

# Energy and Vertex Reconstruction in JUNO

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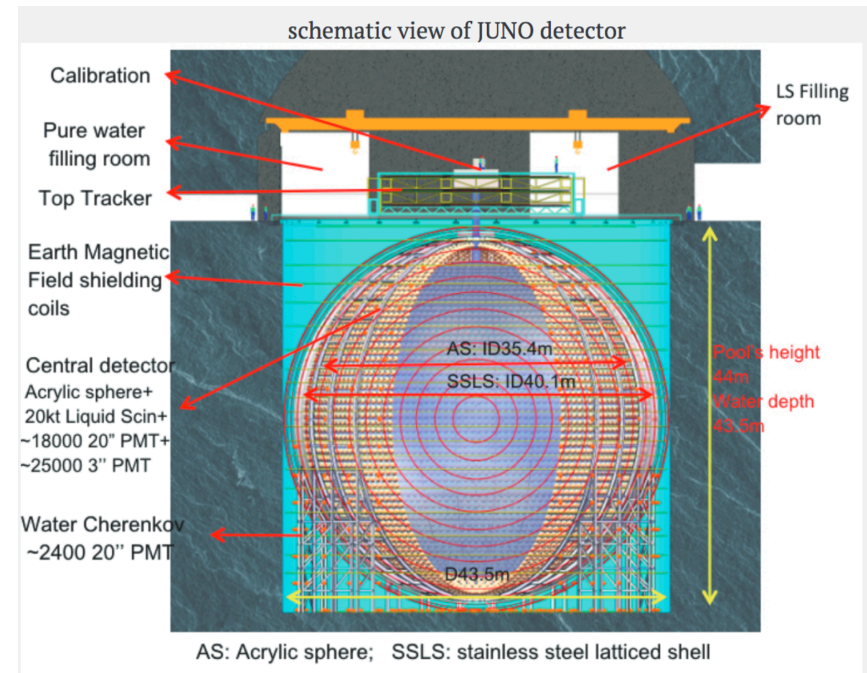
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# The JUNO experiment

- A multi-purpose observatory
  - Determine the neutrino mass ordering
  - Precisely measure  $\sin^2 2\theta_{12}$ ,  $\Delta m_{21}^2$ ,  $\Delta m_{31}^2$
  - Study the solar neutrinos, supernova neutrinos, diffuse supernova neutrino background, etc.
- $3\%/\sqrt{E}$  unprecedented energy resolution
  - Total light level  $\sim 1200$  pe / MeV
  - Attenuation length  $> 20$  m @ 430 nm
  - Photocathode coverage  $\sim 75\%$
  - PMT detection efficiency  $> 27\%$

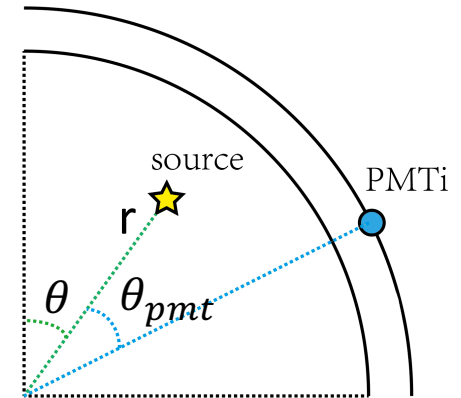


# Charge and time combining maximum likelihood estimation

- The expected light level of PMTs  
 $E * \mu_{i,0}(r, \theta, \theta_{pmt})$  (**3-D nPE map**)
- The pdfs of  $t_r = t_h - t_f - t_d - t_0$   
measured by PMTs  $P_T(t_r|k, d)$
- The likelihood function

$$\mathcal{L}(q_1, q_2, \dots, q_N, t_{1,r}, t_{2,r}, \dots, t_{N,r}, k'_1, k'_2, \dots, k'_N | \vec{r}, E, t_0)$$

$$= \prod_{unhit} e^{-\mu_j} \prod_{hit} \left[ \left( \sum_{k=1}^{+\infty} \frac{e^{-\mu_i} \mu_i^k}{k!} P_Q(q_i|k) \right) P_T(t_{i,r} | d_i, k'_i, t_0) \right].$$



# Performance, conclusion and outlook

- Most of the effects of the charge smearing, dark noise and vertex resolution on the energy resolution have been handled by QTMLE
- The impact of the dark noise, charge smearing and vertex resolution on the energy resolution need further studies.

