VENu

The Virtual Environment for Neutrinos

Marco Del Tutto

12th June 2018

GDR Neutrino Meeting (Paris)

UNIVERSITY OF OXFORD

What is?

VENu

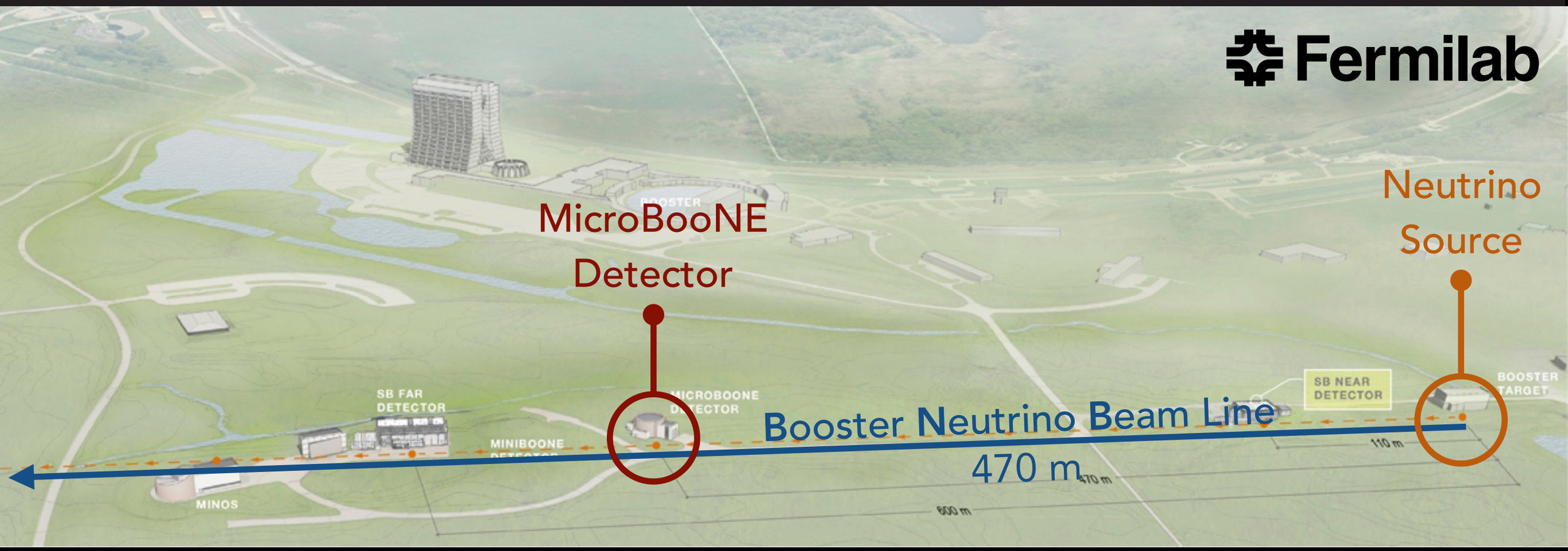
VENu is an event display for the MicroBooNE experiment

- MicroBooNE is a neutrino experiment at Fermilab
- The neutrino detector is a Liquid Argon Time Projection Chamber
- VENu allows to virtually go inside the detector

MicroBooNE

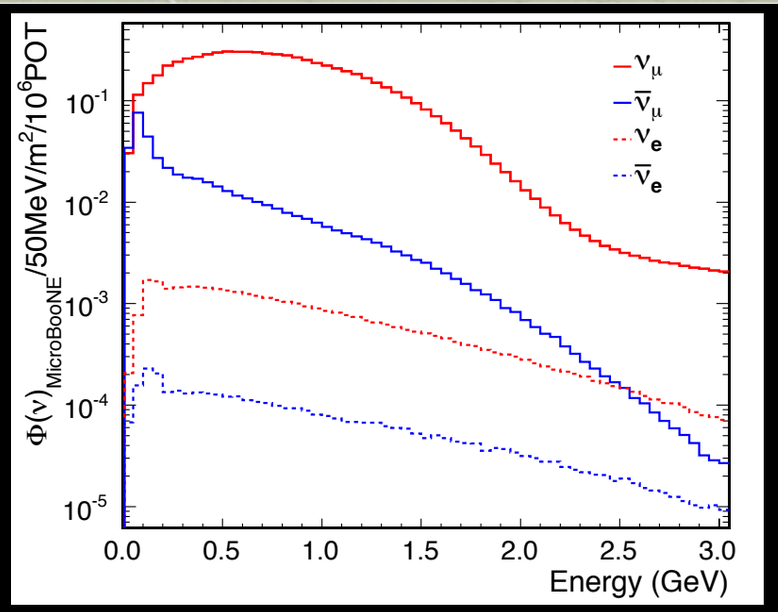
VENu

Fermilab



Goals of **MicroBooNE**:

- low-energy excess observed by MiniBooNE
- SBN search for sterile neutrinos with 5σ sensitivity
- ν-Ar cross section measurements
- R&D for future LArTPC experiments



MicroBooNE

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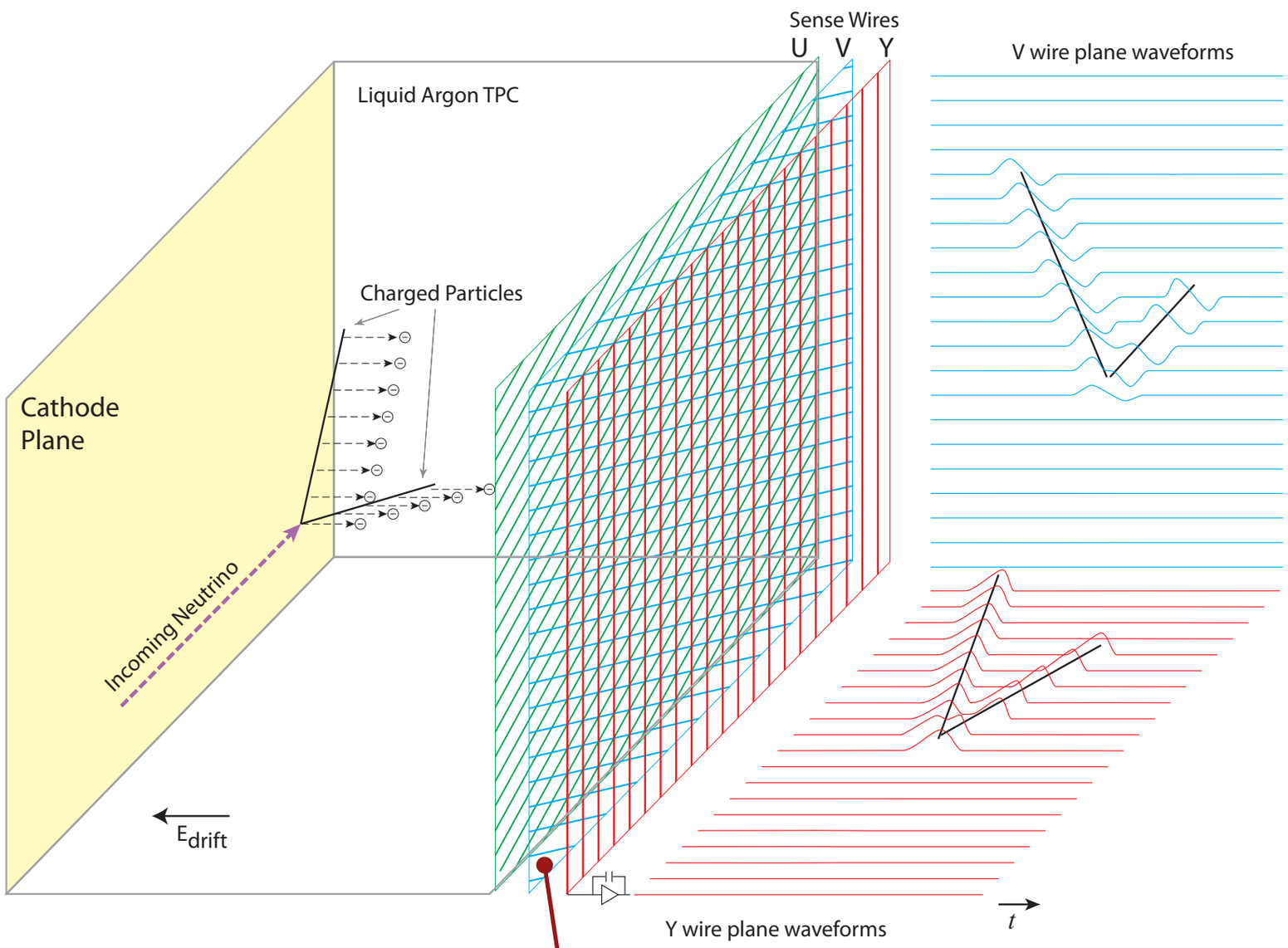
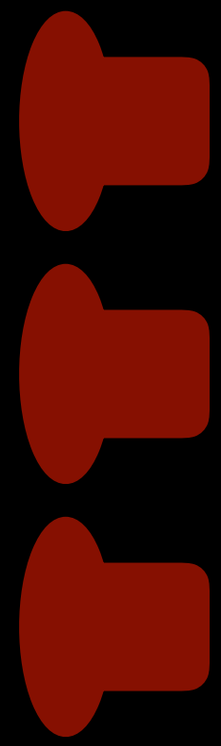


170 ton LArTPC (total mass)



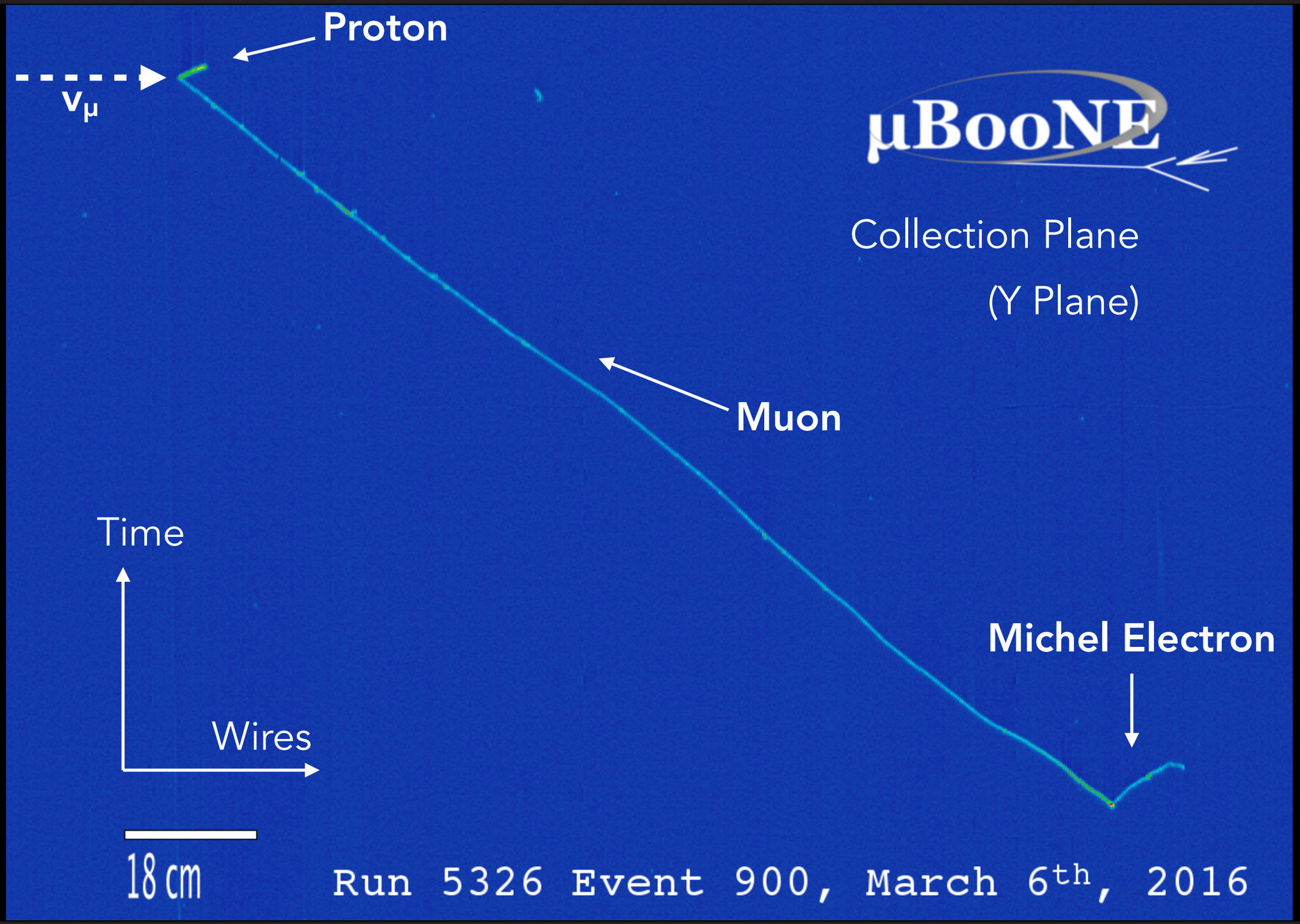
32 8″ Cryogenic PMTs

8192 wires (3 mm pitch)

PMT time resolution: O(10 ns)

