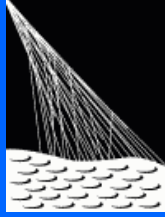
Fluorescence Measurements at ANL and the Auger Experiment

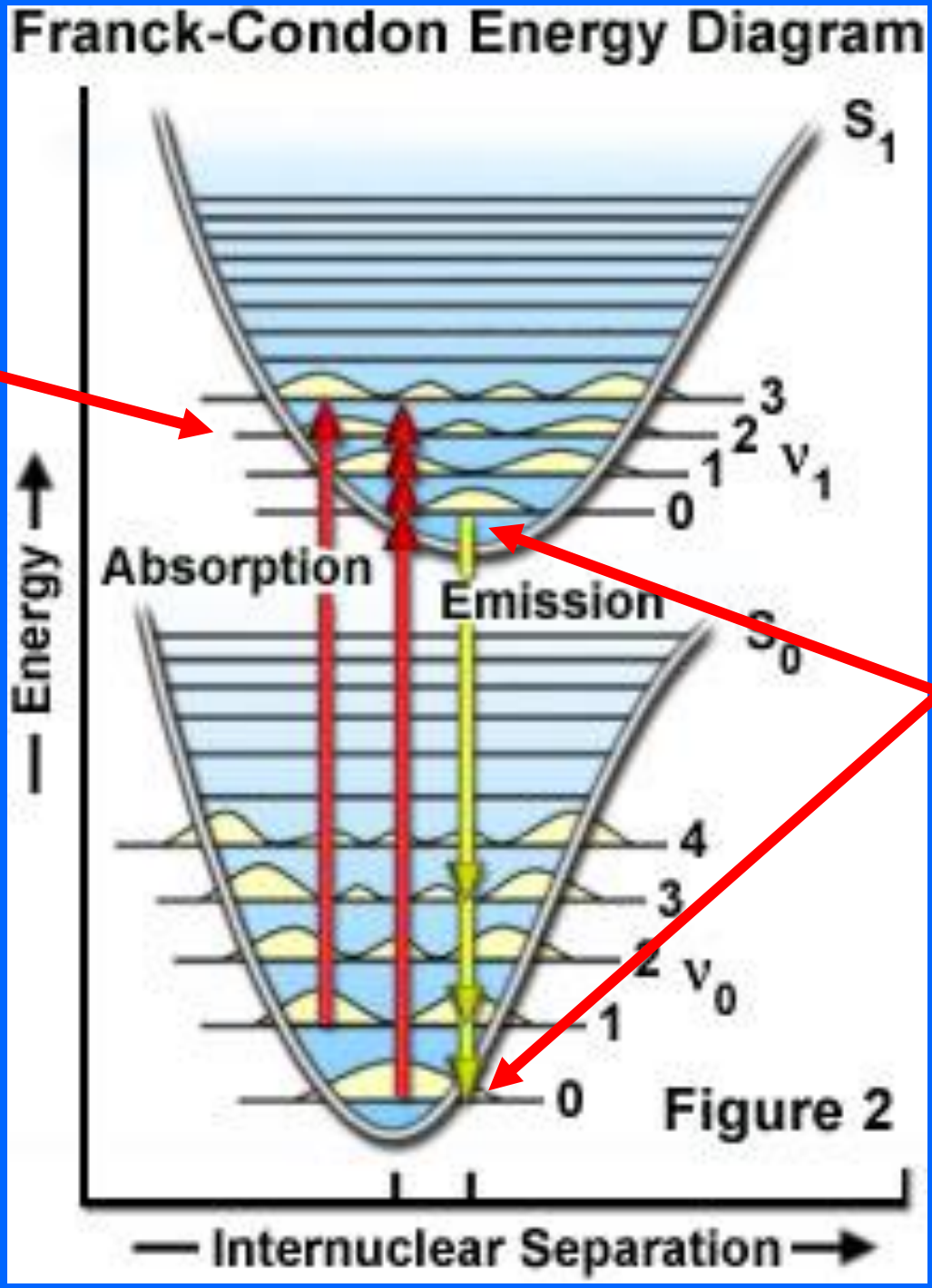


Motivation for Fluorescence Calibrations

AIRFLY Fluorescence Experiment at ANL

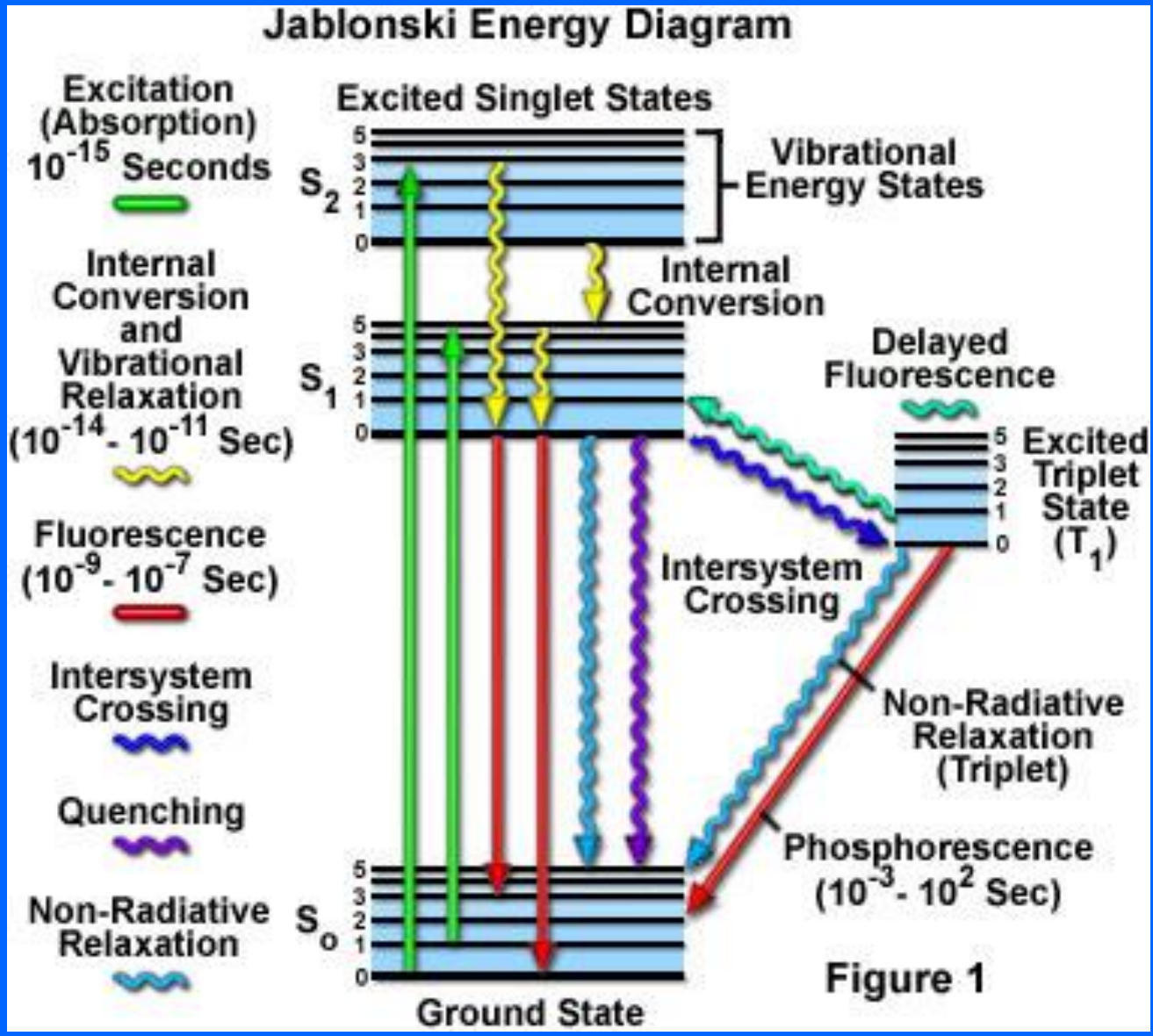
Auger Experiment Update

N_2 Molecule Vibrational Energy Levels

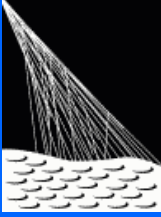


337nm transition

Main transitions are fast, nanoseconds

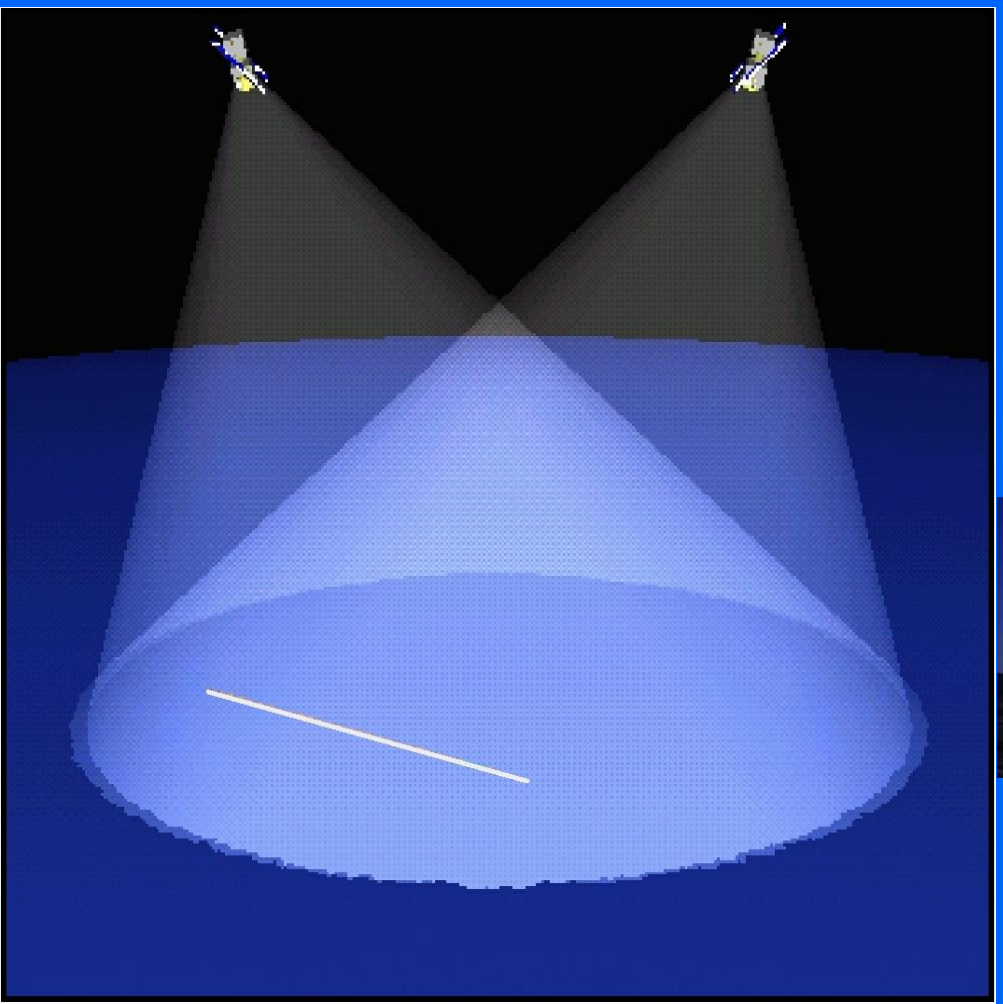


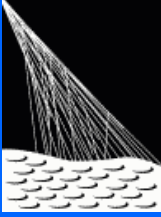
Auger

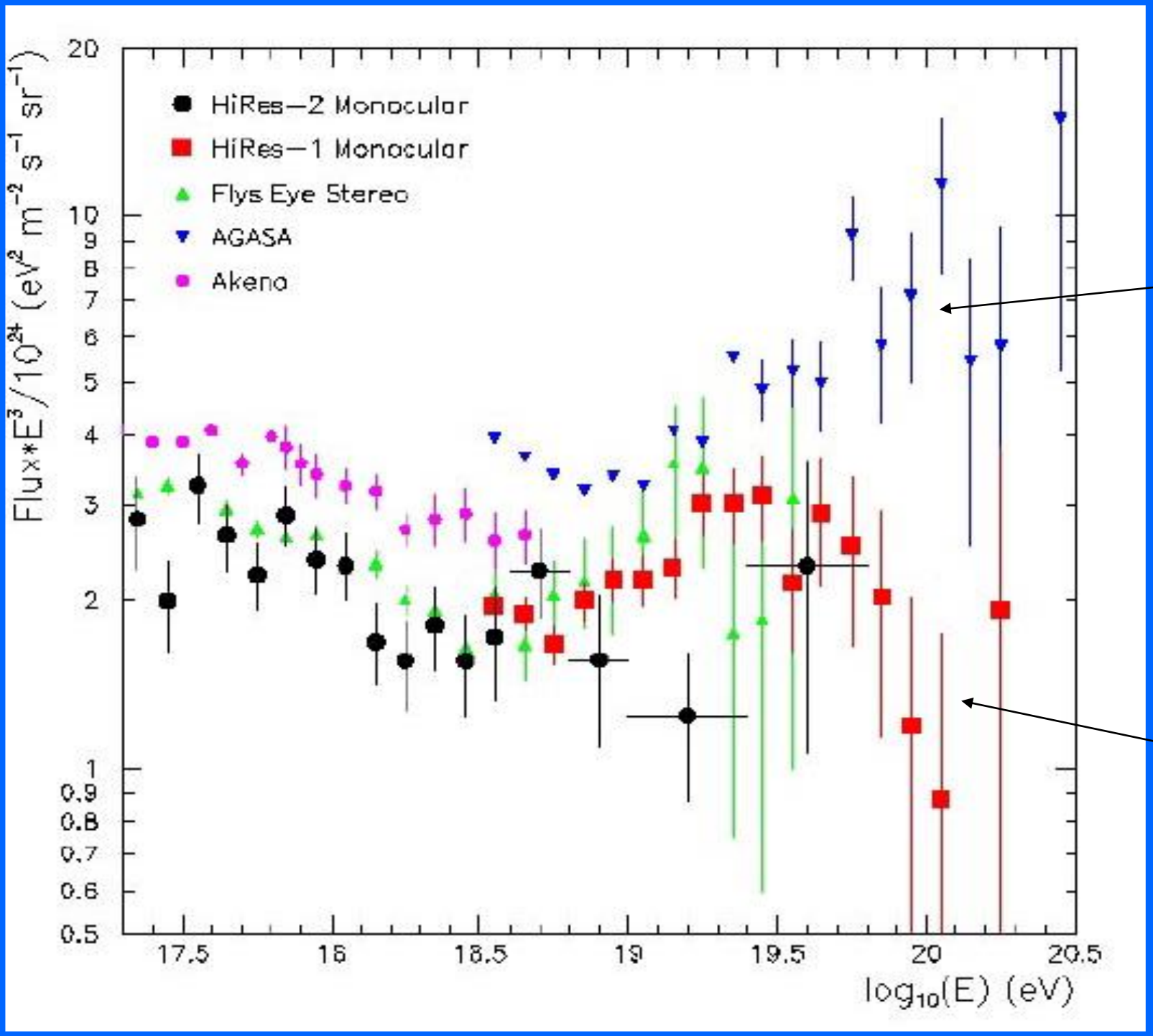


Many experiments use or will use Nitrogen Fluorescence

OWL and EUSO space-based experiments



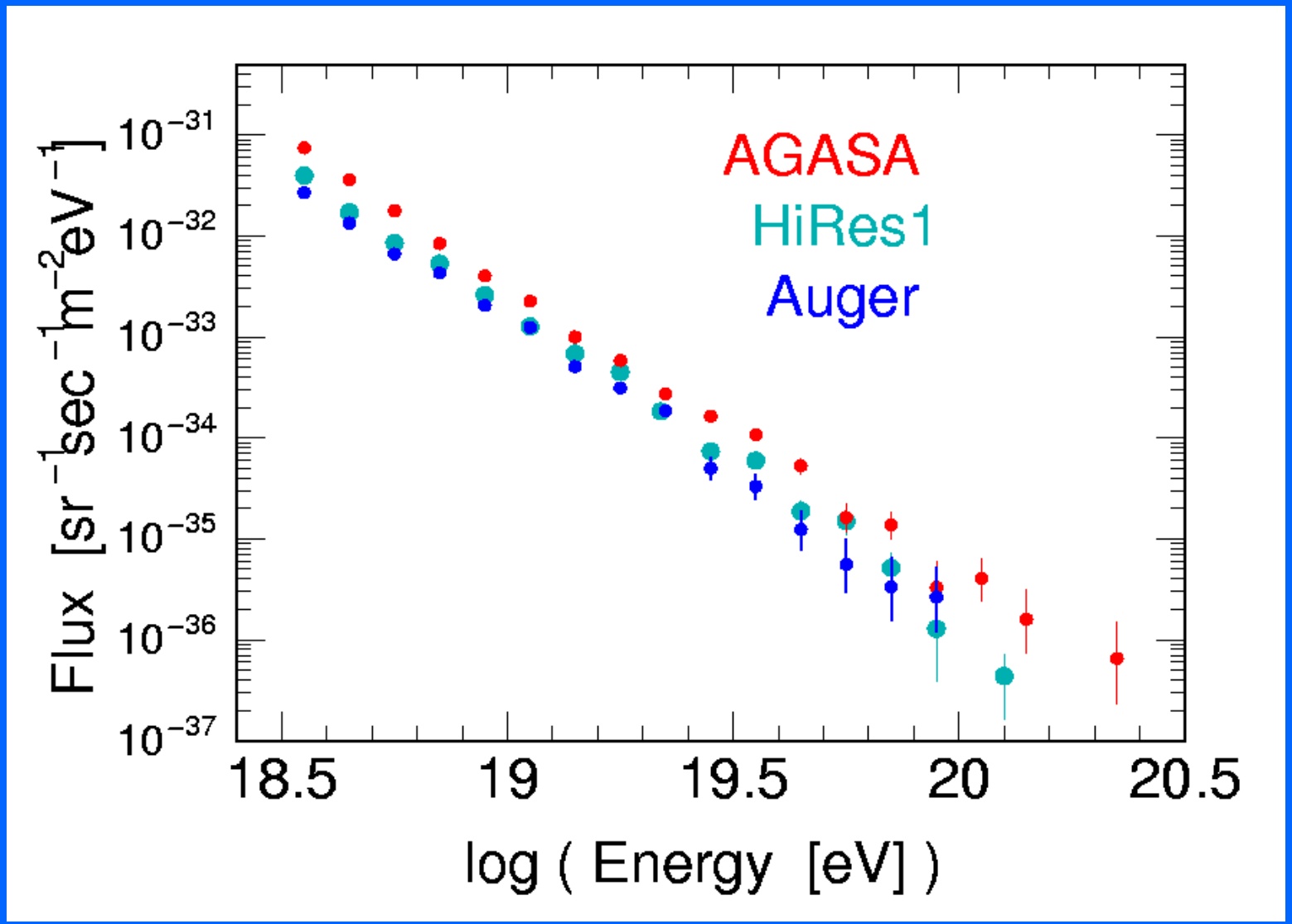




Scintillator

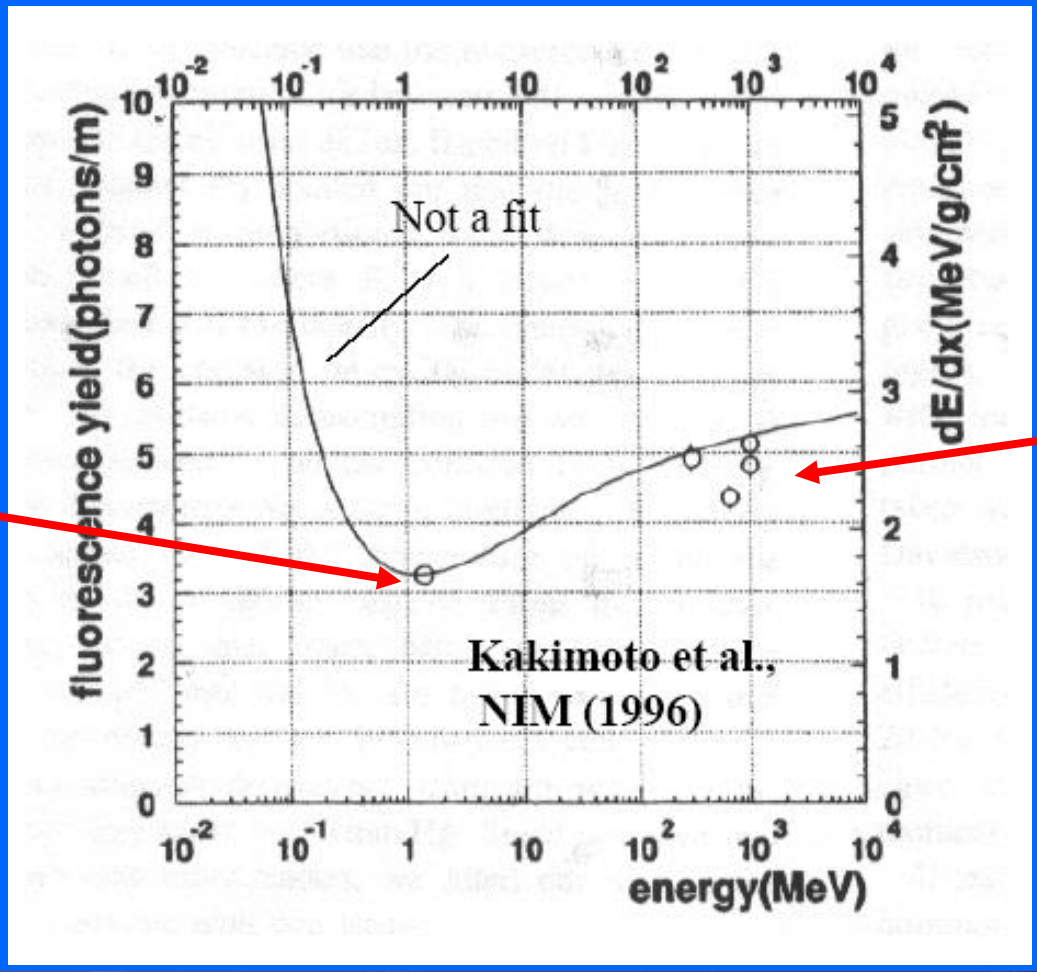
Fluorescence

Due to smaller model dependence, Auger normalizes to its fluorescence detectors. Looks like HiRes. 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

