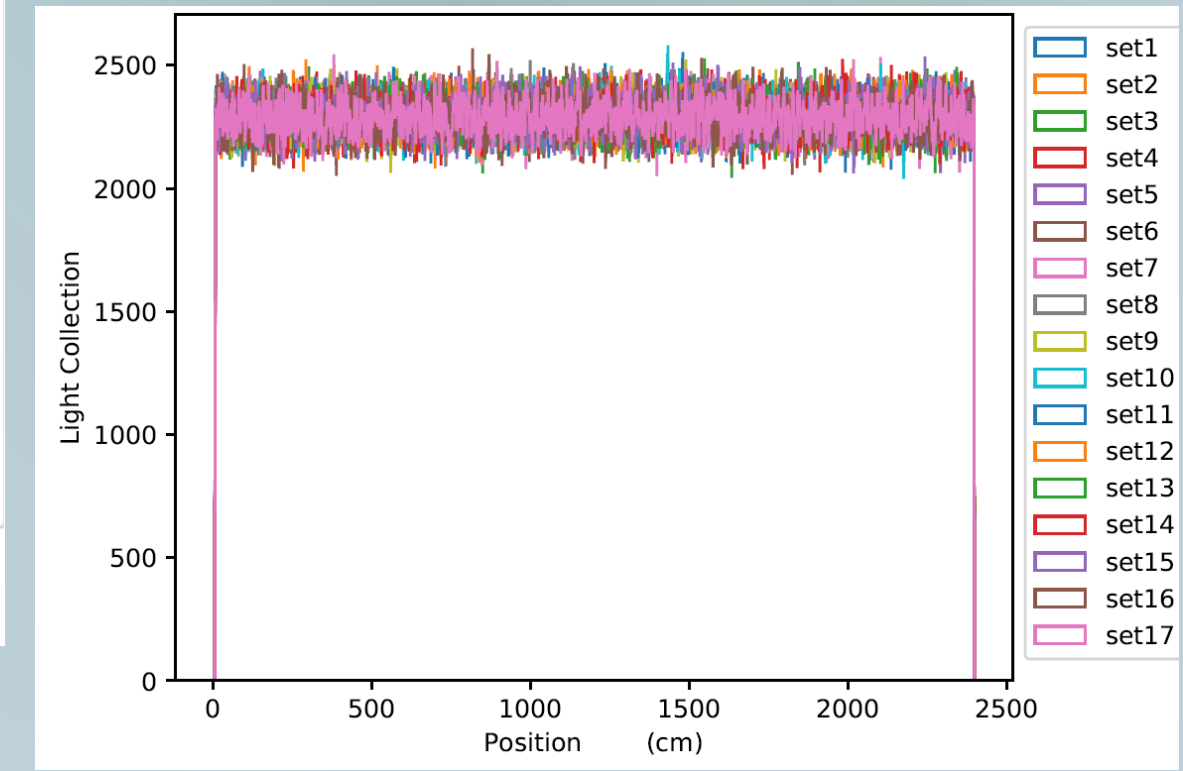


For Many Cases



Light Collection Amount and Implications

- Properties and Definition

It´s acquired after the definition of the PE

It´s relative to the Detector and source Energy

It´s units is arbitrary and is given by the Number of *Counts*

It´s value change according to the source of the Photons

It´s aid to differenciate between the Modules of the Detectors

It´s the **average** of the Optical Hits obtained per channel, for a chosen group of data

It can be calculated for just one accelerator Run

It´s not necessary proportional to the (total) Light Yield

- Corollary

Since this quantity is comming out from the *Counts* or number of Hits there is the intrinsic extension for the Wire planes

Light Collection Amount and Implications

- Suggested Practice

After Commisioning and Calibration, to double Check for the Light Collection Amount for each of the Channel; what is common is to perform this for the Optical Flashes.

Initially, to take as much processes as posible to get the Light Collection Amount.

For the Physics Analysis, to include an intermediate step to obtain the Light Collection Amount; also for each run separately.

Discard data according to the global and local observation; it could be a particulary case for improvement.

Conclusion

The Light Collection Amount is a step forward quantity to aid the Measurements depending on the Photon Detection System in the Detector, according to the expected precision.