TPC spatial resolution: 3 mm

Development



Development

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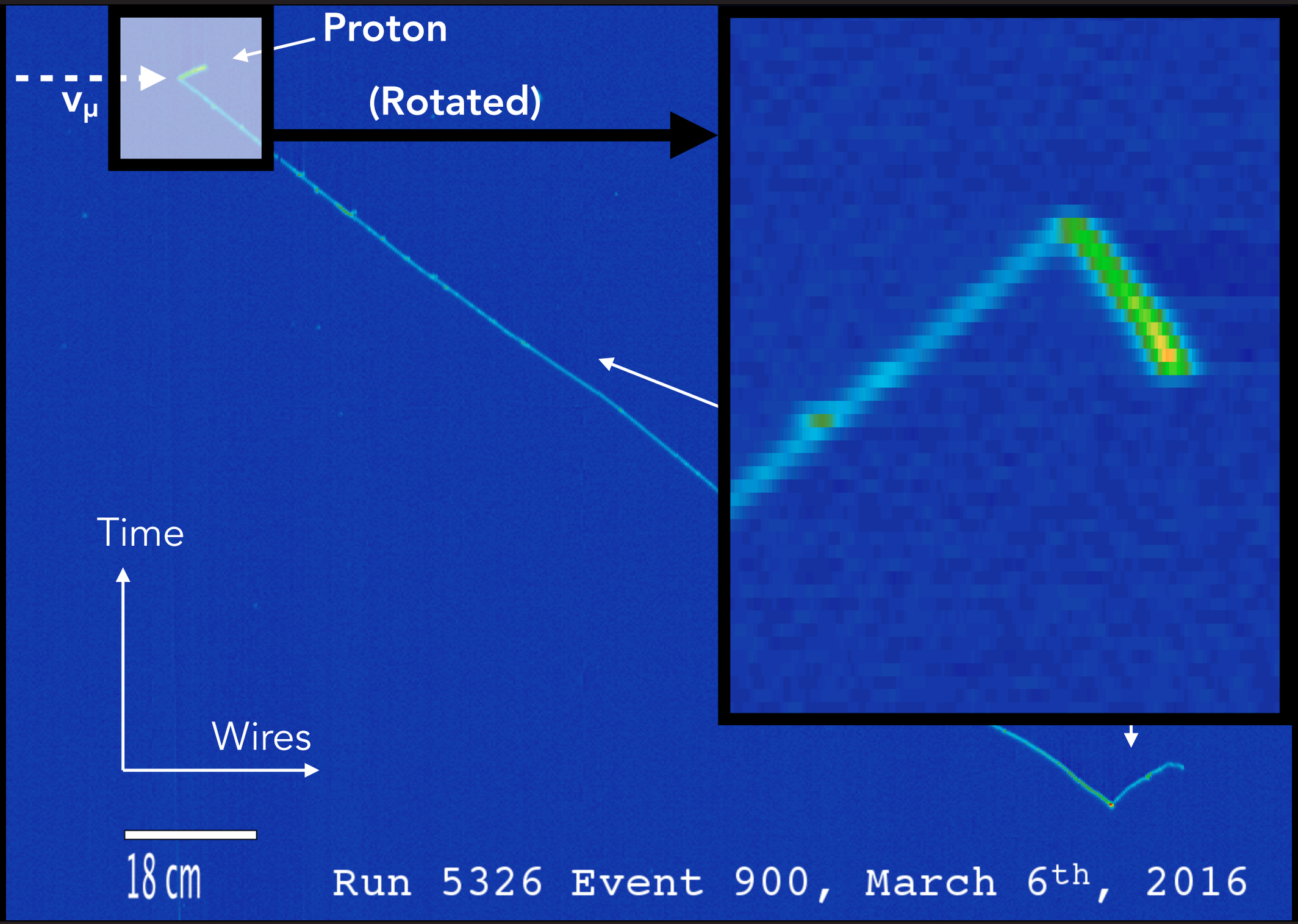
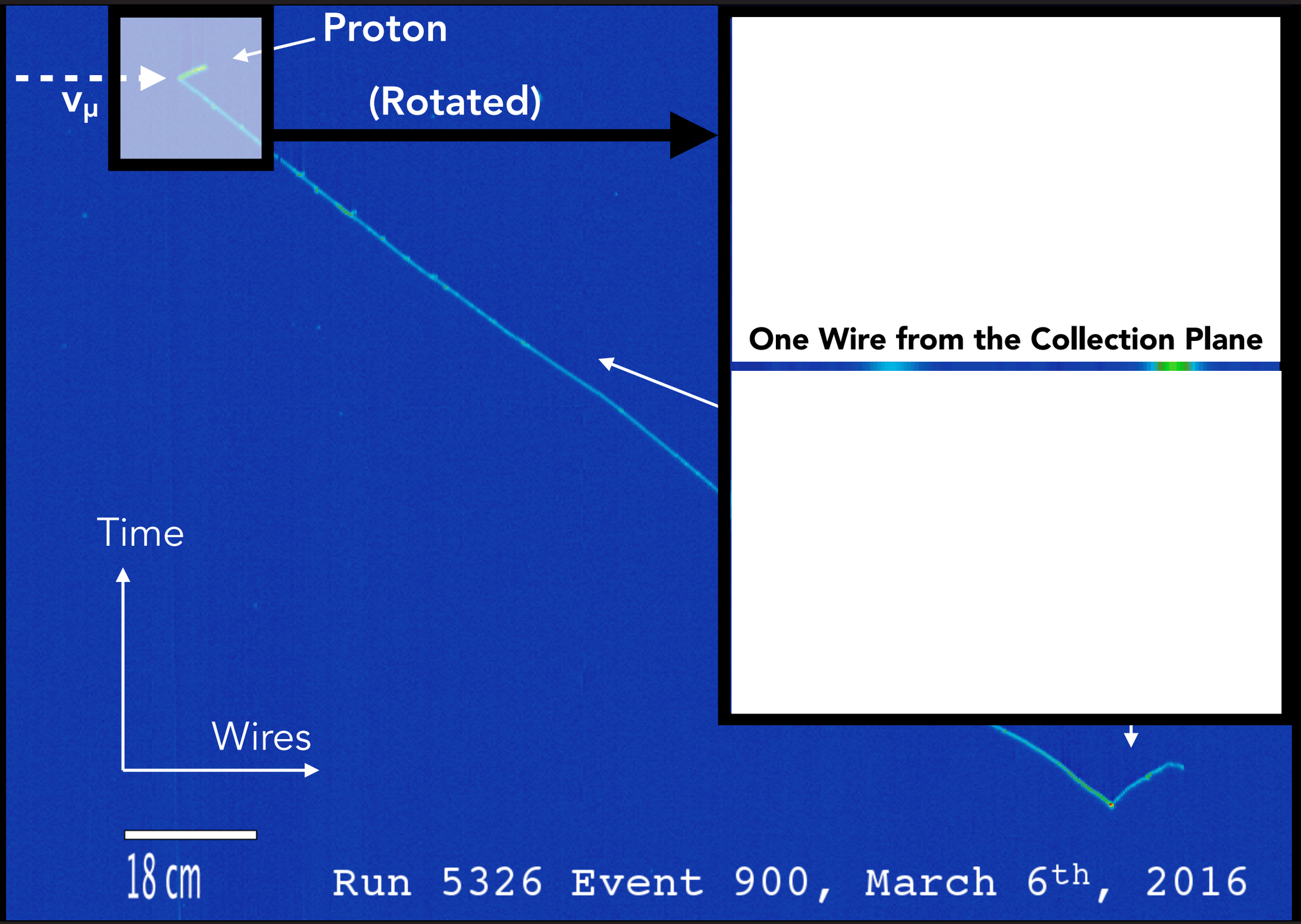


Development



Development

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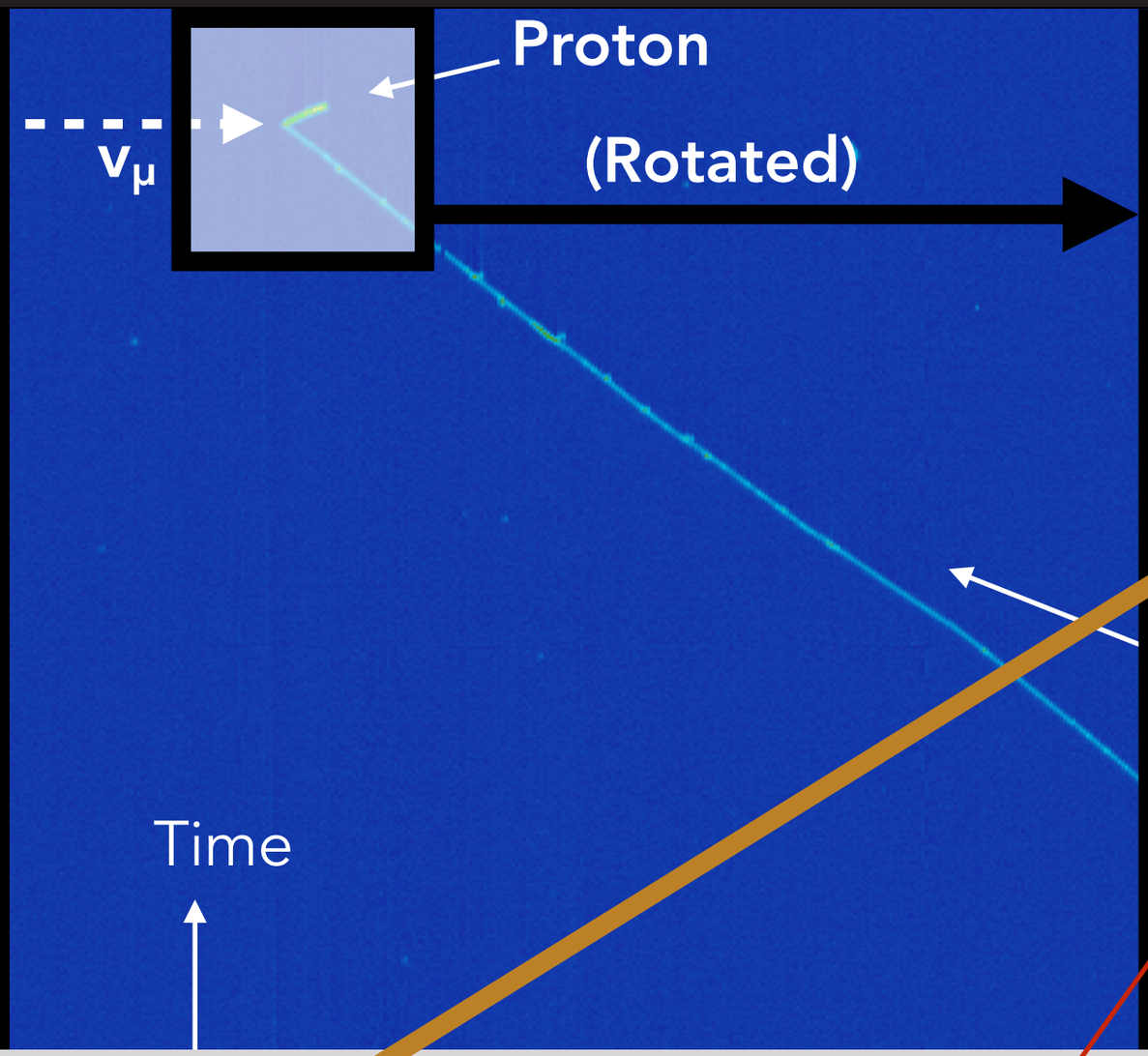
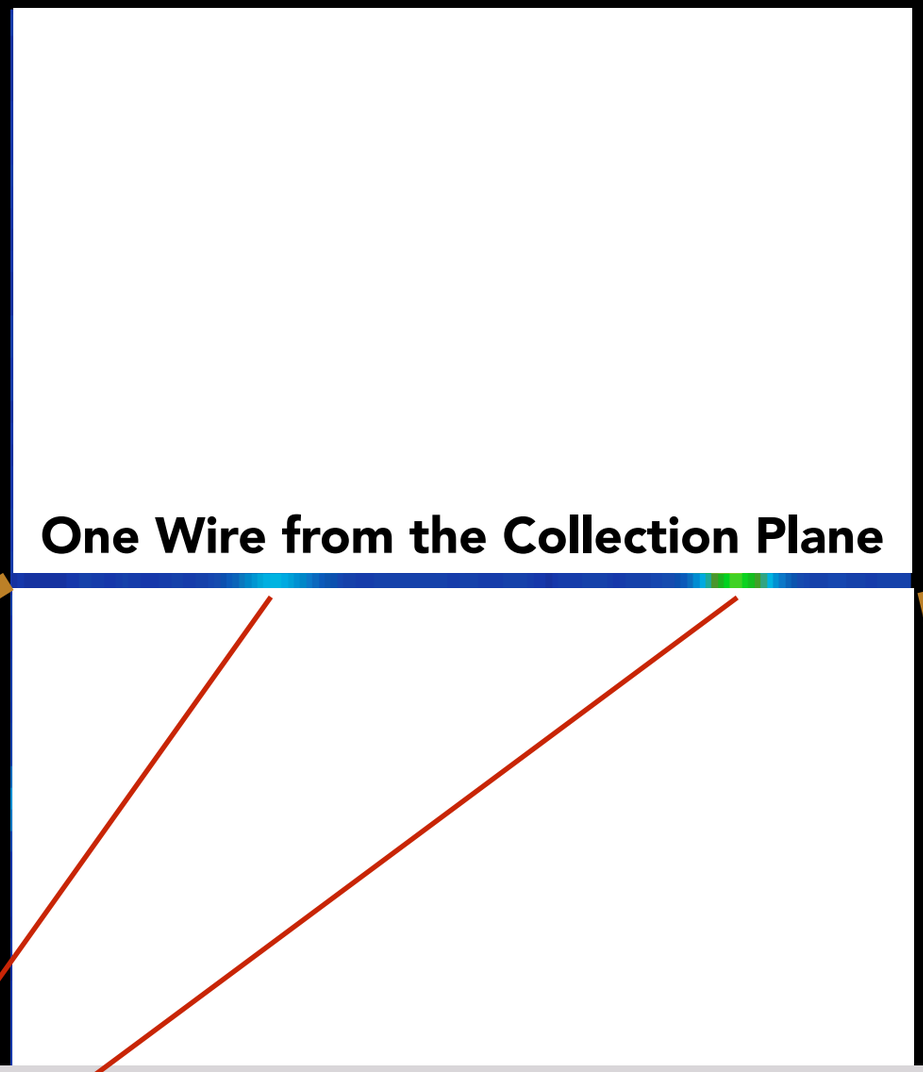
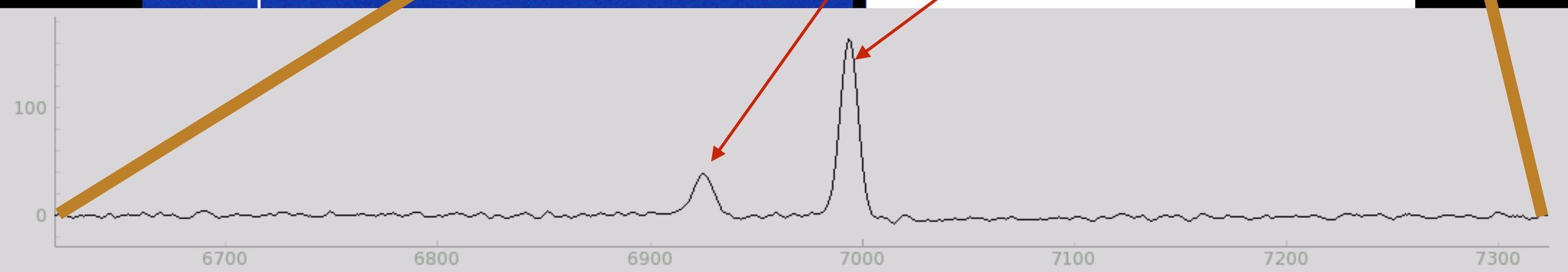
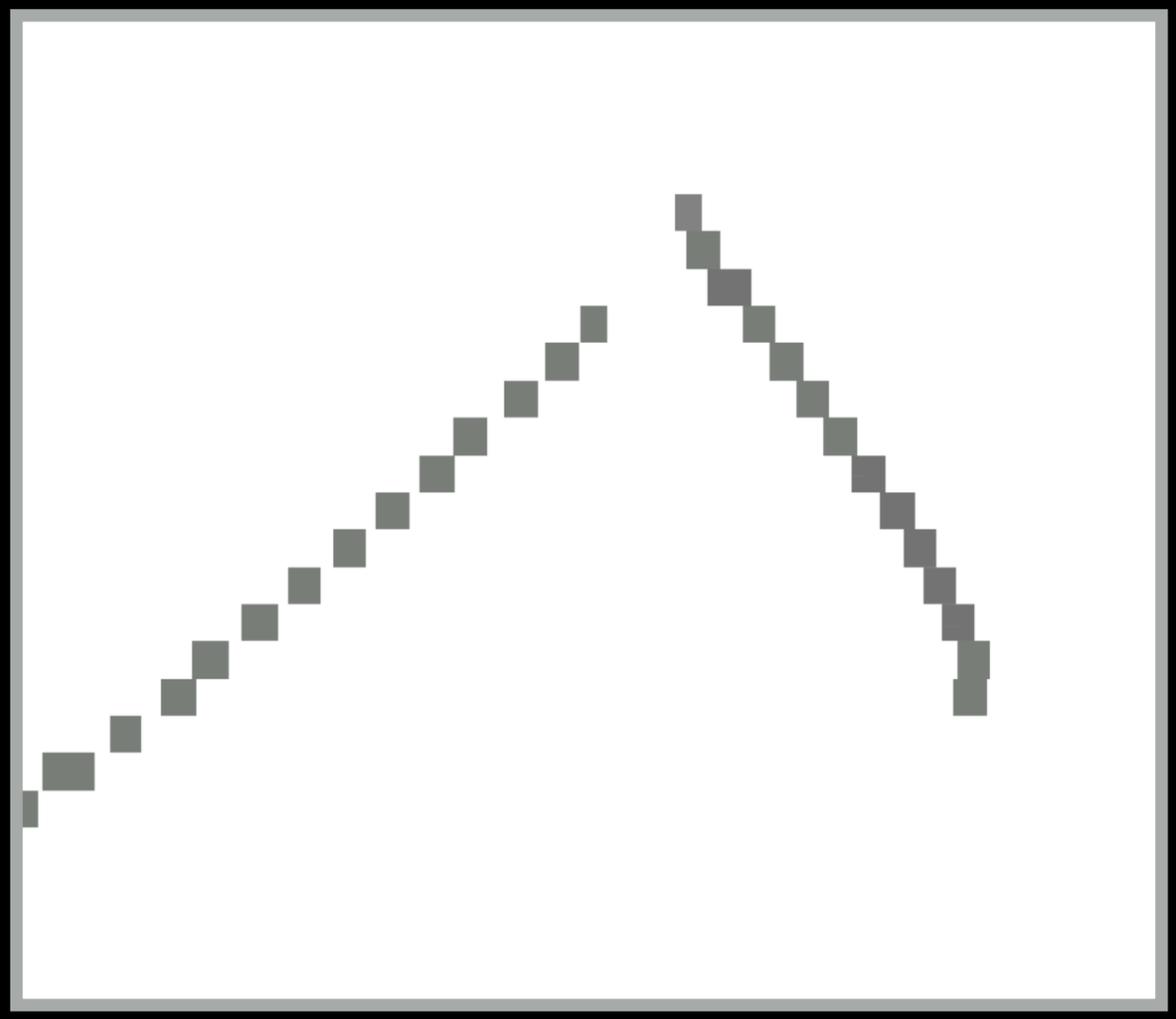


