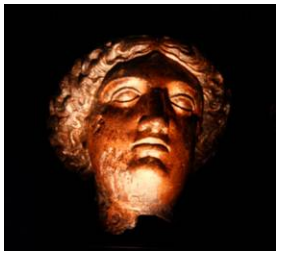
MINOS Detector Operations

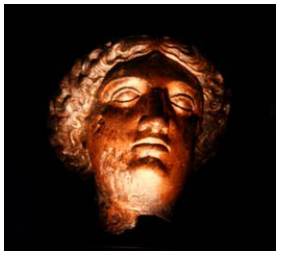
Leo Bellantoni
Fermilab
17 October 2016

Outline



- Introduction
- Shifts, Hardware, Maintenance
  - Stock in hand, repairs
  - Swap rates & manpower for that
- Data Quality
- Calibration

Charge Questions



1.(a) A description of [MINOS ND] operations tasks and how they will be covered

1.(e) A list of the identified resources available

2. Are the MINOS ND performance and calibration requirements well established for the needs of the MINERvA physics program, and is there a clear plan for achieving these requirements?

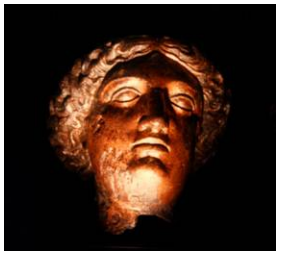
Have the necessary resources been identified?

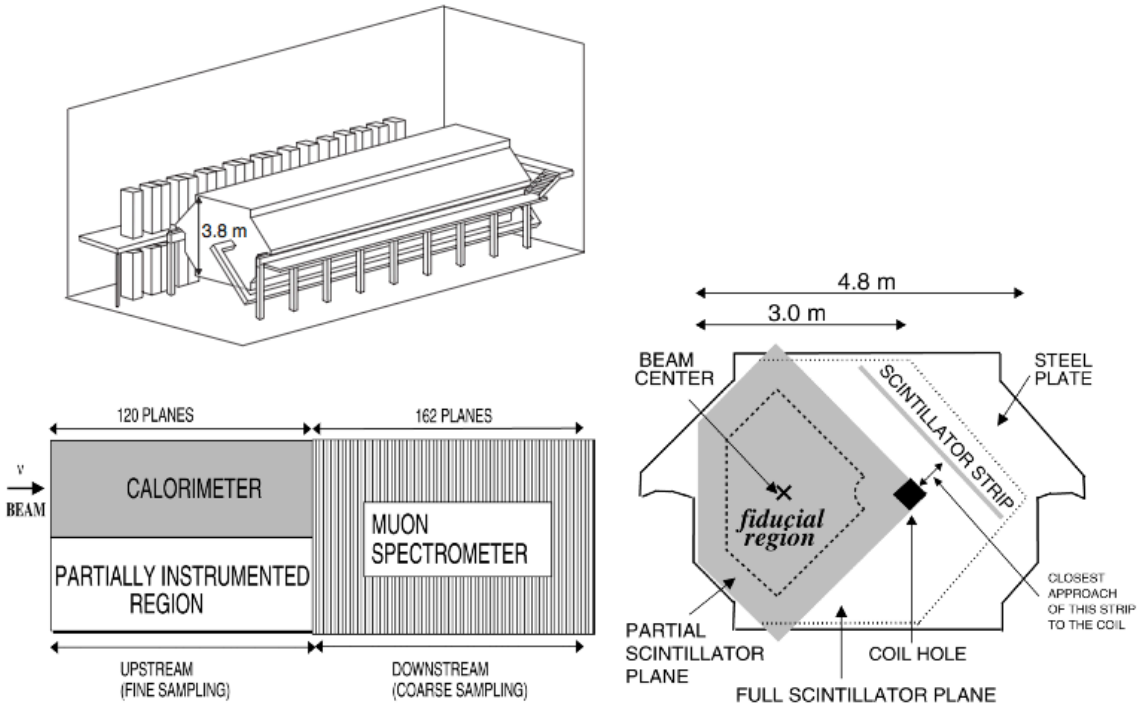
Given the availability of resources, are the expectations for the detector performance and data taking efficiencies realistic?

Is there a clear plan for monitoring the MINOS ND data quality and has the team available for this task in the coming year tested the associated infrastructure?

Introduction

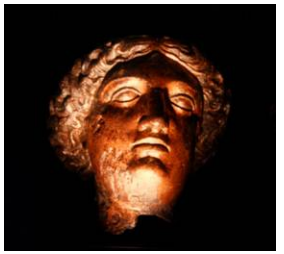
Introduction





- MINERvA uses MINOS ND as a spectrometer for muons
- Only use reconstructed data, have our own MC (does require B-field maps from MINOS db)

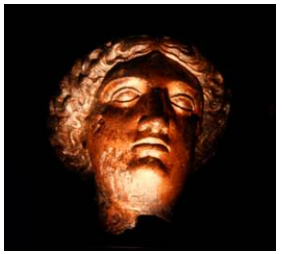
Introduction



- The only thing we need from MINOS ND is muon identification and momentum, but that is really crucial
- Muons are needed for ~3/4 of our analyses
  E.g. q^2 needs the muon
- Muon energy scale comes from MINOS ND and is often one of the largest experimental systematic uncertainties

Shifts, Hardware, Maintenance

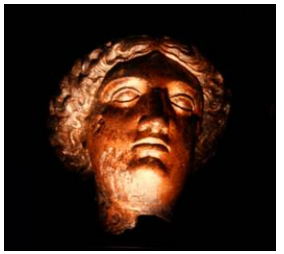
Shifts, Hardware, Maintenance



- **Shifts integrated with MINERvA shift since 2011**
  - **Monitoring histograms, environmental monitors, watching DAQ monitor**

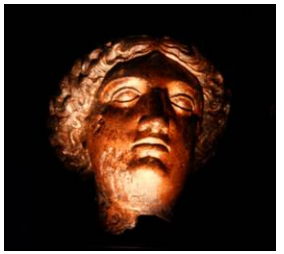
- **Run Coordination, electronics replacements, and detector expertise has been in the Neutrino Division / Tech Support / Operational Support (MINOS Ops) for several years; specifically Steve Hahn, Donatella Torretta, Bill Badgett. Their expertise and effort is being transferred to the MINERvA Collaboration.**

Shifts, Hardware, Maintenance



- **Knowledge transfer from MINOS ND people to MINERvA Ops group:**
  - **Paging MINERvA Ops! Reset DAQ 15 times 1 July – 23 Sept**
  - **Enabled/disabled Light Injection (LI) 3 times**
  - **Replaced 4 minder boards, 1 fan pack, 1 PS**
  - **Full MINOS power cycle 2 times**
  - ***Low fail rate makes for slower knowledge transfer!***
  - ***For problems that happen rarely, or things that just plain break, we will need to be able to call on MINOS experts.***

Shifts, Hardware, Maintenance

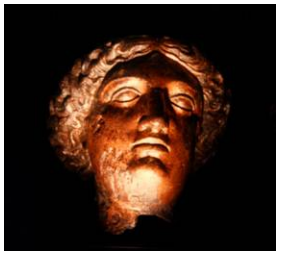


Component	Failure Rate	Spares In Stock or FD
Alner Box	1 / 5 year	190 (5 types)
1440 HV Controller	1 / 2 years	11
1440 HV boards	1 / 6 months	7
Minder Control Board	1 / 6 months	14
MENU Boards	1 / 3 weeks	~700
Master Control Board	1 / 2 years	6
Fan Pack	1 / 4 months	2 Minders, 4 Masters
Rack Protection System	0 / 5 years	21
Wiener Power Supply	1 / 4 months	6 Minders, 2 Masters
Switch Box	1 / year	1

Further spare-count details in MINERvA DocDB 12107

Failure rates from ND Ops Support Group (5 years data)

Shifts, Hardware, Maintenance



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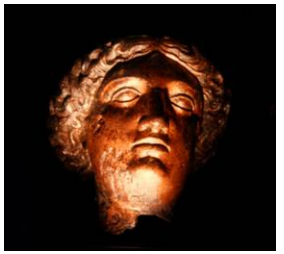
Electronic swap times range typically 1-5 hours

