Fist Observation of Coherent Elastic Neutrino-Nucleus Scattering (CEvNS)

Yuri Efremenko,
ORNL/UTK
August 20, 217

Current Eleatic Neutrino Nucleus Scattering CEvNS

$$\frac{d\sigma}{dT_A} = \frac{G_F^2}{4\pi} m_A \left[Z\left(1 - 4\sin^2\theta_W\right) - N \right]^2 \left[1 - m_A \frac{T_A}{2E_\nu^2} \right] F^2(Q^2)$$

$$\sigma_{tot} = \frac{G_F^2 E_\nu^2}{4\pi} \left[Z\left(1 - 4\sin^2\theta_W\right) - N \right]^2 F^2(Q^2)$$

m_A – nucleus mass

T_A – kinetic energy of recoil nucleus

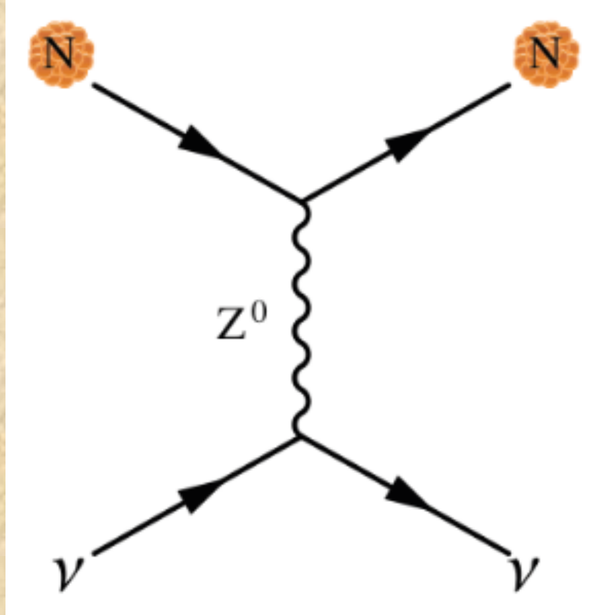
E_ν – neutrino energy

Z – nucleus charge

N – number of neutrons in the nucleus

F is nucleus form factor

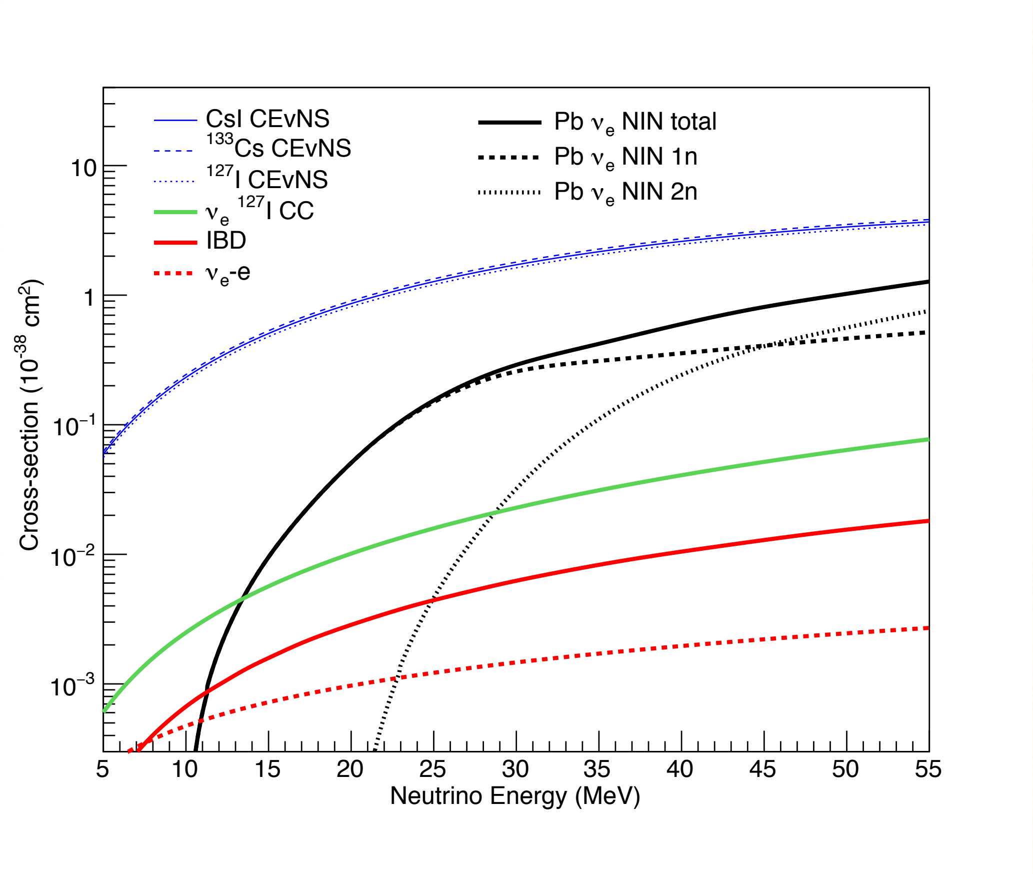
$$E_\nu < 50 MeV$$



D.Z. Freedman PRD 9 (1974)
A. Drukier & L. Stodolsky, PRD 30, 2295 (1984)
Horowitz et al. astro-ph/0302071

Predicted 43 years ago!!!)

CEvNS cross section is Large



Cross section for CEvNS is predicted exactly, so any deviations will tell us about new physics outside of the SM

For experimentalists it is very attractive to see something new, which never been detected before

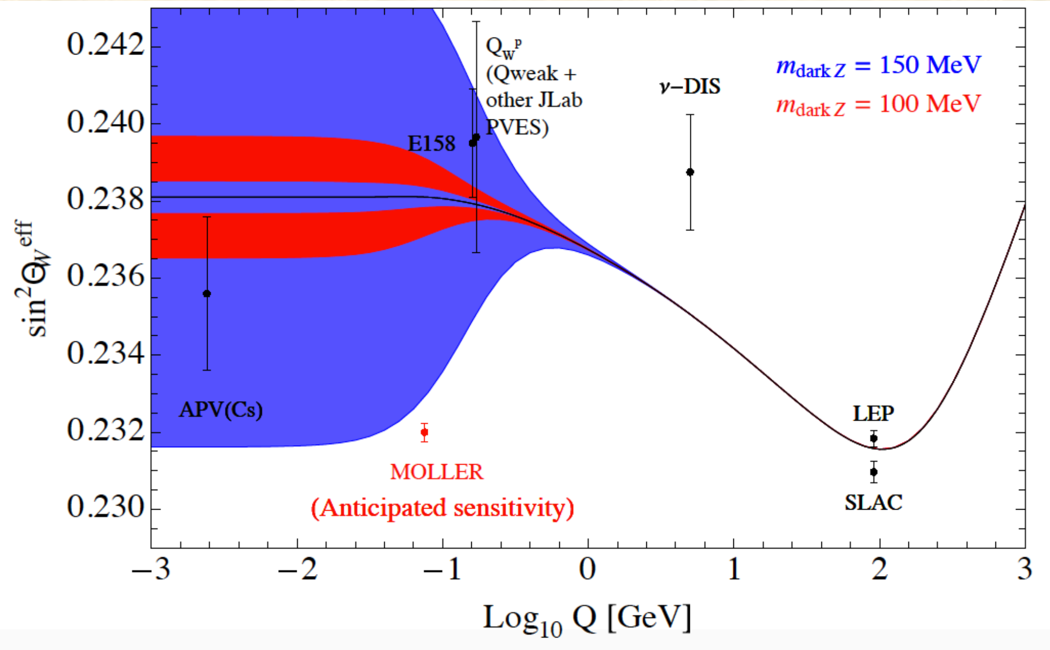
Why CEvNS are interesting?
Weinberg (Electro week) angle

$$\begin{pmatrix} \gamma \\ Z^0 \end{pmatrix} = \begin{pmatrix} \cos\theta_W & \sin\theta_W \\ -\sin\theta_W & \cos\theta_W \end{pmatrix} \begin{pmatrix} B^0 \\ W^0 \end{pmatrix}$$

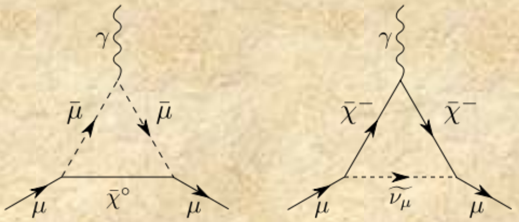
$$\sigma_{tot} = \frac{G_F^2 E_\nu^2}{4\pi}\left[Z\left(1-4\sin^2\theta_W\right)-N\right]^2 F^2(Q^2)$$

Measurements with targets having different Z/N ratio are required.

$Sun^2\theta_w$ is a free parameter in the Standard Model
There is no fundamental theory which explain its value
It is "running" constant, its value depends on the momentum transfer.



Correction to g-2 for muon magnetic moment due to a light mediator



If this is correct it can manifest itself in θ_w value at low Q^2

Why CEvNS are interesting?
Non-Standard Interactions of Neutrinos

new interaction specific to ν's

$$\mathcal{L}_{\nu H}^{NSI} = -\frac{G_F}{\sqrt{2}} \sum_{\substack{q=u,d \\ \alpha,\beta=e,\mu,\tau}} [\bar{\nu}_\alpha \gamma^\mu (1-\gamma^5)\nu_\beta] \times (\varepsilon_{\alpha\beta}^{qL}[\bar{q}\gamma_\mu(1-\gamma^5)q] + \varepsilon_{\alpha\beta}^{qR}[\bar{q}\gamma_\mu(1+\gamma^5)q])$$

J. High Energy Phys. 03(2003) 011

TABLE I. Constraints on NSI parameters, from Ref. [35].

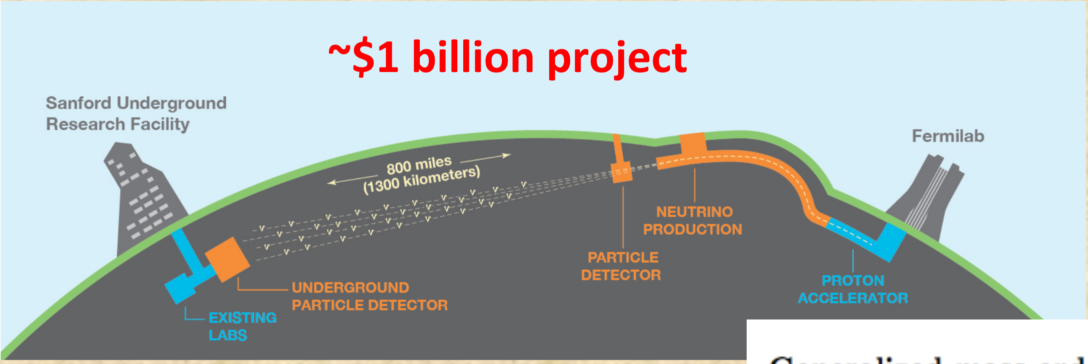
NSI parameter limit	Source
$-1 < \varepsilon_{ee}^{uL} < 0.3$	CHARM $\nu_e N$, $\bar{\nu}_e N$ scattering
$-0.4 < \varepsilon_{ee}^{uR} < 0.7$	
$-0.3 < \varepsilon_{ee}^{dL} < 0.3$	CHARM $\nu_e N$, $\bar{\nu}_e N$ scattering
$-0.6 < \varepsilon_{ee}^{dR} < 0.5$	
$\|\varepsilon_{\mu\mu}^{uL}\| < 0.003$	NuTeV νN, $\bar{\nu} N$ scattering
$-0.008 < \varepsilon_{\mu\mu}^{uR} < 0.003$	
$\|\varepsilon_{\mu\mu}^{dL}\| < 0.003$	NuTeV νN, $\bar{\nu} N$ scattering
$-0.008 < \varepsilon_{\mu\mu}^{dR} < 0.015$	
$\|\varepsilon_{e\mu}^{uP}\| < 7.7 \times 10^{-4}$	$\mu \to e$ conversion on nuclei
$\|\varepsilon_{e\mu}^{dP}\| < 7.7 \times 10^{-4}$	$\mu \to e$ conversion on nuclei
$\|\varepsilon_{e\tau}^{uP}\| < 0.5$	CHARM $\nu_e N$, $\bar{\nu}_e N$ scattering
$\|\varepsilon_{e\tau}^{dP}\| < 0.5$	CHARM $\nu_e N$, $\bar{\nu}_e N$ scattering
$\|\varepsilon_{\mu\tau}^{uP}\| < 0.05$	NuTeV νN, $\bar{\nu} N$ scattering
$\|\varepsilon_{\mu\tau}^{dP}\| < 0.05$	NuTeV νN, $\bar{\nu} N$ scattering

Non-Standard ν Interactions (Supersummetry, neutrino mass models) can impact the cross-section differently for different nuclei

K. Scholberg, Phys.Rev.D73:033005, 2006

Why CEvNS are interesting? DUNE degeneracy I

~$1 billion project



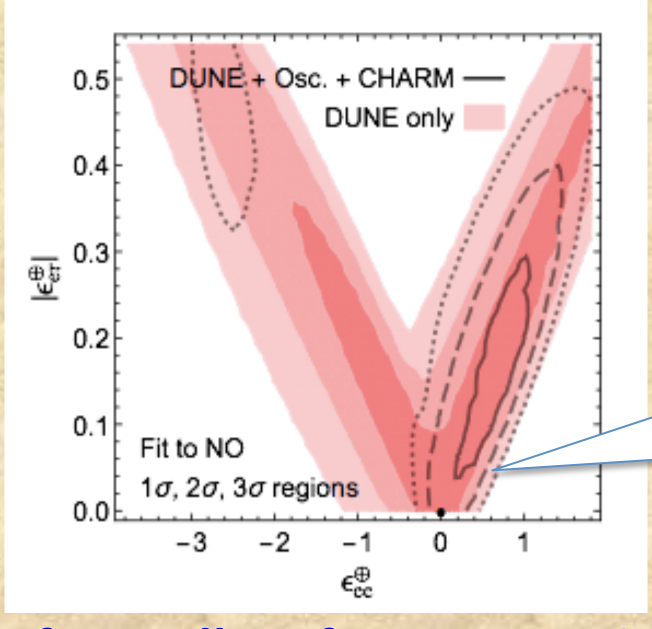
– measuring the charge-parity (CP) violating phase CP,

– determining the neutrino mass ordering (the sign of Δm^2_{12})

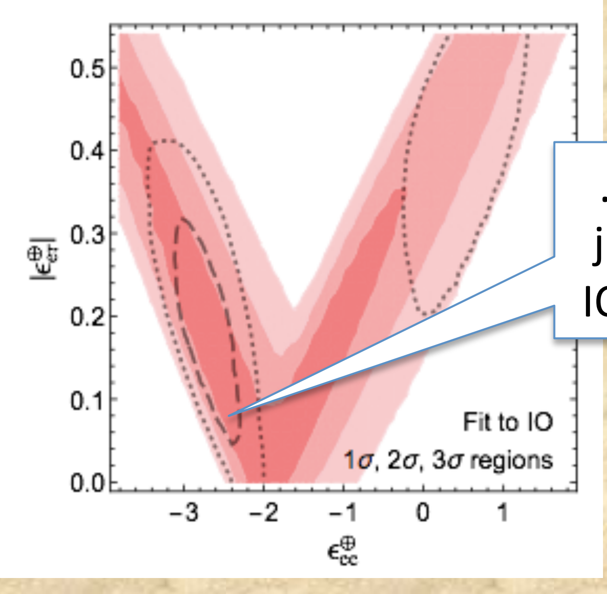
– precision tests of the three-flavor neutrino oscillation paradigm

Generalized mass ordering degeneracy in neutrino oscillation experiments

Pilar Coloma[1] and Thomas Schwetz[2] arXiv:1604.05772v1



NO w/no NSI...



...looks just like IO w/NSI

If you allow for NSI to exist, degeneracy is appears.

We can not tell the neutrino mass ordering without constrains on NSI

Why CEvNS are interesting?
Interest from Neutrino Oscillations

arXiv.org > hep-ph > arXiv:1701.04828

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High Energy Physics – Phenomenology

Curtailing the Dark Side in Non-Standard Neutrino Interactions

Pilar Coloma, Peter B. Denton, M. C. Gonzalez-Garcia, Michele Maltoni, Thomas Schwetz

(Submitted on 17 Jan 2017)

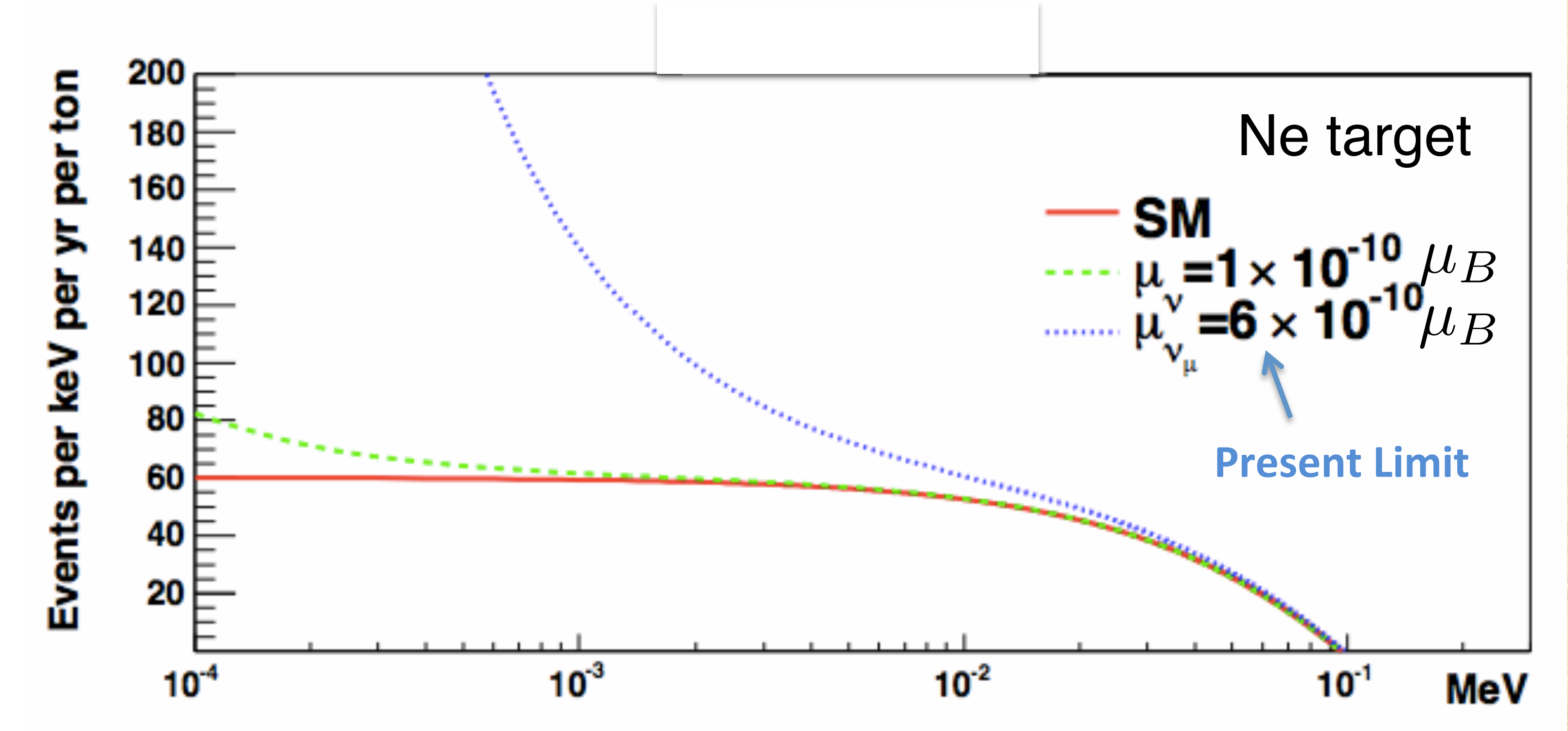
In presence of non-standard neutrino interactions the neutrino flavor evolution equation is affected by a degeneracy which leads to the so-called LMA-Dark solution. It requires a solar mixing angle in the second octant and implies an ambiguity in the neutrino mass ordering. Non-oscillation experiments are required to break this degeneracy. We perform a combined analysis of data from oscillation experiments with the neutrino scattering experiments CHARM and NuTeV. We find that the degeneracy can be lifted if the non-standard neutrino interactions take place with down quarks, but it remains for up quarks. However, CHARM and NuTeV constraints apply only if the new interactions take place through mediators not much lighter than the electroweak scale. For light mediators we consider the possibility to resolve the degeneracy by using data from future coherent neutrino-nucleus scattering experiments. We find that, for an experiment using a stopped-pion neutrino source, the LMA-Dark degeneracy will either be resolved, or the presence of new interactions in the neutrino sector will be established with high significance.

and more in the recent literature...