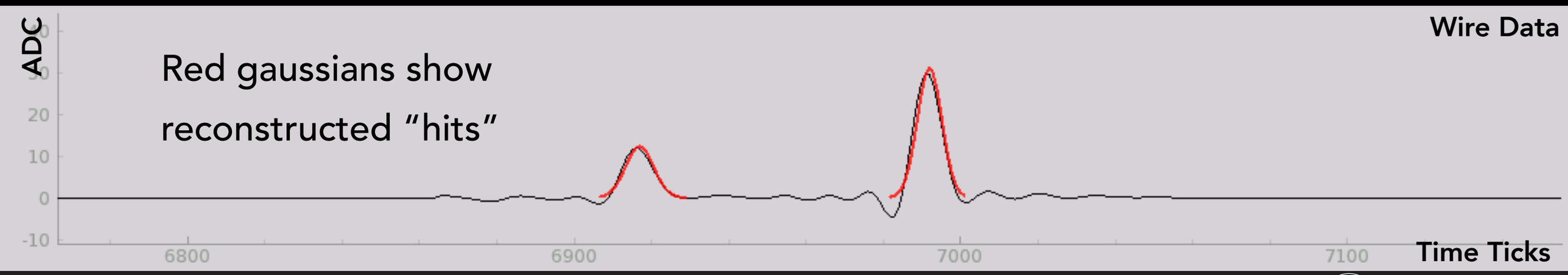




Development

This is only one of the three views. Combining the three views (actually only two are need) we can have a 3D reconstruction of the event.





Marco Del Tutto
12th June 2018

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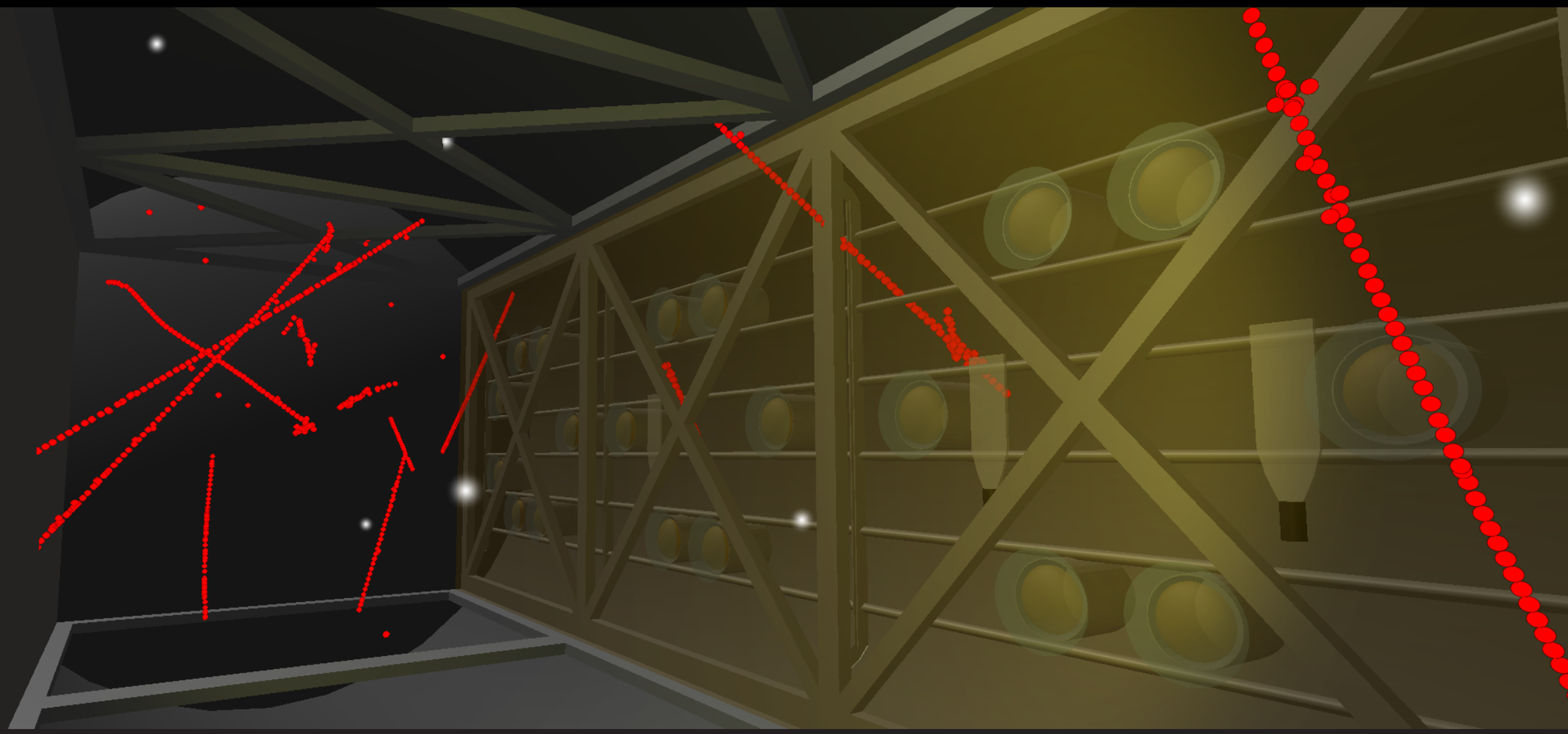
What is it?

VENu

VENu… …is built and rendered in a 3D environment

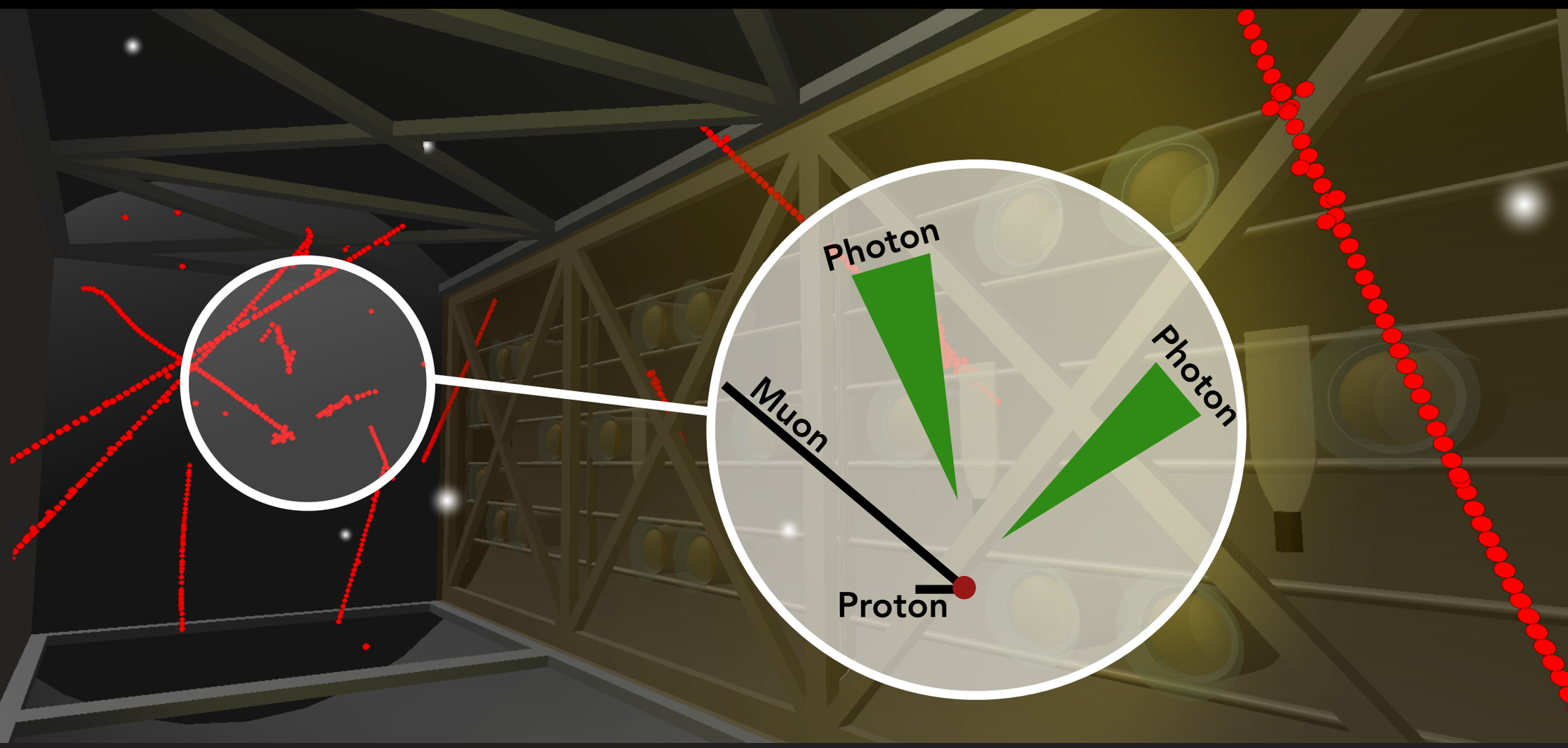


What is it?

