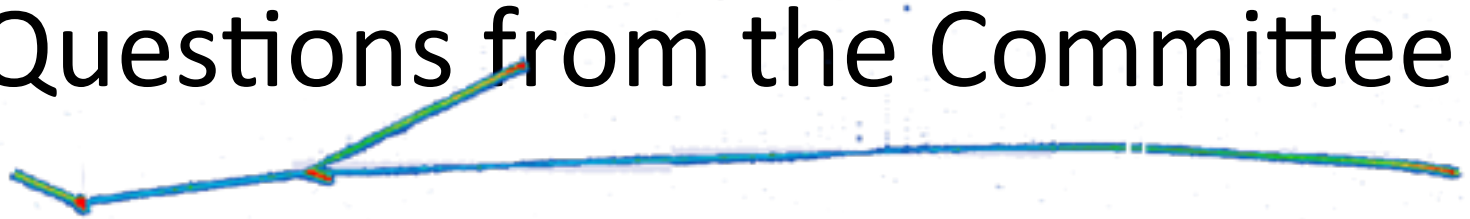
Questions from the Committee

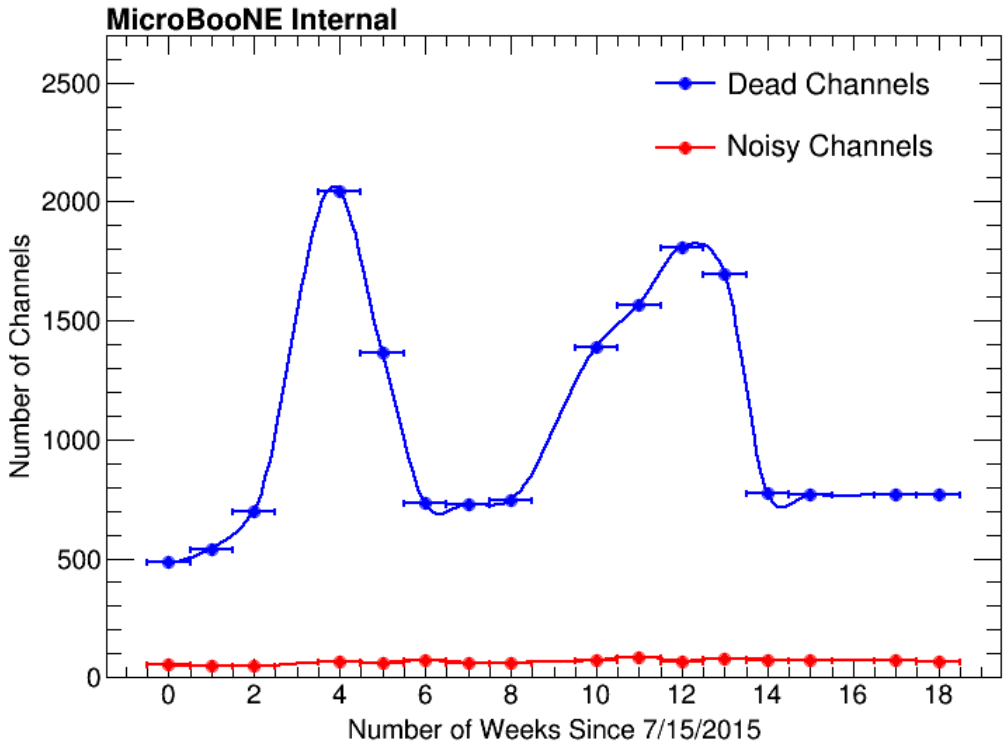


- 1) Are you still losing channels? Can you provide data that supports your conclusions (e.g. no. of non-responsive channels vs. time)?
- 2) Can you please spell-out for us your run plan, highest priority analyses, studies required, reprocessing plans, intermediate milestones, etc for 2016? *(split into 3 for operations/technical coordination, physics analysis, analysis tools)*
- 3) Performance metrics and specifications for a) high priority analyses in 2016 and b) low E excess analysis.
- 4) Which analyses would be impacted by using a PE threshold significantly larger than originally planned?
- 5) What do you most need from the lab or collaboration?
- 6) In the table of spare parts provided in the EOP, can you please add a column that specifies the number of units required for the experiment?

1) Dead/Noisy Channel History at MicroBooNE

Jonathan Asaadi (UT Arlington), Michael Mooney (BNL)