Why CEvNS are interesting? Neutrino magnetic moment

Signature is distortion at low recoil energy E

$$\frac{d\sigma}{dE} = \frac{\pi\alpha^2\mu_\nu^2 Z^2}{m_e^2}\left(\frac{1-E/k}{E} + \frac{E}{4k^2}\right)$$



→requires detector with very low energy threshold

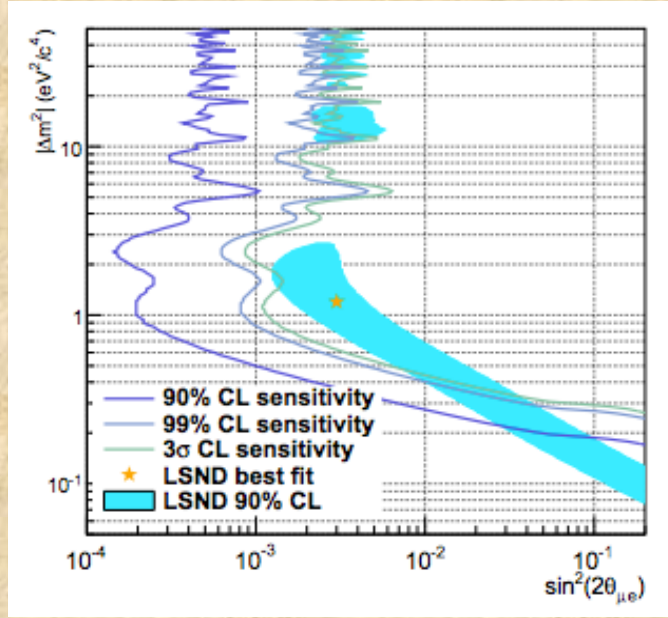
See also Kosmas et al., arXiv:1505.03202

Why CEvNS are interesting? Potential Physics for Future Expansions

The development of a coherent neutrino scattering detection capability provides the most natural way to explore the sterile neutrino sector.

A. Drukier & L. Stodolsky, PRD 30 (84) 2295

A. J. Anderson et al., PRD 86 013004 (2012)



- The cross-section is sensitive to the magnitude of the Neutrino Magnetic Moment (Supersymmetry, Large Extra Dimensions, Right Handed Weak Currents).

  A. C. Dodd, et al., PLB 266 (91), 434

- COHERENT may be the first experiment to observe the Effective Neutrino Charge Radius.

  J. Papavassiliou, J.Bernabeu, M. Passera, HEP-EPS 2005, Lisbon, arXiv:hep-ph/0512029

- The neutron distribution within the nucleus impacts the recoil energy dependent cross-section (Form Factor)

  K. Patton, et al., PRC 86, 024216

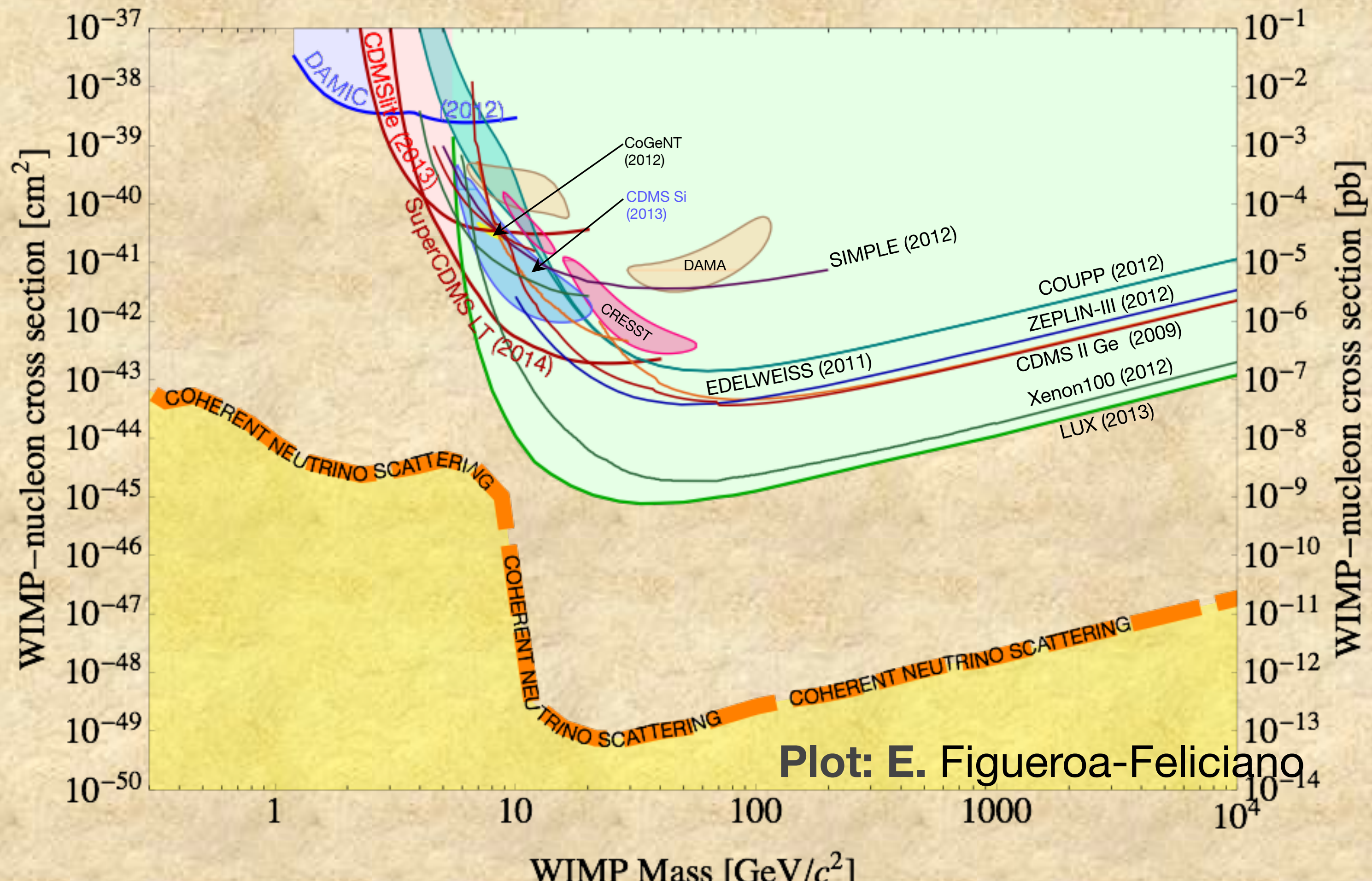
Why to Study CEvNS?

Large effect on Supernovae dynamics.
We should measure it to validate the models

J.R. Wilson, PRL 32 (74) 849

Why to Search for CEvNS

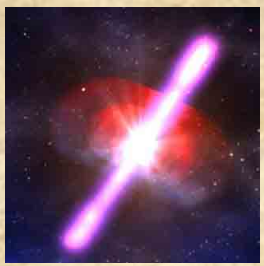
It will be irreducible background for Dark Matter experiments

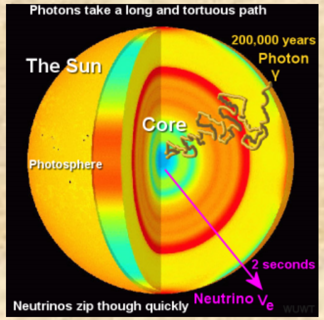


Possible Applications of Coherent Scattering

SN DETECTION (Stodolsky)

10 kpc, 10 ton → 100 events

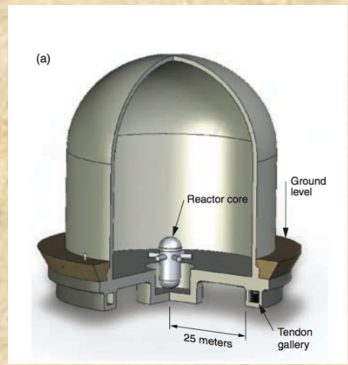




SOLAR NEUTRINOS

~1K events per ton per year.

REACTOR MONITORING



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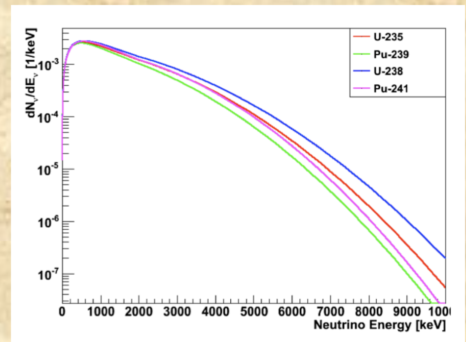

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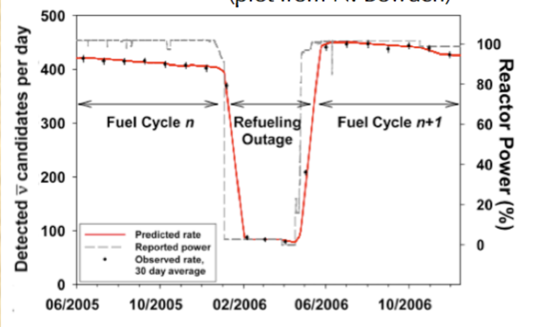
(plot from N. Bowden)



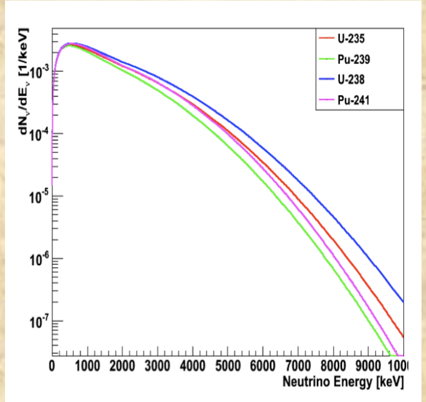
Race for the first CEvNS detection

Experiment	Neutrino Source	Effective E_ν	Distance	Technology	Target	Mass
Ricochet at Chooz	Chooz NPP 2x4.3GW	~4 MeV	355 m	Bolometer	Ge, Zn	5 + 5 kg
Ricochet at MIT	MITR Reactor 5 MW	~4 MeV	4 m	Bolometer	Ge, Zn	5 + 5 kg
MINER	Texas A&M Reactor 1 MW	~4 MeV	2 m	Ionization	Ge, Si	~2-5 kg
CONNIE	Angra NPP 3.8 GW	~4 MeV	30 m	CCD	Si	0.1 kg
RED-100	Kalinin NPP 3.2 GW	~4 MeV	25 m	2 phase	Xe	100 kg
νGeN	Kalinin NPP 3.2 GW	~4 MeV	10 m	Ionization	Ge	~5 kg
CONUS	Brokdorf NPP 3.8 GW	~4 MeV	20 m	Ionization	Ge	~5 kg
COHERENT	SNS (DAR)	~40 MeV	20-30 m	Ionization	CsI, Ar, Ge	14, 30, 10 kg

In red shown experiments which are taking data.