VENu

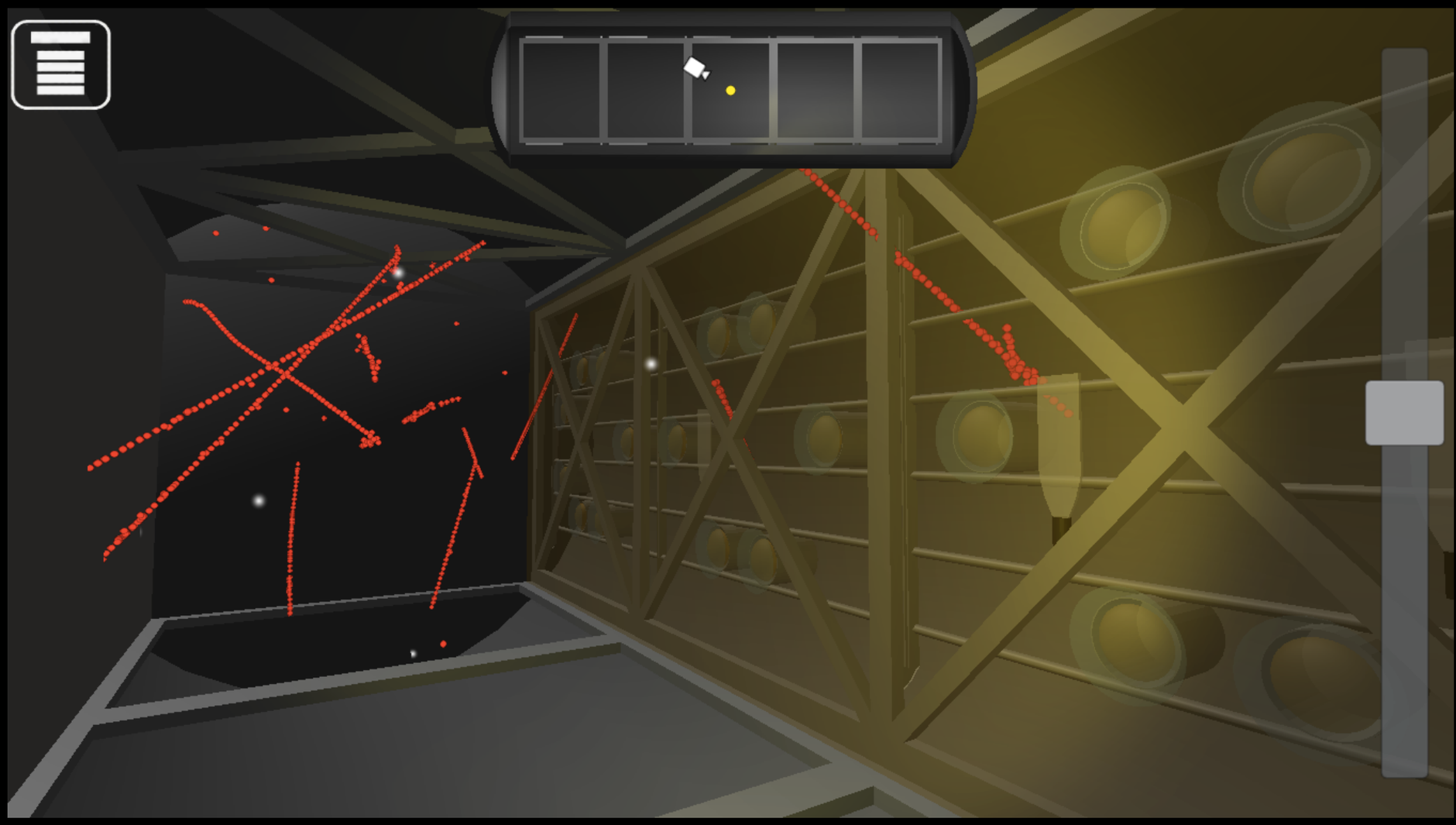
VENu…

…displays actual neutrino interactions from the MicroBooNE detector



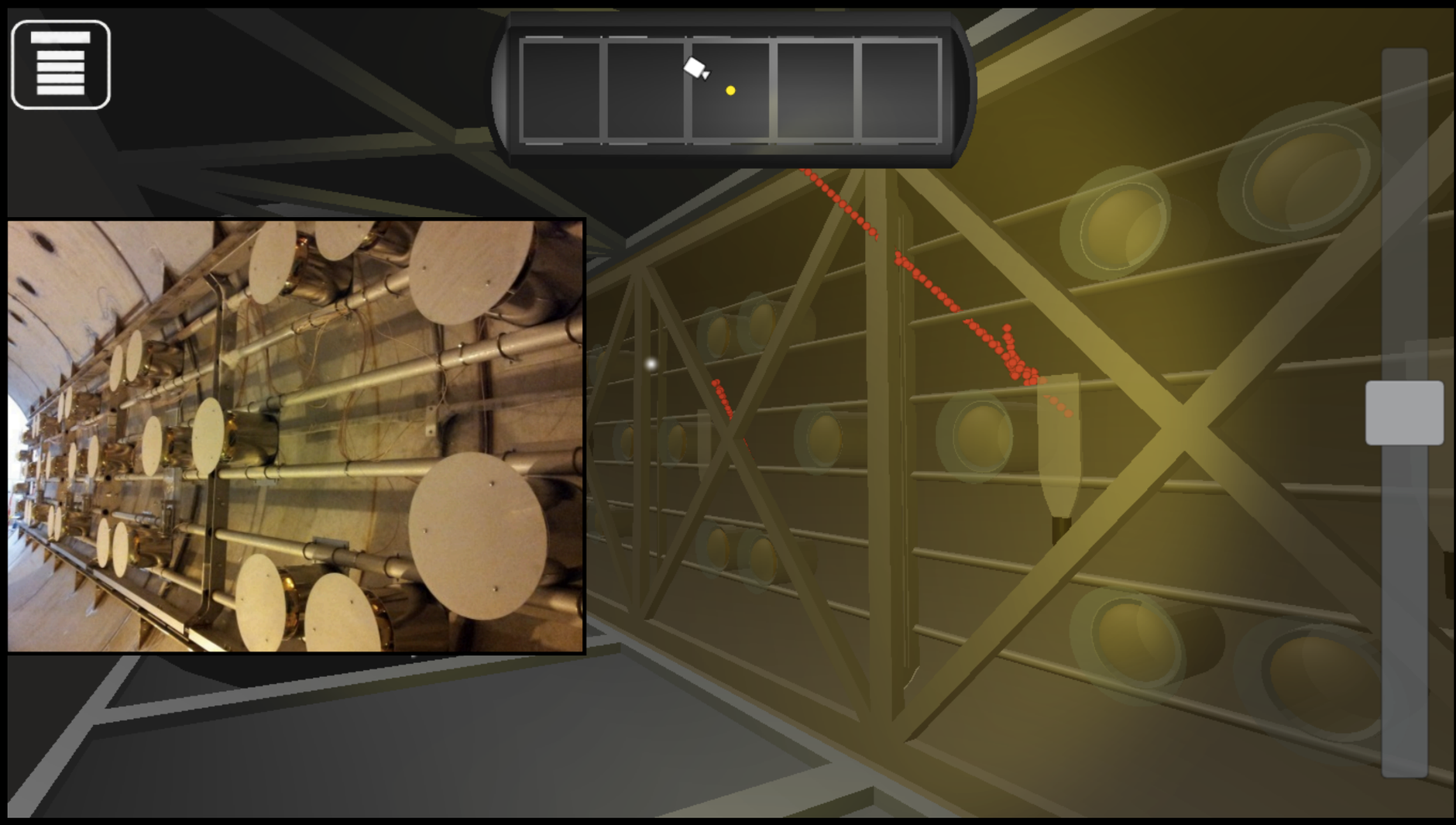
What is it?

VENu runs on smartphones



What is it?

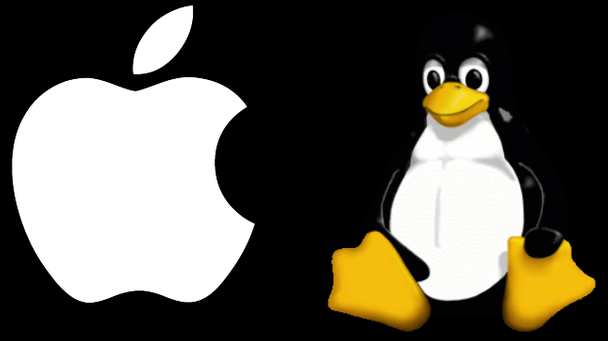
VENu runs on smartphones



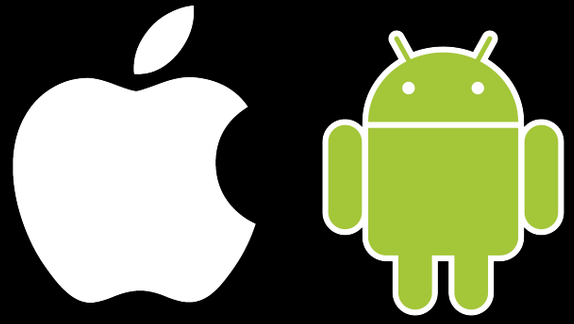
What is it?

VENu…

…is a multi-platform event display



Desktops



Smartphones

Web

…and many more…

What is it?

VENu

VENu… …is a mobile app

iOS

Android

What is it?

VENu

VENu… …is designed to exhibit both virtual and augmented reality features

What is it?

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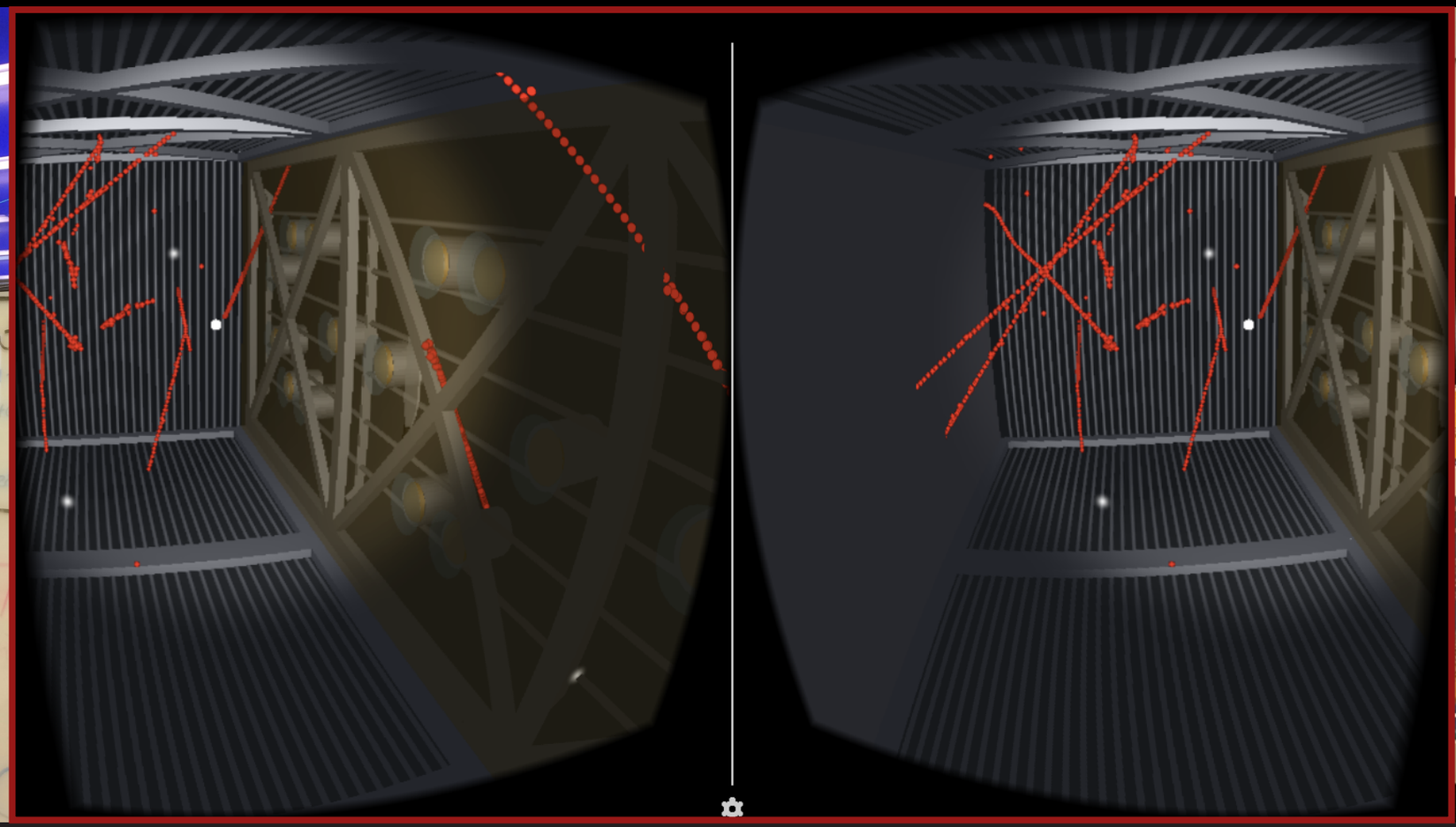
VENu…

…is designed to exhibit both virtual and augmented reality features



Virtual Reality

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Virtual Reality (**VR**) simulates pieces of our world or imagined worlds
Emulation and reception are two basic keys to Virtual Reality

We can use it to immerse the public inside our detector, to explain the physics that we do

Virtual Reality

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Consumers are still focused on the excitement
around the content, rather than the applications

VR is becoming the next frontier
for designer in all industries

Common belief: VR is a brand new phenomenon.