1) Dead/Noisy Channels

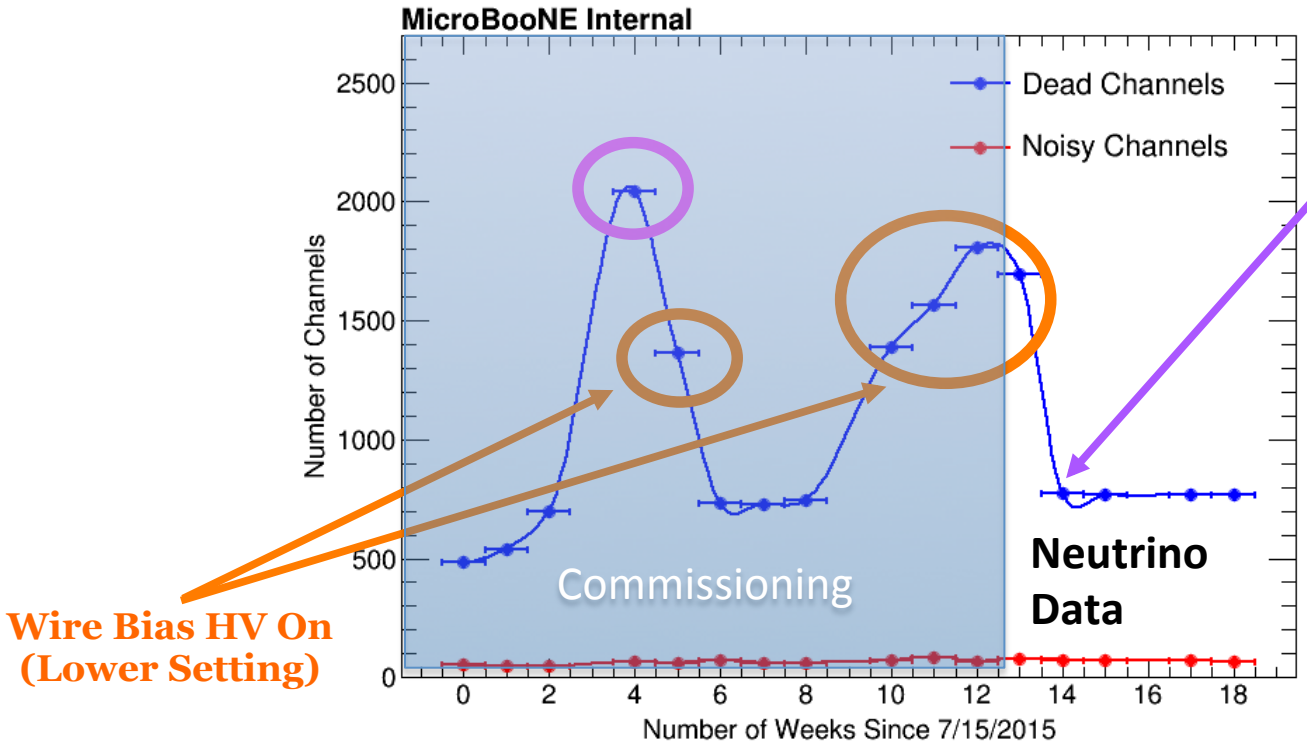


Total Channels:

8256

♦Shown are **dead** (long-term **and** transient) and **noisy** channels
♦Most dead channels transient, fixed with change in ASIC settings
♦Non-transient channels **stable** since wire bias HV settings lowered

1) HV/ASIC Settings



Total Channels:

8256

- Shown are **dead** (long-term **and** transient) and **noisy** channels
- Most dead channels transient, fixed with change in ASIC settings
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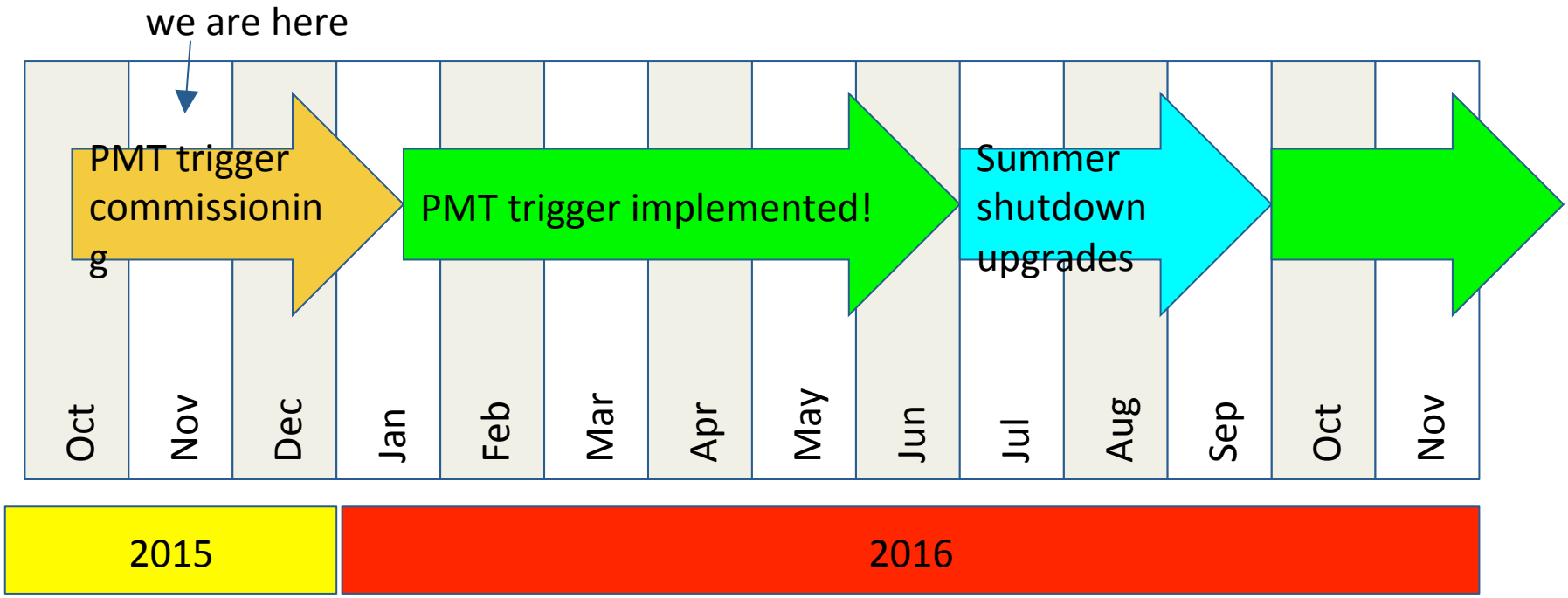
Question 2a)

Can you please spell-out for us your run plan, highest priority analyses, studies required, reprocessing plans, intermediate milestones, etc for 2016? *(split into 3 for operations/technical coordination, physics analysis, analysis tools)*

Run plan


we are here
PMT trigger commissionin g
PMT trigger implemented!
Summer shutdown upgrades
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2015
2016

PMT trigger commissioning plans

PMT Trigger Activities

Activities and runs part of run plan already

(1) Cosmic Muon Paddle data during beam down times (part of current run plan) - with paddle readout
   (a) In addition to prescaled trigger during normal running
   (b) High-statistics, clean, Michel electron sample

(2) Measurements of a spare MicroBooNE 8" PMT in Tall Bo (a LAr test stand). Plan is to run by the end of the year. Lead by Radon Task Force.
   (a) Will pass LAr through filter in order to try and measure radon rate (using Bi-Po coincidence events).
   (b) Will also study PMT dark rate when exposed to ~5 kHz of cosmic-muon level light (100-2000 pe). Is there an increase in the steady PMT dark rate?

