SNO Detector Performance

by R.G. Van de Water, U. of Pennsylvania
for the SNO Collaboration

Abstract

The Sudbury Neutrino Observatory (SNO) is a 1kT heavy water, 10000 photo−tube, realtime, state of the art water Cerenkov detector designed primarily to study Solar neutrinos. The SNO detector has been taking high quality production neutrino data for the last 7 months, as well as many electronic and source calibration runs to study the detector response and systematics. It has met or exceeded all design goals and expectations.

Construction Timeline

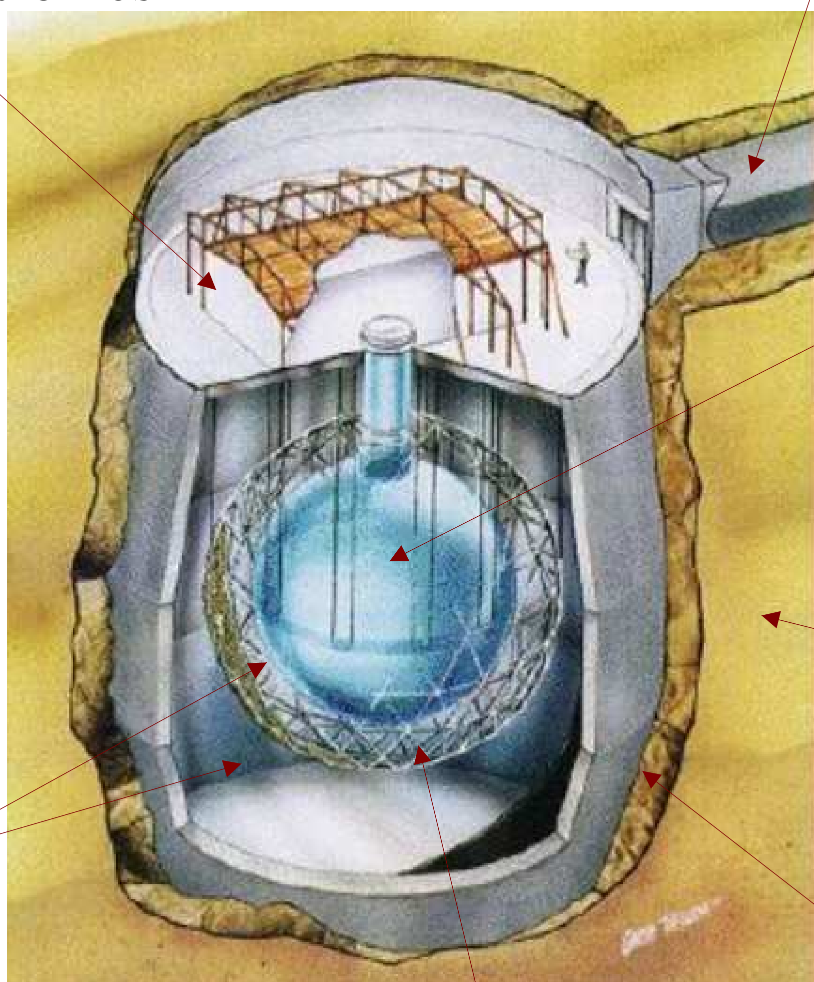
- Vessel construction completed, December 1997
- Air fill running April- September, 1998
- Water fill completed April, 1999
- Commissioning data, May- October, 1999
- Start of production data, ***November 2, 1999***

SNO Detector

2039 m underground[1] in Sudbury, Ontario, in INCO's Creighton Mine

Penn Electronics

Control Room



1 kT D_2O

Norite Rock

7 kT H_2O

Urylon liner

~ 10,000 PMTs on 17 m support

[1] 6000 mwe

Current Status

Since November 1999:

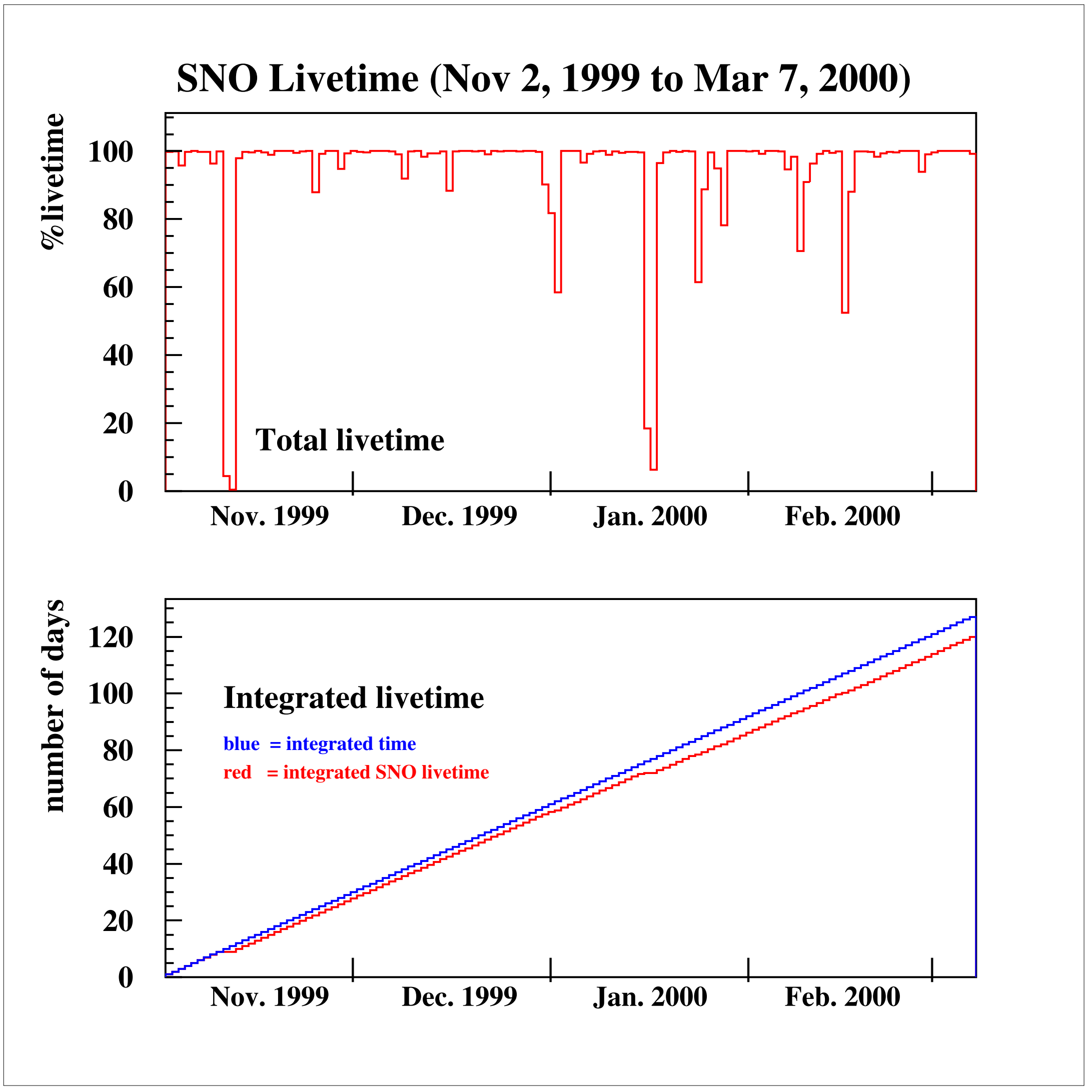
- Start of production data taking, very quiet and stable detector.
- Both light and heavy water clean,
  - U/Th near design goals (~10% SSM neutrons).
- Well over 98% of PMTs operational (more than 99.5% of electronics channels).

Trigger	*Threshold*	*Rate(Hz)*
NHIT100	18.0 PMTs in 100 ns	5–10
NHIT20	18.0 PMT in 20 ns	<1
PULSE GT	Zero bias	5
ESUM	~ 150 photo–electrons	5–7
NHIT100 PRESCALE (1:1,000)	11.0 PMT in 100 nsec	<<1

Total Rate ~20 Hz, well below sustainable maximum rate.

