Physics Intro
JLab Polarimetry Workshop 2003

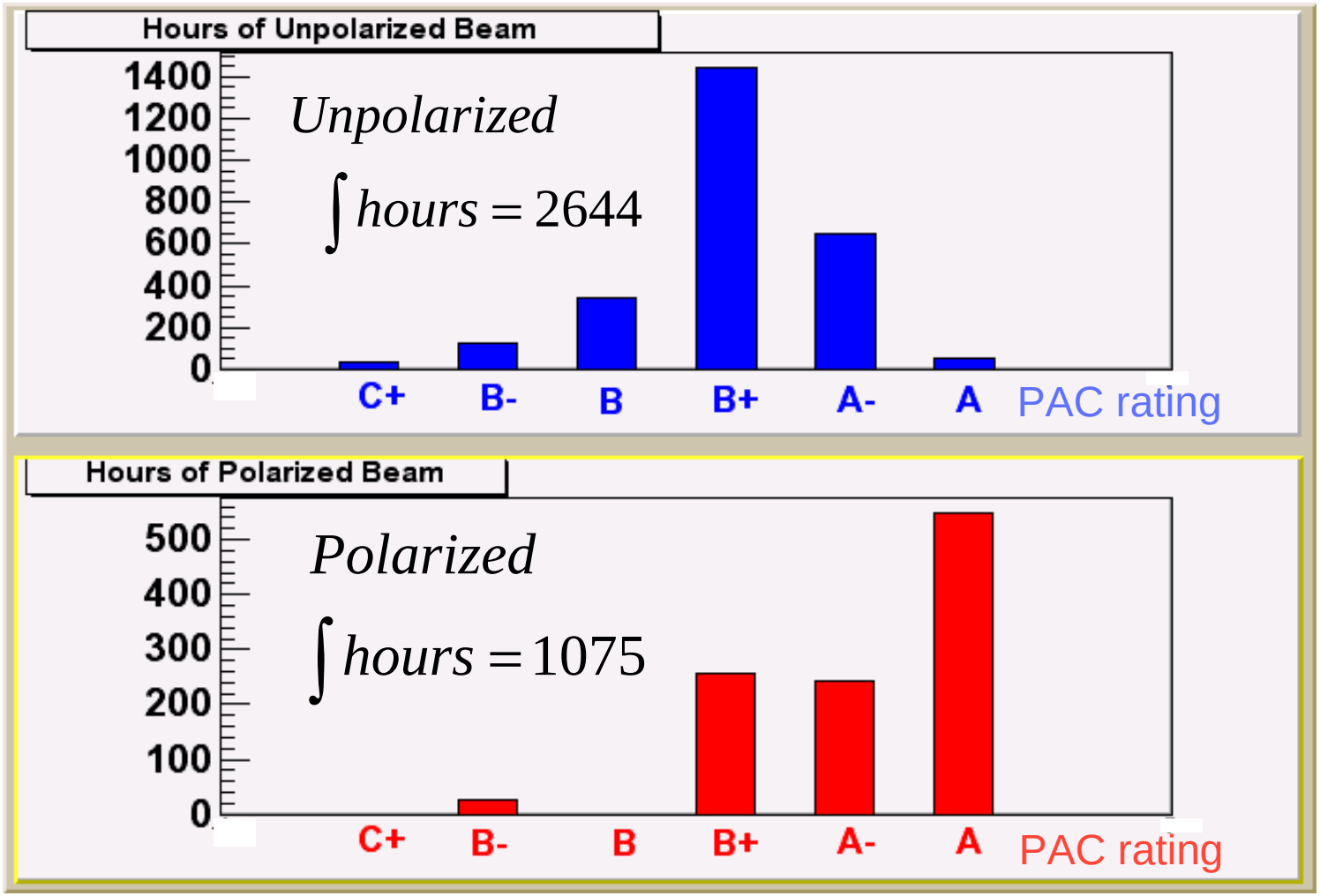
R. Michaels JLab

- Future Needs :

$$\frac{dp}{p} \approx 1\% \quad for \quad 50-100\ \mu A$$
$$\& \quad E \geq 0.85\ GeV$$

- Mini-review of experiments requiring high accuracy.

Hours of Approved Beam Time
All Three Halls



→ 30% of beam time is polarized for ``high value'' experiments.