Proposed additional PMT Trigger Activities

These are proposals which will help understand possible radon contamination - currently under discussion

(1) Remove of ~80% the filter material. Led by Stephen Pordes under the RTF. Planned to occur by the end of the year

(2) Improve trigger schemes in the firmware by **triggering on clusters of neighboring PMTs**

(3) A **12.5 day run** where the **filters are bypassed** for the first 10 days (In proposal stage)

(a) Goal is to observe the rate, pe spectrum, etc. after a several radon-222 lifetimes (3.8 days). The pulses observed after this time would tell us about any other sources of the pe rate

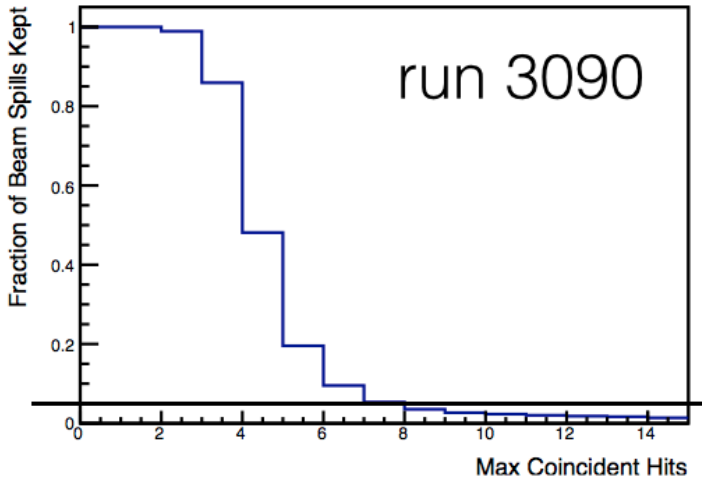
Example of using neighboring clusters for Trigger

Implementing Clustering in Trigger will help a little

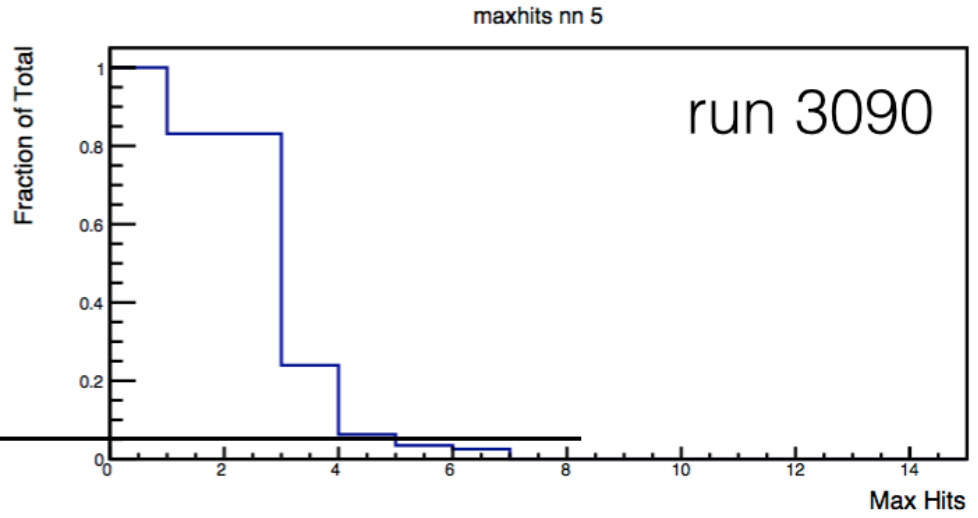
Moves pe threshold from 8 to 5 pe (for 5% accidental fraction)

requires firmware update.

Current trigger



5 Nearest-Neighbors trigger



Normal running configurations

Trigger rates

- Before PMT trigger is commissioned:
  - unbiased BNB at 2-5 Hz
  - unbiased EXT (off-beam triggers) at 0.1 Hz

- After PMT trigger is commissioned:
  - BNB at 2-5 Hz
    - PMT trigger brings down to ~1%
  - EXT pulser to match BNB 1D rate
    - PMT trigger brings down to ~1%

- Additional triggers from:
  - Muon counter system (with no MuCS readout) prescaled to ~0.3 Hz
    - Implement in the next 2 weeks
  - Unbiased EXT triggers (a few percent of the biased trigger rate)
    - Once the PMT trigger is implemented

Calibration run plan

- Laser runs
  - 1/week to 1/month (under study at the moment)
- Pulser runs
  - 1/month or less frequently
- MuCS runs (with MuCS readout)
  - As downtime allows

