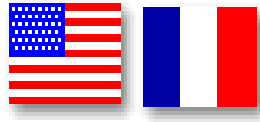


# E158 Collaboration



- UC Berkeley
  - Caltech
  - Jefferson Lab
  - Princeton
  - Saclay
  - SLAC
  - Smith College
  - Syracuse
  - UMass
  - Virginia
- 7 Ph.D. Students**  
**60 physicists**

*Sep 97: EPAC approval*

*1998-99: Design and Beam Tests*

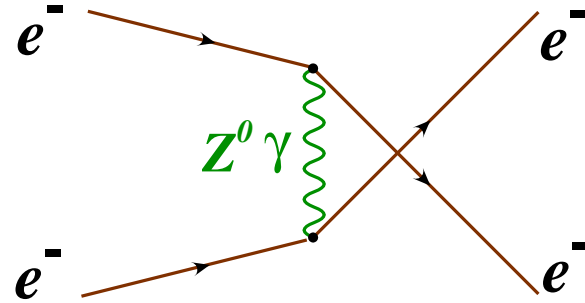
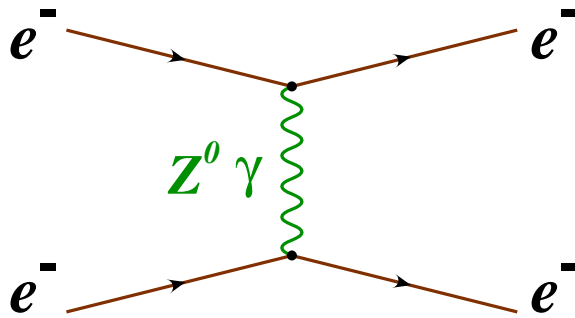
*2000: Funding and construction*

*2001: Engineering run*

*2002: Physics Runs 1 (Spring), 2 (Fall)*

*2003: Physics Run 3 (Summer)*

# Parity Violation in Moller Scattering



For a polarized electron beam and an unpolarized electron target,

$$A_{PV} = \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L}$$

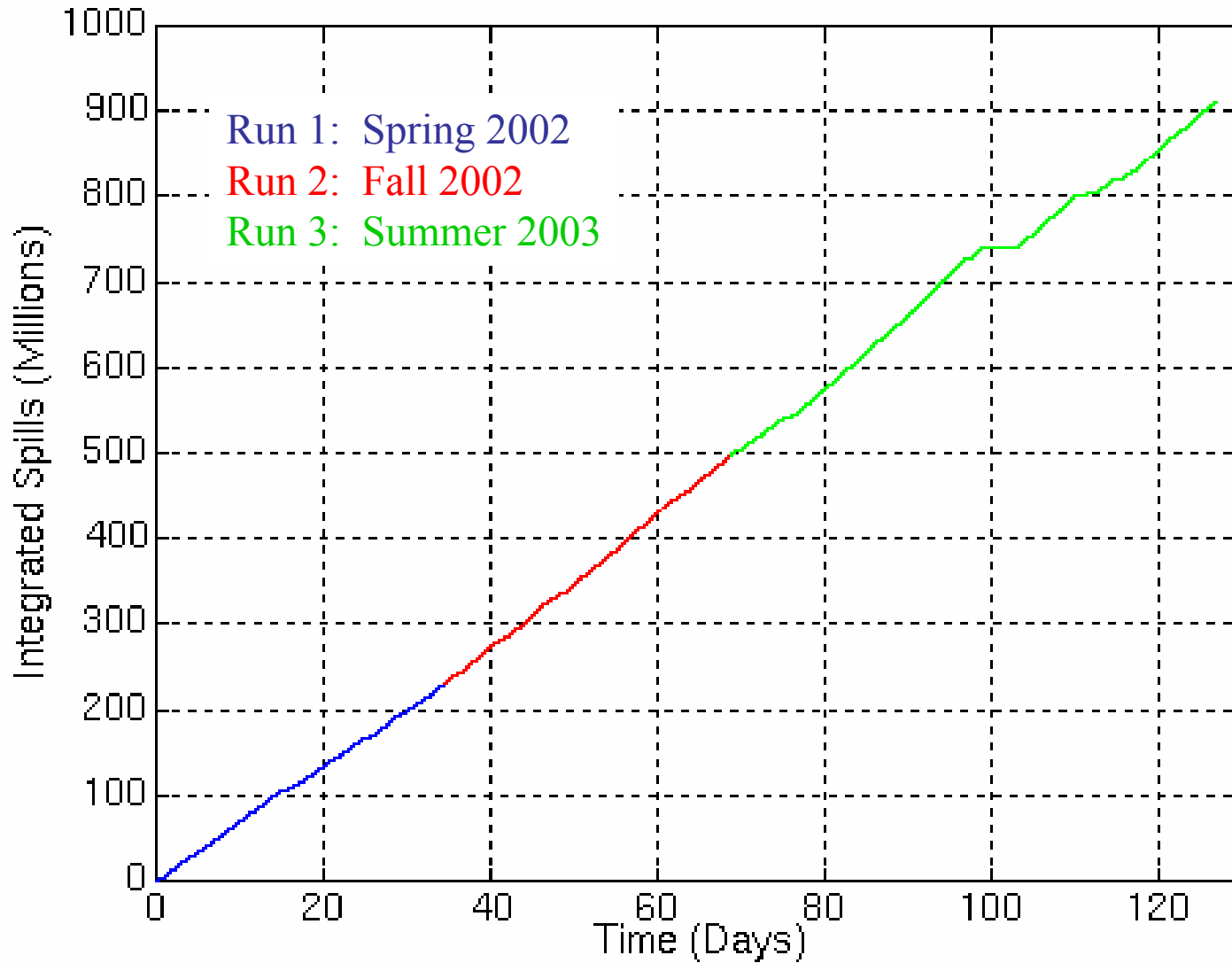
$$A_{PV} \propto (1 - 4\sin^2 \theta_W)$$