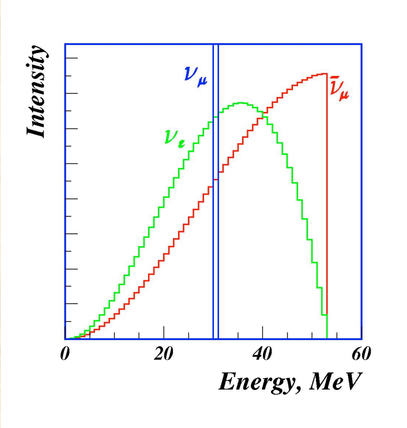
What Source We Can Use to Detect CEvNS

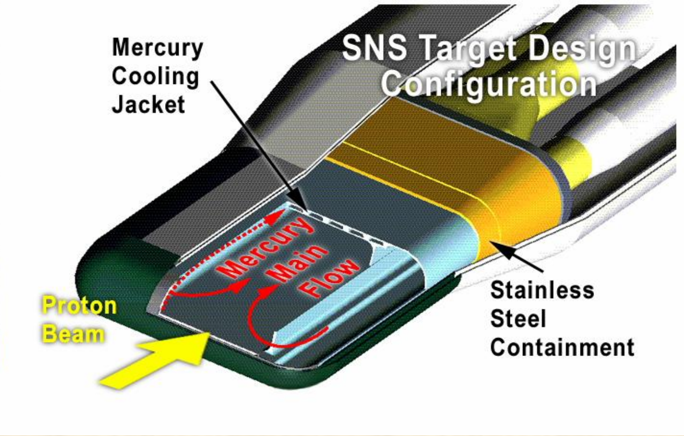
Nuclear Reactors



3 GW – 1 MW
Distance ~10 -20 m
E_ν ~ 4 MeV
Continues operation
$6*10^{20}$ ν/sec
One type of neutrino

Stopped Pion Facilities

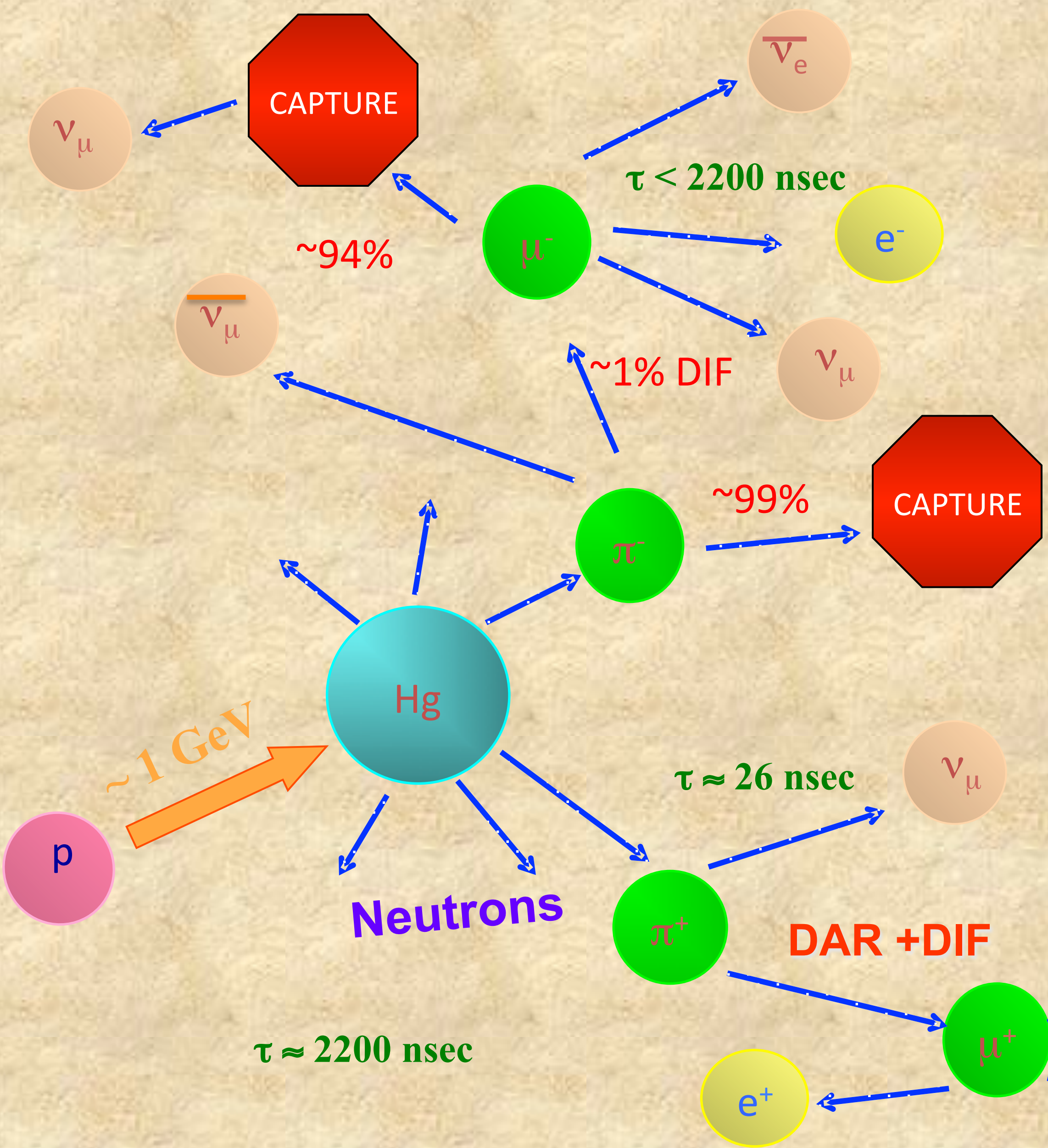


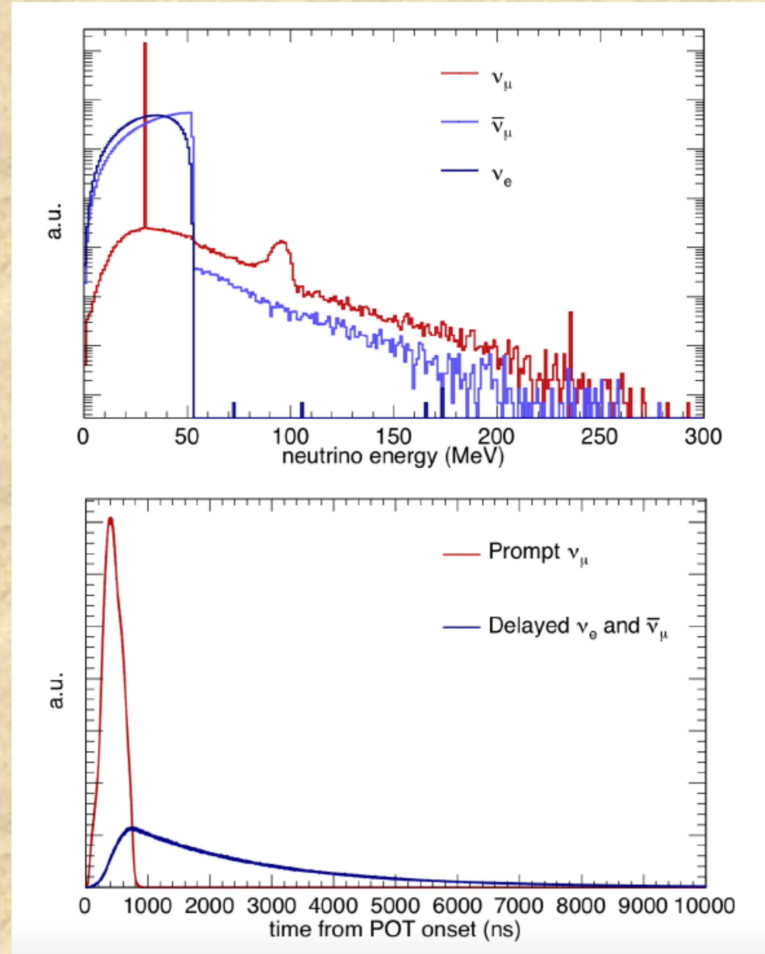


1.3 MW
Distance ~20 m
E_ν ~ 40 MeV
Pulsed beam
$2*10^{15}$ ν/sec
Three types of neutrinos


SNS-Spallation Neutrino Source
My Car

Neutrino Production at the SNS



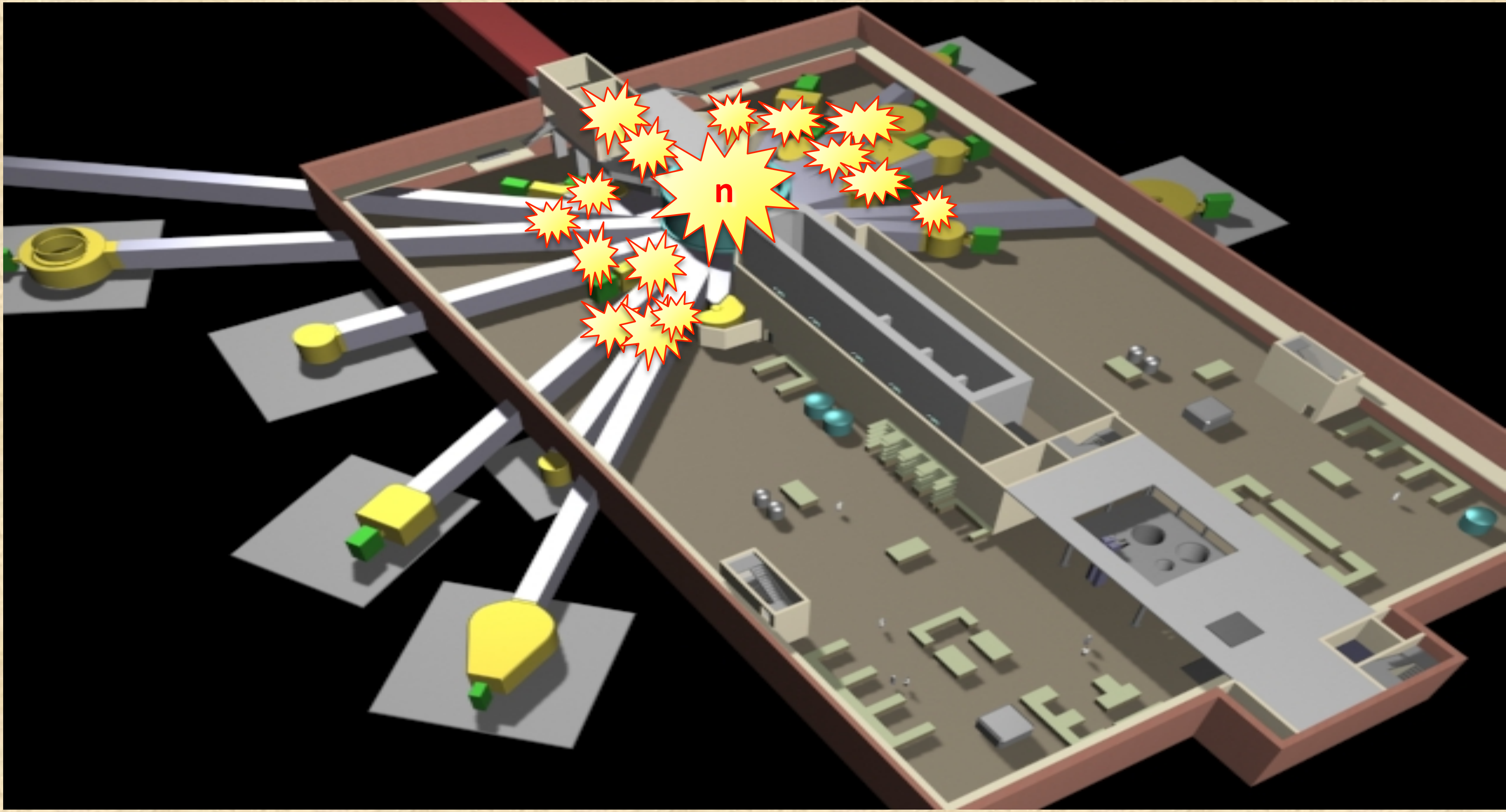


COHERENT SNS

Collaboration was created to make the first detection of the Neutrino Neutral Current Coherent scattering at the SNS

THE UNIVERSITY OF CHICAGO
Duke UNIVERSITY
UF UNIVERSITY of FLORIDA
KAIST
Laurentian University Université Laurentienne
Los Alamos NATIONAL LABORATORY EST. 1943
BERKELEY LAB
MEPhI
NORTH CAROLINA CENTRAL UNIVERSITY FOUNDED 1910
NC STATE UNIVERSITY
NM STATE UNIVERSITY
OAK RIDGE National Laboratory
Sandia National Laboratories
THE UNIVERSITY of TENNESSEE UT KNOXVILLE
TUNL
W UNIVERSITY of WASHINGTON

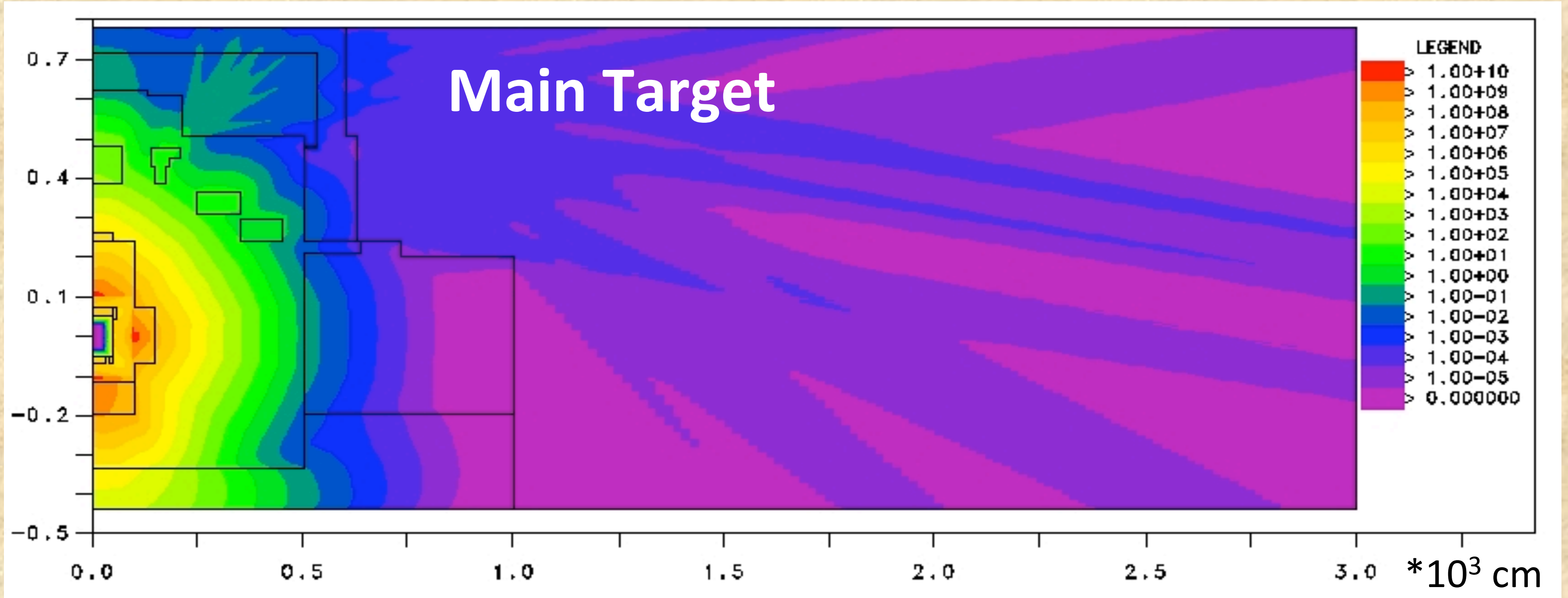
Fast Neutrons at SNS

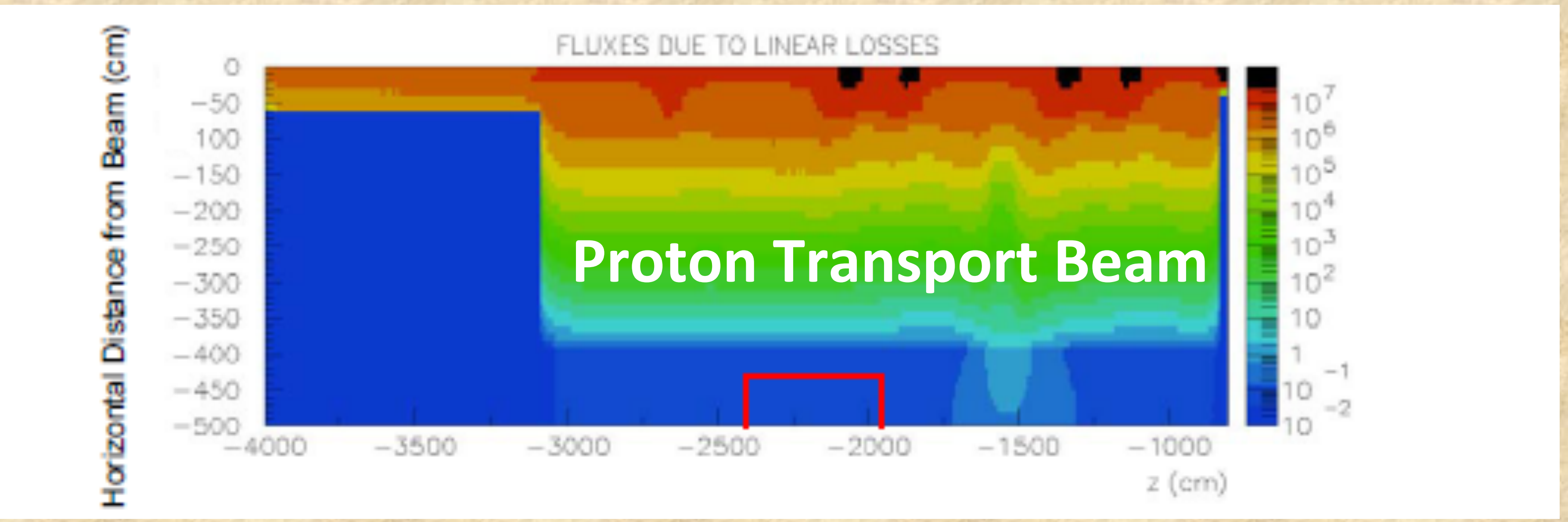


There are Multiple Fast Neutron Sources inside the Target building.

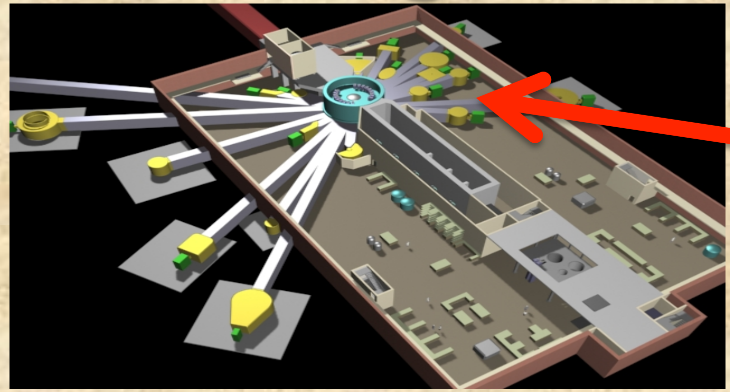
Intermediate Neutrons with energy more than 50 keV can produce nuclear recoils.
This is major background!!!!

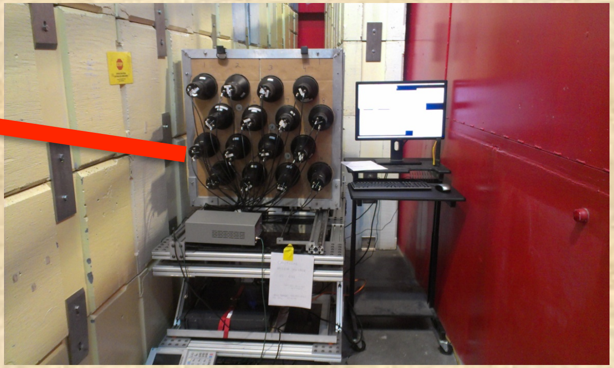
Example of Simulations





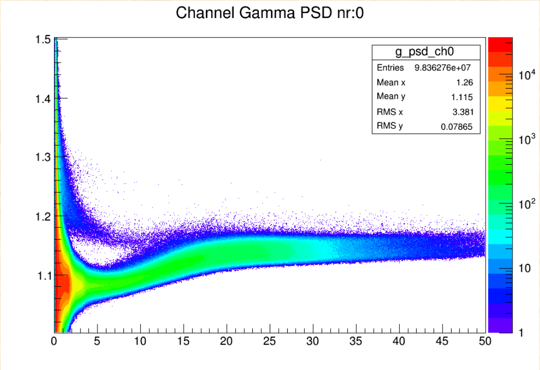
Background Measurements at SNS



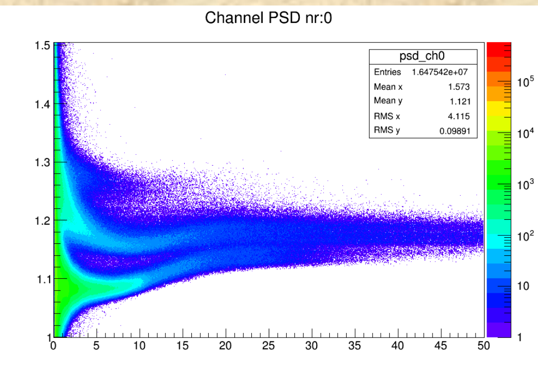


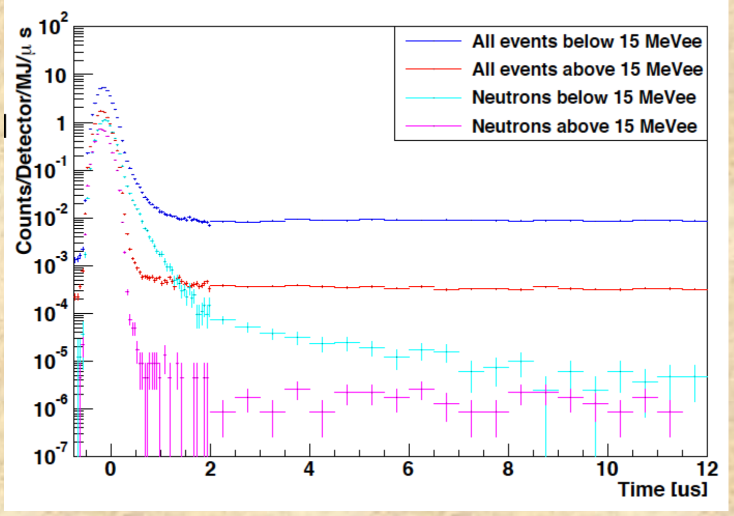
Started in 2013

"Out-of-beam" events, primarily muons.



"In-Beam" events, considerably more neutron events (and 16x less "live time")