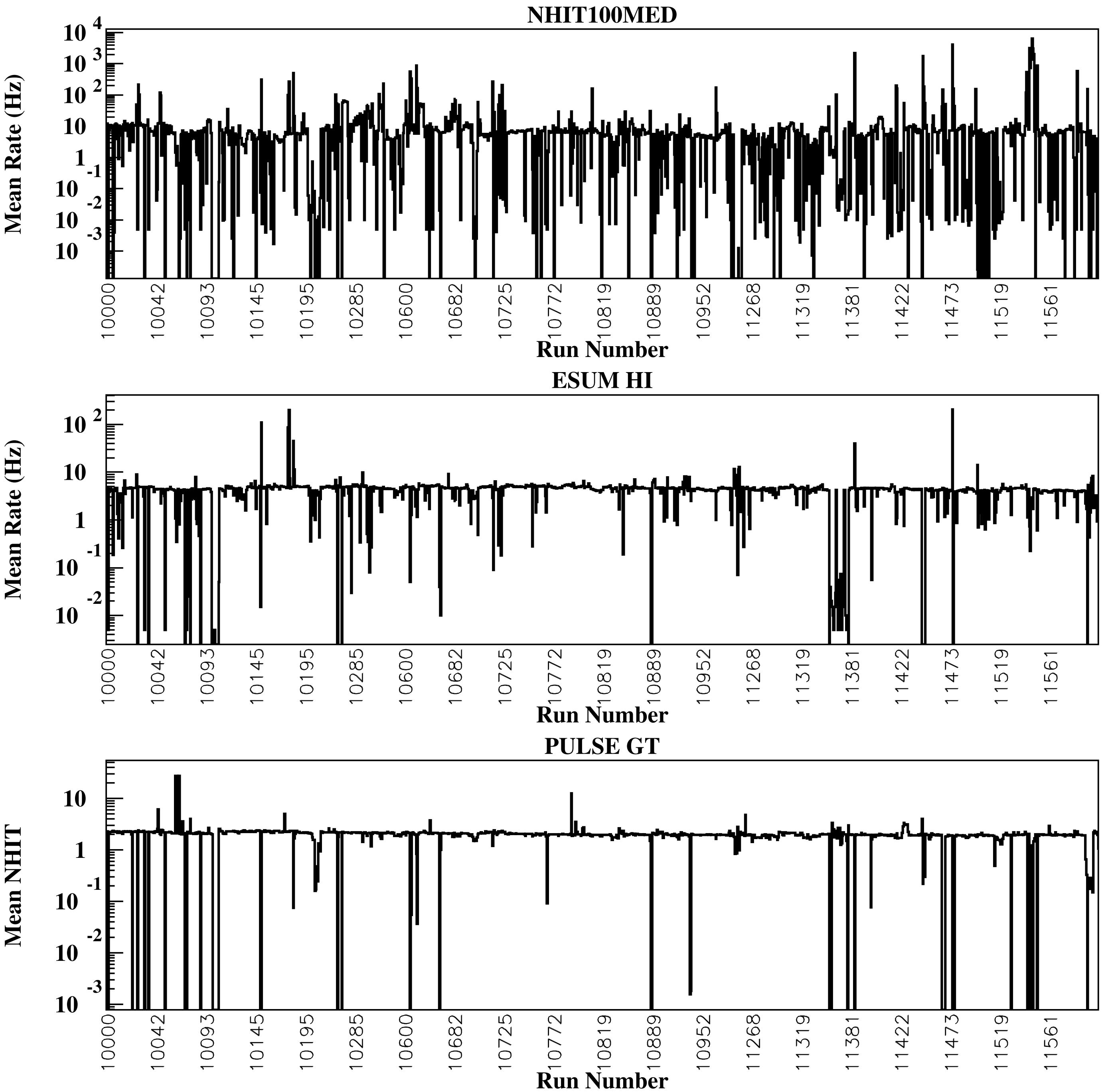
Main physics HW trigger at ~ 2.2 MeV!

