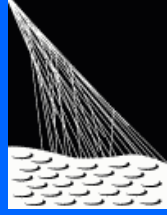
Fluorescence Measurements at ANL and the Auger Experiment

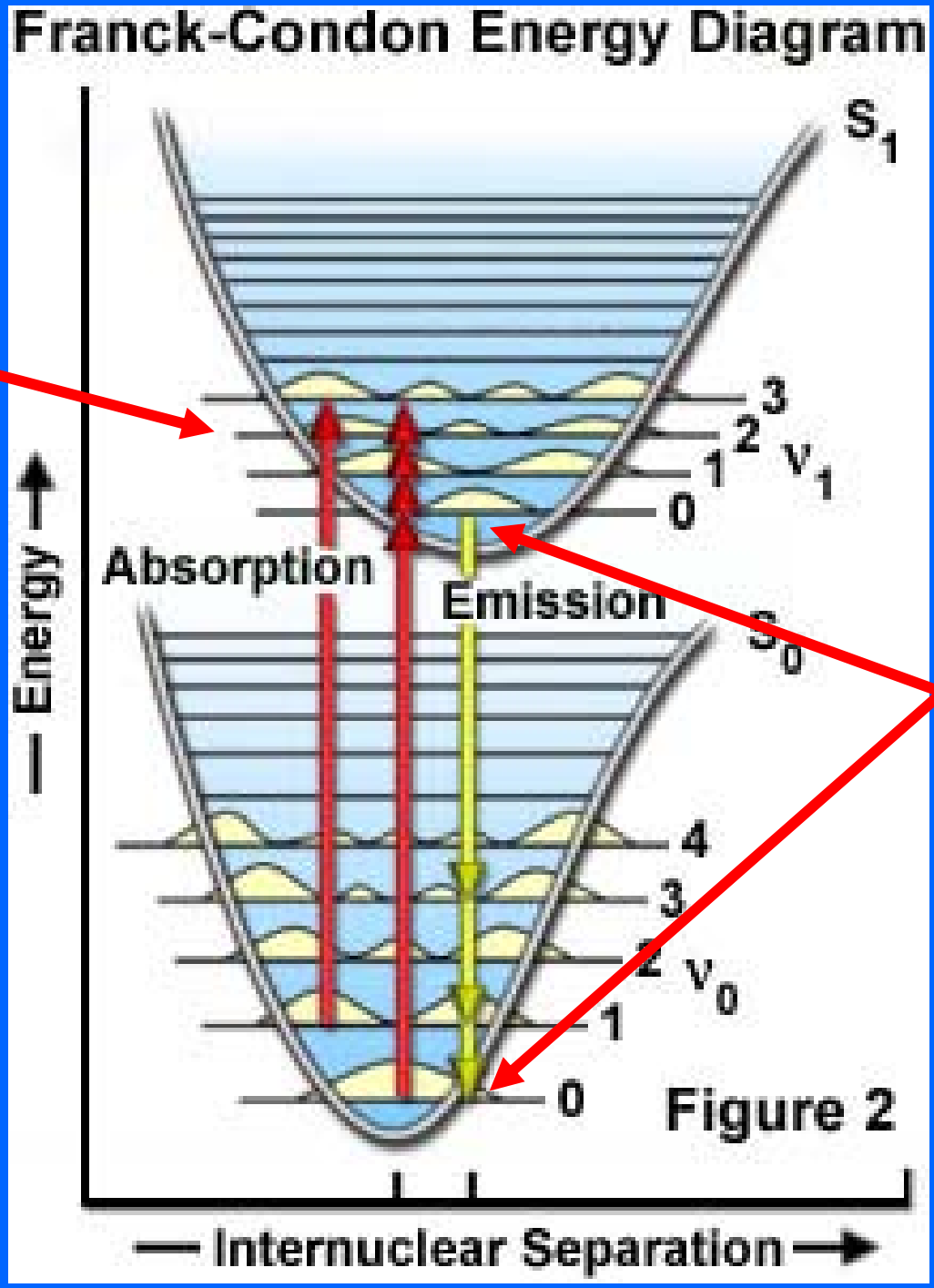


Motivation for Fluorescence Calibrations

AIRFLY Fluorescence Experiment at ANL

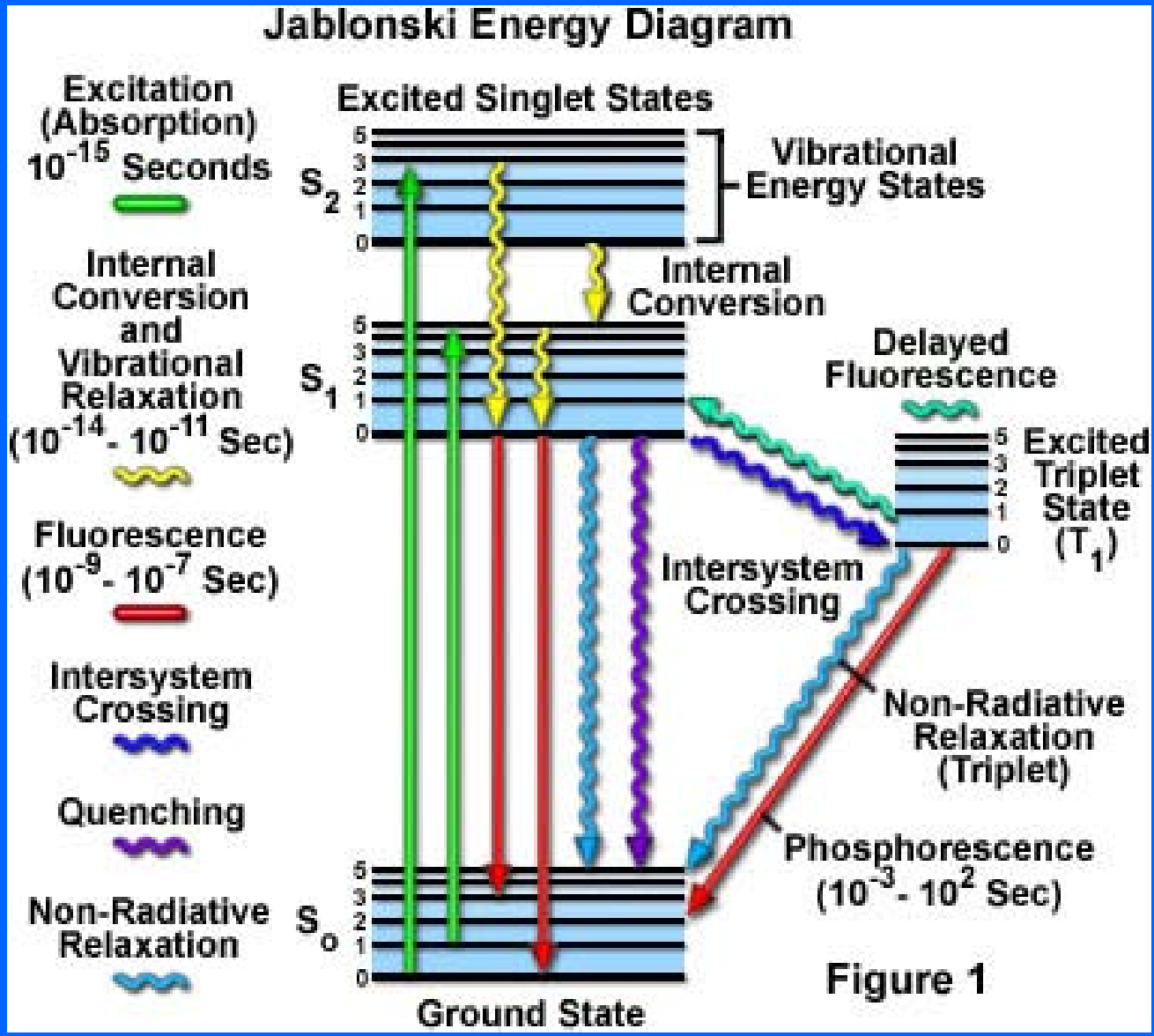
Auger Experiment Update

N_2 Molecule Vibrational Energy Levels

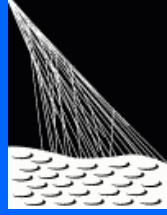


337nm transition

Main transitions are fast, nanoseconds

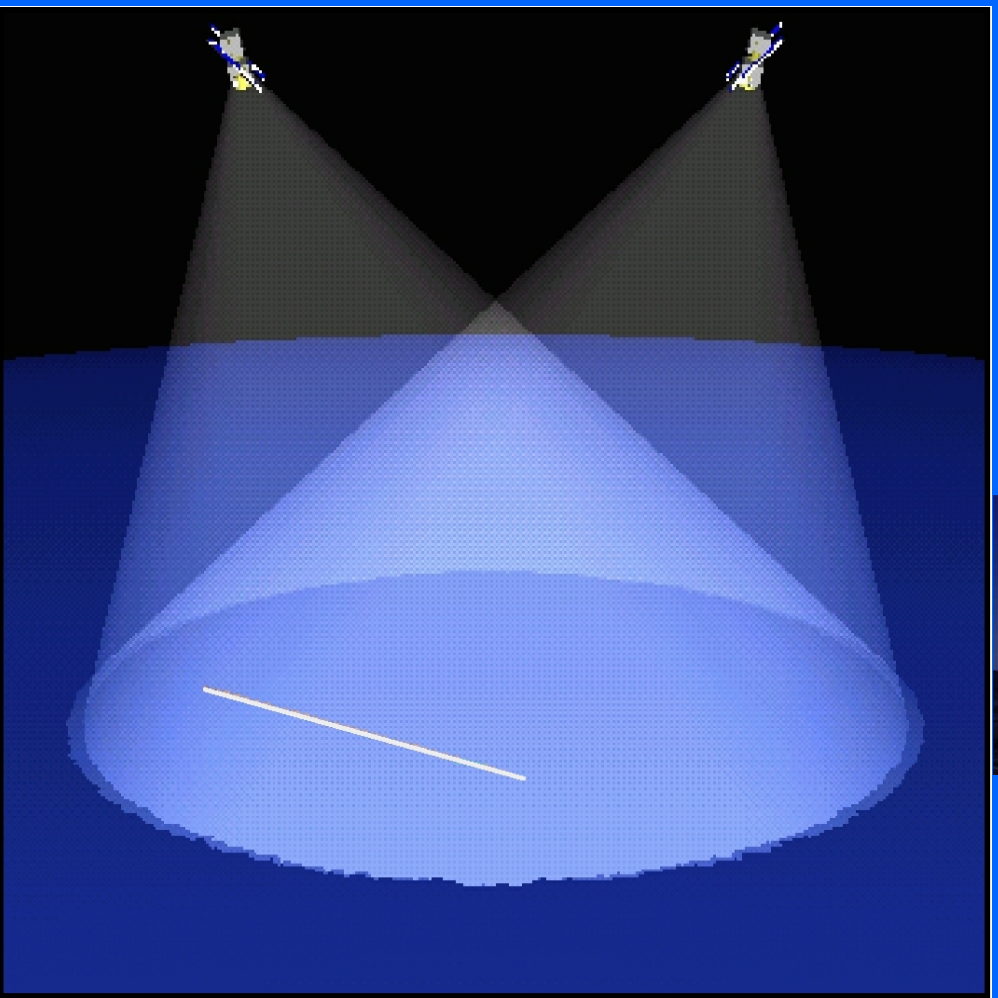


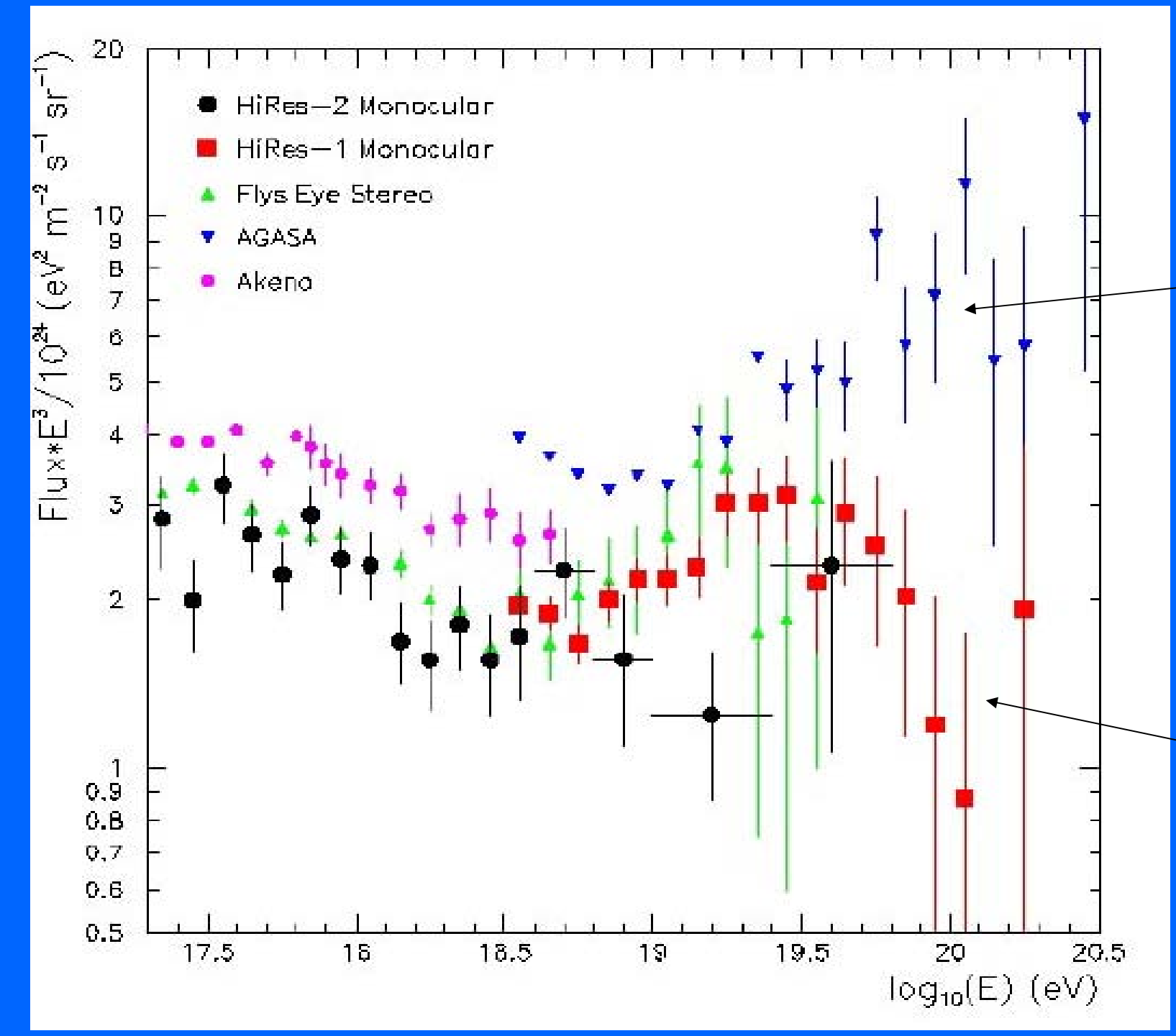
Auger



Many experiments use or will use Nitrogen Fluorescence

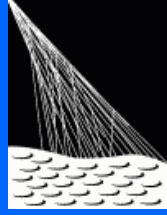
OWL and EUSO space-based experiments



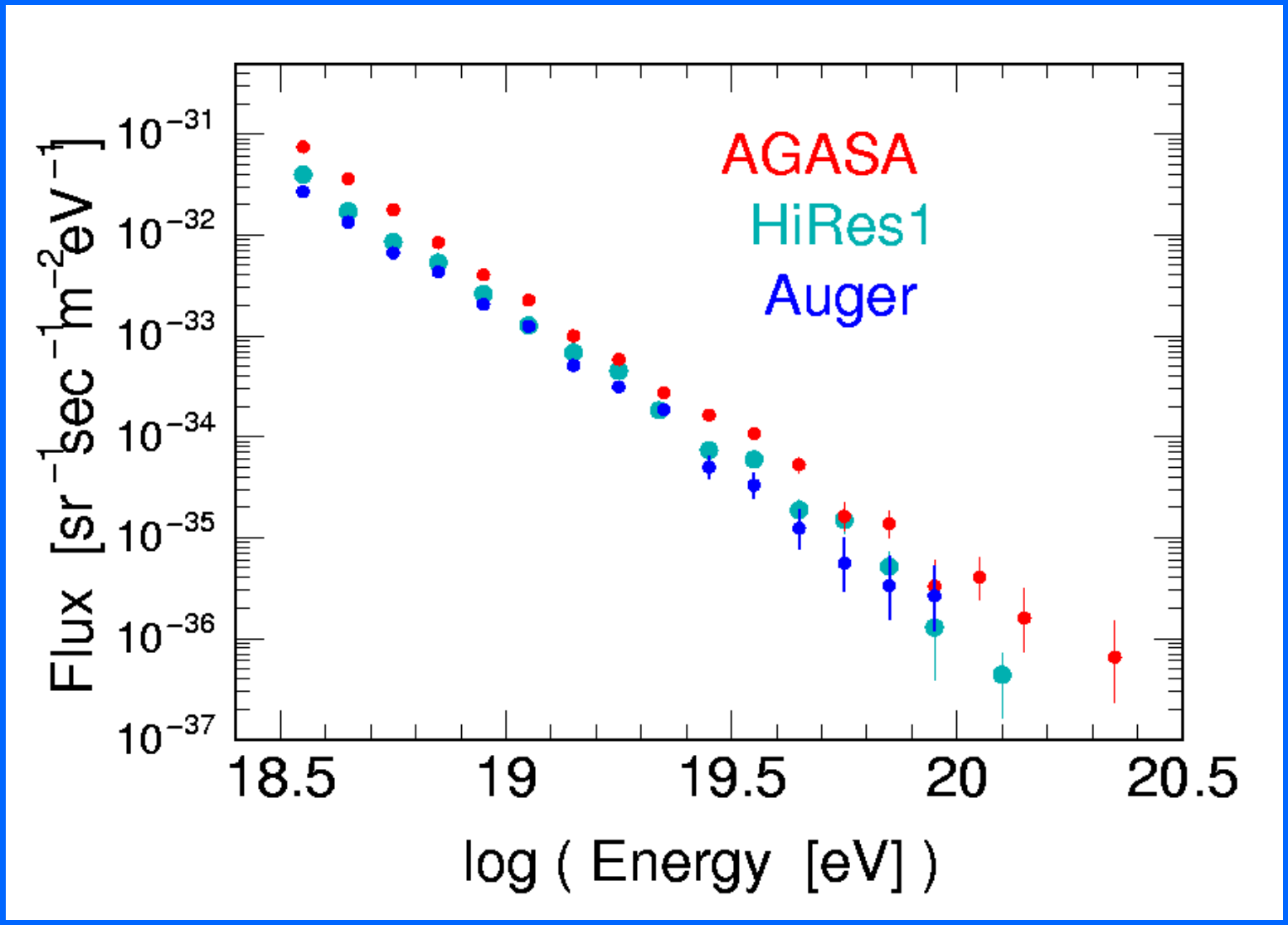


Scintillator

Fluorescence

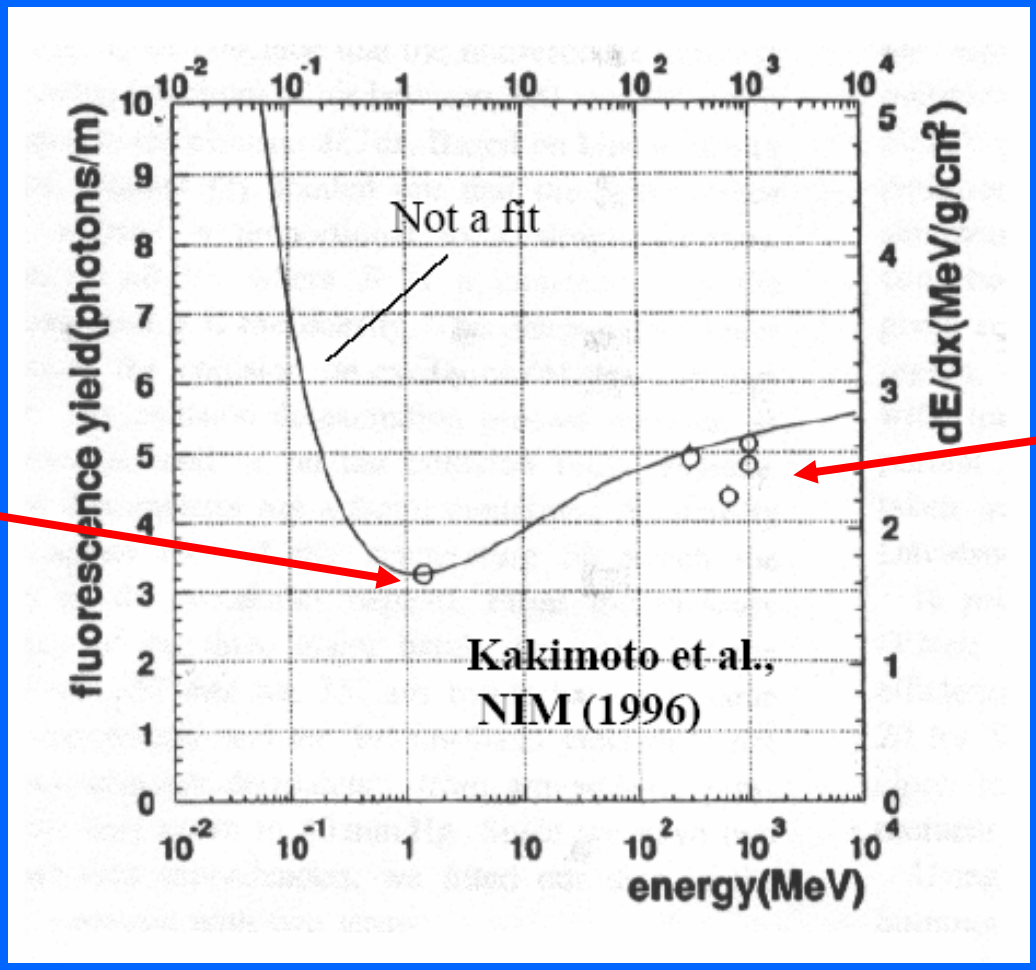


Due to smaller model dependence, Auger normalizes to its fluorescence detectors. Looks like HiRes. Water tank cross section lies right on top of AGASA until statistics run out. Only a 1σ discrepancy (25% in energy scale). Need to reduce σ…



0.22 Auger-years of data

One example measurement of electron-induced fluorescence

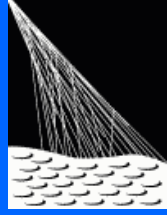


Not an absolute measurement

Agrees with curve?

E(MeV)	< 0.1	0.1-1	1-10	10-100	100-1000	>1000
