Signatures of Dark Sectors at SeaQuest

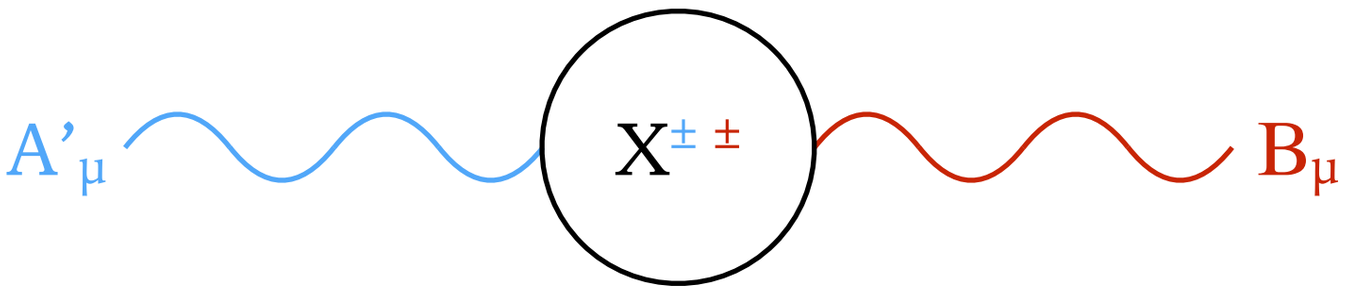
ASHER BERLIN

U.S. Cosmic Visions, New Ideas in Dark Matter,
March 24, 2017

Collaboration with Nikita Blinov, Stefania Gori, Philip Schuster, Natalia Toro

The GeV Scale

The GeV Scale



$$\epsilon \sim \frac{g_D\, g_Y}{16\,\pi^2} \sim 10^{-3}$$

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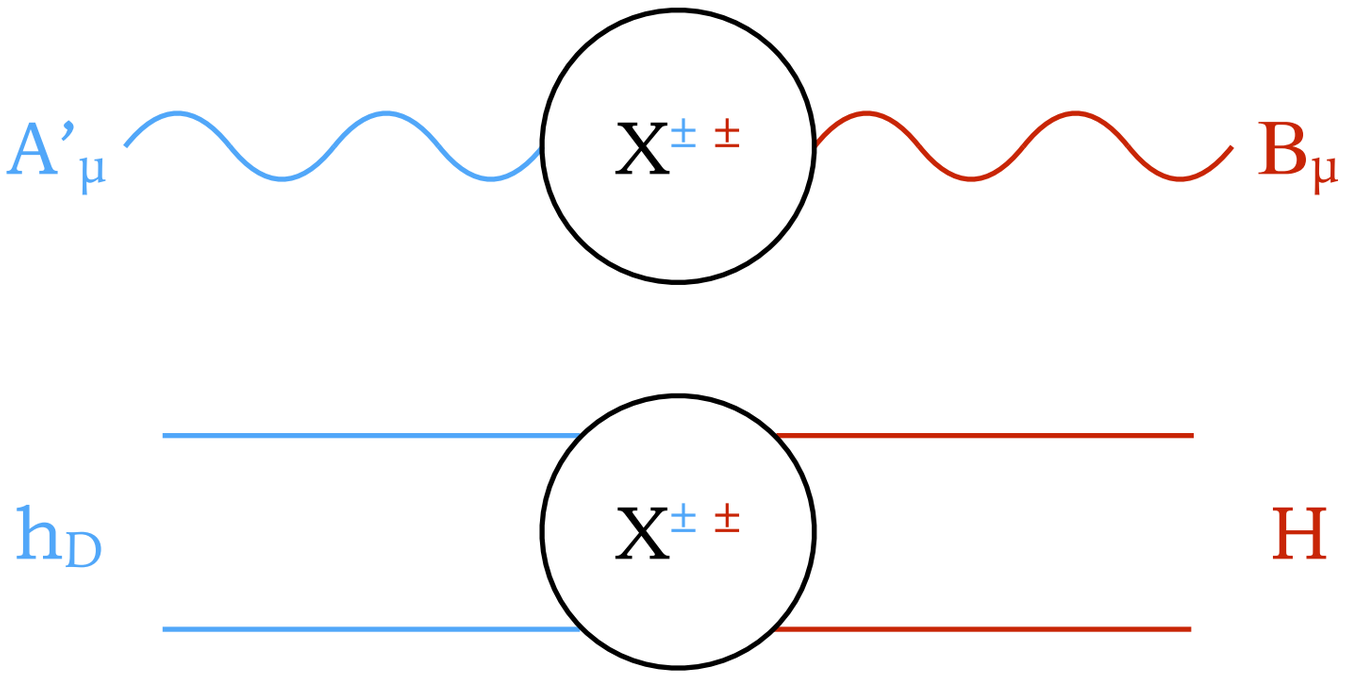

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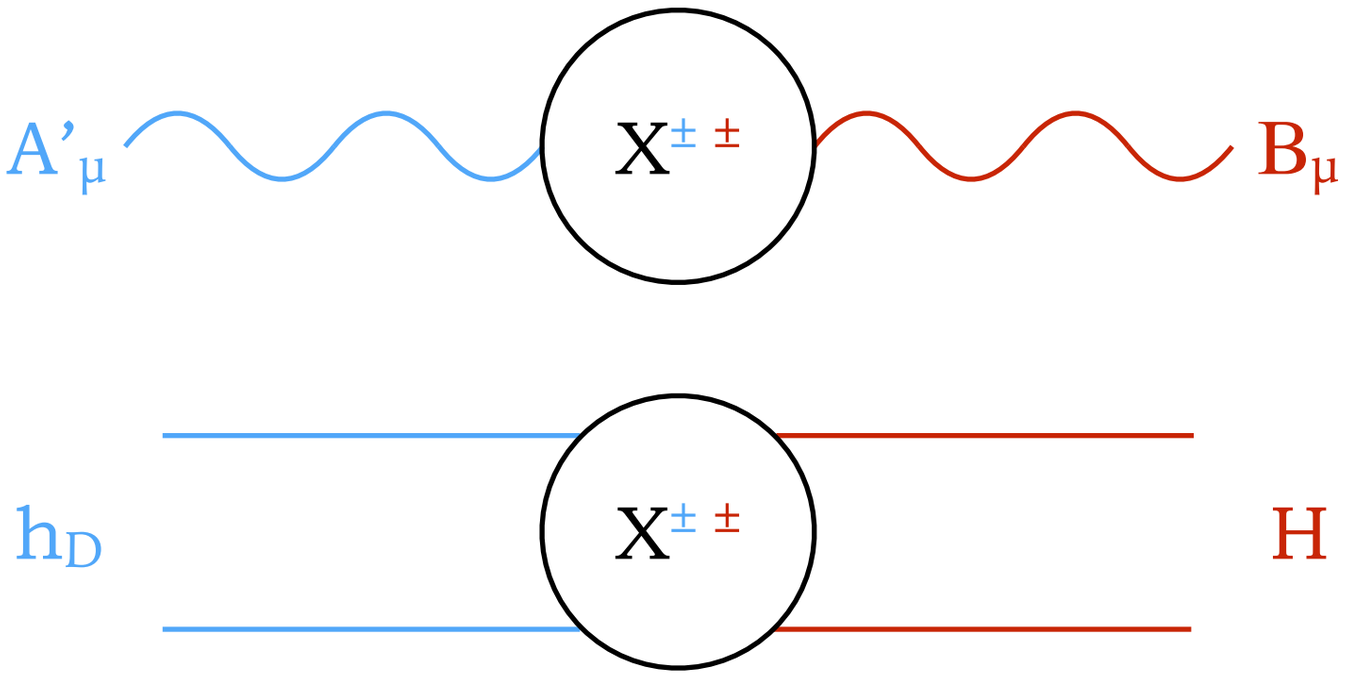