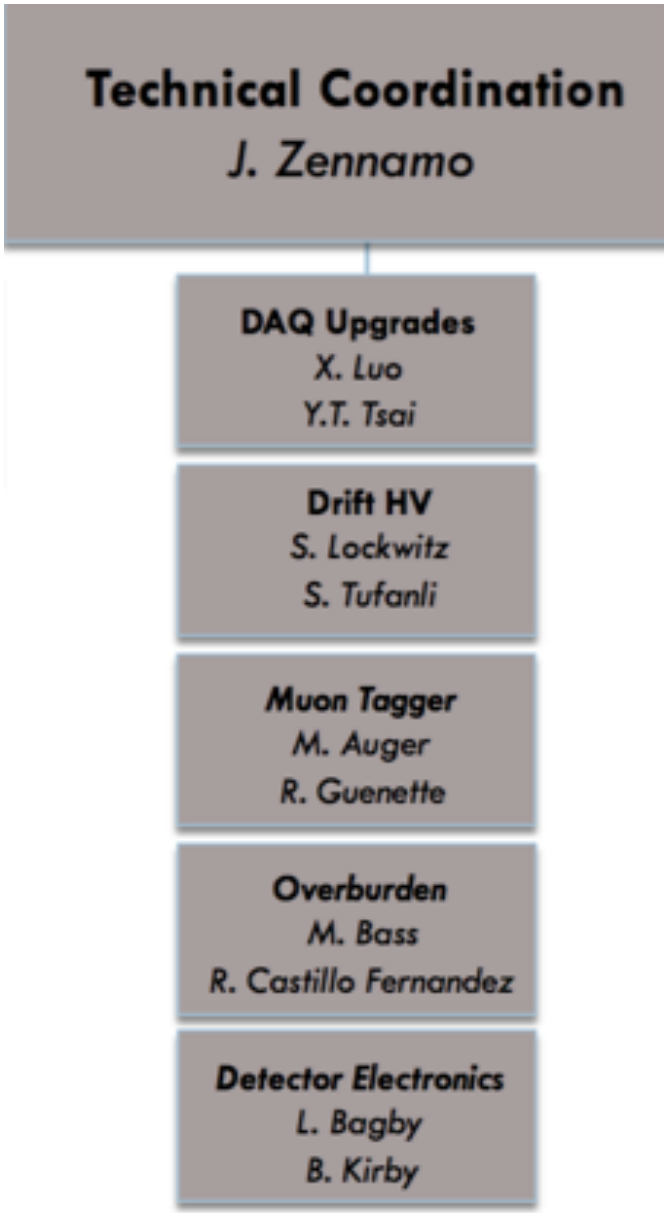
Summer shutdown upgrade proposals

Experimental Program Enhancement Plan

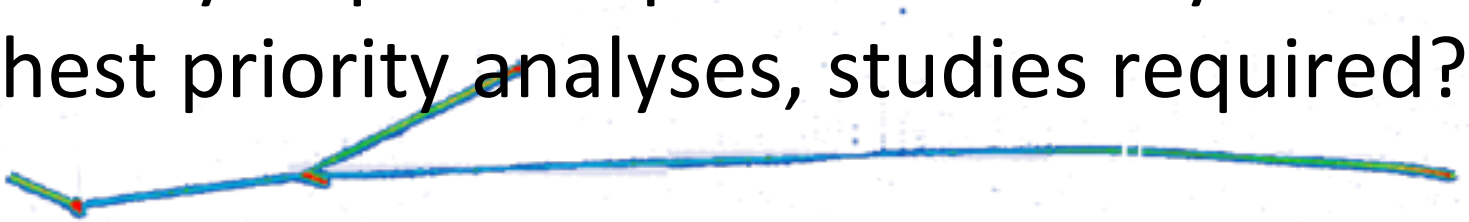
New groups have been formed to define the impact of specific detector upgrades will have on the overall physics program

The goal of these groups will be to define the necessary scope of their upgrade over the next 9 months and actualize it during the 2016 summer shutdown

This may affect the run plan past summer 2016

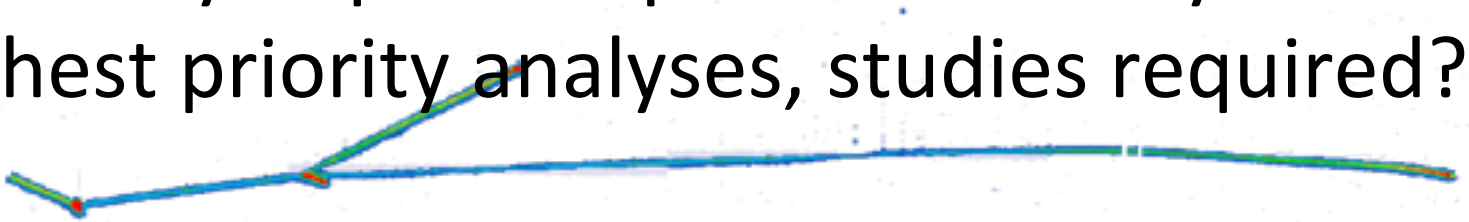


2b) Can you please spell-out for us your highest priority analyses, studies required?



- Detector physics
  - Purity measurements
    - Measurement using through-going cosmic rays
  - Cosmic ray characterization
    - Data/MC tuning
    - Cosmic removal effectiveness
  - Recombination
    - Use cosmic paddle triggered data to characterize recombination for MIPs and for stopping muons
  - Diffusion
    - Measurement using through-going cosmic rays
    - Important for future detector optimizations

2b) Can you please spell-out for us your highest priority analyses, studies required?



- Cross sections: first results
  - ν_μ CC inclusive cross section and single differential cross section in muon momentum and muon angle
    - Will help develop all basic tools needed for other channels
    - Largest statistics
- Low energy excess: updated sensitivity
  - Realistic background estimations
    - Including intrinsics, NC π^0 mis-id, cosmics, and beam-induced, detector-external backgrounds
  - Efficient ν_e selection algorithms
- Beam
  - MiniBooNE flux check

2c) Can you please spell-out for us your run plan, highest priority analyses, studies required, reprocessing plans, intermediate milestones, etc for 2016?

- Intermediate milestones for Summer 2016 results
  - "MCC7": Simulation campaign with "as-is" detector
    - Finalizing requirements, planning software work, and preparing production plans.
    - Target completion date: Jan 2016
  - Signal reconstruction chain finalized
    - Optimize noise filtering, signal calibration, raw signal reconstruction, and hit reconstruction for detector conditions
    - Target completion date: Jan 2016
  - Higher-level reconstruction chain finalized
    - Optimize cluster, track, and shower reconstruction with updated hit reconstruction, especially optimizing for dead/noisy wires
    - Target completion date: March 2016
    - Scheduling software analysis workshop, tentatively Feb 29-Mar 4

2c) Can you please spell-out for us your run plan, highest priority analyses, studies required, reprocessing plans, intermediate milestones, etc for 2016?