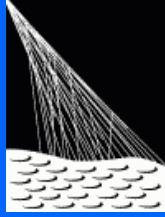


Not an absolute measurement

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



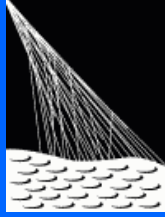
Much more information needed…

Pressure, Temperature, Humidity dependence

Oxygen quenching

More complete energy scan

Absolute measurement to 5%

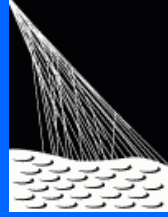


Much more information needed…

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

Fluorescence Calibration at Argonne

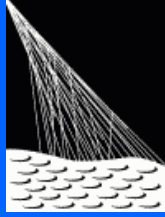


Chemistry Division Van de Graaff

Advanced Photon Source

HEP Division Advanced Wakefield Accelerator

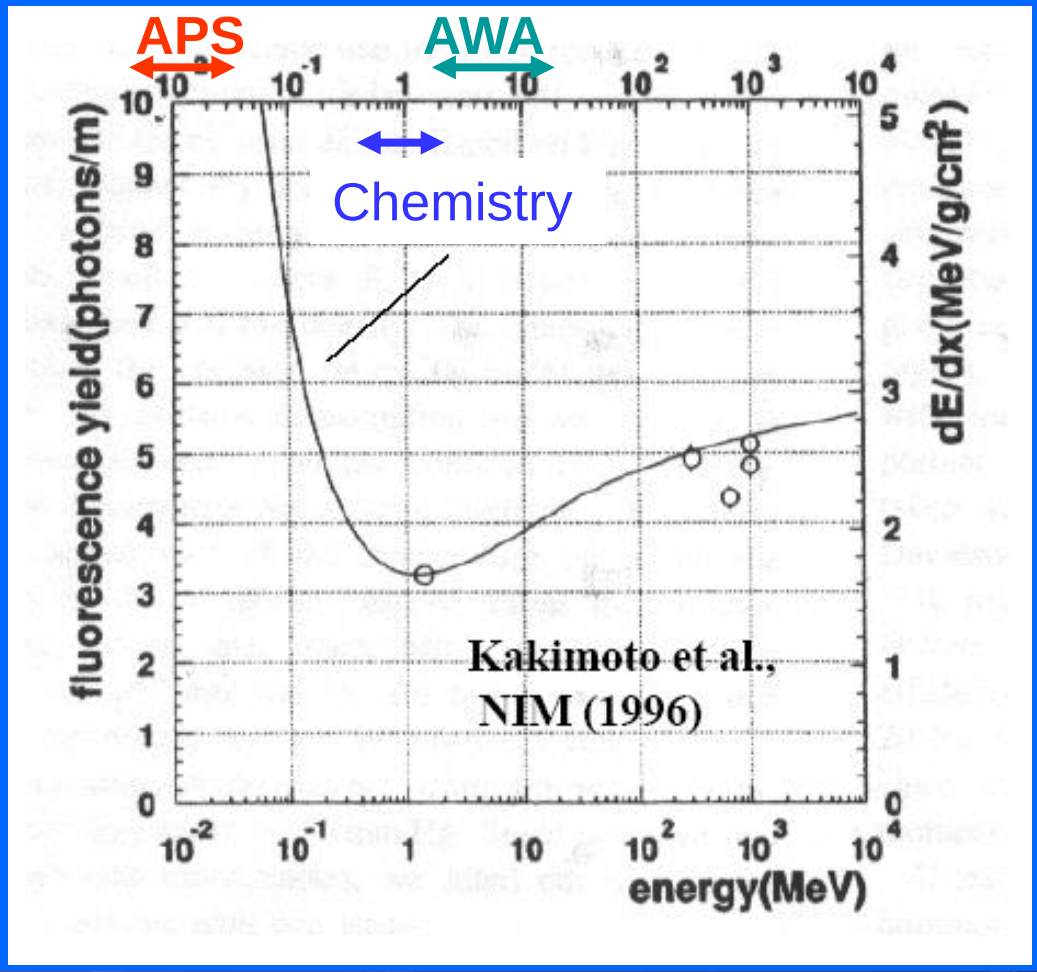
Complementary machines: AWA only accelerator with enough energy to do absolute calibration with Cerenkov gas. Van de Graaff only machine with enough charge to measure spectrum.