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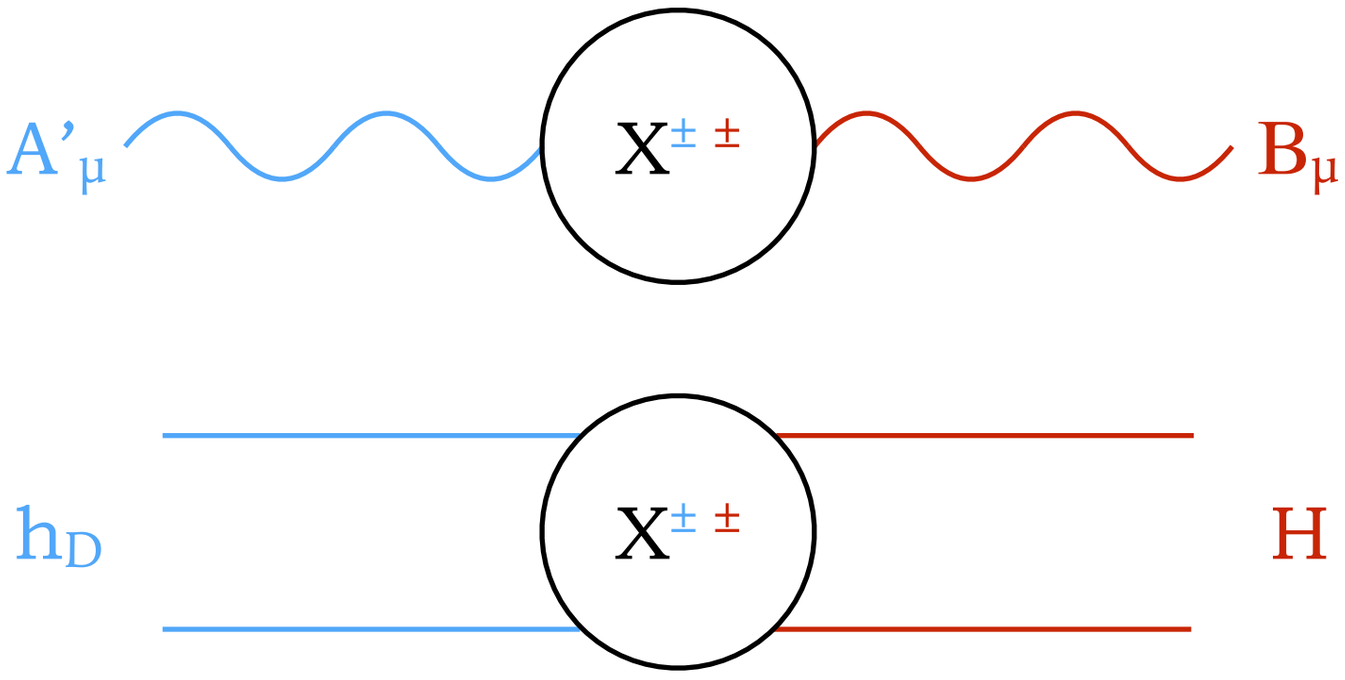

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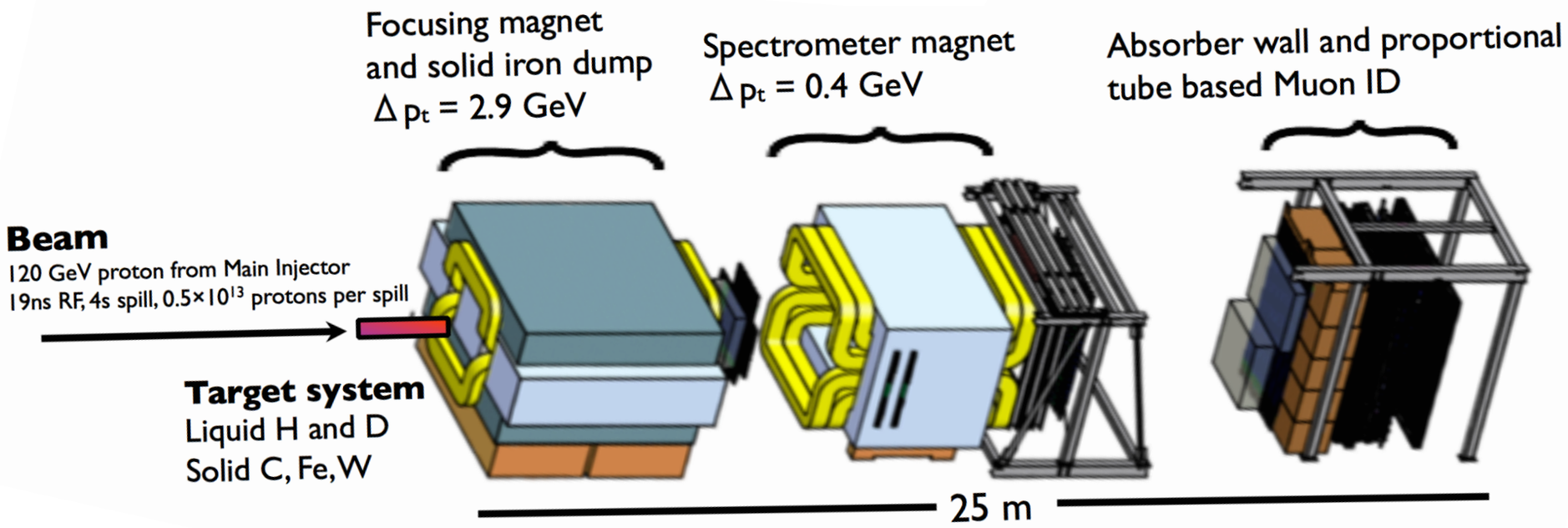
SUSY $\Rightarrow$