- Data processing plans
  - Simulation
    - Generation+reconstruction campaign for Jan 2016
    - Reprocessing of reconstruction for March 2016
  - Data, Flash-filter: Requiring flash > 50 PE (neutrino ID threshold)
    - Continue to run reconstruction on events with significant flashes; use to evaluate reco tools and for near-term priority physics results
  - Data, trigger eff:
    - Continue to provide samples as needed for trigger efficiency studies, apply Michel electron reconstruction/selection
  - Data, reprocessing: Updated reconstruction software on entire dataset, post-application of PMT trigger
    - Signal reconstruction chain finalized → initial reprocessing, Jan 2016
    - 2D/3D reconstruction chain finalized → final major reprocessing, March 2016

3) Performance metrics and specifications for a) high priority analyses in 2016 and b) low E excess analysis.

Metrics vs. Specifications

- Metrics
  - Used to quantify progress towards analysis goals as we update our analysis methods and tools
- Specifications
  - Quantify when metrics meet analysis requirements
  - Based on specific analysis goals

Common metrics for high priority analyses in 2016

- PMT flash finding efficiency
  - Key input for neutrino event selection efficiency estimates
- PMT flash-track matching efficiency (t_0 reconstruction)
  - Lots of analyses such as purity, diffusion, and recombination depend on matching PMT flashes to tracks
- Tagging efficiency for tracks entering/exiting TPC
- Track reconstruction efficiency
  - Matching track angle, length

Metrics and specifications for detector physics measurements

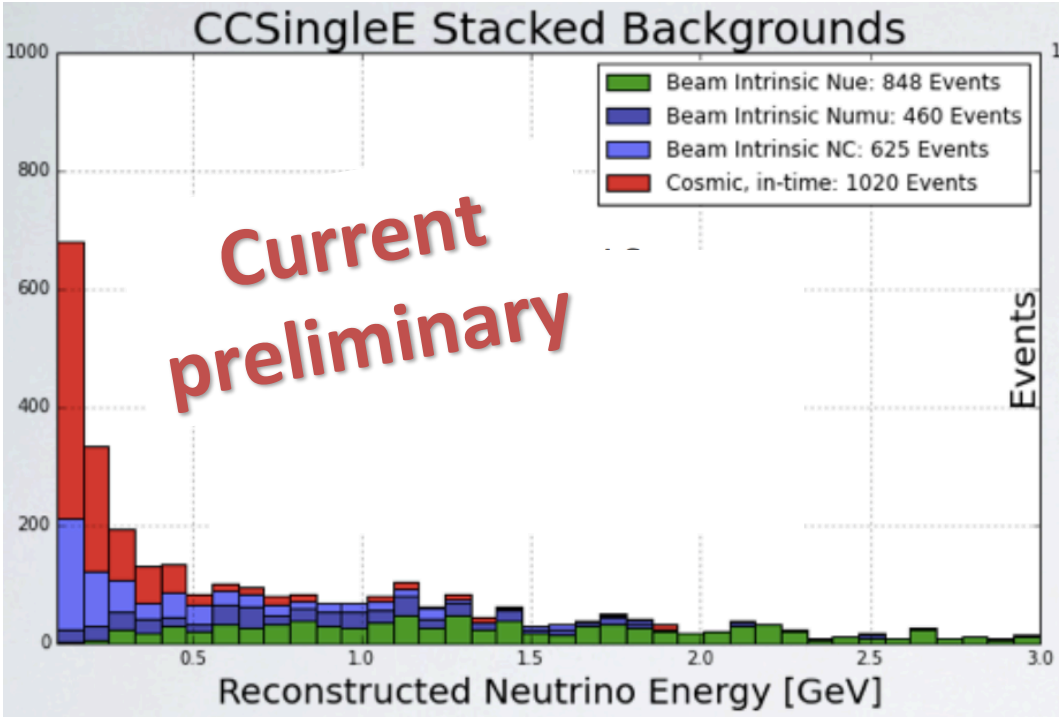
- Purity, recombination, and diffusion measurements all make use of common metrics on previous slide
- For detector physics measurements, specifications for these metrics are all focused on achieving high purity (low efficiency is OK)

Metrics for Low Energy Excess Analysis

- ν_e CC Reconstruction Efficiency (>200 MeV)
  - Shower reconstruction efficiency (>100 MeV)
  - Shower data/MC comparisons
    - 3D Axis, 3D Start Point, Energy, dQ/dx, dE/dx
  - ν_e CC selection efficiency on reconstructed objects
- π^0 Background Rejection
  - π^0 reconstruction efficiency
  - π^0 reconstructed mass resolution
- Cosmic rejection
  - ν_e CC Mis-ID rate on off-beam data events
- Cosmic + beam-induced, TPC-external rejection
  - ν_e CC Mis-ID on neutrino MC + cosmic-overlay events
- ν_e CC Energy Resolution (>200 MeV)

Specifications for Low Energy Excess Analysis

- The specifications will be based on maximizing our sensitivity to a MiniBooNE-like electron signal
- Current analysis framework being developed to include few remaining pieces, including PMT information, π^0 reconstruction, and track PID information



Metrics for ν_μ CC inclusive analysis

- ν_μ selection efficiency
  - Full-length track reconstruction efficiency
    - Matching track start/stop point, direction (calorimetry), length
    - Track angular resolution
    - Momentum resolution
  - Vertex reconstruction efficiency
- Cosmic rejection
  - ν_μ CC Mis-ID rate on off-beam data events
- Cosmic + beam-induced, TPC-external rejection
  - ν_μ CC Mis-ID on neutrino MC + cosmic-overlay events
- Muon/pion separation

Specifications for ν_μ CC inclusive analysis

- The specifications will be based on minimizing our total error on the ν_μ CC inclusive single differential cross sections
- The first full analysis chain for this analysis has been established (see public note)
  - Remaining pieces are improvements in cosmic removal, tracking efficiency and resolution, and the development of a common framework for treatment of systematic uncertainties (beam, cross sections) to be used for all MicroBooNE analyses.

