Fermilab, Science, SMP
&
What's after SMP?

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www.phys.utk.edu/people/faculty/gollapinni.html

December 9, 2017

Thank you!

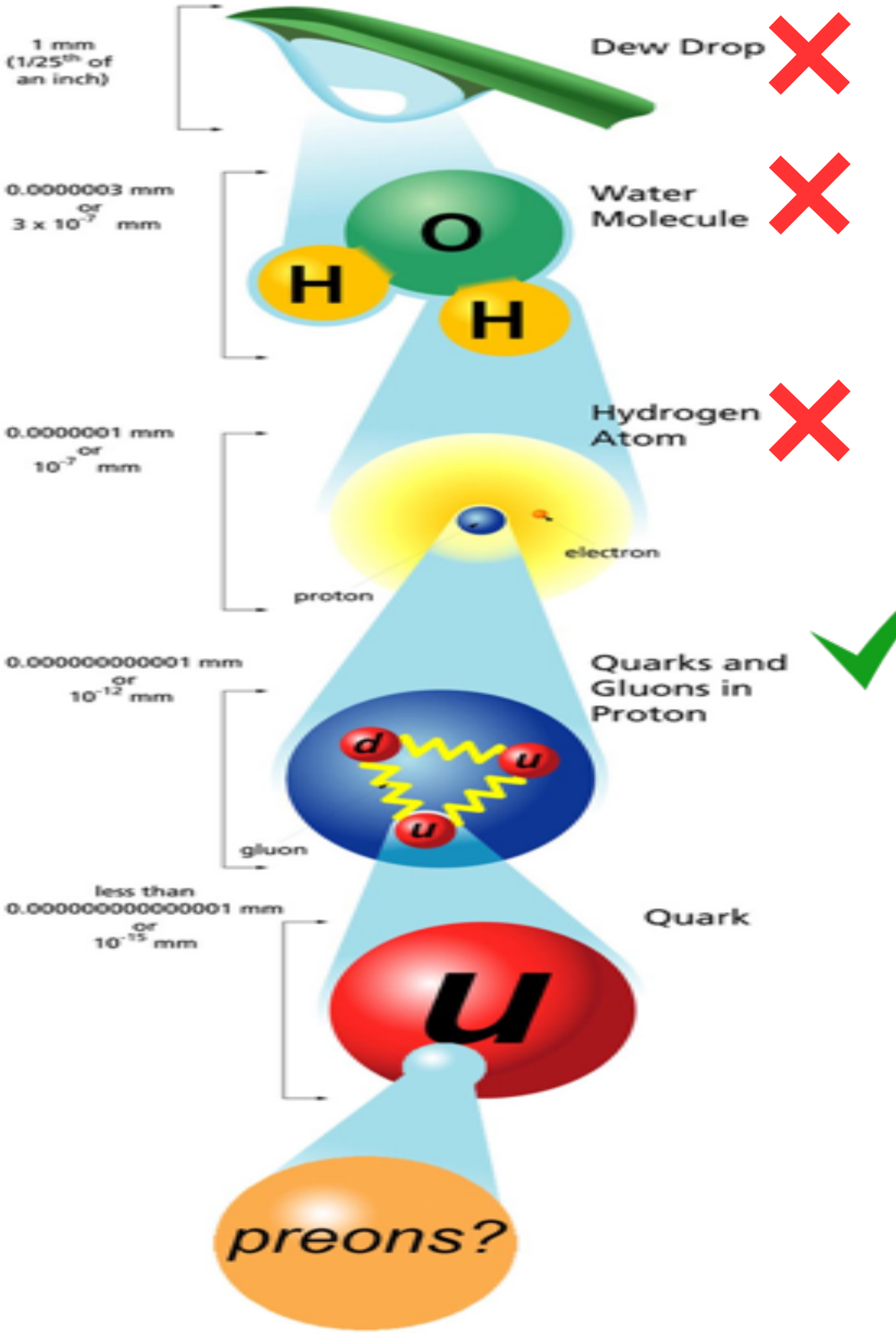
- Thank you for registering your child in SMP and helping them explore science and what we do at Fermilab!

- Congratulations to your graduating child! and we hope you consider enrolling their siblings in future SMP sessions

- We hope this has been an useful, informative and engaging experience for your child!

Did you get to see our bisons?

Fermilab & Science



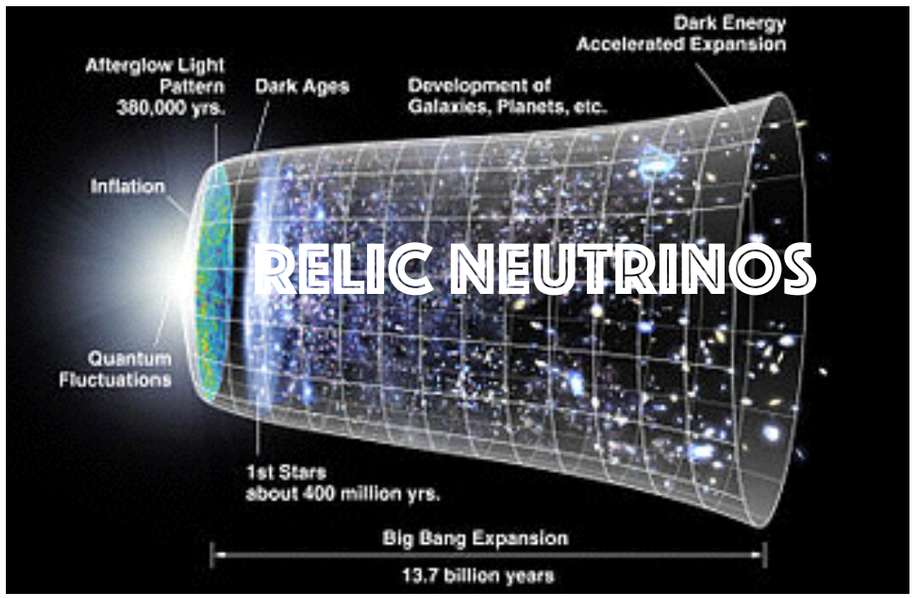
What is the world made of at the most fundamental level?

Somewhere here....

Tens of million or trillion times smaller than a dew drop

At Fermilab, we make our own particles and a big part of our research is studying about “neutrinos”

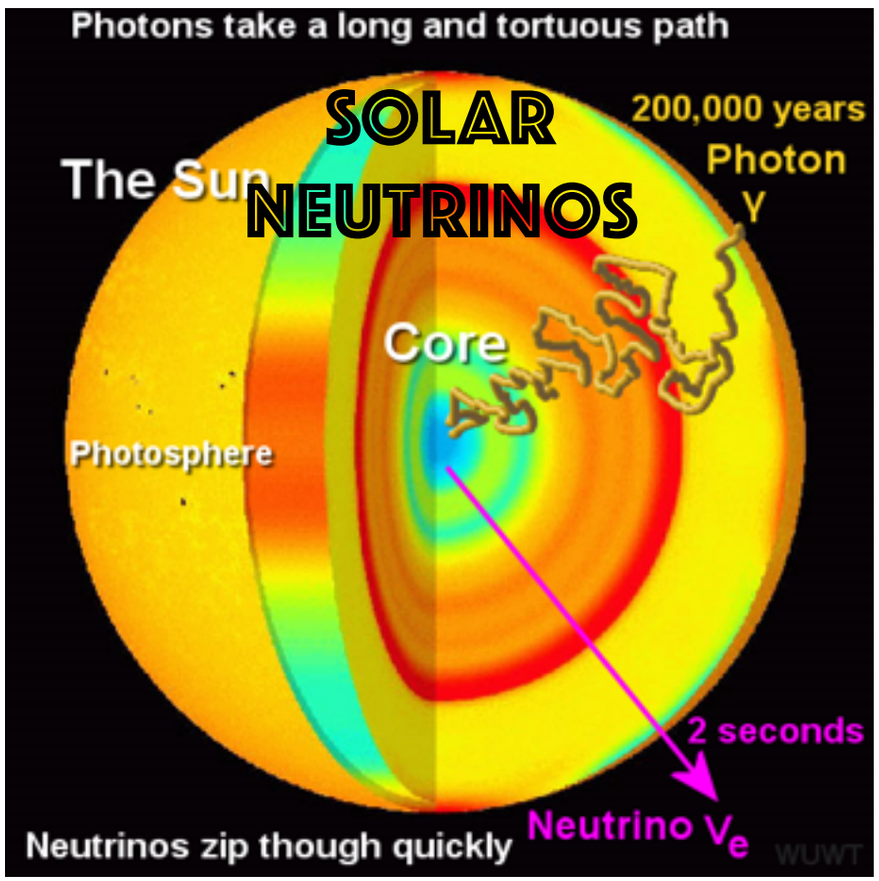
Good thing: Neutrinos are everywhere!

