

Studying Neutrino Directionality with Double Chooz

Erica Caden

Drexel University

Double Chooz Collaboration

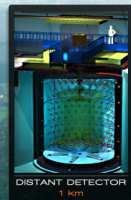
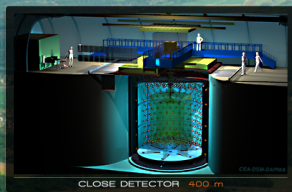
							
Brazil	France	Germany	Japan	Russia	Spain	UK	USA
CBPF UNICAMP UFABC	APC CEA/DSM/IRFU: SPP SPHN SEDI SIS SENAC CNRS/IN2P3: Subatech IPHC ULB	EKTU Tübingen MPIK Heidelberg TU München U. Aachen U. Hamburg	Tohoku U. Tokyo Inst. Tech. Tokyo Metro. U. Niigata U. Kobe U. Tohoku Gakuin U. Hiroshima InstTech.	INR RAS IPC RAS RRC Kurchatov	CIEMAT-Madrid	Sussex	U. Alabama ANA U. Chicago Columbia U. UCDavis Drexel U. IIT KSU LLNL MIT U. Notre Dame Sandia National Laboratories U. Tennessee

Spokesperson: H. de Kerret (CNRS/IN2P3-APC)
Project Manager: Ch. Veyssi re (CEA-Saclay)

Web Site: www.doublechooz.in2p3.fr/



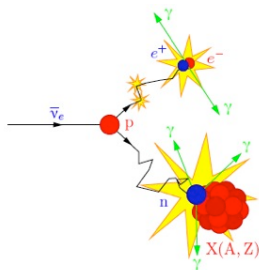
The Double Chooz Experiment



CEA/DSM/IRFU - DC&M/L COLOMBEL

Detecting Neutrinos with Double Chooz

- Reactor neutrinos are detected through Inverse Beta Decay, in which the positron gets the kinetic energy and the neutron gets the momentum of the incoming neutrino.
- At reactor energies, neutron thermalization is a non isotropic process in which the neutron's initial direction is preserved.
- With each scatter, the average cosine with respect to the incoming direction is:
$$\langle \cos \theta_n \rangle = \frac{2}{3A}$$
- Our two part coincidence signal lets us study neutrino directionality.



Principle of Neutrino Direction Reconstruction

- We define \vec{p} as the average of the positron-neutron vector

$$\vec{X}_{e-n}^i = \vec{X}_n^i - \vec{X}_e^i$$

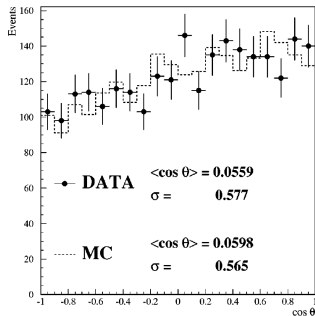
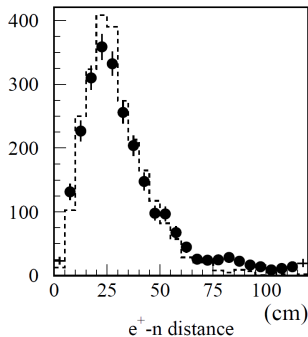
where \vec{X}_n^i and \vec{X}_e^i are the reconstructed vertices of the n and e^+ of event i .

$$\vec{p} = \frac{1}{N} \sum_{i=1}^N \vec{X}_{e-n}^i$$

- $\text{Cos}(\theta)$ between \vec{p} and a vector that points from the reactor to the detector, \vec{X}_{RD} , should tend more towards +1 than -1.

Directionality in CHOOZ

CHOOZ was the first non-segmented scintillator detector to measure reactor neutrino directionality. With ~ 2500 events, they located the reactors within an 18° cone.



	$ \vec{p} $	ϕ	θ	Uncertainty
Data	0.055	-70°	103°	18°
MC	0.052	-56°	100°	19°

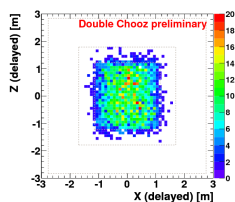
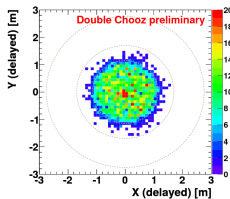
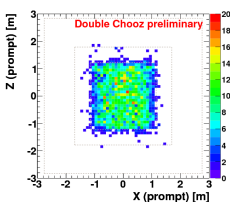
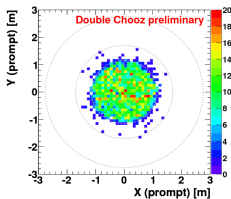
{PRD.61.012001}

Neutrino Candidates

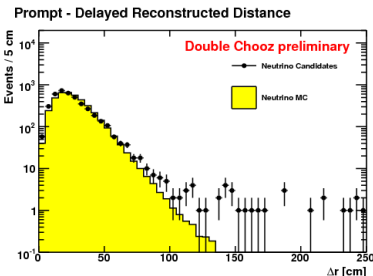
- Double Chooz has a different detector design than CHOOZ, and therefore different neutrino selection cuts.
- Position reconstruction isn't used in the DC analysis, just as a cross check that our events are where we expect them to be.

Prompt:

Delayed:



Double Chooz Preliminary Results



- Directionality analysis will employ cuts on positron & neutron position and the separation between the two events that are not needed for a θ_{13} analysis.
- The systematic effects of these cuts are currently being studied and their uncertainties will be analyzed and propagated into the final fit.
- Preliminary results will be forthcoming!

Thank You!

