MINERνA with Hydrogen and Deuterium

- Nucleon structure - PDF's, especially high-x behavior, can be cleanly studied with ν/ $\bar{\nu}$ H.

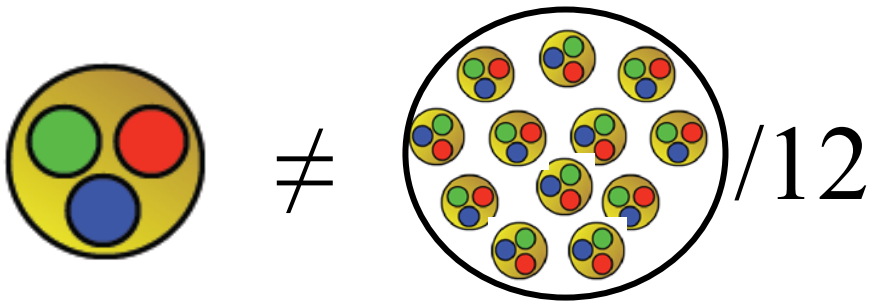
$$F_2^{\nu p} = 2x\,(d + \bar{u} + s)$$

$$F_2^{\bar{\nu} p} = 2x\,(u + \bar{d} + \bar{s})$$

At high x →

$$\frac{F_2^{\nu p}}{F_2^{\bar{\nu} p}} = \frac{d}{u}$$

- Cross with minimal nuclear effects



- Combine with other MINERνA measurements (νHe, νC, νFe, νPb) to determine neutrino induced nuclear effects.
- Current models for these nuclear effects not consistent with extracted effects for νFe.

Fiducial Volume = 3 tons CH, **0.2t He**, 0.15t C, 0.7t Fe and 0.85t Pb

Expected CC event samples:

9.0 M ν events in 3 tons of CH

0.6 M ν events in He

4.0x10^{20} in LE and 12.0x10^{20} ME NuMI beam configurations in 4 years

Project X Event rates: What to assume per year?

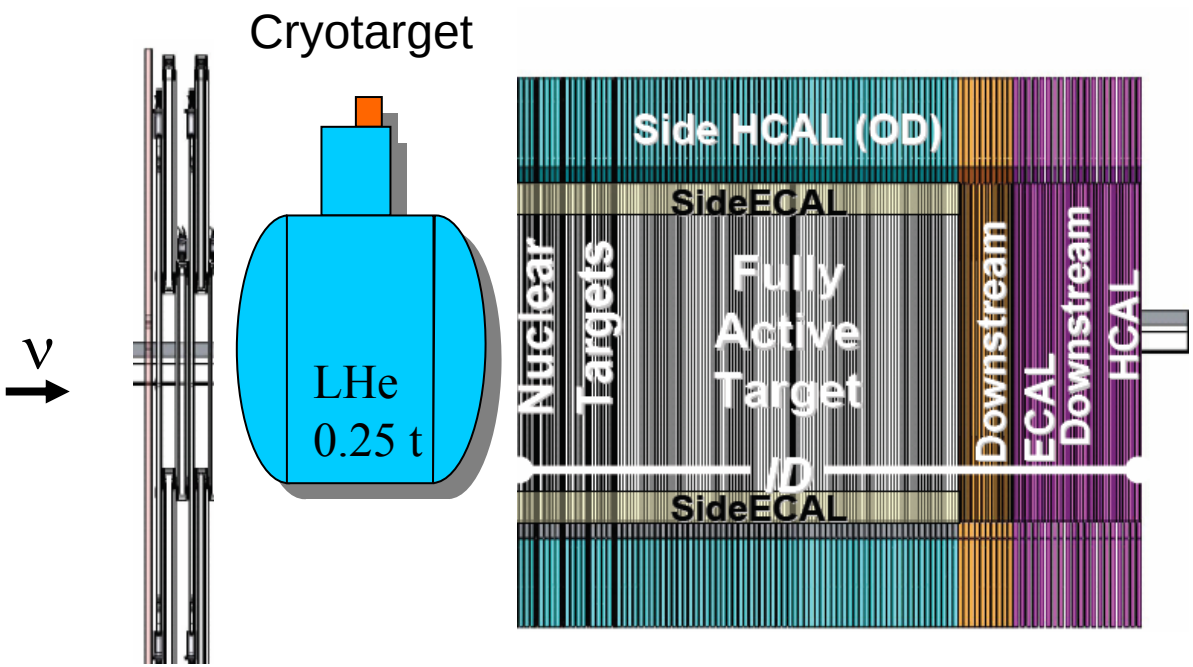
Assume 32.0x10^{20} protons in ME beam (2 years, 4 years?)

0.6 M ν events in H

1.2 M ν events in D

MINERνA: from here to Project X

- Extending run for Hydrogen and Deuterium was listed as a possible extension in our original proposal to Fermilab
- 2006: NSF Funding received for Helium Target: vessel, cryocooler, stand
- Everything designed to also be usable for Hydrogen and Deuterium
- Strategy is to demonstrate reconstruction with Helium (2010): then Propose Hydrogen and Deuterium Run



Nuclear Targets: 6.2 tons (40% scint.)

Fully Active Target: 8.3 tons