Diagnosis times harder to quantify & longer for newbies

Shifts, Hardware, Maintenance



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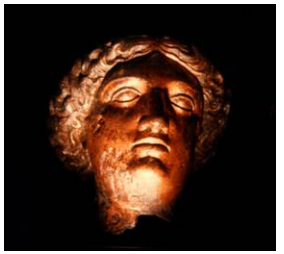
Totals to ~0.15 FTE in the swap itself

ND Ops group personnel estimate ~0.5 FTE for all Ops

We will move some of this to shifters, rest to on-calls

Shifts, Hardware, Maintenance



- **Magnet gets annual checkup (via ND Ops)**
  - **~ 5 hours Walt Jaskierny**
  - **~ 20 hours next year, PS hoses need to be checked (repeat in 5-7 years time) Steve Chappa**

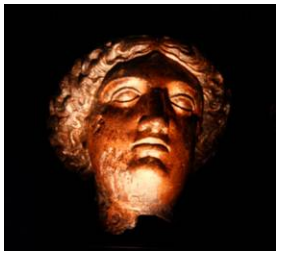
- **LeCroy HV1440 units need to get dust cleaned out of fan filters on an annual basis (~16 hour job). Done by ND Ops in the past – 1/year jobs not ideal for universities**

- **Electronics power supplies ~0.05 FTE [Dave Huffman, PPD/EED]**

∃ Test stand at D0

- **Used for vxWorks testing, new Linux/SLF releases – both are infrequent. ND Ops will continue support**

Shifts, Hardware, Maintenance



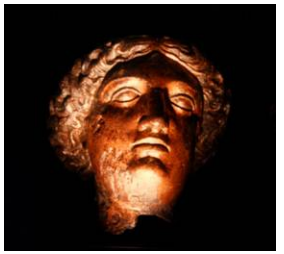
- **Electronics repair contract with Gary Drake/ANL**
  - **7k$ as T&M used in FY16; 8.5k$ left**
  - **That was a good year – 25k$ has happened in the past**

- **Hardware from FD coming back to FNAL (included above)**
  - **Lecroy 1440 mainframes: 11 return, 2 in use on ND, 1 spare already**
  - **GPS "True Time" units: 2 / 1 / 2**
  - **DAQ computers: 3 are worth keeping & have been installed**
  - **21 MVME controller cards, 21 RPS units**

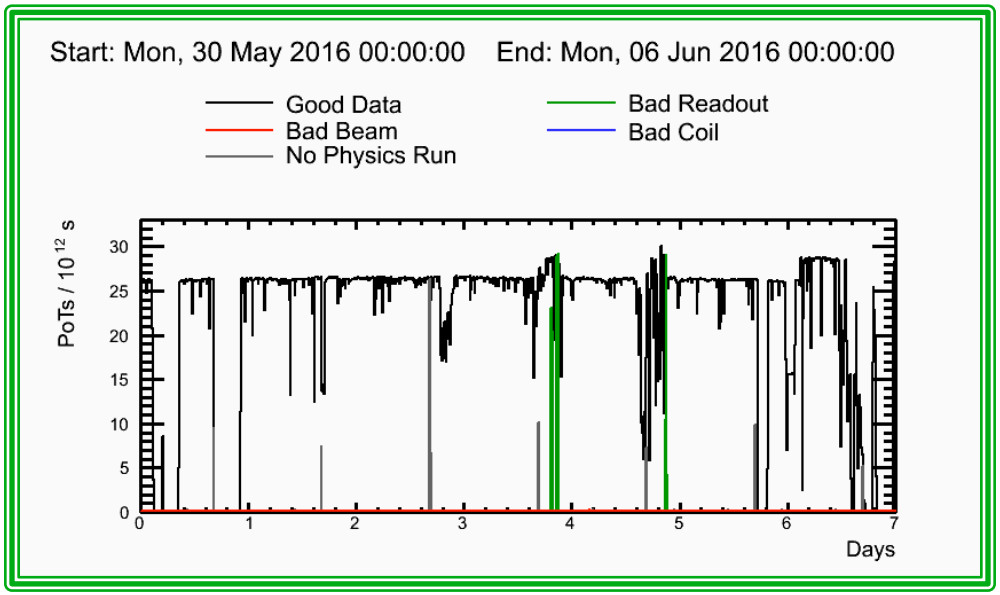
- **Complete re-inventory planned after relevant FD parts are back**

Data Quality

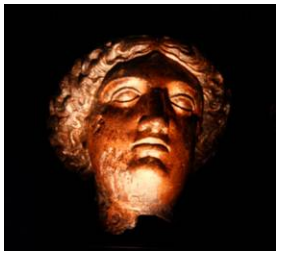
Data Validation & Bad Channel Finder

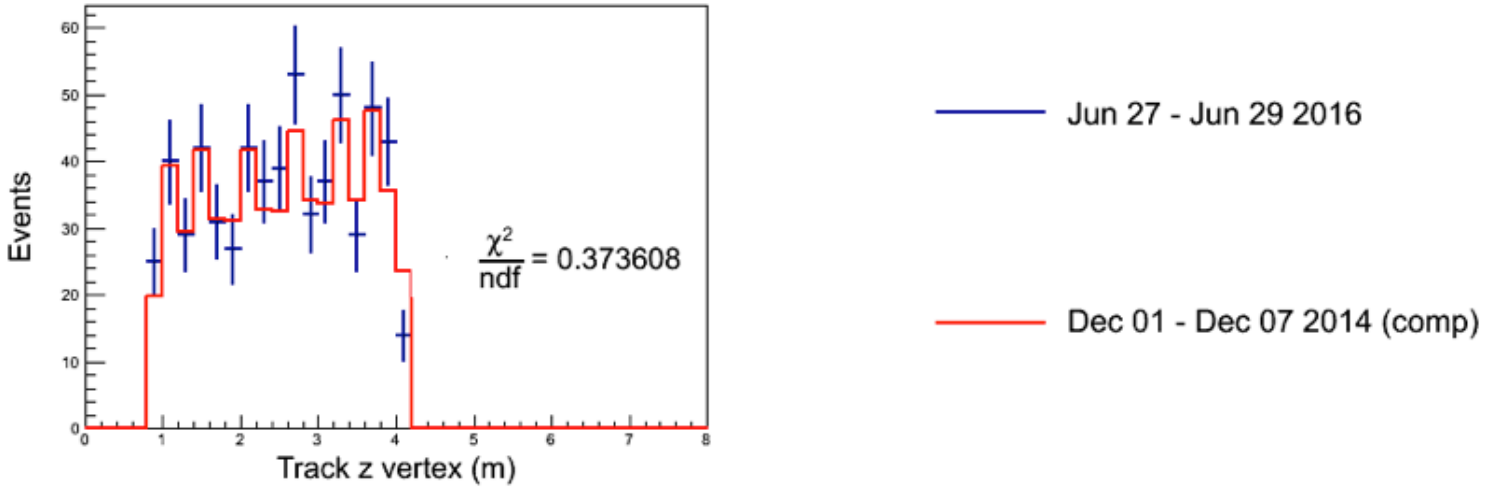


- Automated process from the keepup processing; list of flagged bad channels are sent out in an email; then MINERvA Ops group goes and changes them.
- We will include checking of the plots produced in shift duties
- Andy Blake (MINOS / Lancaster University) agrees to improve documentation
- Skill transfer in process for oversight of the processing – must learn the MINOS offline environment
- FTE for oversight is small, but will need to be able to call on MINOS experts