Contrib(%)	10	12	23	35	17	3

45% of Fluorescence Due to Electrons and Positrons < 10 MeV in 10^{19} eV Shower



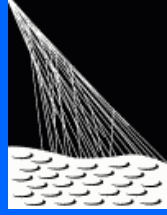
Much more information needed…

Pressure, Temperature, Humidity dependence

Oxygen quenching

More complete energy scan

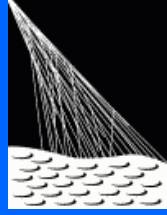
Absolute measurement to 5%



Much more information needed…

Complete Spectrum from 300-400 nm
(Rayleigh scattering $1/\Lambda^4$)

Spectrum has been measured before but only piece-by-piece with 14 filters, each with different inefficiencies and acceptance from wrong wavelengths



Much more information needed…

Previous measurements differ by as much as x3 in various wavelengths

Best measurements disagree with best models by as much as x5 in various wavelengths

Usually in the smaller spectral lines so not a disaster, but still a problem

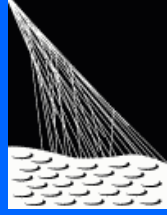
Fluorescence Calibration at Argonne

Chemistry Division Van de Graaff

Advanced Photon Source

HEP Division Advanced Wakefield Accelerator

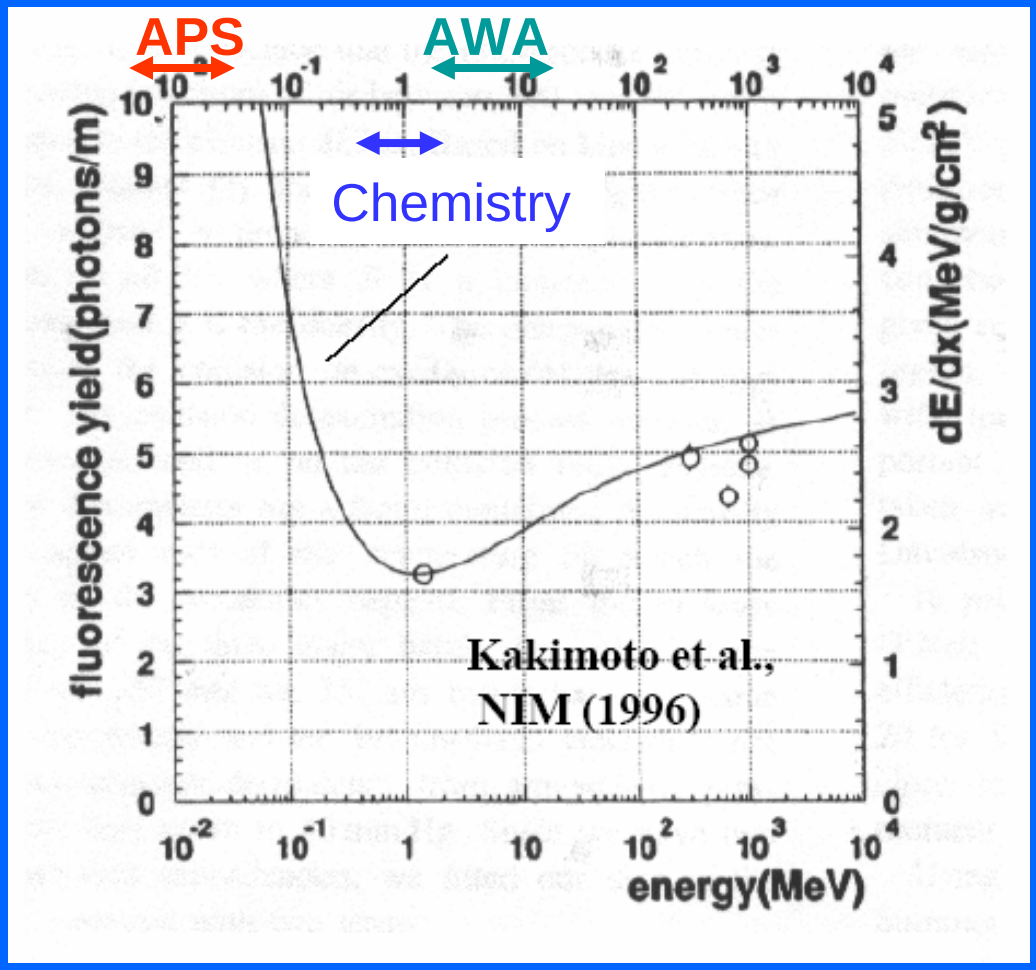
Complementary machines: AWA only accelerator with enough energy to do absolute calibration with Cerenkov gas. Van de Graaff only machine with enough charge to measure spectrum.