However, VR has a rich stories past
that spans well over a century in the making.

History of VR

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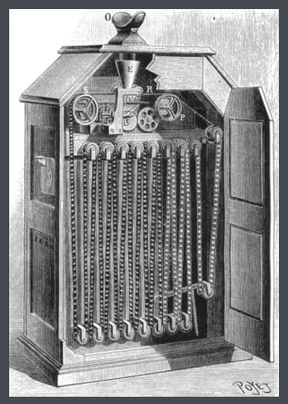

Kinetoscope
Single person film experience
1890

Stereoscopic photo viewers
1930s

First head mounts displays
1950s

Sensorama (Heilig)
Sight, sound, smell, vibration
1962

Lanier coins "Virtual Reality"
1989

Luckey develops Oculus Rift
2011

Facebook acquires Oculus Rift
2015

VR Today

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Google Cardboard

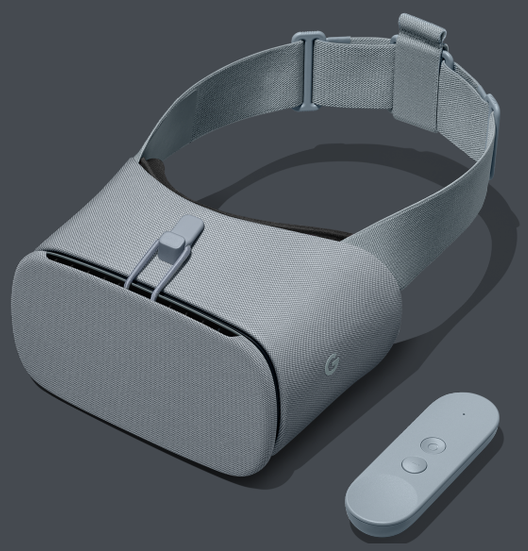
Uses smartphone for display, rotating tracking and processing

Oculus Rift

Tracks lateral motion of the head
Tracks the position of motion controller

Google Daydream

Uses an external input device for rotation tracking



HTC Vive

Better support for room scale tracking

VR @ MicroBooNE

VENu

Google Cardboard

Uses smartphone for display, rotating tracking and processing

Oculus Rift

Tracks lateral motion of the head
Tracks the position of motion controller

- We have an Oculus Rift version of VENu
- Needs a powerful computer to run
- Currently used in outreach events
- But not portable

VR @ MicroBooNE

VENu

Google Cardboard

Uses smartphone for display, rotating tracking and processing

Oculus Rift

Tracks lateral motion of the head
Tracks the position of motion controller

- Can be paired with many of the smartphones available on the market
- Portable
- Not expensive (can be used as gadget)
- Limited by smartphone performances

Why?

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"We had been thinking about new ways to show off the MicroBooNE experiment. MicroBooNE is an innovative technology, and we wanted an innovative way to show it off"

Sam Zeller

MicroBooNE co-spokeperson

Why?

VENu

50%

Characterise scientists as secretive

55%

Believe science is too specialised for them to understand

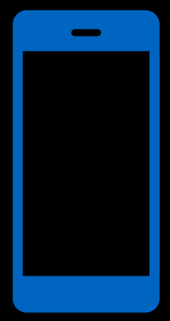
From "Public Attitudes to Science" 2014, UK Gove

Why?

VENu

50%

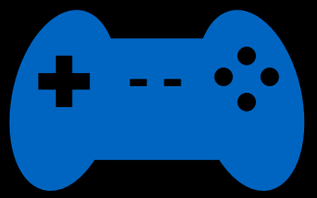
Characterise scientists as secretive



Mobile App

55%

Believe science is too specialised for them to understand



Game

Learning sections

From "Public Attitudes to Science" 2014, UK Gove

Why?

VENu

- Connections with the general public;
- The educational game included in the application will allow young people to hunt neutrinos and to learn more about them in a fun environment;
- To offer a tool for neutrino physicists to interact with the public while describing their research.

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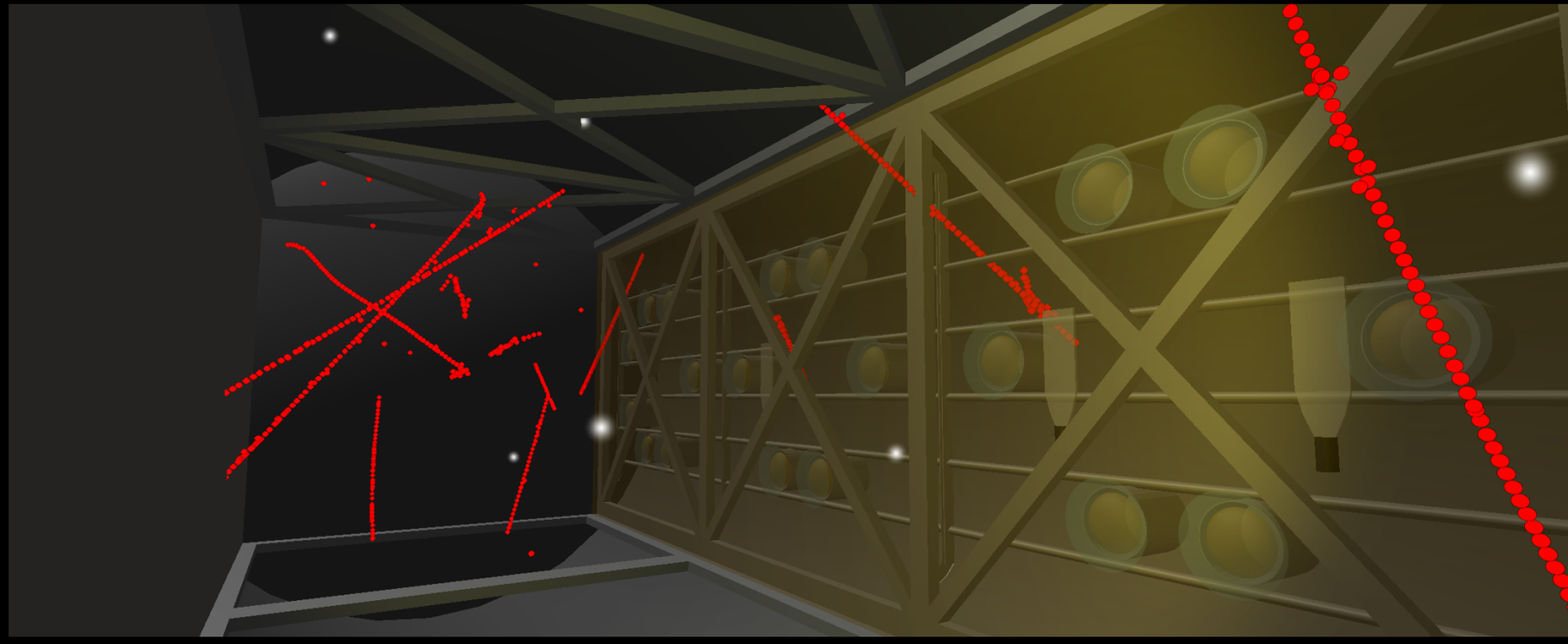
How did we do it?



Development

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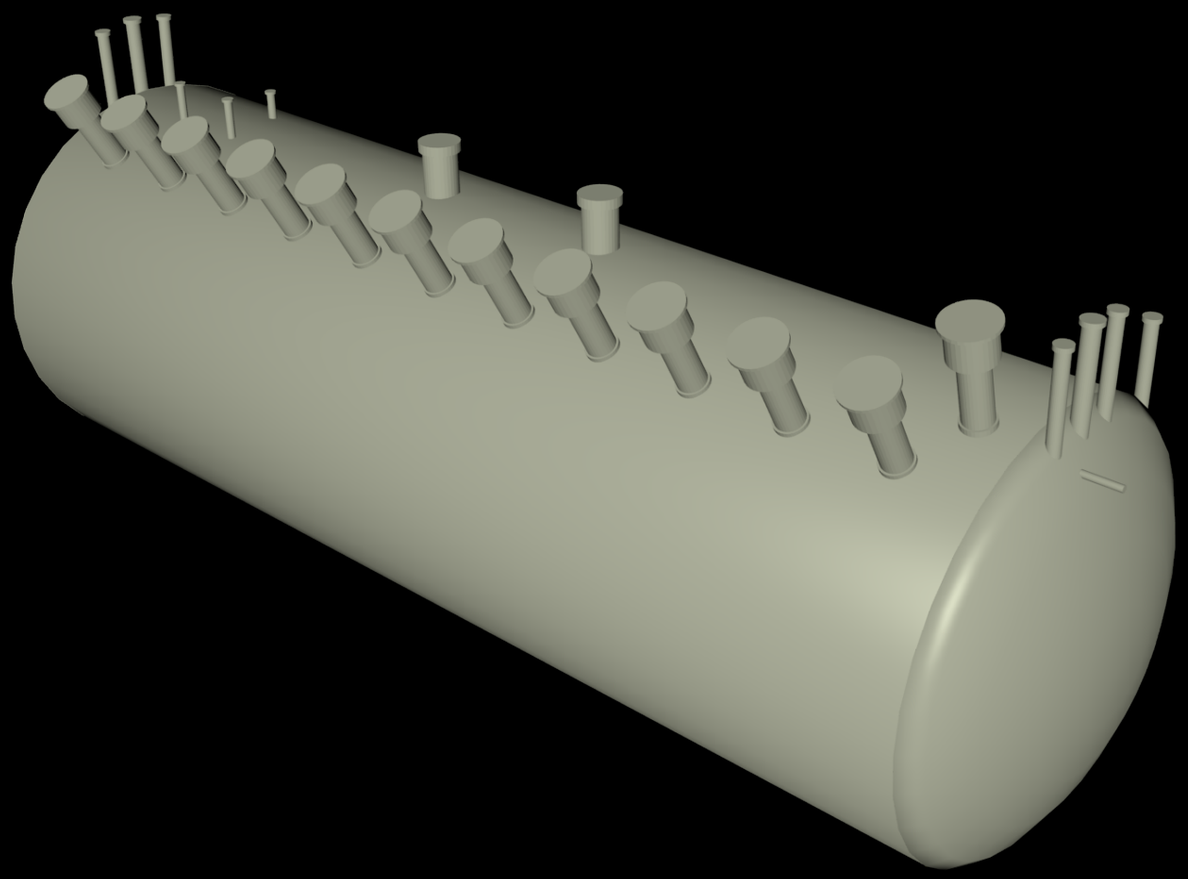
We used Blender to render the detector geometry