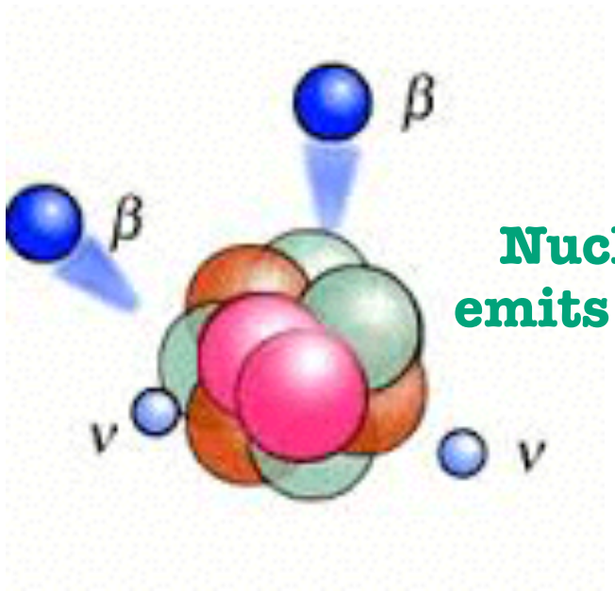


Neutrinos created during big bang are still floating around…trillions of them!

Neutrinos carry 99% of the supernovae explosion

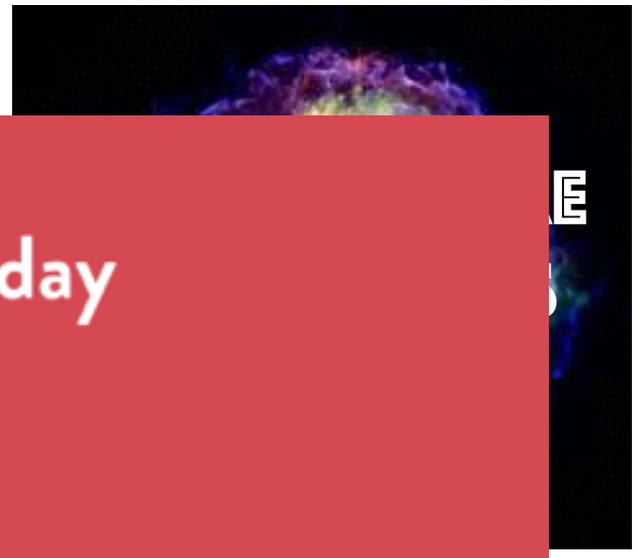
Every star produces a ton of neutrinos





Nucleus also emits neutrinos

Good thing: Neutrinos are everywhere!



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Nucleus also
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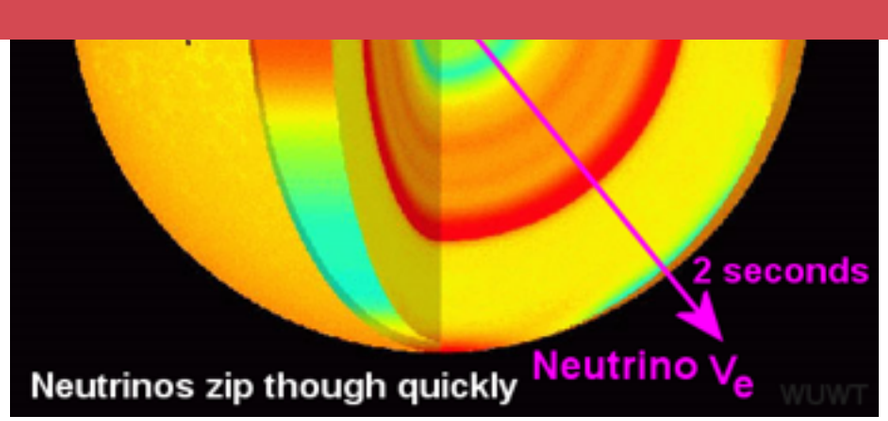


1 million neutrinos/day
per banana

Bad thing: Neutrinos are not very sociable

Two things to remember:

1. They are abundant and easy to produce in copious amounts
2. Neutrinos are very, very, very…very weakly interacting

GeV scale neutrinos can travel about 200 earths without interacting

1 MeV neutrino requires about 10 light years of lead to be stopped

(1 light year is about 6 trillion miles)

Bad thing: Neutrinos are not very sociable

Two things to remember:

1. They are abundant and easy to produce in copious amounts
2. Neutrinos are very, very, very…very weakly interacting

For Comparison,

- For a proton require 0.1 mm of lead to stop
- For an electron require 10 mm of lead to stop

1 MeV neutrino requires about 10 light year of lead to be stopped

(1 light year is about 6 trillion miles)

Bad thing: Neutrinos are not very sociable

Two things to remember:

1. They are abundant and easy to produce in copious amounts
2. Neutrinos are very, very, very…very weakly interacting

So, how in the world do you detect them?

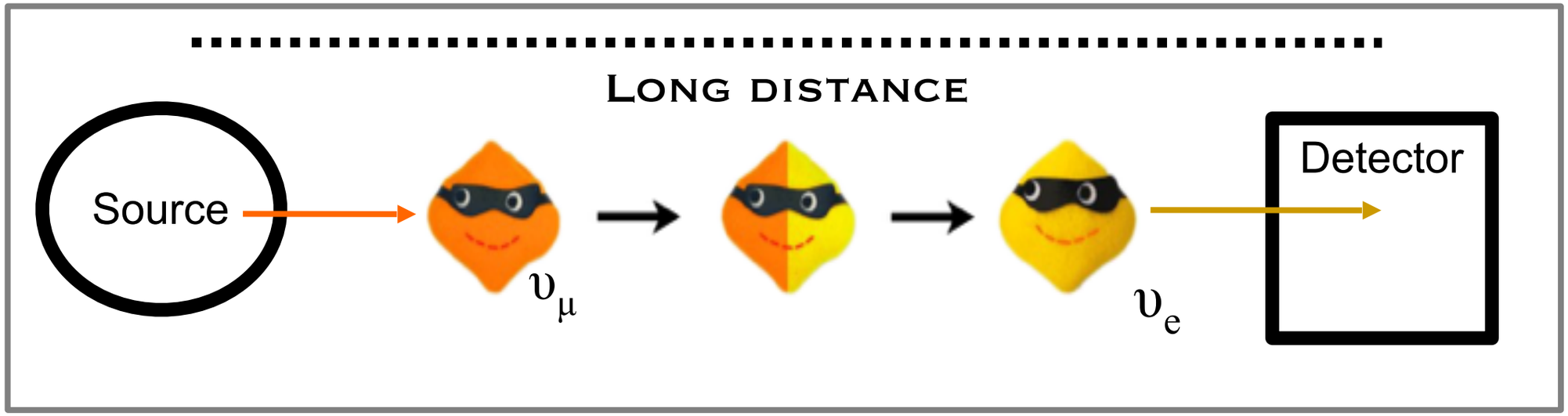
Bad thing: Neutrinos are not very sociable