$$A_{PV}^{meas} = P_e \cdot A_{PV}$$

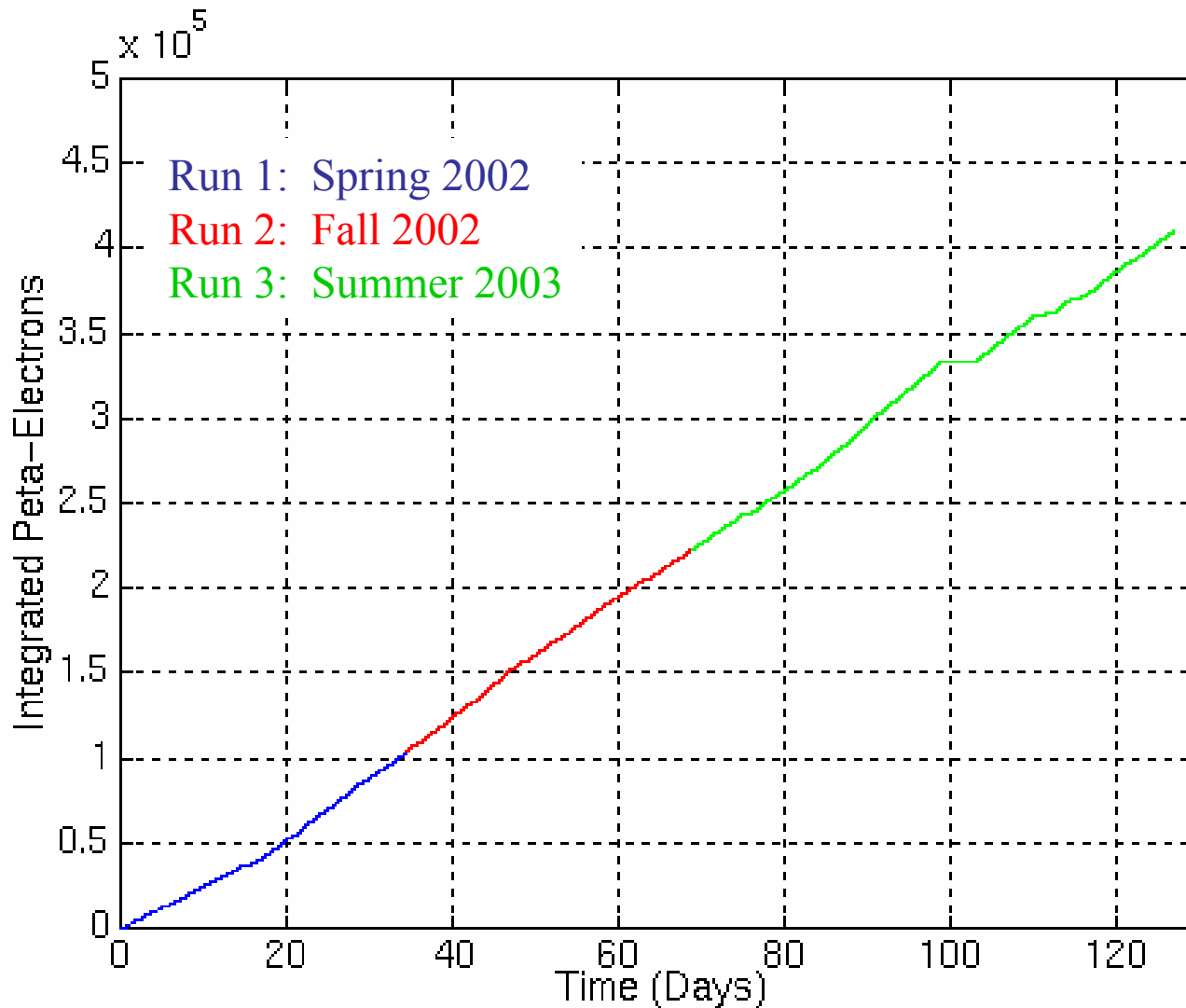
For E158,  $E=48$  GeV,  $Q^2=0.03$  GeV<sup>2</sup>