Heroes…

AWA group notably
Manoel Conde, Felipe Franchini, Zikri Yusof

Chemistry staff notably
Sergey Chemerisov and Bob Lowers



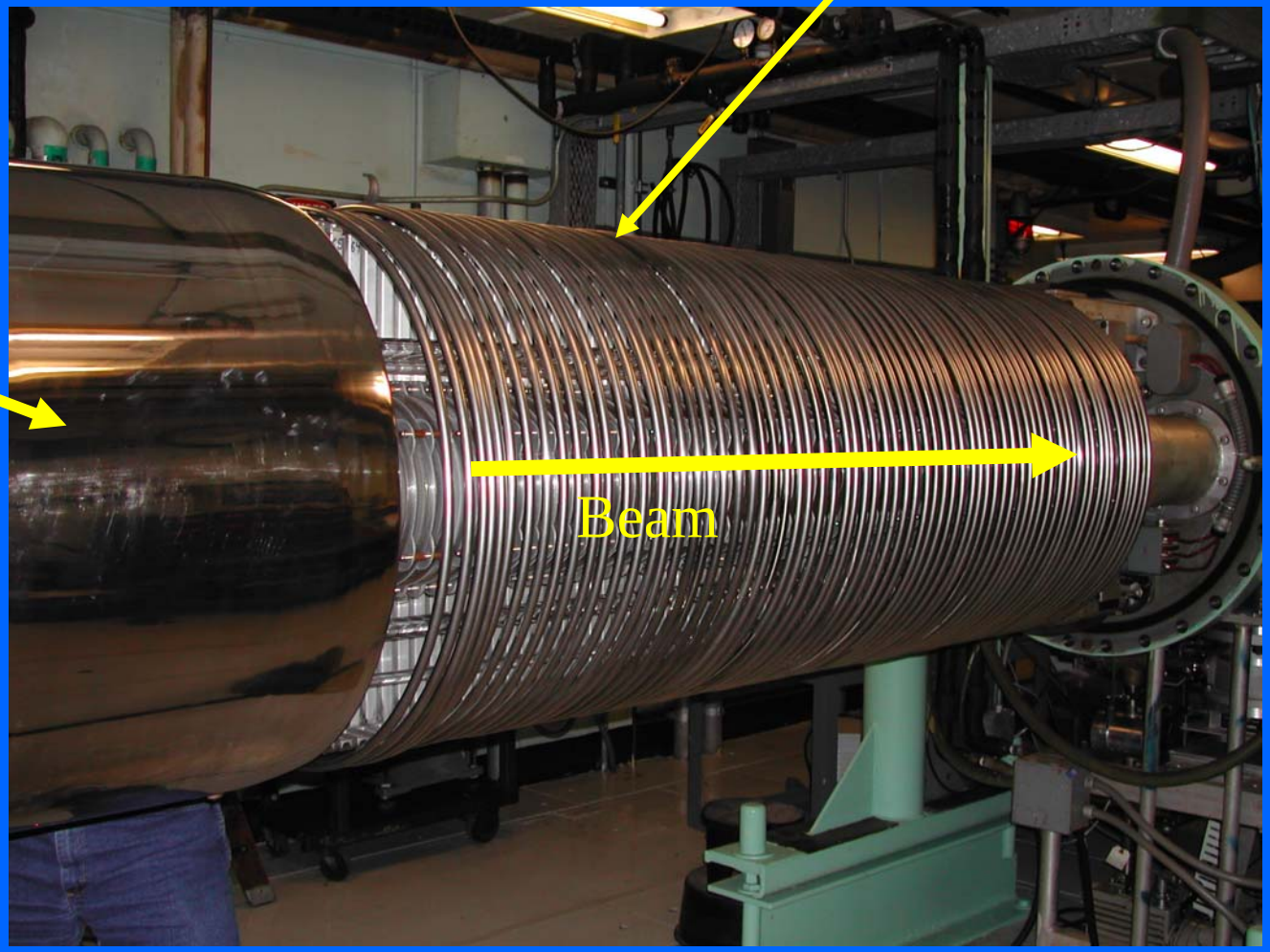
E(MeV)	< 0.1	0.1-1	1-10	10-100	100-1000	>1000
Contrib(%)	10	12	23	35	17	3

45% of Fluorescence Due to Electrons and Positrons < 10 MeV in 10^{19} eV Shower

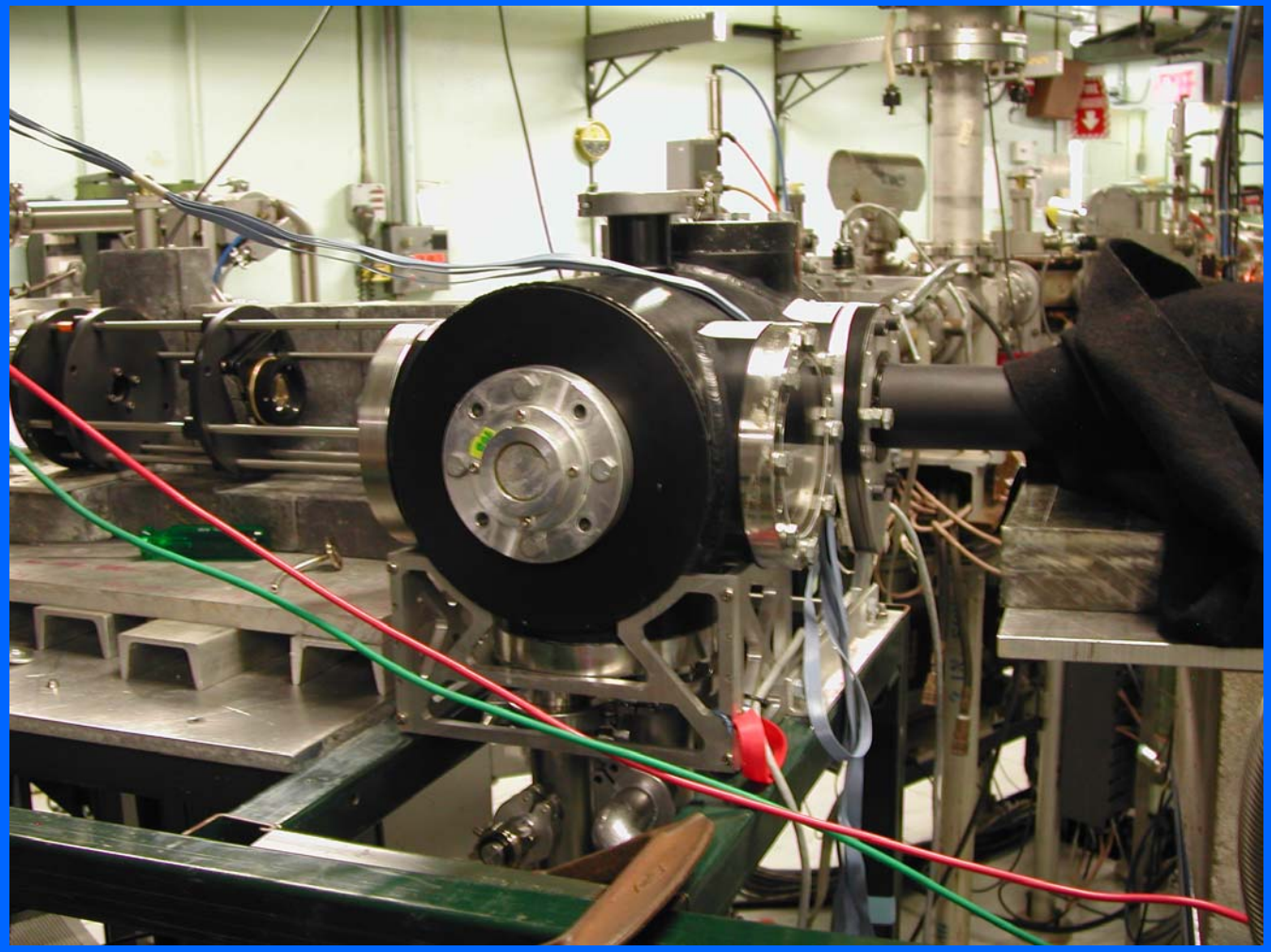
Van de Graaff with cover removed

Resistor plates step V down to zero

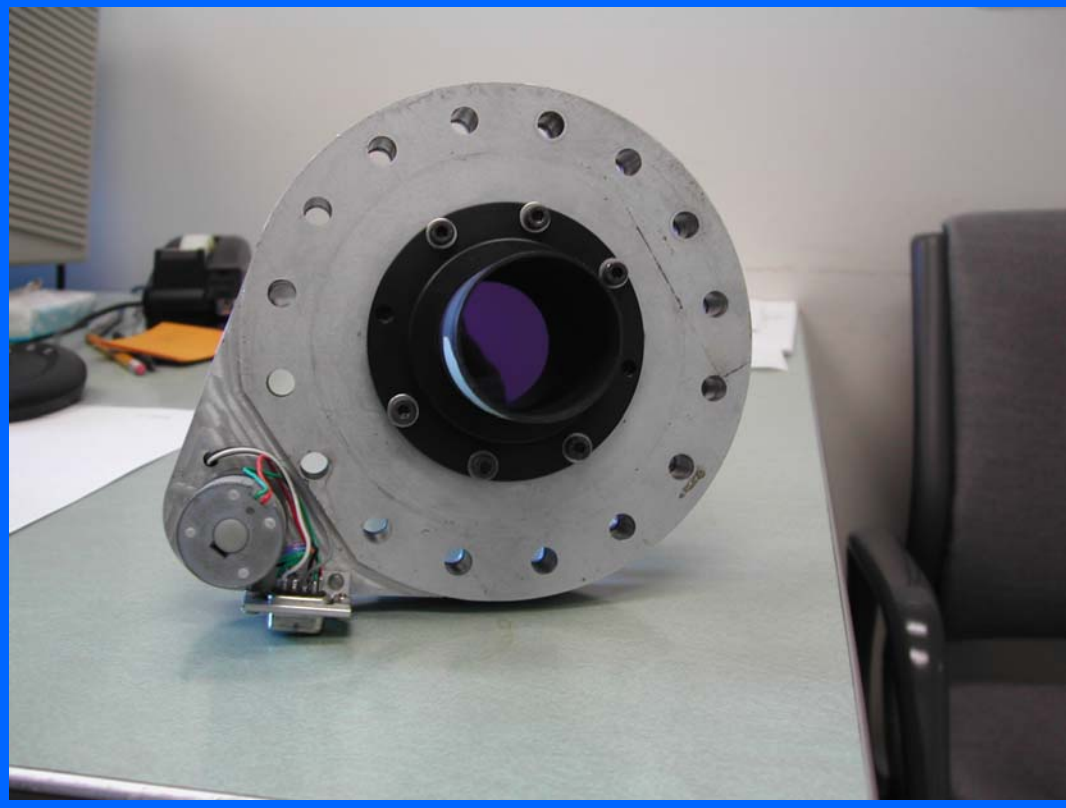
Charged to 3 million volts



AIRFLY Experiment, led by Paolo Privitera from INFN



AIRFLY Experiment, led by Paolo Privitera from INFN

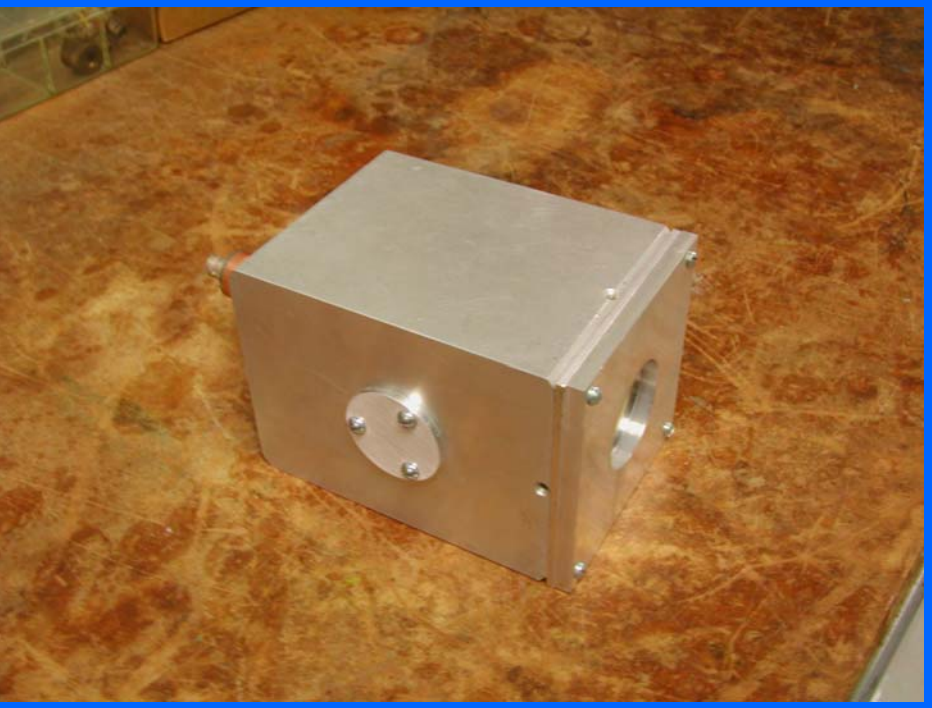


AIRFLY Running Plan

	AWA	Van de Graaff	APS
2-day PMT	X	X	X
1.5 week run	Today's talk	Today's talk	
3 week run	December	Just completed	
Depends on data needs			