Data Quality Monitoring

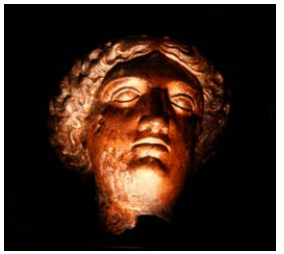


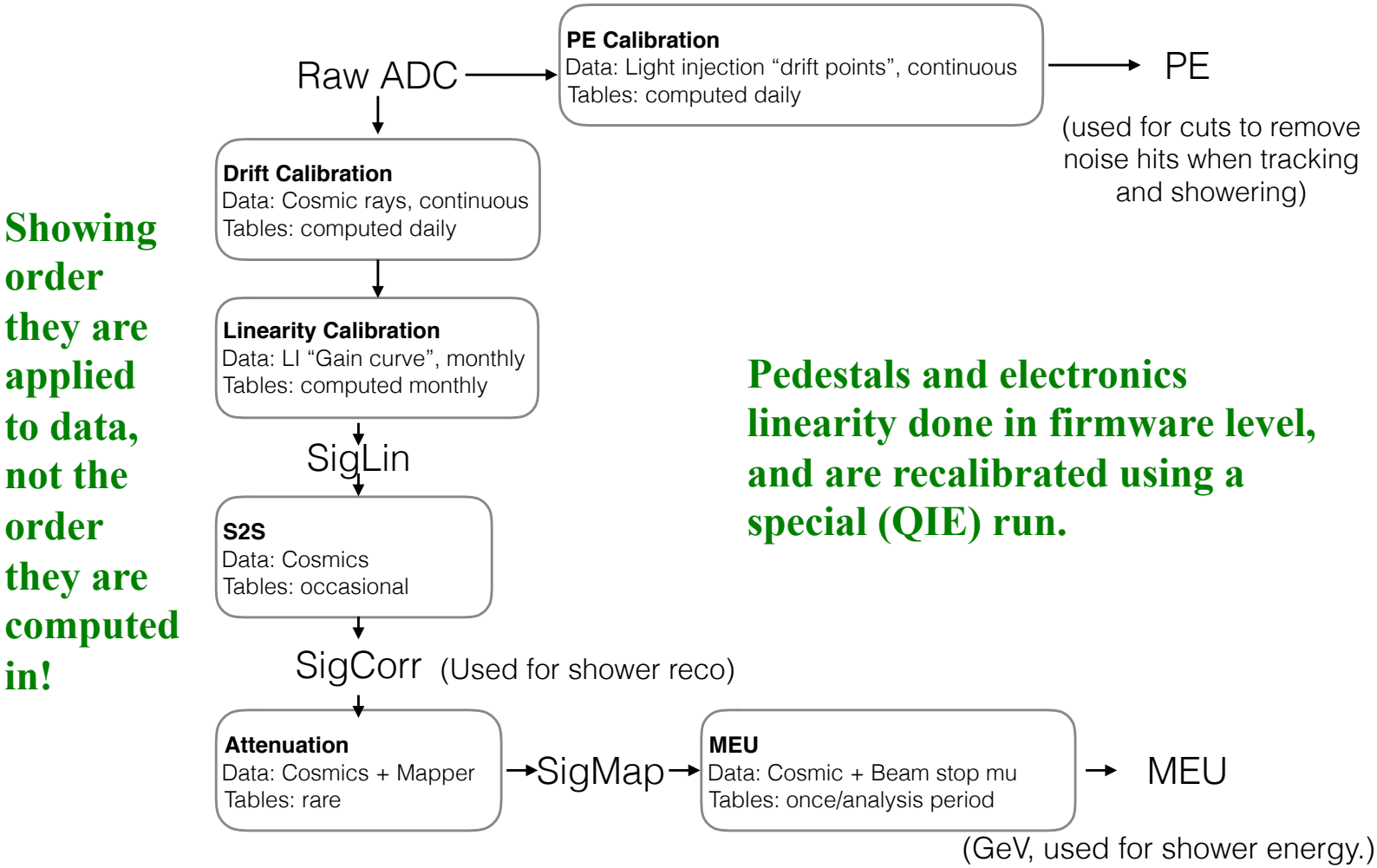


- Also an automated process
- We will include checking of the plots produced in shift duties
- Rui Chen (MINOS/U. Manchester) agrees to improve documentation. He is on-site through CY17 and agrees to continue oversight
- FTE for oversight is small, but will need to be able to call on MINOS experts after hand-off

Calibration

Calibration

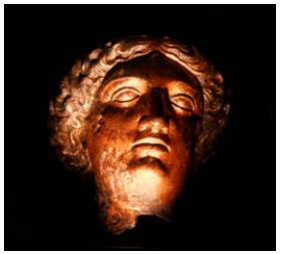




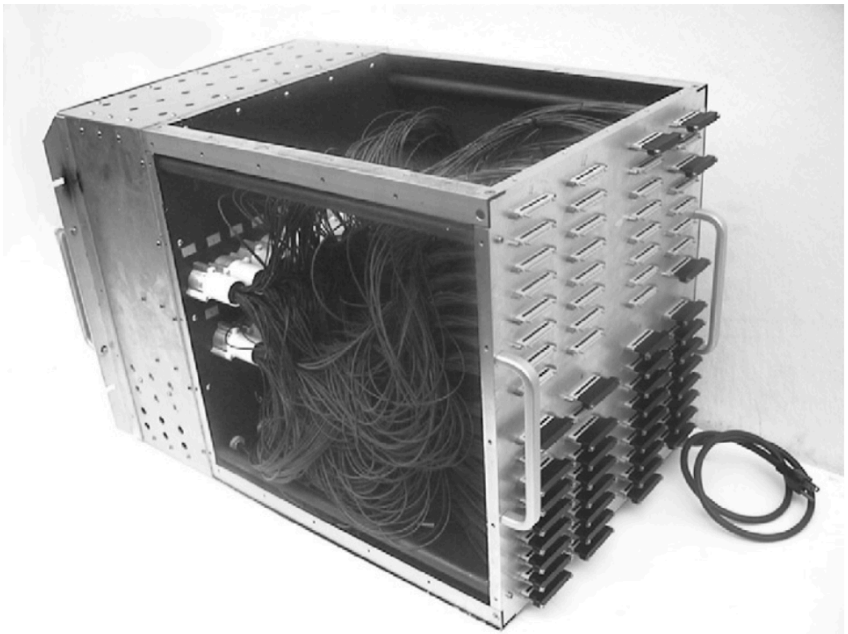
Showing order they are applied to data, not the order they are computed in!

Pedestals and electronics linearity done in firmware level, and are recalibrated using a special (QIE) run.

Calibration



Light Injection System



An LED pulses measured amounts of light into the scintillator bars for calibration

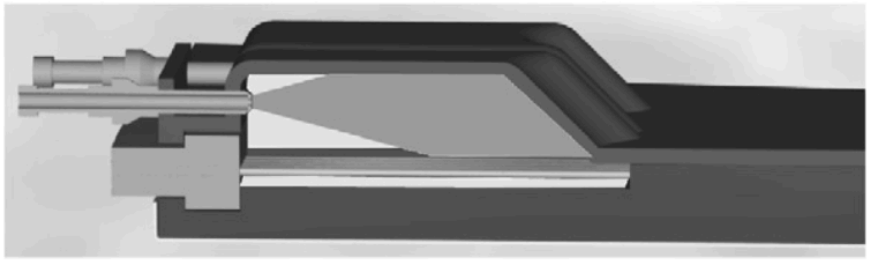
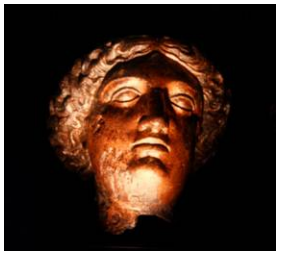


Fig. 15. A cutaway computer model illustrating the concept behind the light-injection module. A curtain of 10 green WLS fibres runs from right to left along the bottom of the LIM cavity, and the injected blue light illuminates them from above. The T-shaped component at the lower left is a cutaway of the bulk optical connector, into which the WLS fibres are glued. In the upper left foreground is a cutaway of a CLRC01 connector, which terminates the light-injection fibre; an uncut connector is visible behind it.

Calibration



"What would happen if we didn't do some/all of the MINOS calibrations?