At tree level,  $A_{PV} = -3 \times 10^{-7}$

# E158 Physics Runs



# E158 Physics Runs



- Total integrated data sample ~4X Run1 data sample
- Beam performance met or exceeded all goals!  
(intensity, polarization, jitter, efficiency)

# E-158 Beam

(and comparison with 500 GeV Linear Collider Design)

| Parameter                   | E-158              | NLC-500               |
|-----------------------------|--------------------|-----------------------|
| Charge/Train                | $5 \times 10^{11}$ | $14.4 \times 10^{11}$ |
| Repetition Rate             | 120 Hz             | 120 Hz                |
| Energy                      | 45 GeV             | 250 GeV               |
| e <sup>-</sup> Polarization | 85%                | 80%                   |
| Train Length                | 270ns              | 267ns                 |
| Microbunch spacing          | 0.3ns              | 1.4ns                 |
| Beam Loading                | 10%                | 22%                   |
| Energy Spread               | 0.15%              | 0.16%                 |

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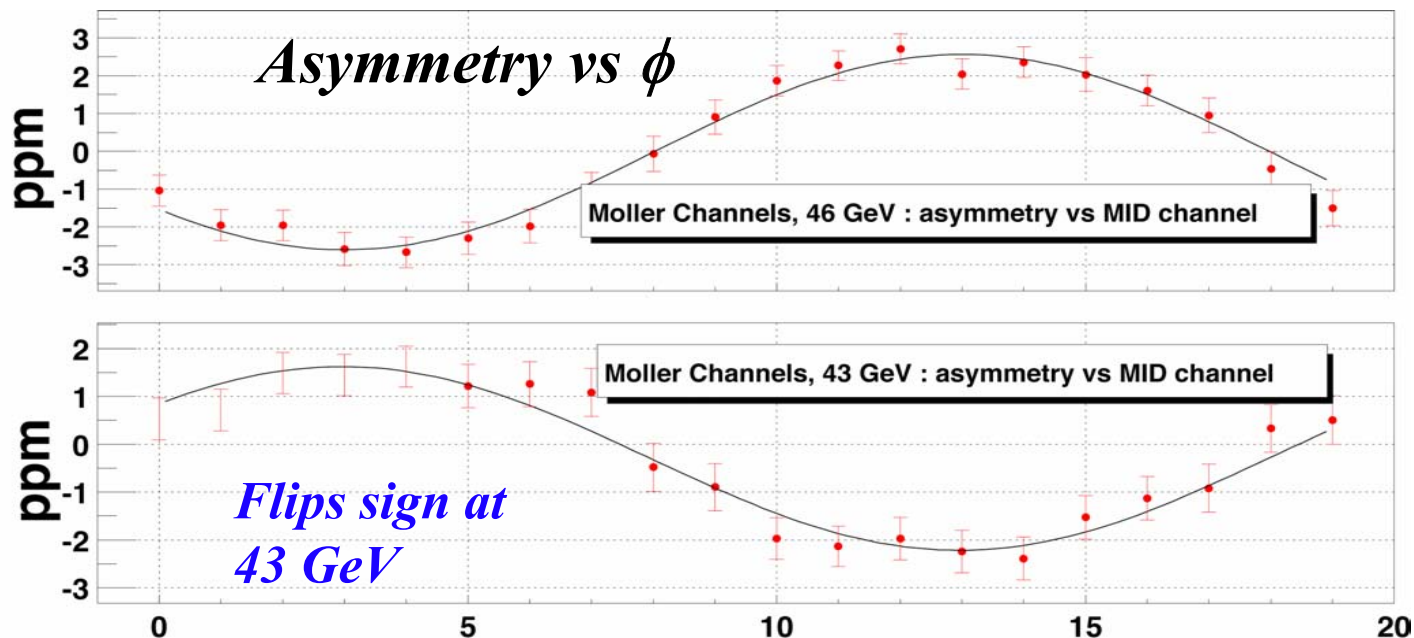
IP Beam Instrumentation Groups for LC will be pushing for ESA beam tests!