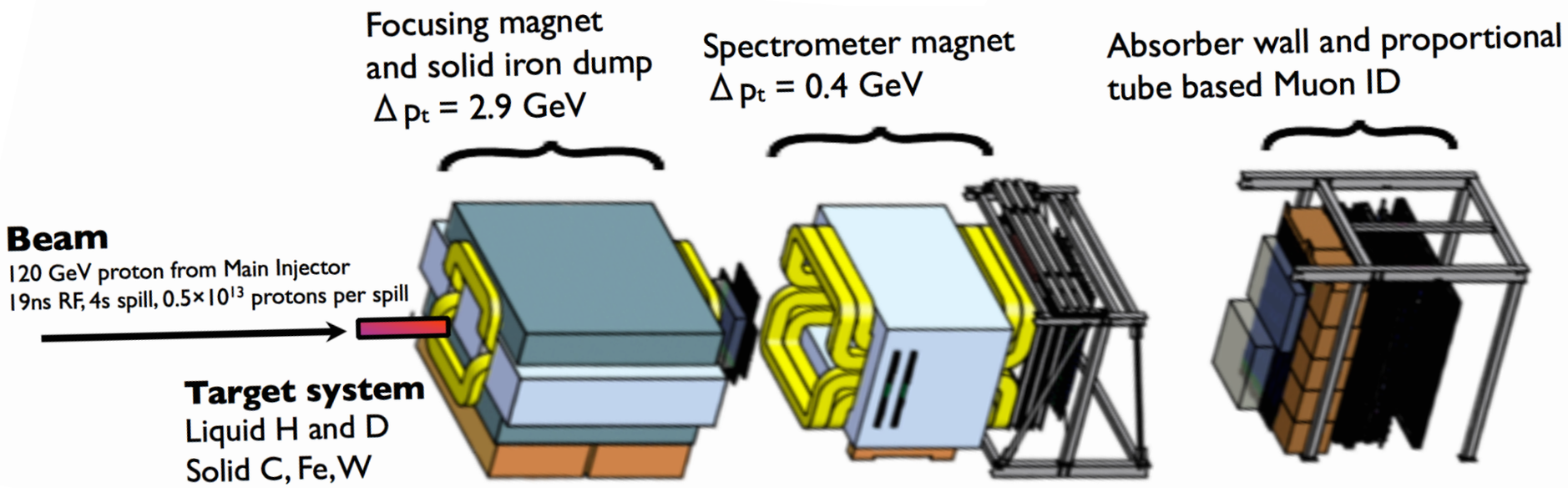
$$m_{A'} \sim 4\pi\,\epsilon\, v \sim \mathcal{O}(1)\ \text{GeV} \times \frac{\epsilon}{10^{-3}}$$

SeaQuest

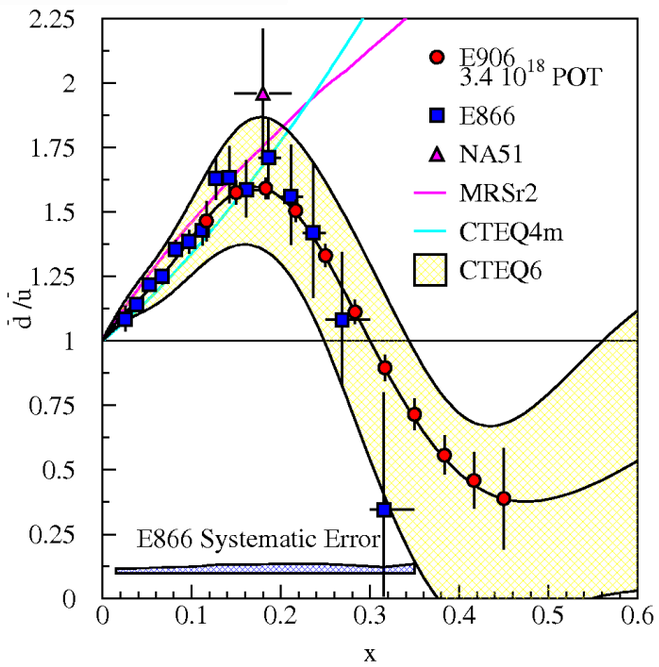


(Ming X. Liu)

SeaQuest



- Measure sea quark fractions at mid-x via Drell-Yan off of different targets.



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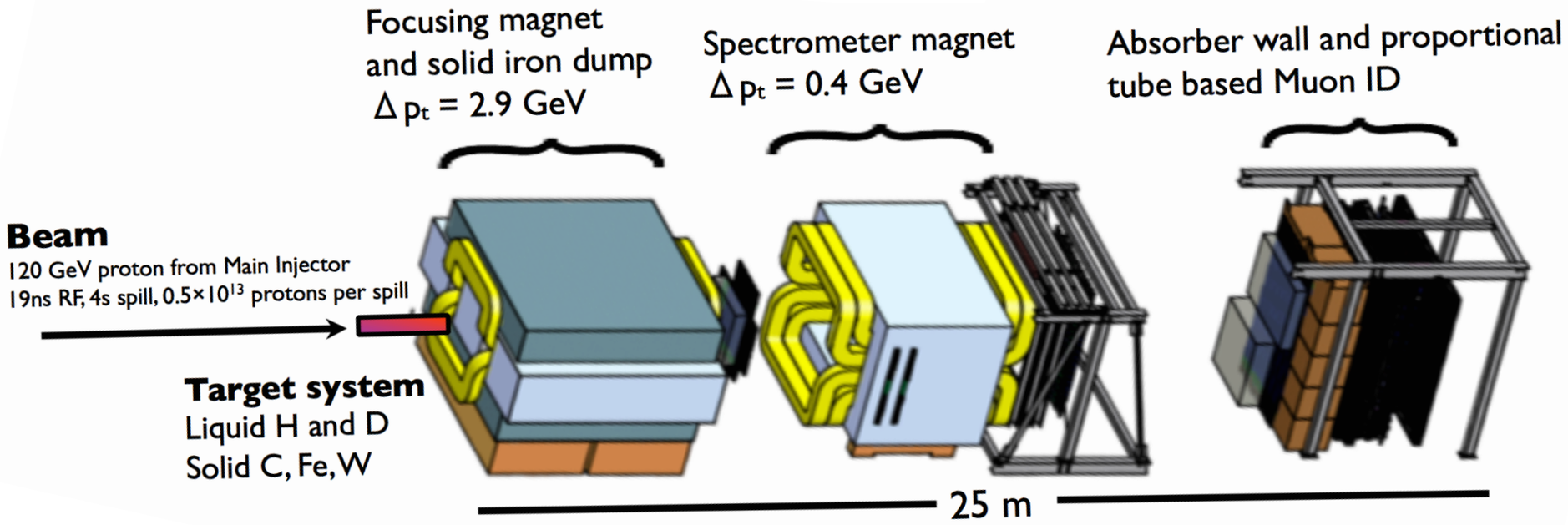

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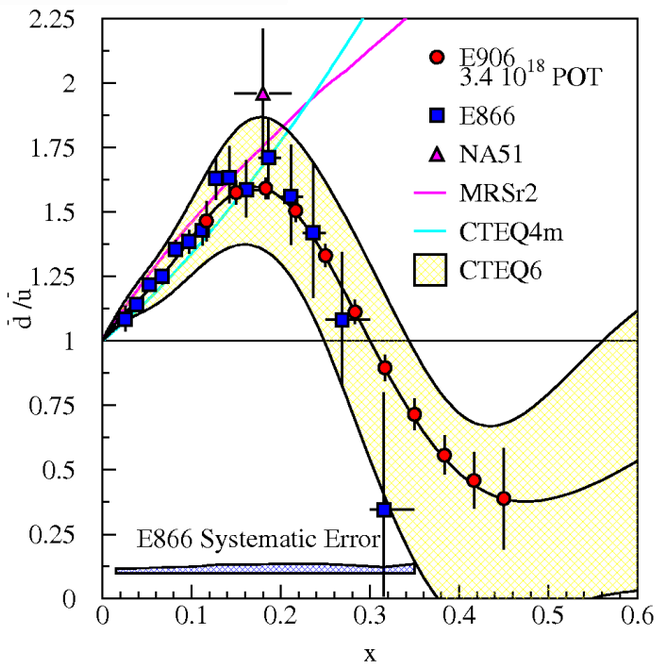