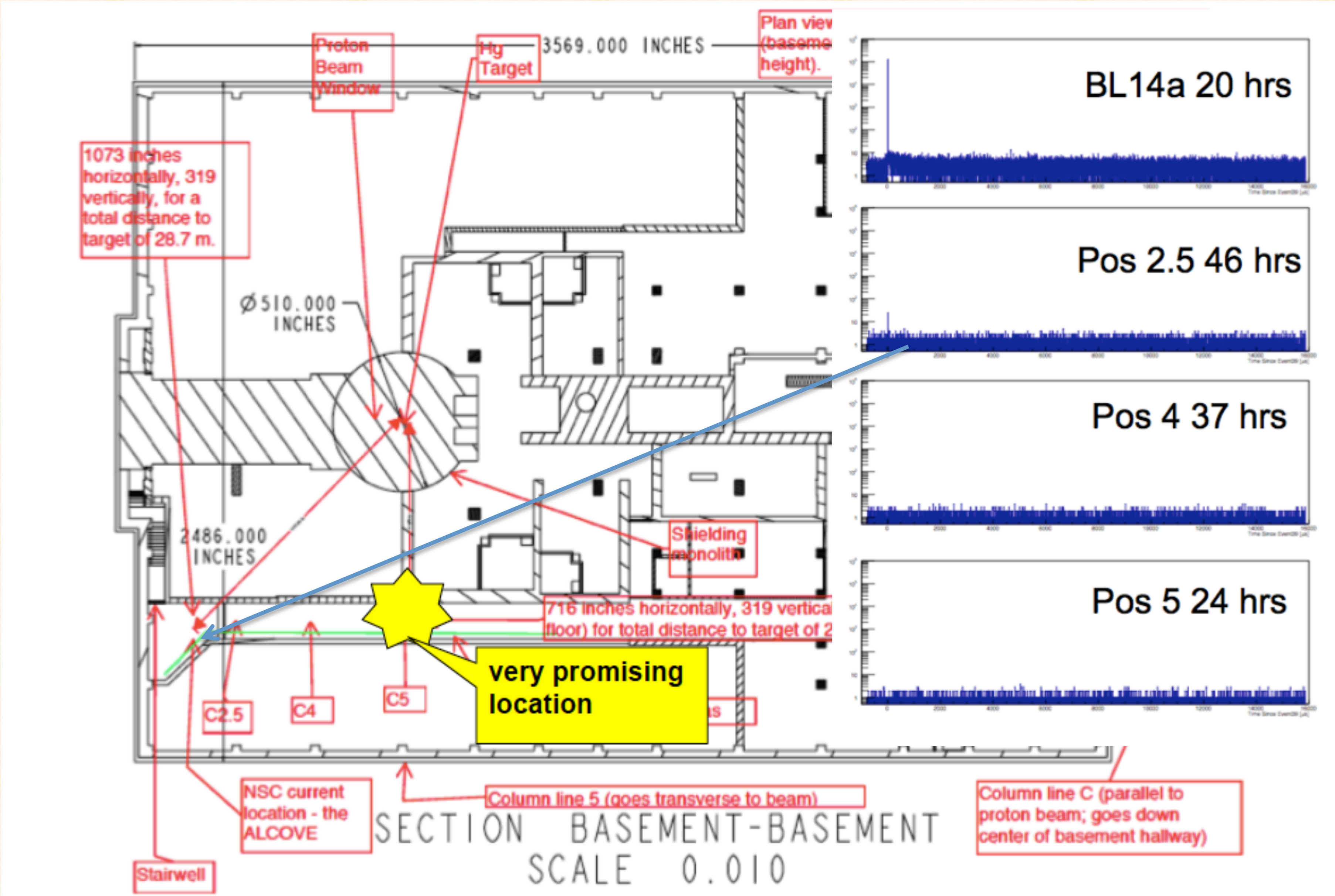




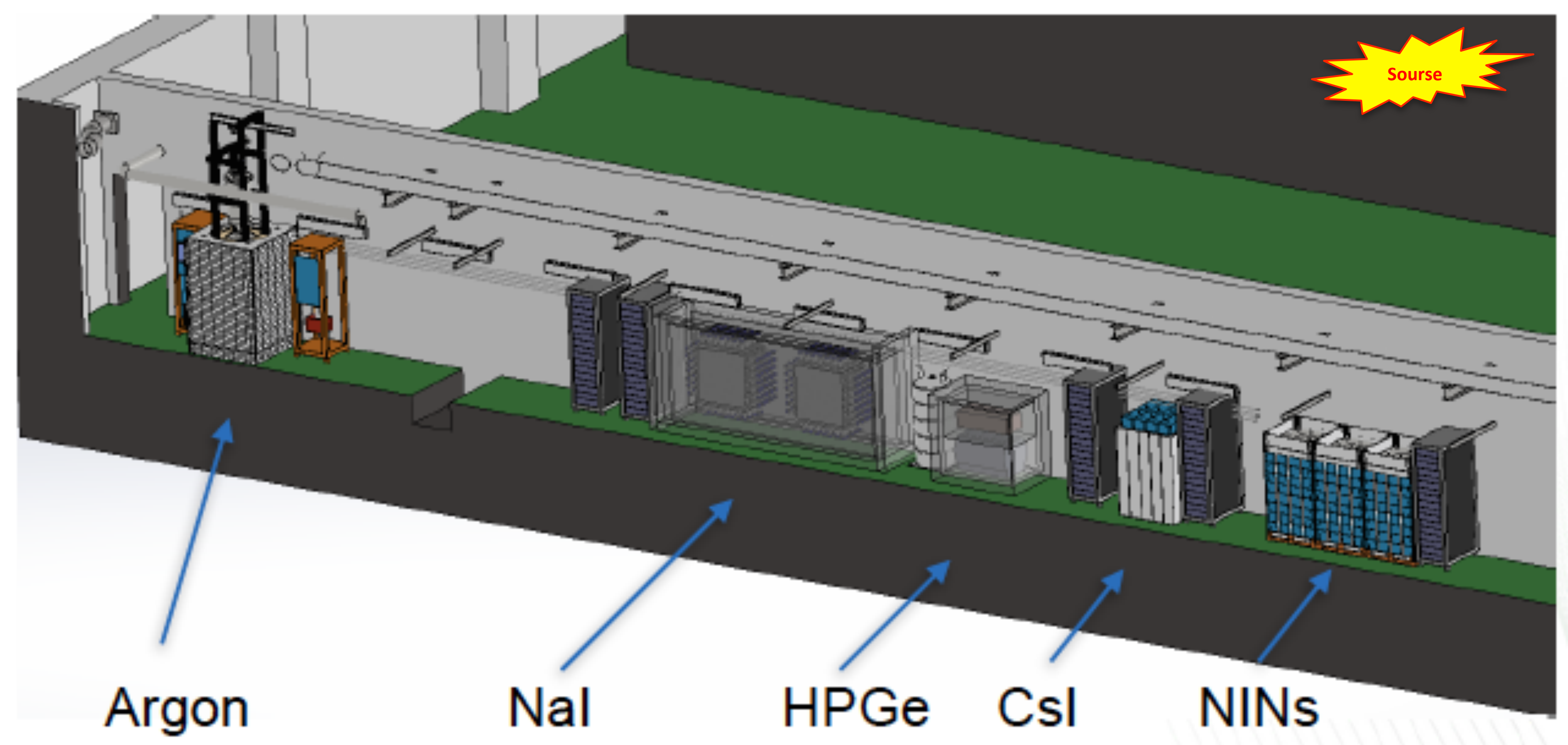
Neutrons flux in the target building 100000 times more than we can tolerate

Time structure is similar to the ones from neutrinos

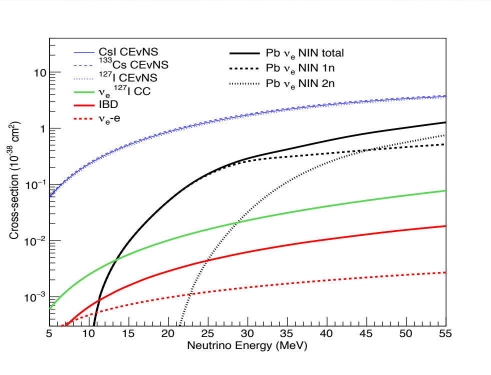
Finding Neutrino Alley



Neutrino Alley at the SNS



Basement location is isolated from Neutron beam Lines
There are no voids between SSN target and Neutrino Alley
There is extra protection from cosmic rays by neutron beam lines shielding
However, there is no protection from Neutrinos



Neutrino Induced Neutrons (NIN)

Never been measured.
There are only theoretical calculations

Lead assembly with ^{3}He neutron detectors

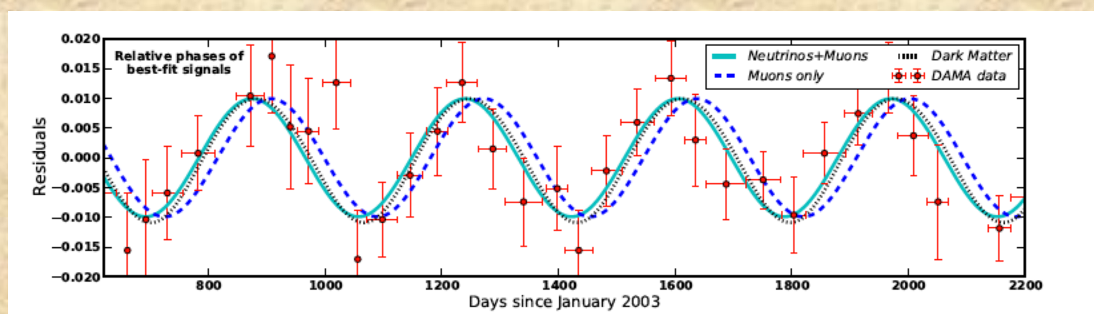
This reaction on Lead is used by HALO experiment in the SNOlab, to watch for supernovae.

In

Fitting the annual modulation in DAMA with neutrons from muons and neutrinos

Jonathan H. Davis[1]
[1] *Institute for Particle Physics Phenomenology, Durham University, Durham, DH1 3LE, United Kingdom*
j.h.davis@durham.ac.uk

author explains DAMA seasonal modulations by solar neutrino induced interactions in the DAMA shielding



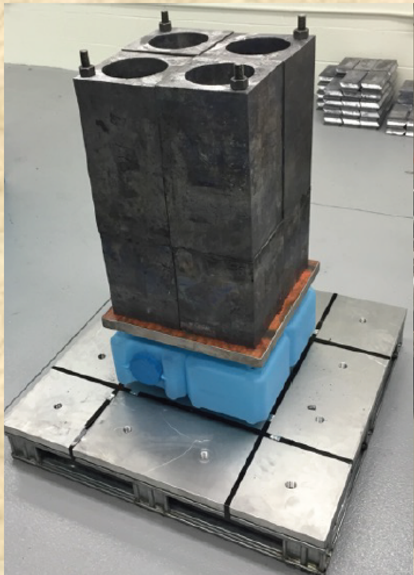
Comment on "Fitting the annual modulation in DAMA with neutrons from muons and neutrinos"

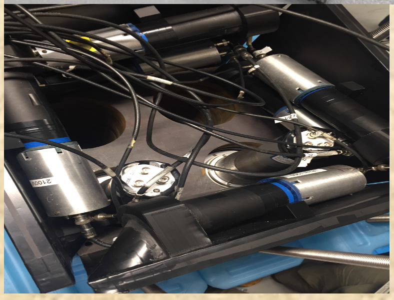
P.S. Barbeau[a], J.I. Collar[b], Yu. Efremenko[c], and K. Scholberg[a,*].
[a] *Department of Physics, Duke University, Durham, NC 27708 USA*
[b] *Department of Physics, University of Chicago, Chicago, IL 60637 USA*
[c] *University of Tennessee, Knoxville, TN 37996 USA*
* *Corresponding author. E-mail: schol@phy.duke.edu*

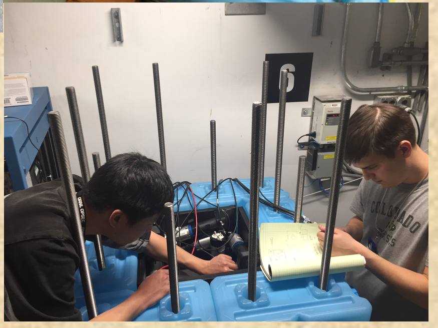
In this article we show that J.Davis is wrong by a ~6 orders of magnitude if to trust nuclear theory

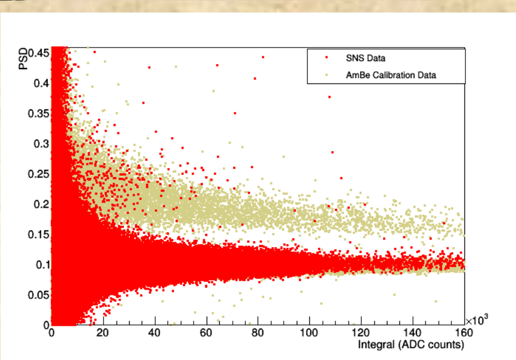
Neutrino Induced Neutrons – NINs

Never been detected, theoretical cross sections are differ by 30%







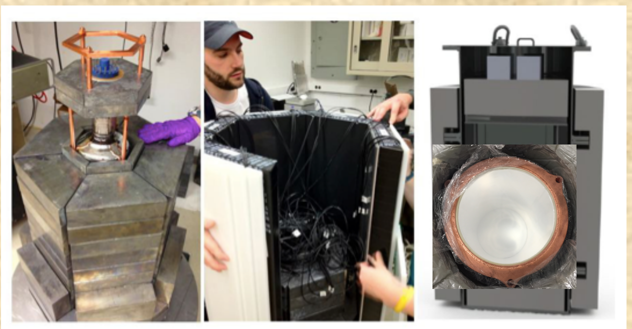


- Liquid scintillator detectors with n/g separation capability
- Two sets with Lead (1 ton) and Iron (700kg) targets.
- Neutron detection Efficiency ~10%

Collaboration started program of measurements with Lead and Iron targets looking for the first detection of NINs and measurement of their production cross section

Three Detector Technology for COHERENT Phase I

CsI

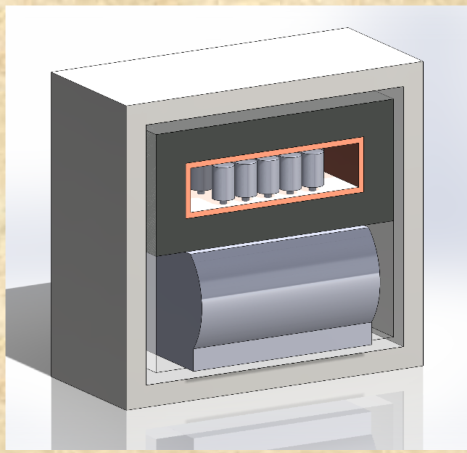


14 kg

LAr

30 kg

HPGe

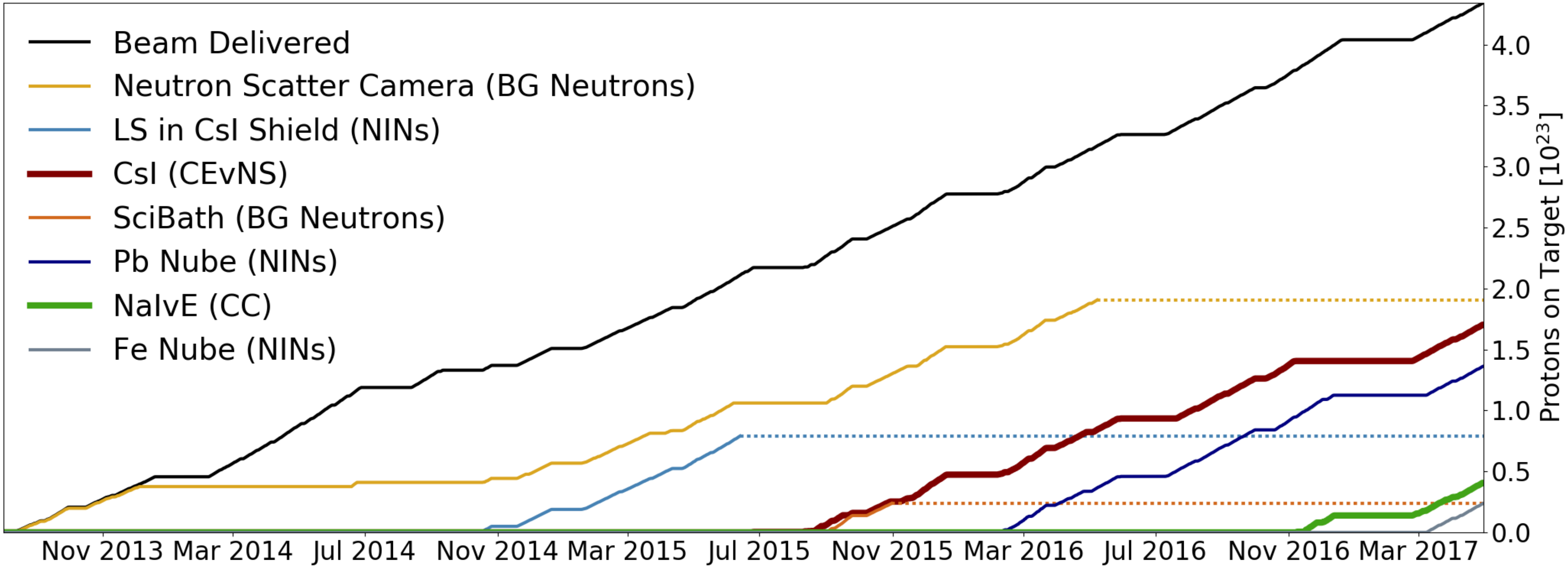


10 kg

NaI

185 kg

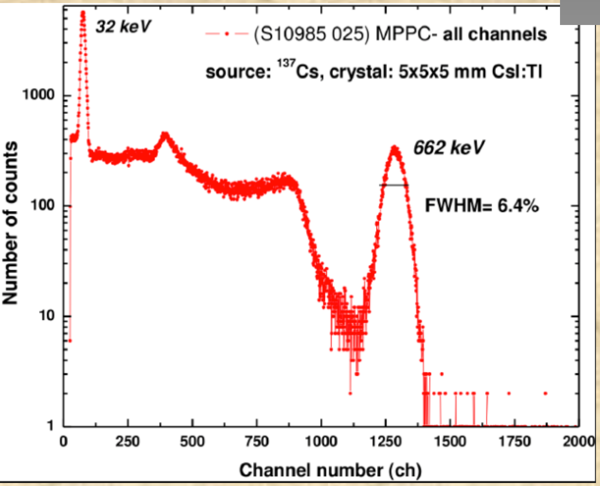
Monitoring of Accumulated Statistics



Before looking for CEvNS we studied backgrounds for 2 yeas.

One of the important measurement was to look for NINs in the CsI shielding to be sure that they are not an issue

CsI Is Good as a Detector for CEvNS



Inexpensive - 1$/g

High density 4.51 g/cm^3

bright scintillator ~64 ph/keVee

can be low radioactive

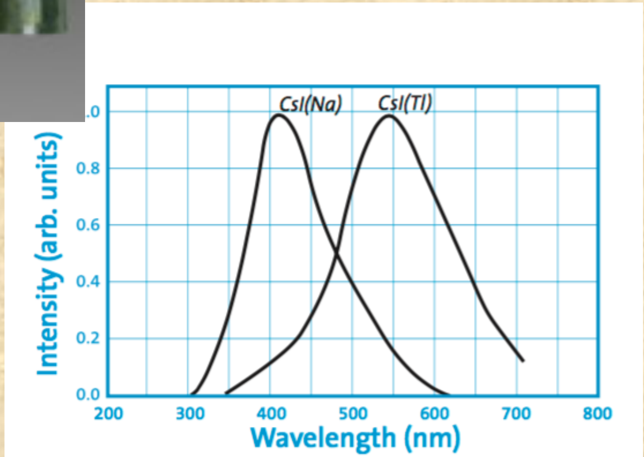


Figure 1. Scintillation emission spectrum of CsI

Light emission at 420 nm match well PMT sensetivity

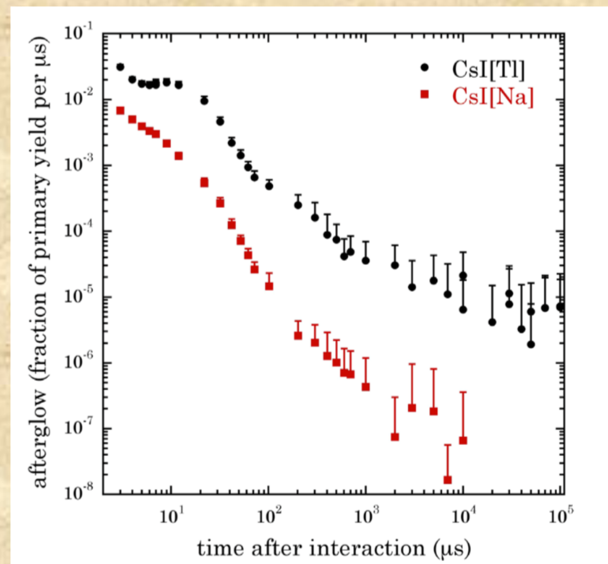
$Cs_{(z=55,A=133)}$ and $I_{(z=53,A=127)}$ both have large and similar number of neutrons

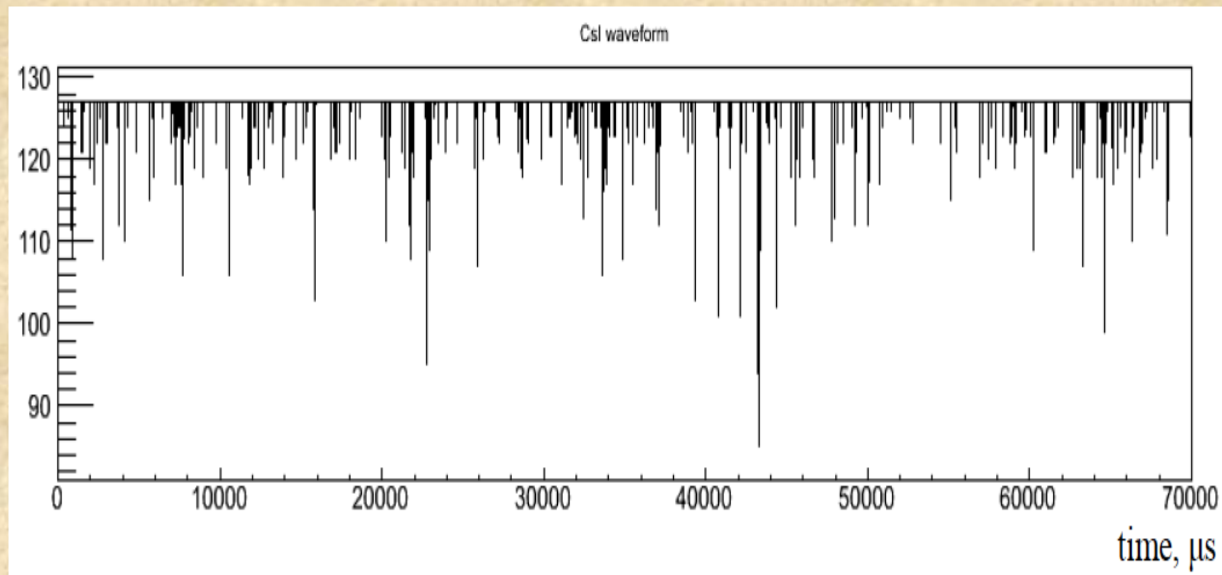
CsI is Bad as a Detector for CEvNS

Quenching (response to nuclear recoils) is not know very well

It is slow – 630 nsec (single Ph.E. for small signals)