Heroes…

AWA group notably
Manoel Conde, Felipe Franchini, Zikri Yusof

Chemistry staff notably
Sergey Chemerisov and Bob Lowers



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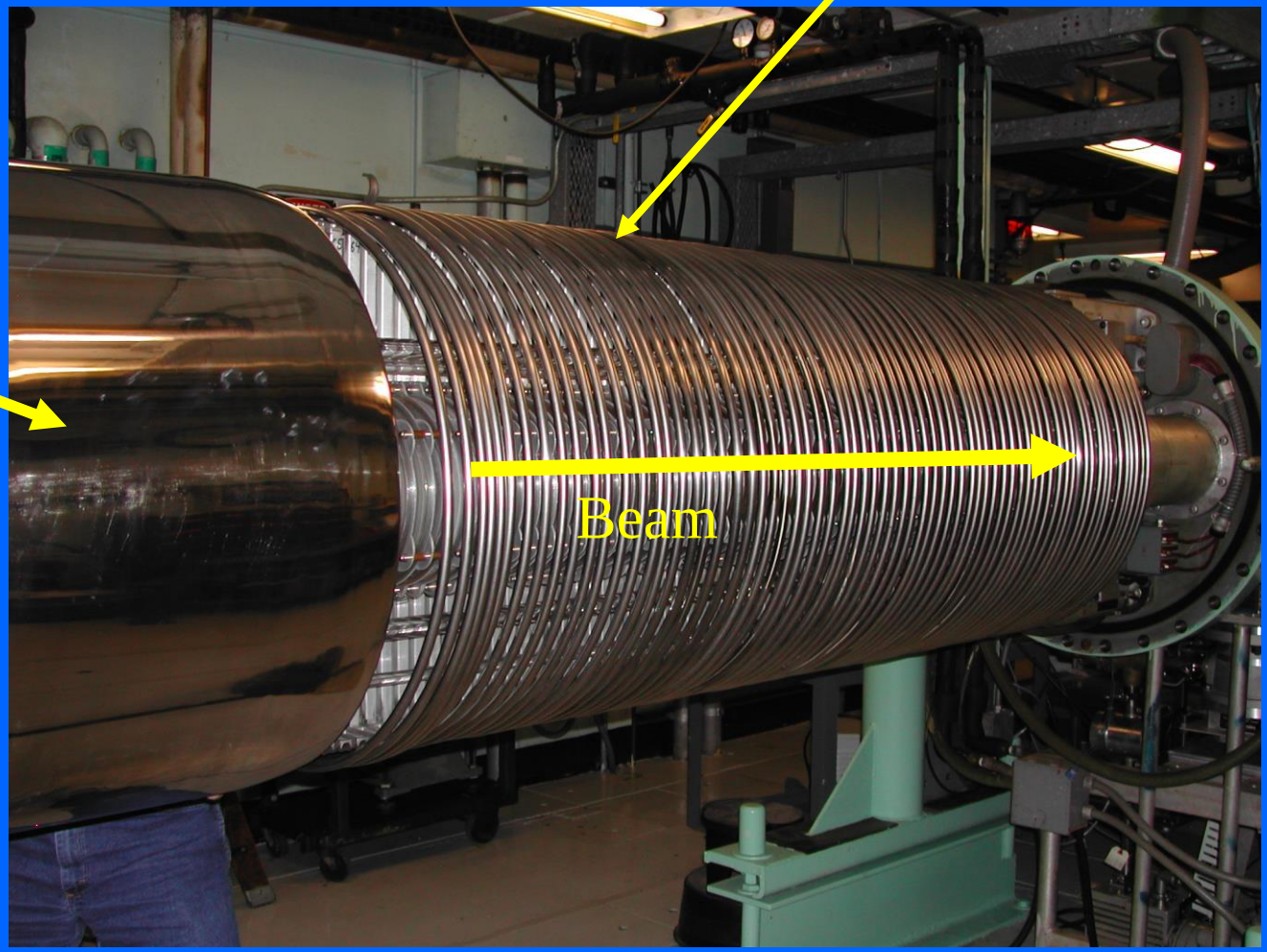
45% of Fluorescence Due to Electrons and Positrons < 10 MeV in 10^{19} eV Shower