Production running livetime



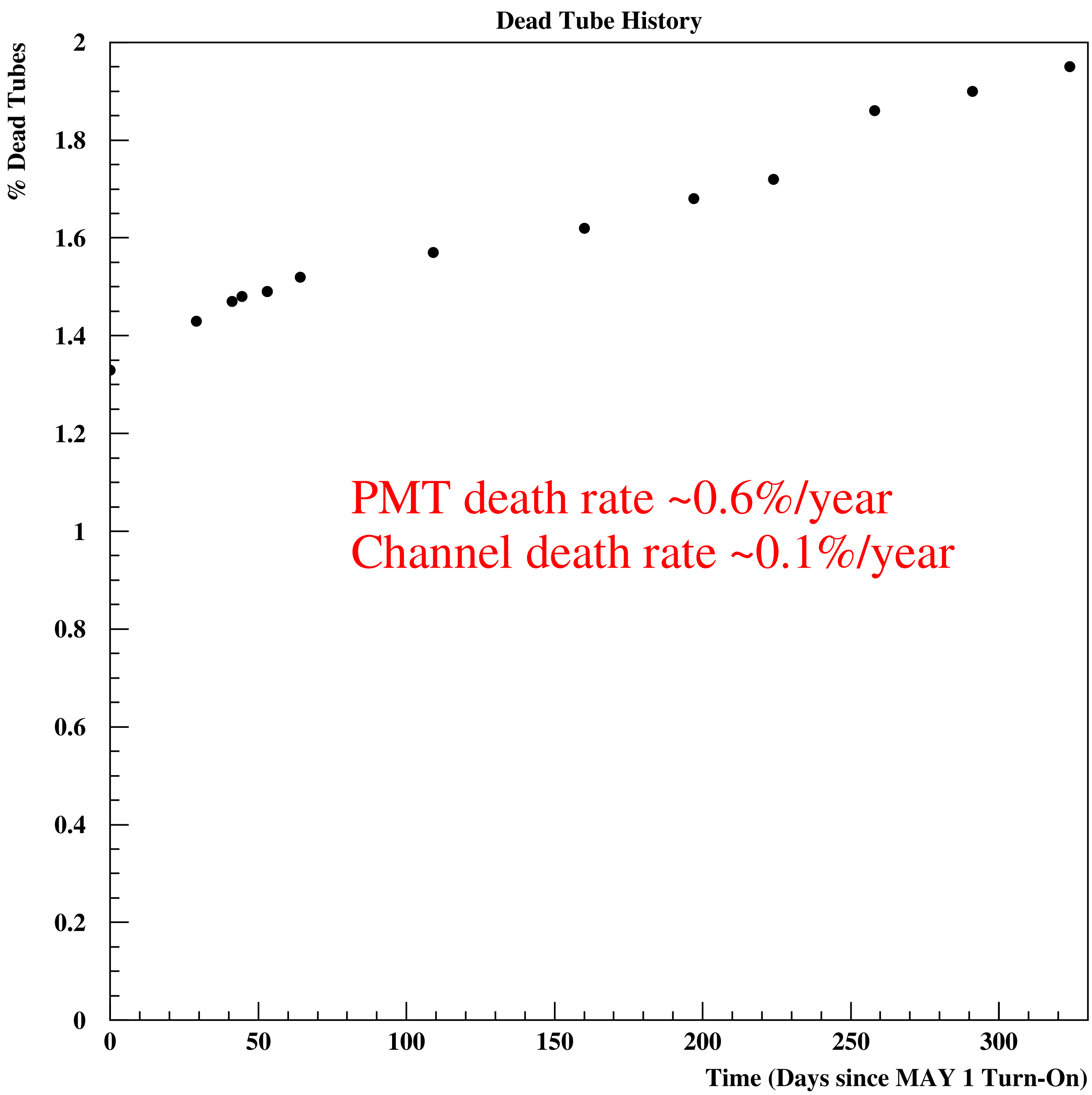
Since November, the detector has been on ~95% of the time, with ~80% solar neutrino livetime. Neutrino downtime (15%) mainly due to calibrations and repairs.

Stable Detector Rates
–decreasing PULSE_GT nhit.



CUTS: SRunLen≥1

Dead PMT/Channel History



Calibrations

First detector calibrations are underway.

Current Sources:

" Electronics calibrations (electronic pulser)

  ñ very stable, done weekly

" Phototube timing (laser diffusing ball)

  ñ time resolution near design goal of σ=1.7ns, at intrinsic limit of tube time spread.

  ñ Channel thresholds at design goal ~0.25 pe.

" Optical calibrations (laser diffusing ball)

  ñ Production calibration data has been taken and is being analyzed.

