Run Group M E4nu/SRC

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Experiments

Electrons for Neutrinos: Addressing Critical Neutrino-Nucleus Issue (E12-17-006)

- O. Hen (MIT), A. Ashkenazi (MIT), K. Mahn (MSU), E. Piasetzky (TAU),
- S. Stepanyan (JLab) and L.B. Weinstein (ODU)

Exclusive Studies of Short Range Correlations (SRCs) in Nuclei using CLAS12 (E12-17-006A)

- O. Hen (MIT), A. Schmidt (MIT), E. Piasetzky (TAU), H. Szumila-Vance,
- S. Stepanyan (JLab) and L.B. Weinstein (ODU)
- Approved by PAC 46 with an A rating
 - "First, a reasonably small number of days (~20) of running on targets relevant for the neutrino program, will have a strong impact. We recommend that these days be scheduled expeditiously."

SRC Experiment Goals

- Build on the tremendous success of the CLAS6 data mining SRC program (Science, Nature, PRL, Phys Lett B, and lots more to come)
 - SRC pairs are ~20% of all nucleons
 - 75% of KE
 - Predominantly pn pairs
 - Small center of mass momentum
 - Increasing the neutron fraction increases the probability that a proton is in an SRC pair
- Existing data set is tiny (dozens to 100s of (e,e'pN) events on each nucleus)
 - Take 10 to 40 times more data on a wider range of nuclei
- Topics to explore
 - Three nucleon SRCs?
 - Constraining the NN interaction at short distances
 - Understanding factorized effective theories
 - SRC formation mechanisms
 - SRCs and the EMC Effect

• ...



Duer et al, Nature 560 (2018) 617

e4v Experiment Goals

Neutrino oscillation measurements

- need to reconstruct the incident neutrino energy from the scattered particles
- need accurate event generators that include all relevant physics (QE, SRC, MEC, IC, FSI, resonances, DIS, etc)

Electrons (vector current) and neutrinos (vector plus axial currents) interact similarly

⇒use electron scattering to test energy reconstruction techniques and vector current reaction mechanisms

Energy Reconstruction Example2.26 GeV beamZero pion events





Peaks in same location

Status and plans

- July 2018: Approved by PAC46 for 45 days
- October 2018: ERR
 - Run plan
 - targets

E	d	⁴He	С	0	²⁸ Si	⁴⁰ Ar	⁴⁰ Ca	⁴⁸ Ca	Sn	Pb	Total
1.1	Х	Х	0.5	0.5	Х	0.5	Х	Х	Х	Х	1.5
2.2	Х	Х	1	Х	Х	1	Х	Х	Х	Х	2
4.4	2	1	1	Х	Х	1	Х	Х	1	1	7
6.6	5	3	2	Х	2	2	3	3	4	5	29
Total days	7	4	4.5	0.5	2	4.5	3	3	5	5	<u>39.5</u>

Plus overhead and H normalizations

Configuration and Targets

- Forward Tagger off (shielded)
- large Moller cone
- vacuum pipe downstream of target to reduce backgrounds
- BAND (Backward Angle Neutron Detector)

Targets:

- Dedicated C plus encapsulated H2O dual target
- Dedicated 40Ca plus 48Ca dual target (Hall C target material)
- Saclay liquid target system for H, D, 4He, Ar
 - Standard 5-cm target cell for H, D, He
 - 0.5-cm cell for Ar
- USM solid target moving system for C, Si, Sn and Pb targets
 - Or dedicated C, Sn and Pb triple target

Solid target assemblies

- Space targets 5 cm apart for vertex resolution
 - Existing design
 - Solid targets are glued to a kapton disk, which is glued to a foam cylinder, and held inside a kapton cylinder filled with helium.
 - H2O and C targets assembly
 - Reduces 1.1 GeV target changes
 - H2O target is self-normalizing
 - C/Sn/Pb target assembly if USM target system not ready
- 40 and 48Ca targets in sealed capsule to avoid oxidation
 - 15-cm long capsule with entrance and exit windows
 - Needs to be designed (Hall B plus target group)



USM target



USM Target

>University Santa Maria, Valparaiso, Chile

Hayk Hakobyan, Inaki Vega and Milan Ungerer

- Compatible with Saclay target
- Solid targets on a moveable tape controlled by a piezoelectric motor
- <u>https://vimeo.com/118170785</u>

USM Target prototype



Need to test in vacuum, low temperature and high magnetic field

						time	
		Target	Target Change	Beam	Beam Change	hours	days
$H_{2}O$ and C		C and H2O capsule		1.1		48	2.00
			C/O->USM			52	2.17
		Н		1.1		8	0.33
			H->Ar			8	0.33
		Ar		1.1		24	1.00
					1.1->2.2	16	0.67
		Ar		2.2		48	2.00
			Ar->H			8	0.33
		Н		2.2		8	0.33
			H->Ar		2.2->4.4	8	0.33
		Ar		4.4		48	2.00
Ar/H and					4.4->6.6	4	0.17
		Ar		6.6		96	4.00
solia			Ar->solid			2	0.08
targets		C		6.6		96	4.00
largets		Si		6.6		96	4.00
		Sn		6.6		192	8.00
		Pb		6.6		240	10.00
					6.6->4.4	4	0.17
		C		4.4		48	2.00
		Sn		4.4		48	2.00
		Pb		4.4		48	2.00
					4.4->2.2	4	0.17
		C		2.2		48	2.00
Ca capsule	\neg		USM->Ca		2.2->6.6	24	1.00
		Ca		6.6		288	12.00
			Ca->Saclay			52	2.17
		4He		6.6		144	6.00
					6.6->4.4	4	0.17
Long cell		4He		4.4		48	2.00
			4He->d			8	0.33
CryO	$ \rightarrow $	d		4.4		96	4.00
targets]				4.4->6.6	4	0.17
		ď		6.6		240	10.00
			d->H			8	0.33
		H		6.6		48	2.00
					6.6->4.4	4	0.17
		Н		4.4		48	2.00

Preliminary run plan

RGM status

- Responding to ERR recommendations
- Liquid target cells and solid target assemblies complete in 2019
 - Work done by Hall B engineering staff
- Expect USM target system complete in Fall 2019
 - Work done by USM

Ready to run next year!