



FitToT 4ns

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Bouke Jung (bjung@nikhef.nl)

KM3NeT collaboration meeting



PMT calibration

Efficiency-related

- Relative PMT efficiency
= (Absolute QE) * (Collection eff.) * ...
- Gain
- Gainspread

Time-related

- PMT Time offset
- Transit time spread (TTS)



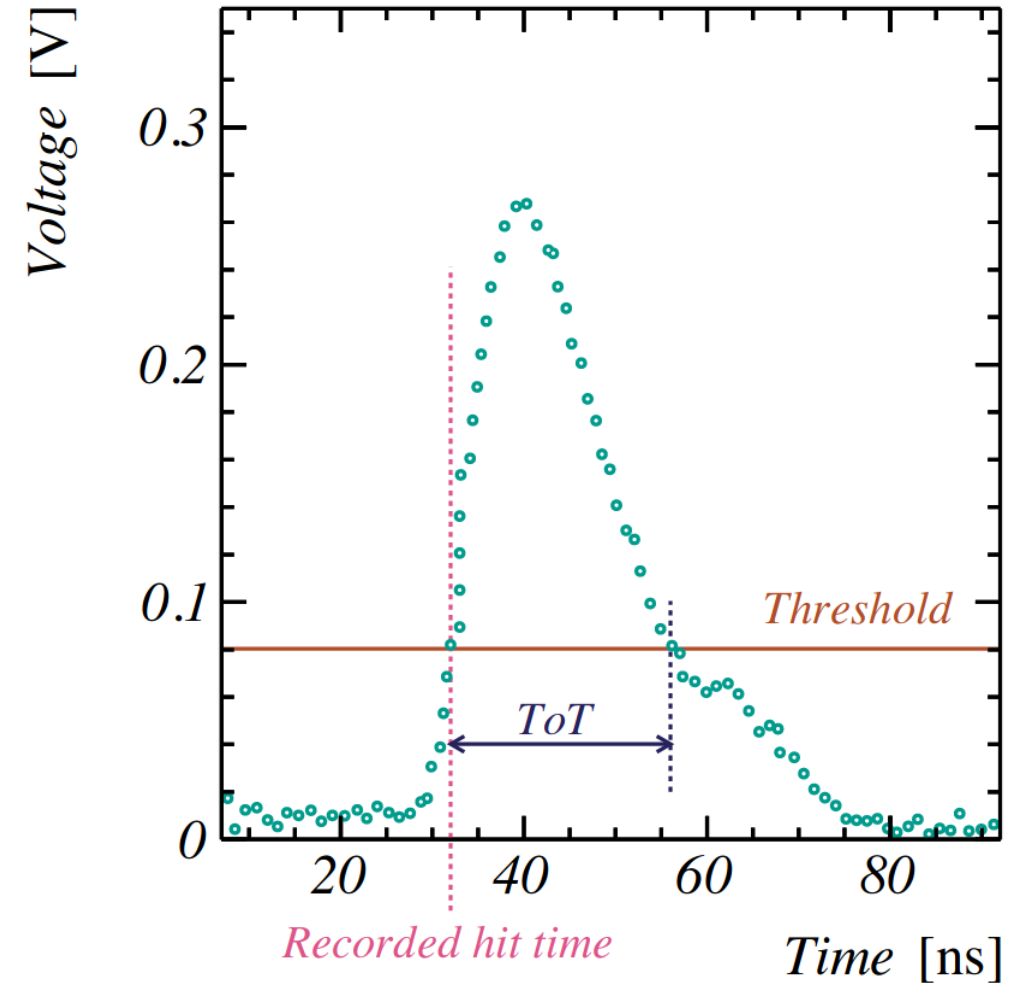
PMT calibration

Efficiency-related

- Relative PMT efficiency
= (Absolute QE) * (Collection eff.) * ...

