Studying Neutrino Directionality with Double Chooz

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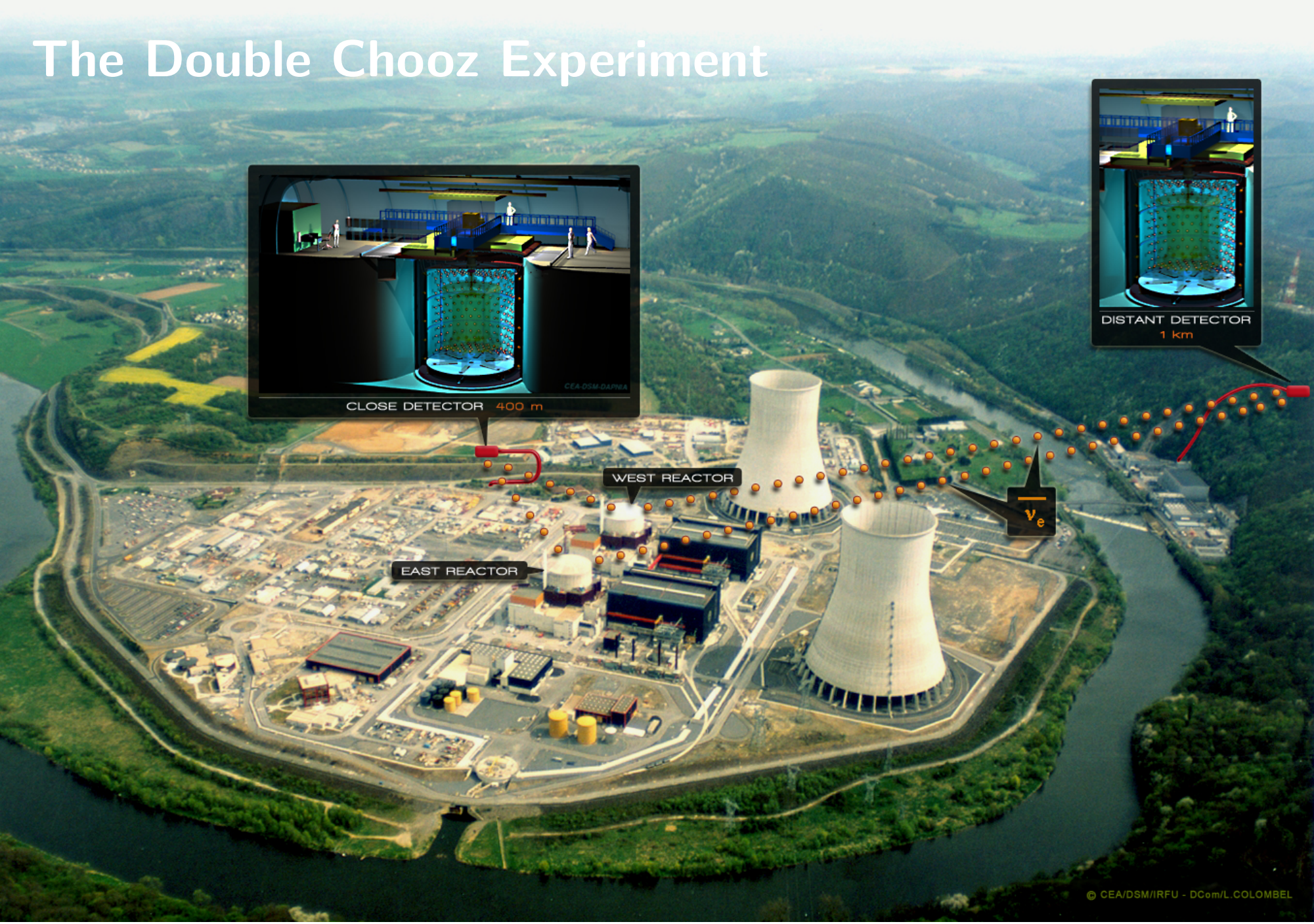
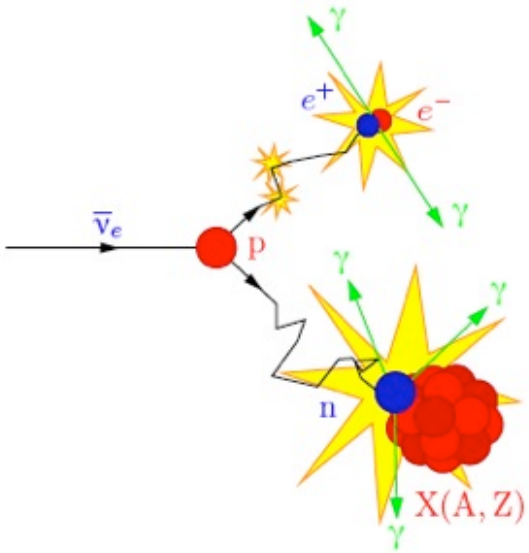
The Double Chooz Experiment