Question 4

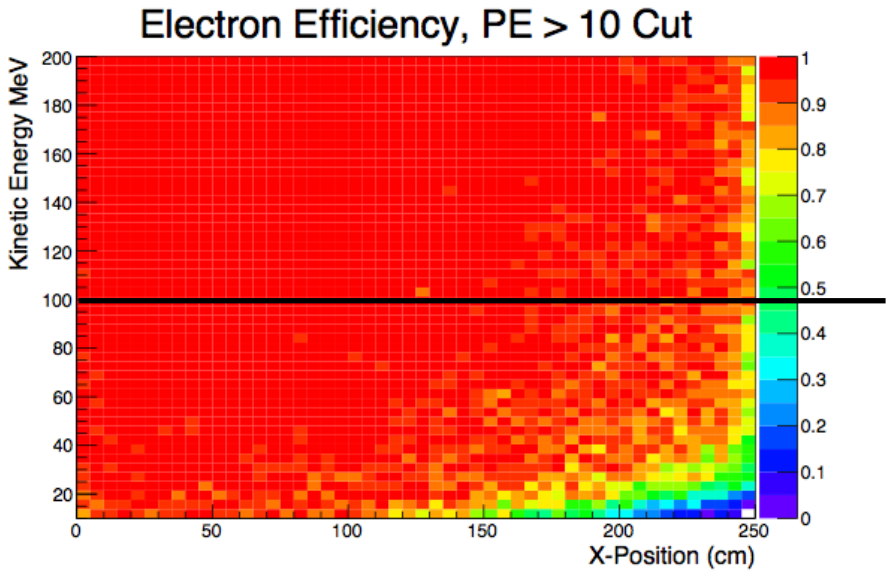
- Which analyses would be impacted by a PE threshold significantly higher than originally planned?

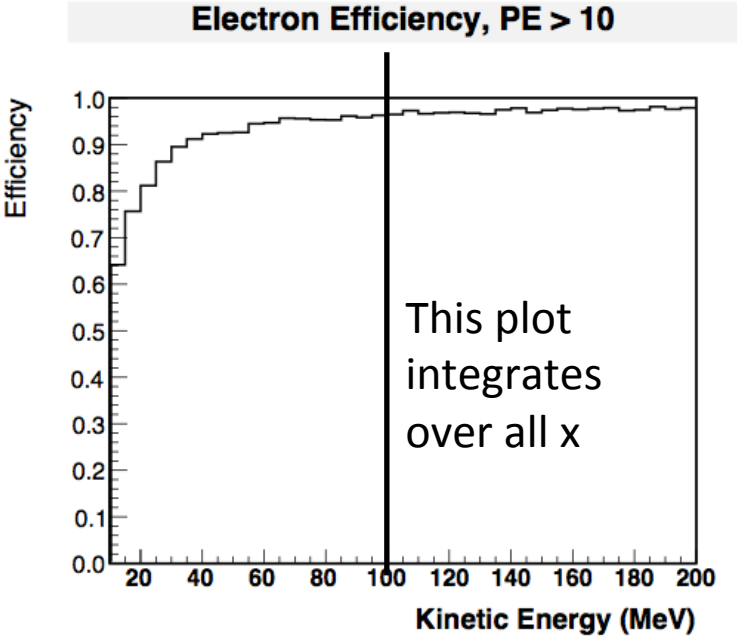
Answer

- The TDR aimed for a >2 pe threshold
- We will look at the effect of a >10 pe cut, which reduces the fraction of BNB spills accepted to <5%
- Note that we plan to be doing everything in our power to understand and reduce the background light rate
  - e.g. remove large fraction of filter material to reduce emanation rate

Analyses

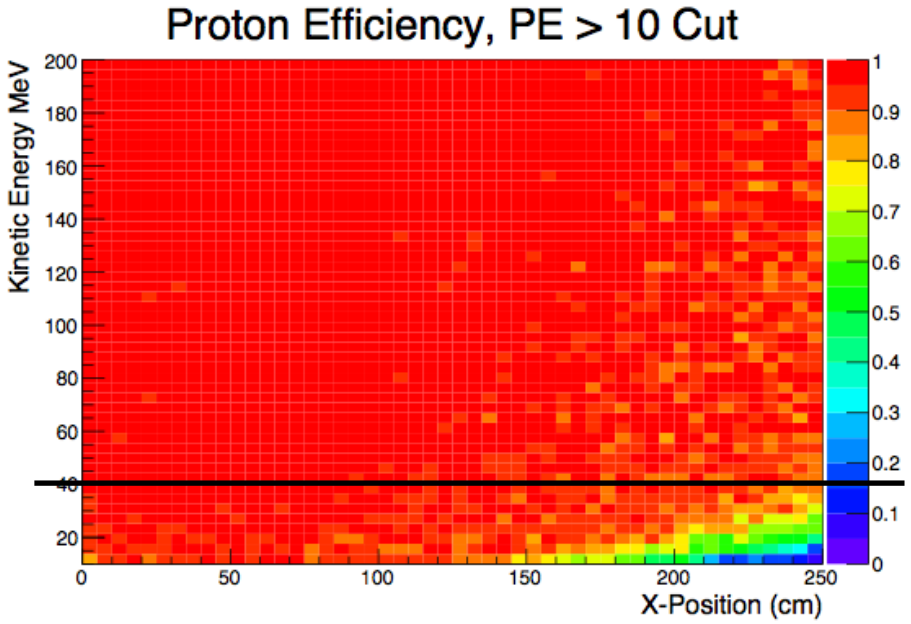
- List of some analyses and an estimate of their energy ranges
  - **Low energy excess**: ~140 MeV electrons from 200 MeV neutrinos + some proton energies
  - At >10 PE should be fully efficient across detector for most of the electron energy range