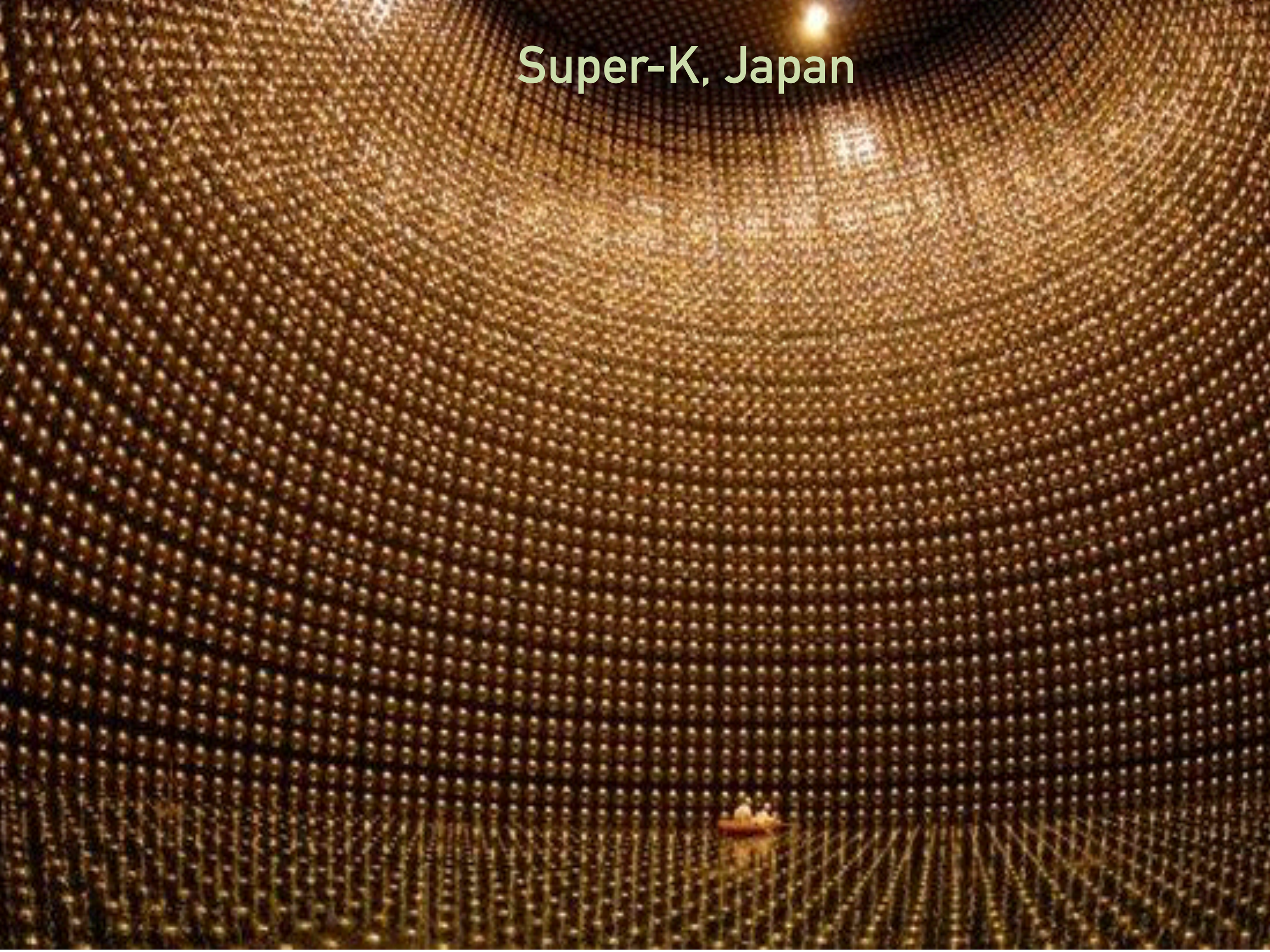
1. Produce them in large quantities in a well defined area

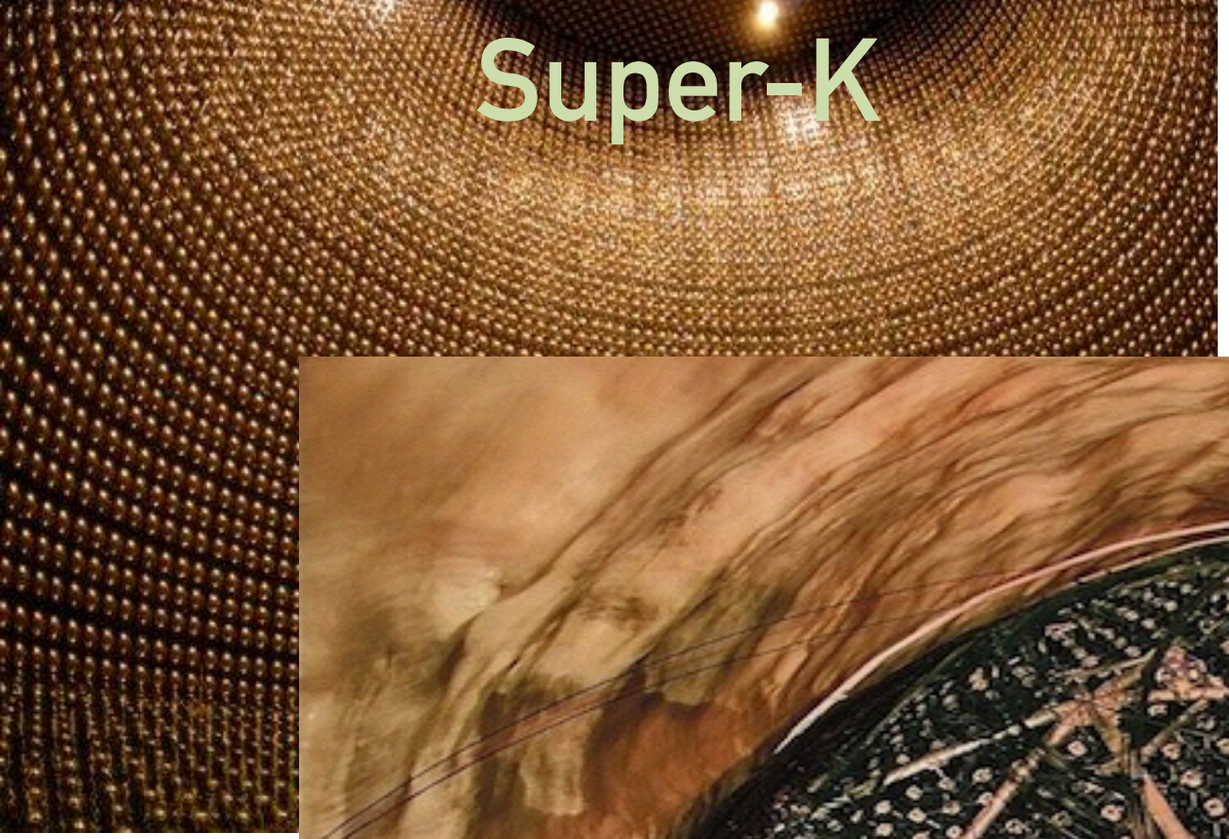
2. Put something very dense, very big and very sensitive for neutrinos to interact

Neutrinos can change flavors!