To demonstrate: i) precision beam energy and energy spectrum measurements

ii) precision polarimetry

iii) beam diagnostics downstream of IP in presence of beamstrahlung  
(mimic beamstrahlung and disruption angles with bremstrahlung  
and multiple scattering from a thick target)

# Transverse Asymmetry in Moller Scattering



*Observe ~ 2.5 ppm up-down asymmetry  
w/ horizontal polarization*

*First measurement of single-spin  
transverse asymmetry in e-e scattering.*

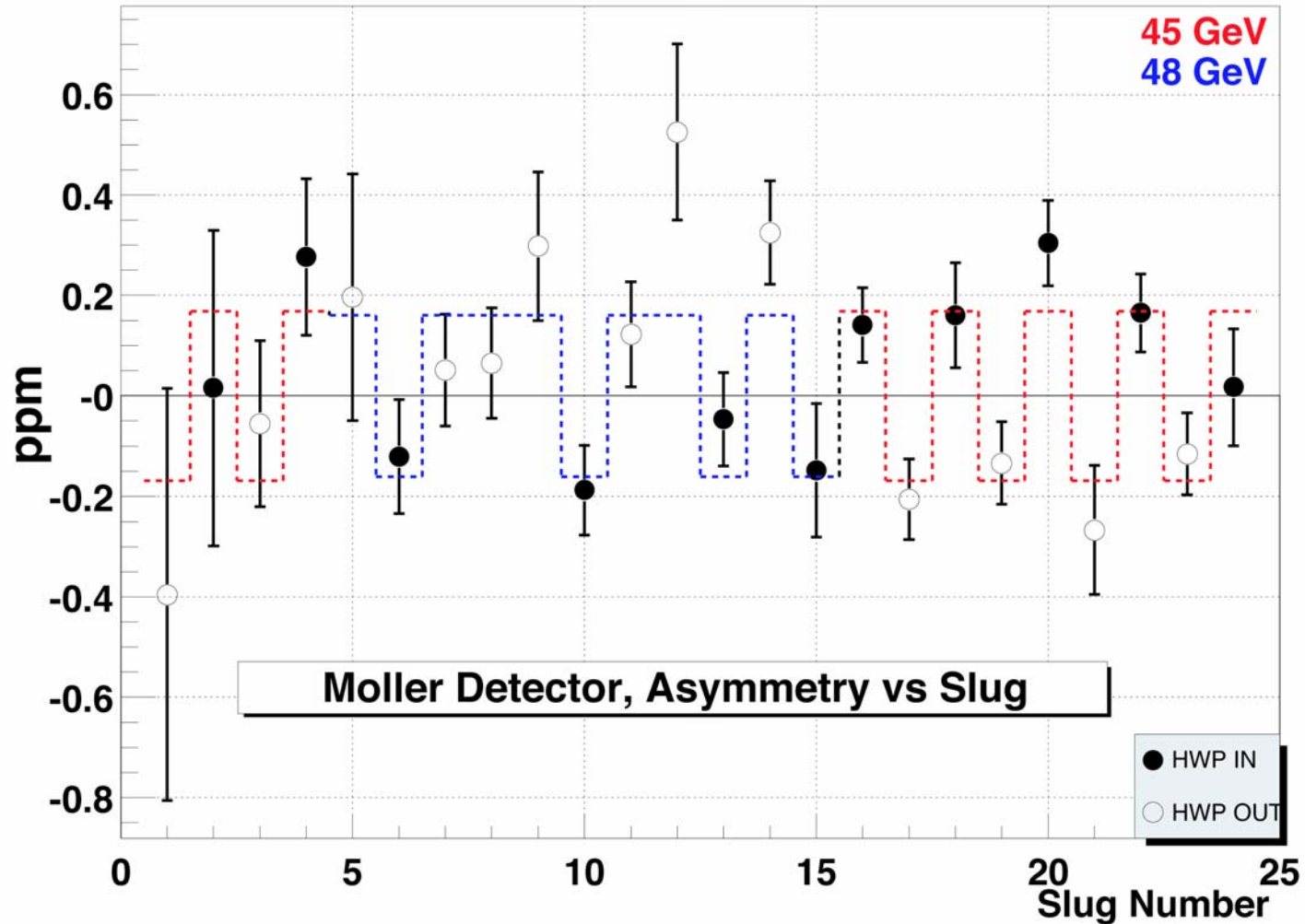
Theory References:

1. A. O. Barut and C. Fronsdal, (1960)
2. L. L. DeRaad, Jr. and Y. J. Ng (1975)
3. Lance Dixon and Marc Schreiber; (higher order calc. in progress)

*Two-photon exchange  
QED effect*

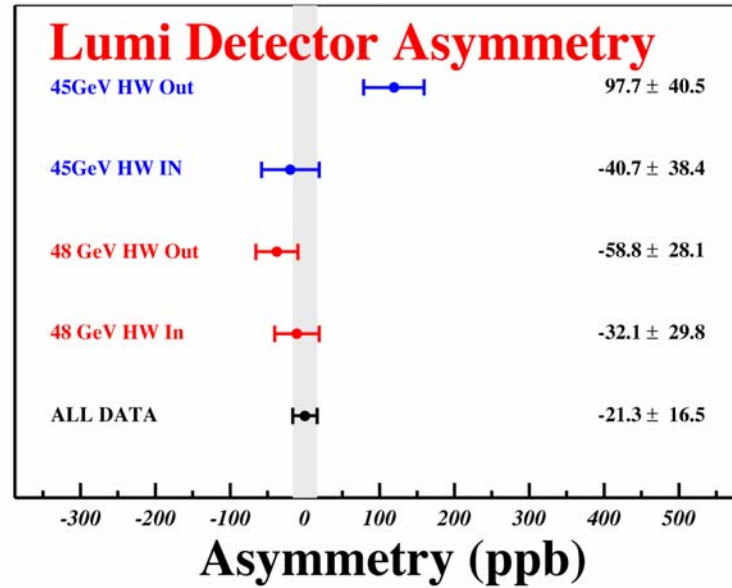
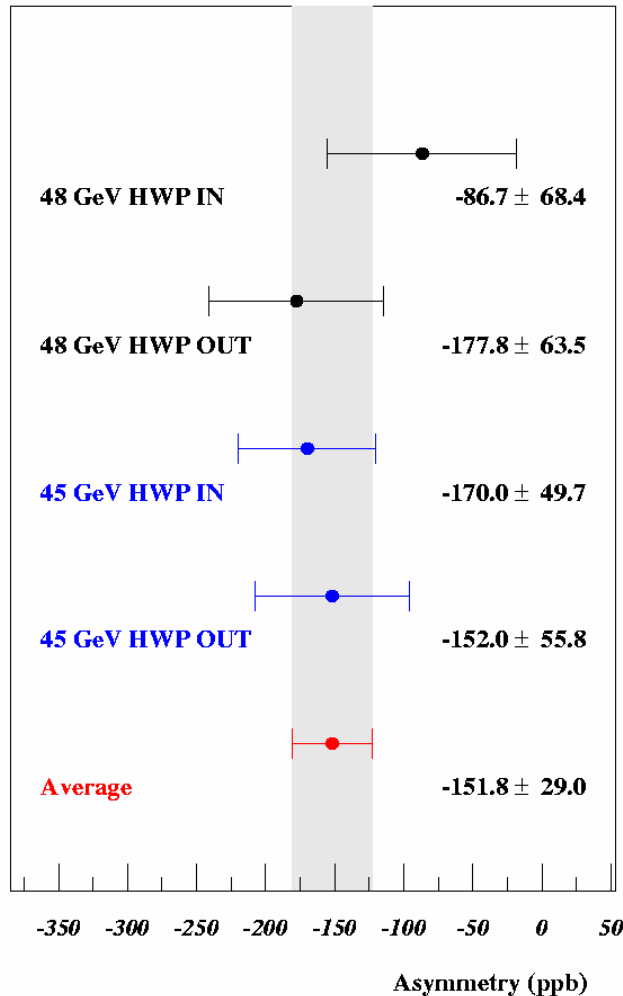
➡ *May also be useful for checking normalization factors (polarization, dilutions)*

