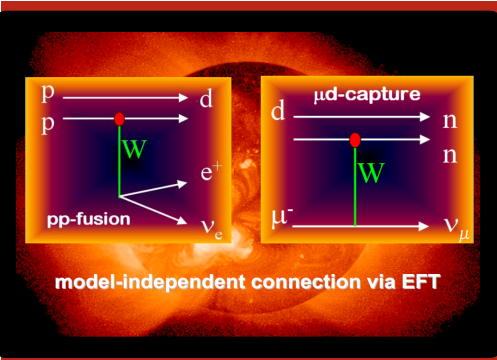


MuSun Experiment : Measuring the Rate of Muon Capture On the Deuteron

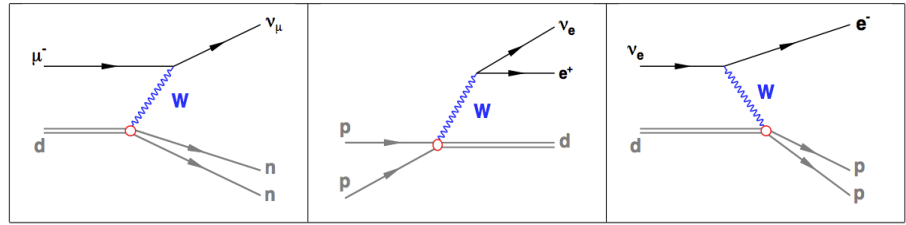


Goal:

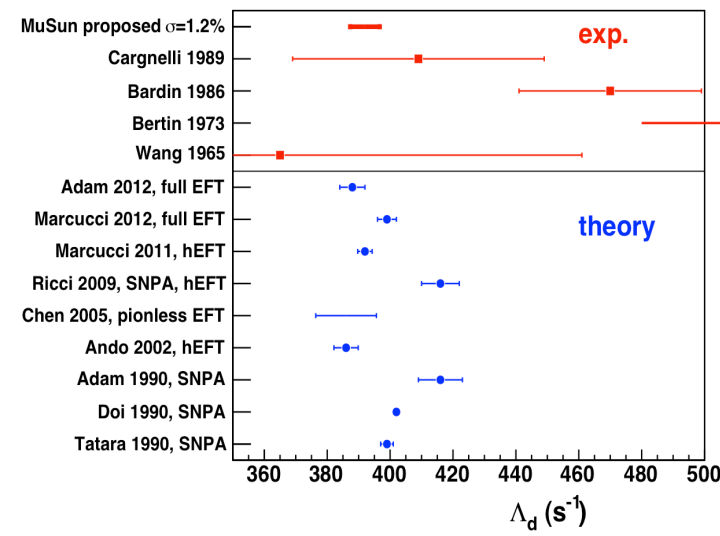
- Measure the rate Λ_d for muon capture on the deuteron (doublet state) to better than 1.5% precision.

Physics Significance

- Simplest weak interaction process on a nucleus that can be both calculated and measured precisely.
- Chiral Perturbation Theory relates μ -d capture to p-p fusion in the sun and v-d reaction at SNO.



- Existing experiments are not precise and only marginally consistent with theory