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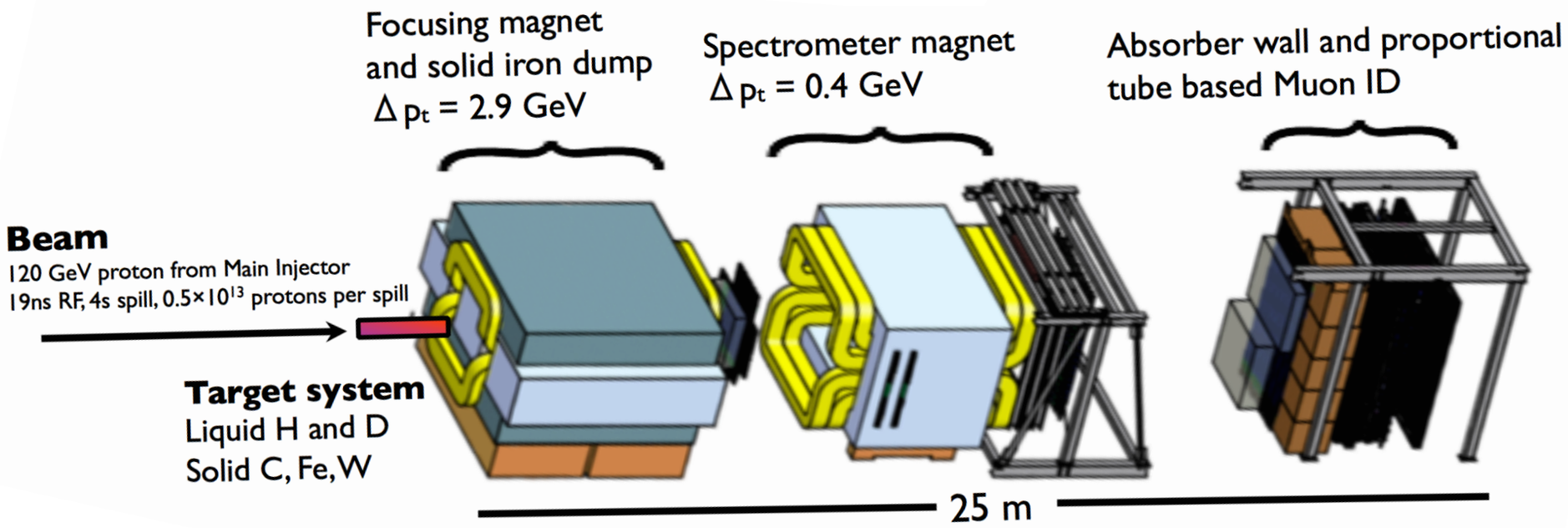

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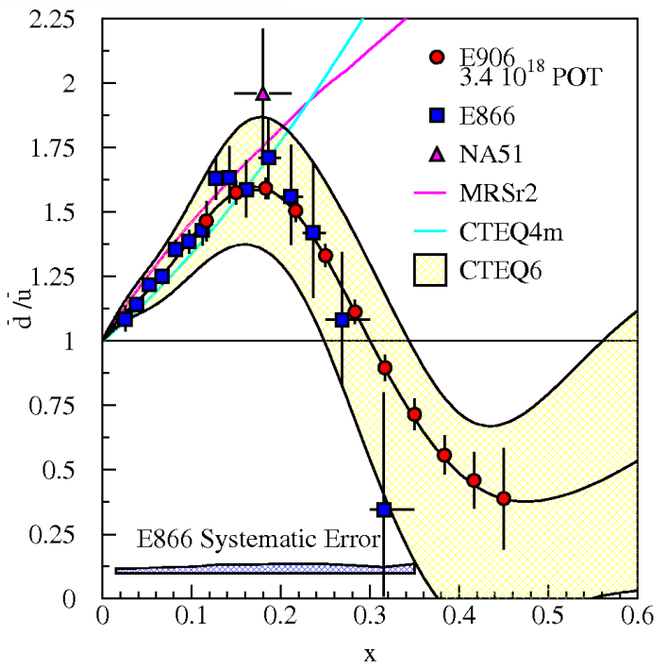

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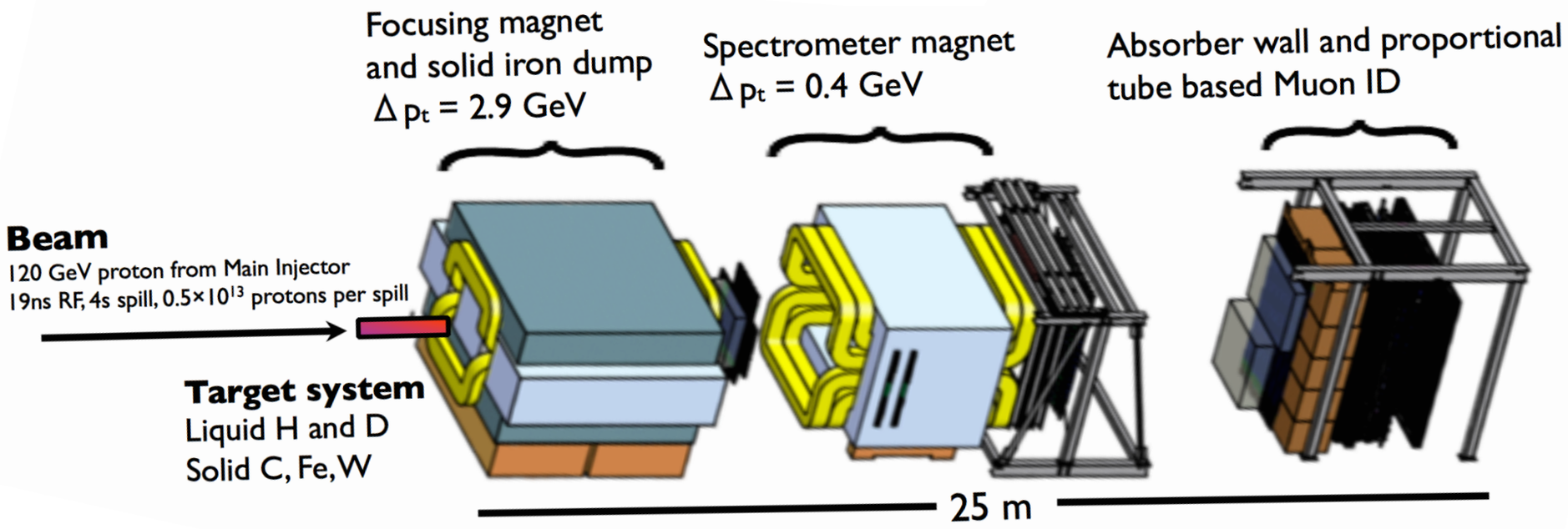

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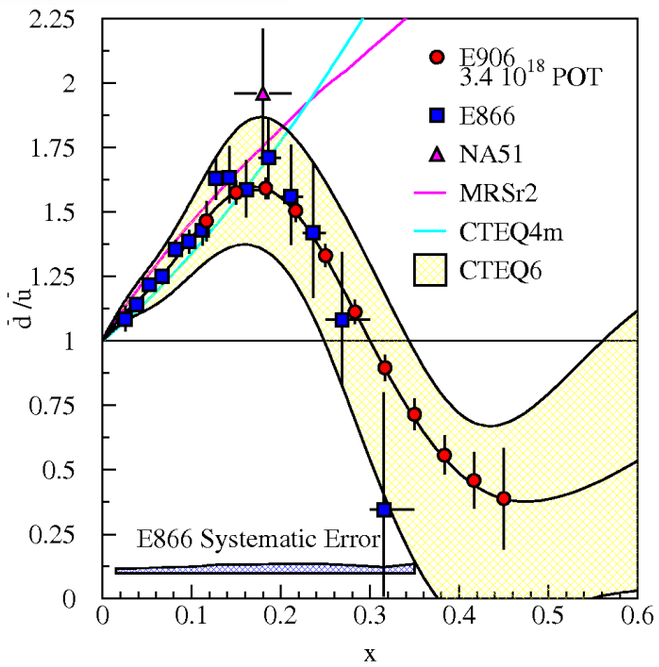