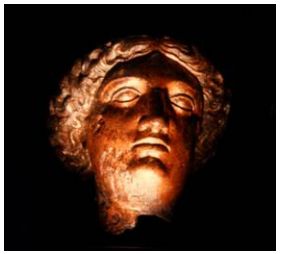
MINOS DB interface has a rollback feature, which uses the DB as it was on a previous date. We ran the MINOS MC w/ 2014-08-08 as generation (decalibration) date, but with DB interface rolled back to use calibrations as of either 1 Jan 2012 or 1 Jan 2010

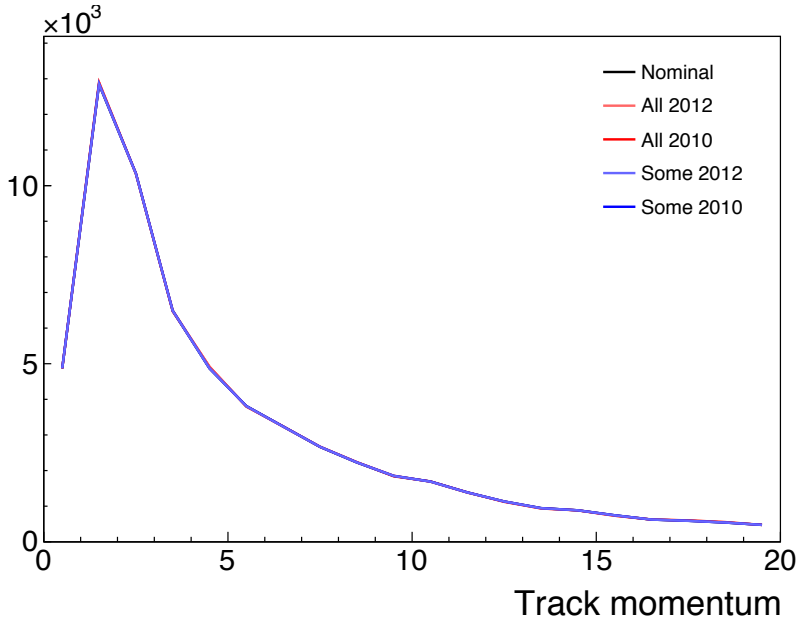
This simulates 2 and 4 years without calibration

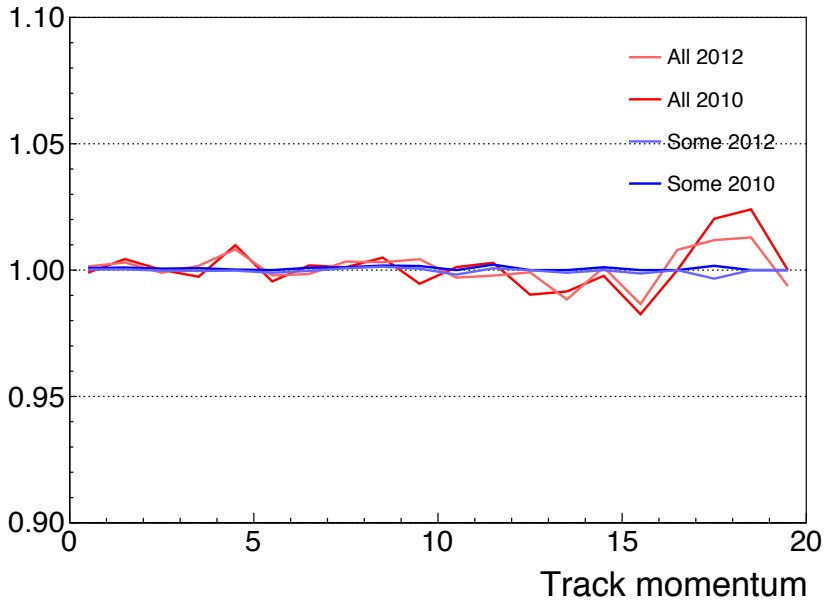
"SOME" means no Attenuation, S2S, Linearity or MEU calibration;
"ALL" means all the calibrations in the database were rolled back.

Accidental overlays not in this study

Calibration





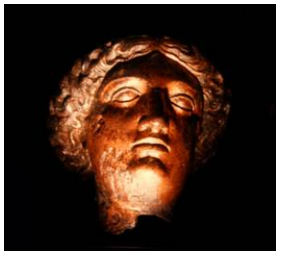


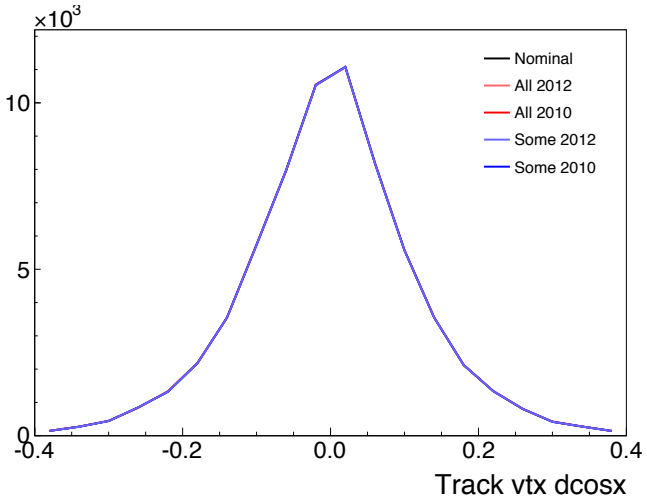
Muon momentum in MINOS changes ~few % worst case with all calibrations removed

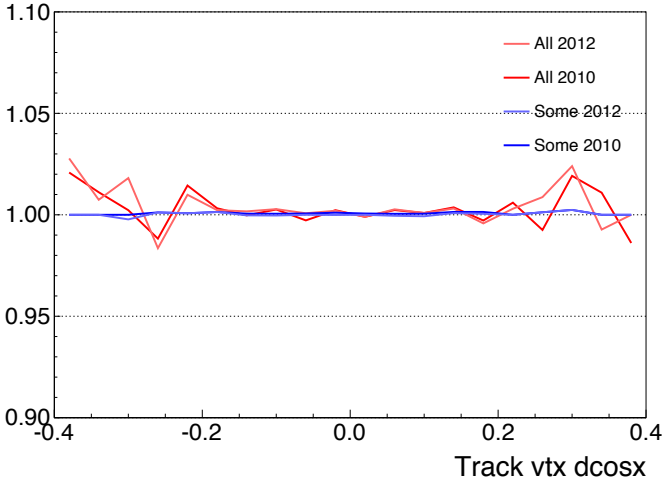
Well under 1% with Linearity, Attenuation, S2S, MEU gone