- Gain
- Gainspread

Via time-over-threshold (ToT)



Gain-calibration

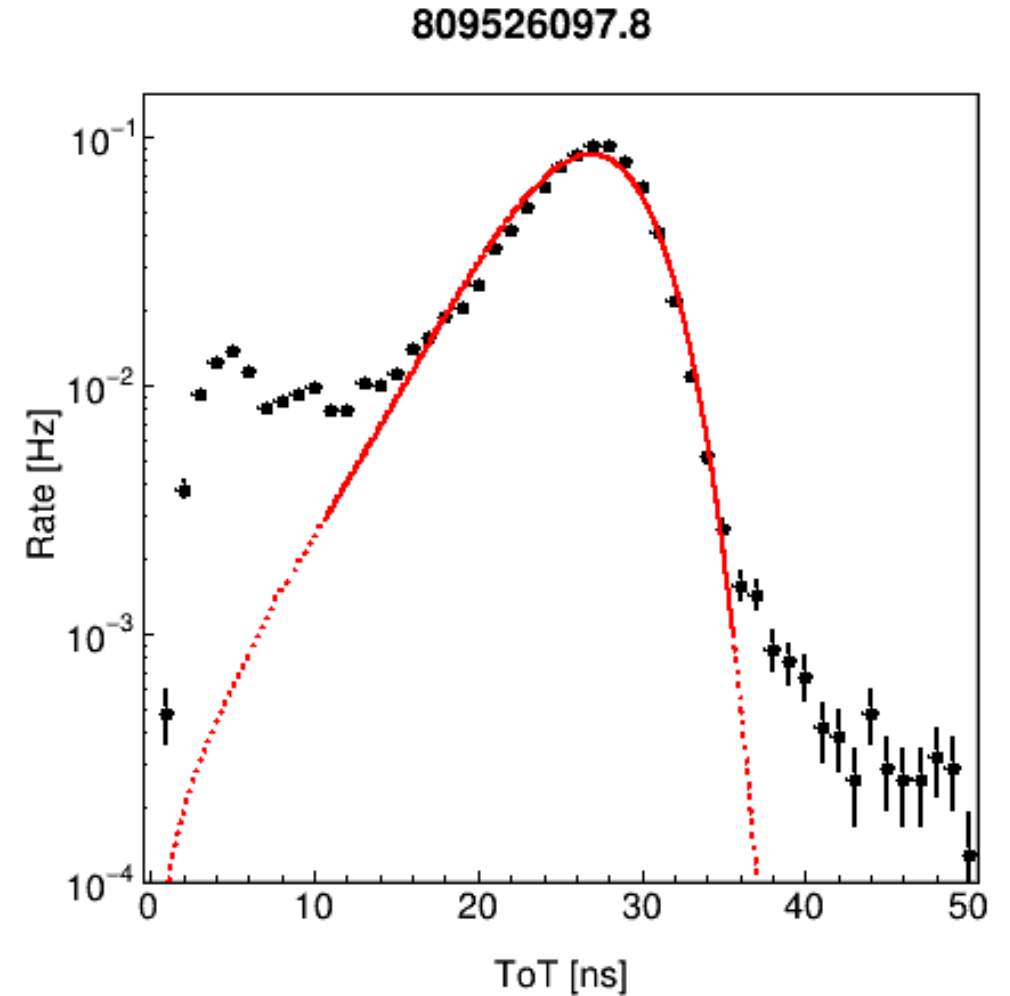
- **Analysis chain**

- JCalibrateToT
- (JMergeCalibrateToT)
- JFitToT

- **Fitting procedure**

1. Select fit range
2. For each ToT in range, determine:
 - i. $n_{pe}(ToT)$
 - ii. $P(n_{pe}, G, GS)$
 - iii. $D n_{pe} / d ToT$
3. Optimize fit for gain and gain-spread