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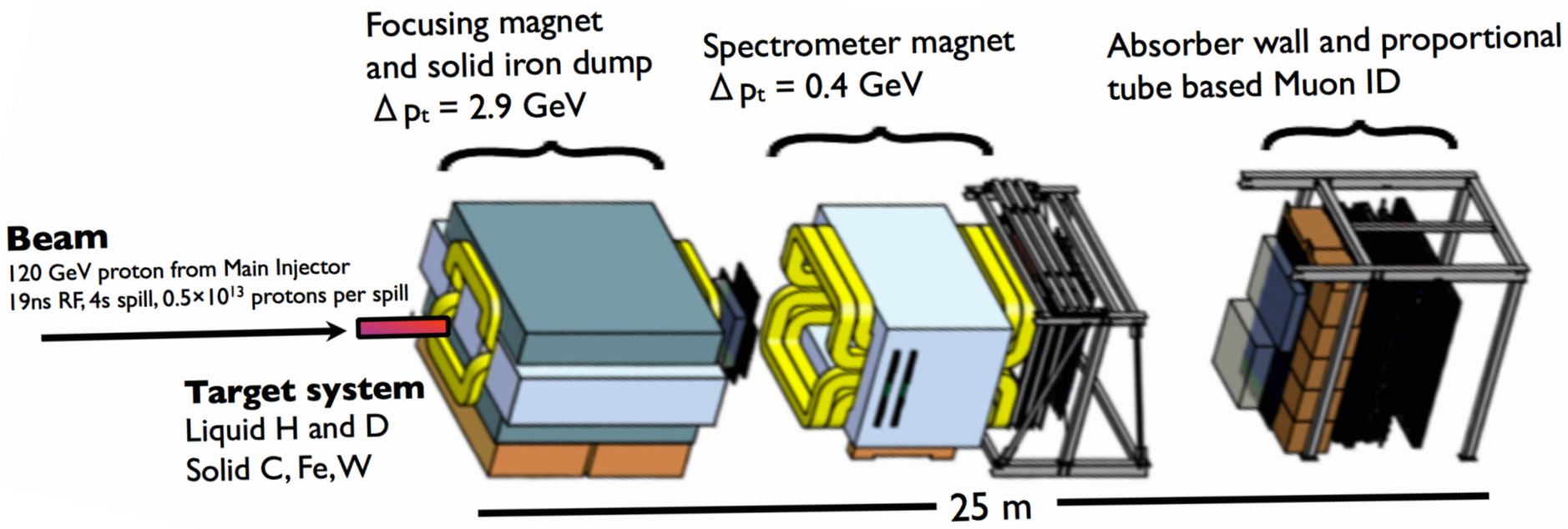
SeaQuest



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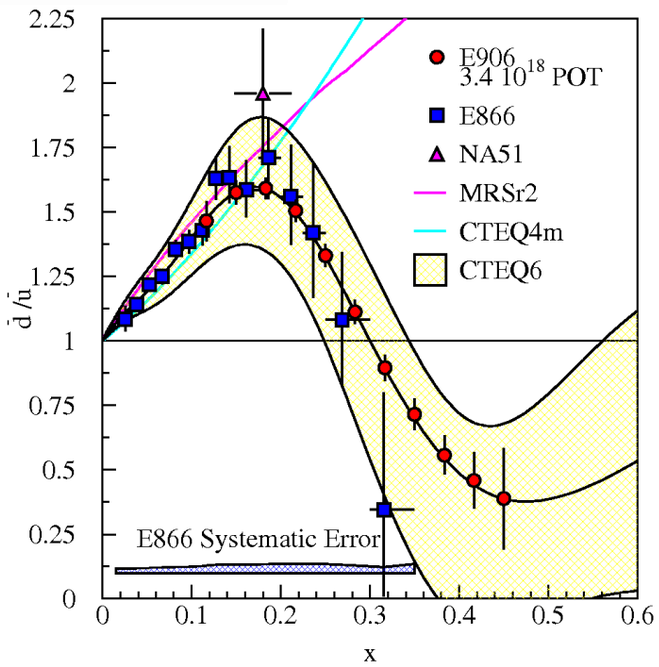
- ECAL upgrade possible within the year.



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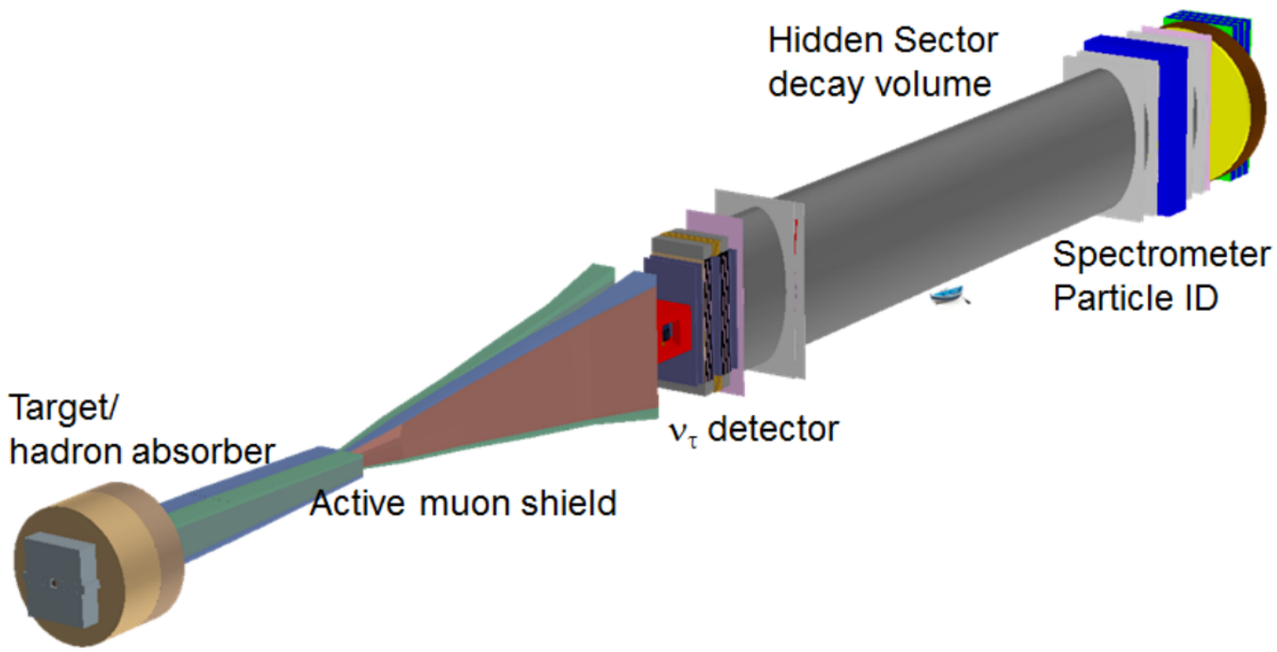
SHiP