Experimental Method: Lifetime Technique

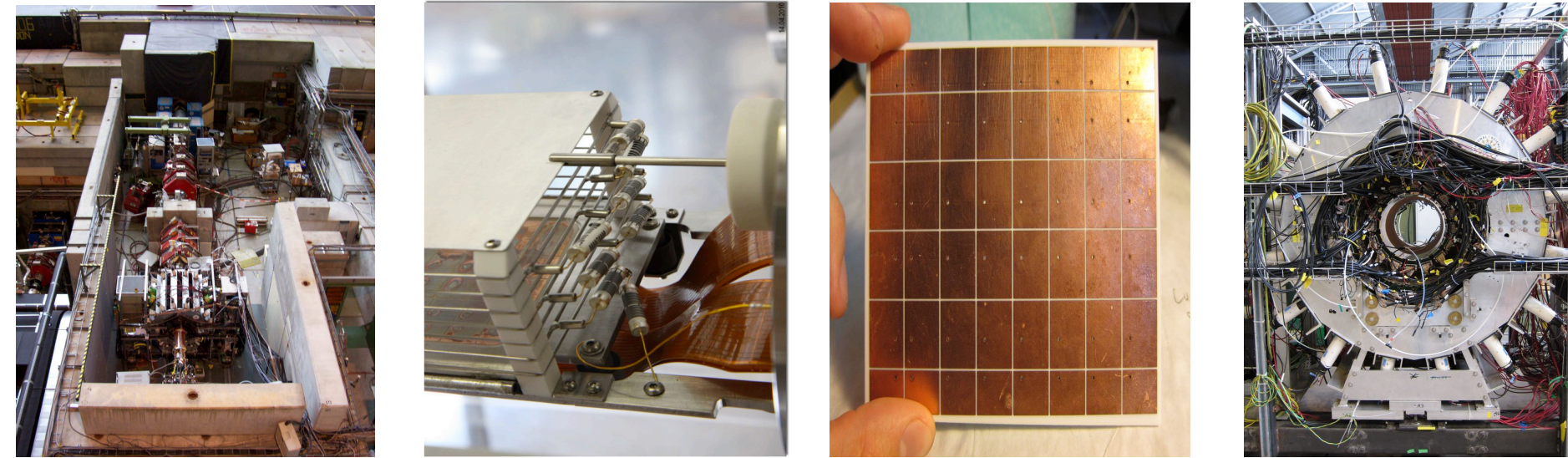
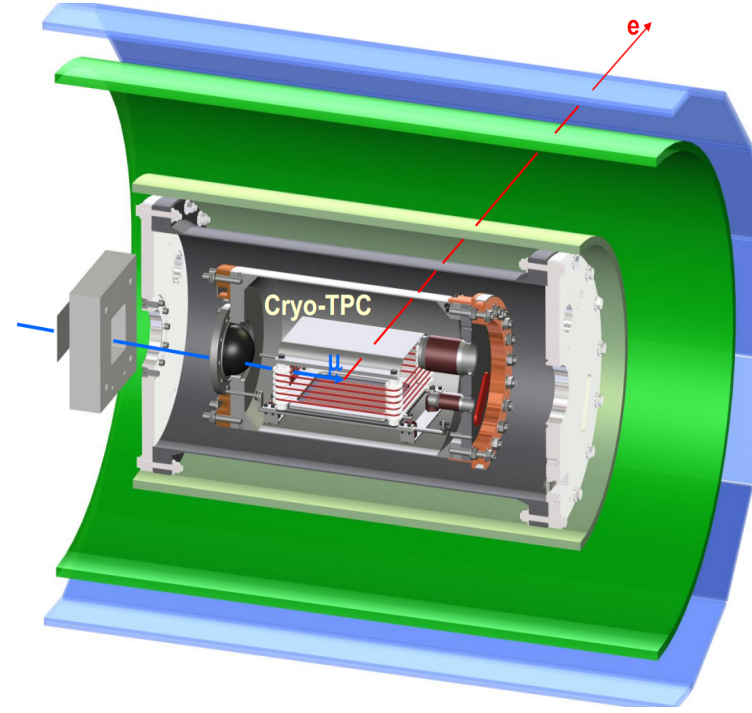
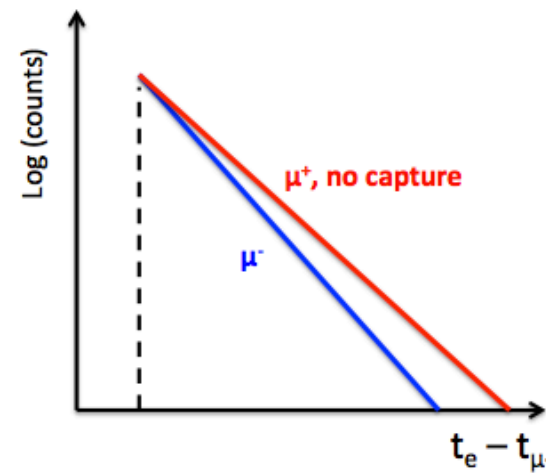
Focus on channels of the muon disappearance:
 Muon decay: $\mu^- \rightarrow \nu_\mu + e^- + \bar{\nu}_e$
 Muon capture: $\mu^- + d \rightarrow \nu_\mu + n + n$