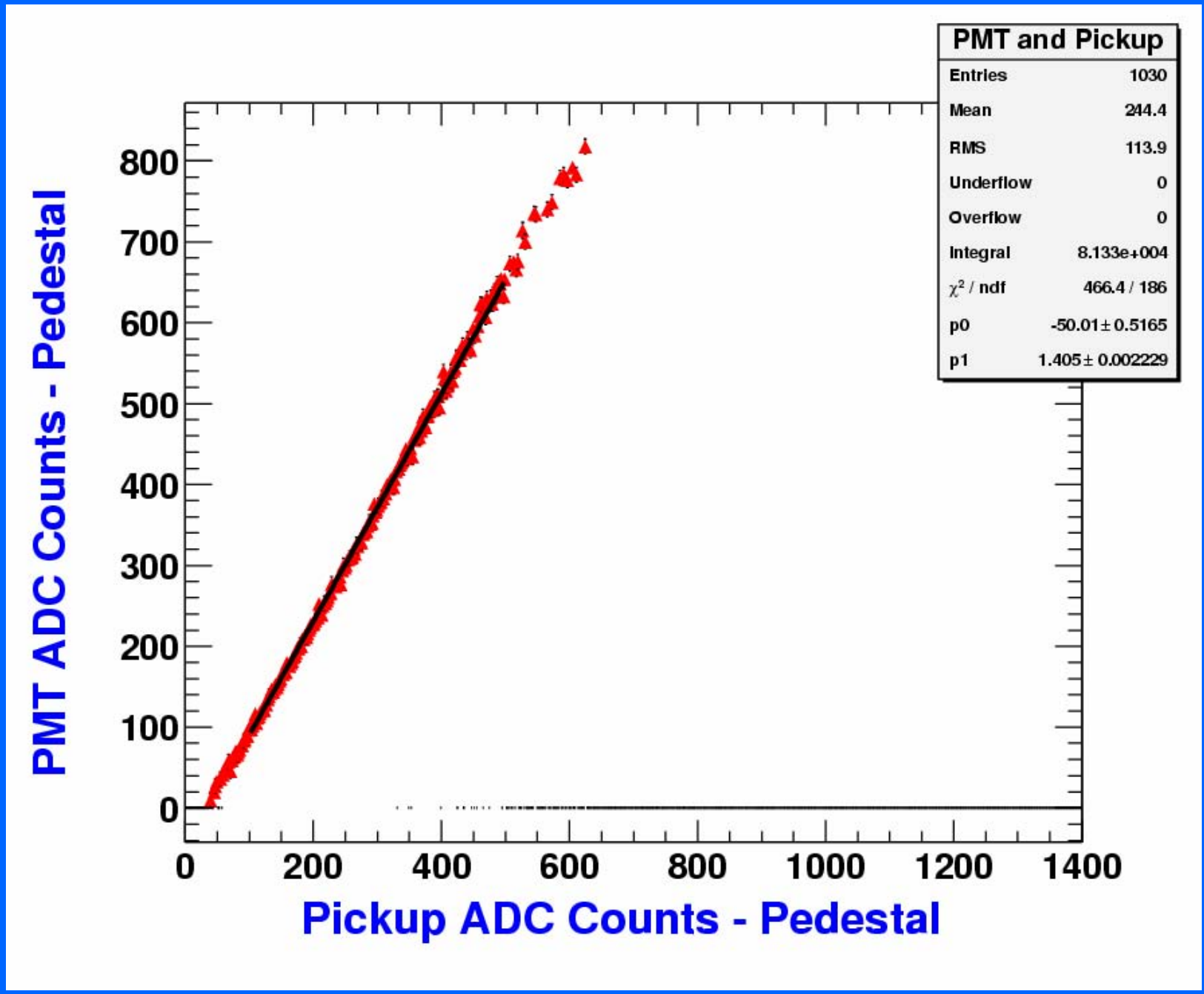
Beam Pickup, used for all the PMT measurements

Faraday Cup, mainly used to check Pickup

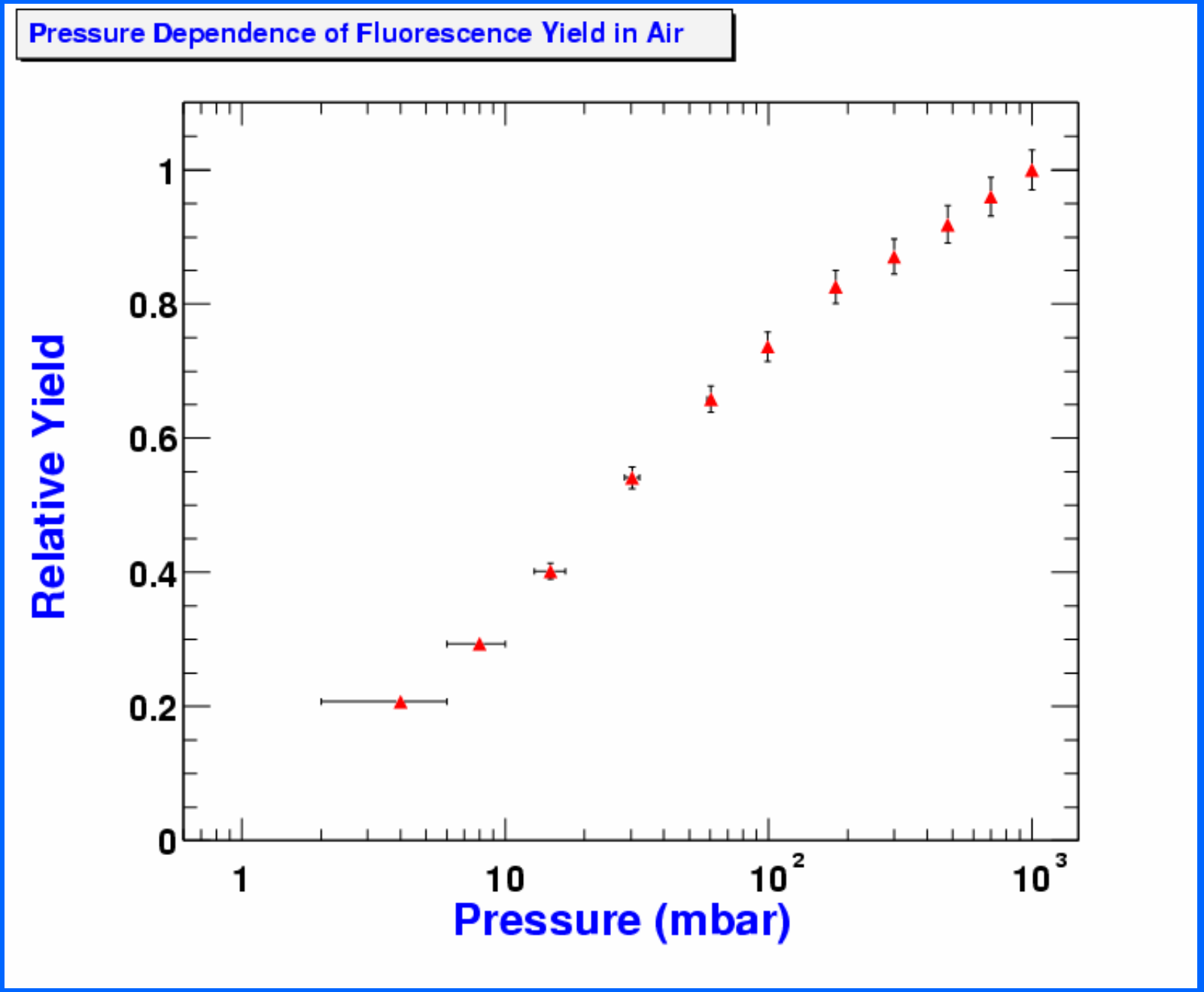


Will fit slopes from PMT vs Pickup, an experiment with 2 electronics channels!

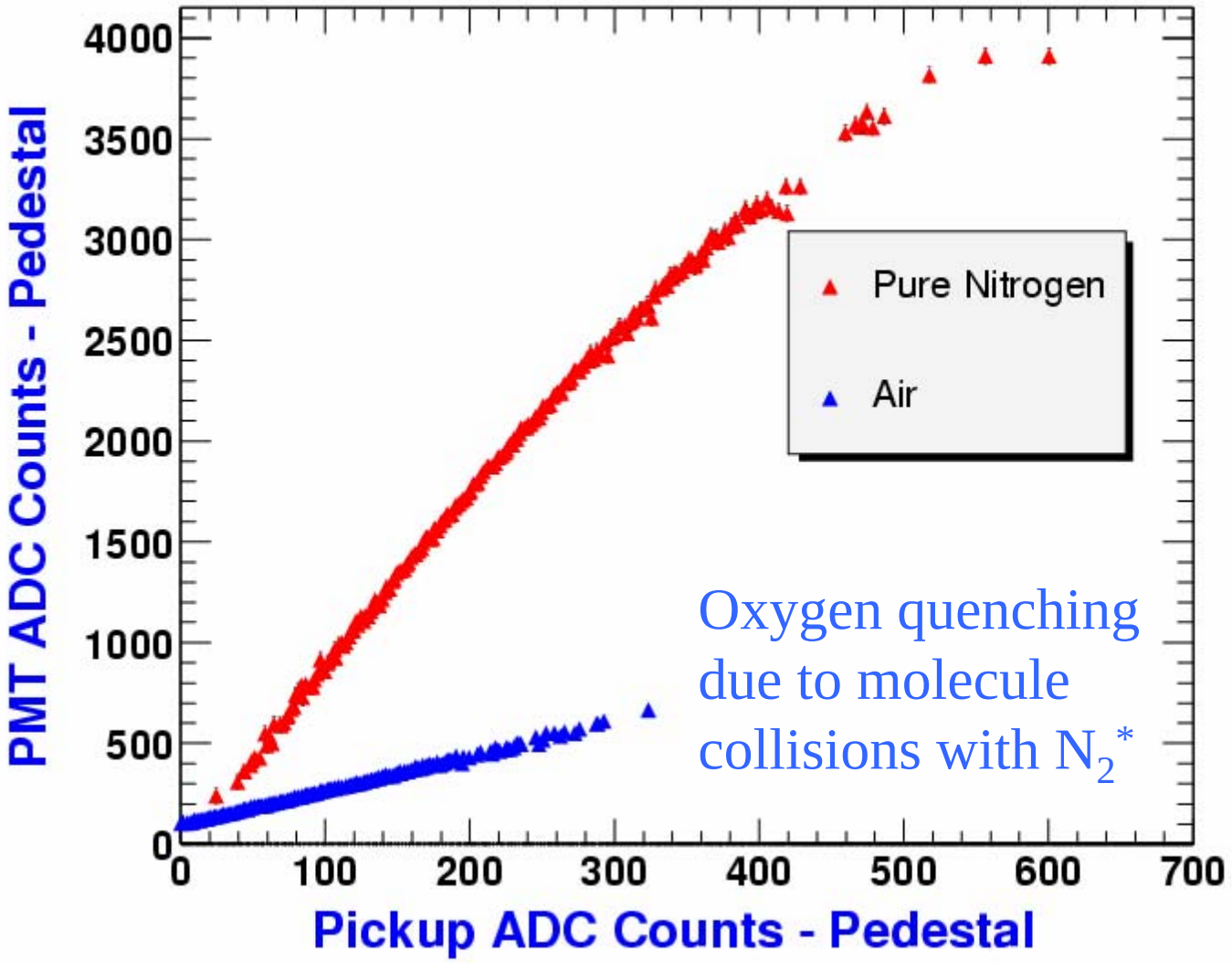
AWA PMT Fluorescence Data, 14 MeV electrons