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

$$\vec{X}^i_{e-n} = \vec{X}^i_n - \vec{X}^i_e$$

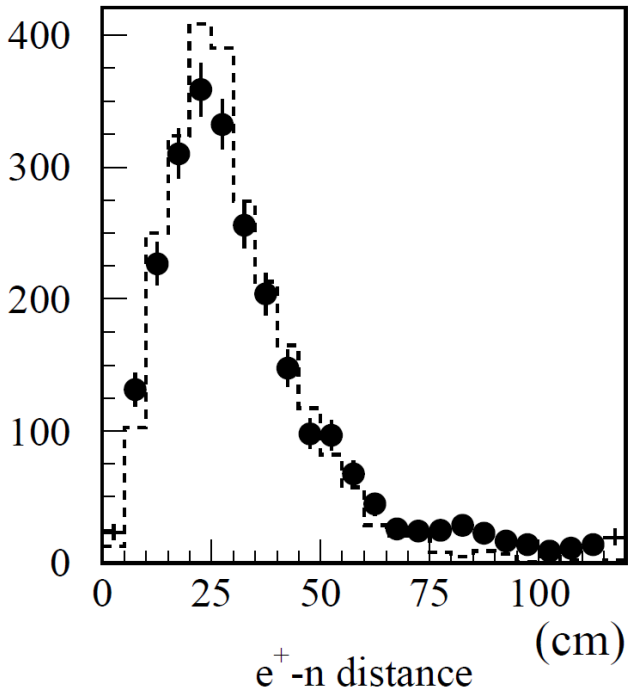
where $\vec{X}^i_n$ and $\vec{X}^i_e$ are the reconstructed vertices of the n and e^+ of event i.

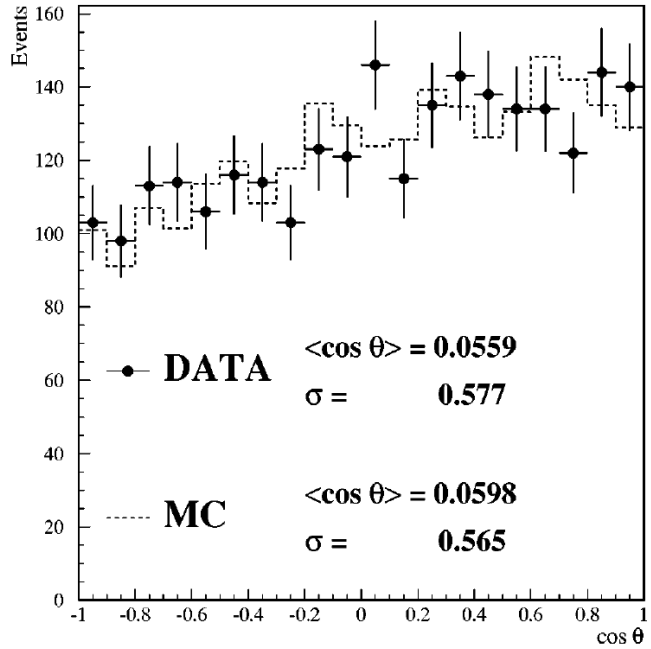
$$\vec{p} = \frac{1}{N}\sum_{i=1}^{N} \vec{X}^i_{e-n}$$

- Cos(θ) 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 $\sim$ 2500 events, they located the reactors within an 18° cone.