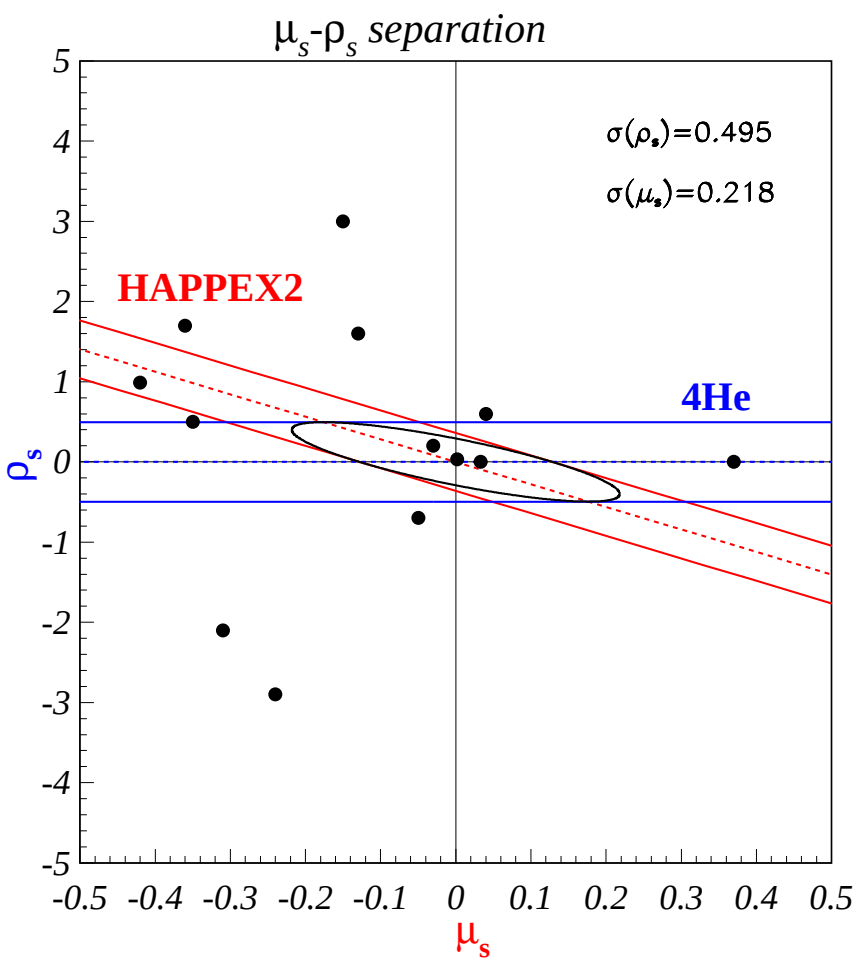
Experiments Requiring High Precision Polarimetry

Experiment	Systematic Error (w/o pol.)	Polarization Error	Statistical Error	Energy (GeV)	Status
^{4}He ρ_s	0.6 %	2.0 %	2.2 %	3.2	2004
^{208}Pb R_n	1.0 %	1.0 %	3.0 %	0.85	2006
Q_{weak} $\sin^2\theta_W$	2.4 %	1.4 %	2.8 %	1.16	2007
DIS ^{2}H $\sin^2\theta_W$	0.3 %	1.0 %	0.7 %	6	LOI

→ Low energy difficult for Compton

→ High currents $50\text{–}100\,\mu A$ difficult for Møller.

Strangeness Radius and Magnetism



u, d, s quarks in low energy structure ?

Electromagnetic scattering → not sufficient to isolate s quark effects. Need another DOF.

Weak interaction → Parity violation

Radius ρ_s

Magnetic Moment μ_s

Standard Model Tests

The standard model of electroweak interaction :