Blender is an open source 3D modelling software, that imports easily into Unity



blender

Development

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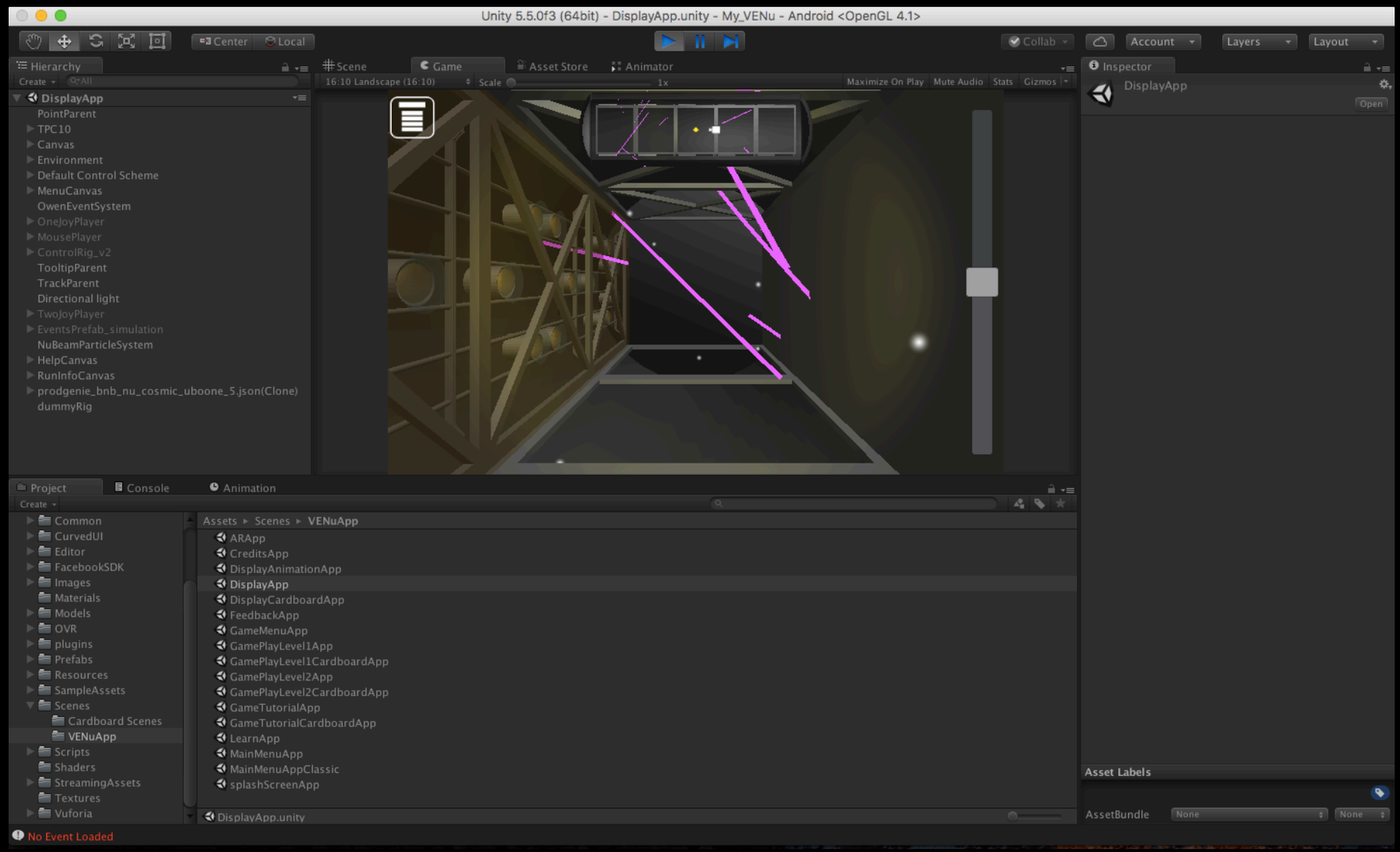
We built VENu using the Unity game engine



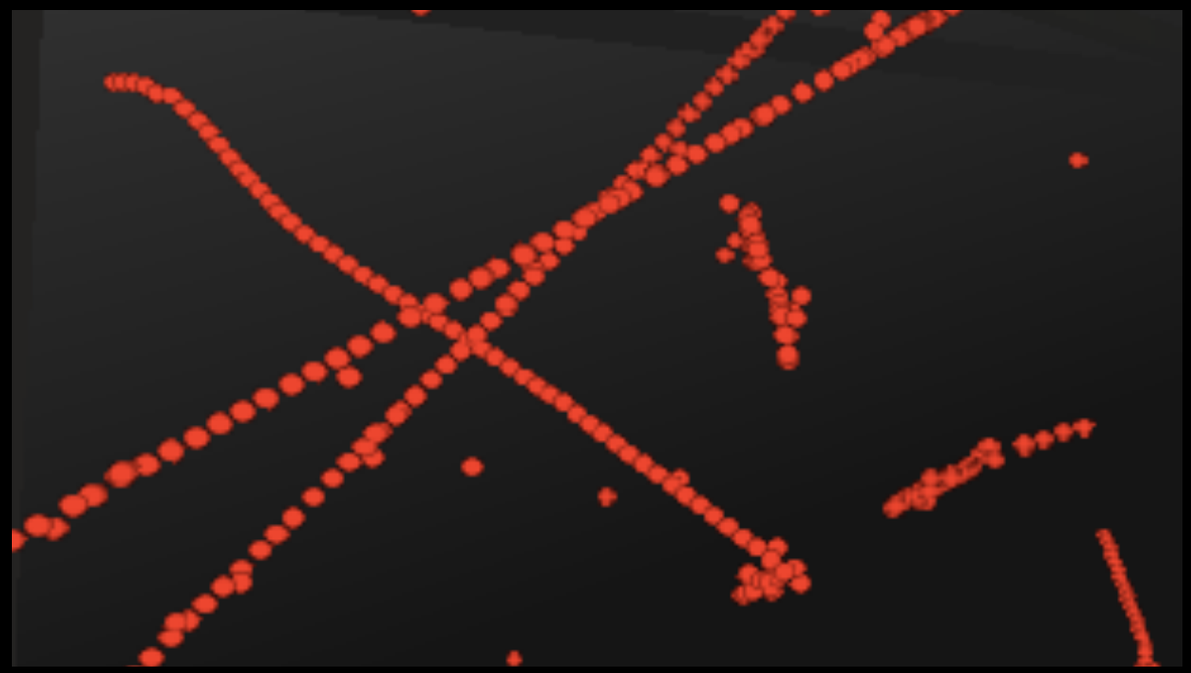
unity

Development

The data from the MicroBooNE detector are processed in a simplified json format.

They are then transformed into Unity prefabs.

prefabs in Unity are assets that allow to store a game object (like a particle trajectory)



Development

The data from the MicroBooNE detector are processed in a simplified json format.

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prefabs in Unity are assets that allow to store a game object (like a particle trajectory)

All code available on GitHub!

https://github.com/VENuProject

A

History

VENu

December 2015 first idea to develop VENu for smartphones

Development…

October 2016 testing among MicroBooNE collaborators

November 2016 testing with students at Arnold Matthew School (Oxford)

December 2016 website construction

January 2017 launch! 