	Location	Timeline	E_{beam} (GeV)	POT	Baseline (m)
SeaQuest	Fermilab	April, 2017	120	$1.44 \times 10^{18} \rightarrow 10^{20}$?	$5 - 25$
SHiP	CERN	2026 ?	400	2×10^{20}	$60 - 110$

The SIMP Miracle

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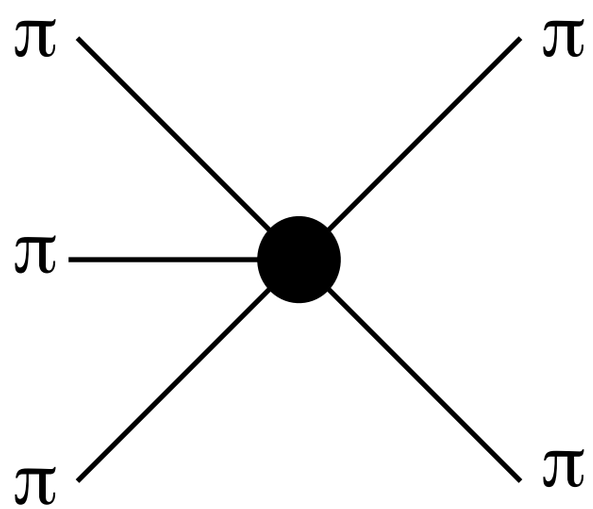

$$m_\pi \sim \alpha_\chi \ \left(T_{\rm eq}^2 m_{\rm pl}\right)^{1/3} \sim \alpha_\chi \times 1 \text{ GeV}$$

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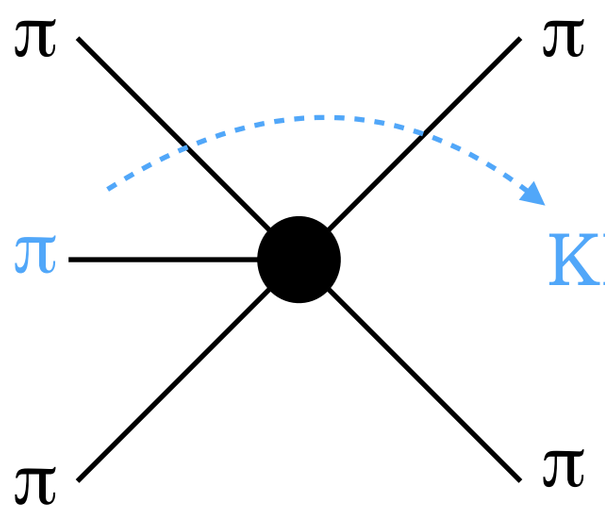

(Need to expel heat)