$$R = W \cdot P(n_{pe}) \cdot \frac{dn_{pe}}{dToT}$$



Gain-calibration

- **Analysis chain**

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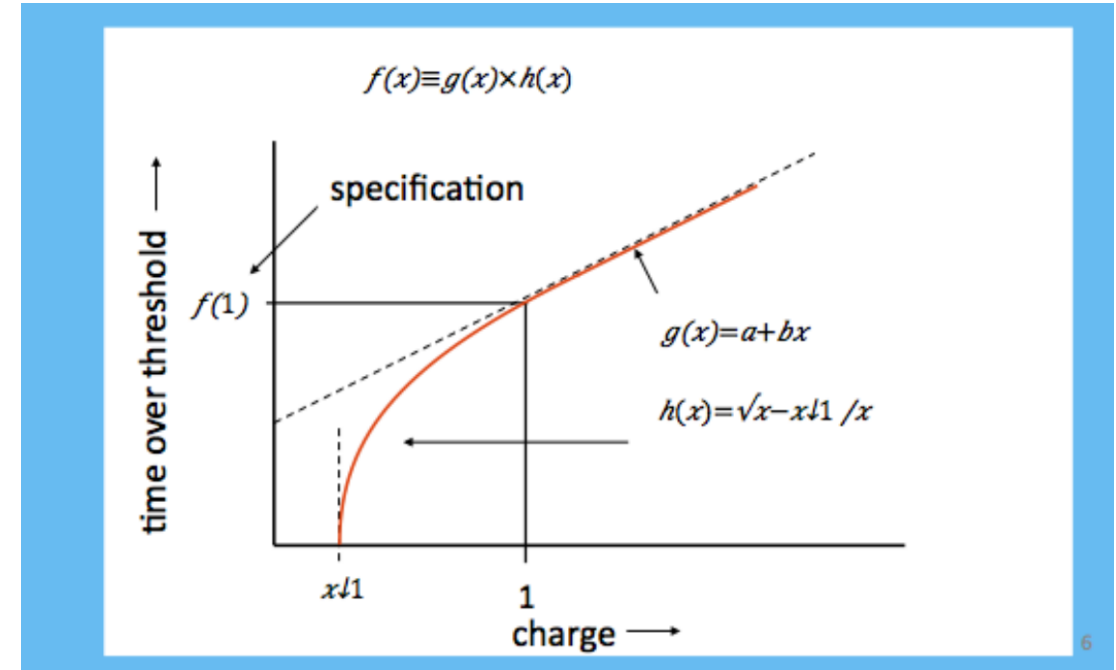
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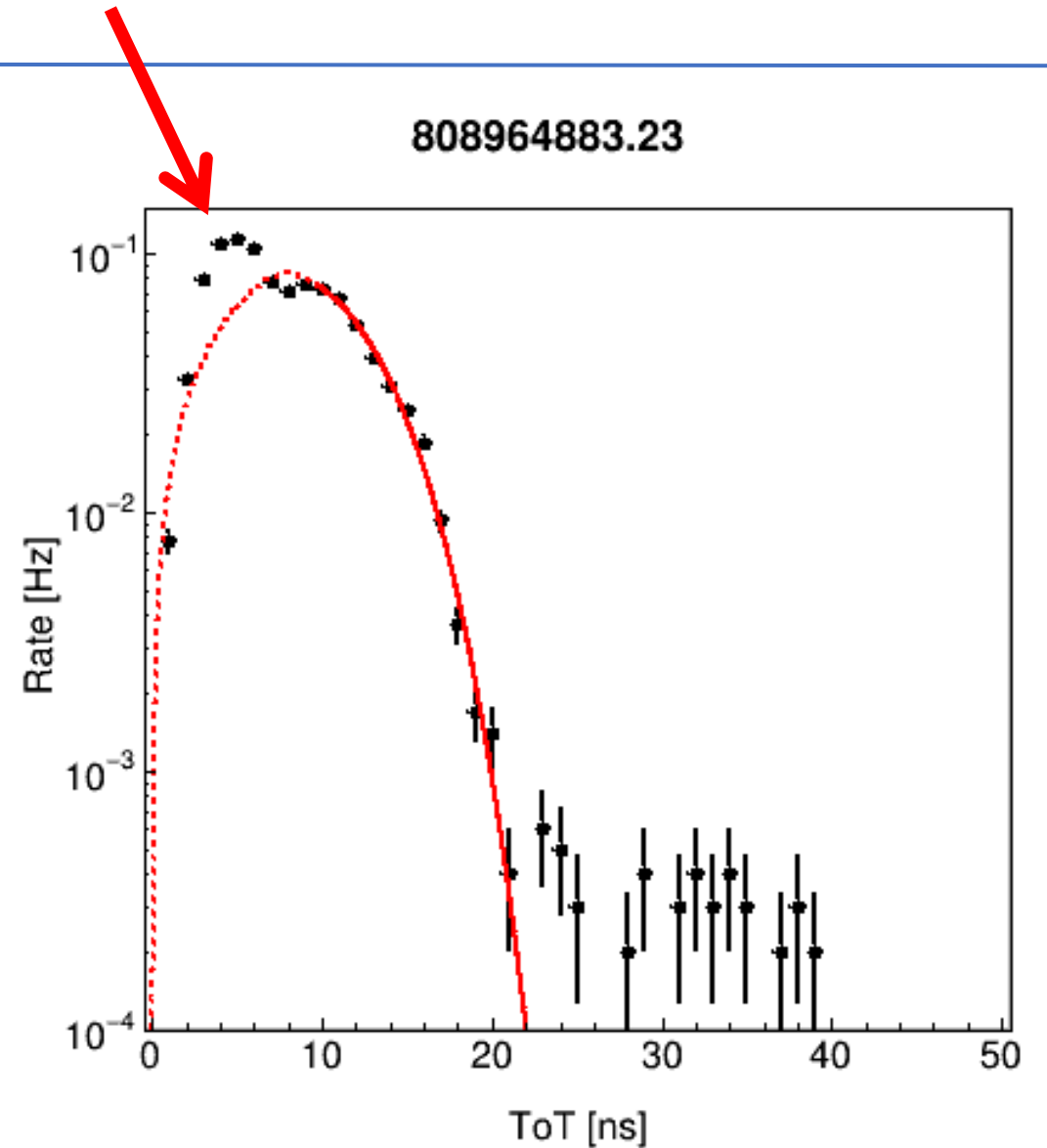
- **Relation ToT vs npe based on simple Jpp model**