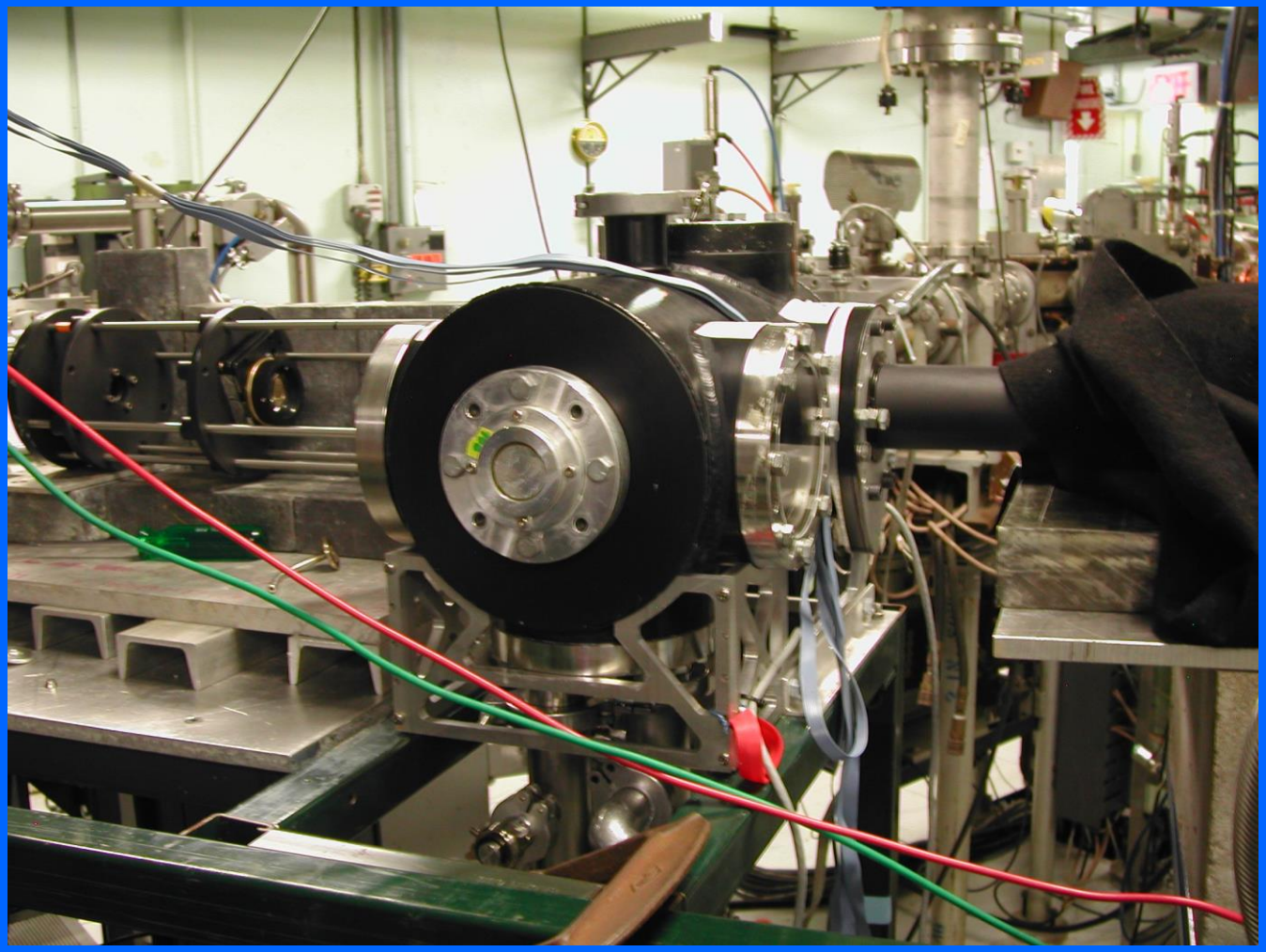
Van de Graaff with cover removed

Resistor plates step V down to zero

Charged to 3 million volts



AIRFLY Experiment, led by Paolo Privitera from INFN



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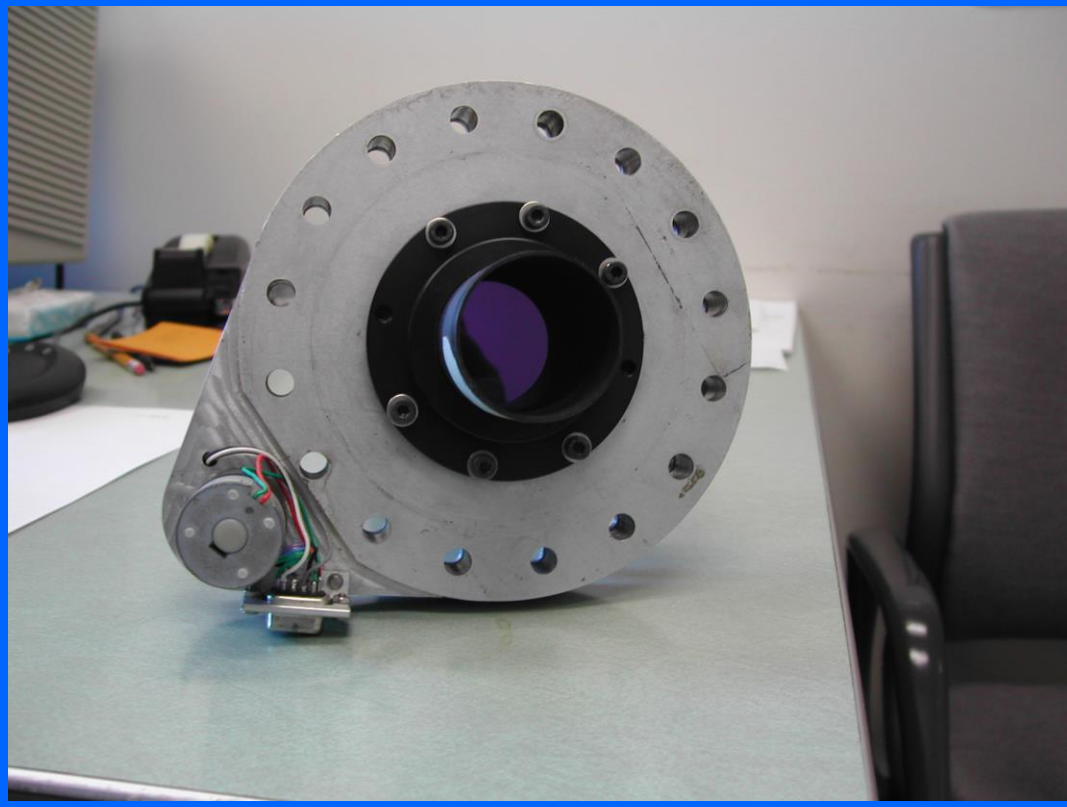
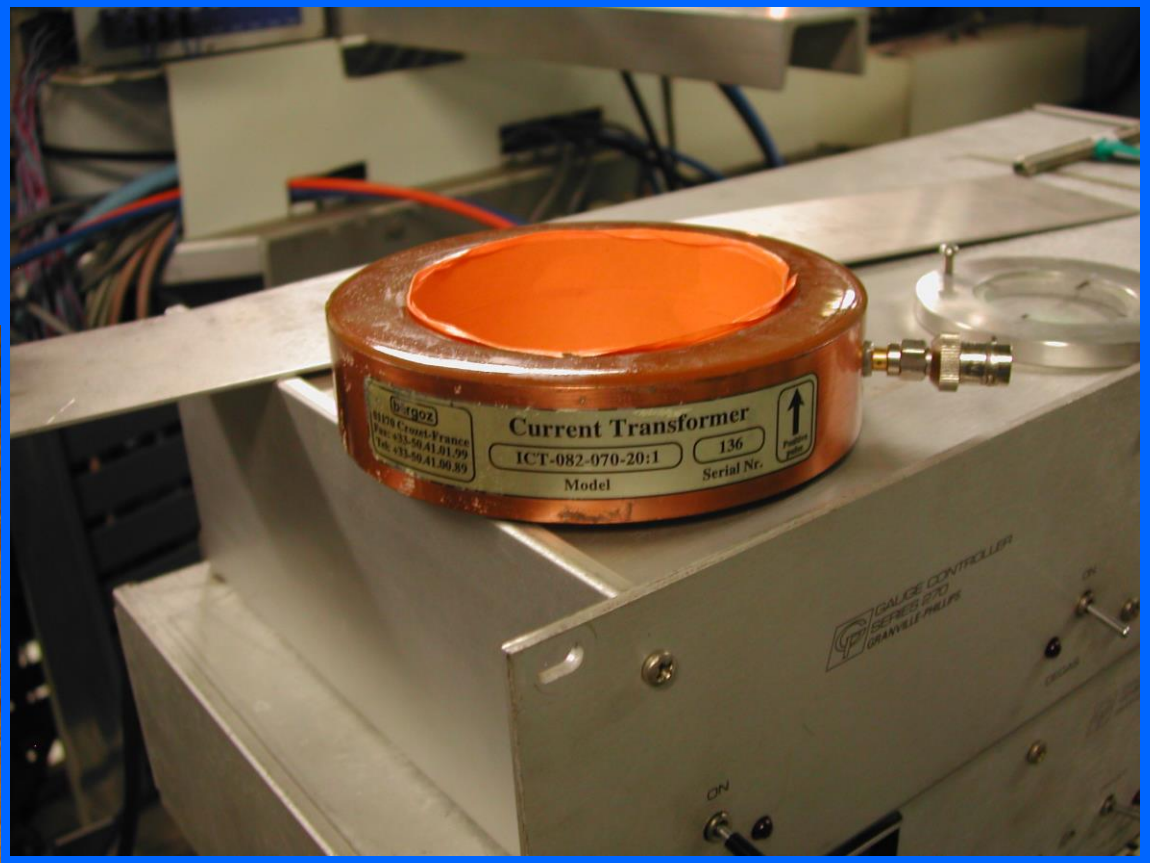
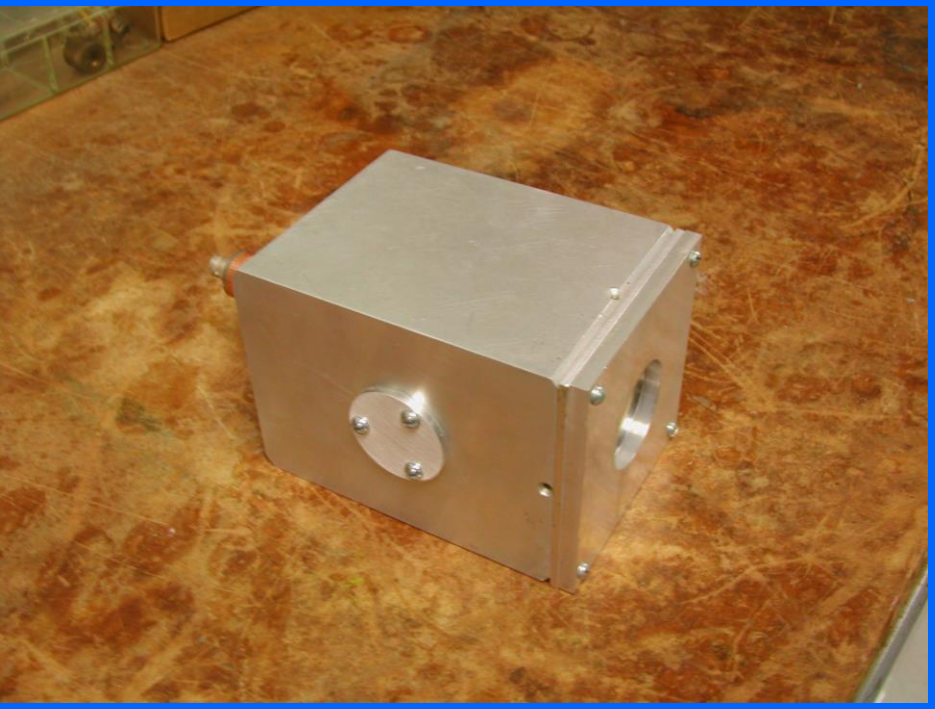


Beam Pickup, used for all the PMT measurements

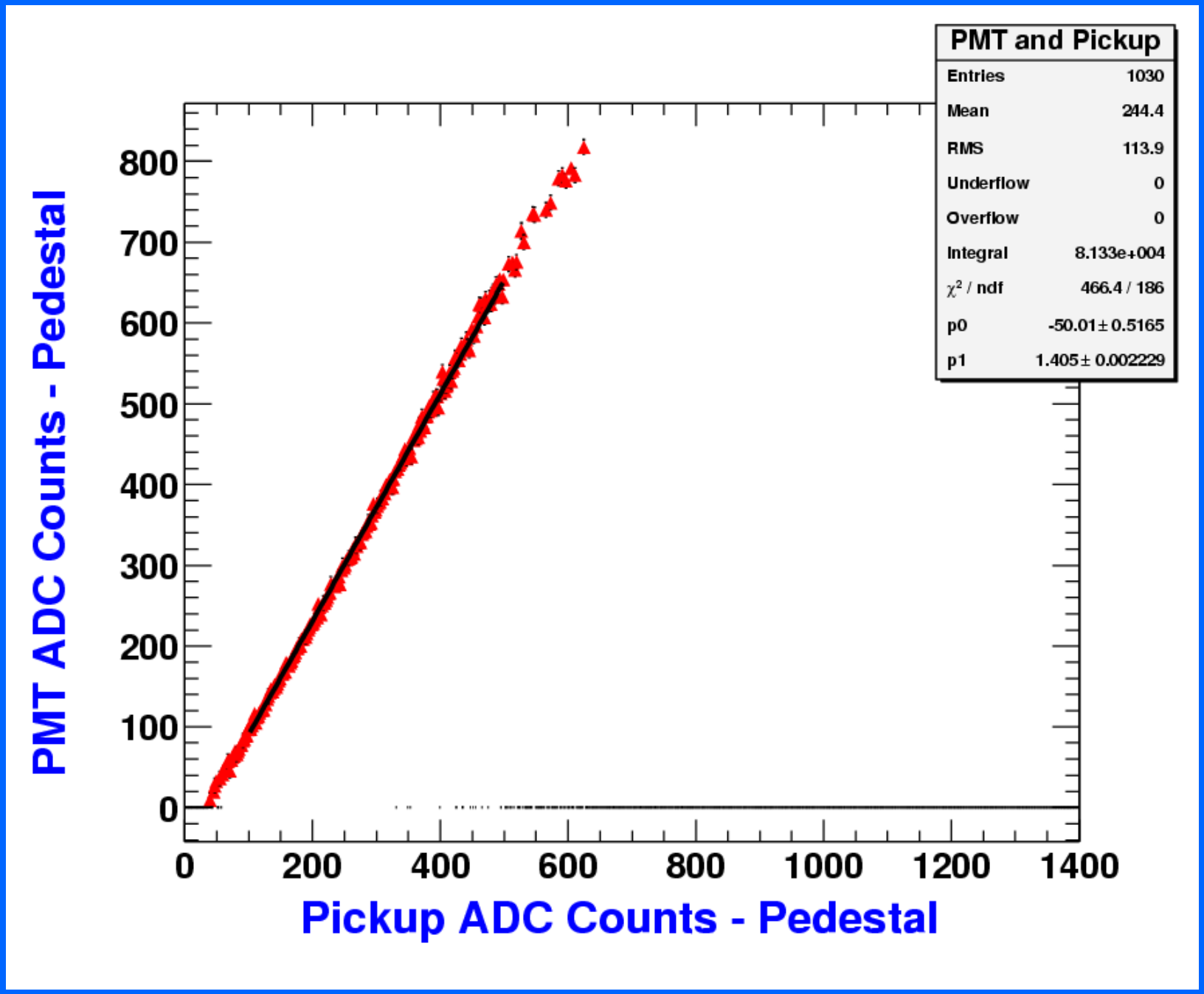


Faraday Cup, mainly used to check Pickup

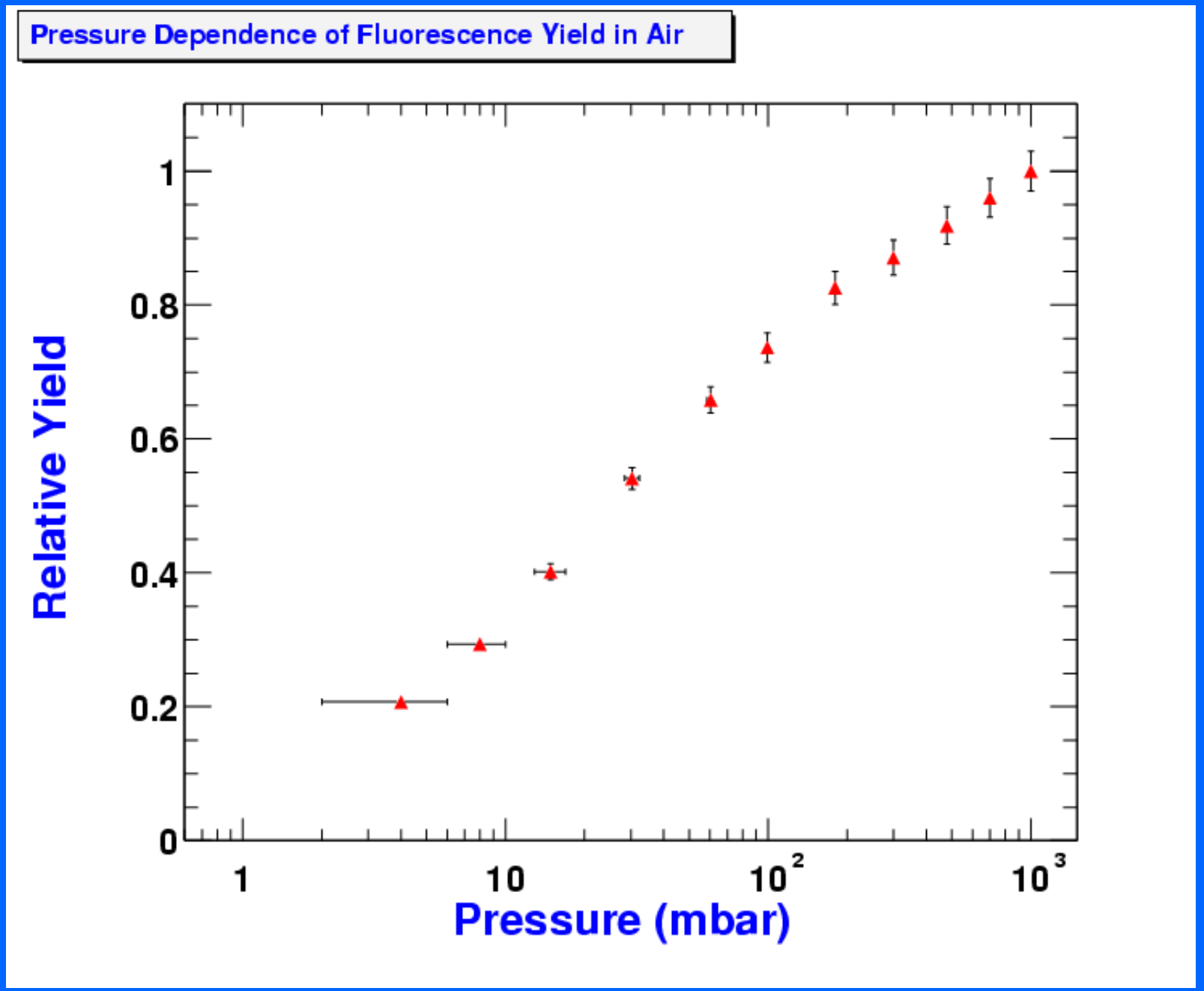


Will fit slopes from PMT vs Pickup, an experiment with 2 electronics channels!