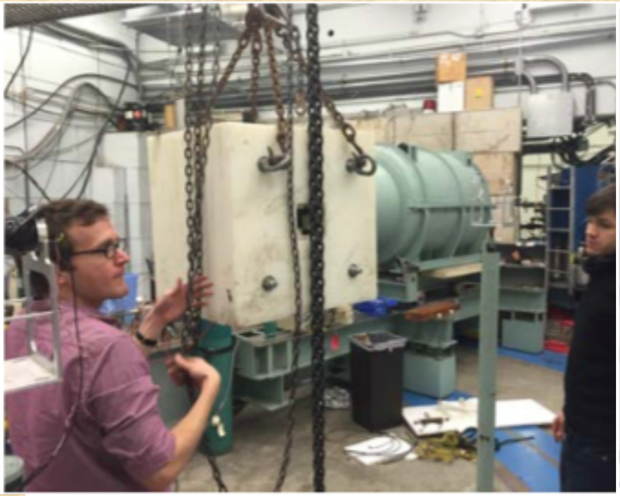
It has a large afterglow

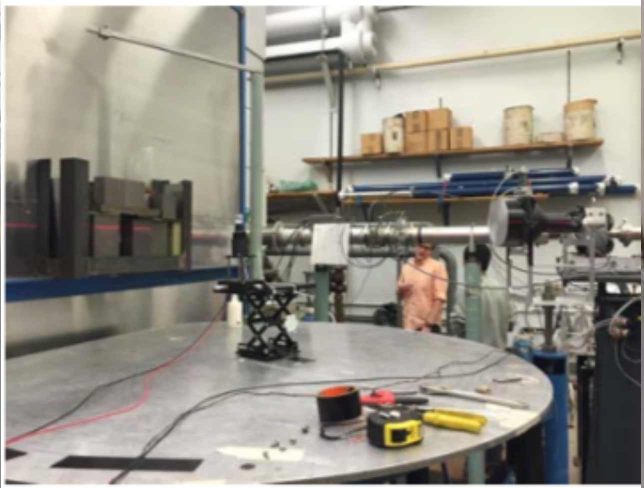


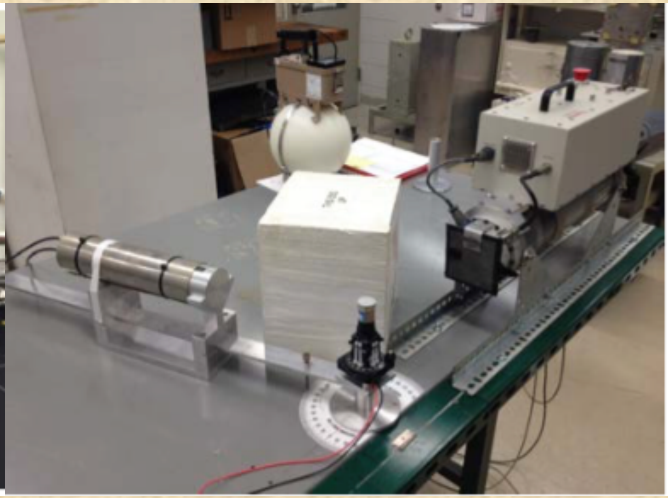


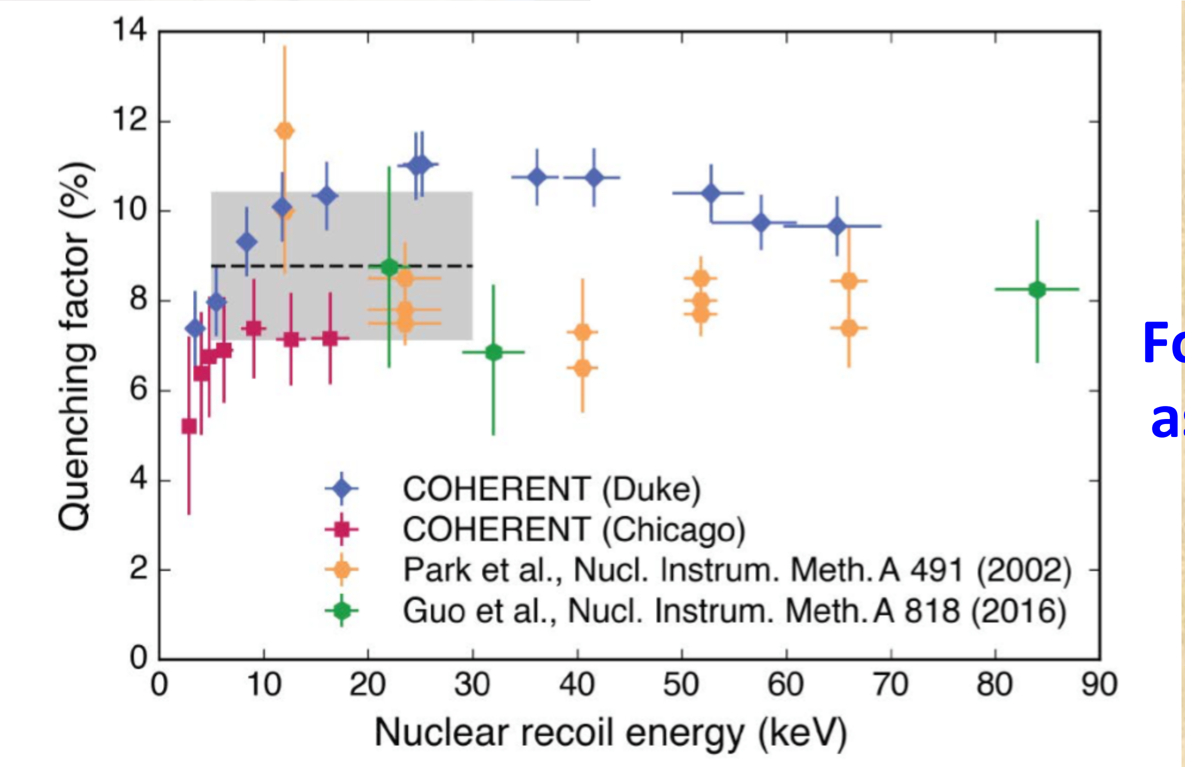
The large afterglow, creates problems for a large crystals working on the surface

Quenching Measurement at the TUNL neutron beam









For the first publication we assumed flat quenching of 8.8% +/- 2.2%

NINs Background Concern

The "neutrino alley" @ SNS

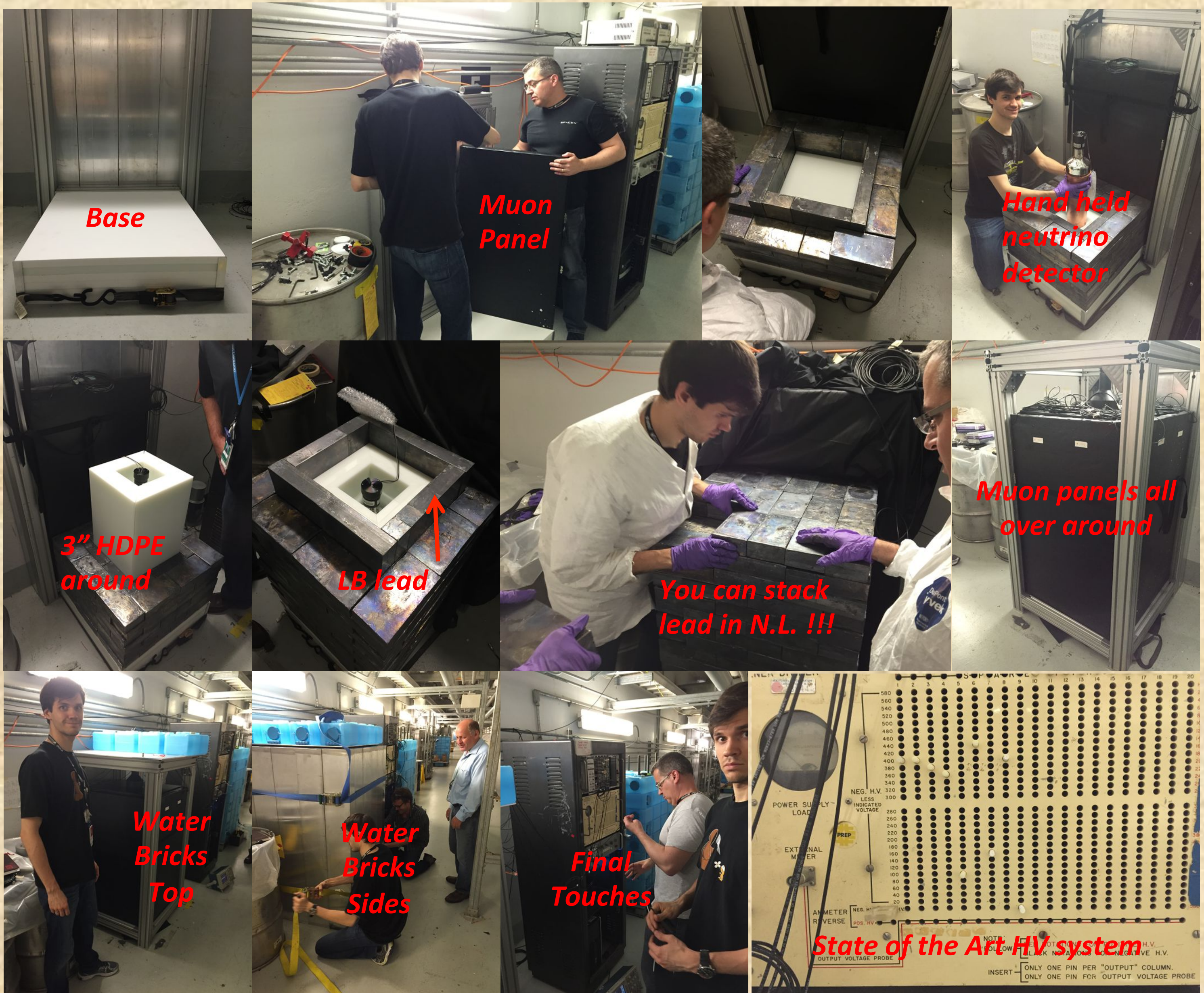
Prior to CsI installation LSc detector has been deployed at the same location with the same shielding but without inner poly layer

Taking data from November 2014 till June 2015

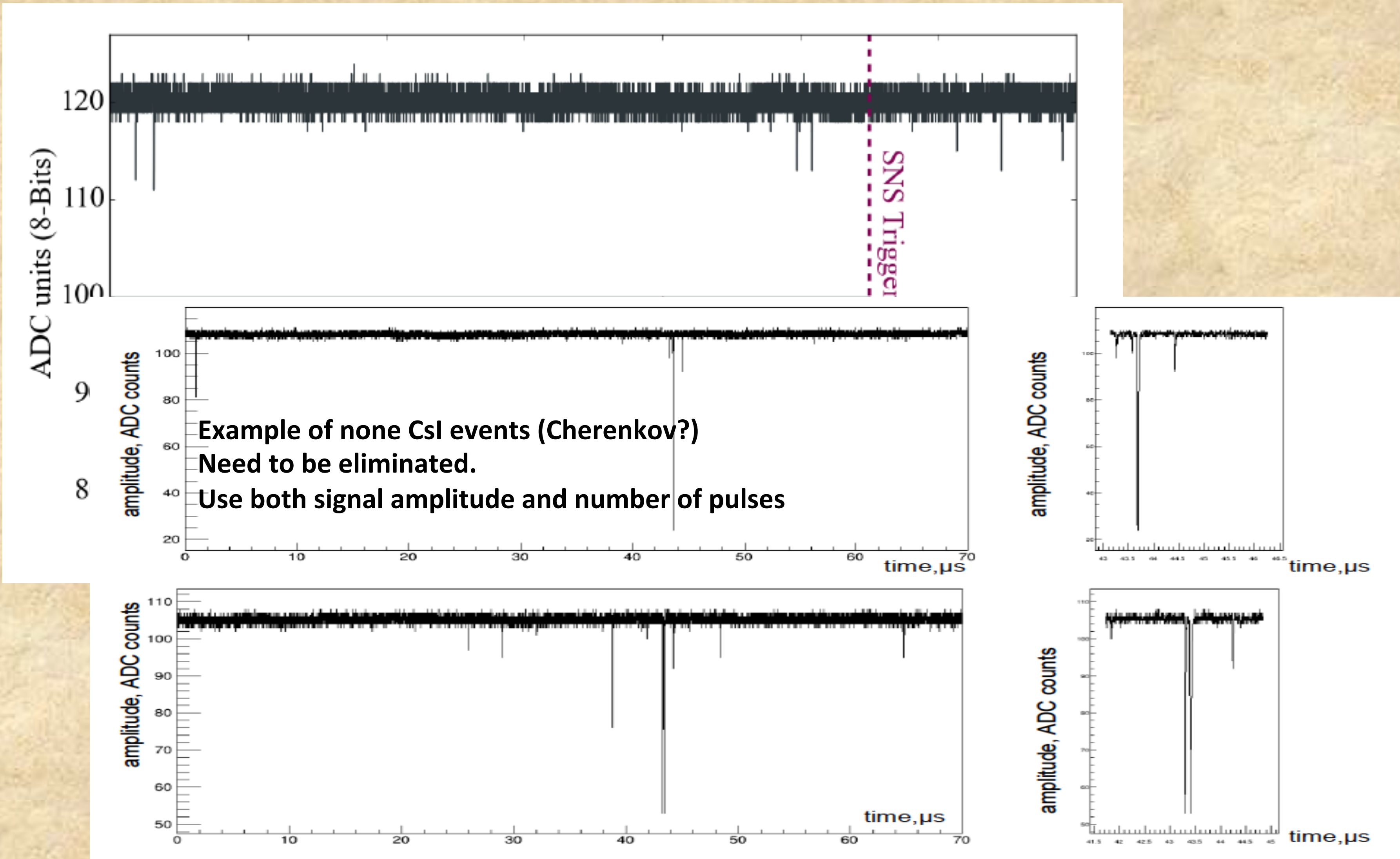
No NINs has been seen, and non has been expected for this setup

GOOD !!!

CsI detector Installation (August 2015)

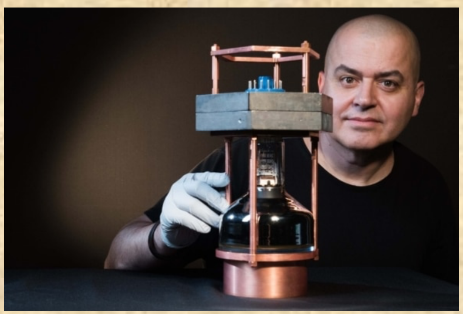


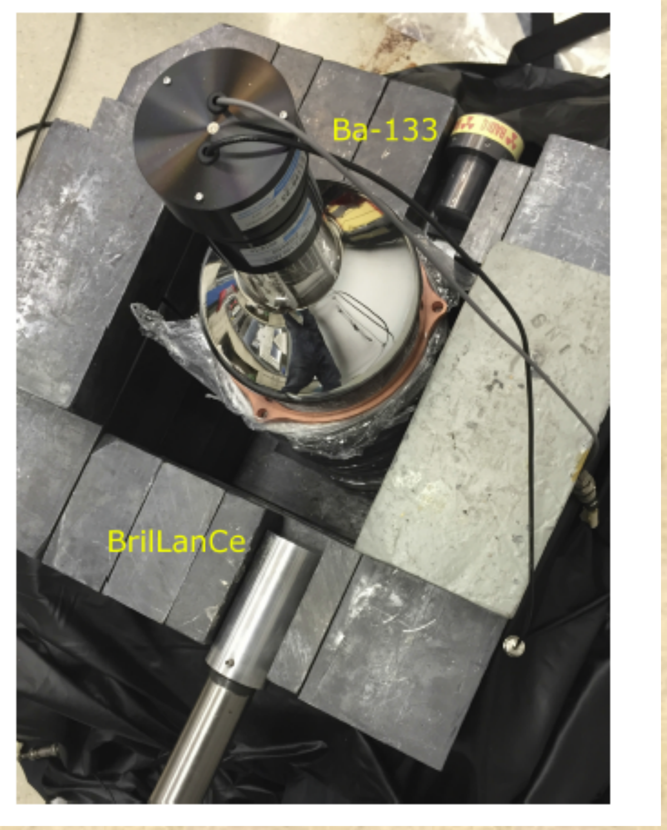
DAQ recorded waveforms in 70 usec window using SNS timer (60 Hz)

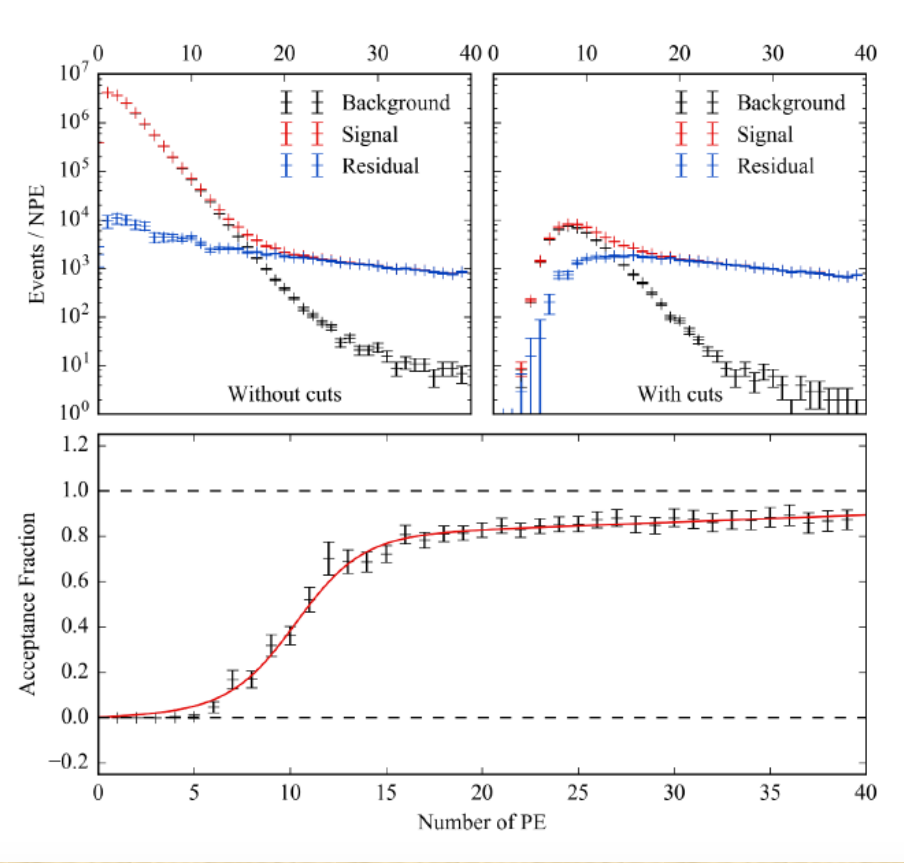


Example of none CsI events (Cherenkov?)
Need to be eliminated.
Use both signal amplitude and number of pulses