- Assume pulse is Gaus with exp. tail
- ToT will increase logarithmically until saturation point
- Linear increase afterwards



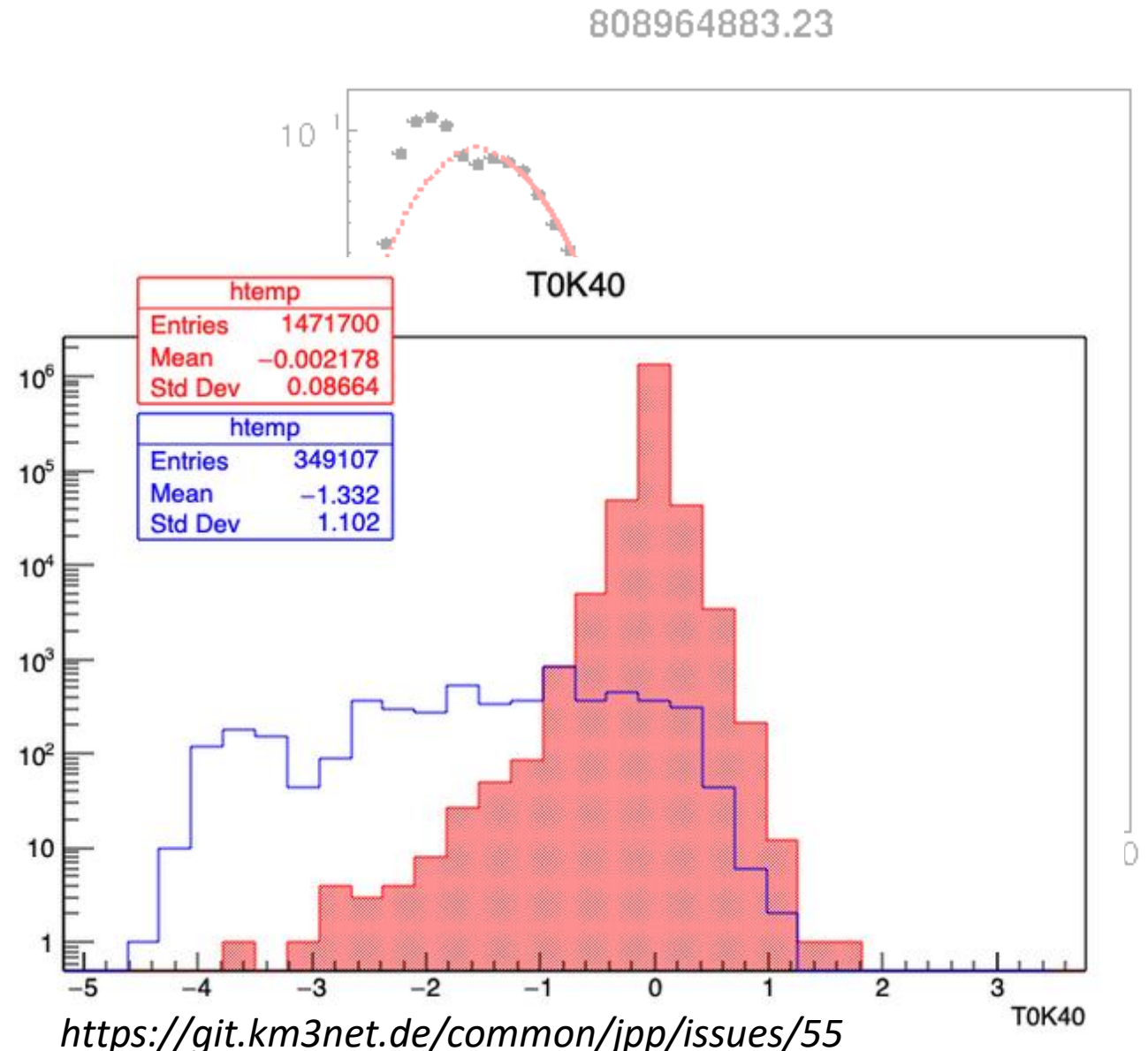
An issue

- Fit range is bounded at 10 ns
 - Prevents inclusion of **bump around 4 ns**