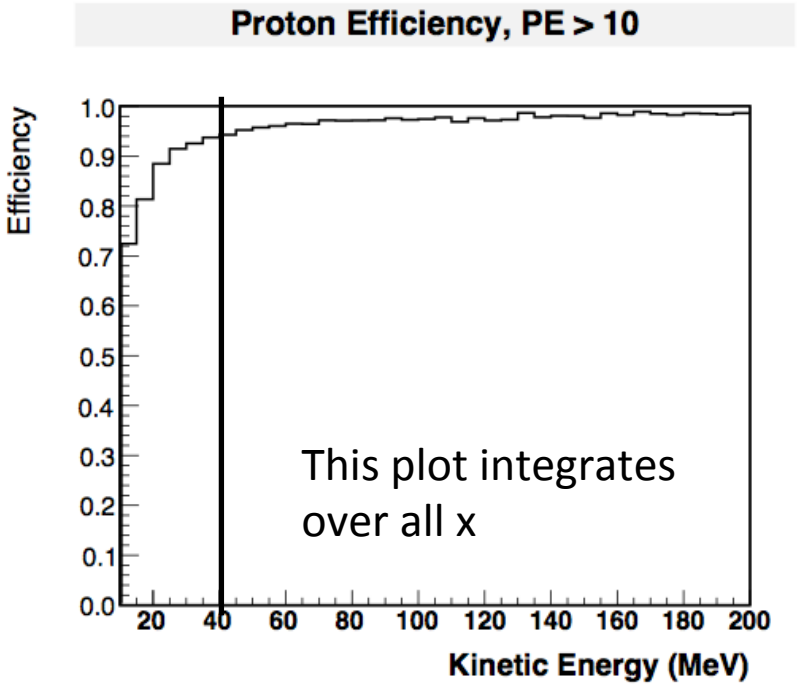




Analyses

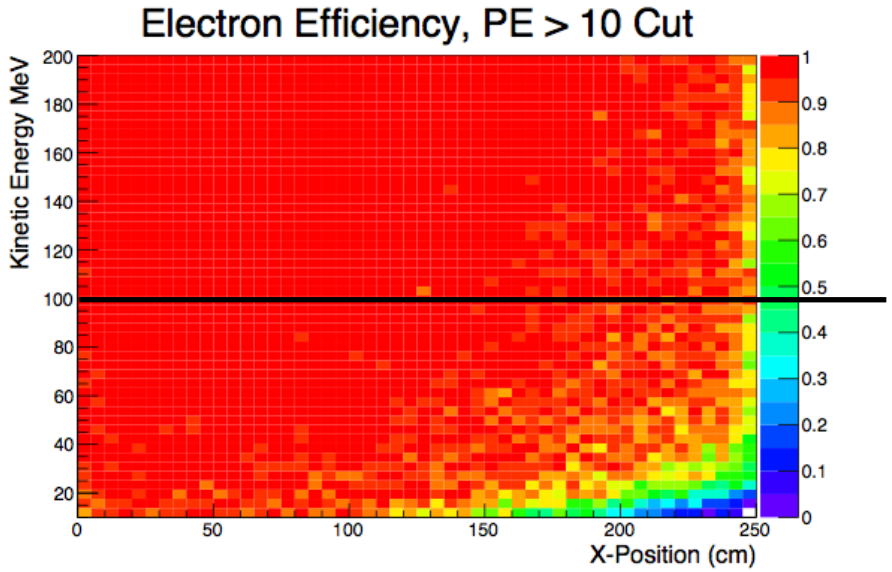
- List of some analyses and an estimate of their energy ranges
  - Some analyses require detecting low energy protons: **NC-elastic, Δ_s, dark matter searches**
  - The TDR set a goal of detecting 40 MeV protons at an efficiency near 1. We are above 90% for a >10 PE cut





Analyses

- List of some analyses and an estimate of their energy ranges
  - **indirect dark matter searches**: main channels are pi0+gamma, pi+ + pi-. 100s of MeV of e- energy
  - Energy should be high enough to be mostly unaffected



Analyses

- List of some analyses and an estimate of their energy ranges
  - **Proton Decay**: These events are at energies near 940 MeV. So we do not expect a lot of problems for this analysis

Analyses

- List of some analyses and an estimate of their energy ranges
  - **Supernova stream**: uses an entirely different readout scheme, so this threshold doesn't affect it
  - Background rate could affect ability to search for coincident hits. But expect about 20-30 hits within the time of a few ns, so should be over current background rate of accidental coincidences

Summary Table

Analysis	**Energy Range**	**Effect of >10 PE cut**
Low Energy Excess	>200 MeV neutrino ~140 MeV e- + proton	minimial
Lower energy excess	as low as possible	start to become inefficient in e- by 50 MeV
CC-inclusive x-sec (as currently studied)	Already uses >50 pe cut	None
NC-elastic,direct dark matter, Δ_s	Goal is 40 MeV proton and above	90% efficiency at 40 MeV
Indirect dark matter	100s of MeV e-	minimal impact
Proton decay	~940 MeV total energy	Minimal
Supernova neutrinos	10s of MeV	Different stream, so PE threshold not an issue

Efficiency vs. OpFlash Cut

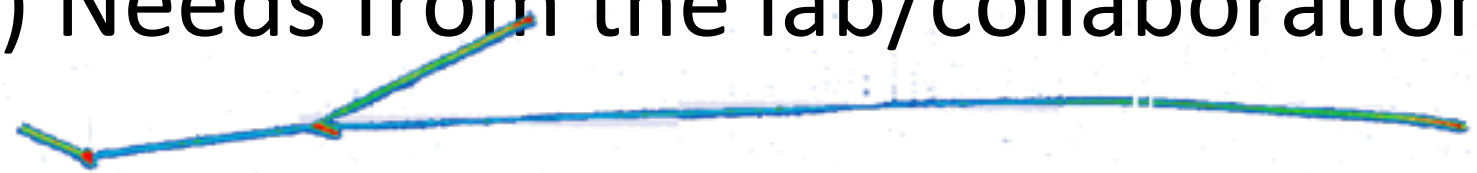
For different Final States

Using previous BNB neutrino MC for 128 kV field. We expect that these events have worse light yield than what the detector sees.

