# T32 @ J-PARC results (arXiv:1105.5818 [physics.ins-det] )

J-PARC T32 collaboration:

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### R&D steps toward 100kt LAr detector



LAGUNA-LBNO at LBNE Collaboration meeting

# Purpose of 250L

- Test-beam with well-defined charged particles
  - To benchmark performance of detector using J-PARC K1.1BR beamline.
  - To develop realistic simulation/reconstruction software
  - As the first step, the  $K+/\pi+PID$  response was checked with proton decay momentum region  $\sim$  350MeV/c.
- Test of double phase detector with the size of ~0.4m x 0.8m readout. (-> not this time. Next test-beam)
  - to optimize the detector for neutrino/proton decay physics. (gain of LEM, ~10, is enough. i.e. easier than dark matter search.)

#### Minutes of 9<sup>th</sup> J-PARC PAC

http://j-parc.jp/NuclPart/PACmeeting\_1001\_e.html

J-PARC PAC endorses the LAr R&D prog.(P32) and recommend to have test-beam w/ 250L (T32)

#### PROPOSAL EVALUATIONS

- P32: (Towards a Long Baseline Neutrino and Nucleon Decay Experiment with a next-generation 100 kton Liquid Argon TPC detector at Okinoshima and an intensity upgraded J-PARC Neutrino beam)
  - The proponents propose to develop a suitable scalable Liquid Argon TPC detector with gas amplification in Argon vapor as an R&D for a next-generation long baseline neutrino experiment.
  - The PAC acknowledges the high scientific merit of a neutrino oscillation experiment with a baseline longer than T2K. The measurements of the mixing angle  $\theta_{13}$  and a possible CP violation in the lepton sector are of highest significance.
  - Before large detectors can be considered, it has to be shown that such a technique is adequate for the purpose and superior to alternative schemes. In particular, the readout scheme and the scalability are open questions. Based on a small-scale R&D, a roadmap has to be put forward.
  - The specific P32 proposal is to set up and test a 250 Liter LAr prototype TPC in a low-energy charged particle beam at J-PARC, preferentially with kaons from the K1.1BR beamline. The PAC encourages the team to proceed with this development work and recommends the allocation of beam time of a low intensity charged particle beam at J-PARC for this test.

#### Hadron Hall







#### Fitch Cherenkov



- no degrader run with 800 MeV/c
- Clear discrimination power between K and others due to 3.5m distance and 200ps resolution of TOFs
- Optimized to 800 MeV/c
- Clear discrimination power between K and others using 2 dimensional info.
- We use both information.
- External PID power from beam equipments is excellent (e.g. ~100% pure K ) before the degrader(s).



# Physics motivation and LAr detector configuration

### dE/dx (MC) and accumulated data

 Right: dE/dx in each pitch (K, π) as a function of the distance from the particle stopped point.



Distance from End Point (cm)

- Largest K and π samples ever accumulated for Liquid
  Argon TPC to verify the PID.
  - 7000 800MeV/c K+ events w/ 2 LGs
  - 35000 800MeV/c K+ events w/ one LG
  - 40000 800MeV/c K+ w/ 1 LG and 1LB
  - 70000 200MeV/c  $\pi$  + events w/o degraders
  - 2500 800MeV/c e+ events
  - 1500 800MeV/c proton events

### Drawings of 250L cryostat



#### Setup of Oct-2010 test-beam



#### purification system



- Evacuation
  - Turbo + getter pump (~350L/sec)
  - Achieved vacuum level is ~1x10<sup>-3</sup> Pa
- Purification for initial filling
  - Purify LAr (from tanks) directly
  - Filters made by ourselves are used (CuO+MS)
- Keep or improve of the purity after filling
  - Gas-to-gas recirculation system using a gas pump (max. ~80L/min)
  - Commercial Filter (SAES Microtorr (MC3000-903-V);
    <0.1ppb for O<sub>2</sub>, H<sub>2</sub>O but cannot remove N<sub>2</sub>)



Purity is one of most crucial items for LAr TPC system. (1ppb provides 1/e attenuation for 300µs drift electrons)

#### Long term Purity test at KEK (~20 days)





View from cathode side (see 1cm strip anode at far side)



EP1

#### **Events**



# Slow monitor and control

Excellent stability during the test beam !! (~1 week)





#### Purity meas. w/ Cosmic ray (1)



# **Purity Estimation from Cosmic Rays**

#### Single dataset example

- Dataset 87 hours after LAr filling
- Use ~100 high quality tracks and accumulate information.
- Correct charge according to cosmic ray injection angle
- Q vs. T for data with ≥20 channel (each T bin fitted by Landau)
- Lifetime by fitting MPV by expo.

#### **Purity time variation**

- At the beginning :  $\tau \approx 670 \mu s$  (~0.45 ppb)
- At the end :  $\tau \approx 385 \mu s$  (~0.78 ppb)
- Degrading with 2ppt/hour.

We observed degradation of purity but during short time of test it was not worth fixing, we concentrated on data collection



### Simulation

### Beam Line Geometry for simulation

~5.3m		detector	material	thickness [mm]
	Degrader	Fitch Cherenkov	Acryl	40
BDC		BDC	Plastic	5
K Beam		TOF	Plastic	20,25
	7	Degrader	Lead glass	125
TOF1	TOF2		Lead	25
		LArBDC	Plastic	5
Fitch Cherenkov(FC)	250LAr	Hatch	SUS304*	50
		250L Ar	Lq.Ar	836.4

The 250LAr detector and beam equipments in K1.1BR -> geometry is implemented to QSCAN (see Devis Lussi's talk) \*Beam window (210 × 210mm<sup>2</sup>) is constructed by honeycomb structure.

...Radiation length is short. (~ 0.16X<sub>0</sub>)<sup>19</sup>

### **Example of simulations**



#### Implementing common simulation code to obtain results

# For next test-beam (double phase test) -> see Filippo Resnati's talk

- Tests using 3I test-stand has been succeeded
- All components for 40cm x 80cm double phase readout has been constructed at CERN. (see figure). Will be tested using ArDM cryo-systems.





# Summary / plan

- J-PARC T32 collaboration had test-beam using well defined charged particles in Oct-2011.
  - To establish the PID performance of charged particles around momentum of proton decay region.
  - Largest K and π samples ever accumulated for Liquid Argon TPC, and they are under analyzing inside the collaboration. (see Devis Lussi's talk as well)
- Next test-beam with double phase 2-D readout is being planned (see Filippo Resnati's talk)

### Backups