# E158 Run1 Moller Asymmetry



# E158 Run1 Result

## Moller Asymmetry



**$A_{PV}(e^-e^- \text{ at } Q^2 = 0.027 \text{ GeV}^2):$**   
 **$-151.9 \pm 29.0 \text{ (stat)} \pm 32.5 \text{ (syst)}$**   
**parts per billion**  
*(preliminary)*

***Significance of parity nonconservation in Møller scattering:  $3.6\sigma$***

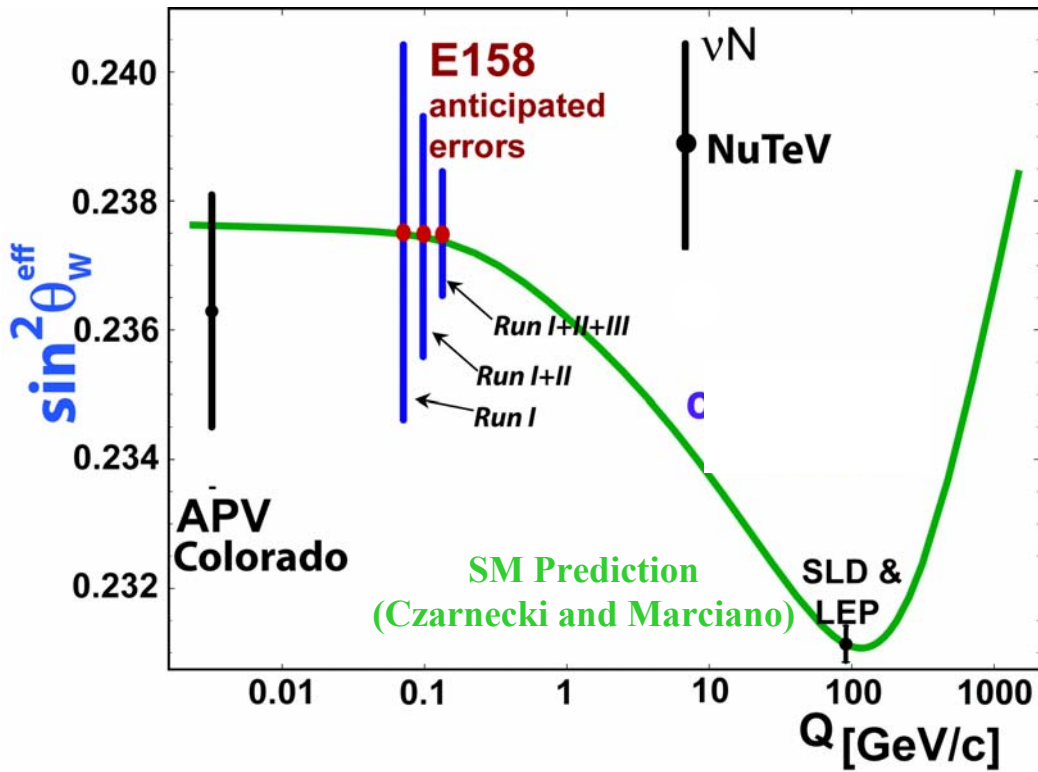