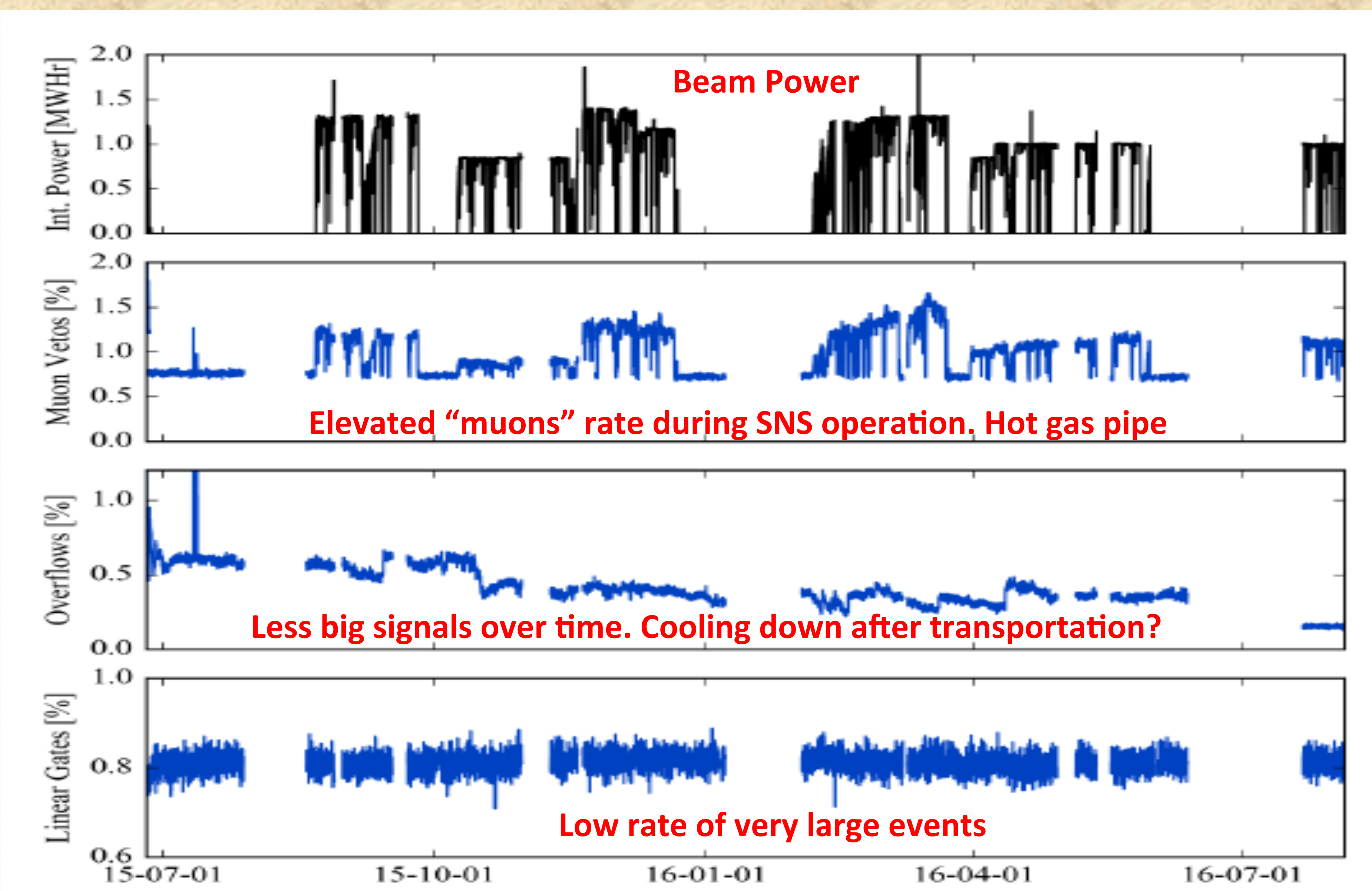
Calibration of efficiency with ^{133}Ba source via Compton scattering at Chicago



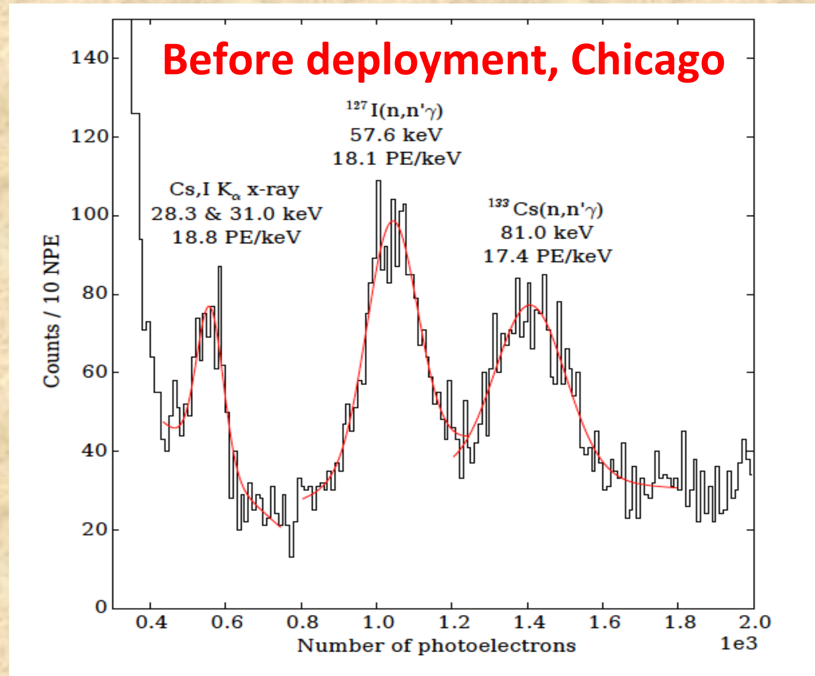


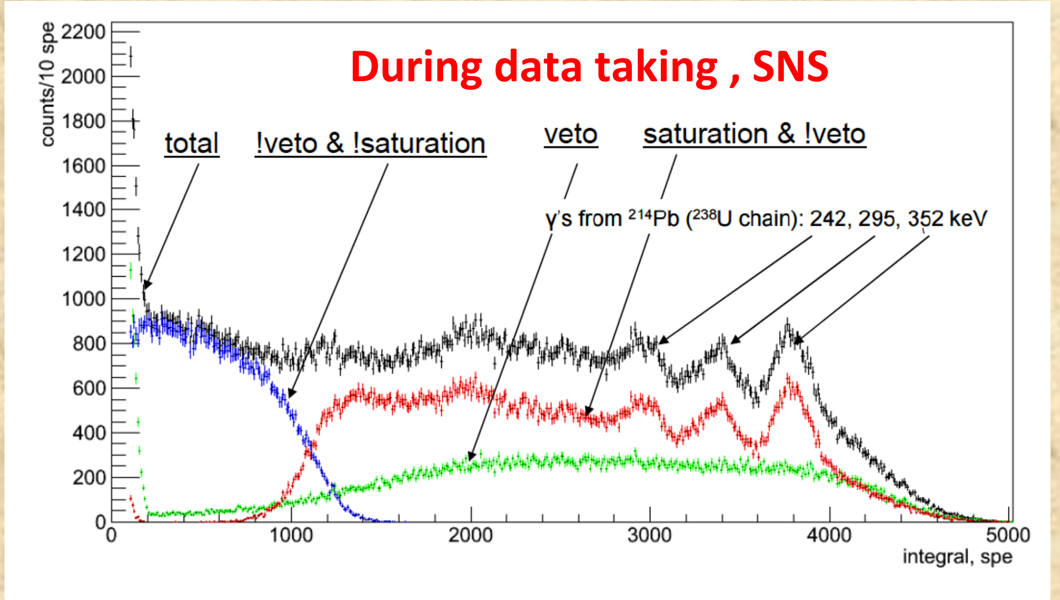


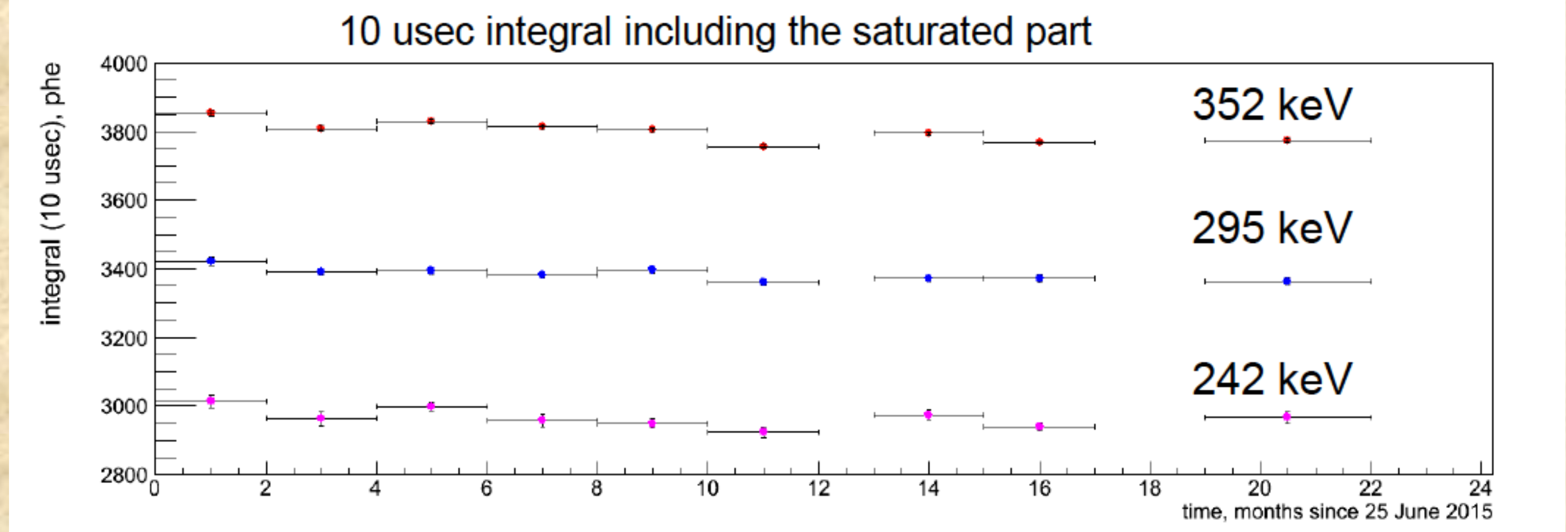
Detector stable operation



Energy Calibration







No drift in the energy scale

CsI Data Analysis

Quasi blind data analysis was implemented.

Two separate groups did their independent analysis using very different software tools

Event algorithms of waveform analysis were different and not shared

After both groups were happy with their results final experimental plots were generated.
Expected signals were generated based on accumulated statistics
(both groups ended up with a slightly different efficiencies and number of POT)

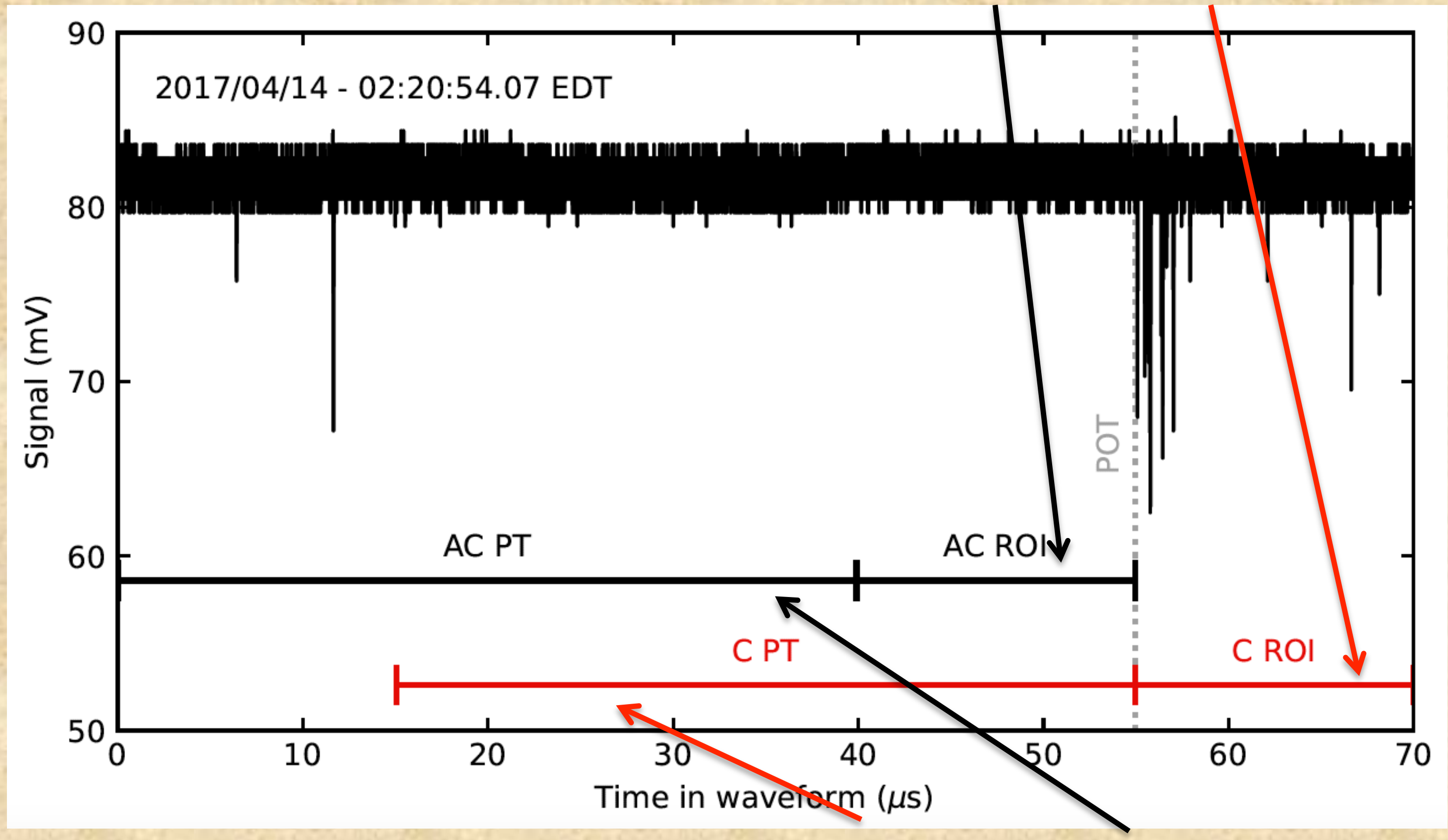
After both groups compare their results and discovered that they are in agreement, results were unveiled during May-17 collaboration meeting

Collaboration was so happy with result so we forgot to take a group photo

DAQ recorded waveforms in 70 usec window using SNS timer (60 Hz)

Analysis procedure:

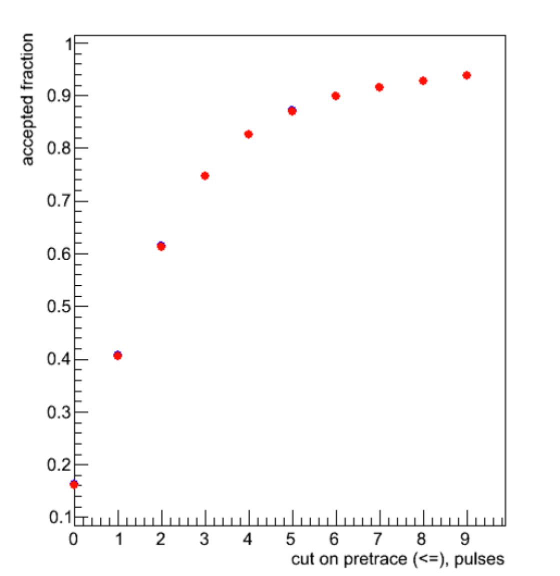
Apply same "Cherenkov" cut using BG and signal and ROI windows

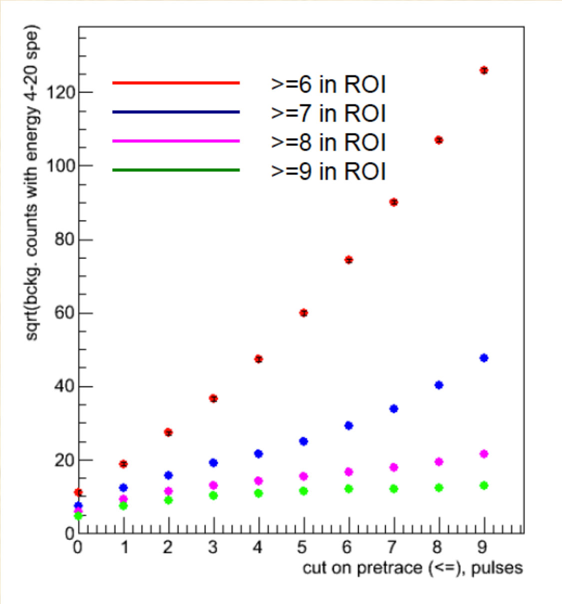


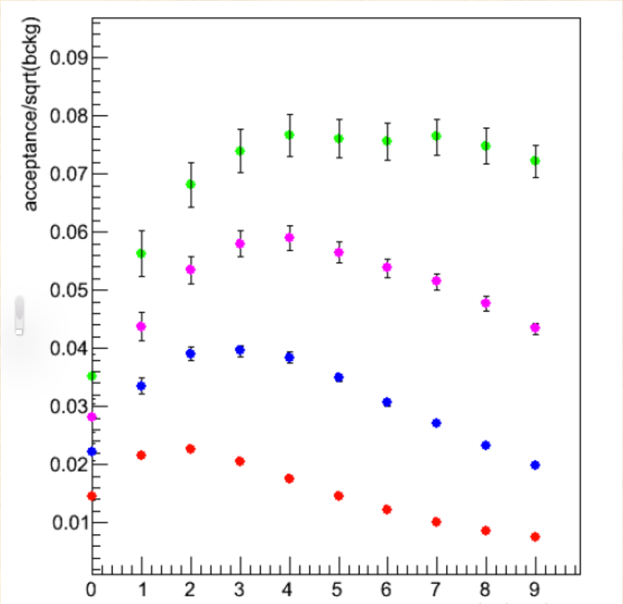
Apply cut on prior activity using signal and BG pre trace windows