$$\Lambda_{\mu^-} = \Lambda_{\text{cap}} + \Lambda_{\text{dec}}$$

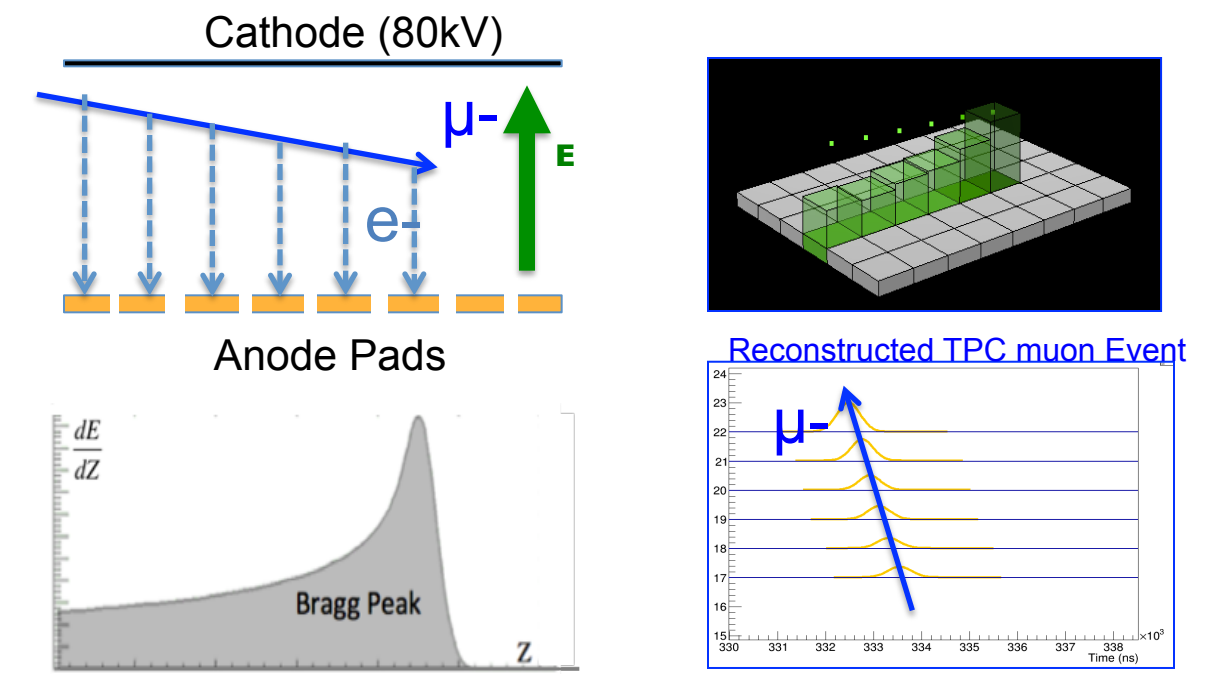
$$\Lambda_{\mu^+} = \Lambda_{\text{dec}} \sim 455\text{kHz}$$

$$\Lambda_{\text{cap}} = \Lambda_{\mu^-} - \Lambda_{\mu^+} \sim 400\text{Hz} \pm 6\text{Hz}$$

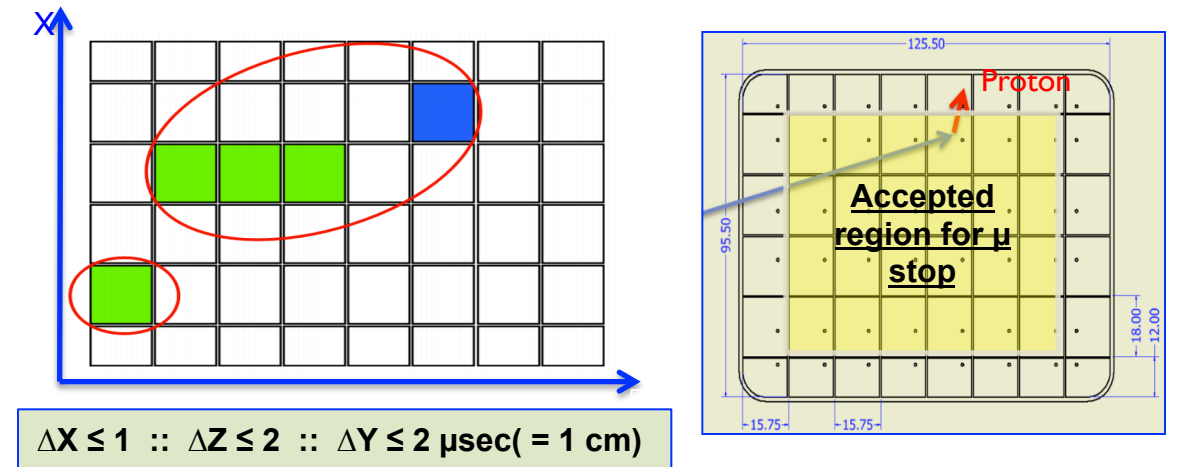
- Determine the Λ_{cap} to 1.5% level.
- Measure the t_e to Λ_{μ^-} 10ppm.
- Require 10^{10} events.