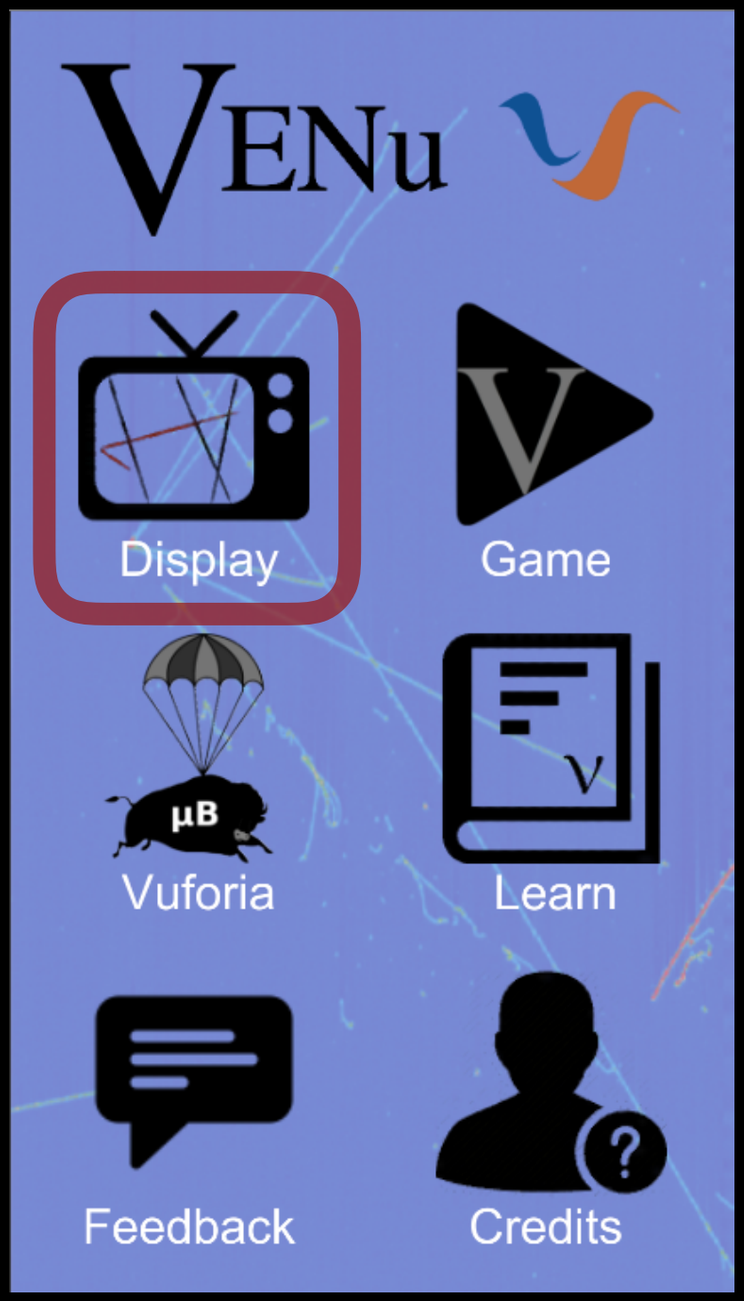
Up to now outreach events

The Menu

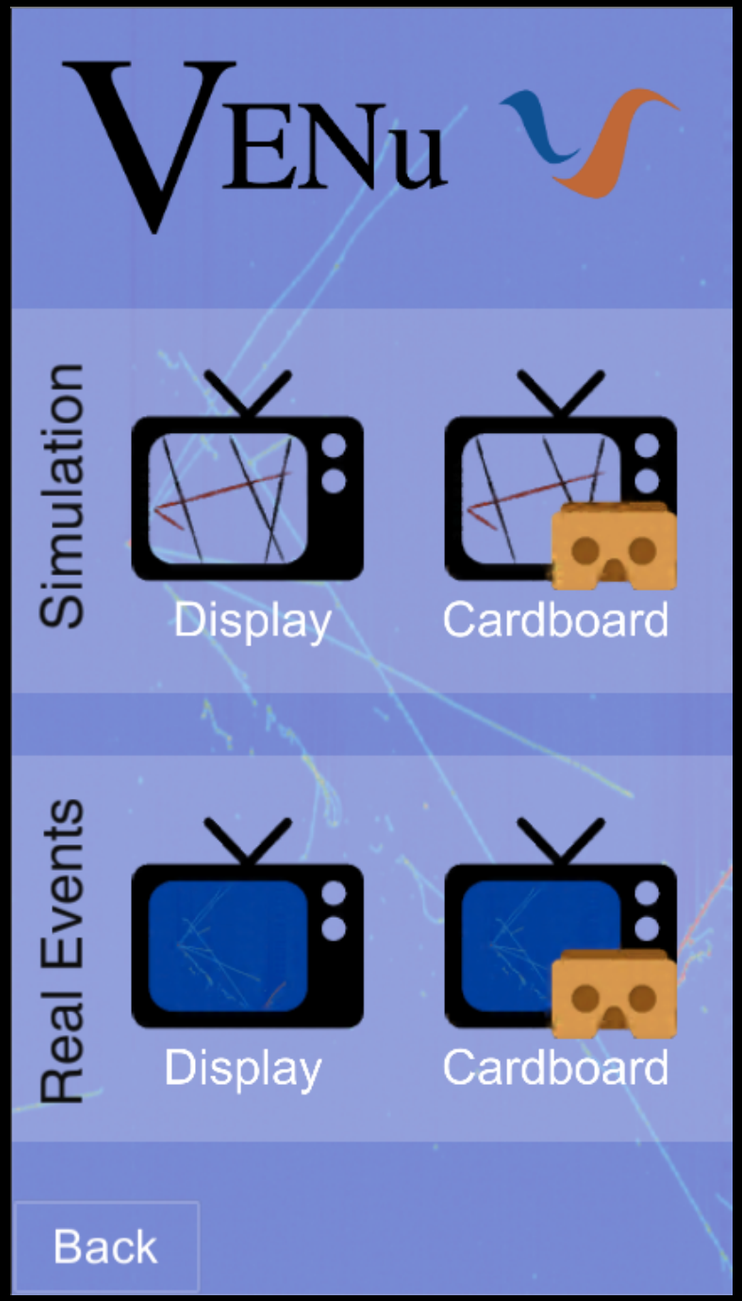
Main Menu

The Menu

Main Menu

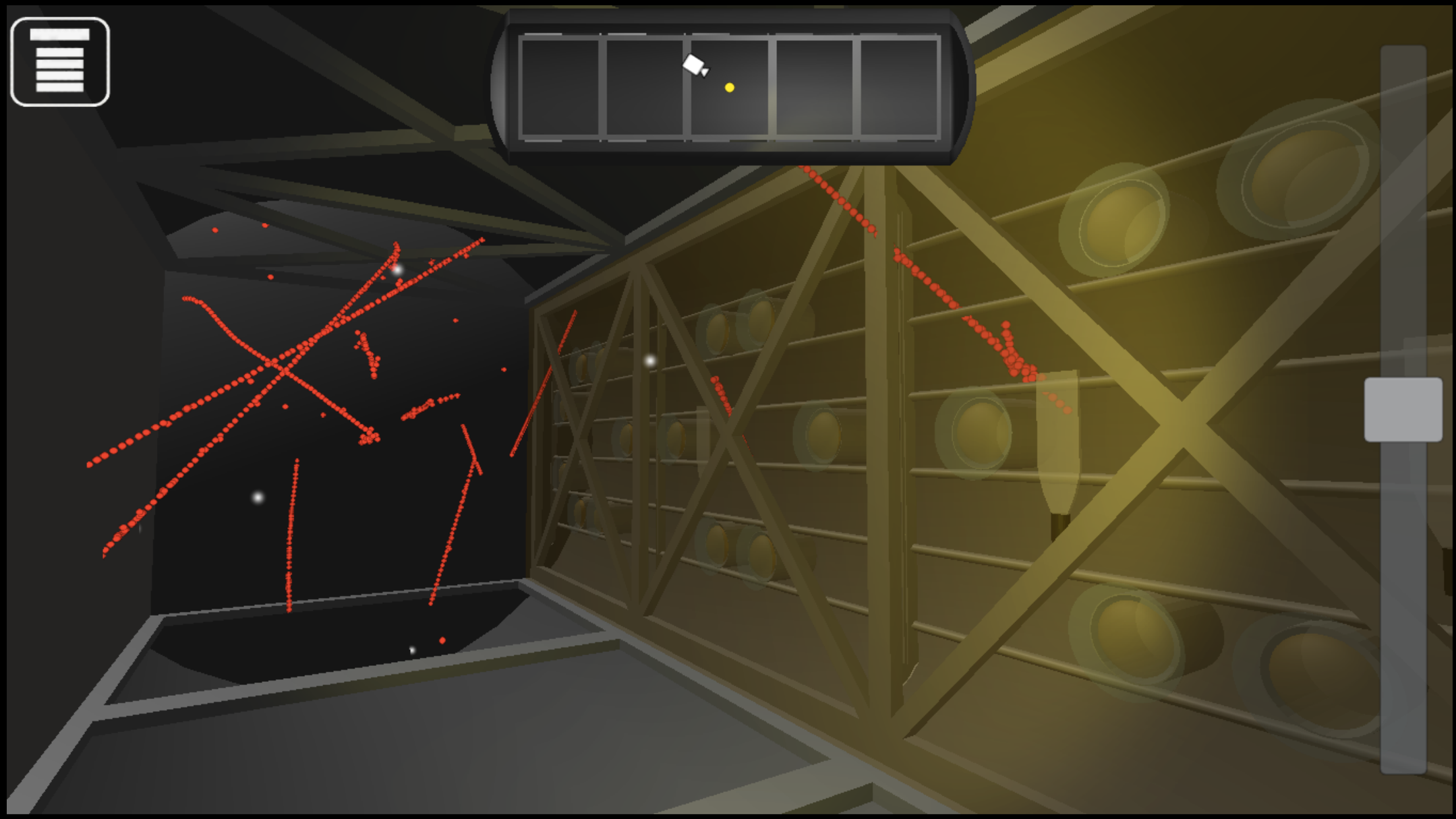


Display Menu



The Display

VENu



The Learning Sections

Learn Menu

VENu Learn

- What are neutrinos?
- Where do neutrinos come from?
- How to make a neutrino beam
- Neutrino interactions
- What is a cross-section?
- Cosmic rays

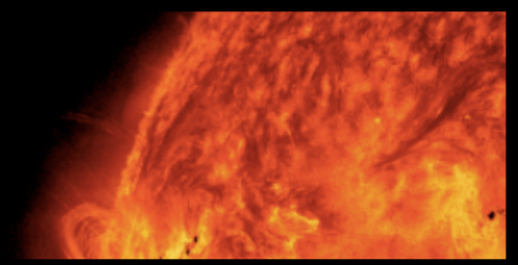
Main Menu

Learn Section

VENu Learn

Where do neutrinos come from?

Neutrinos were first produced in the universe some 14 billion years ago, 10 to the -43 seconds after the Big Bang. A mere second later, they were already rapidly moving away from the rest of the hot and dense primary particle soup; scientists are still seeking to detect these neutrinos that survive from the Big Bang. So far, only two sources of extraterrestrial neutrinos have been observed: the sun and supernovae.



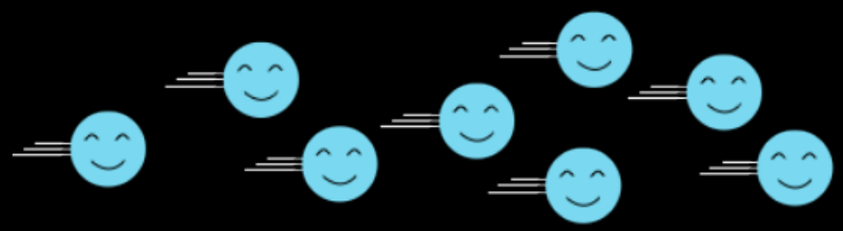
Main Menu | Learn Menu

The Tutorial

VENu

1/5

All starts with a neutrino beam produced at Fermilab...

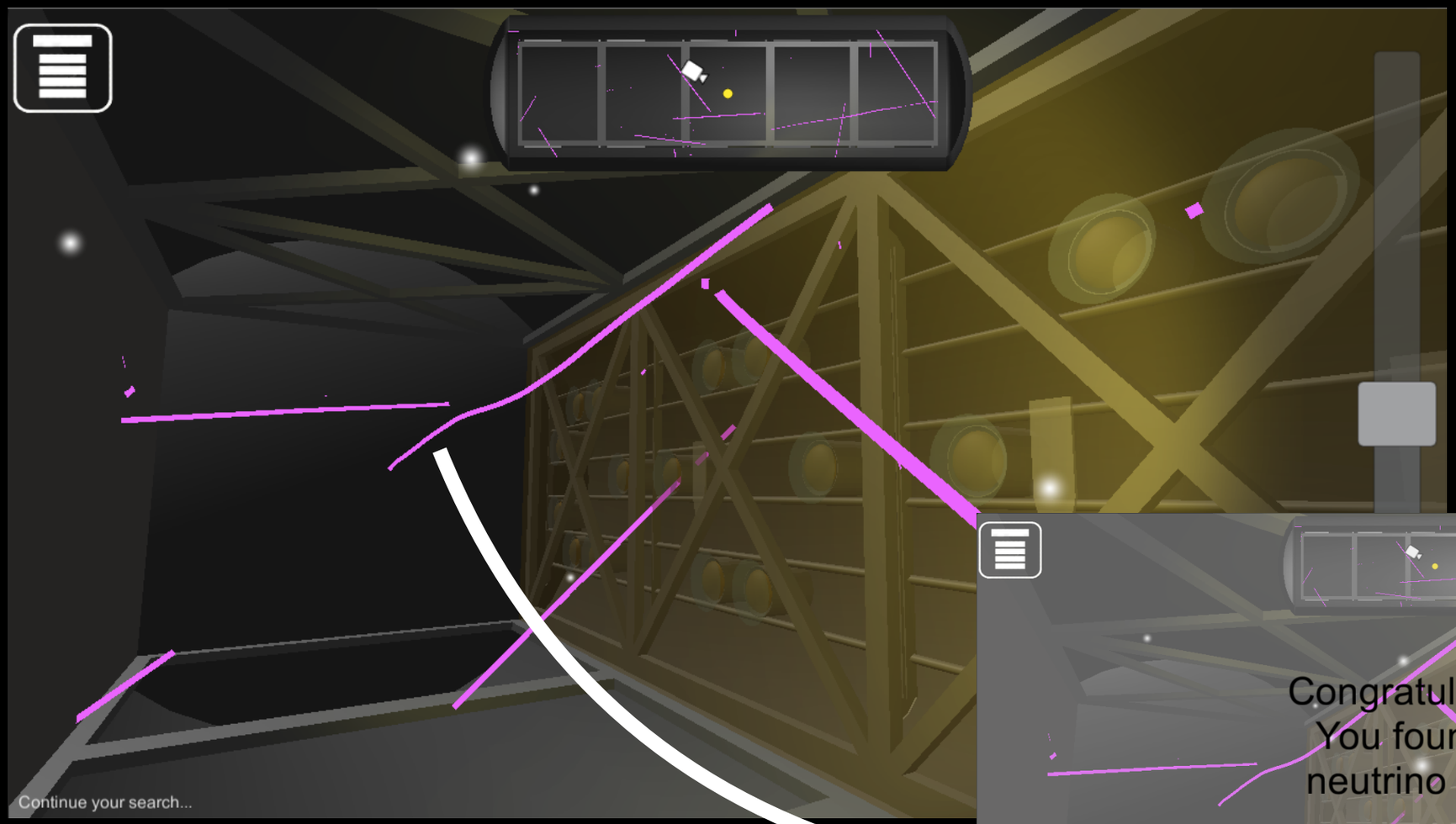


Learn how to make a neutrino beam

Back

Next

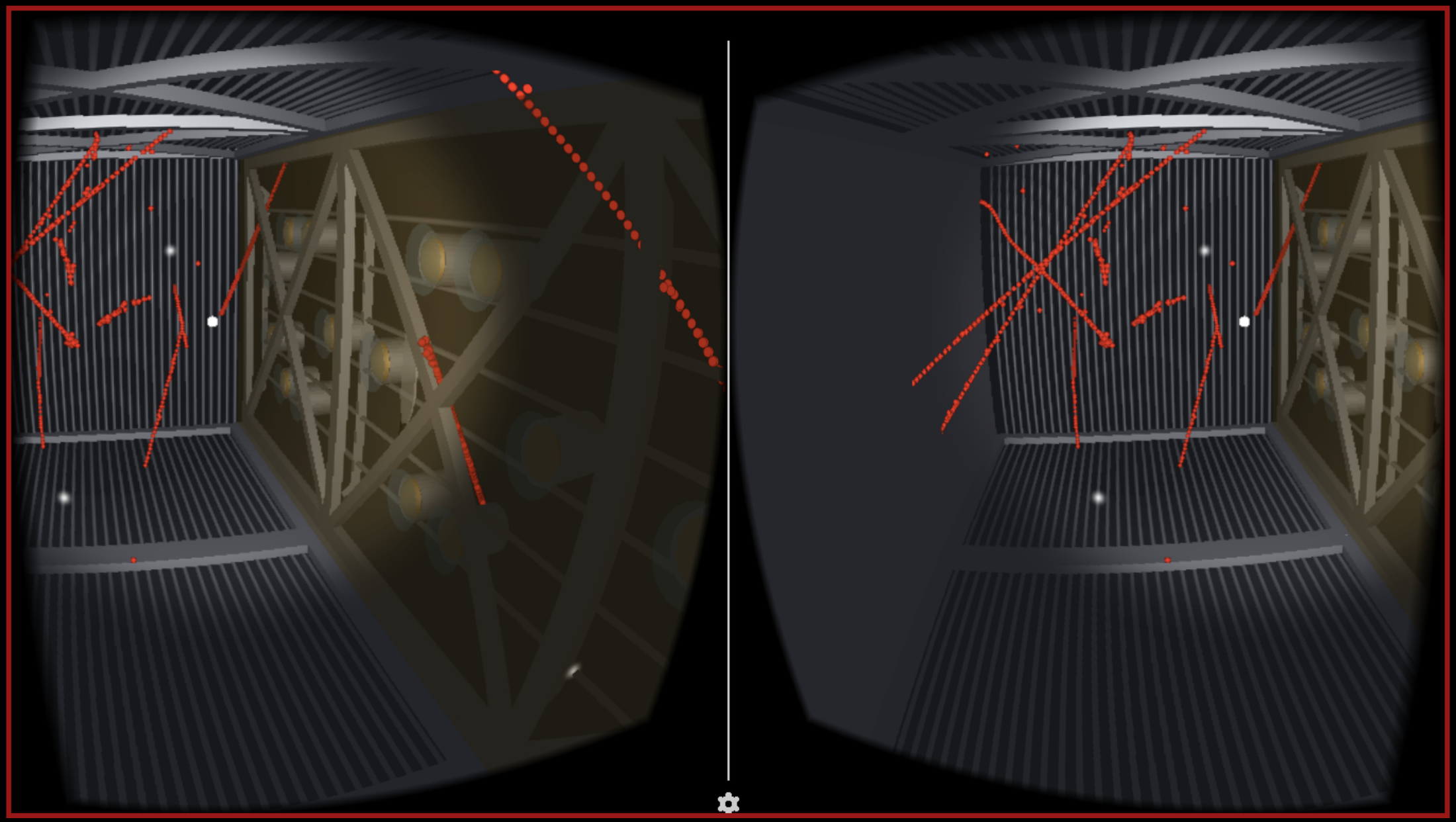
The Game



Clicking on the
neutrino-induced track

The VR Mode

VENu



Who was engaged?

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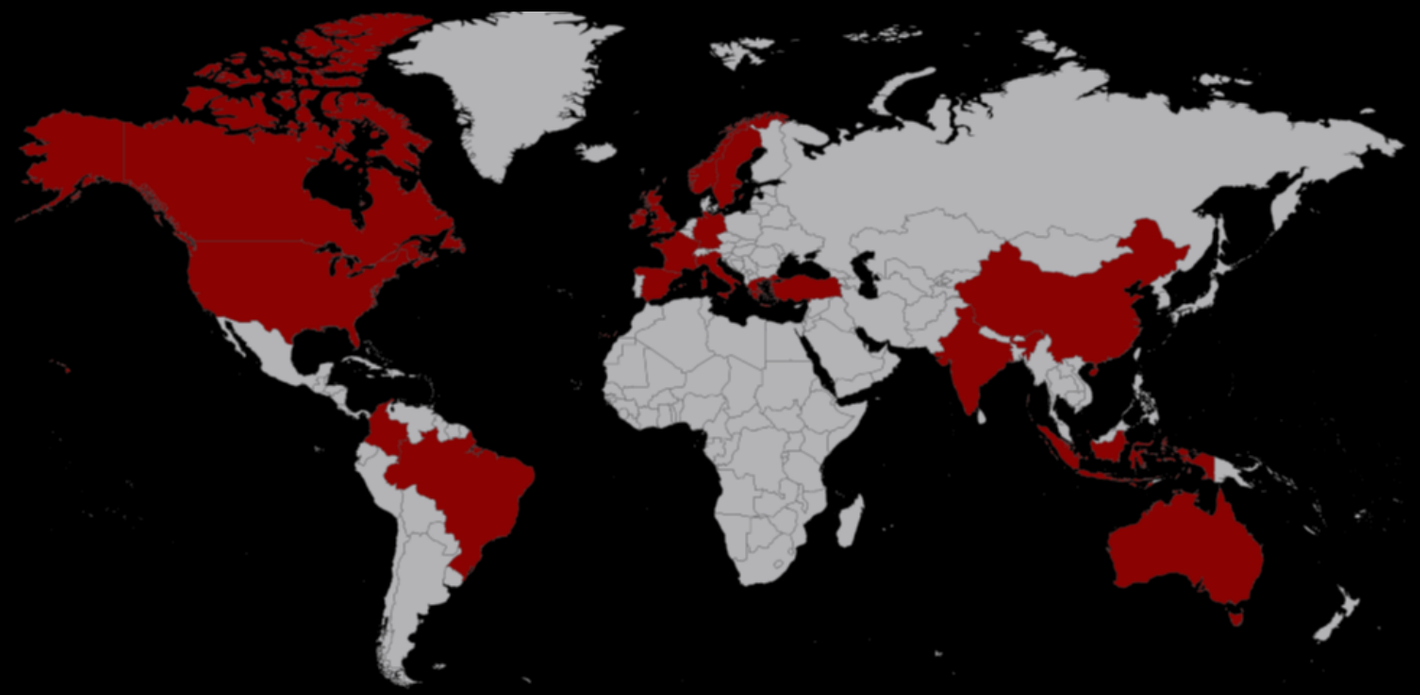

Other than UK and USA, we have downloads mainly from Canada, Italy, France, Germany, Australia, Switzerland, China and India.