# Weak Mixing Angle

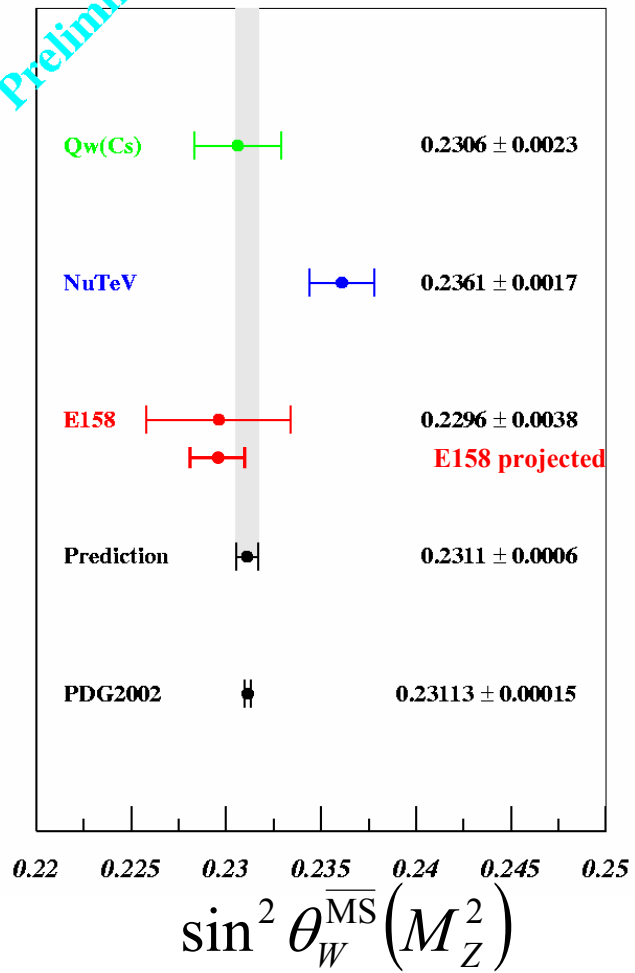
**E158 Preliminary (Run 1 only):**

$$\sin^2\theta_W(M_Z^2) = 0.2296 \pm 0.0025 \text{ (stat)} \pm 0.0027 \text{ (syst)}$$

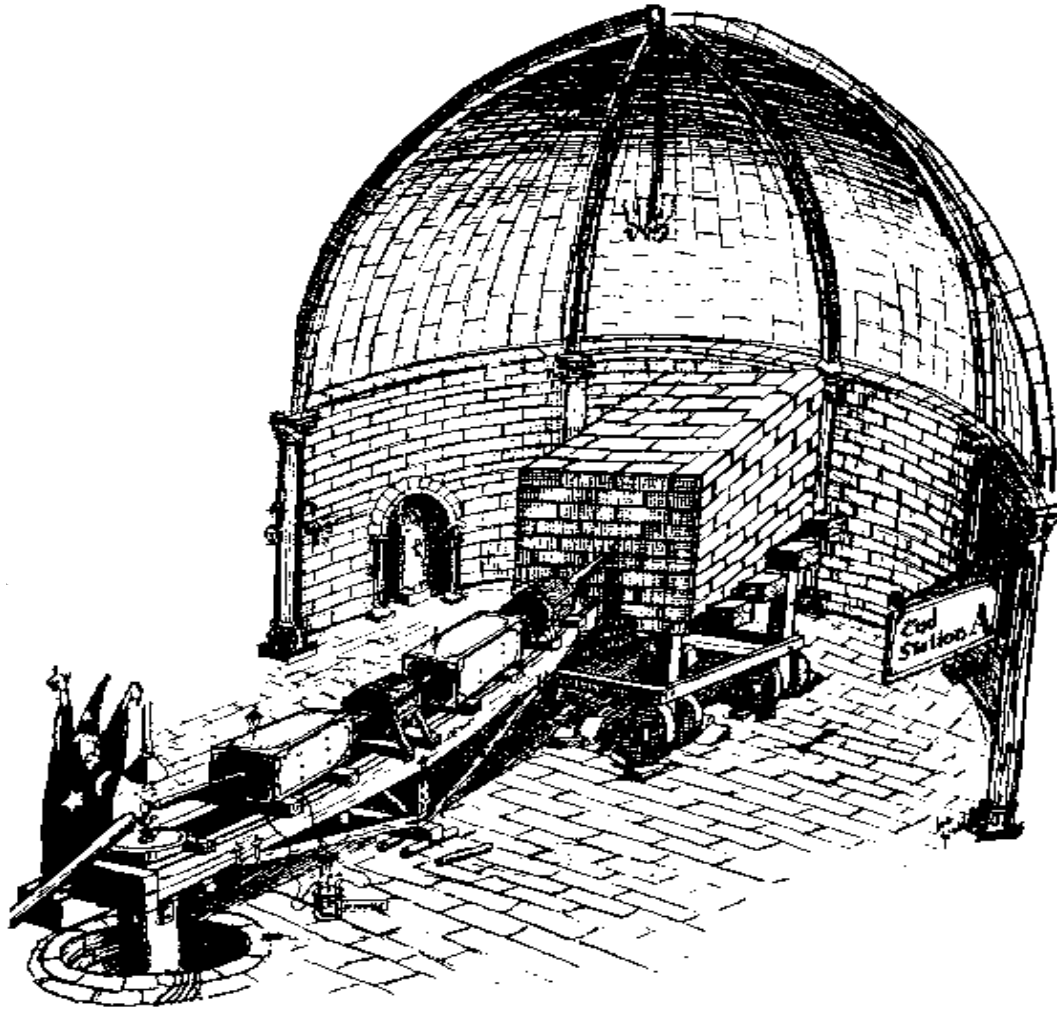
Runs 1,2,3 projected:  $\pm 0.0012$        $\pm 0.0010$