A neutrino created as one flavor can change into another flavor




Super-K, Japan


Super-K


SNO, Canada

Super-K

SNO

IceCube Laboratory

IceCube

50 m

Amundsen-Scott South Pole Station Antarctica

1450 m

2450 m

2820 m

bedrock

Digital Optical Module
DOM
86 strings
5160 optical sensors

Eiffel Tower 324 m

The Fermilab Neutrino Complex

Linac
Length: 150m
Proton Energy: 400 MeV

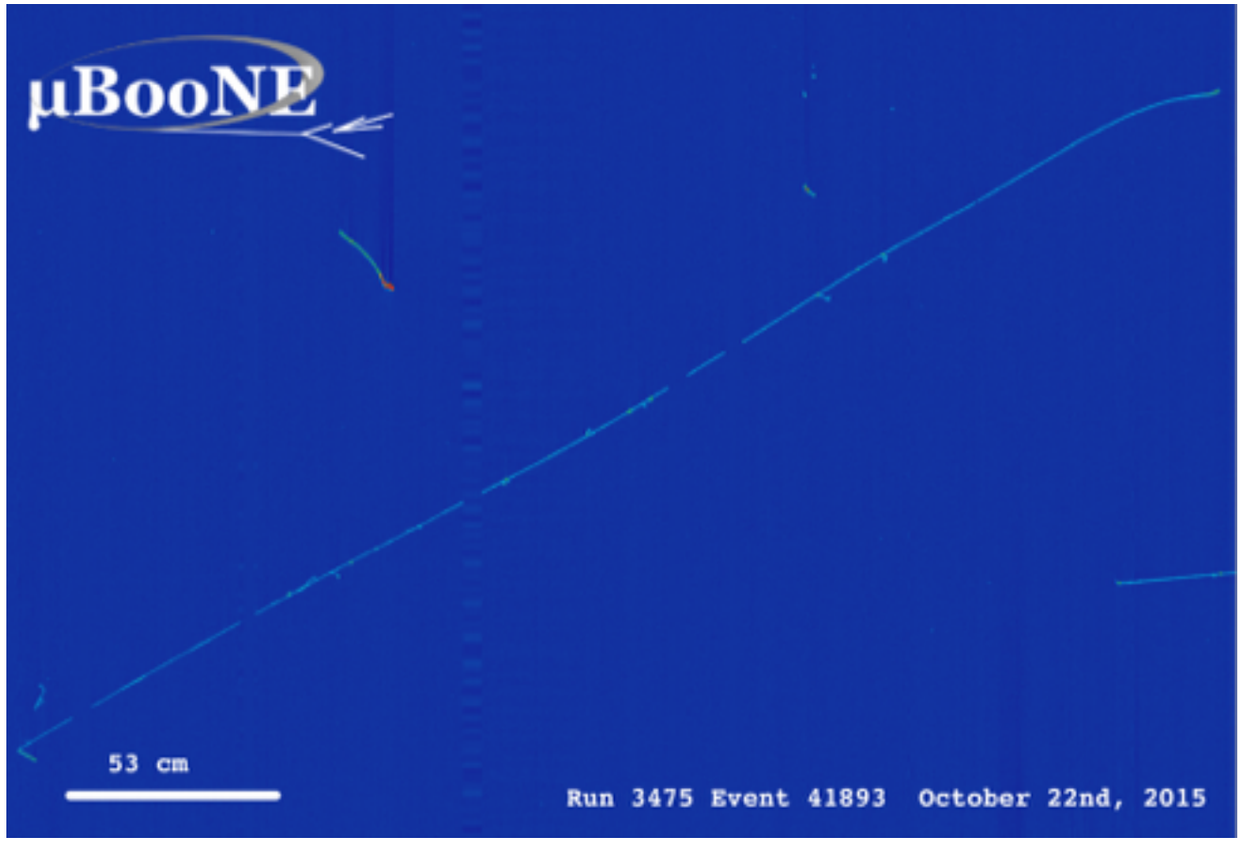
Booster (BNB)
Circumference: 468m
Proton Energy: 8 GeV

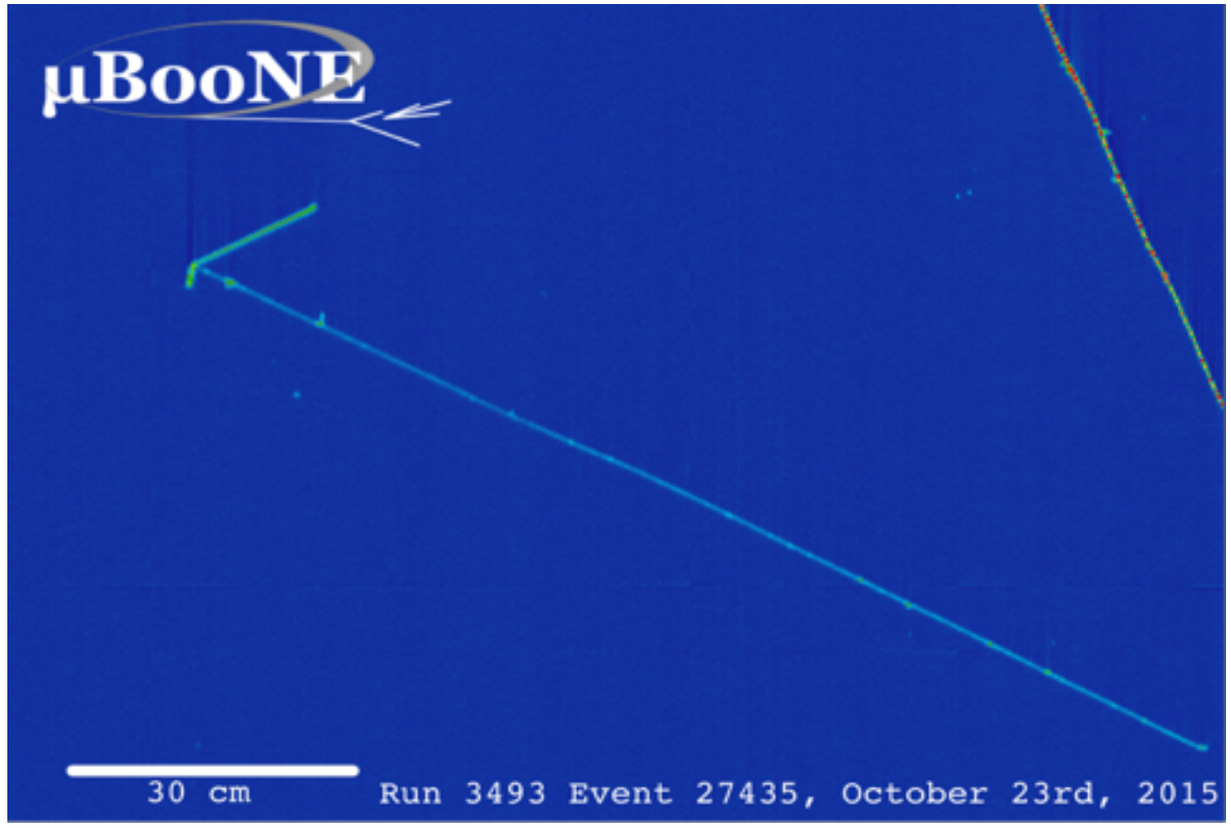
MicroBooNE
470m baseline

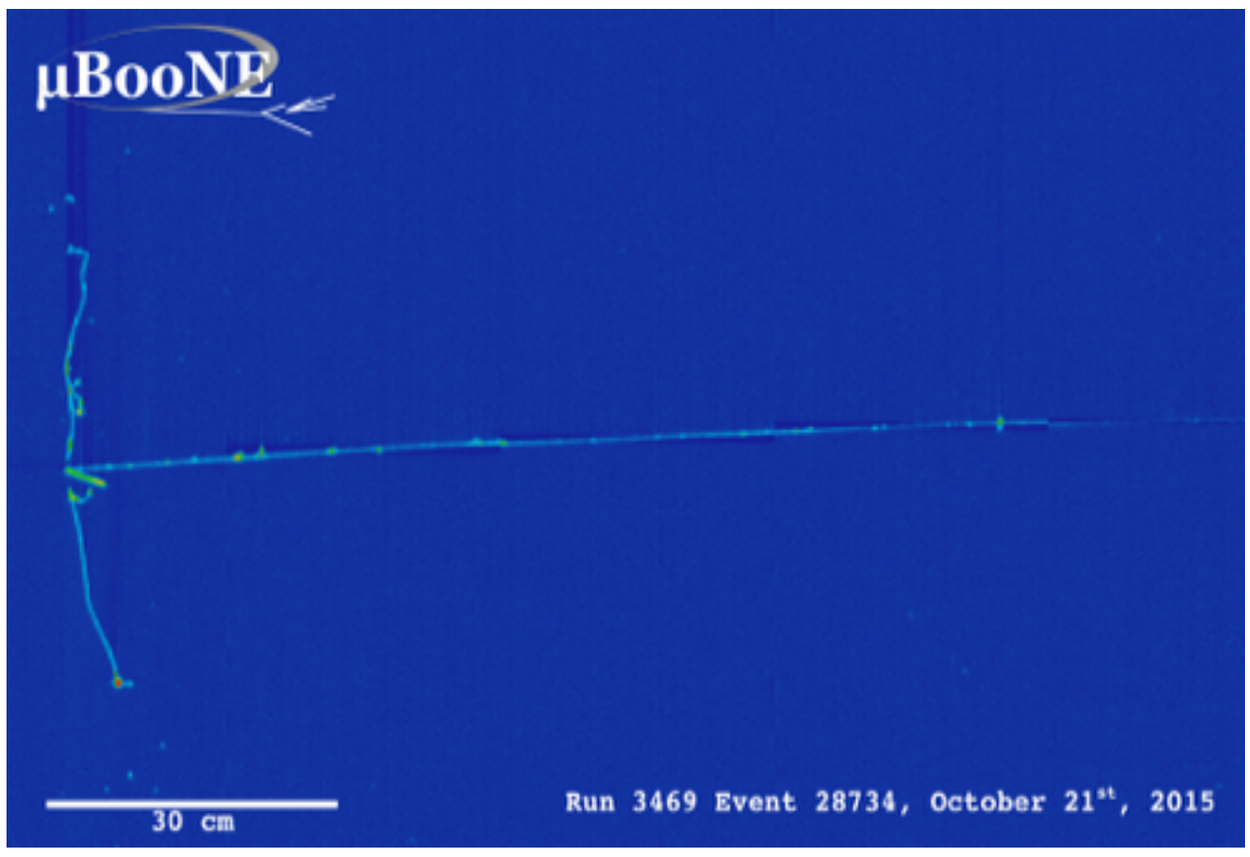
Main Injector (NuMi)
Circumference: 3.3km
Proton Energy: 120 GeV

