

$$U = R_{23}(\theta_{23}) R_{13}(\theta_{13}) R_{12}(\theta_{12})$$

$P_{\mu\mu}$

$\theta_{23} \approx \theta_{atm}$

$$\theta_{23} \approx \theta_{atm} + \theta(\theta_{13})$$

$P_{ee}$

$$\approx 0$$

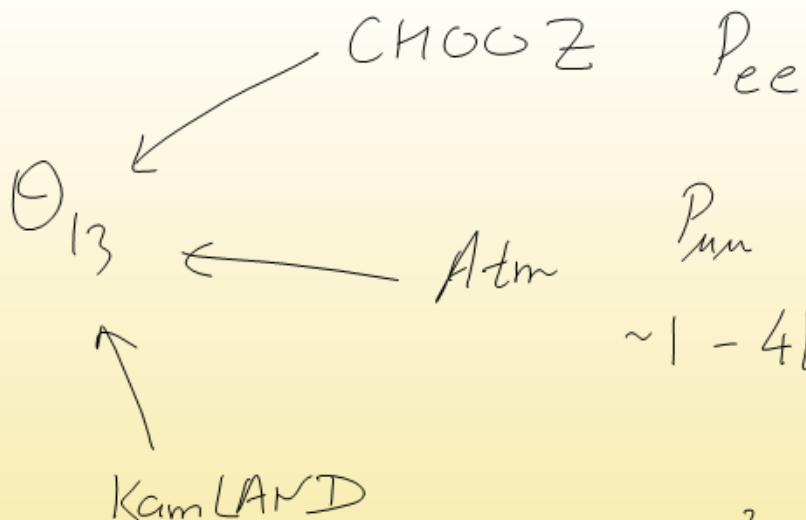
reactor

$$\theta_{reactor}$$

$P_{ee} \sim \sin^2 \theta_{12}$

$$\begin{matrix} \nu_e & \nu_e \\ \nu_\mu & \rightarrow \nu_x \\ \nu_\tau & \nu_y \end{matrix} \quad \theta_{12} \approx \theta_{10}$$

$$\begin{pmatrix} \nu_x \\ \nu_y \end{pmatrix} = \begin{pmatrix} c_{12} & s_{12} \\ -s_{12} & c_{12} \end{pmatrix} \begin{pmatrix} \nu_1 \\ \nu_2 \end{pmatrix}$$



$$\sim 1 - 4|U_{e3}|^2 (|U_{\mu3}|^2) \sin^2 \Delta_{32}$$

$$P_{ee} \sim 1 - \sin^2 2\theta_{12} \sin^2 \Delta_{21} + \dots (\text{small}) \rightarrow \theta_{13}$$

$$\sim 1 - 4C_{13}^2 S_{23}^2 (1 - C_{13}^2 S_{23}^2) \sin^2 \Delta_{32}$$

$\sin^2 \theta_{13} < 0.05$

row phases

$$\begin{pmatrix} e^{ix_1} \\ e^{ix_2} \\ e^{ix_3} \end{pmatrix} \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}$$

$$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix} \begin{pmatrix} e^{i\phi_1} \\ e^{i\phi_2} \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} e^{ix_1} a & e^{ix_1} b & e^{ix_1} c \\ e^{ix_2} d & e^{ix_2} e & e^{ix_2} f \end{pmatrix}$$

$$\begin{pmatrix} a e^{i\phi_1} & b e^{i\phi_2} & c \\ d e^{i\phi_1} & e e^{i\phi_2} & f \end{pmatrix}$$

column phases

$$\nu_\alpha \longrightarrow e^{i\lambda} \nu_\alpha$$

□  
↓  
rephase  
invariant

$$\nu_\alpha = U_{\alpha i} \nu_i$$

$$U_{\alpha i} \longrightarrow e^{+i\lambda} U_{\alpha i}$$

$$U_{\alpha j}^* \longrightarrow e^{-i\lambda} U_{\alpha j}^*$$

$$U_{\alpha i} U_{\alpha j}^* \longrightarrow U_{\alpha i} U_{\alpha j}^*$$

$N_{\frac{1}{2}}$  Plaquette

$$\begin{matrix} \nu_L \\ \nu_A \\ \nu_Z \end{matrix} = \begin{pmatrix} \bigcirc & \square \\ \square & \bigcirc \end{pmatrix} \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

$$D_{\alpha\beta ij} = U_{di} U_{\beta j} U_{\alpha j}^* U_{\beta i}^*$$