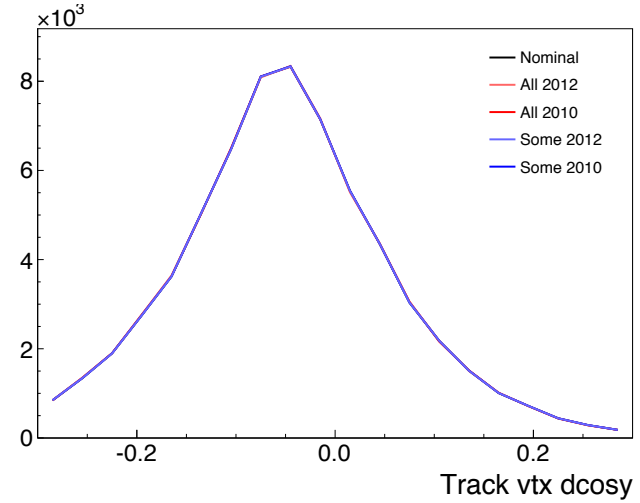
Muon directions in MINOS on next slide

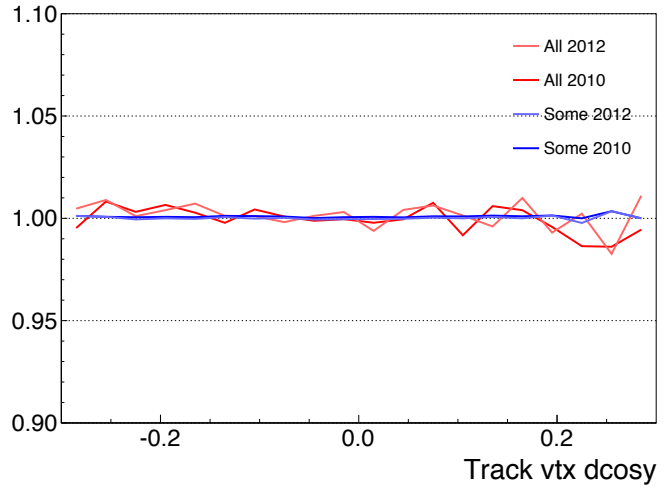
Calibration



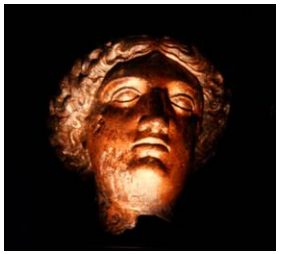


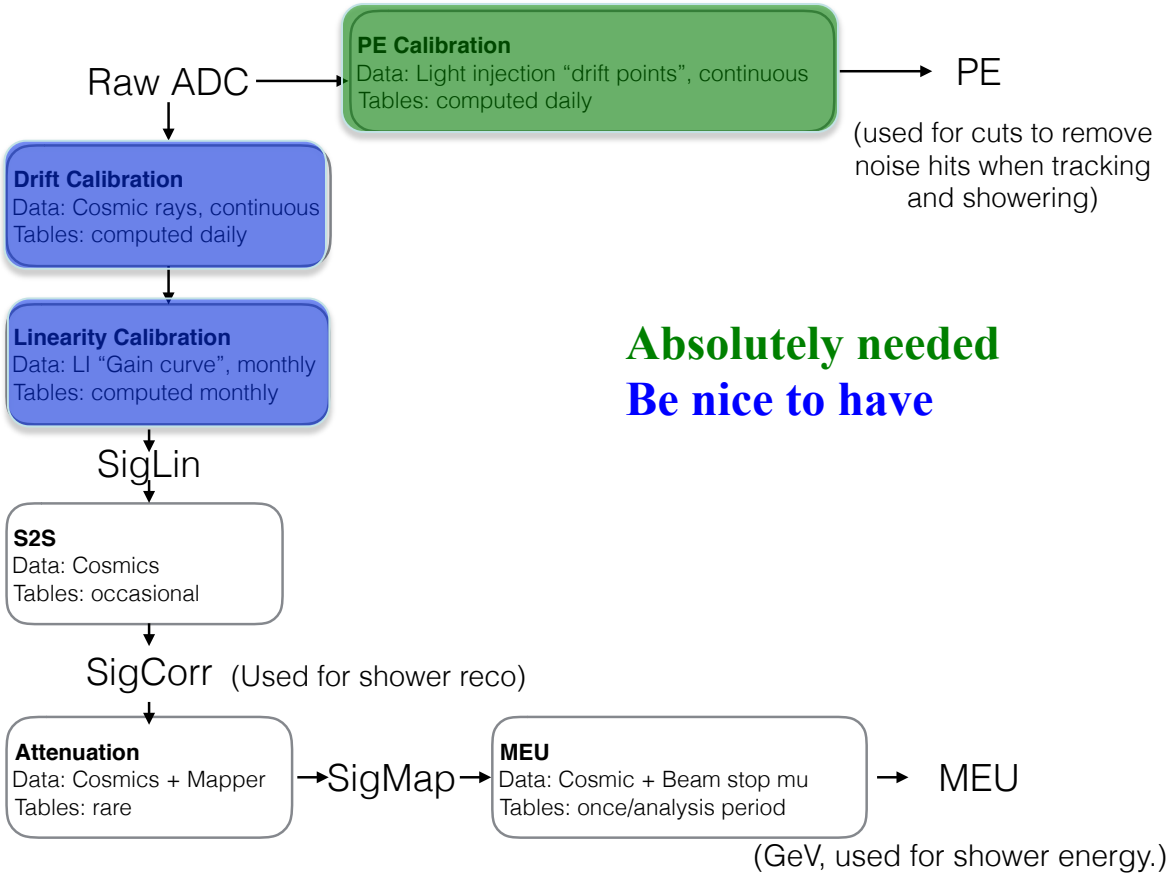






Calibration





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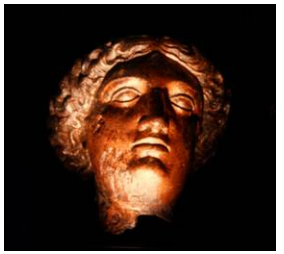
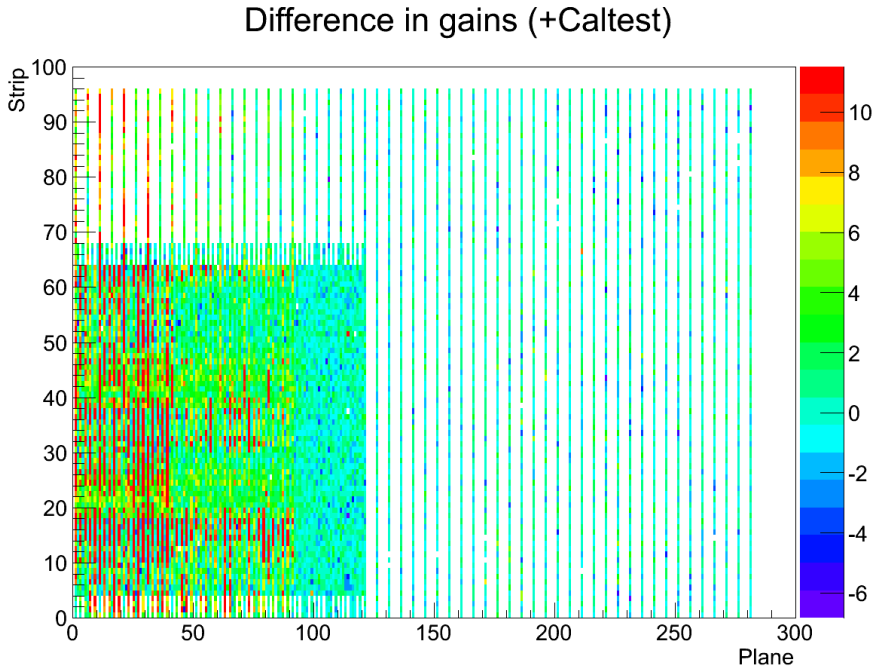


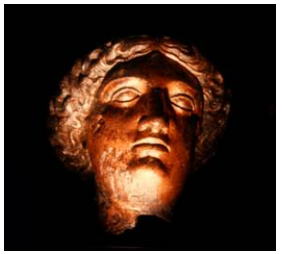
Gains for tracker are from Light Injection system, from pulses taken concurrently with data at 50% full scale –This is the PE Calibration.

~2% increase / year

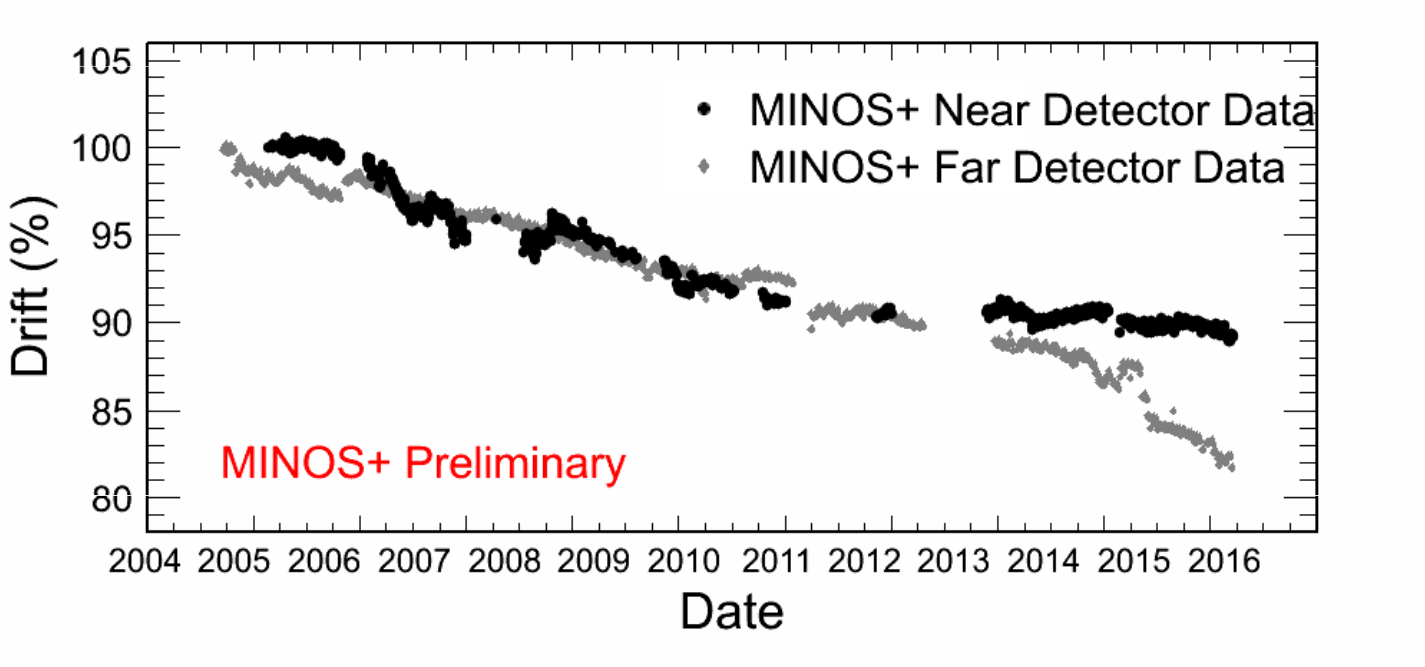
MINOS Expert is Nathaniel Tagg, who is also a MINERvA collaborator. He's agreed to continue support; he's also the expert on the Linearity calibration and will keep that going.