Experimentally very successful

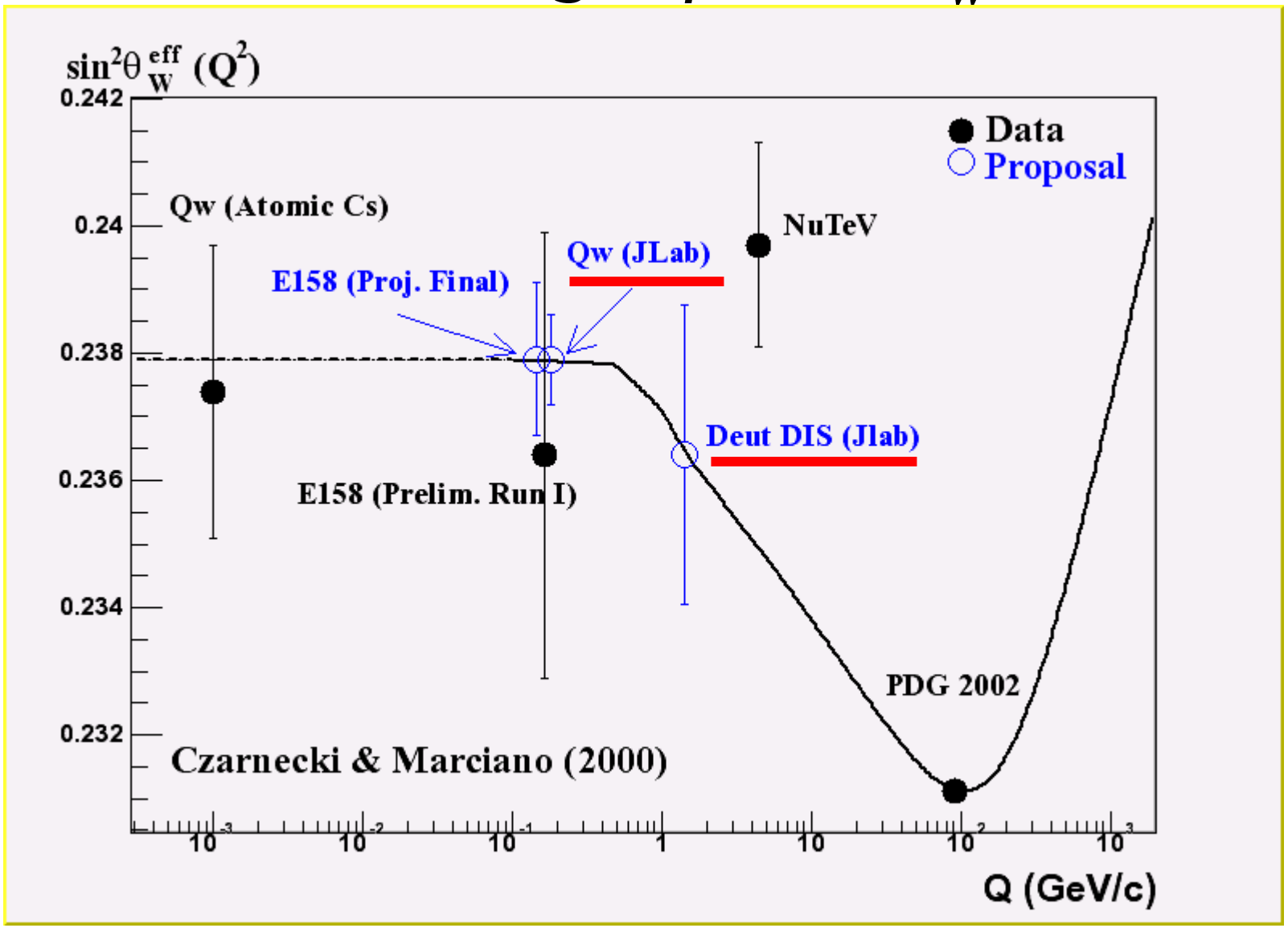
But seems it must break down !!

(issues: many parameters, origin of mass, unification with gravity, etc)

Frontiers:

1. Higher energy
2. Higher precision → JLab parity → Q^{p}_{weak} ; DIS e - ^{2}H

Running of $\sin^2\theta_W$

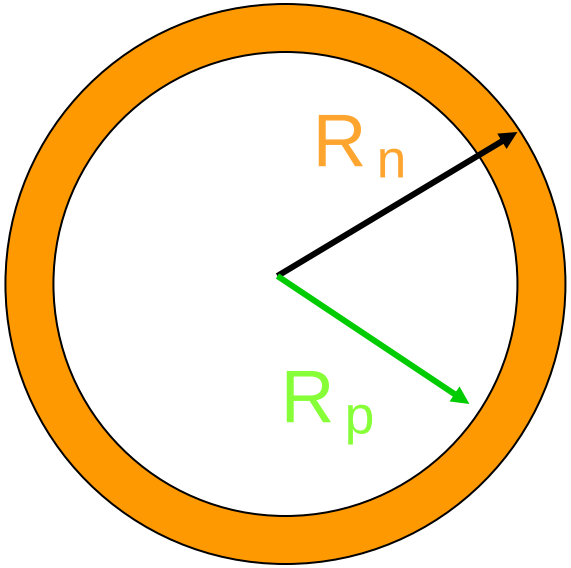


How Big is a Nucleus ?