" Energy and angular response calibrations

  ñ γ- ray sources: ^{16}N source, "pt" source

Upcoming sources

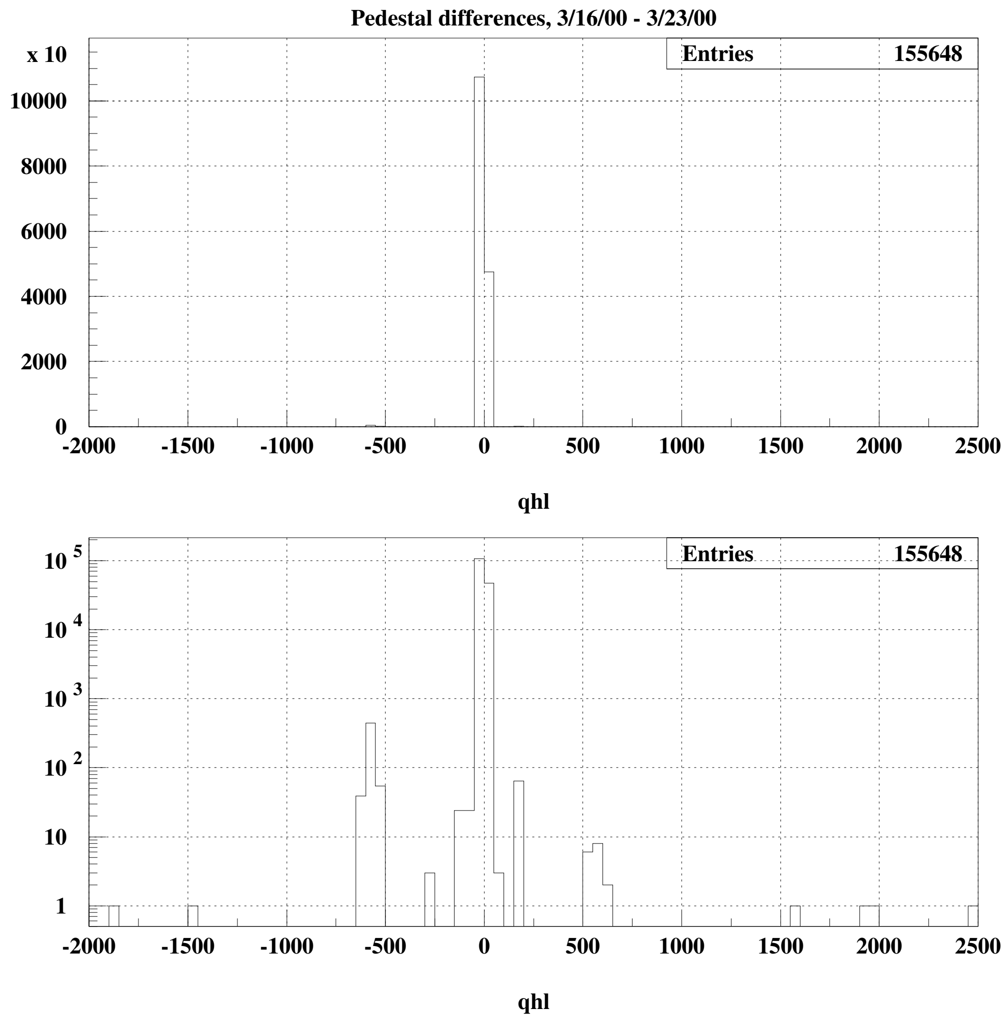
" Position reconstruction (^{8}Li β source)