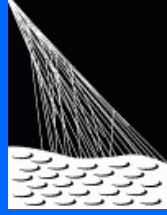


AWA PMT Fluorescence Data, 14 MeV electrons

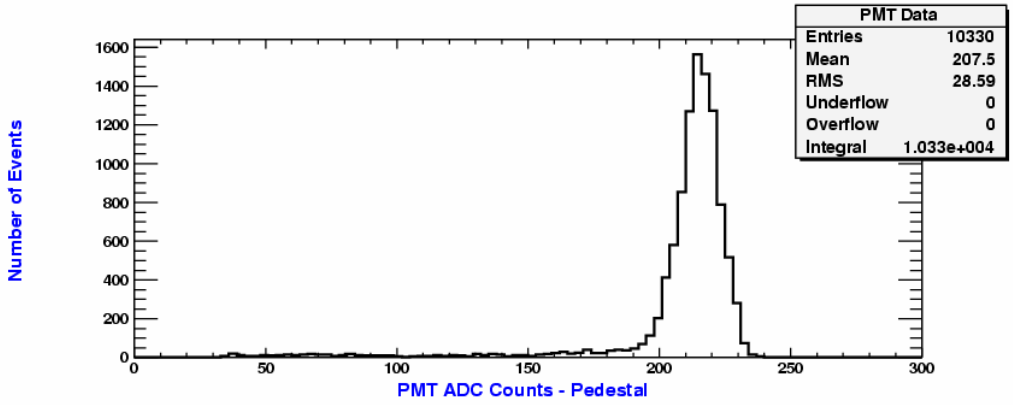


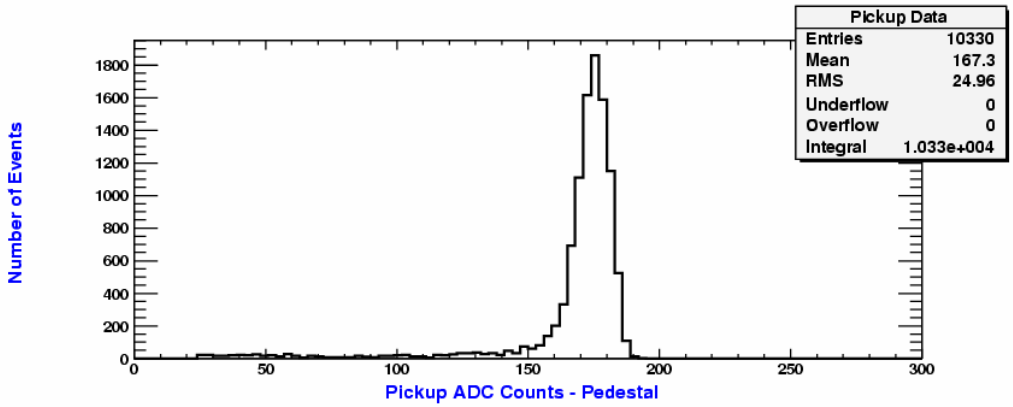
AWA PMT Fluorescence Data, 14 MeV electrons

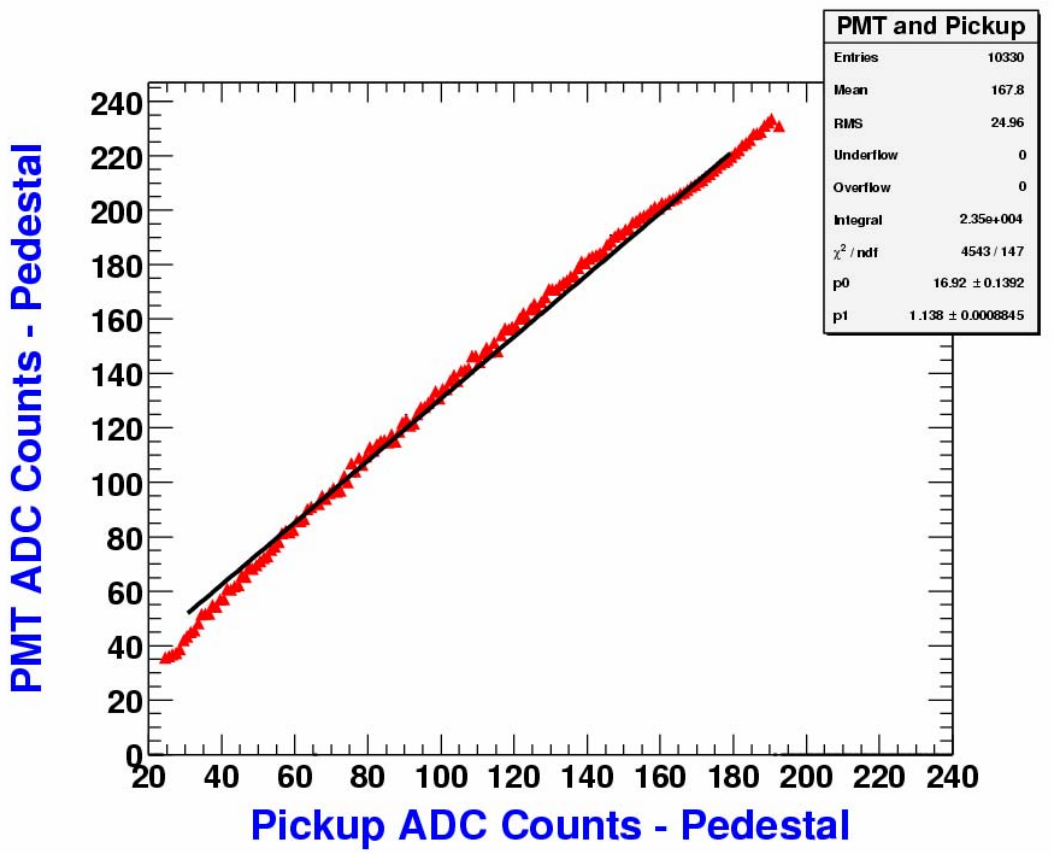


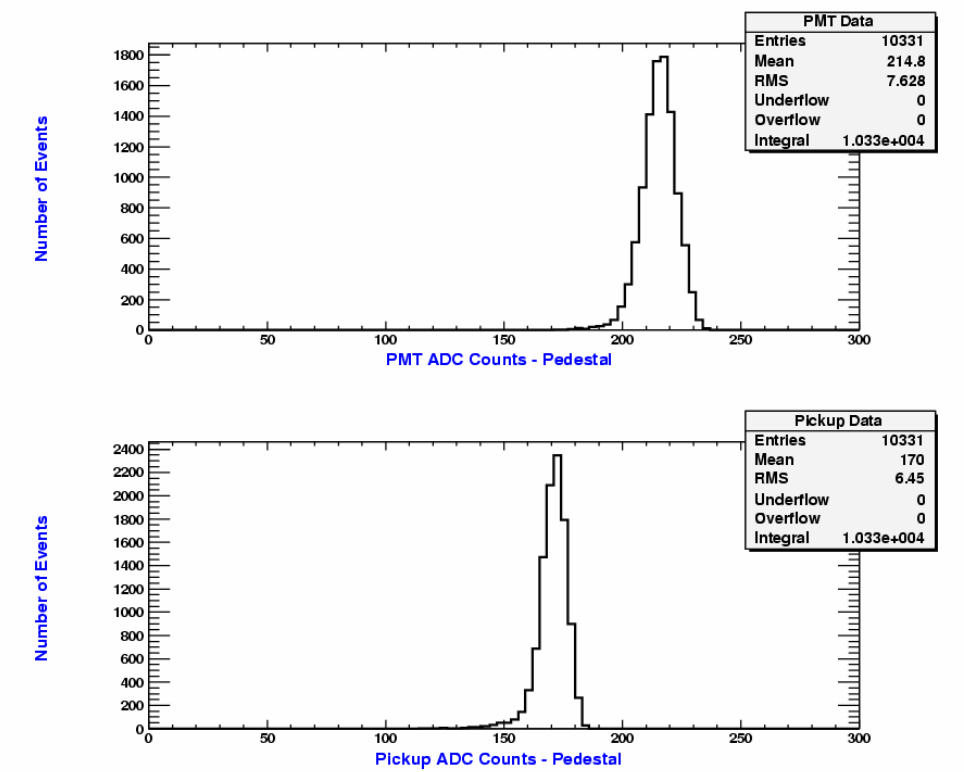


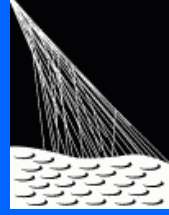
0.5 MeV Run at Van de Graaff with beam halo