Is the size determined by Neutrons ?

After 50+ years of nuclear physics we don't know if $R_n > R_p$

Idea (T.W. Donnelly & I. Sick) : Z^0 boson as probe of Neutrons



Picture of a Heavy Nucleus

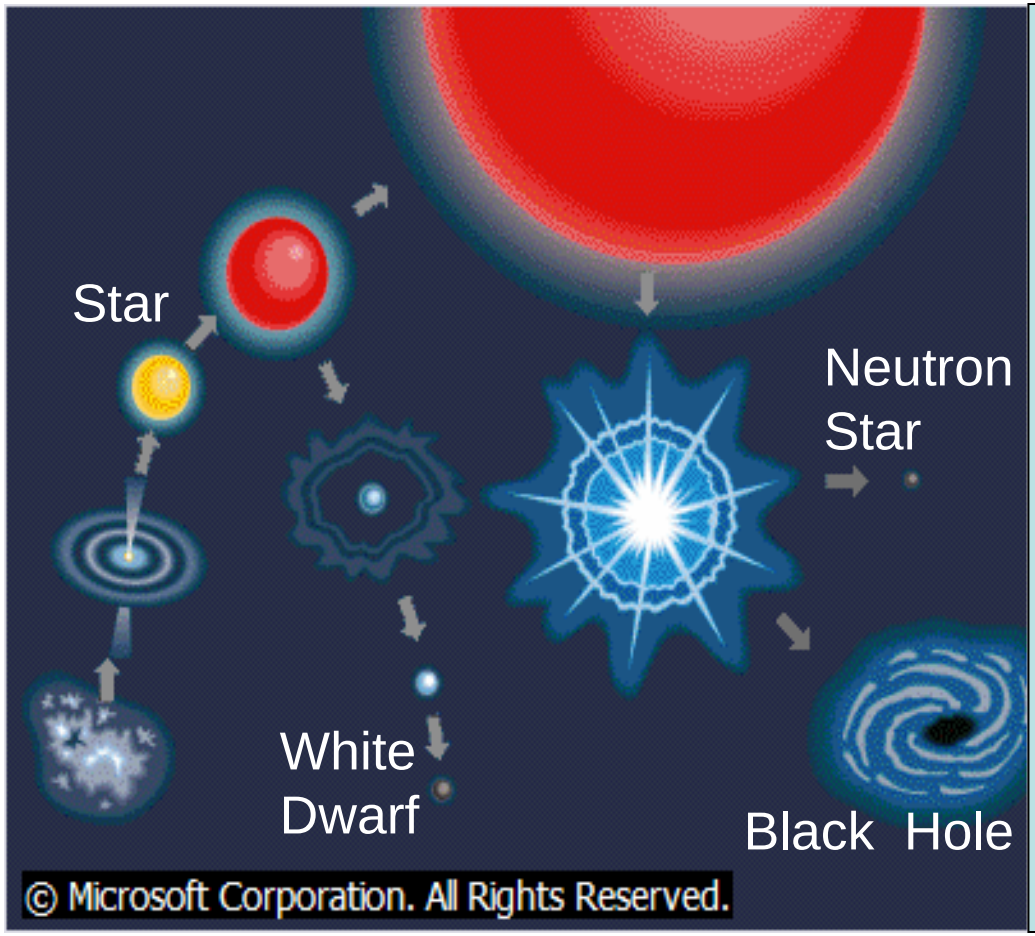
$\gamma \quad (electromagnetic) \rightarrow$

sees mainly protons

$Z^0 \quad (weak) \rightarrow$

sees mainly neutrons

R_n → Calibrate Theory of Neutron Star Structure



Neutron Stars:
One of 3 possible deaths.

Compare R_n to NS Radius:

Exotic core ? Quark matter ?

Neutron stars too cold ?

$$R_n - R_p \geq 0.25\ fm \rightarrow \nu\ cooling$$

1% polarimetry is vital for the Lead Radius Experiment !!

Conclusion

Precision Polarimetry of Vital Importance to Future JLab Physics Program !!

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$$\& \quad E \geq 0.85\ GeV$$