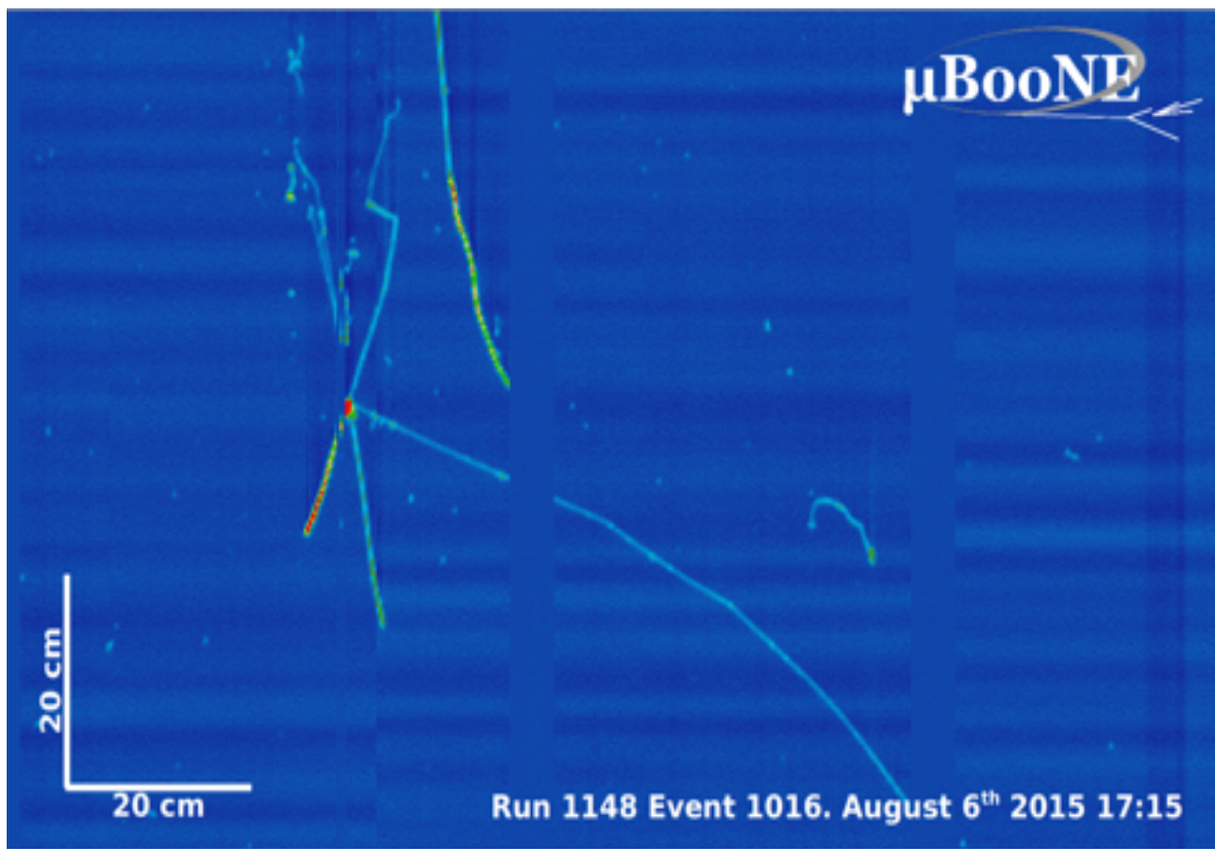
Fermilab produces two neutrino beams through this complex — only facility in the world that can do this!

Here is some valuable “mess” that neutrinos make when they pass through our detector