Results from Actual Experiments can validate the decrease in the systematic uncertainty using the Light Collection Amount to refine data analysis and to interpreted better the experimental results.

Acknowledgment

Conference Organizers

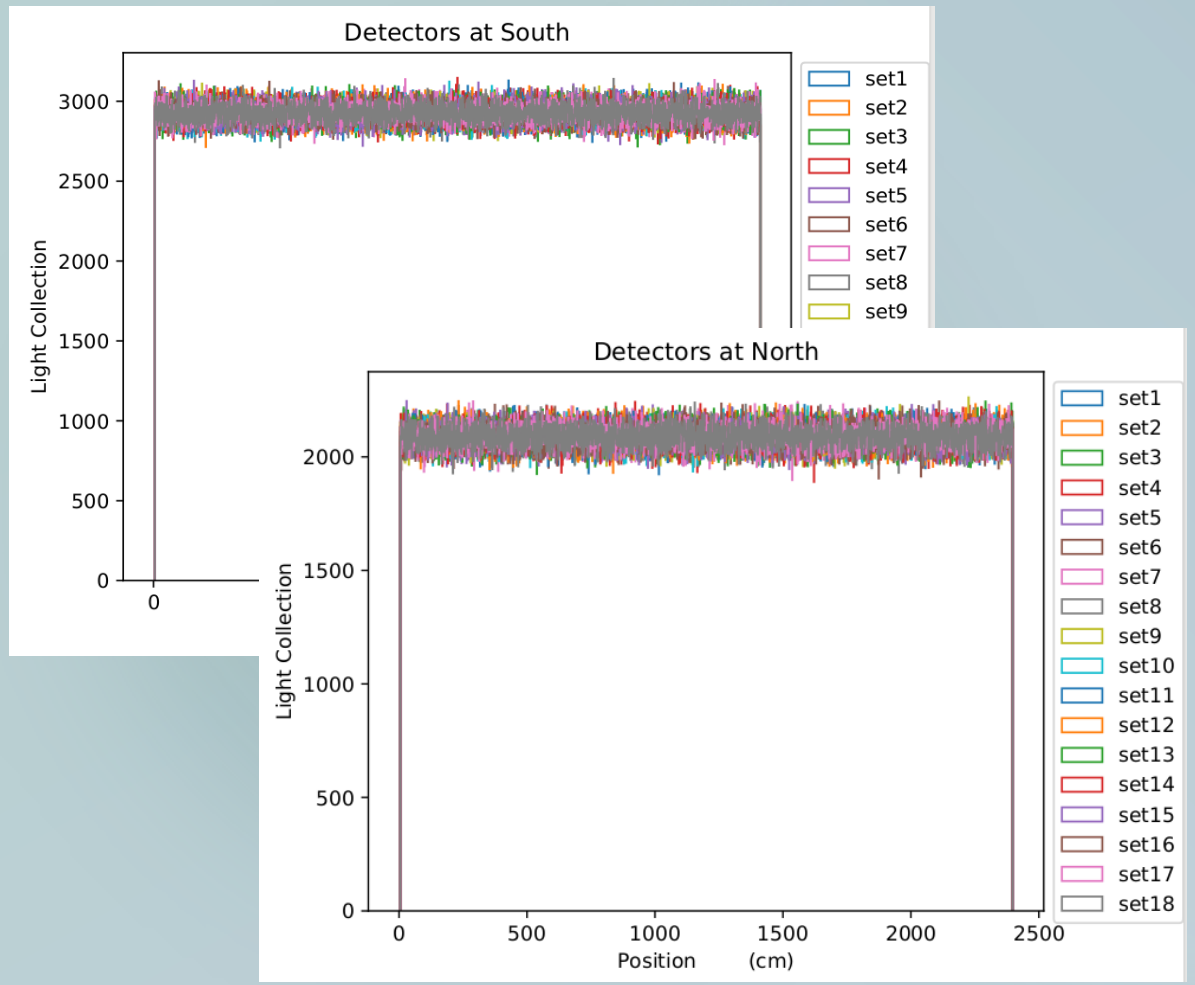
People in the *Universidade Estadual de Campinas,* in São Pablo Brazil

People in the Fermi National Laboratory, in Illinois U.S.

FAPESP

Fictitious Detector, Results in Python

Model C1



Model G