Who was engaged?

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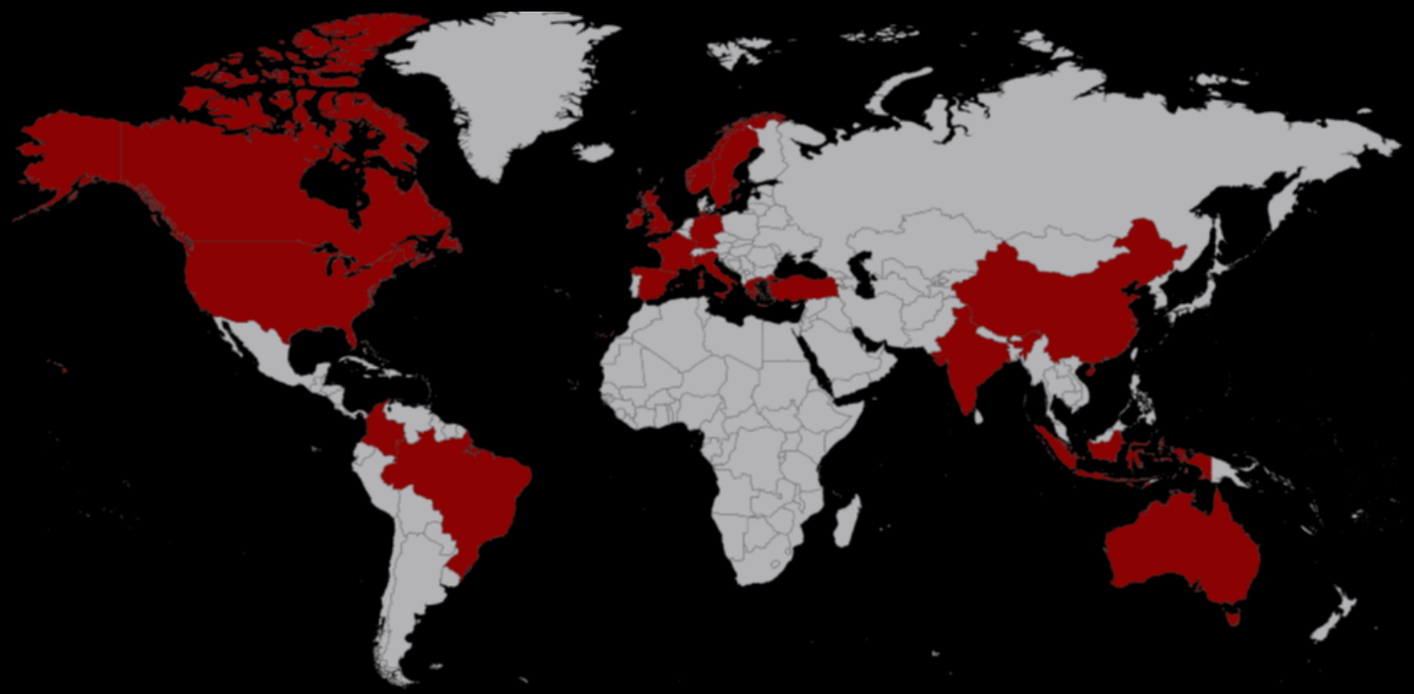

More than 4300 downloads up to now!

> 800 Android downloads (score 4.9/5)

> 3500 iOS downloads (score 5/5)

What now?

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VENu is now being used for outreach events at Fermilab and in many other institutions (Oxford, Bern, Columbia, …)

We are working with the new Oxford VR/AR Hub group to better integrate VR in education. The first Oxford VR school will be hold in a few weeks!

Who was engaged?

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Stargazing

When 28 January 2017

Where Physics Dep. University of Oxford

Link https://www2.physics.ox.ac.uk/events/2017/01/28/stargazing-oxford-2017

Who was engaged?

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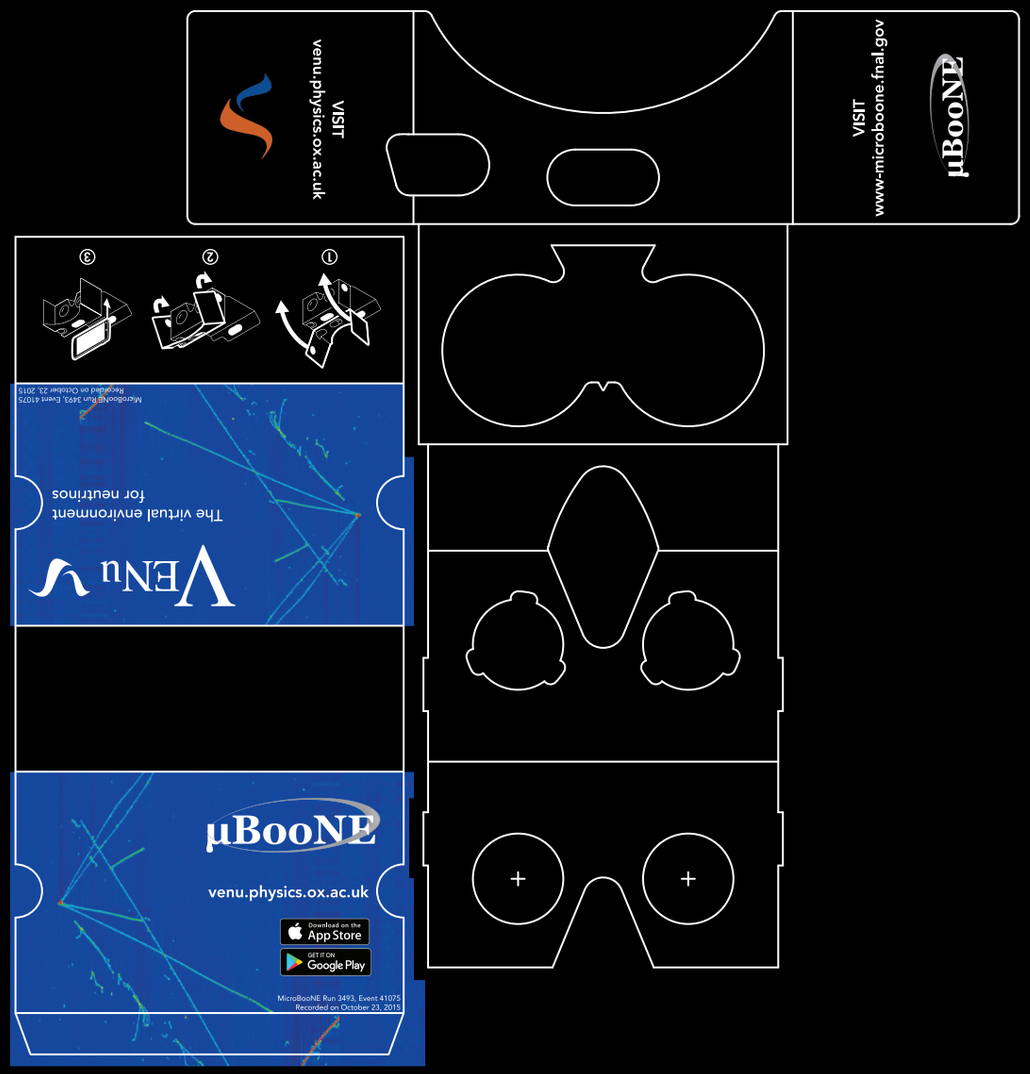
We designed custom
Google Cardboards



Credit: Wouter van de Pontseele

Credit: Wouter van de Pontseele

Stargazing, Oxford University, 28 January 2017

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Stargazing, Oxford University, 28 January 2017

Credit: Wouter van de Pontseele

Stargazing, Oxford University, 28 January 2017

Who was engaged?

VENu

Chicago Science Festival

When 20 May 2017

Where Chicago Merchandise Mart

Link http://www.illinoisscience.org/chiscifest2017/

Chicago Science Festival, 20 May 2017

Who was engaged?

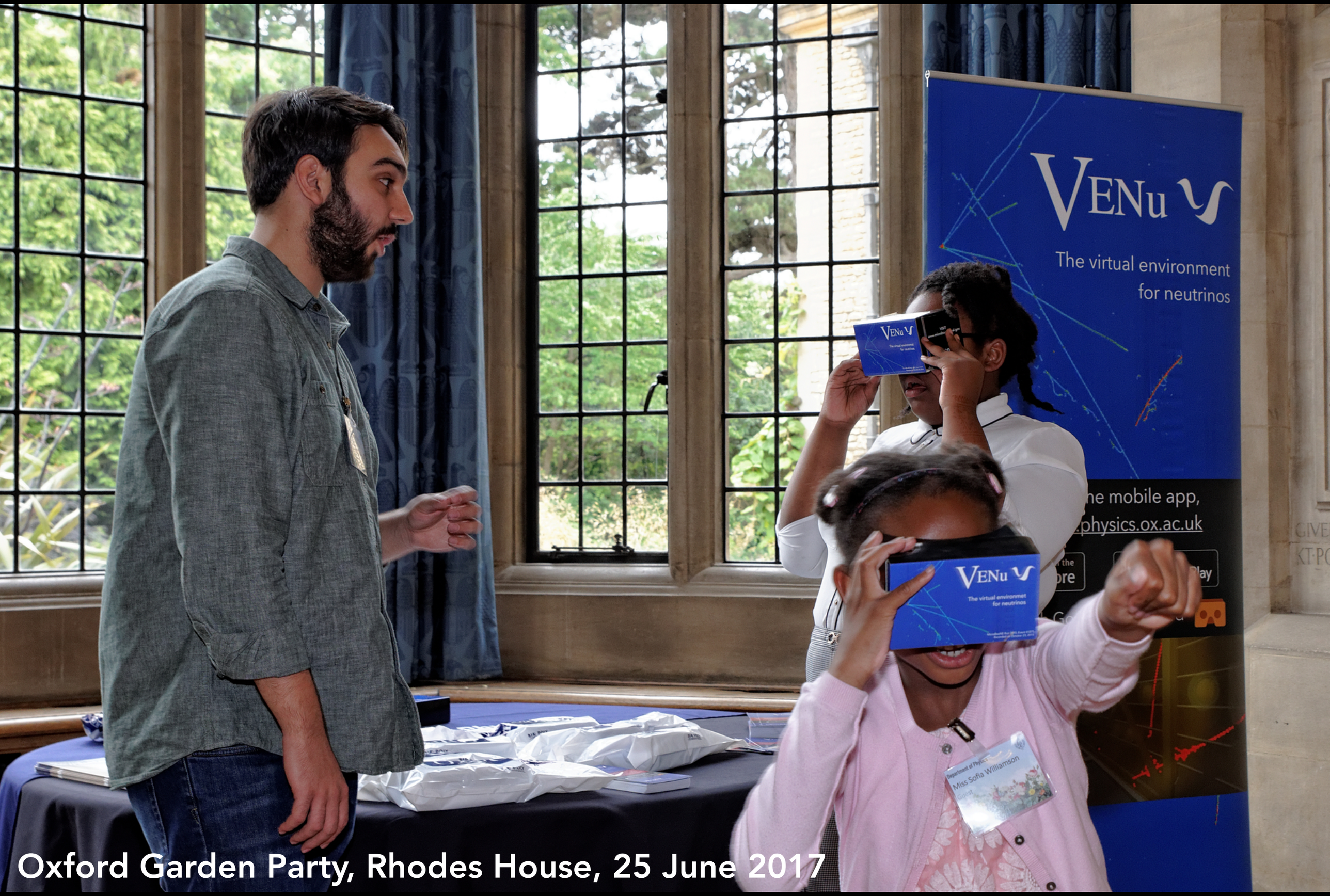
VENu

Oxford Garden Party

When 25 June 2017

Where Rhodes House, Oxford

Link physics.ox.ac.uk/events/2017/06/25/2017-physics-alumni-garden-party



Oxford Garden Party, Rhodes House, 25 June 2017

Credit: Junior Williamson

Future

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Add new features:

- 3D introductory video;
- allow users to perform simple analyses;
- stream live data;
- add other detectors (ICARUS, SBND, DUNE, …)

Conclusions

VENu

The app is available for free: venu.physics.ox.ac.uk

Download on the App Store

GET IT ON Google Play

Contact us: venu.developers@physics.ox.ac.uk

facebook.com/venuneutrinos

Team

VENu

MOBILE APP, CARDBOARD VERSION AND GAME

Marco Del Tutto University of Oxford

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SPECIAL THANKS TO

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Roxanne Guenette University of Oxford