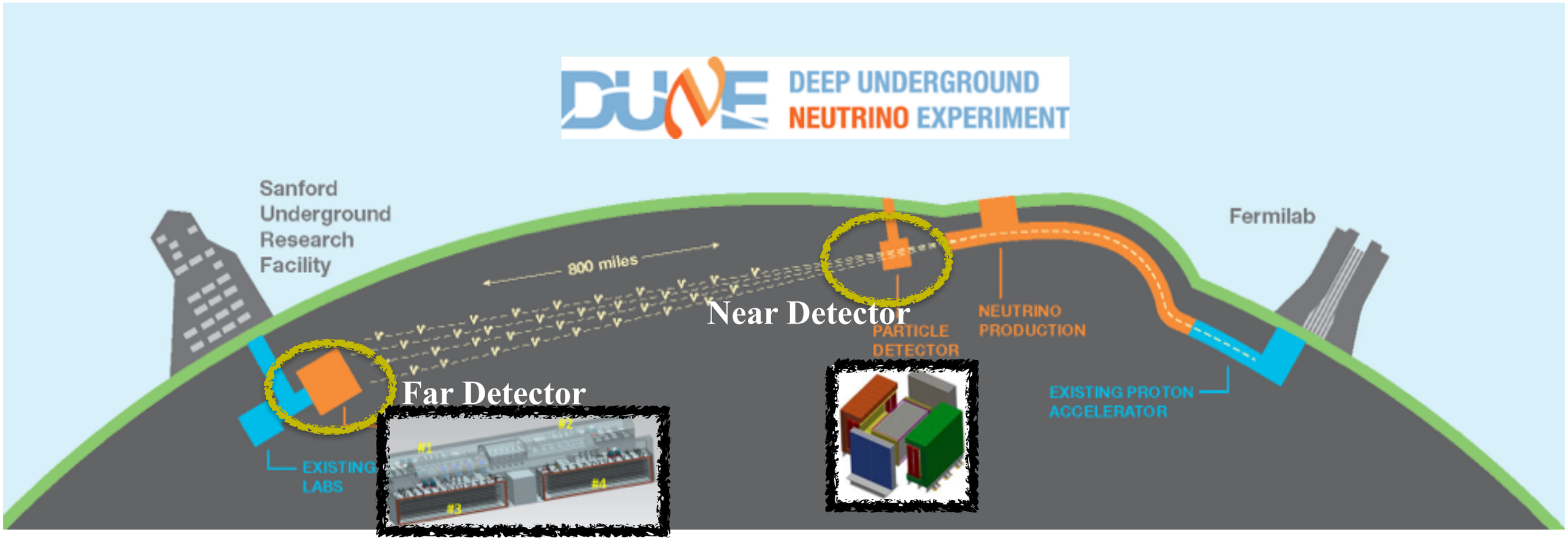






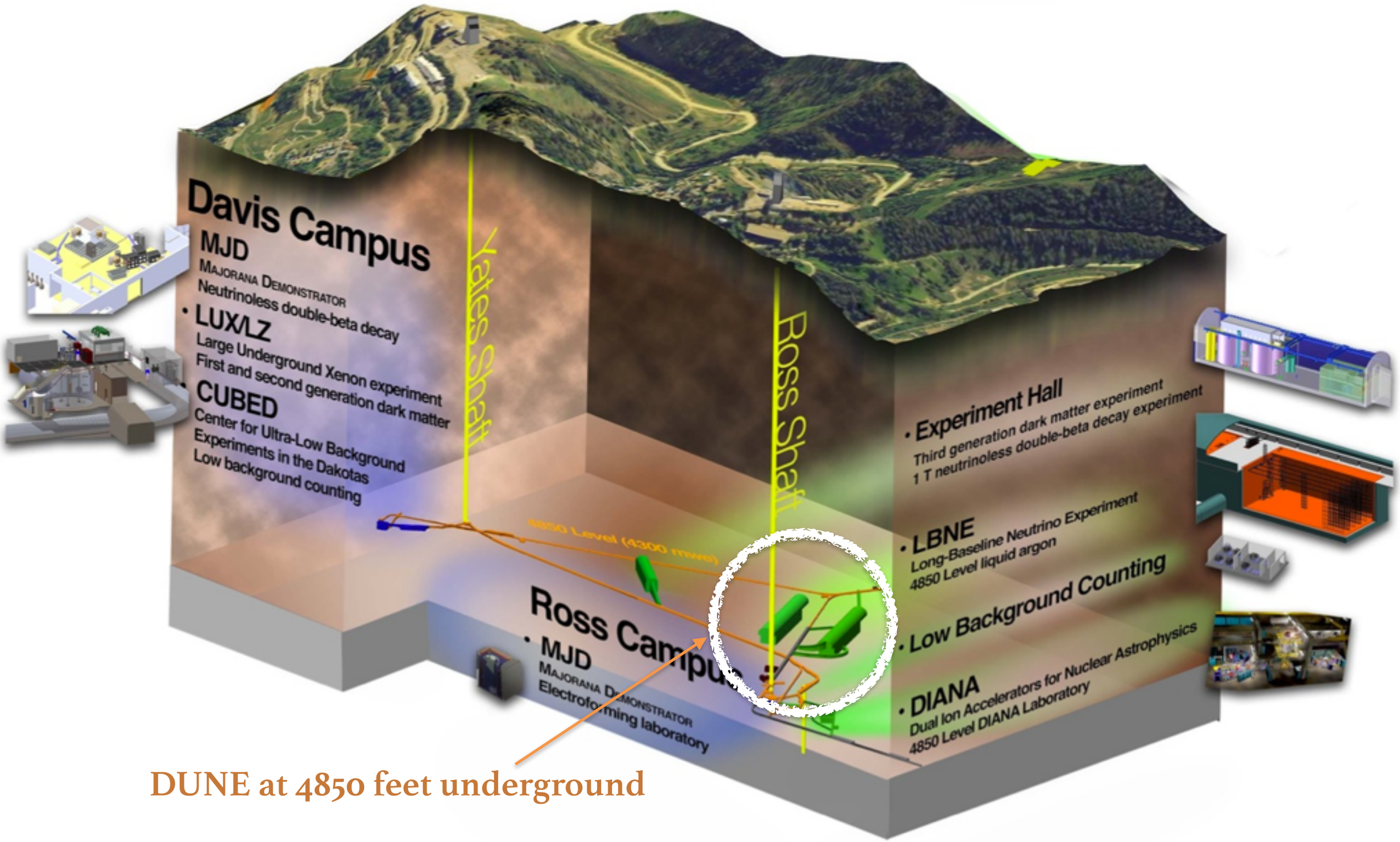
The Deep Underground Neutrino Experiment (DUNE)

- Neutrinos from Fermilab travel to South Dakota 800 miles underground
- Massive detector ~1 mile underground with more than 40 kilotons of active detector mass
- Uses liquid argon — an ultra cold liquid; Argon, a gas at room temperature, condenses to a liquid when cooled below -186°C (-303°F)



The DUNE Far Site

South Dakota Research Facility (SURF)



DUNE at 4850 feet underground

Fall 2017 SMP

Date	Topic (Click for Slides)	Speaker (Click for Photos)	Tours
Sept 23[1]	**Fermilab Open House** *(Registration is separate from SMP registration)*		
Sept 30	Introduction to Science at Fermilab	Dan Hooper University of Chicago	G1 & G3: Wilson Hall G2 & G4: Accelerator Division
Oct 7	Einstein and the Modern Physics Revolution	Elliott McCrory Fermilab Accelerator Division	G1 & G3: Accelerator Division G2 & G4: Wilson Hall
Oct 14	Particle Physics	Cecilia Gerber University of Illinois at Chicago	G1 – DZero[2] G2 – SiDET G3 – Neutrino G4 – GCC
Oct 21	Accelerators	Cindy Joe Fermilab Neutrino Division	G1 – SRF G2 – Neutrino G3 – GCC G4 – DZero[2]
Oct 28	Cosmology	Brian Nord Fermilab Particle Physics Division	G1 – Magnets G2 – GCC G3 – DZero[2] G4 – SRF
Nov 4	Neutrinos	Leo Aliaga Fermilab Scientific Computing Division	G1 – SiDET G2 – DZero[2] G3 – SRF G4 – Magnets
Nov 11 Location: IARC	Detectors: Seeing the invisible	Angela Fava Fermilab Neutrino Division	G1 – Neutrino G2 – SRF G3 – Magnets G4 – SiDET
Nov 18[1]	Introducción a la ciencia en Fermilab[3]	Marcela Carena Física el sábado por la mañana Fermilab división de física de partículas	Accelerator Division or Wilson Hall
Nov 25		*Thanksgiving Break*	
Dec 2	Energy and Climate	Erik Ramberg Fermilab Particle Physics Division	G1 – GCC G2 – Magnets G3 – SiDET G4 – Neutrino
Dec 9	Physics and society	Pushpa Bhat Fermilab Director's Office	No tours: Graduation Ceremony

Fall 2017 SMP

- A multitude of topics introduced along with tours to Fermi experiments and research areas
- Many fundamental changes to the program to modernize and improve engagement for students
- Buses provided for onsite tours

What did we do new this time?

- More interaction and engagement during the two-hour lecture

  - Interactive teaching tools: Clickers and Flash cards to respond to multiple choice questions and to trigger two-way discussion

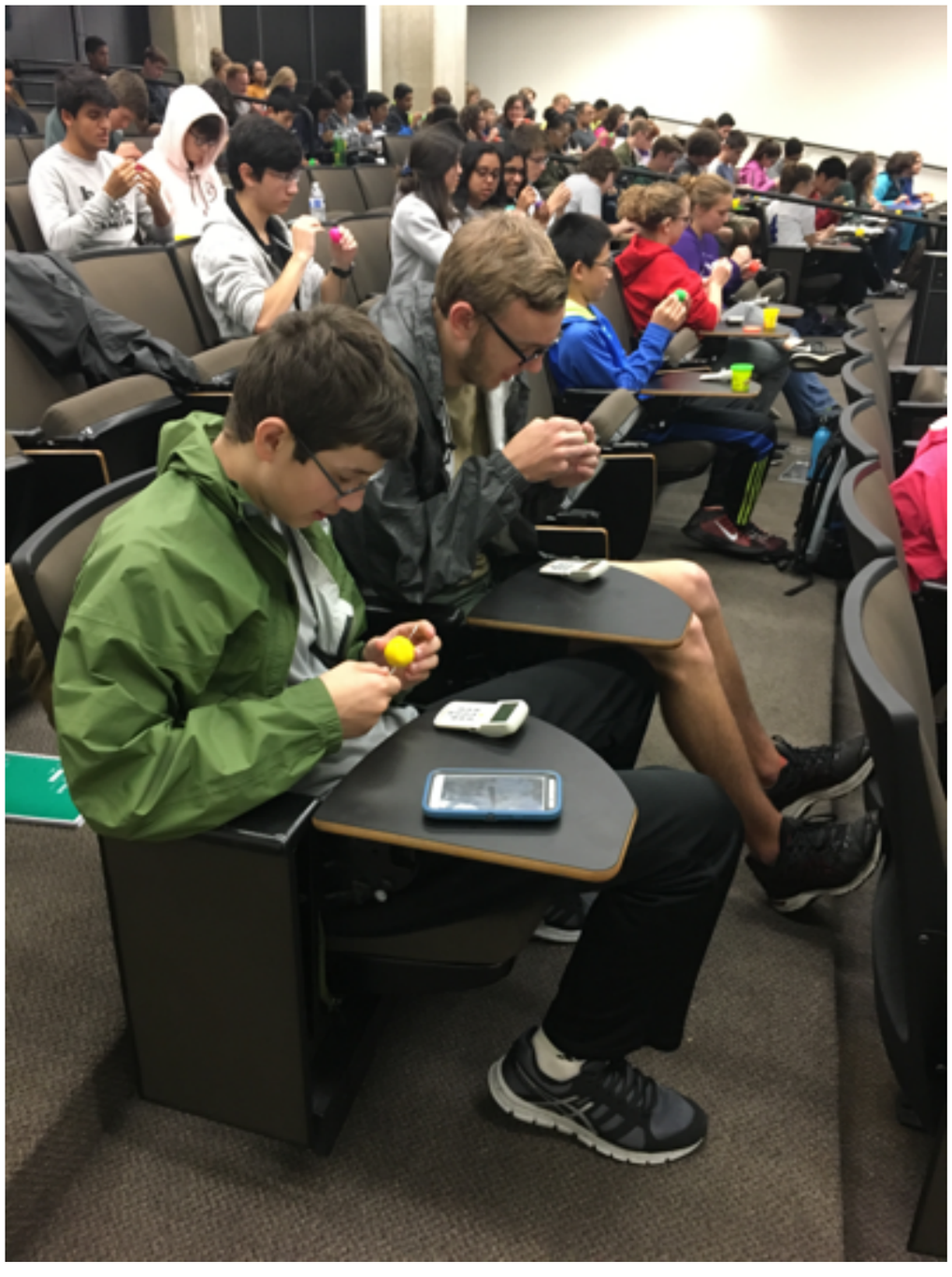
  - training lecturers with teaching techniques to motivate students to ask questions