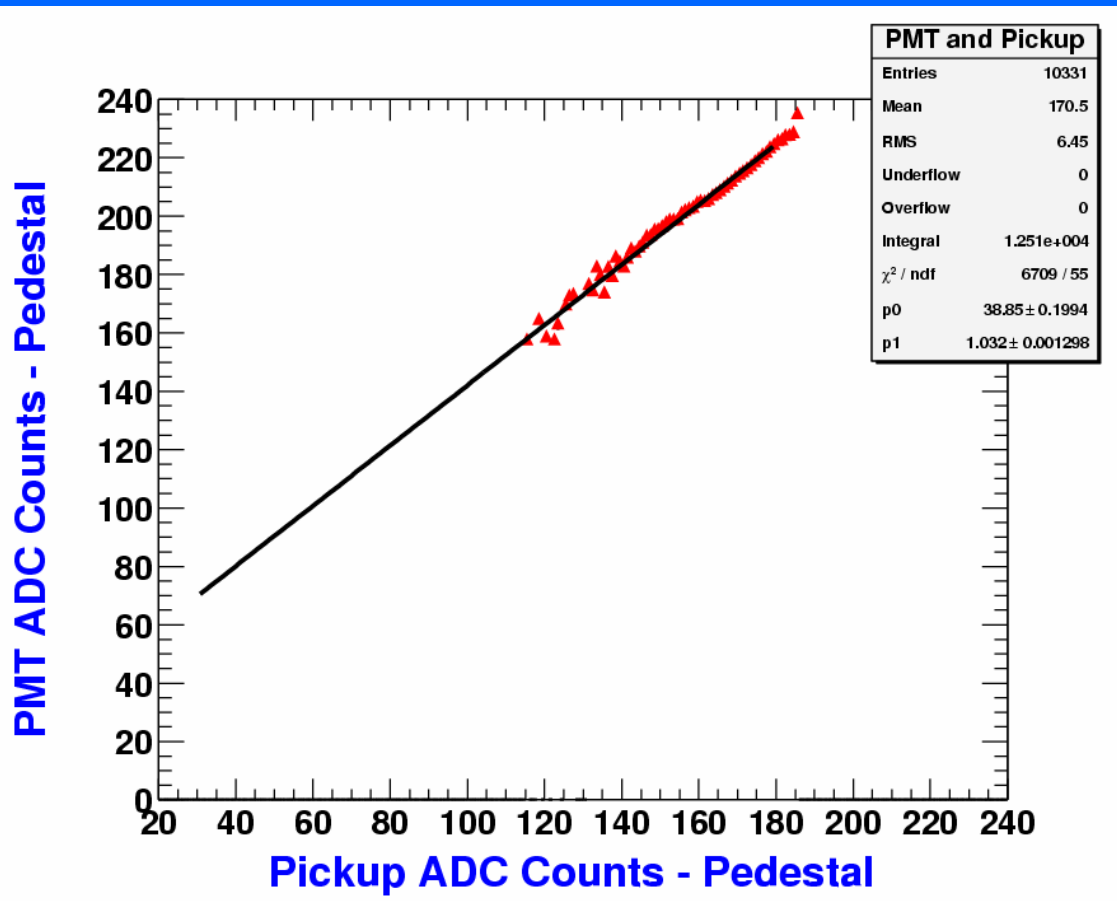




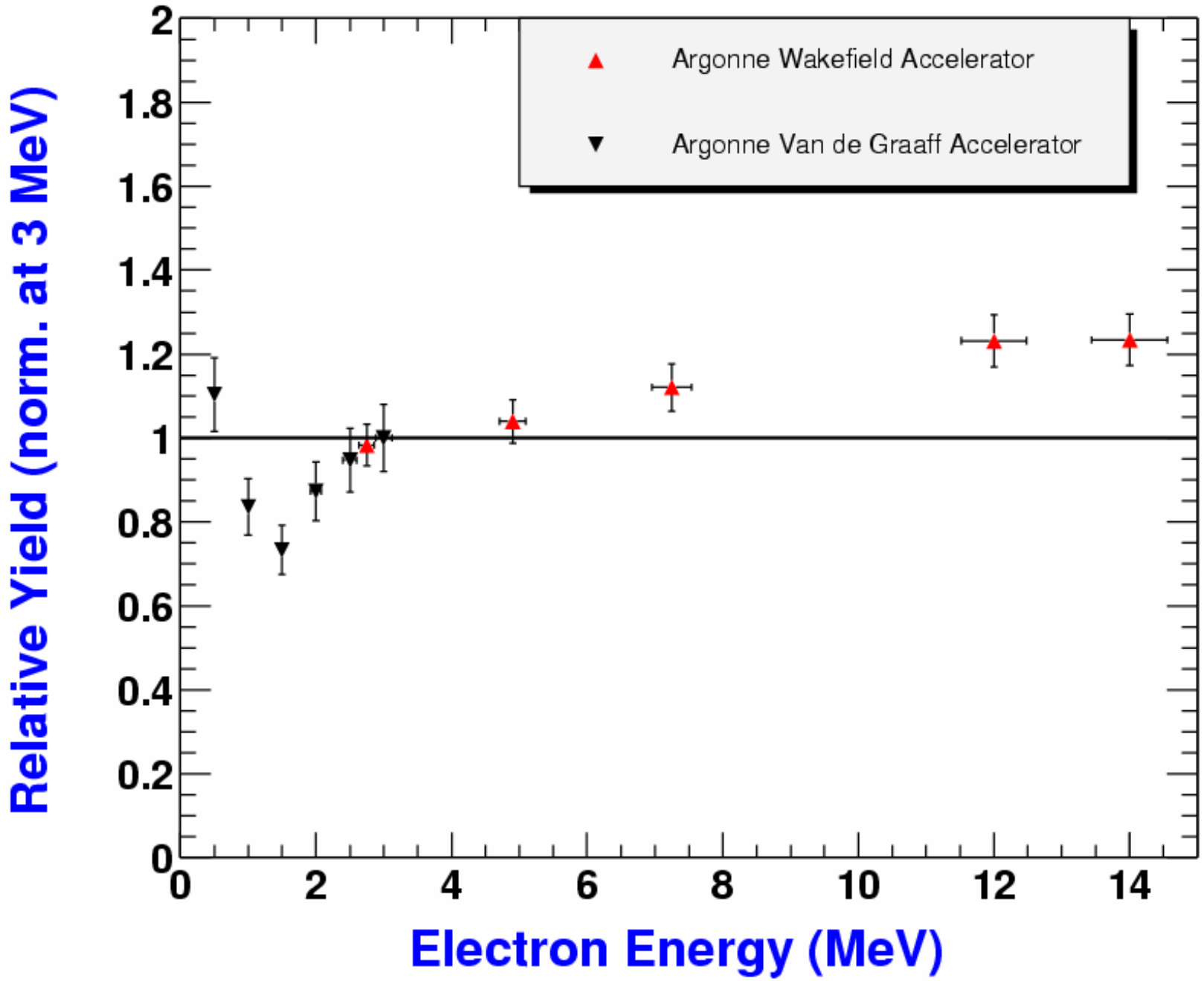


5 minutes later, beam halo is gone

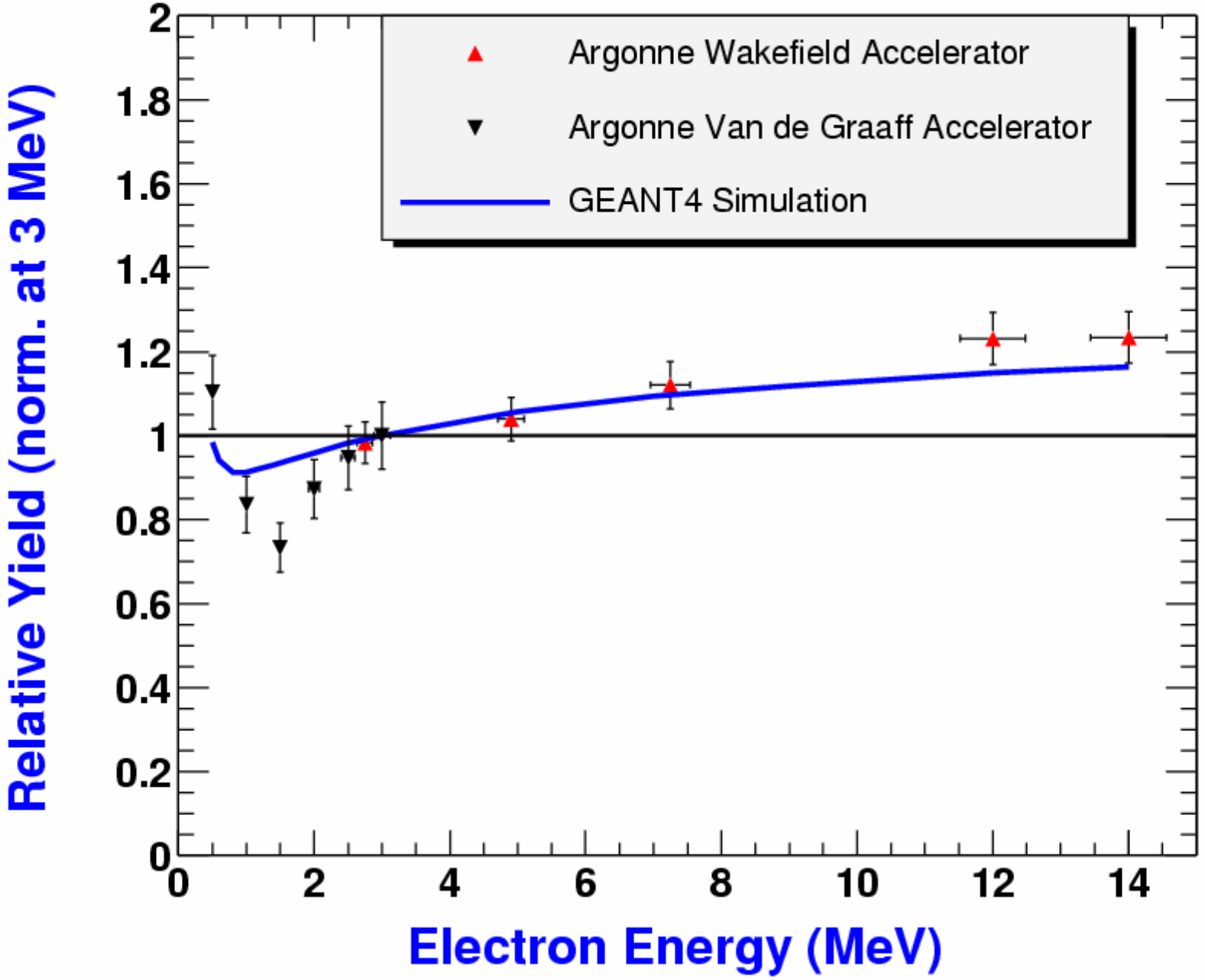
Cut ±2 sigma around main beam pickup peak for both AWA and Van de Graaff