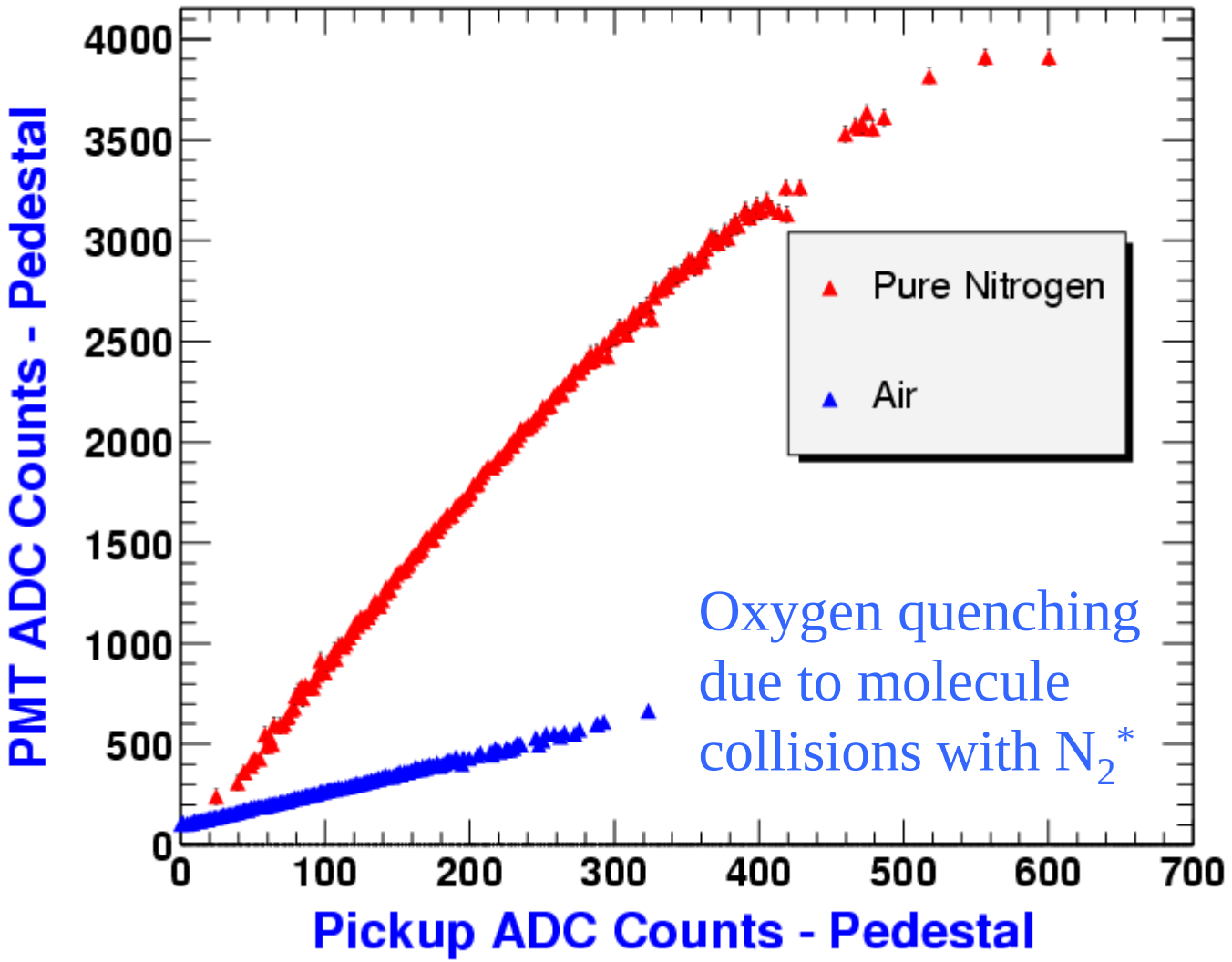
AWA PMT Fluorescence Data, 14 MeV electrons

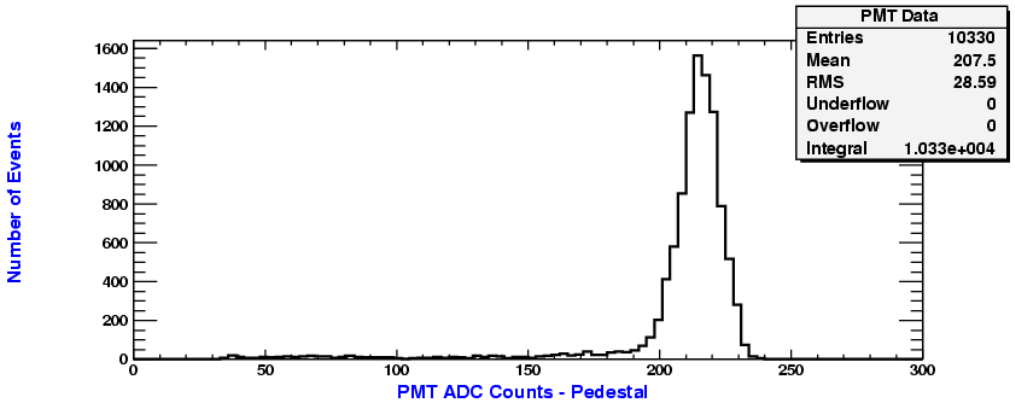


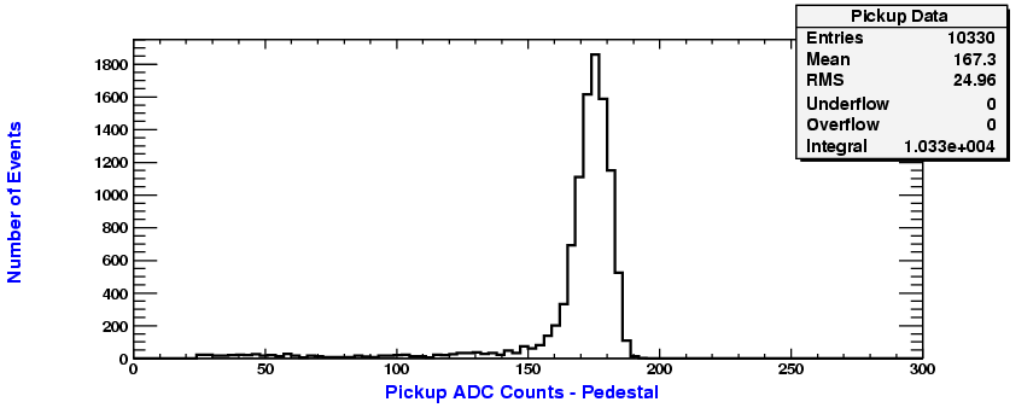
AWA PMT Fluorescence Data, 14 MeV electrons

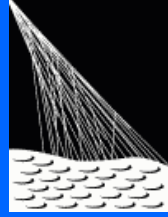


AWA PMT Fluorescence Data, 14 MeV electrons

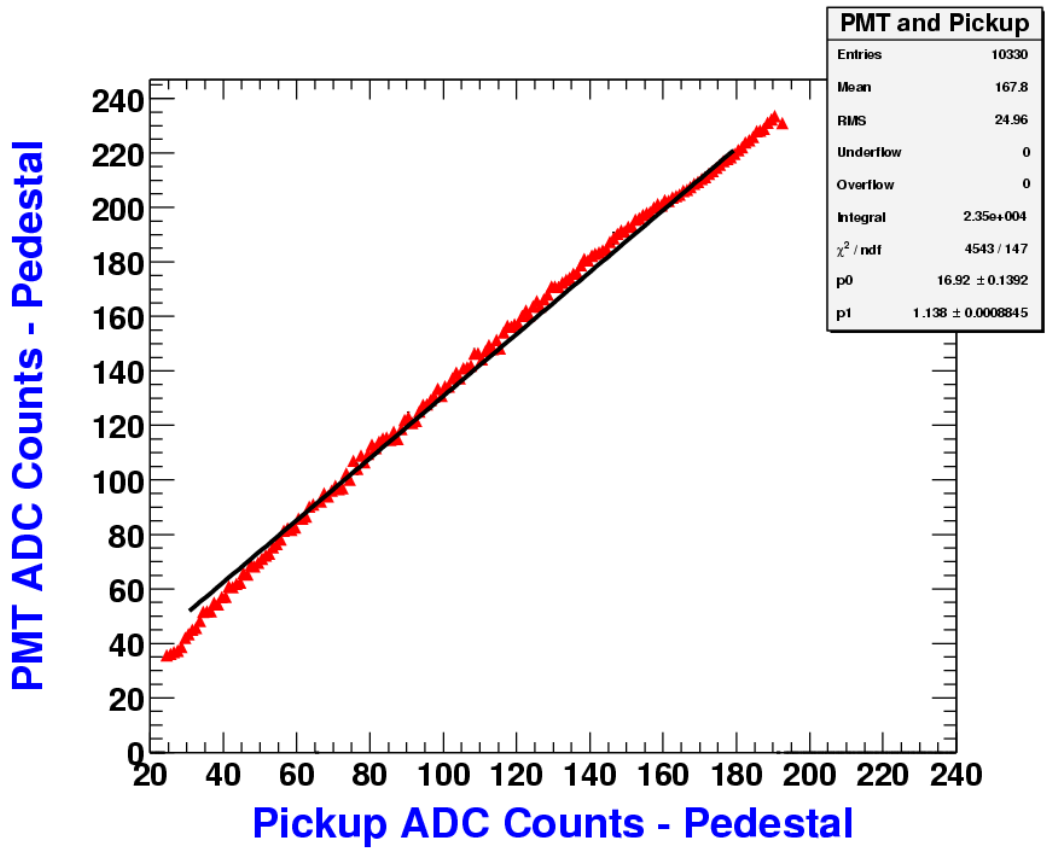


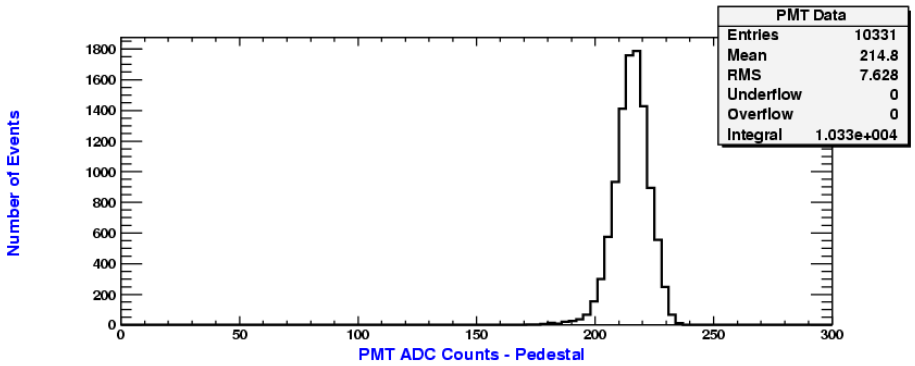


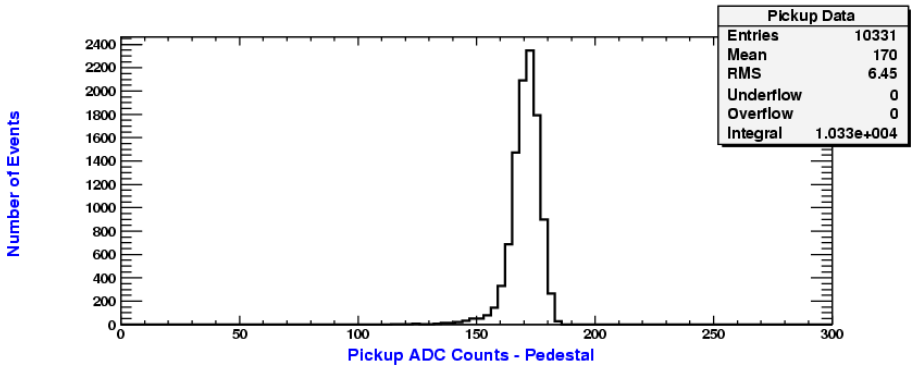




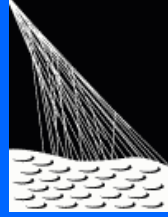
0.5 MeV Run at Van de Graaff with beam halo