Subtract BG ROI events from Signal ROI events

Blind Cut Optimization





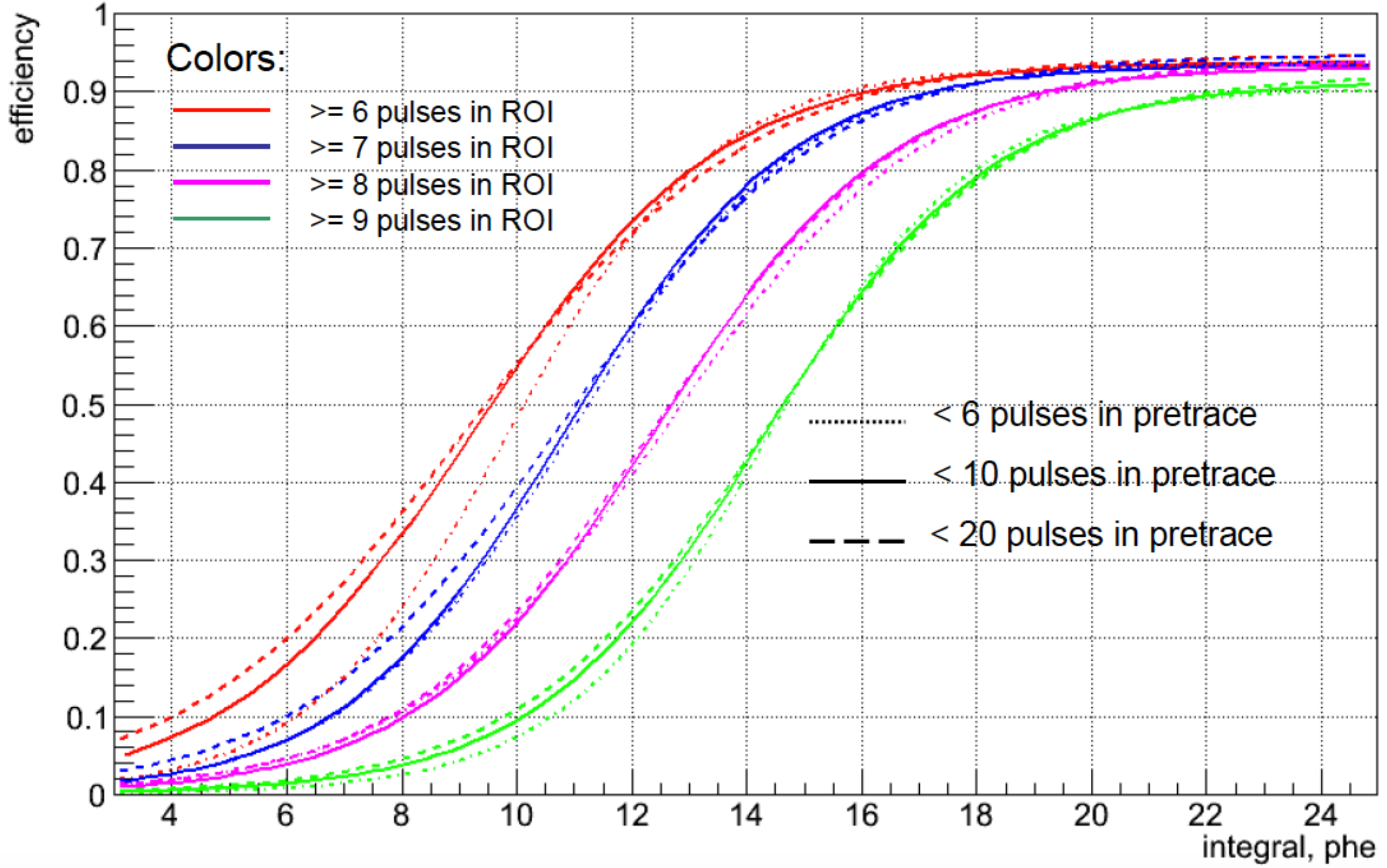


Strict cut on pre trace reduce acceptance

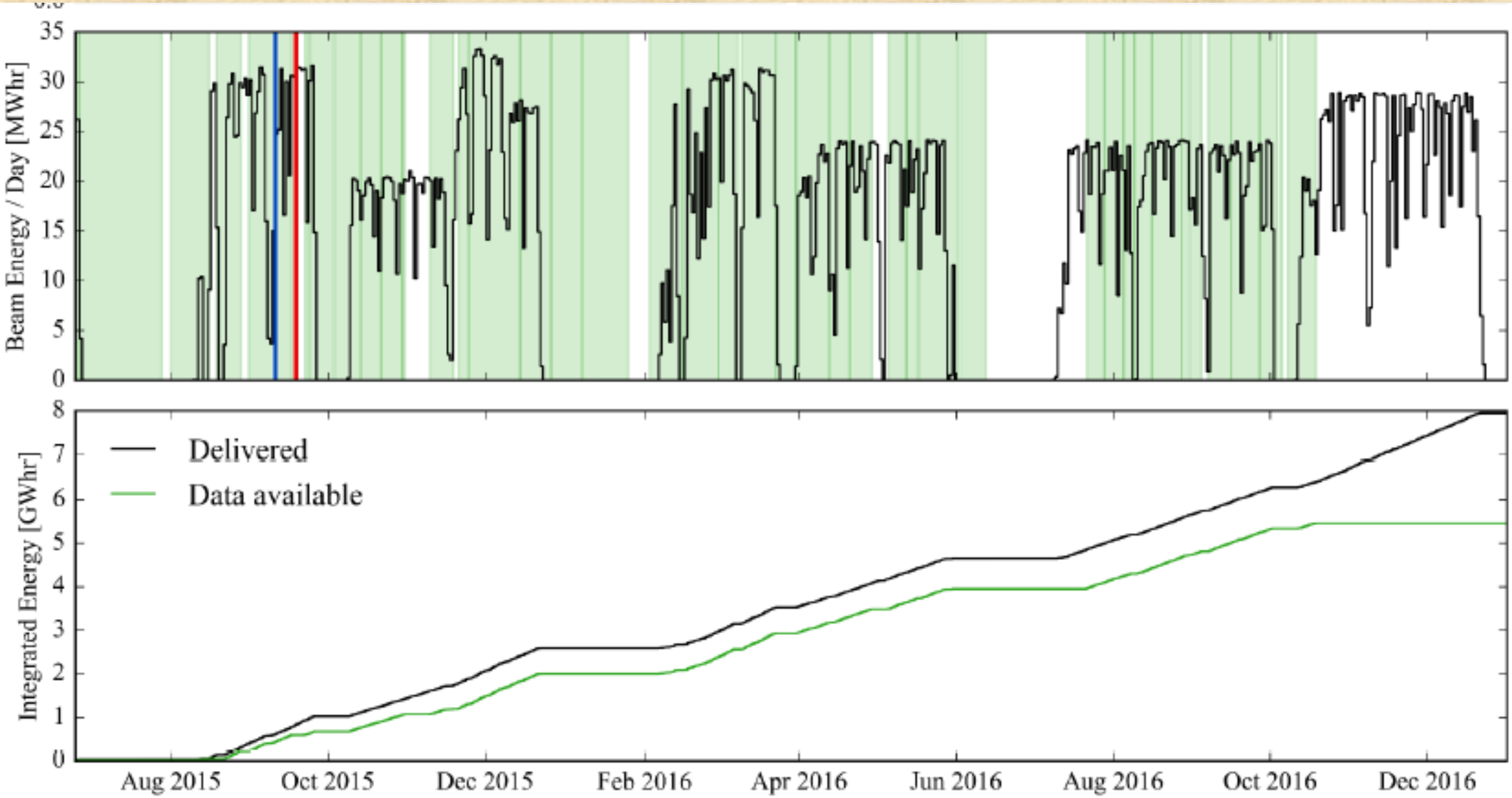
Strict Cherenkov cut at ROI reduce BG

There is optimal combination of both → *significance*

Signal Efficiency Based on Ba Calibration Data

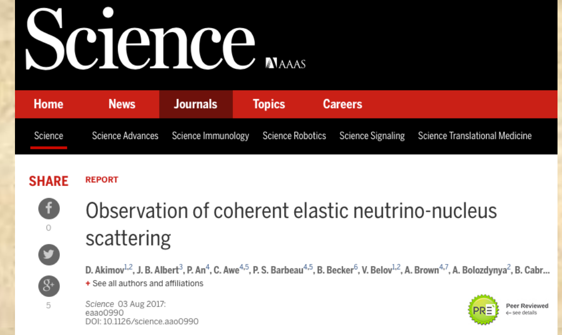


CsI Accumulated Statistics



~6 GWh were recorded, this is $1.4*10^{23}$ POT or 0.22 grams of protons delivered to the SNS target

CEvNS detected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REPORT

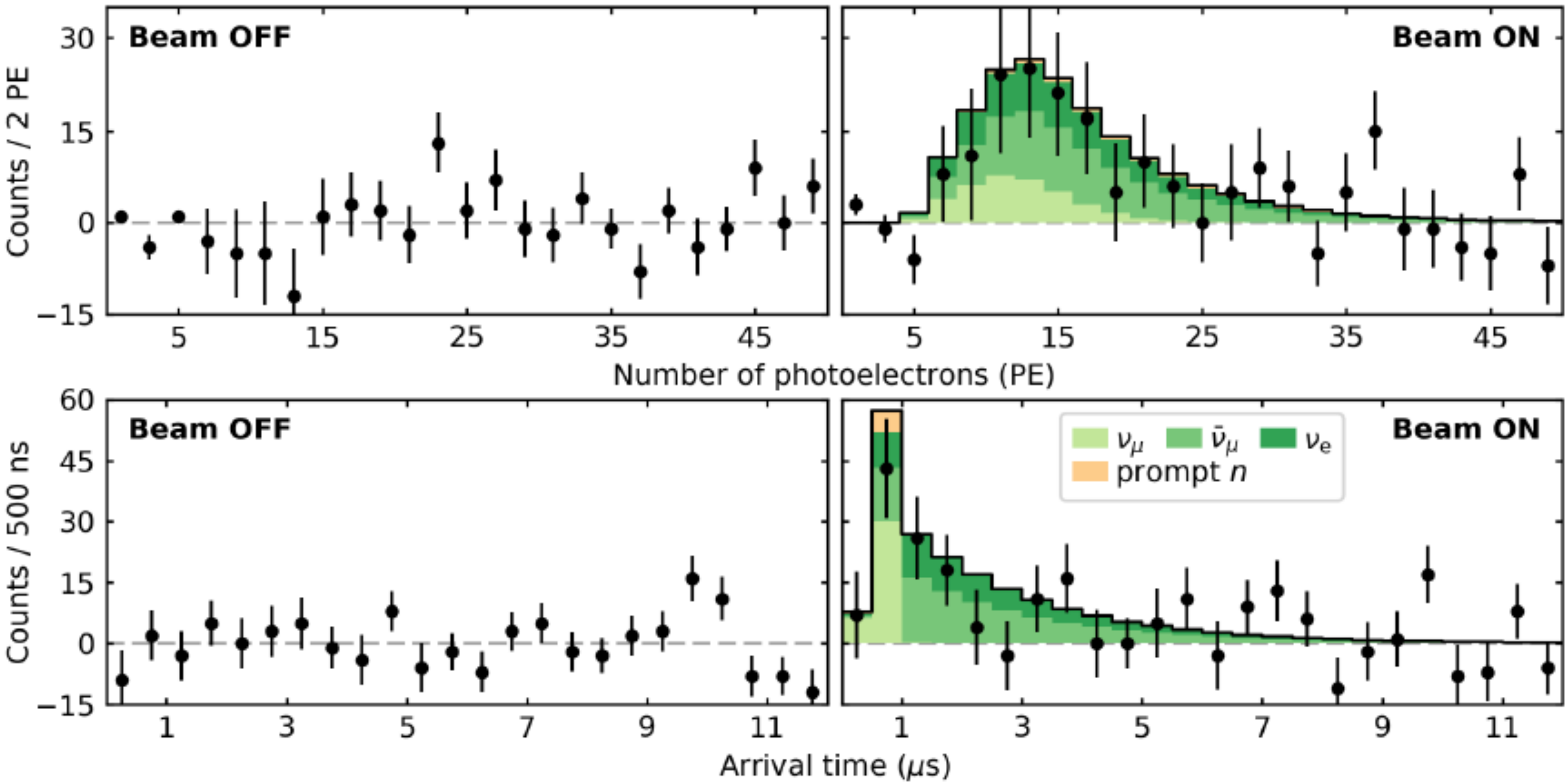
Observation of coherent elastic neutrino-nucleus scattering

D. Akimov[1,2], J. B. Albert[3], P. An[4], C. Awe[4,5], P. S. Barbeau[4,5], B. Becker[6], V. Belov[1,2], A. Brown[4,7], A. Bolozdynya[2], B. Cabr...

+ See all authors and affiliations

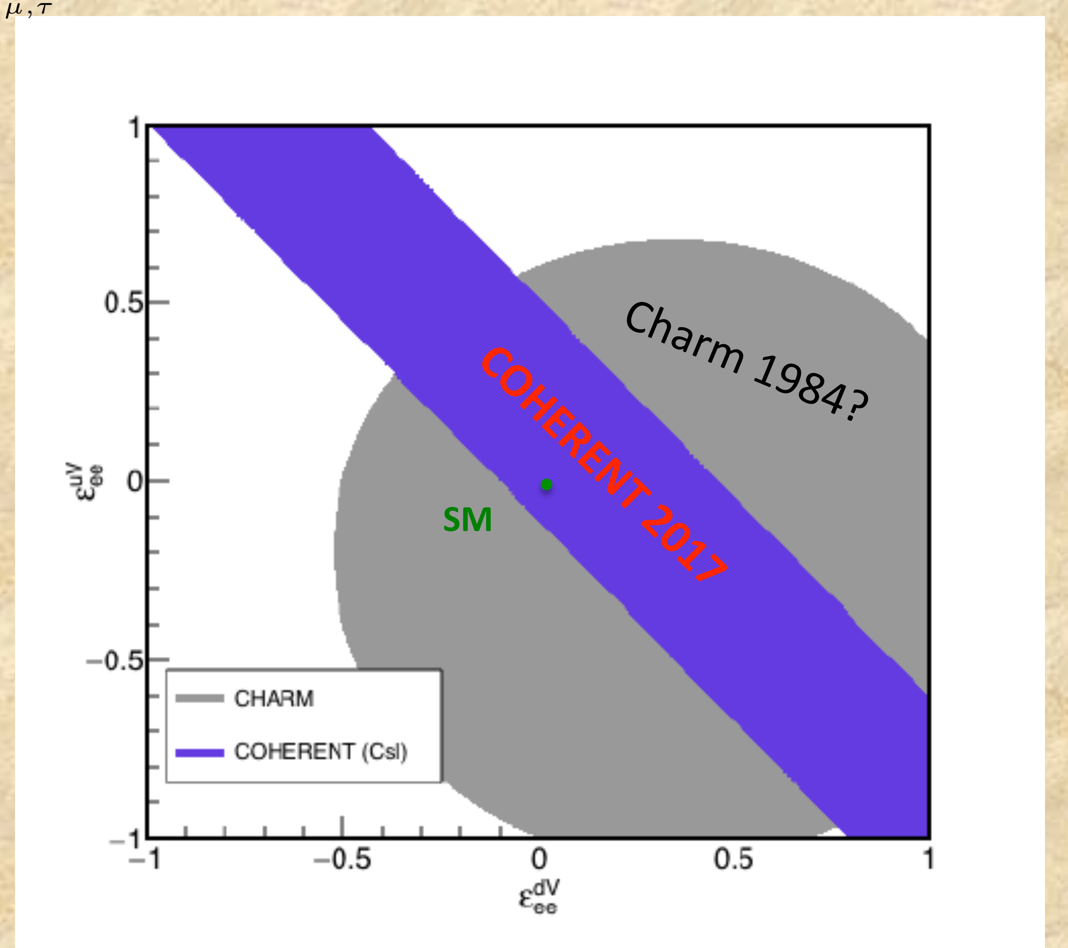
Science 03 Aug 2017:
eaao0990
DOI: 10.1126/science.aao0990

Peer Reviewed



First Application of CEvNS
Constrain on non standard neutrino interruptions

$$\mathcal{L}_{\nu H}^{NSI} = -\frac{G_F}{\sqrt{2}} \sum_{\substack{q=u,d \\ \alpha,\beta=e,\mu,\tau}} [\bar{\nu}_\alpha \gamma^\mu (1-\gamma^5)\nu_\beta] \times (\varepsilon_{\alpha\beta}^{qL}[\bar{q}\gamma_\mu(1-\gamma^5)q] + \varepsilon_{\alpha\beta}^{qR}[\bar{q}\gamma_\mu(1+\gamma^5)q])$$



Why CEvNS are interesting?
Interest from Neutrino Oscill…ons

arXiv.org > hep-ph > arXiv:1701.04828

Search or Art…
(Help | Advanced…

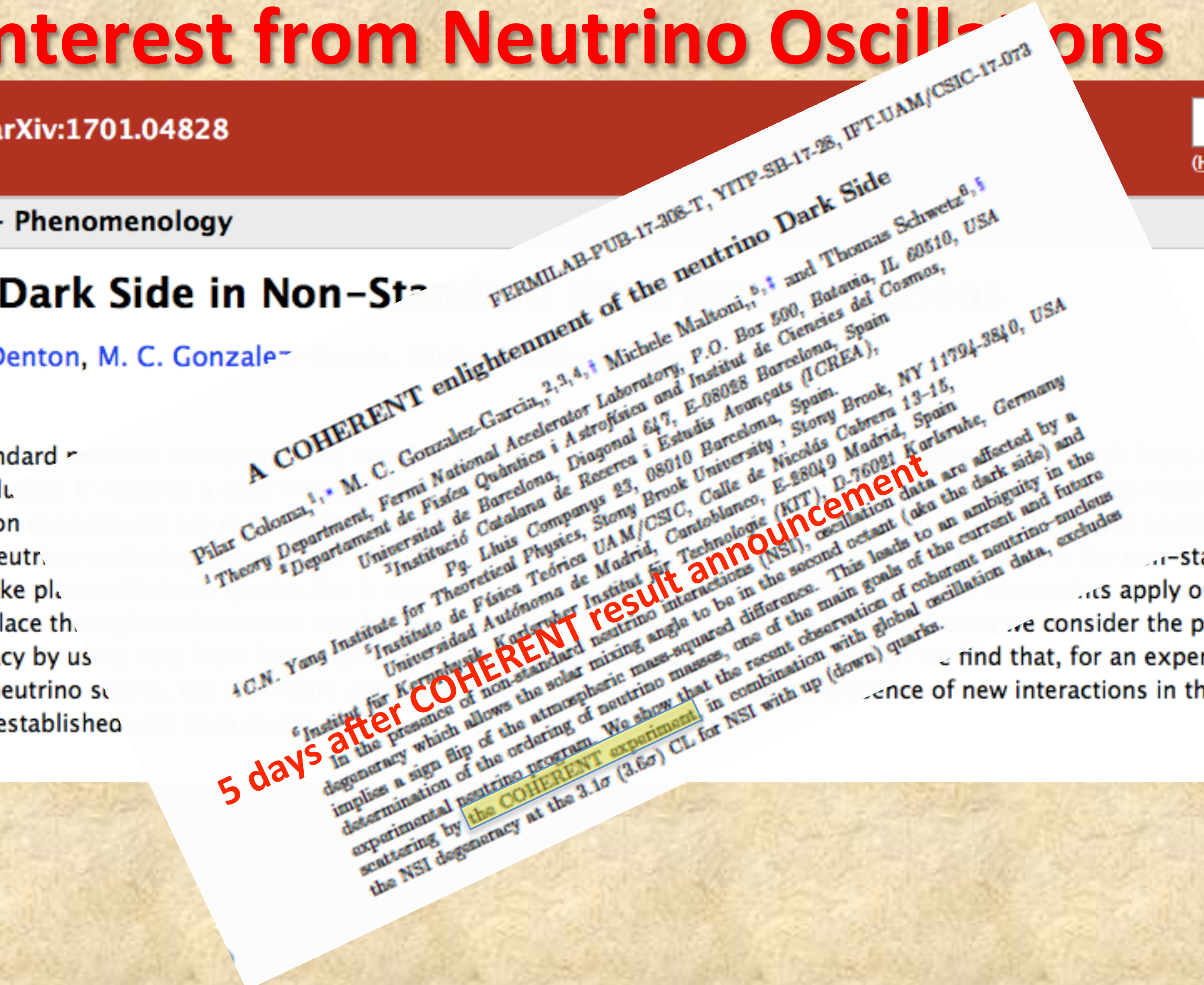
High Energy Physics – Phenomenology

Curtailing the Dark Side in Non-St…

Pilar Coloma, Peter B. Denton, M. C. Gonzale…

(Submitted on 17 Jan 2017)