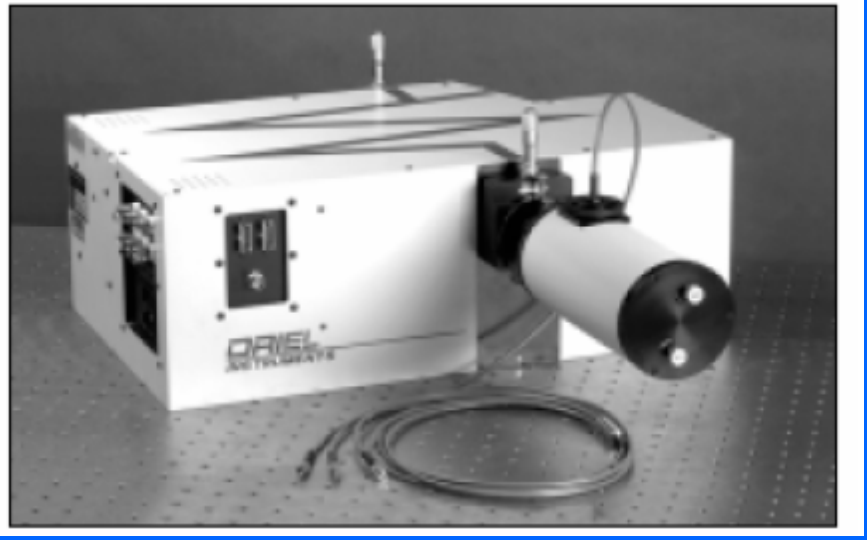


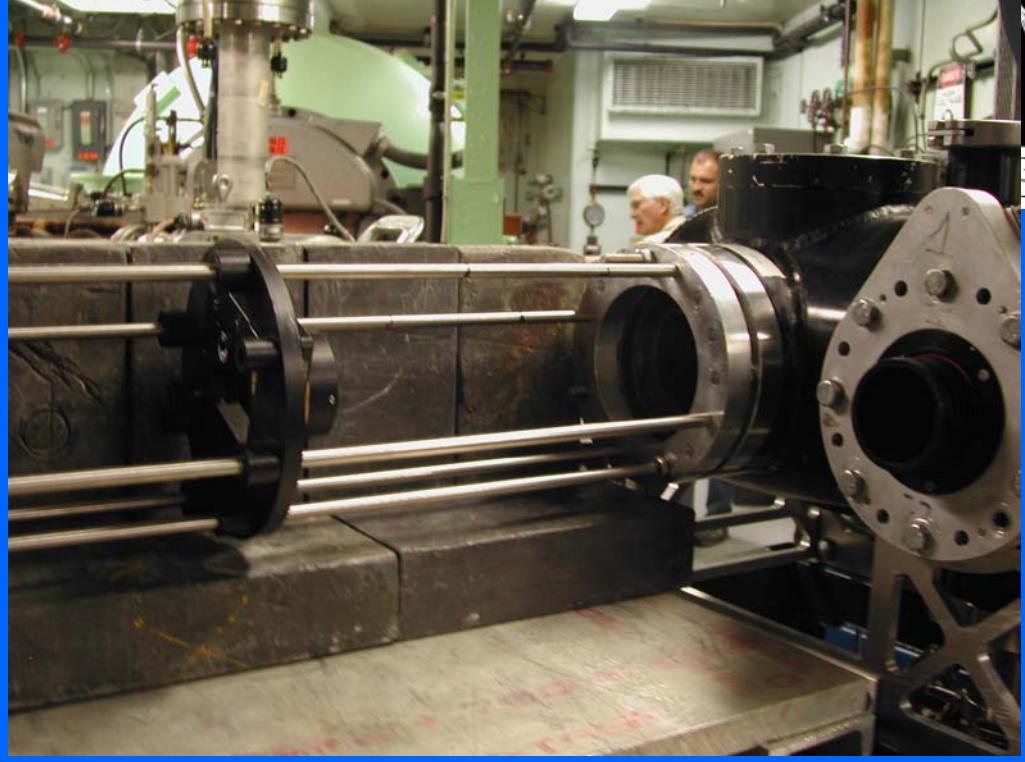
Nitrogen Fluorescence Yield in Air



Nitrogen Fluorescence Yield in Air

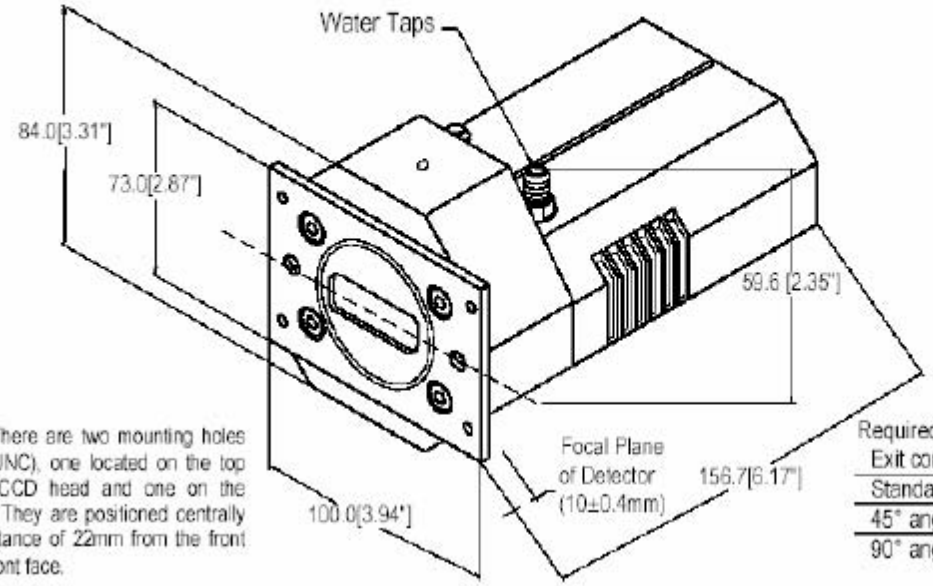






ANDOR
TECHNOLOGY

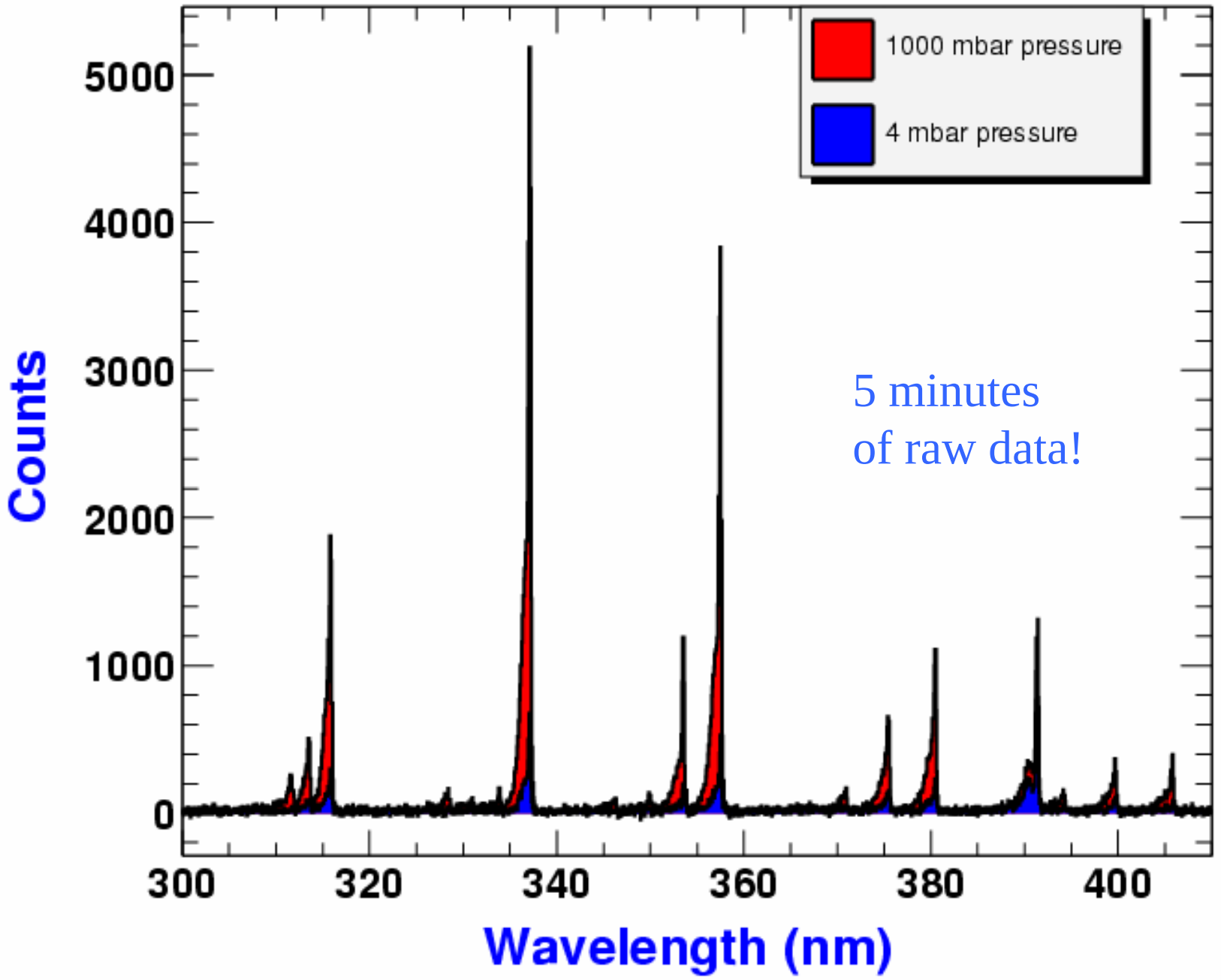
DV420

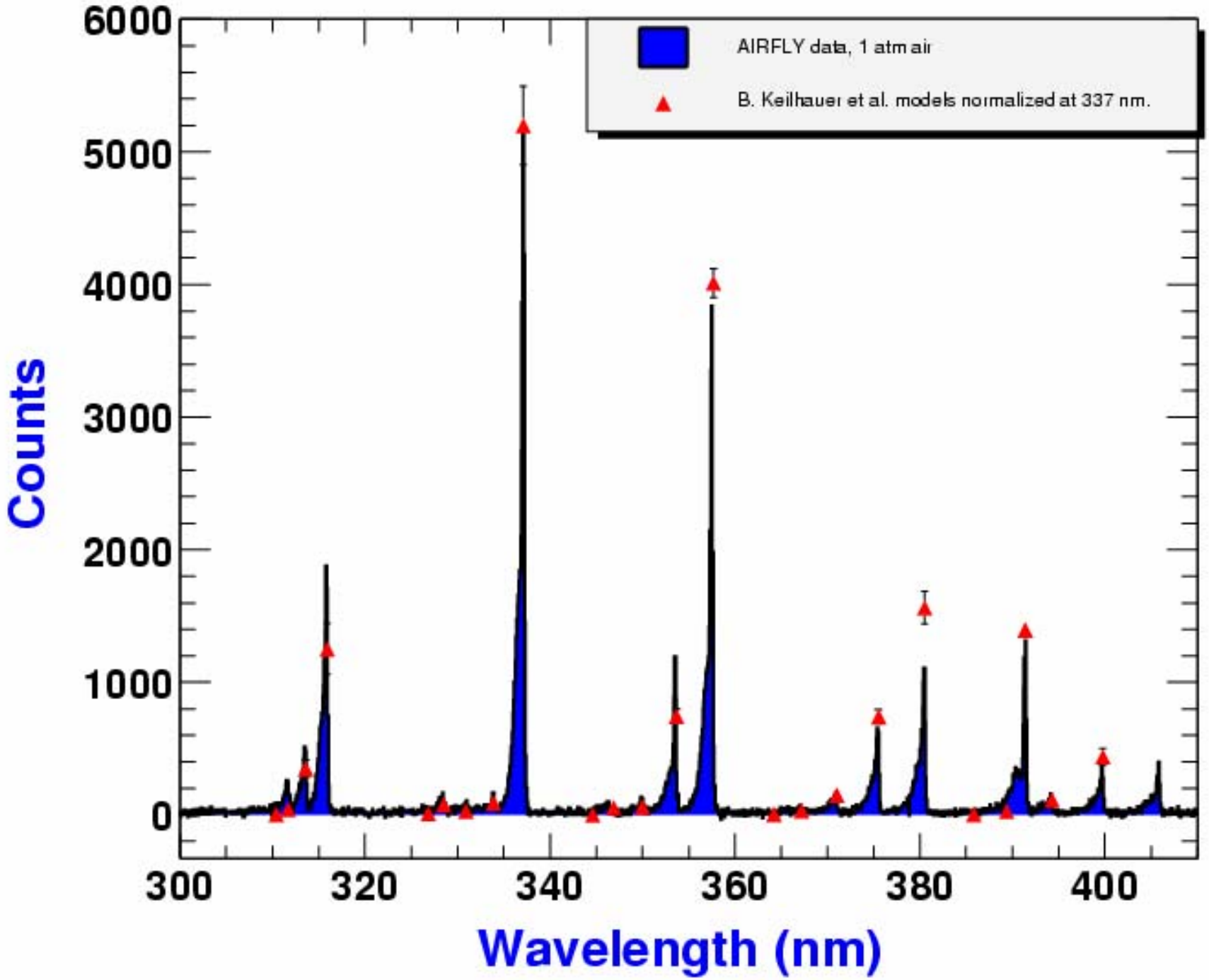


Note: There are two mounting holes (1/4-20UNC), one located on the top of the CCD head and one on the bottom. They are positioned centrally at a distance of 22mm from the front of the front face.

Required Cable Clearance at back:

Exit connector type	Clearance
Standard	140 mm
45° angle	50 mm
90° angle	40 mm


1000 mbar pressure
4 mbar pressure
5 minutes
of raw data!
Counts
5000
4000
3000
2000
1000
0
300
320
340
360
380
400
Wavelength (nm)


AIRFLY data, 1 atm air
B. Keilhauer et al. models normalized at 337 nm.
Counts
Wavelength (nm)
6000
5000
4000
3000
2000
1000
0
300
320
340
360
380
400

Main goal for December running at AWA

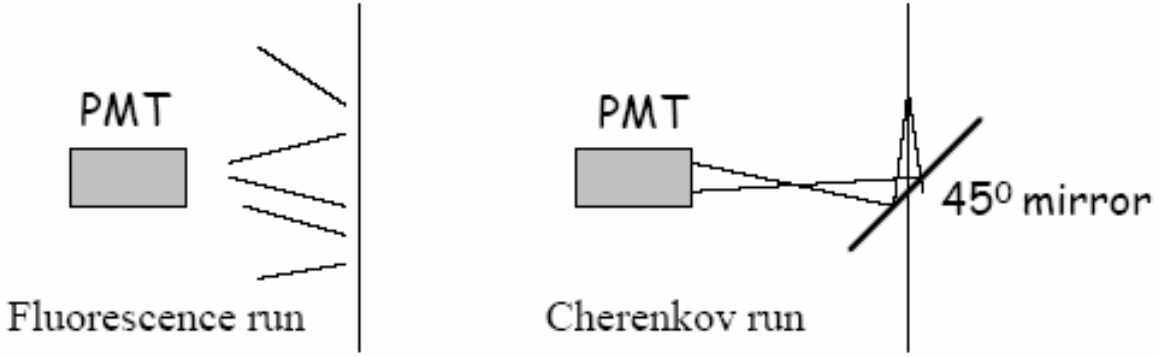
New Method for Absolute Measurement of Fluorescence Yield

IDEA: normalize to well known process (cherenkov emission) to cancel detector systematics. The normalization is done at ? ? = 337 nm.

$$N_{337}(\text{fluor.}) = FLY \times Geom_{fluor} \times T_{filter} \times QE_{337} \times N_{electr.}$$

measured — known — MC — Cancel! — relative meas.

$$N_{337}(\text{cher.}) = CHY \times Geom_{cher} \times T_{filter} \times QE_{337} \times N_{electr.}$$

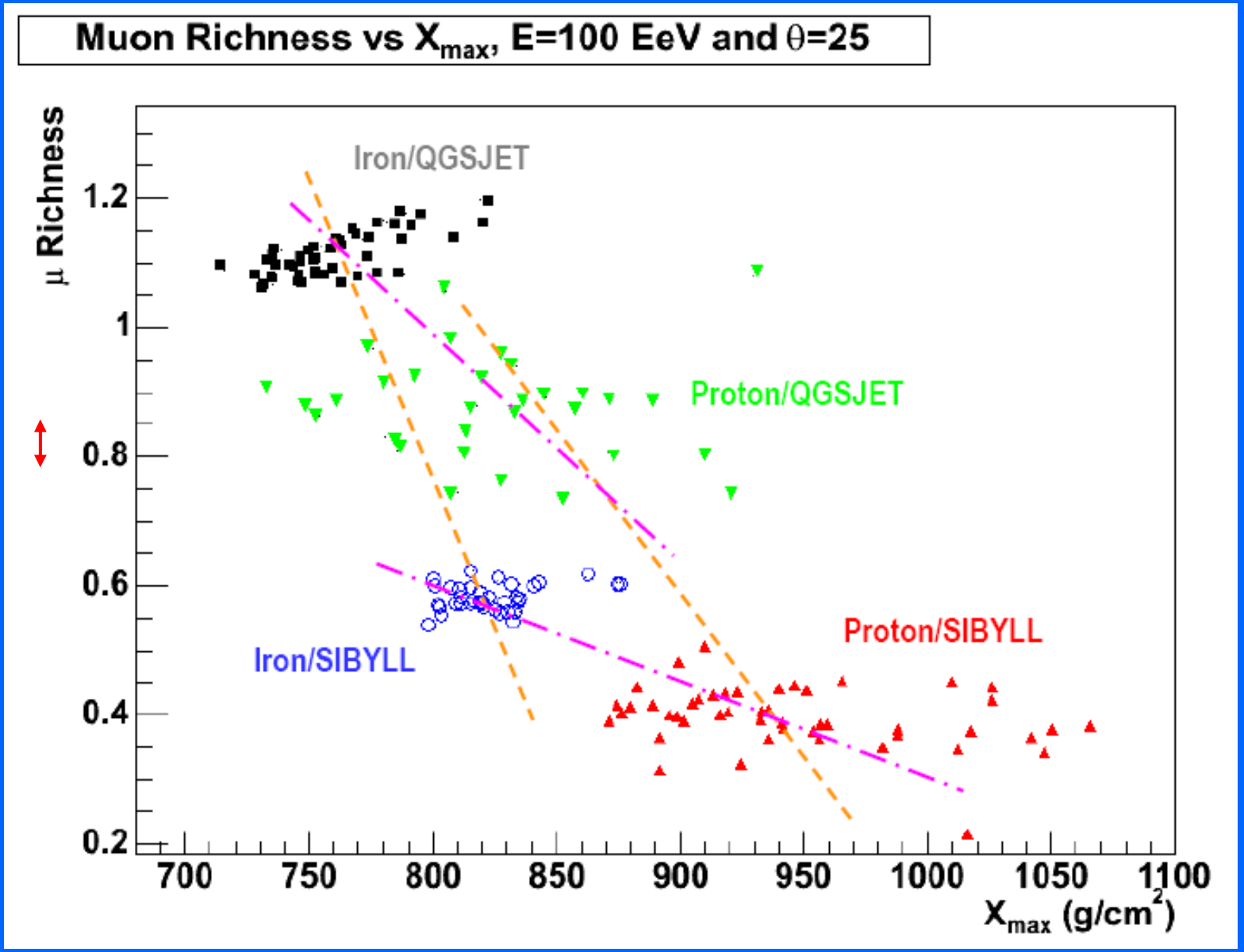


? Systematic error potentially = 5%

? First tests very encouraging!