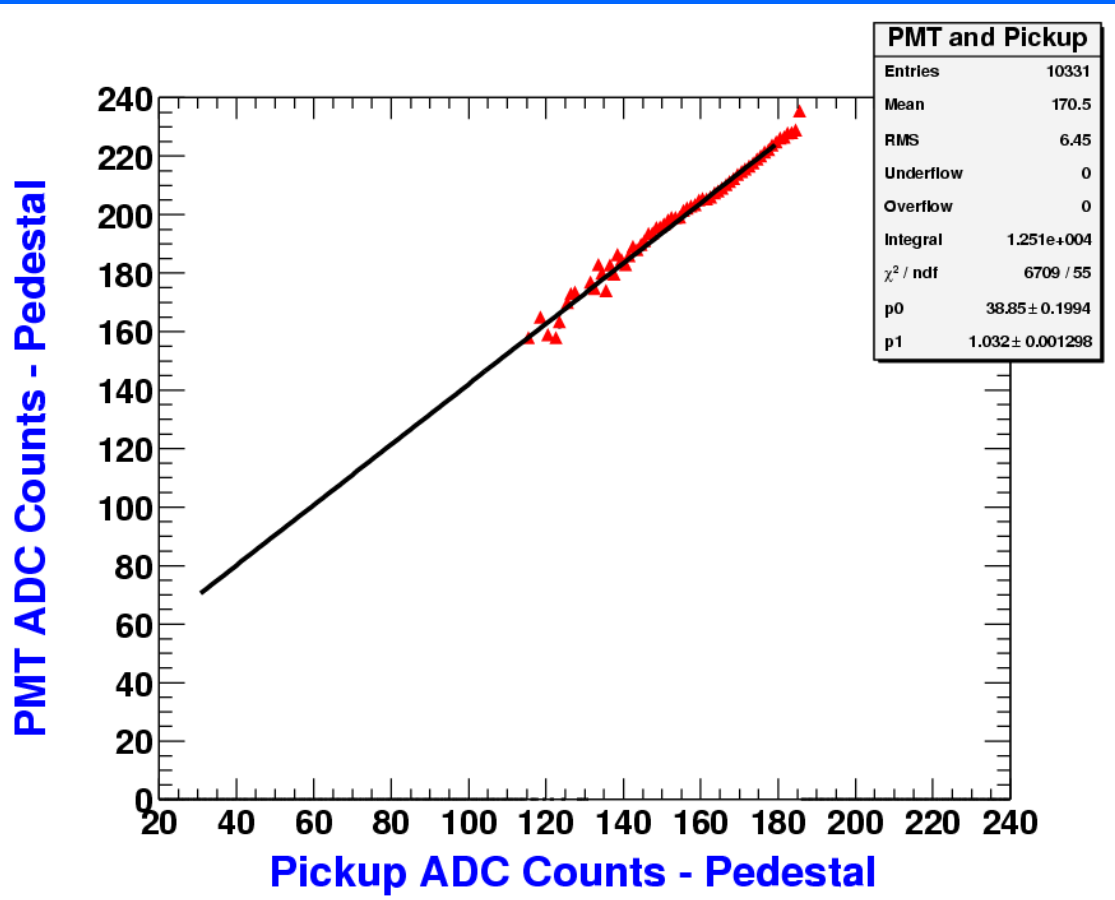




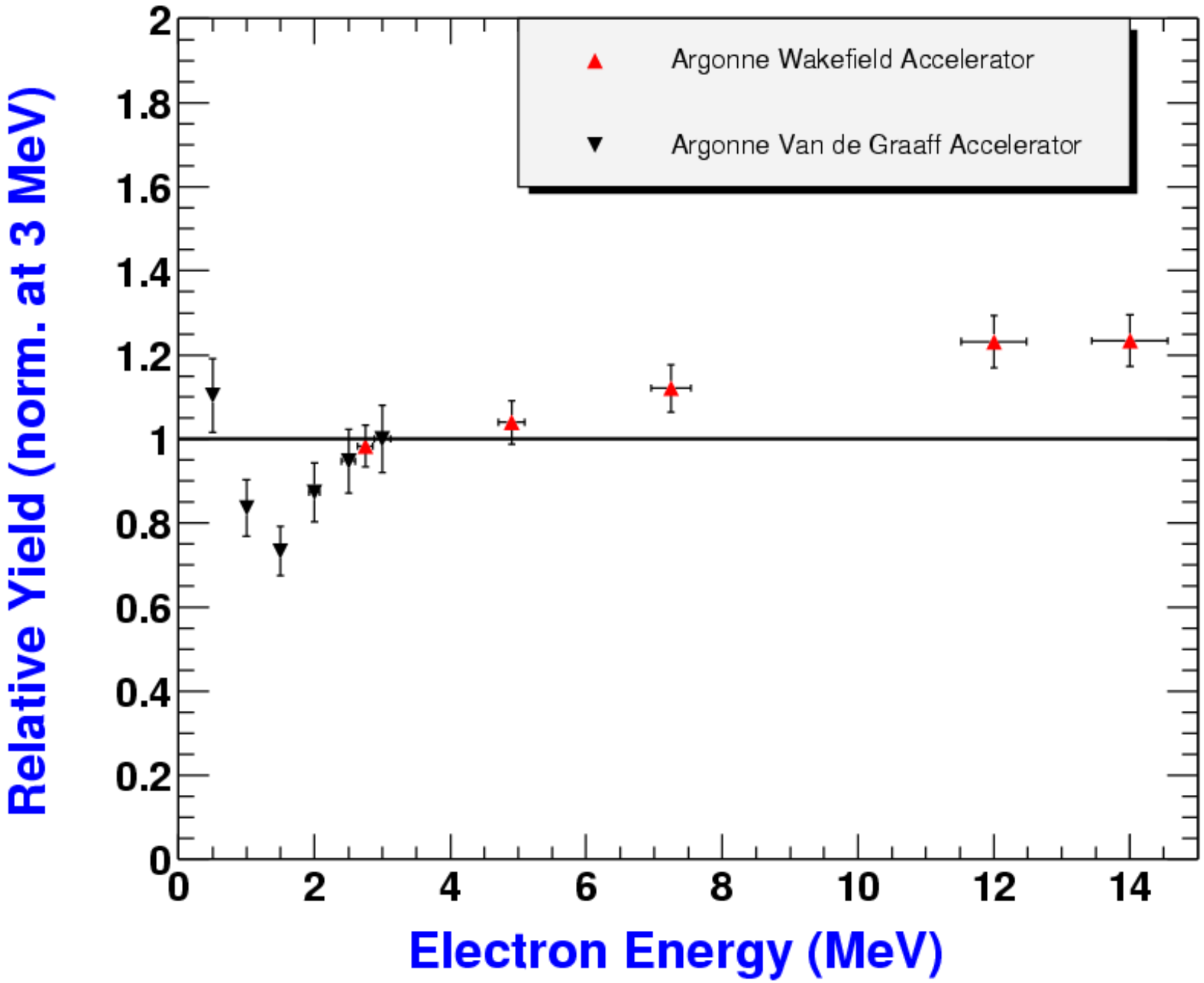
Cut ±2 sigma around main beam pickup peak for both AWA and Van de Graaff