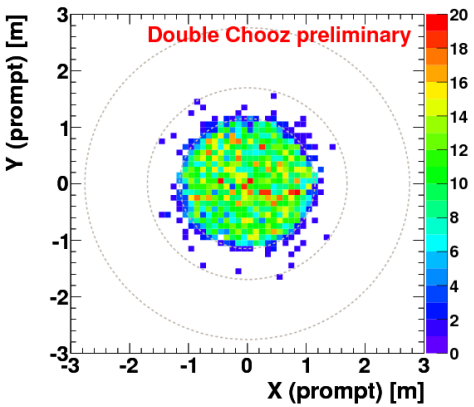
	$\lvert\vec{p}\rvert$	ϕ	θ	Uncertainty
Data	0.055	-70°	103°	18°
MC	0.052	-56°	100°	19°

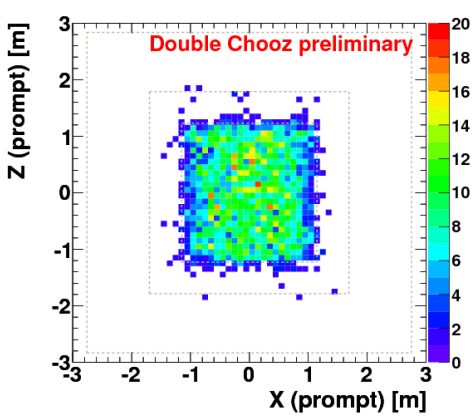
{PRD.61.012001}

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:





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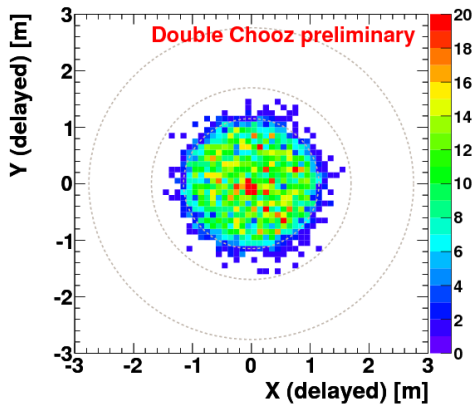
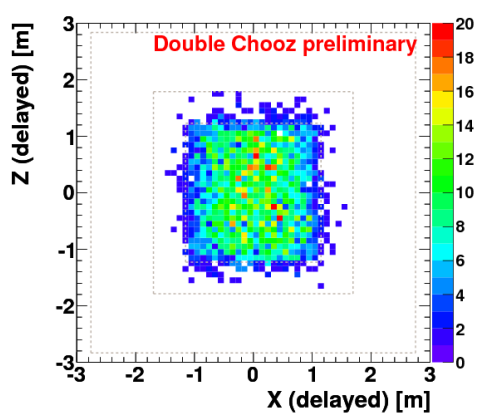
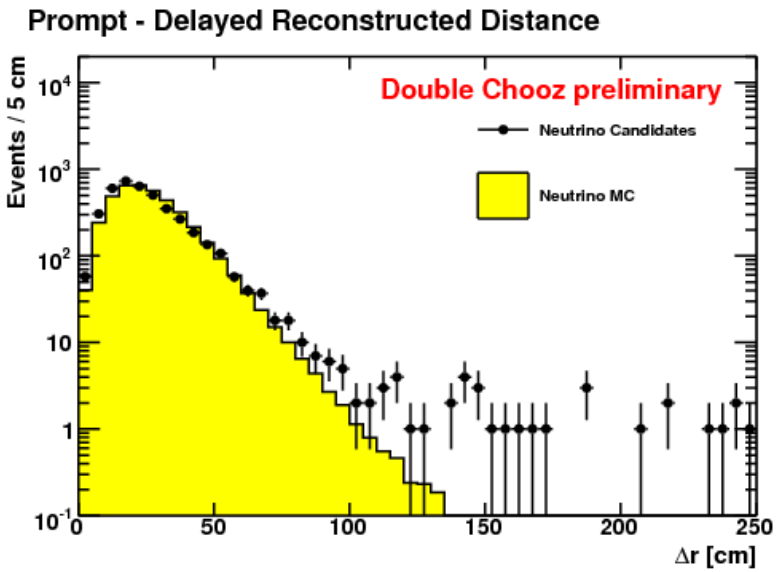




Double Chooz Preliminary Results



- 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 propogated into the final fit.
- Preliminary results will be forthcoming!

Thank You!