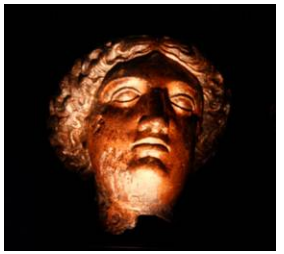
Calibrations



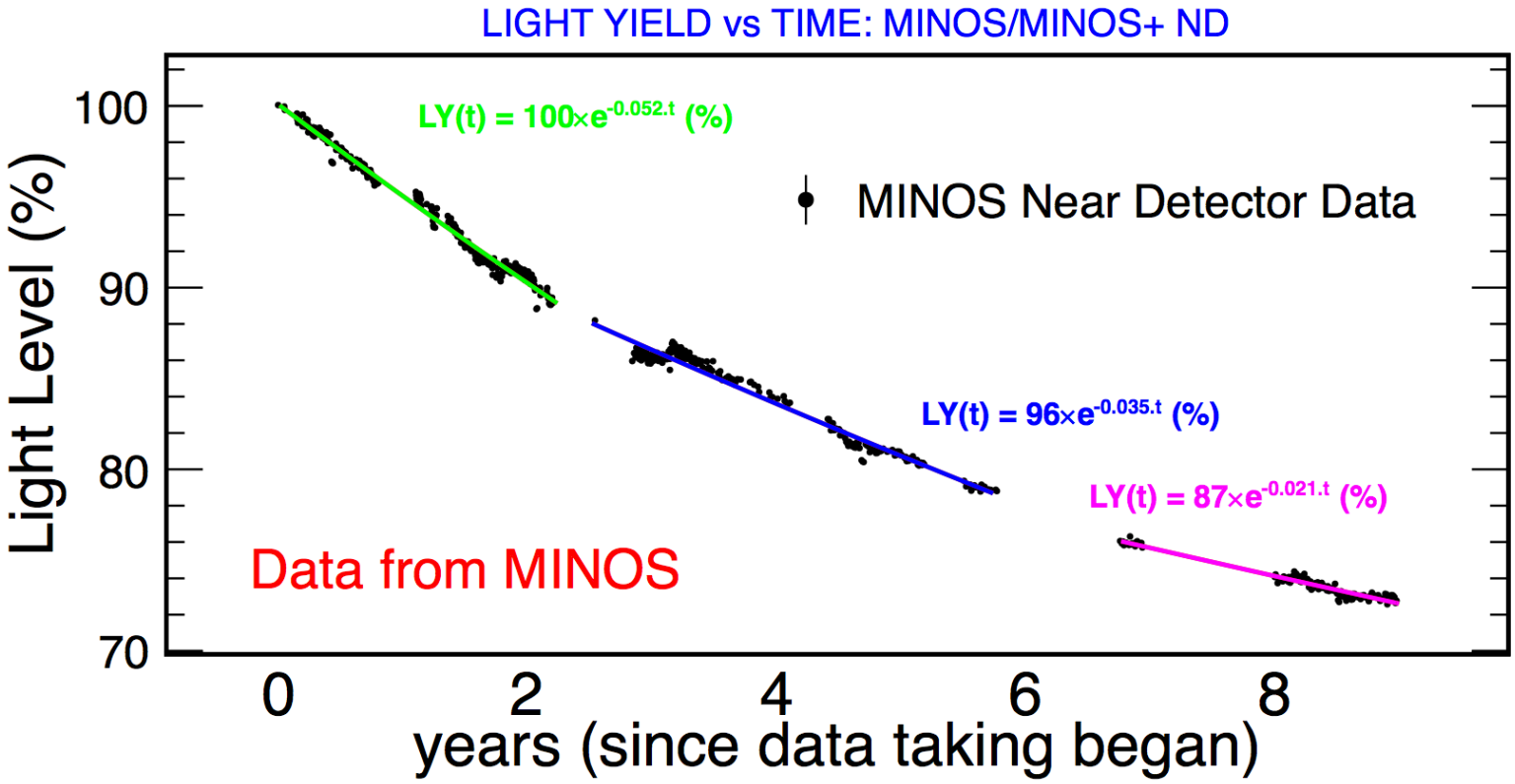
- **Drift calibration measures the overall response of the detector with cosmic rays**
- **Drift calibration / LI gains tracks scintillator aging**
  - **gains going up ~ 2% annually**
  - **Drift response down ~1% annually**



Calibrations

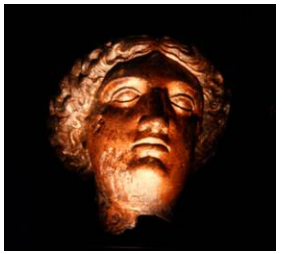


- **Drift calibration / LI gains tracks scintillator aging**
  - **Straight-through MIP was ~7 P.E. in 2008 NIM paper**
  - **Threshold for tracking is 2 P.E.**



Conclusion

Conclusion



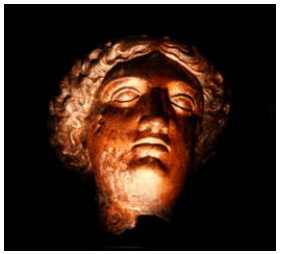
The primary concern is that the MINOS detector and calibration system work too well.

The evaporation time of rarely-used skills as the MINOS collaboration moves on professionally is comparable to mean time between failures that require rarely-used skills to solve.

It seems the situation is particularly acute in regards to the Light Injection hardware and online software.