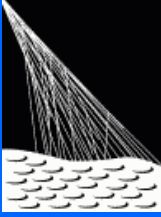


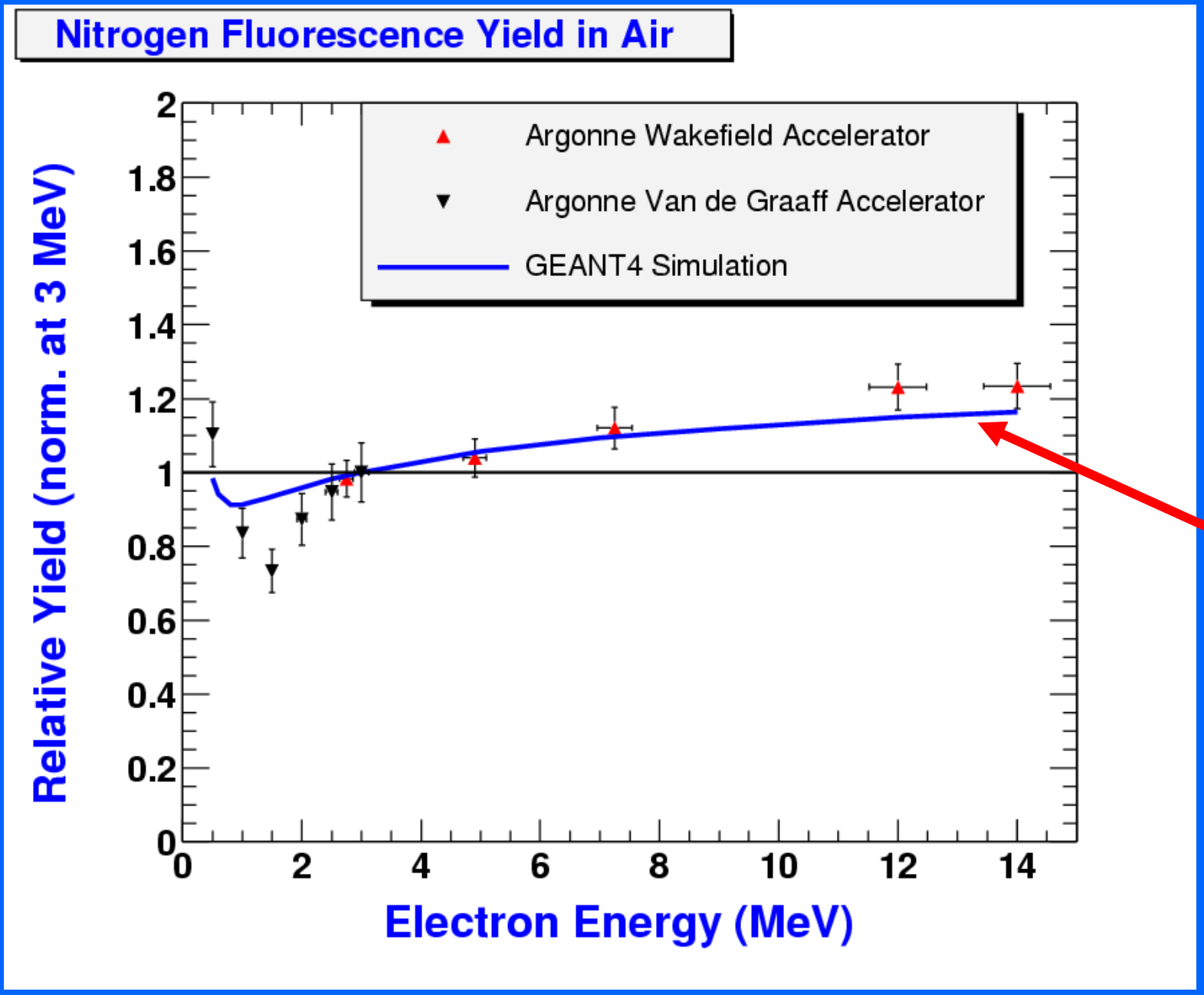
5 minutes later, beam halo is gone



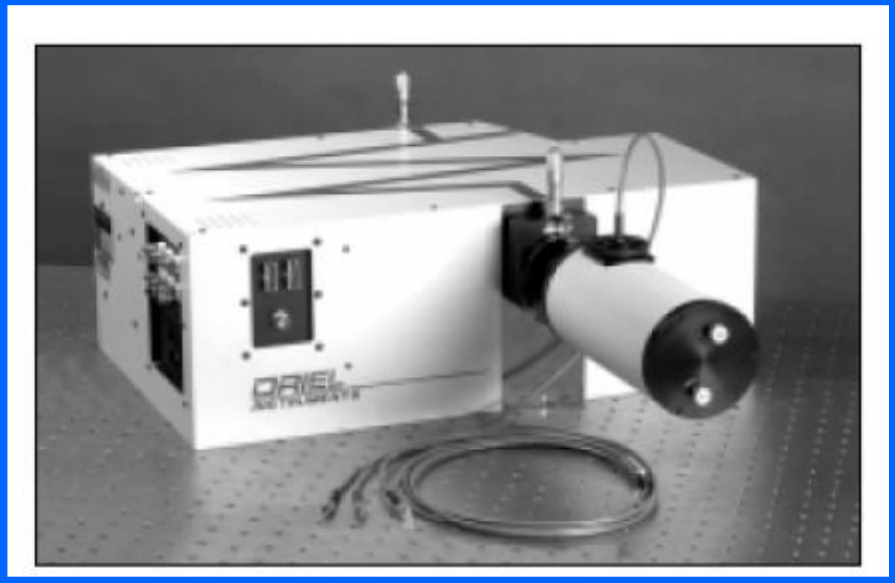
Nitrogen Fluorescence Yield in Air

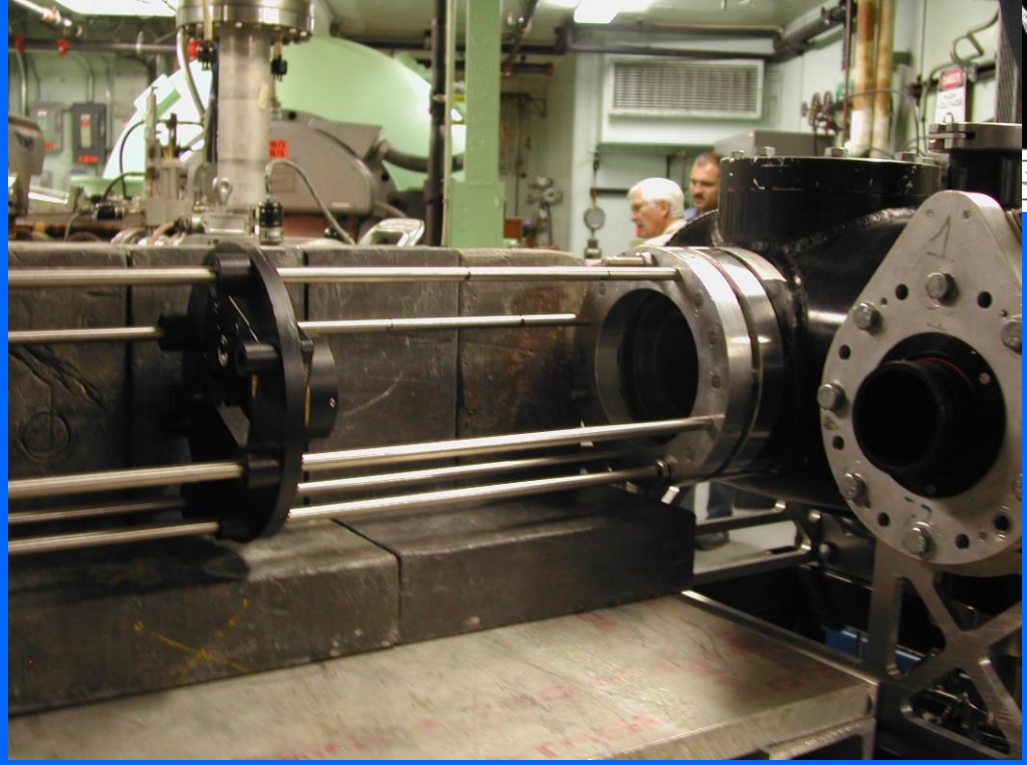






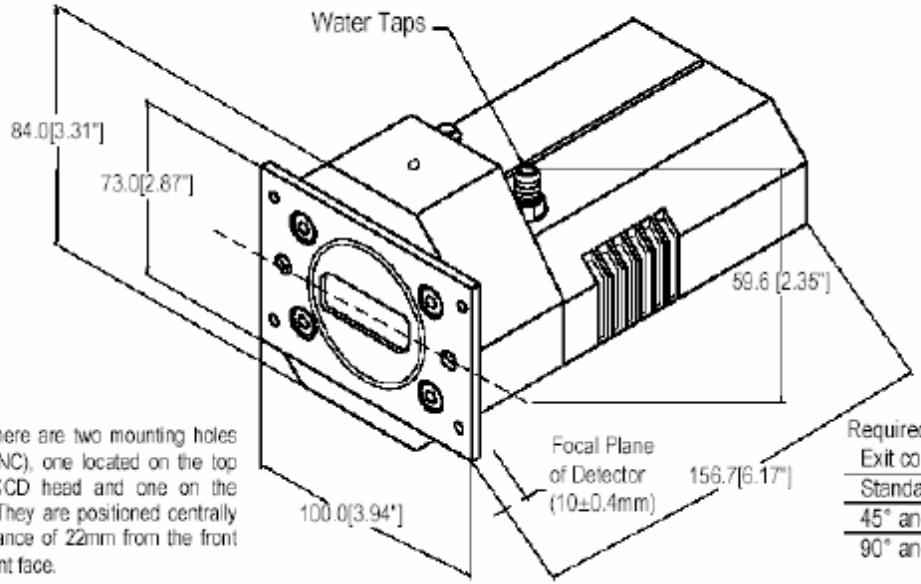
Don't take too seriously yet, different low energy input gives different curves.