Preliminary

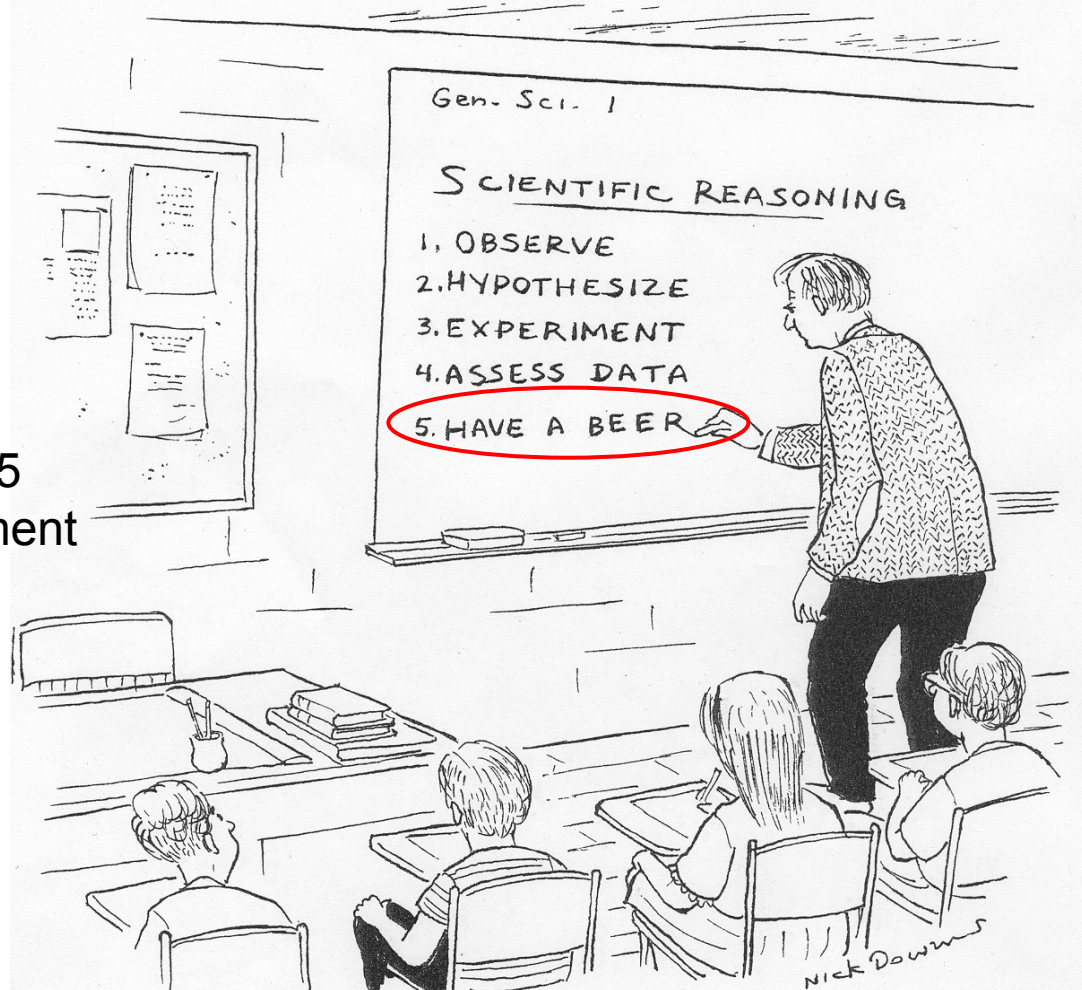


THANKS to Accelerator Operations  
and all the Support Groups!!



From The E158 Collaboration

# THANKS to Accelerator Operations and all the Support Groups!!



... onto steps 4 and 5  
for the E158 experiment

From The E158 Collaboration