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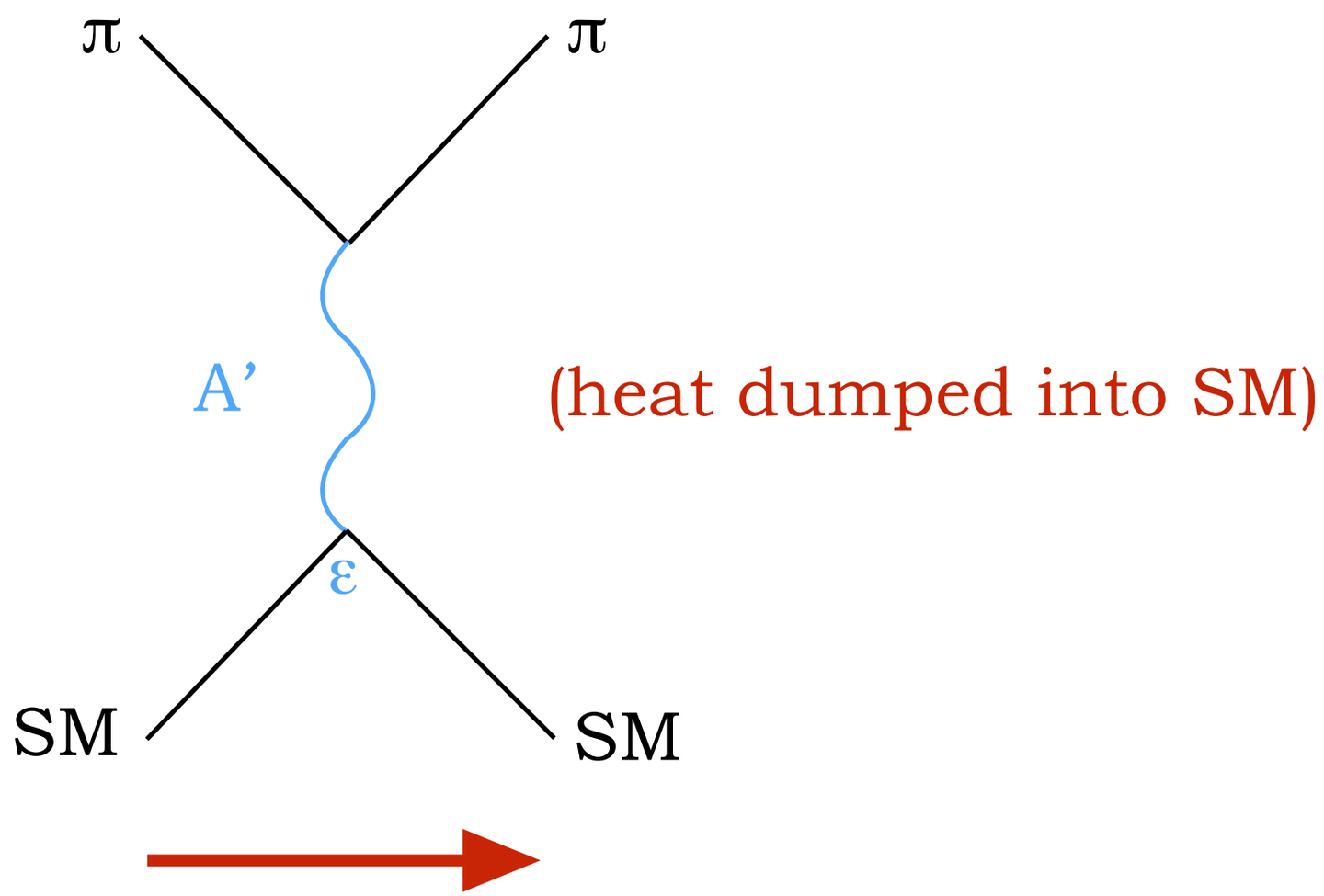
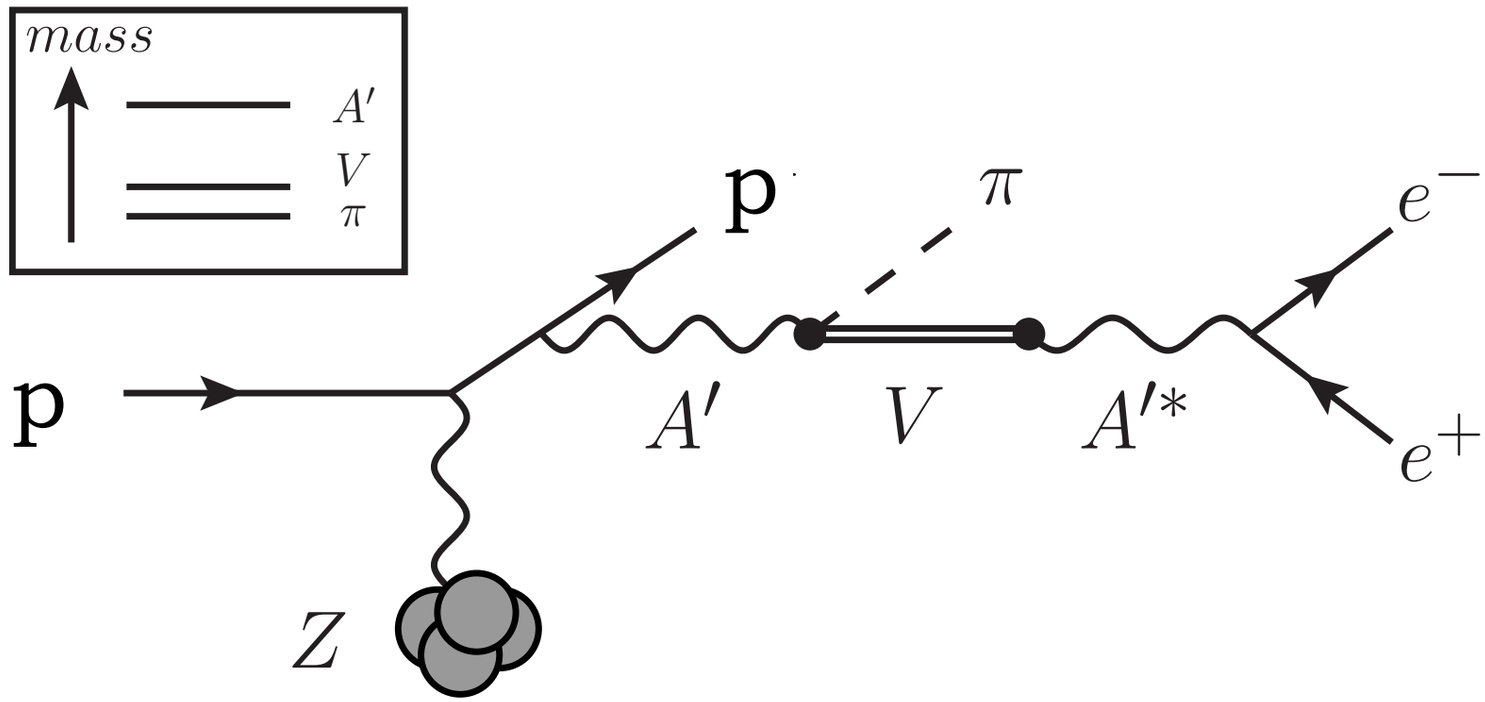
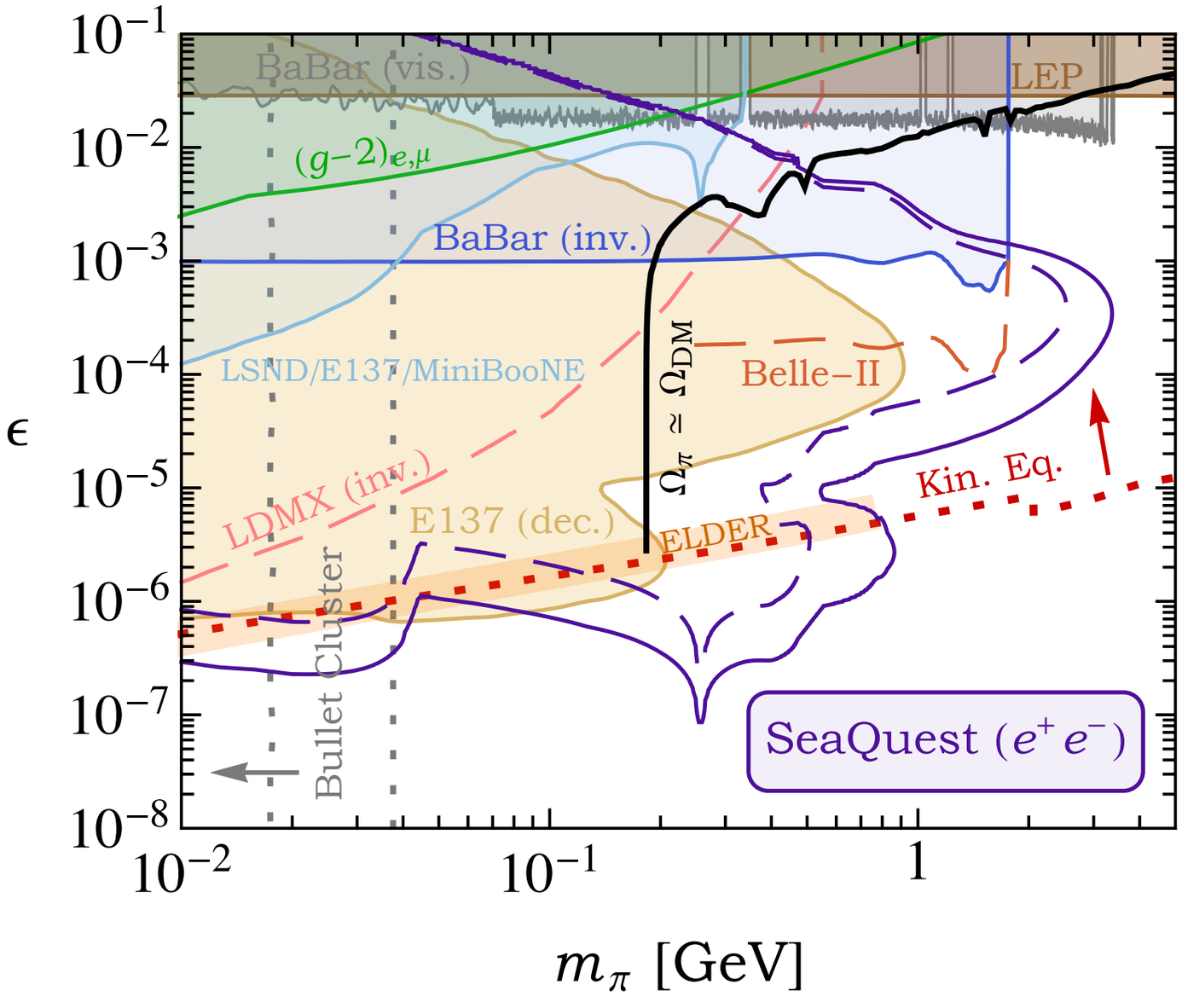