  - More Eyes-on and Show-And-Tell activities

  - Hands-on activities

Show-And-Tell and live demos of how accelerators work — Cindy Joe

understanding how structure of atom (Rutherford scattering) using play-doh balls, pins and screws — Cecilia Gerber



Show-And-Tell and live demos of how accelerators work — Cindy Joe

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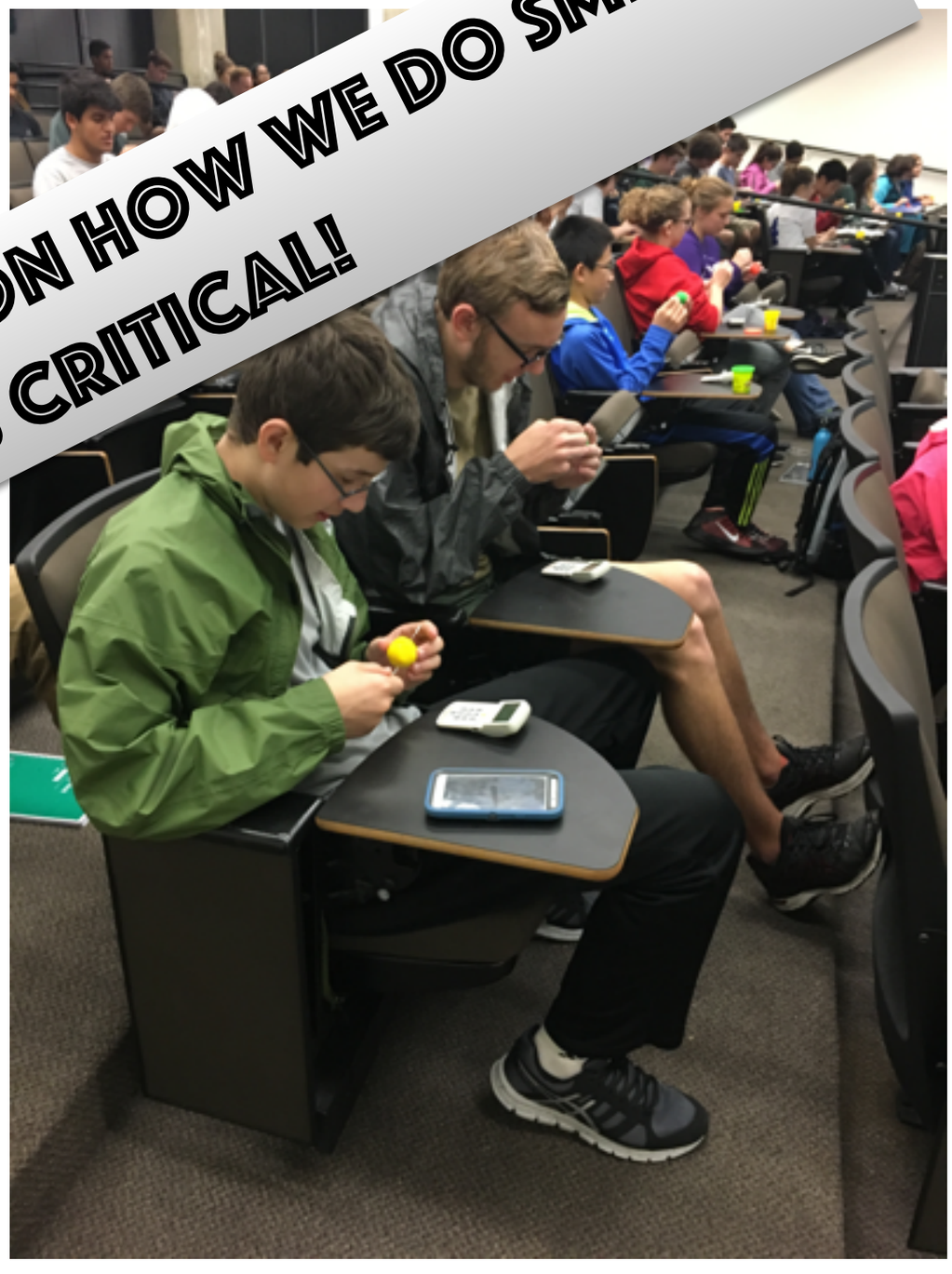


WE ARE CONTINUING TO IMPROVE ON HOW WE DO SMP AND YOUR FEEDBACK IS CRITICAL!

Feedback/Criticism on SMP Fall 2017?

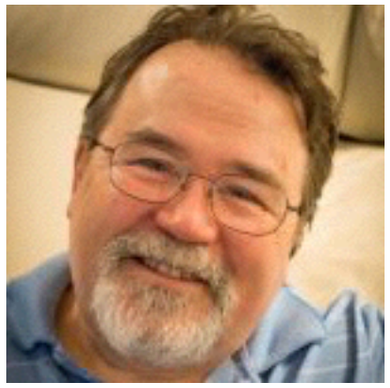
(Feel free to throw tomatoes)