Data Analysis (TPC)



- 3D track reconstruction and energy
- 40ns time resolution and $\sim 10\text{keV}$ energy resolution to distinguish muon, He3, proton, triton, and impurity recoil.
- TPC serve as a cut box to define a "good muon stop" event to fill the lifetime histogram.



Paul Scherrer Institute in Switzerland

- World's most intense continuous beam muon source
- three months beam time in the summer of 2011 and fall of 2013; accumulated $\sim 1E10$ events of production data.
- Production run in the summer of 2014 . And final run expected in 2015.

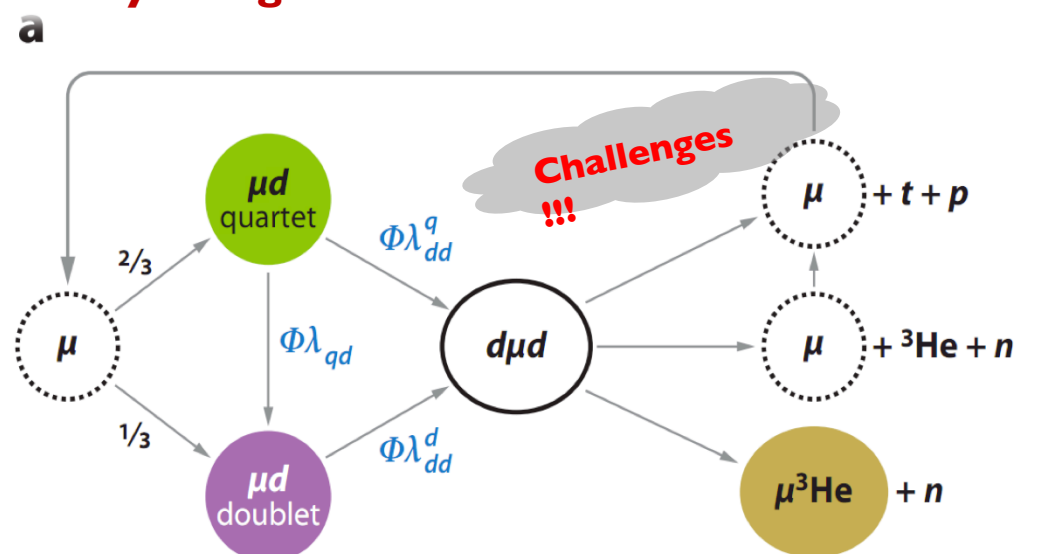
Collaboration:

PSI, University of Washington, Boston University, University of Kentucky, Regis University, PNPI