Signal Example



SeaQuest Reach



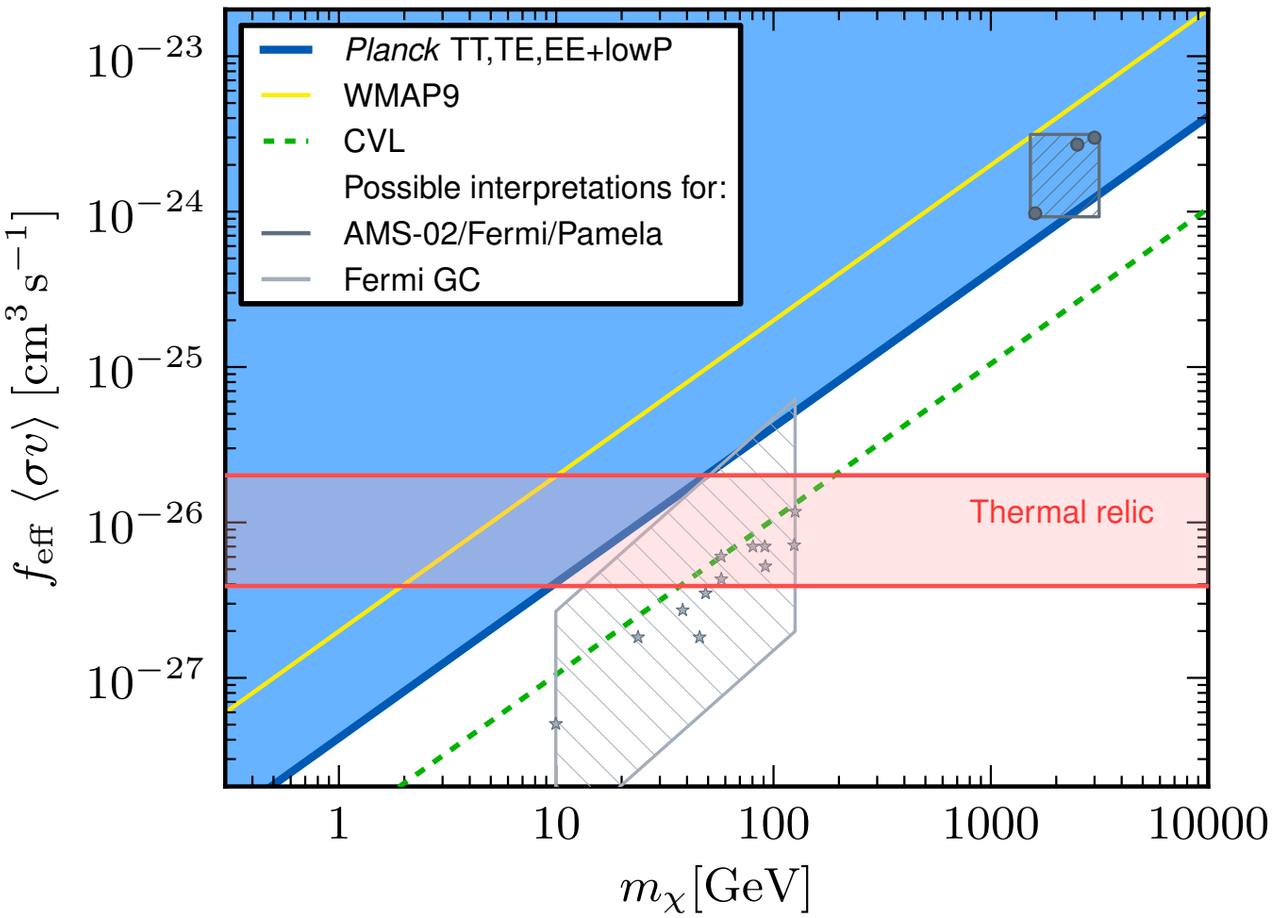
Hidden Valley

SHiP

SeaQuest

Back Up Slides

GeV-Scale Thermal Relics



DM < 10 GeV has suppressed annihilations at late times.

arXiv:1502.01589

GeV-Scale Thermal Relics

- CMB $\Rightarrow$ s-wave DM > 10 GeV.
- DM < 10 GeV has suppressed annihilations at late times.
- $v_{\rm CMB} \sim \sqrt{3\,x_f}\ \dfrac{T_{\rm CMB}}{m_{\rm DM}} \sim 10^{-8} \times \dfrac{1\ {\rm GeV}}{m_{\rm DM}}$
- $m_{A'} > m_{\rm DM}$
- Scalar DM $\Rightarrow$ p-wave, $\sigma v \propto v^2$
- pseudo-Dirac $\Rightarrow$ inelastic DM

Mass Spectrum

A’

Prevent

$\pi\ \pi \rightarrow$ A’ A’

$\pi\ \pi \rightarrow \pi$ A’

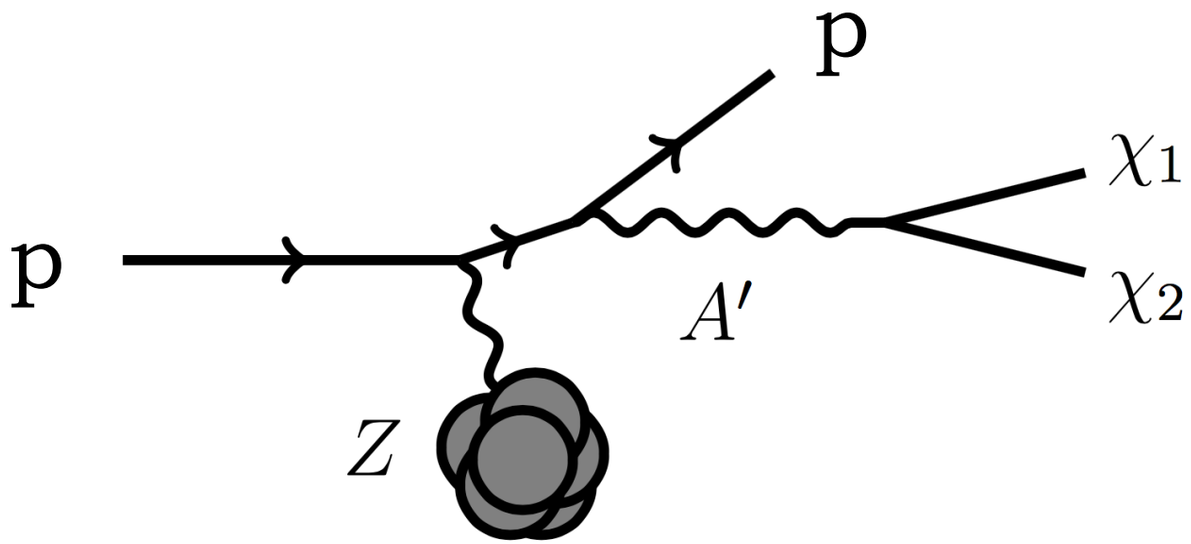
(CMB)

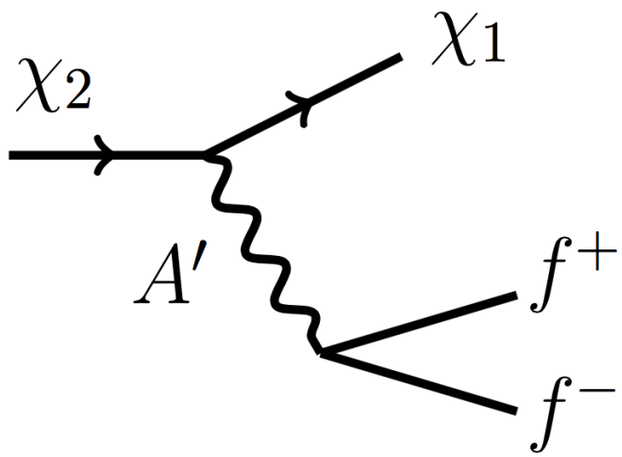
Vector Mesons, V

Pions, π

m_π / f_π > 1

Inelastic Dark Matter





SeaQuest Reach