" neutron source

" background sources

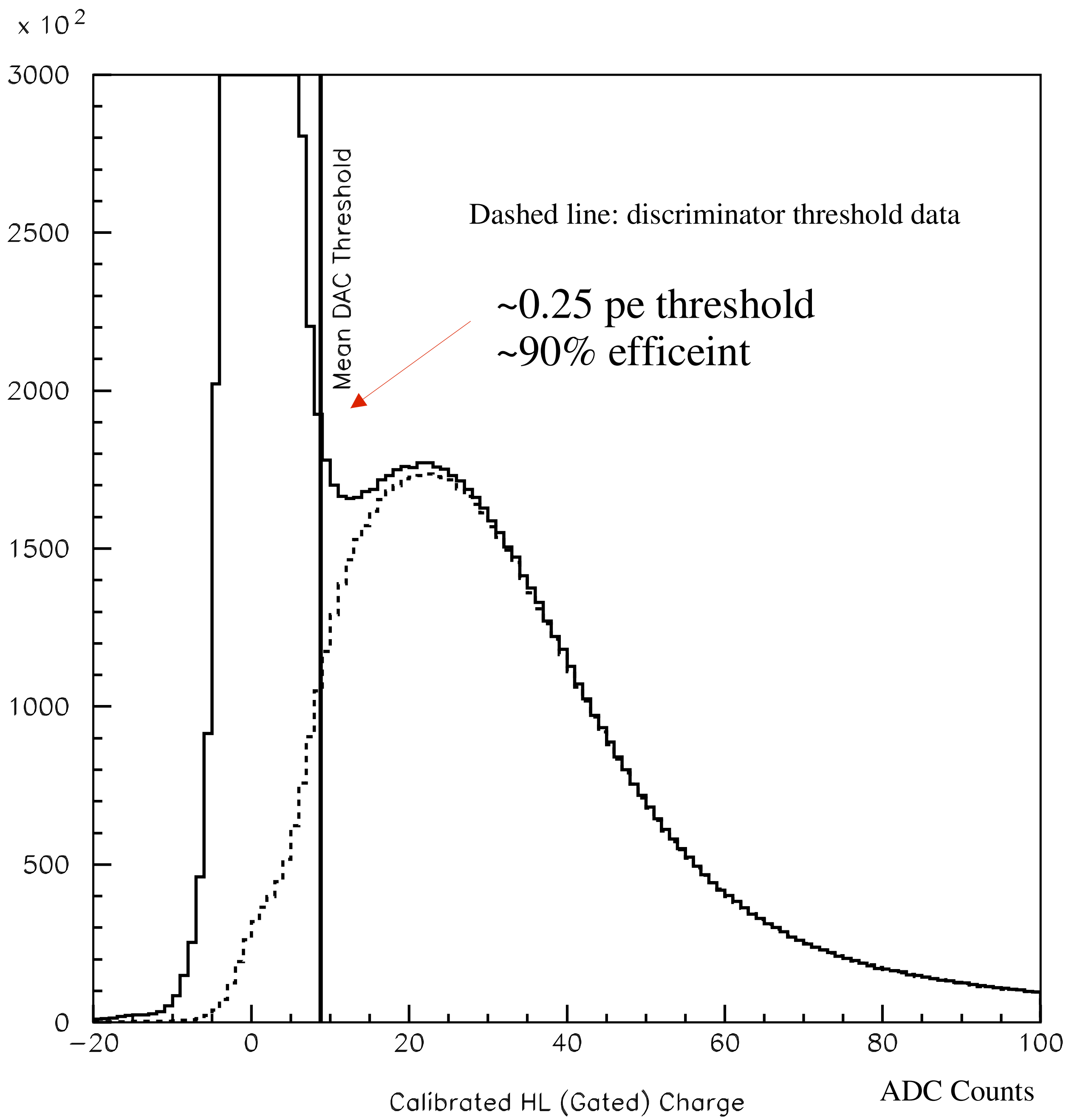
  ñ Triggered, low energy γ- ray sources.