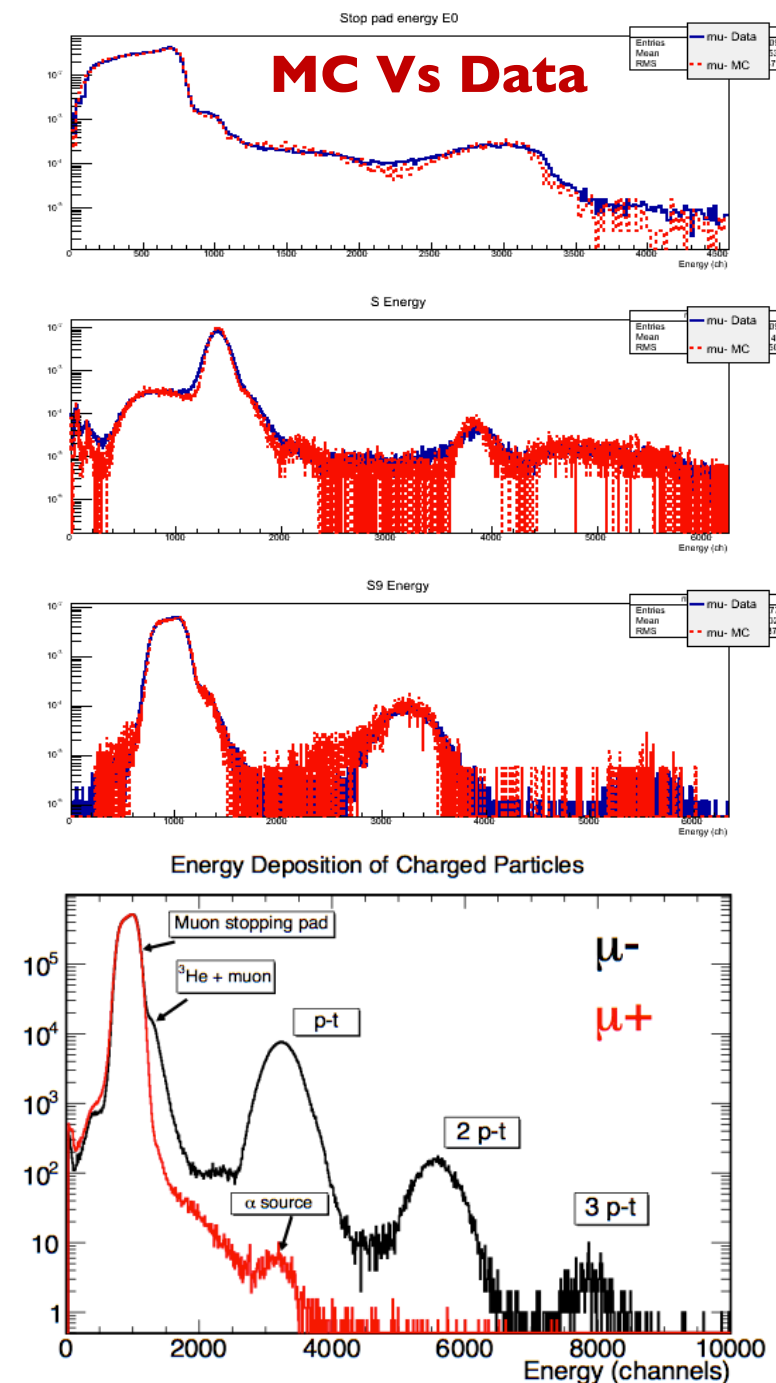
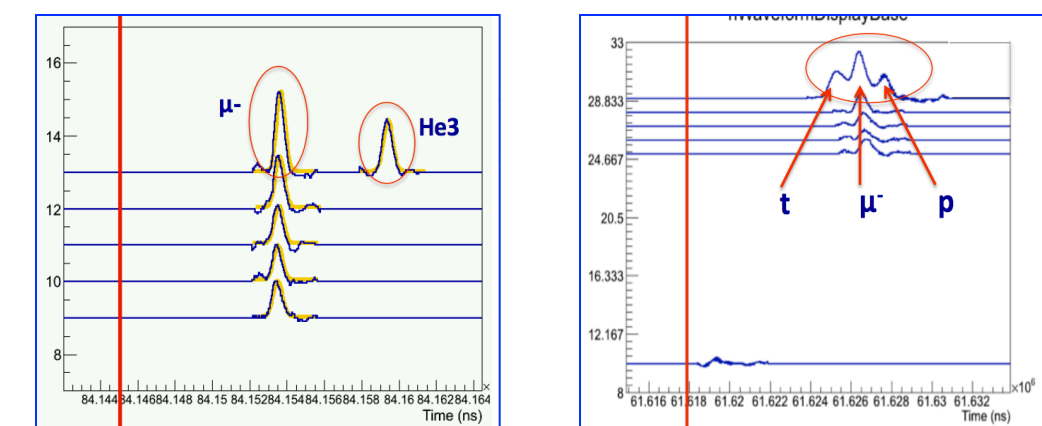
Contact:

Xiao Luo: xiaoluo@buphy.bu.edu

Real story: A Muon in Deuterium gas can do many things...



Muon Catalyzed fusion will happen $\sim 5\%$ of the time and the corresponding signals are one of the main sources of systematic errors.



To prevent systematic error, it is crucial to make time independent cuts.