ANDOR TECHNOLOGY

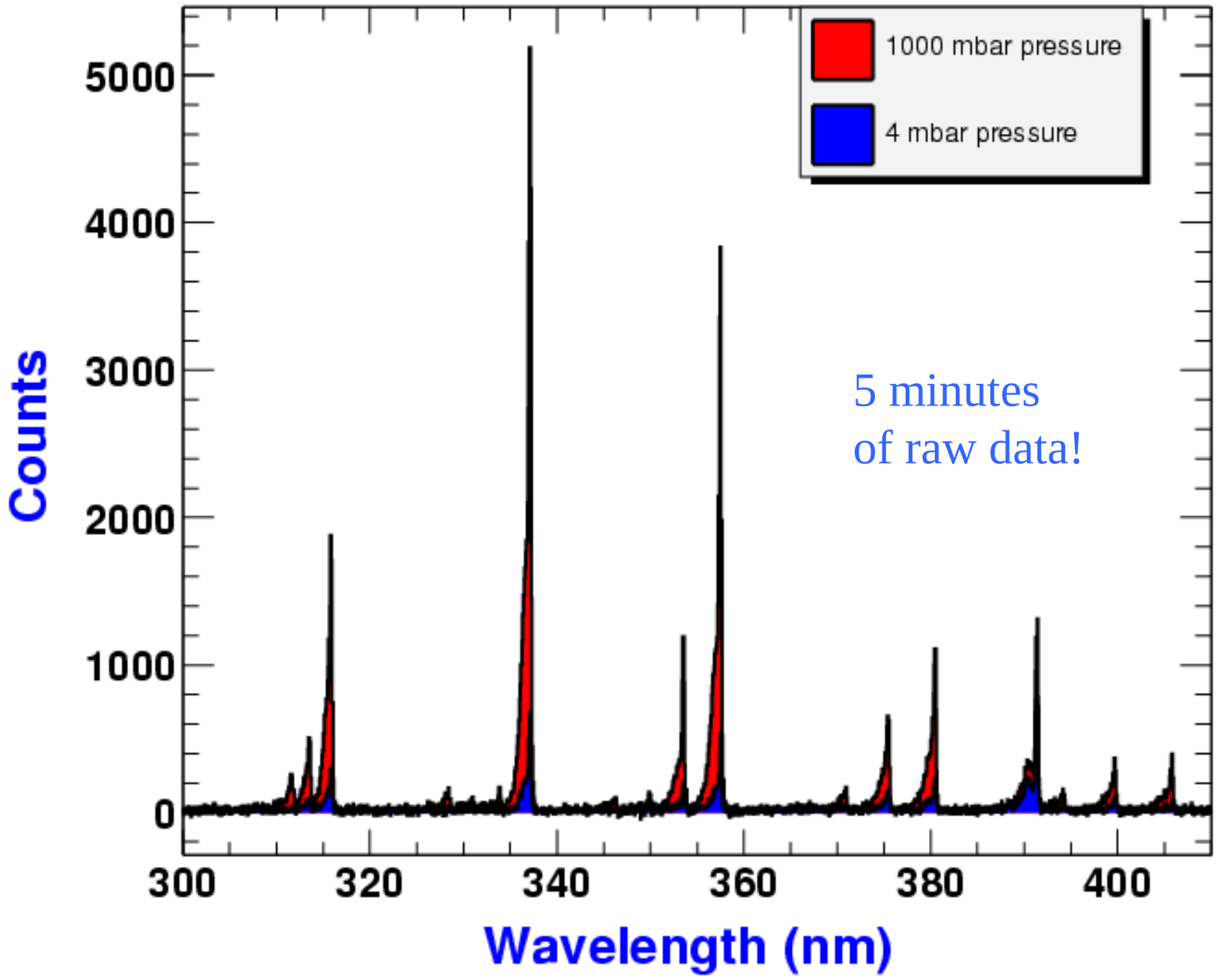
DV420

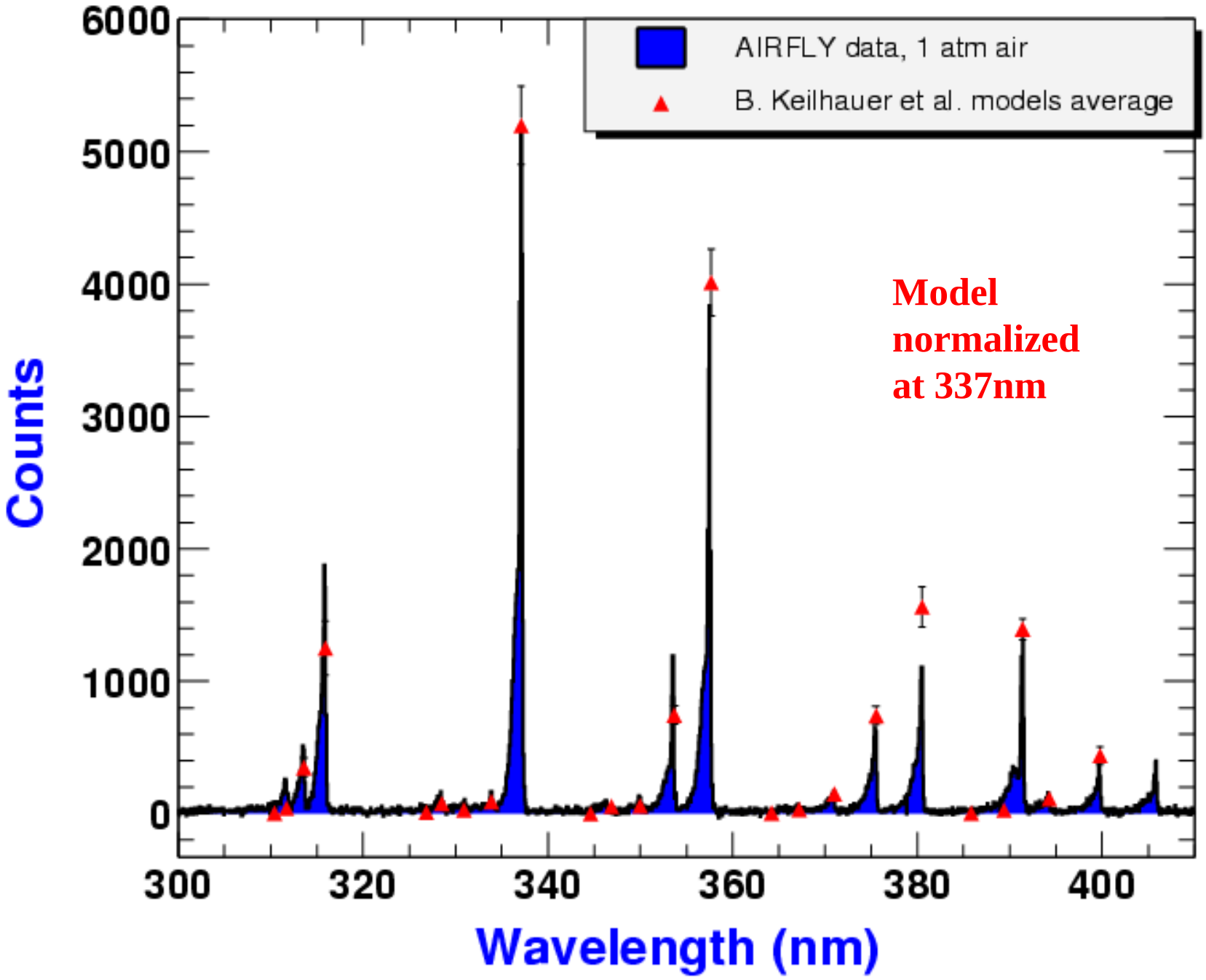


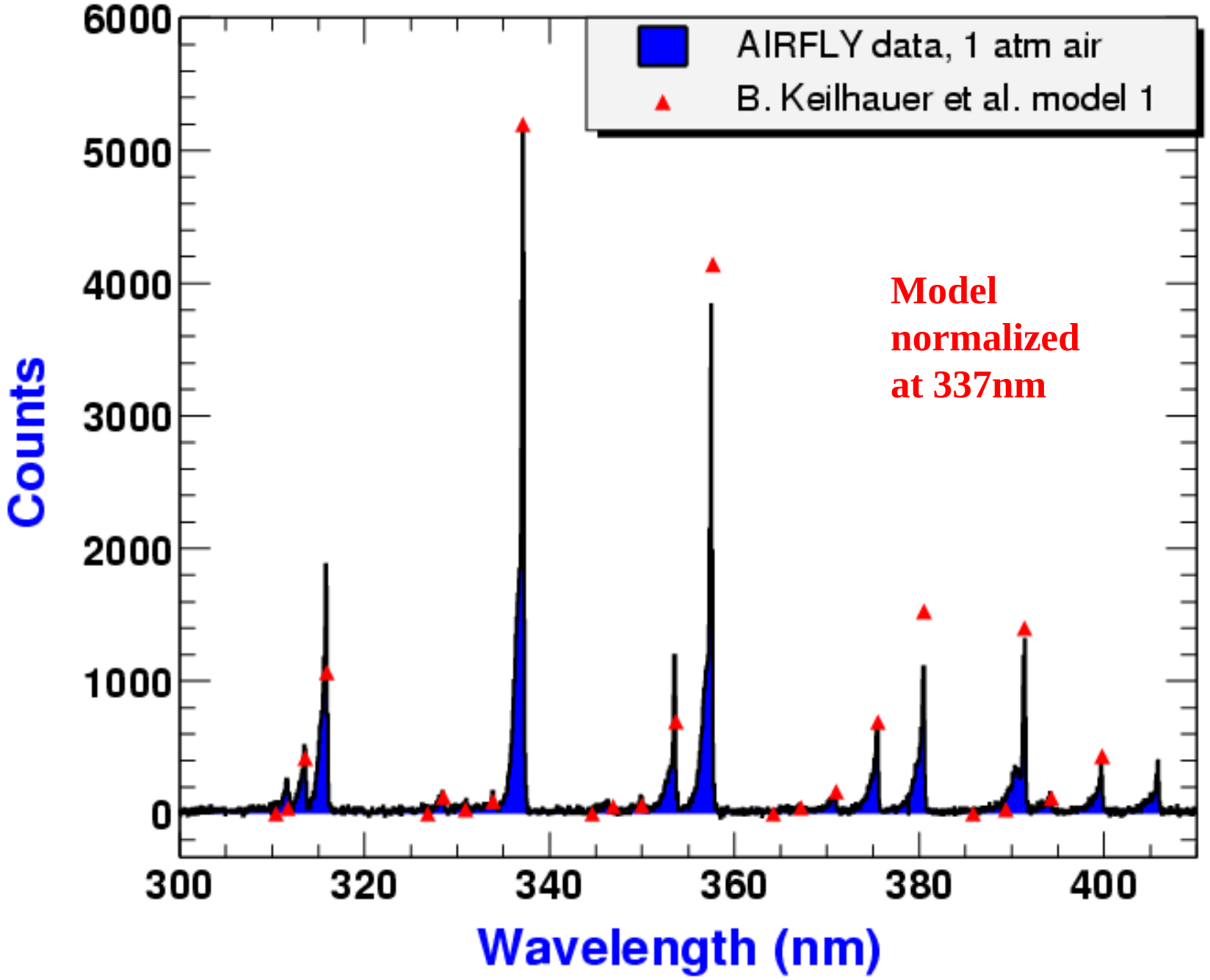
Note: There are two mounting holes (1/4-20UNC), one located on the top of the CCD head and one on the bottom. They are positioned centrally at a distance of 22mm from the front of the front face.

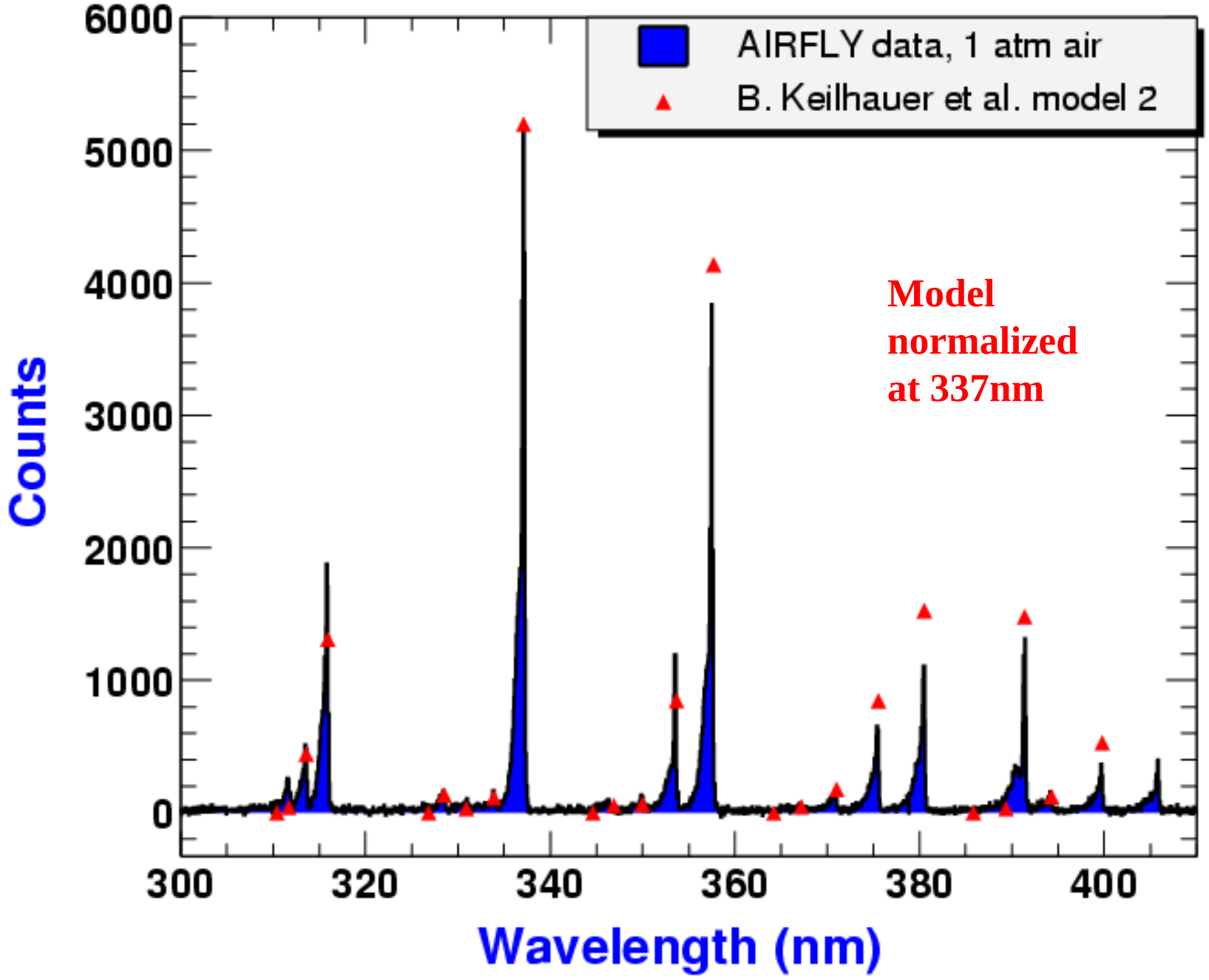
Required Cable Clearance at back:

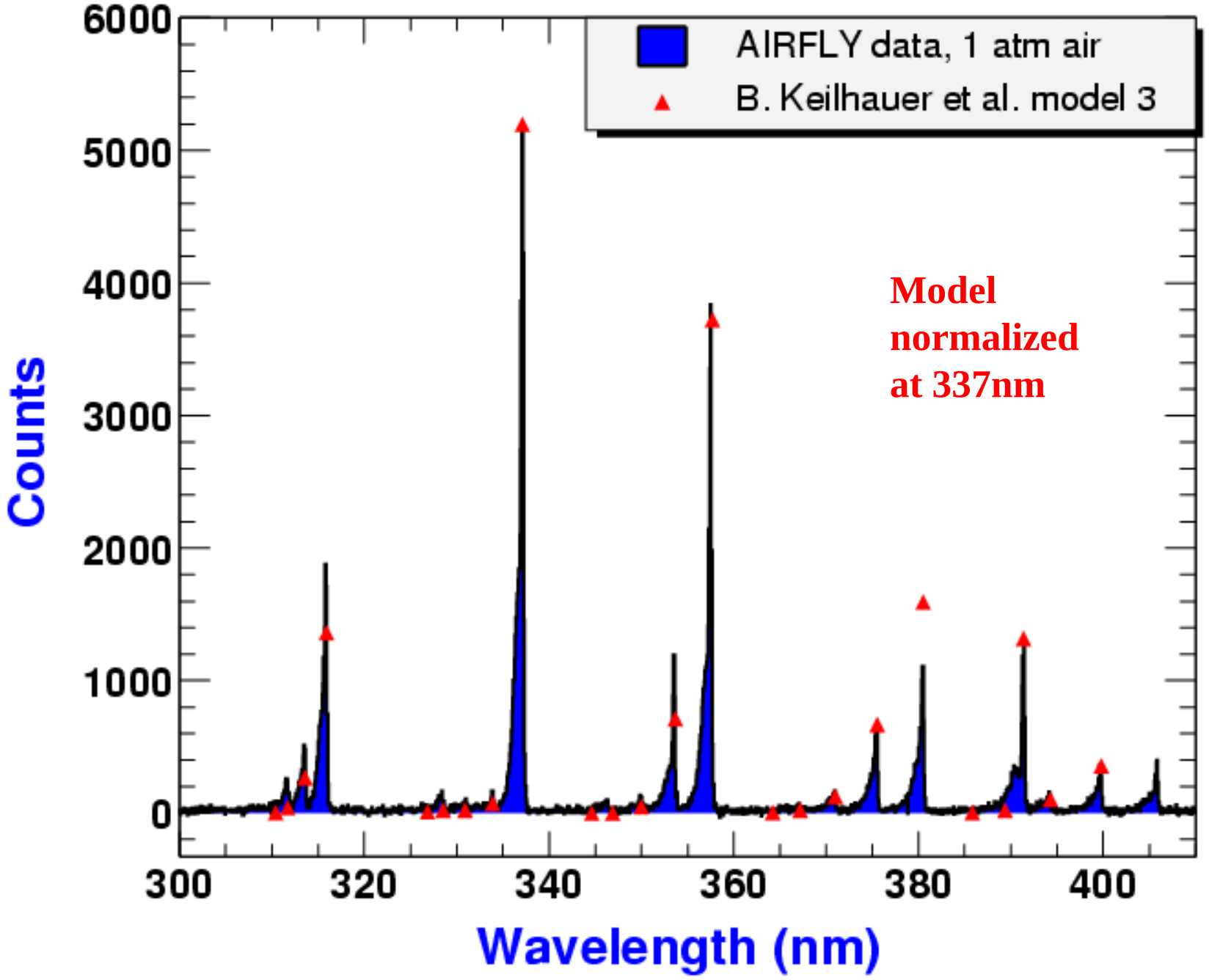
Exit connector type	Clearance
Standard	140 mm
45° angle	50 mm
90° angle	40 mm


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 average
Model
normalized
at 337nm
Counts
Wavelength (nm)
6000
5000
4000
3000
2000
1000
0
300
320
340
360
380
400


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


AIRFLY data, 1 atm air
B. Keilhauer et al. model 2
Model
normalized
at 337nm
Counts
Wavelength (nm)
6000
5000
4000
3000
2000
1000
0
300
320
340
360
380
400


AIRFLY data, 1 atm air
B. Keilhauer et al. model 3
Model
normalized
at 337nm
Counts
Wavelength (nm)
6000
5000
4000
3000
2000
1000
0
300
320
340
360
380
400

Main goal for December running at AWA

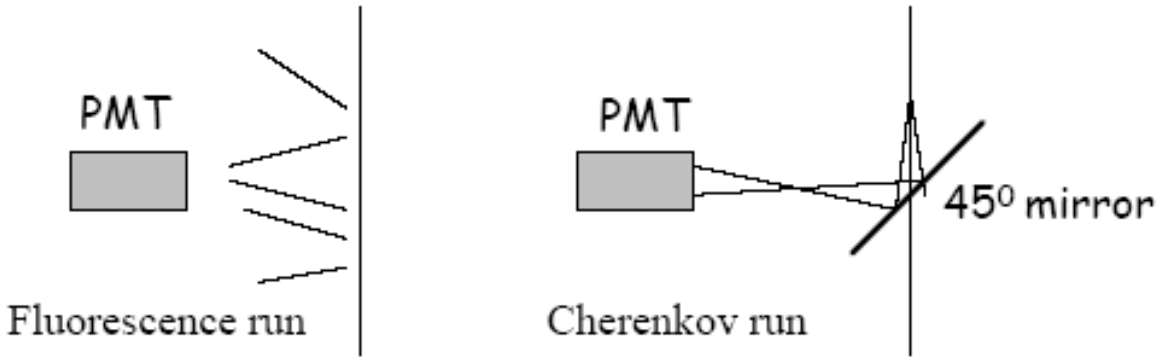
New Method for Absolute Measurement of Fluorescence Yield

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

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

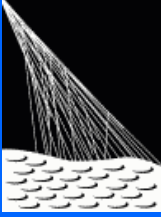
measured — known — MC — Cancel! — relative meas.

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



? Systematic error potentially = 5%

? First tests very encouraging!



The End