Electronics calibrations

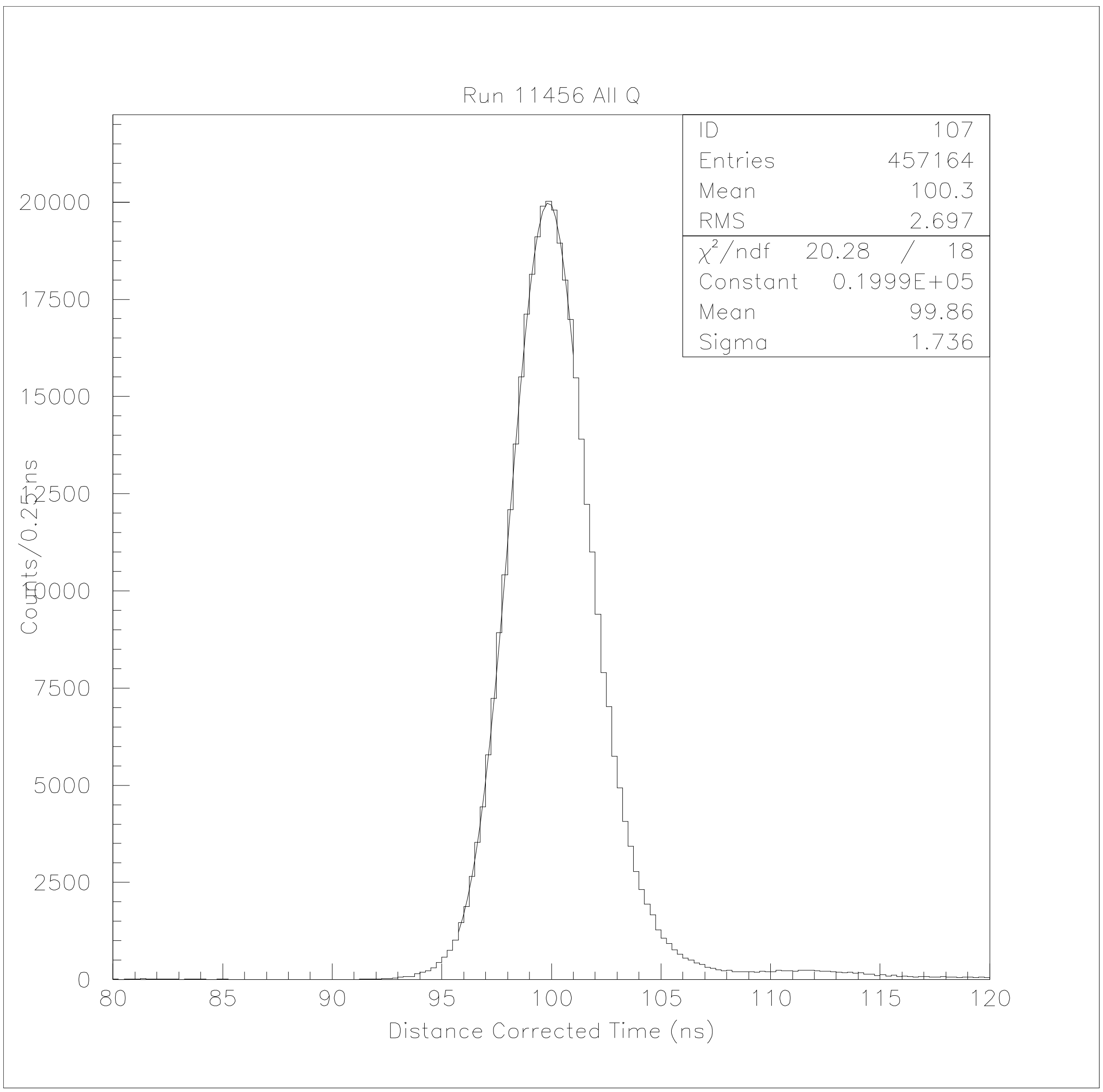


Charge offsets are shown for
10,000 PMTs Δ 16 cells = 160,000 entries

PMT calibration
Single P.E. Response

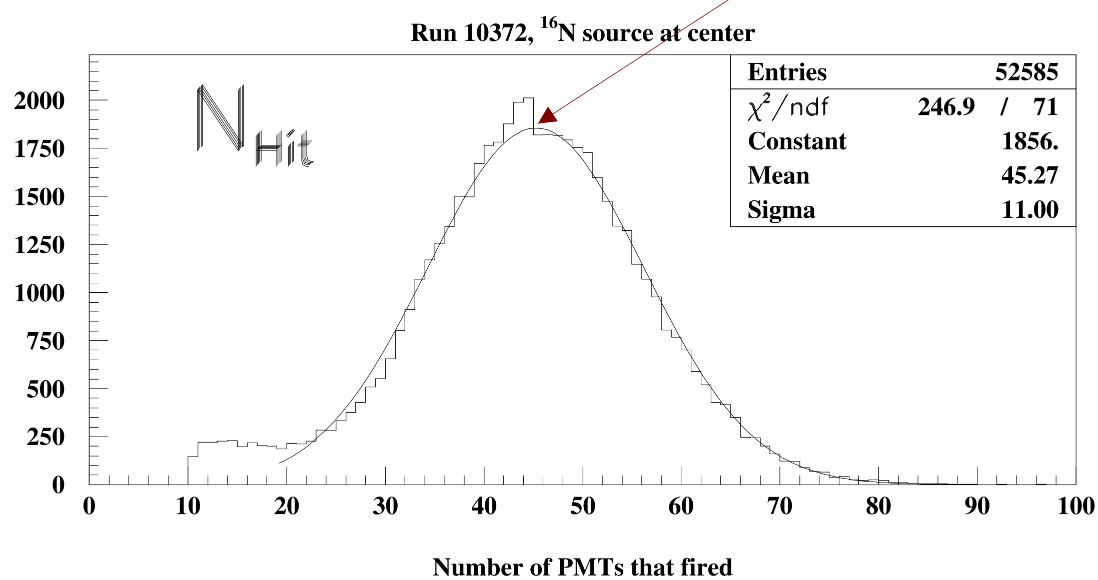


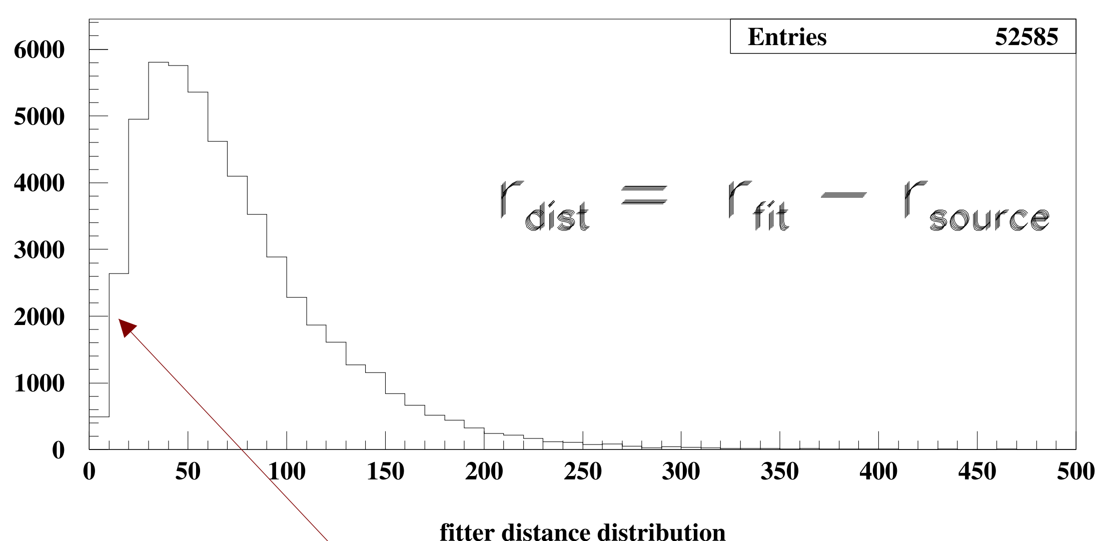
PMT calibration
Timing ~1.7 nsec



Measurements with ^{16}N

Roughly ~9 hits/MeV





γ compton scattering length ~ 35cm

Backgrounds

- Cosmic rays & spallation
  - virtually unimportant due to great depth (~ 3 muons/hour)
  - cut spallation via correlation with muons
- NC backgrounds:
  - ^{238}U, ^{232}Th
    - long lived daughters emit γ- rays that disassociate d: $\gamma + d \; \} \;\; n + p$
    - levels determined from water assays and pmt analysis.
- CC, ES backgrounds:
  - γ- rays from rock, PSUP, etc, are measured to be low (<1% SSM rate).
- Instrumental backgrounds
  - flashing photo- tubes, other pulsed light sources, bursts, electrical pickup, etc, are understood and well characterized.

Conclusions

SNO is in great shape!

- Routine neutrino data taking
  - 7 months, ~80% neutrino livetime.
- Detector is very quiet
  - 20Hz rate at ~2MeV HW threshold.
- First data is being taken
  - electronics and Photo- multiplier calibrations are understood.
  - optical calibration in progress.
  - energy calibration data has been taken.
- Near term goals
  - complete calibration program.
  - increase neutrino statistics in pure D_2O phase, ~1 year total.