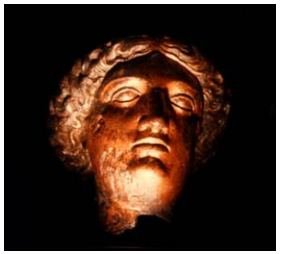
Backup info

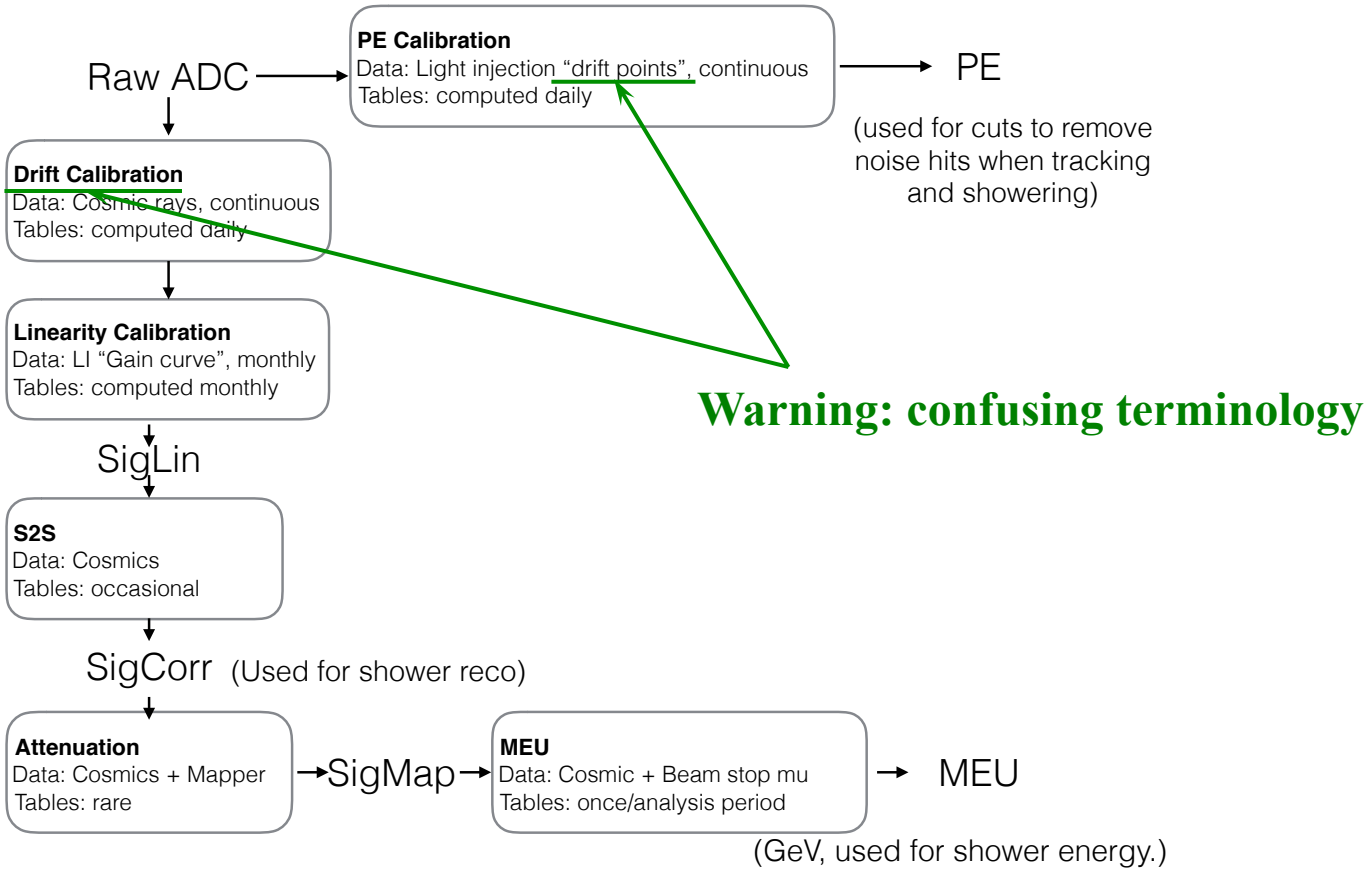
MINERvA Calibration Group



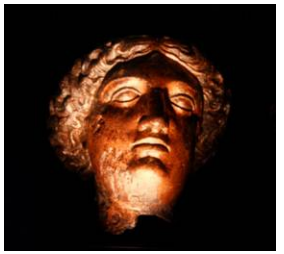
- Pedestals (Aaron McG., 6 years)
  - Finally ready to share the fun with someone else
  - Anushree/keepup person will take over
  - Instructions are in DocDB 12389
- Gains (Ben M., 2 years)
- FEB swaps (ops group)
- Strip to strip/Timing (Dan R., 2 years)
- Calibration Processing (Dan R., 2 years)
  - involves three separate processings over the data
- MEU (Jeffrey, 1.5 years)
- Veto Calibration (Heather, since the dawn of veto calibration)
- DocDB 7747 includes details on calibrations chain