In presence of non-standard n… …he so-called LMA-Dark solu… ordering. Non-oscillation … …ion experiments with the neutr… …-standard neutrino interactions take pl… …ts apply only if the new interactions take place th… …we consider the possibility to resolve the degeneracy by us… …find that, for an experiment using a stopped-pion neutrino s… …ence of new interactions in the neutrino sector will be established…


FERMILAB-PUB-17-308-T, YITP-SB-17-28, IFT-UAM/CSIC-17-073

A COHERENT enlightenment of the neutrino Dark Side

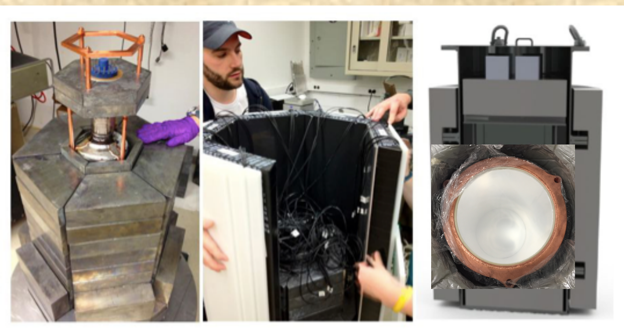
Pilar Coloma,[1,*] M. C. Gonzalez-Garcia,[2,3,4,†] Michele Maltoni,[5,‡] and Thomas Schwetz[6,§]

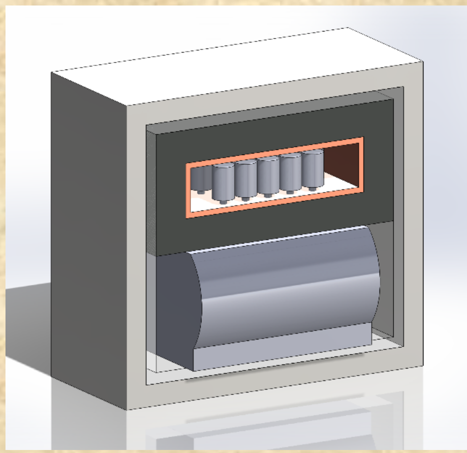
[1] Theory Department, Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, IL 60510, USA
[2] Departament de Fisica Quàntica i Astrofisica and Institut de Ciencies del Cosmos, Universitat de Barcelona, Diagonal 647, E-08028 Barcelona, Spain
[3] Institució Catalana de Recerca i Estudis Avançats (ICREA), Pg. Lluis Companys 23, 08010 Barcelona, Spain.
[4] C.N. Yang Institute for Theoretical Physics, Stony Brook University, Stony Brook, NY 11794-3840, USA
[5] Instituto de Física Teórica UAM/CSIC, Calle de Nicolás Cabrera 13-15, Universidad Autónoma de Madrid, Cantoblanco, E-28049 Madrid, Spain
[6] Institut für Kernphysik, Karlsruher Institut für Technologie (KIT), D-76021 Karlsruhe, Germany

In the presence of non-standard neutrino interactions (NSI), oscillation data are affected by a degeneracy which allows the solar mixing angle to be in the second octant (aka the dark side) and implies a sign flip of the atmospheric mass-squared difference. This leads to an ambiguity in the determination of the ordering of neutrino masses, one of the main goals of the current and future experimental neutrino program. We show that the recent observation of coherent neutrino-nucleus scattering by the COHERENT experiment, in combination with global oscillation data, excludes the NSI degeneracy at the 3.1σ (3.6σ) CL for NSI with up (down) quarks.

Three Detector Technology for COHERENT Phase I

CsI LAr HPGe NaI





14 kg 30 kg 10 kg 185 kg

Liquid Argon Detector

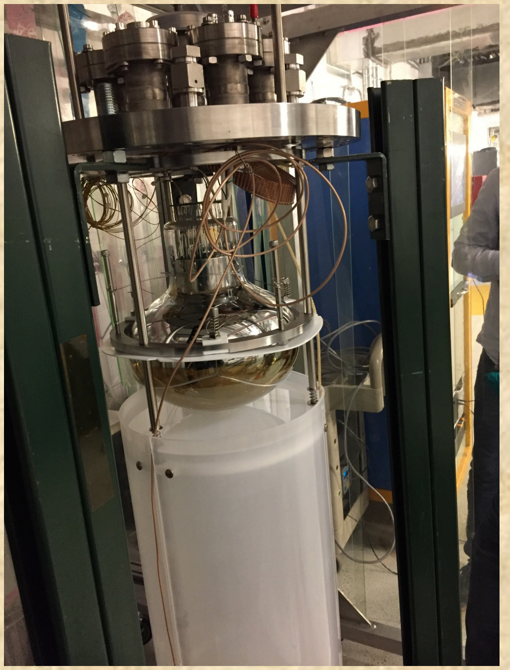
Specs:

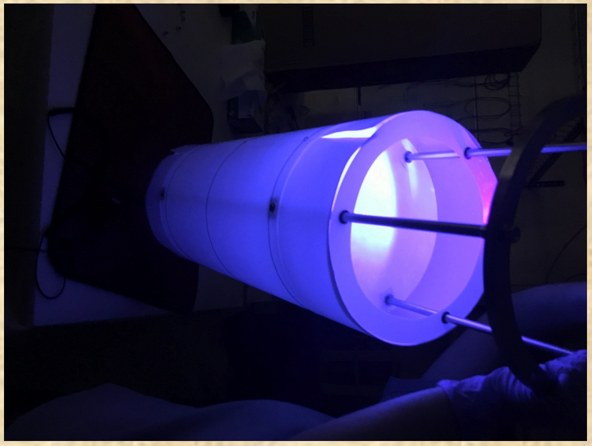
- LAr
  - ~30 kg fiducial volume
- 2×Hamamatsu R5912-02-MOD 8”PMTs
  - 8 ‘’ borosilicate glass window
  - Standard bialkali photocathode (K_2CsSb)
  - 14 dynodes
  - QE: 18%@400 nm
- WLS - Tetraphenyl butadiene (TPB)
- Cryomech cryocooler – 90 Wt
  - PT90 single-stage pulse-tube cold head
  - compressor: CP950

LAr Construction

- Acrylic cylinders and discs coated by TPB
  - 3 x cylinder by airbrush
  - 2 x disk by evaporation at ORNL
- The thickness of the TPB is optimal ~ 0.2 mg/cm^2
- Teflon wrap

- Detector was assembled at clean room at the staging area



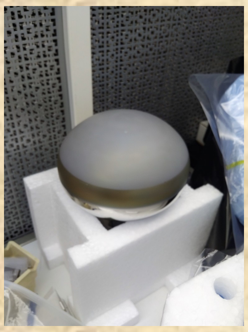


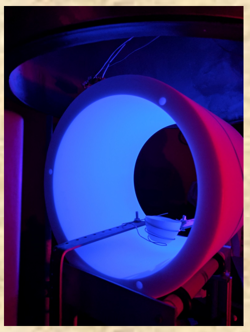
We conducted major refurbishing of LAr detector during June-July

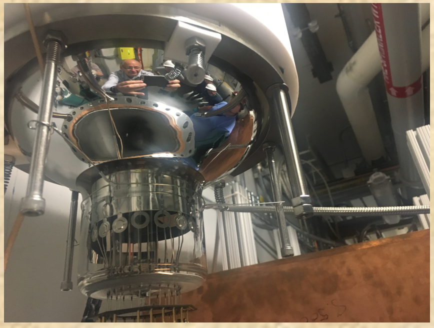
- First prototype worked from January till May 2017.
- No Lead shielding has been installed
- Cryogenics and vacuum – no problems
- It has very low light output 0.3 ph.e. /keV

June – July 2017 Detector has been opened and rebuild

- New PMT, with frosty window and direct TPB coating
- New Teflon cylinder with TPB coating via evaporation

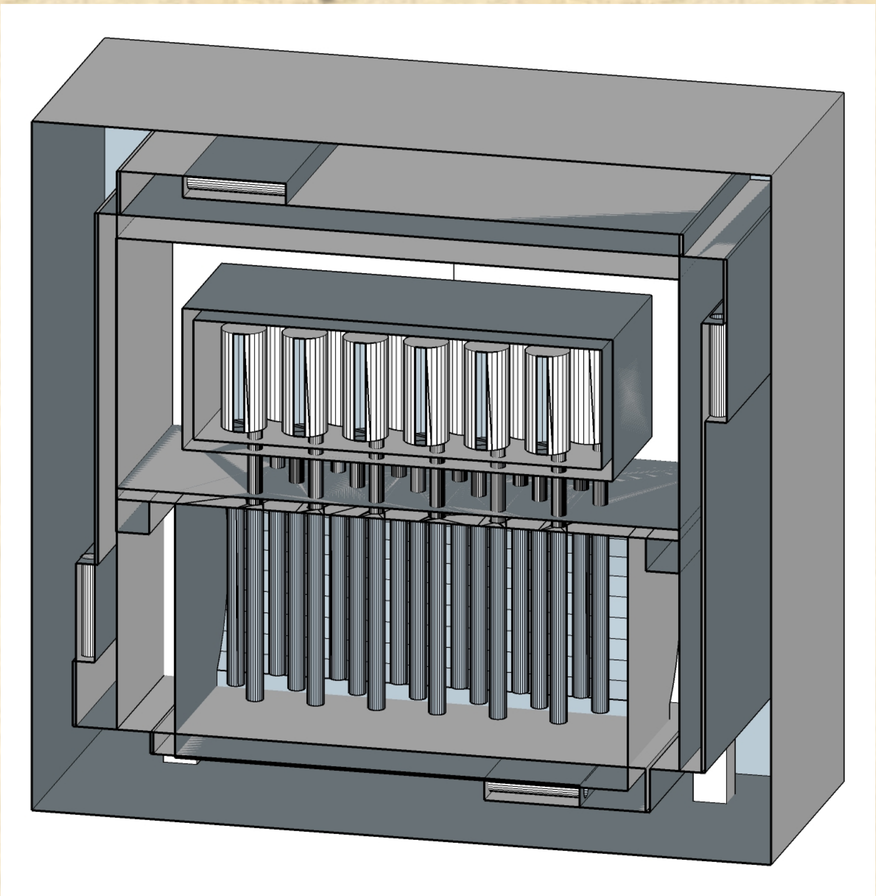






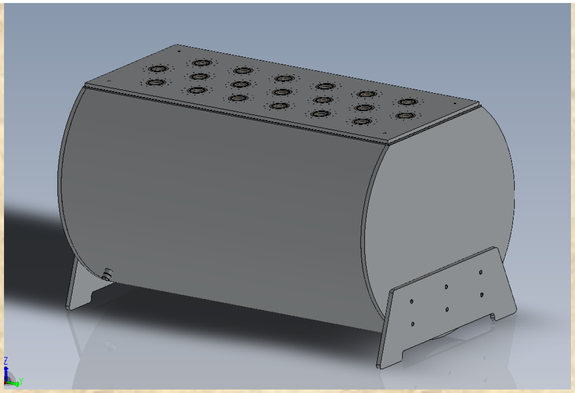
- Started to take data again from the second half of July
- Lead shielding is completed
- Should have 40 events by the end of the year.
- ^{39}Ar is the biggest concern

Array of Germanium Detectors (NC)



Up to 10 kg of Ge detectors using common LN pool

Surrounded by comprehensive shielding

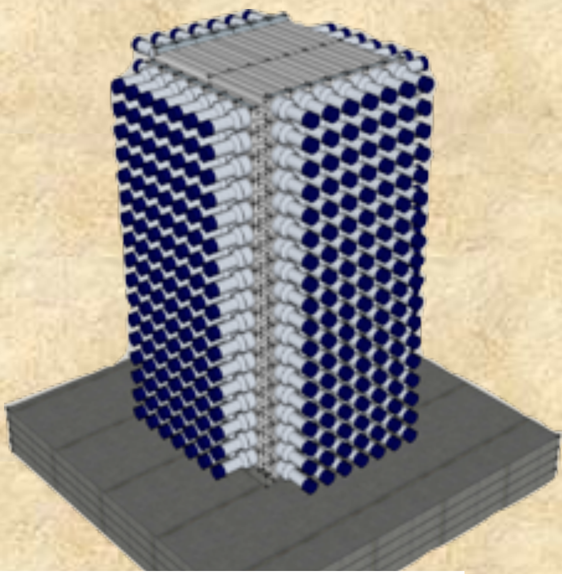


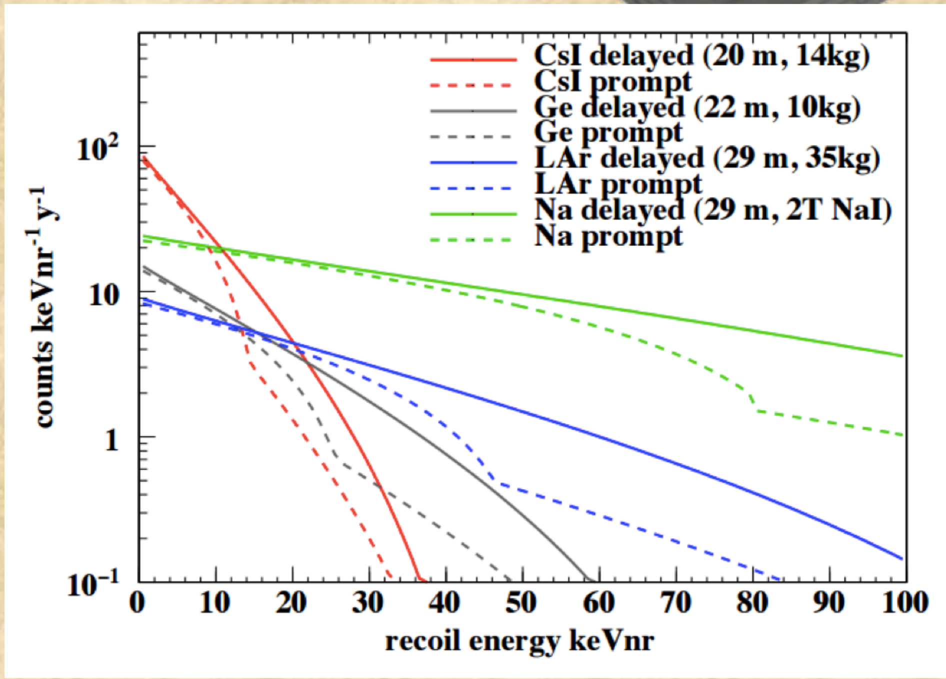
Dewar fabrication nearing completion.

Expected deployment on site
Winter 2017.

NaI as a Neutrino Detector

- COHERENT deployed a 185 kg detector ~ 6 months ago
- Upgrade later this month: installation of a muon veto to reduce backgrounds to the I-127 CC interaction
- COHERENT has access to ~ 9T of NaI scintillator detectors—initial plans are to deploy 2T that are already in-hand
- Design of 2T DAQ and shield is progressing





List of some ideas for neutrino physics at the SNS

Test of the S.M. via NSI and Sun$^2\theta_w$

Study Neutrino oscillations – Test of the LSND claim

Neutrino Magnetic moment

Measurement of Neutrino Spectra from Muon Decay

**CC and NC Cross section Measurements
for Supernovae Physics, and Nuclear Theory**

Nuclear Form Factors (neutron radius)

Conclusion

SNS is the world most powerful pulsed neutrino source

Neutrino Energy range at the SNS is just right to study CEvNS

There is comprehensive and exciting neutrino program at the SNS

Presently COHERENT collaboration is engage in deployment of the first generation of detectors to see “First Light”

We just detected the “First Light” with CsI detector

There are many ideas what to do next with neutrinos at the SN

We hope to collect even more ideas after that workshop

OAK RIDGE NATIONAL LABORATORY

Neutrino Studies at the Spallation Neutron Source

Overview presentation

Proposal

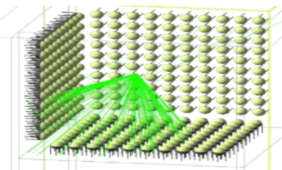
Steering Committee

Collaborators

2003 Project Workshop

Photo & Image Gallery

Info For Collaborators



Thursday, August 28

8:30-8:50	G.R. Young (ORNL)	Welcome & Workshop Task
8:50-9:30	G.M. Fuller (UCSD)	Neutrino-Nucleus Interactions in Physics and Astrophysics
9:30-10:10	D.J. Dean (ORNL)	Neutrinos and Nuclear Structure
10:10-10:30	Coffee Break	
10:30-10:50	R.L. Burman (LANL)	Previous Measurements with Stopped-pion Neutrinos
10:50-11:30	Y.V. Efremenko (UT)	Possibilities at the SNS
11:30-12:00	F.T. Avignone (USC)	The Status of Neutrino Physics
12:00-1:00	Lunch	
1:00-1:20	R.L. Burman (LANL)	Neutrino Flux Normalization
1:20-1:50	R.L. Talaga (ANL)	Calibration of the OMNIS-LPC Supernova Neutrino Detector
1:50-2:20	A.B. Balantekin (Wisconsin)	Solar Neutrinos, Neutrino Cross Sections, and NUSEL Developments
2:20-2:50	E.E. Kolbe (Basel)	Fundamental Physics with SNS2 and RIA
2:50-3:30	Discussion + Coffee	
3:30-3:45	A.E. Ekkebus (SNS)	Overview of the Spallation Neutron Source
3:45-4:00	G.L. Greene (UT)	Logistics of SNS Projects
4:00-5:00	SNS Tour	
5:00-5:20	A.R. Fazely (Southern U.)	Physics with Pion Decay-in-Flight Neutrinos
5:20-5:40	R.L. Tayloe (Indiana)	The FINeSE Experiment
5:40-6:00	G.J. VanDalen (Embry-Riddle)	Oscillations at the SNS Neutrino Source
7:30-	Dinner	Riverside Tavern (Get map) (Get directions)

8:30-9:00	P. Vogel (Cal-tech)	Neutrino-Nucleus Cross Sections: Measurements Confront Calculations
9:00-9:30	W.R. Hix (UT)	Neutrino-Nucleus Interaction and the Core Collapse Supernova Mechanism
9:30-10:00	B.S. Meyer (Clemson)	Neutrinos and Supernovae Nucleosynthesis: Importance for Astronomy and Cosmochemistry
10:00-10:20	Coffee Break	
10:20-10:50	G. Mills (LANL)	Previous Neutrino Measurements and Limitations
10:50-11:20	W.C. Louis (LANL)	Future Experiments at the SNS
11:20-12:00	Open Discussion	
12:00-12:40	Lunch	
12:40-2:30	Mezzacappa (chair)	Theory Breakout Session
12:40-2:30		Experiment Breakout Session
	I. Stancu (Alabama)	Homogeneous Detectors: Technology and Performance
	K.A. Lan (U. Houston)	Thin wall straw tube gas detector
	Efremenko/Burman	Shielding Issues
2:30-3:30	Wrap-Up	