ANL may also play the key role in improving the water tank measurement…

Need ~5% measurement of Nmuons to maintain separation

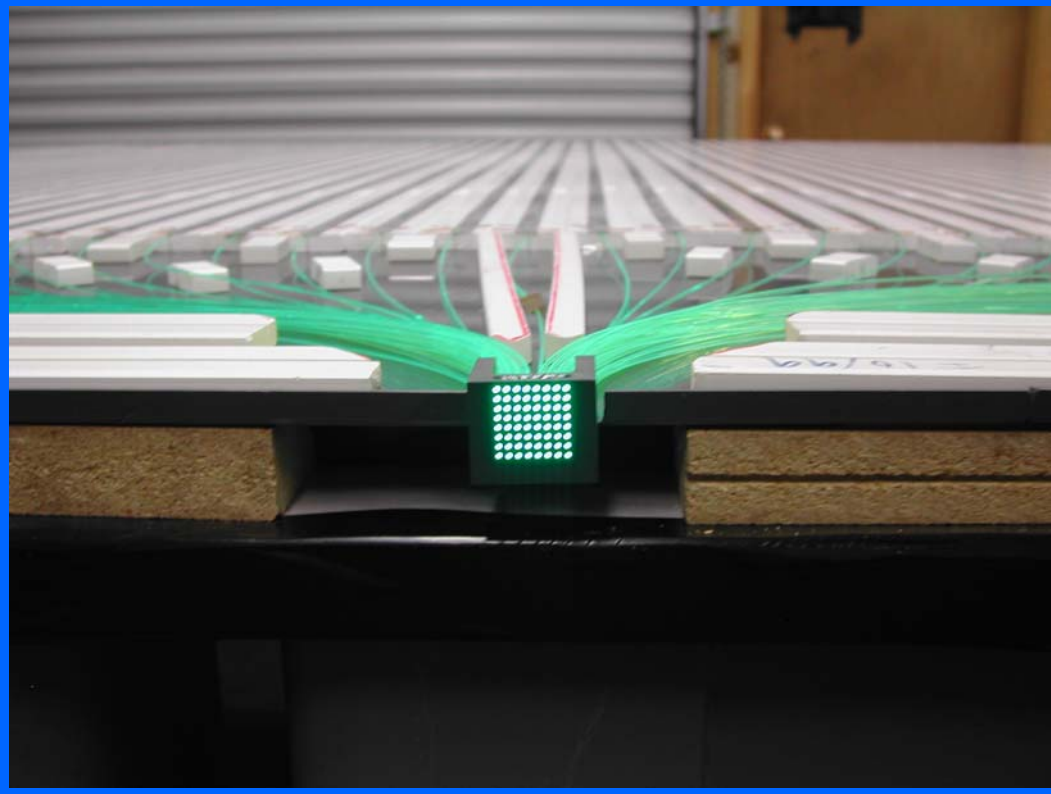


Basics of Current Design

Scintillator strips are 200cm x 4.1cm, 64 strips per module, 5.2 m^2

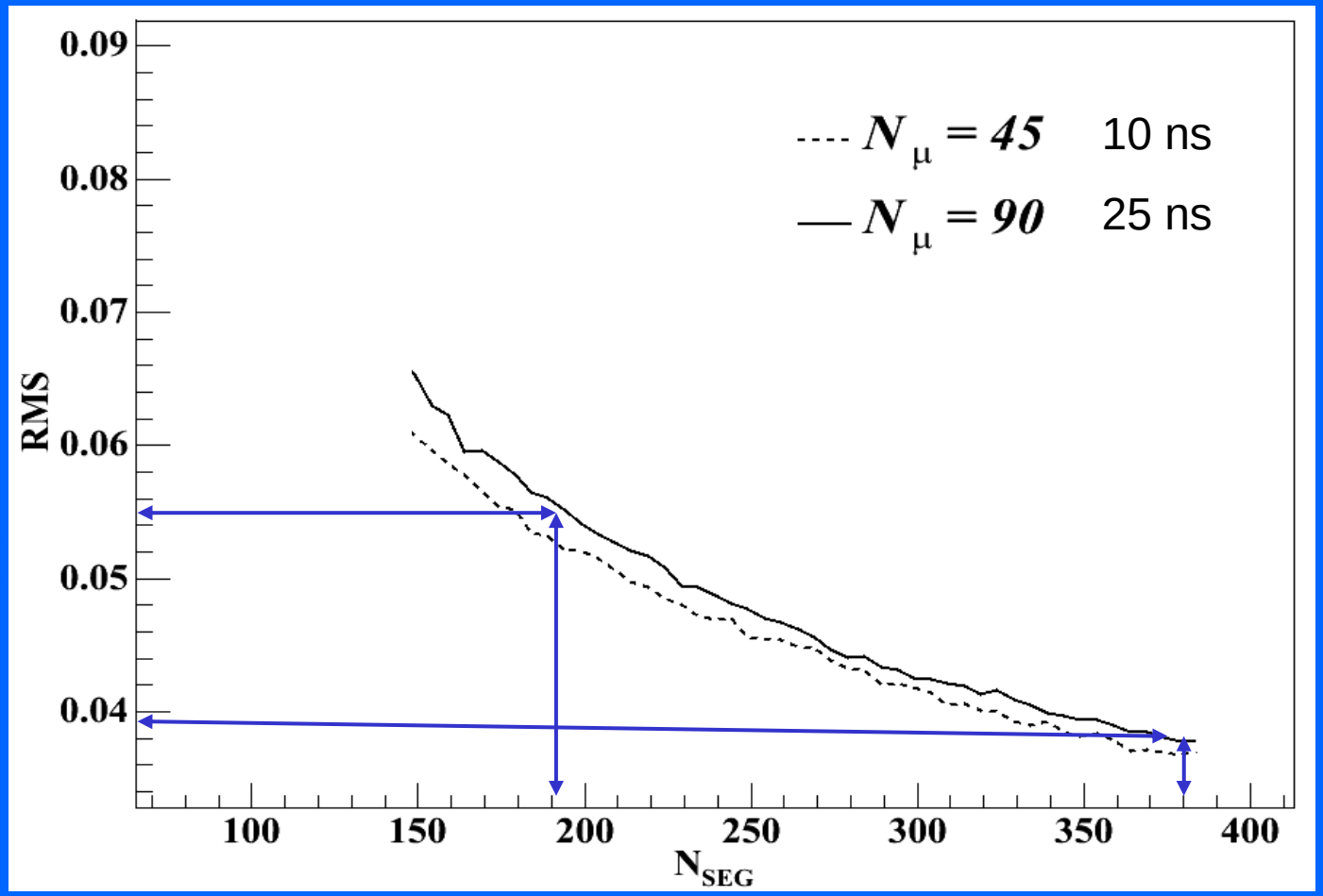
6 modules per 31.2 m^2 unit, read out with 64-pixel PMTs

Electronics counts number of strips over threshold every clock cycle and sends 9 bits per unit



What segmentation per 30 m^2 unit is needed?

RMS of N_μ / N_μ^{Real}

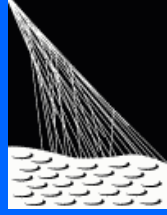


Segments: **192** ← 384

For comparison CASA/MIA had 10 segments per 30 m^2

Going from 384 segments to 192 saves $0.45M

Proposed Final Muon Layout



Energy (E range) (EeV)	Detector Spacing (m)	Size (km^2)	θ_{max} (deg)	#events/ Year	Total Number of 30 m^2 Sites
0.4 (0.2-0.6)	375	2.5	45 (60)	700 (1150)	29
1.0 (0.6-3)	750	23	45 (60)	1050 (1750)	61
6.0 (3-10)	1500	250	45 (60)	310 (515)	127

6 * 127 = 762 modules, about a $1.5M project, but approval cannot come until Auger South is complete. Also depends on Airfly results.

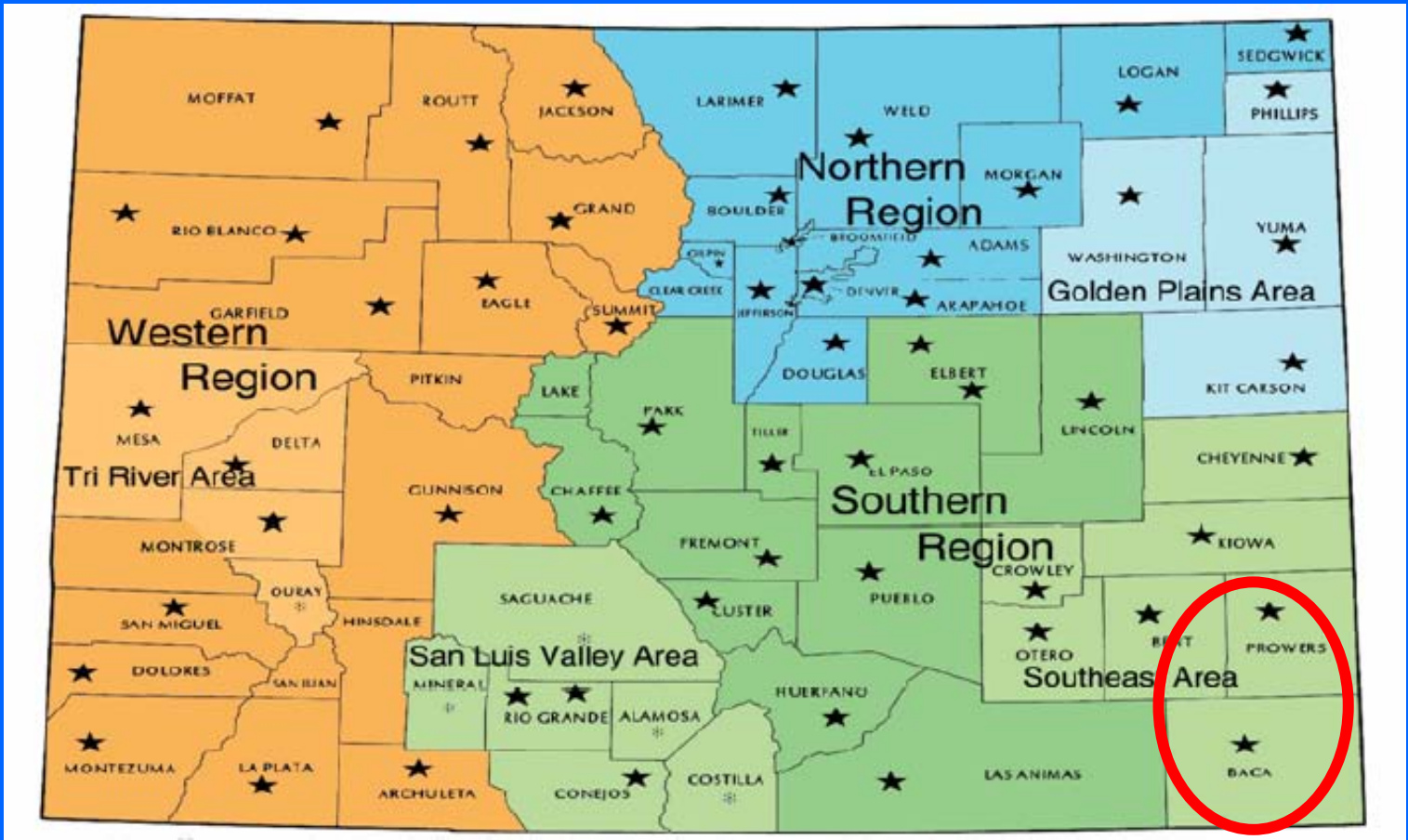
Fluxes estimated from current Auger spectrum

Construction Progress

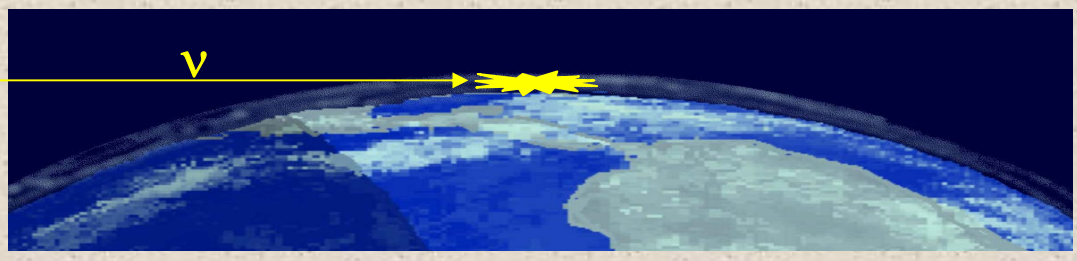
905 surface detector stations deployed

Three fluorescence buildings complete each with 6 telescopes

Auger North Site Selected in June, Colorado site wins



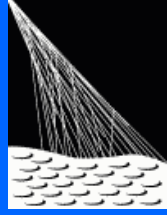
Hal, Rich, and I attended first organizational meeting last week. Plan is a R+D proposal in the spring then a full proposal writing workshop at UC in August-September.



Sensitivity of Large Cosmic Ray Air Shower Experiments for New Physics Searches

M. C. Espírito Santo
LIP - Lisboa

HEP2005
Lisboa, July 2005



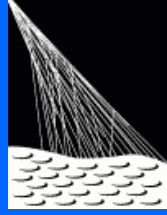
Besides the TeV-scale gravity signatures like Black Holes discussed in my previous seminar:

Excited Lepton sensitivity to 100 TeV

Leptoquark sensitivity to 100 TeV

Heavy Gluinos in Split Supersymmetry

But Tim/Carlos suggest the obvious one is Squarks in R-Parity Violating models, Tim is working on the cross section and UC group will simulate it…



The End