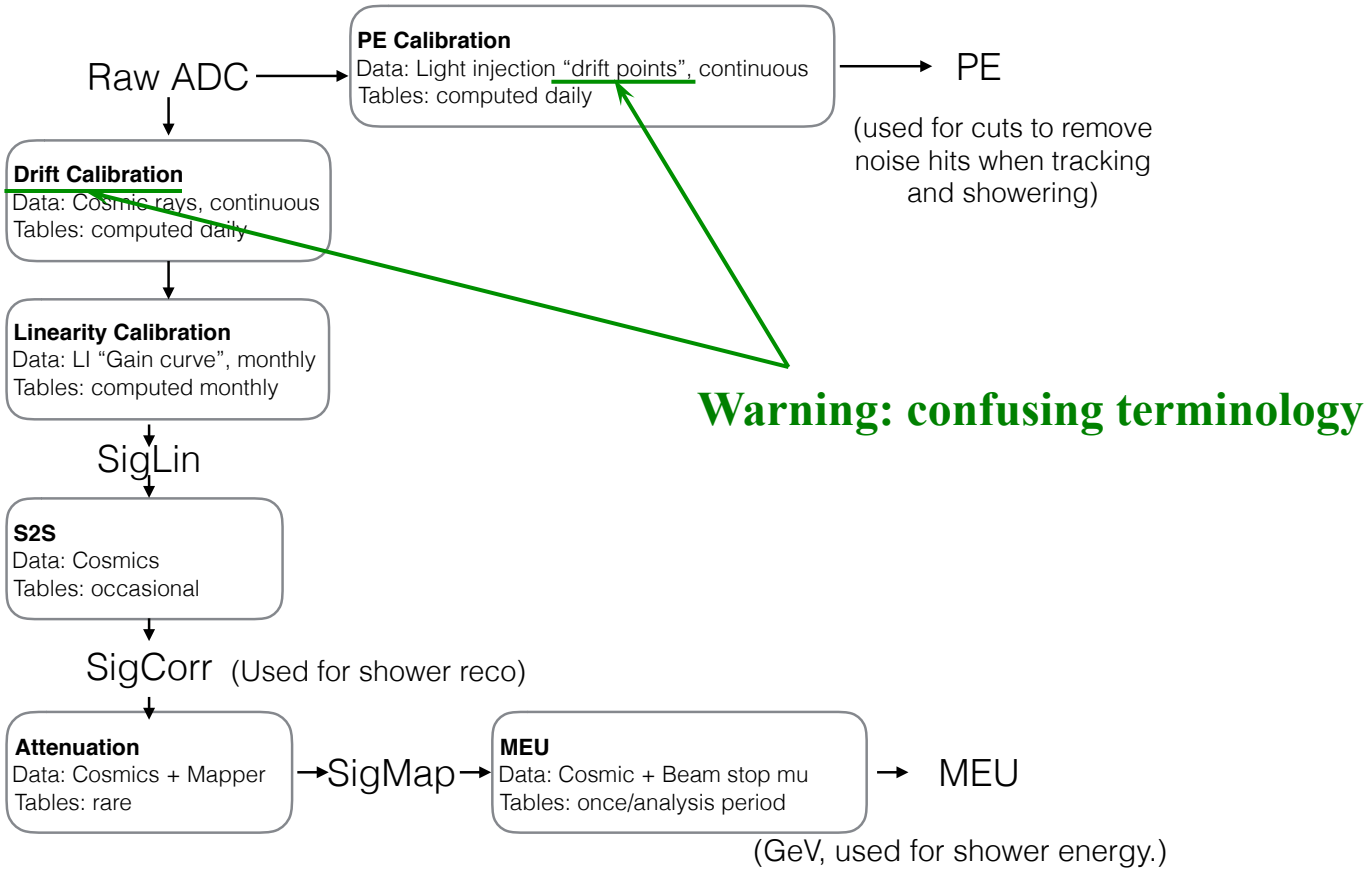
Calibration



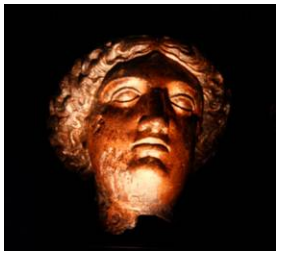


Calibration

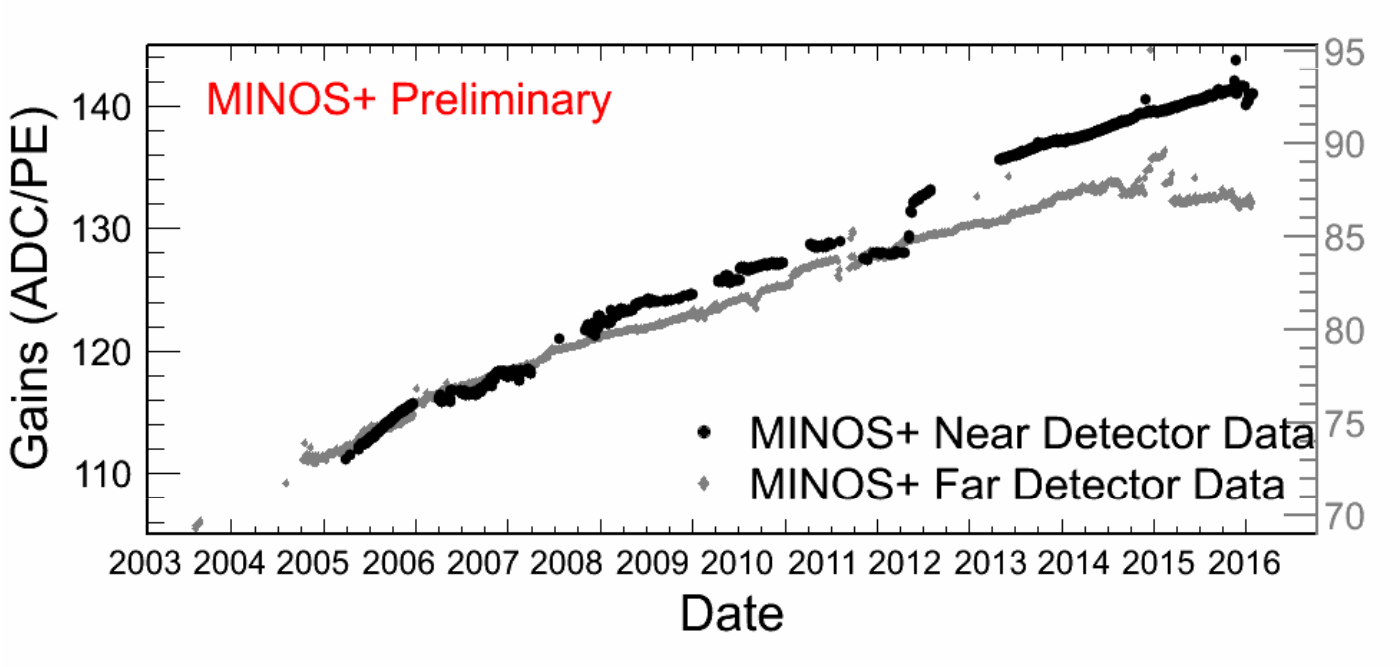




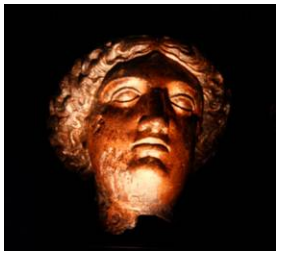
Calibrations



- **Drift calibration / LI gains tracks scintillator aging**
  - **gains going up ~ 2.% annually**
  - **Drift response down ~1% annually**
  - **Straight-through MIP was ~7 P.E. in 2008 NIM paper**
  - **Threshold for tracking is 2 P.E.**



Calibration



Drift Calibration, S2S, Attenuation, MEU: The sequence for calorimetry.

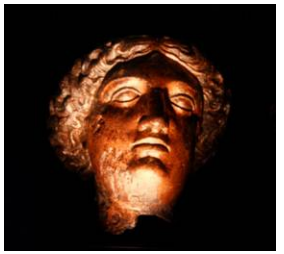
Not expected to be needed for the MINERvA physics program

These calibrations introduce a 3% systematic uncertainty (accuracy in mean) for reconstruction of hadronic energy.

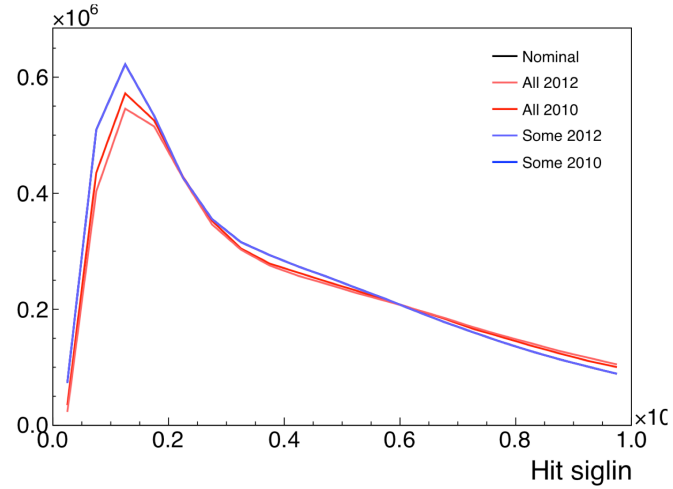
Drift Calibration moves at about 10% / decade

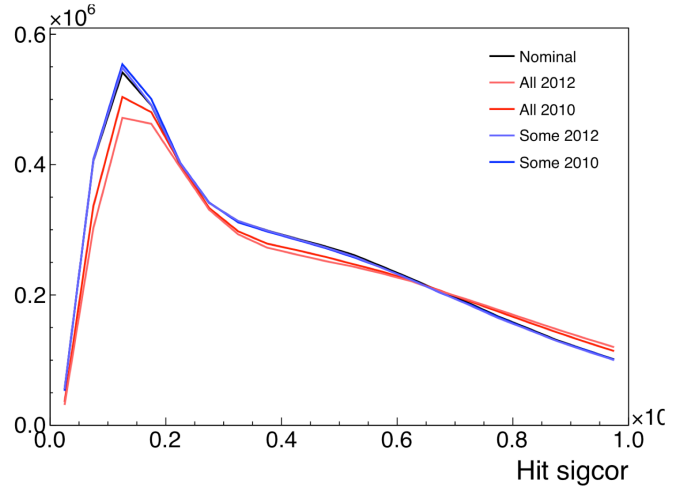
Beam intensity impacts MEU at ~2% level

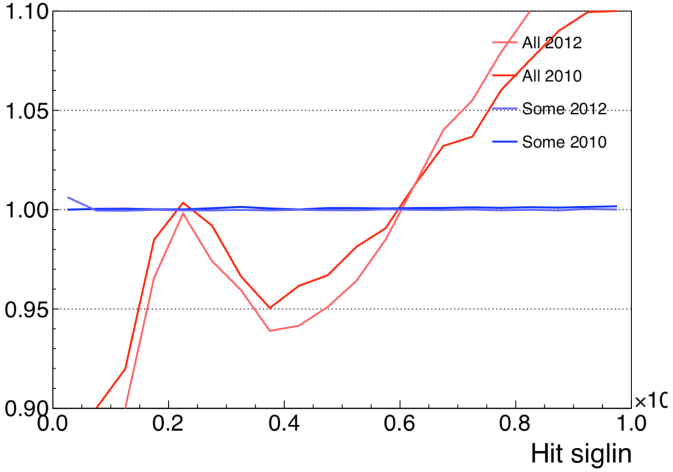
Calibration

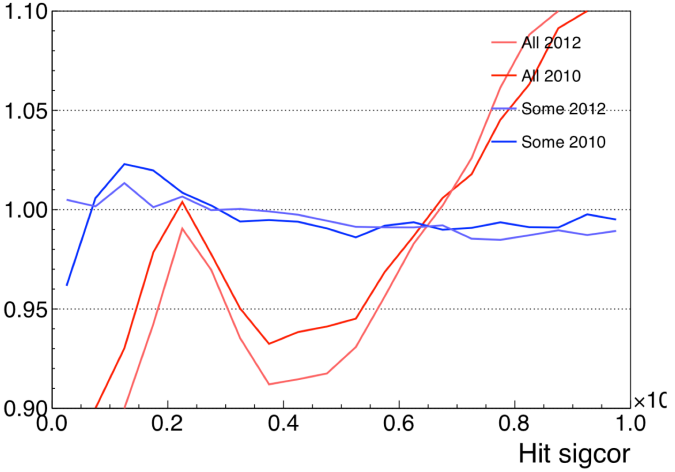


Did it work?

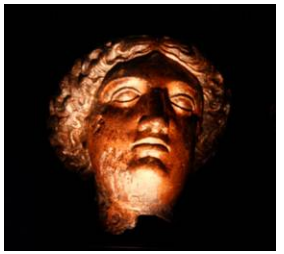








Updated ND Org Chart



Effective: Oct 15, 2016

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M. Hronek
E. Johnson
J. Saviano
S. Schuler

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S. Brice, Head
S. Zeller, Deputy Head
R. Rameika, Assoc. Head for ProtoDUNE
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ProtoDUNE
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SBN Project
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C. James
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SBN Science
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NuMI Department
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MINERvA
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(J. Saviano, Admin. Supt.)
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NOvA
P. Shanahan, Ldr.
(E. Johnson, Admin. Supt.)
G. Brunetti, RA
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