All entries include Edeposited>0 cut

NPE Cut	CC Numu mu+p+X	cc nue e+p+X	NC p+X	NC Pi0+X
>=0	100%	100%	100%	100%
>1	96%	94%	95%	94%
>2	96%	94%	95%	94%
>4	95%	93%	93%	92%
>10	95%	93%	89%	91%
>20	94%	93%	84%	90%

5) Needs from the lab/collaboration



- Office Space!!!!! This always becomes a crisis situation in the summer and is now becoming a chronic problem year round (new people!)
- TSW with PPD to clarify support for 24/7 cryo ops team and LArTF
- Priority from the lab on cryogenic engineering in support of understanding and mitigating the radon problem in the detector
- Funding for Spares from FNAL for their responsibilities. Support for spares from other groups where appropriate
- Admin support to monitor all collaborators ITNAs and set up ITNAs for new collaborators
- Continued support for costing and design of upgrades (Overburden, muon tagger, etc.)
- Collaboration support for more Operations experts (Online Monitoring, etc.)

6) List of Spares

Subsystem	Part name / description	Model number	Number in uBooNE	Number of spares	Current location	Expected final location	Lead time for extra replacements	Responsible organisation
Readout Electronics	XMIT Board		9	2	LArTF	LArTF	4 months	Nevis
Readout Electronics	PMT Shaper Board		4	1	LArTF	LArTF	4 months	Nevis
Readout Electronics	PMT FEM Board		4	1	LArTF	LArTF	4 months	Nevis
Readout Electronics	CTRL Board		9	2	LArTF	LArTF	4 months	Nevis
Readout Electronics	TPC Trigger Board		1	1	LArTF	LArTF	4 months	Nevis
Readout Electronics	TPC FEM Board		130	12	LArTF	LArTF	4 months	Nevis
Readout Electronics	NIM module	688AL (level adapter)	5	2	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	623 (discriminator)	4	3	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	365AL (coincidence)	4	1	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	365ALP (coincidence)	0	1	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	375L (coincidence)	0	1	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	222 (gate generator)	3	2	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	428 (fan-in-fan-out)	2	1	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	620AL (discriminator)	0	2	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	1880 scaler	1	1	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	622 (coincidence)	0	1	LArTF	LArTF	2 hours	PREP
Readout Electronics	NIM module	429A (fan-in-fan-out)	2	1	LArTF	LArTF	2 hours	PREP
Trigger	Inline inverting transformer	EG&G IT 100	1	2	Wilson Hall	Wilson Hall		FNAL
HV	Glassman power supply	LX150N12	1	1	PAB	PAB	<10 weeks	ND
HV	Cable		1	1	PAB	PAB	2 weeks	ND
HV	Filter Pot		1	1	PAB	PAB	1 weeks	ND
HV	Cable		1	1	PAB	PAB	2-3 weeks	ND
HV	Feedthrough		1	1	MiniBooNE	MiniBooNE	2-3 weeks	ND
HV	Spring tip		1	1	PAB	PAB	2-3 weeks	ND

6) List of Spares

PMT	HV module		5	1+1	Wilson Hall	DAB	Unknown	MIT
PMT	Lambda PS	TDK-Lambda	1	In production		DAB		FNAL
Laser	Steerable Mirror	T-OMG		1	Wilson Hall	DAB		Bern?
Laser	Dichroic Mirror	266nm Dichroic Mirrors		4	Wilson Hall	DAB		Bern?
Laser	Water Filters	Flow XF6 3/8		4	Wilson Hall	DAB		Bern?
Laser	Flash Lamps	Flashlamps		2	Wilson Hall	DAB		Bern?
Laser	Brewster Polarizer	2-BFP-0266-2040		4	Wilson Hall	DAB		Bern?
Laser	Waveplate	2-CPW-ZO-L/2-0266		2	Wilson Hall	DAB		Bern?
Cabling	warm cabling		6.4 km	>=1 for every cable type	LArTF	LArTF		FNAL
DAQ	uboonedaq-evb		1	1	LArTF	LArTF	days	SCD
DAQ	uboonedaq-seb01		9	1	LArTF	LArTF	days	SCD
DAQ	uboonedaq-seb10		1	1	LArTF	LArTF	days	SCD
DAQ	10 Gigabit Network Interface Card		12	2	LArTF	LArTF	days	SCD
DAQ	PCIe Card w/ fuse			1	LArTF	LArTF		
Slowmon	Slow controls box		21	2	DAB	DAB	< 1 week	KSU/FNAL
Racks	Rack protection system		21	4	DAB	DAB		KSU/FNAL
Electronics	Calibration fanout			1	DAB	DAB		
Racks	Interlock		1	In production		DAB	1 month	
Racks	AC switch box		21	3	DAB	DAB		
Purity Monitor	LAr PM Electronics Module	Type 2, Jan 2013, Ser #15	3	1	Wilson Hall	DAB	1 month	FNAL
Purity Monitor	LAr PM Automation Module		3	1	LArTF	LArTF	1 month	FNAL
Purity Monitor	Flash Lamp Bulb	6427, 5J Large Bulb Xe	2	3	Wilson Hall	DAB	2 weeks	FNAL
Purity Monitor	Flash Lamp Housing		2	1	Wilson Hall	DAB	2 weeks	FNAL
Purity Monitor	Flash Lamp Power Supply	68826	2	1	LArTF	LArTF	2 weeks	FNAL