The SMP team

http://saturdaymorningphysics.fnal.gov/about-us/

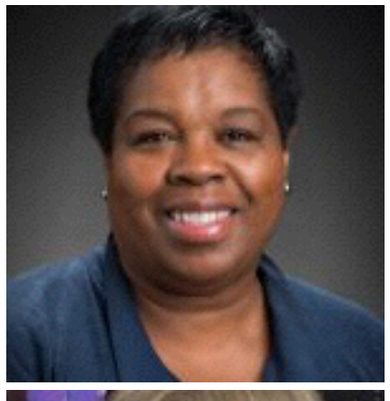
Sowjanya Gollapinni Elliott McCrory

Co-chairs of SMP

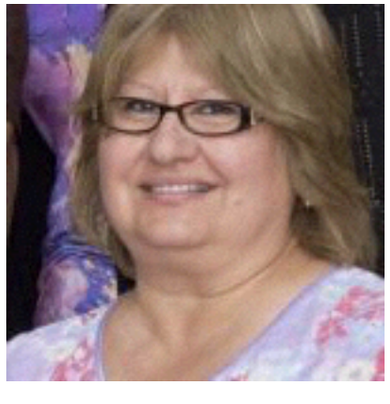


Robert Bernstein
Senior Advisor

Sandra Charles
Program Manager



Rosa Foote
Administrative support



SMP Onsite Coordinators

Ting Li

Adam Anderson

Javier Duarte

Minerba Betancourt

Kirsty Duffy

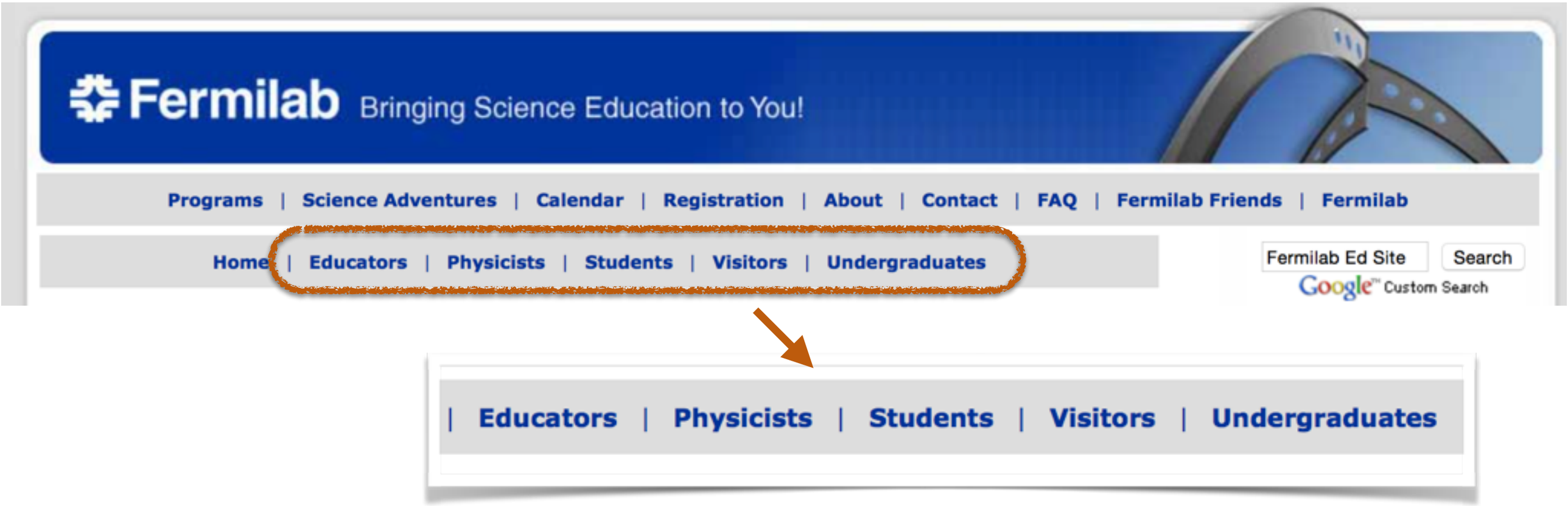
What’s after SMP?

both for your graduating SMP child and their siblings :)

Keep them Engaged

Many ways to do it!

http://ed.fnal.gov



- Not just Fermilab — Illinois is rich with laboratories and educational institutes; Chicago area is also rich in opportunities/resources

- Look at Argonne National Lab (ANL), UC, UIC, NIU, IIT etc. — every place has their own education/outreach efforts

Keep them engaged

http://ed.fnal.gov//home/students.shtml

Classes

Science Adventures
(K-8)

Fermilab Junior Prairie Rangers
(4-6)

Sat. Morning Physics
(9-12)

ASK-A-SCIENTIST
(http://ed.fnal.gov/programs/tours/ask-a-scientist.shtml)

Special Events

Fermilab Outdoor Family Fair
(K-12)

Wonders of Science
(2-7)

Family Open House
(3-12)

STEM Career Expo
(9-12)

Keep them engaged

http://ed.fnal.gov//home/students.shtml

More Opportunities

Science Center's Hands-on Exhibits
(4-8)

Scout Programs
(4-12)

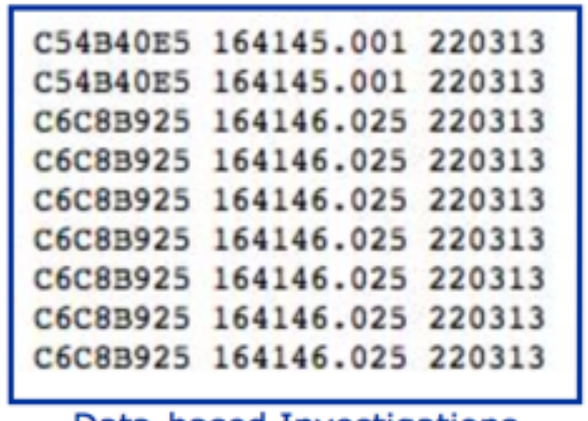
QuarkNet Summer Research
(9-12)

Student Tours
(5-12)

Activies/Games

Fermilabyrinth
(6-12)

Decam Interactive
(6-12)



Data-based Investigations
(9-12)

Higgs Game
(9-12)

QuarkNet Internships

(Summer research program)

- http://ed.fnal.gov/interns/programs/quarknet/index.shtml

- Eligibility: High School Students in 10-12th grade when applying. Must live in Fermilab area; U.S. Citizenship or permanent resident status required;

- 6 week internship program; students work with scientists on Fermilab research programs

Applications open
March 1, 2018

TARGET Internships

- http://diversity.fnal.gov/target/
- **Eligibility:** High School Students in 10-11th grade in Illinois when applying. Proof of evidence to work in U.S. required;
- 6 week (June 25 to Aug. 3) paid internship program; students work with scientists on Fermilab research programs
- The program goals are to encourage students to undertake college study and pursue careers in STEM

Application period	December 18, 2017 – February 21, 2018
Interview invitation – Email	**March 15, 2018**
Interviews	April 9, 2018 (Chicago) April 10, 2018 (Batavia)
Internship Offer – Email	May 3, 2018

Aims to increase the representation of underrepresented minorities and women in STEM fields

Undergraduate Internships

http://ed.fnal.gov/interns/programs/

CCI - Community College Internships

For community college students.

Helen Edwards Summer Internship (formerly PARTI)

For physics & engineering majors in European countries.

Lee Teng Undergraduate Internship

For juniors and exceptional sophomores in physics or engineering at U.S. institutions.

SIST - Summer Internships in Science and Technology

For under-represented minorities majoring in STEM fields at 4-year U.S. colleges.

SULI - Science Undergraduate Laboratory Internship

For U.S. citizens or Permanent Resident Aliens in physics or engineering.

VetTech Internship Program

For military veterans to intern as a technician to provide routine technical support for an experiment or group.

Fermilab Cooperative Education Program (Co-Op Program)

http://diversity.fnal.gov/coop/

- A longer-term STEM engagement/education program
- Students typically work a minimum of 3 semesters or 4 quarters at Fermilab, alternating periods of full-time study at their institution with full-time employment at the laboratory
- **Eligibility:** Full time undergraduate enrollment in a 4-year program of study at a U.S. college or University for the duration of appointment; Academic standing as a sophomore with a GPA of 3.0 or 4.0; 18 years of age at time of appointment

We encourage applications from students majoring in:

- Mechanical engineering
- Electrical and electronic engineering
- Computer science and Engineering
- Environment, safety and health
- Finance and accounting
- Project management
- Human resources
- Communications

Key Dates for all Internships

http://ed.fnal.gov/interns/key-dates/

Program	Applications Open	Application Deadline	Program Dates
CCI	October 16, 2017	**January 12, 2018**	June 4–August 10, 2018
GEM	TBA	**TBA**	Summer 2017
Helen Edwards Summer Internship	October 30, 2017	**January 8, 2018**	June 25–August 31, 2018
Italian Student Program	TBA	**TBA**	TBA
Lee Teng	November 2017	**January 22, 2018**	May 29–August 10, 2018
SIST	TBA	**TBA**	May 21–August 10, 2018
SULI	October 16, 2017	**January 12, 2018**	June 4–August 10, 2018
TARGET	TBA	**TBA**	June 25–August 3, 2018
TRAC	December 11, 2017	**February 18, 2018**	Eight-week period in summer 2018
VFP	October 16, 2017	**January 12, 2018**	June 4–August 10, 2018

Closing thoughts

- Science is about society and people
- A science literate population benefits everyone; More than anything it promotes critical thinking
- Science education is also about social justice; opportunities for everyone regardless of our differences
- Science and scientific method is about objectivity; Following that in our day-today life will help rid society of biases
- SMP is not just about Fermilab but about science and promoting science literacy from young age — thank you for enrolling your children in our program

Questions/comments/
suggestions/criticisms?