- May lead to incorrect calibration in PMTs with anomalously low gain
- Propagates into 40K calibration
 - Too high QE
 - Low t_0
 - ...



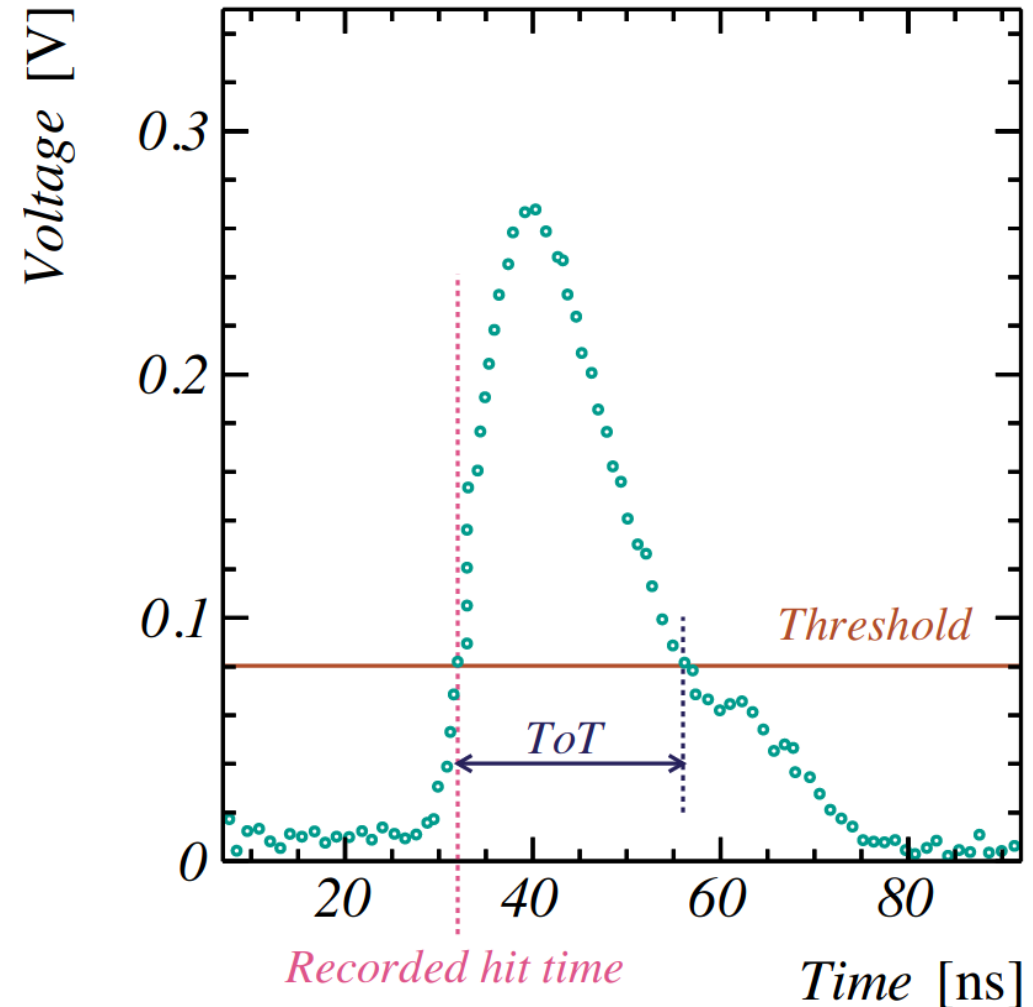
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- Solutions
 1. HV tuning
 2. Incorporate 4ns-bump



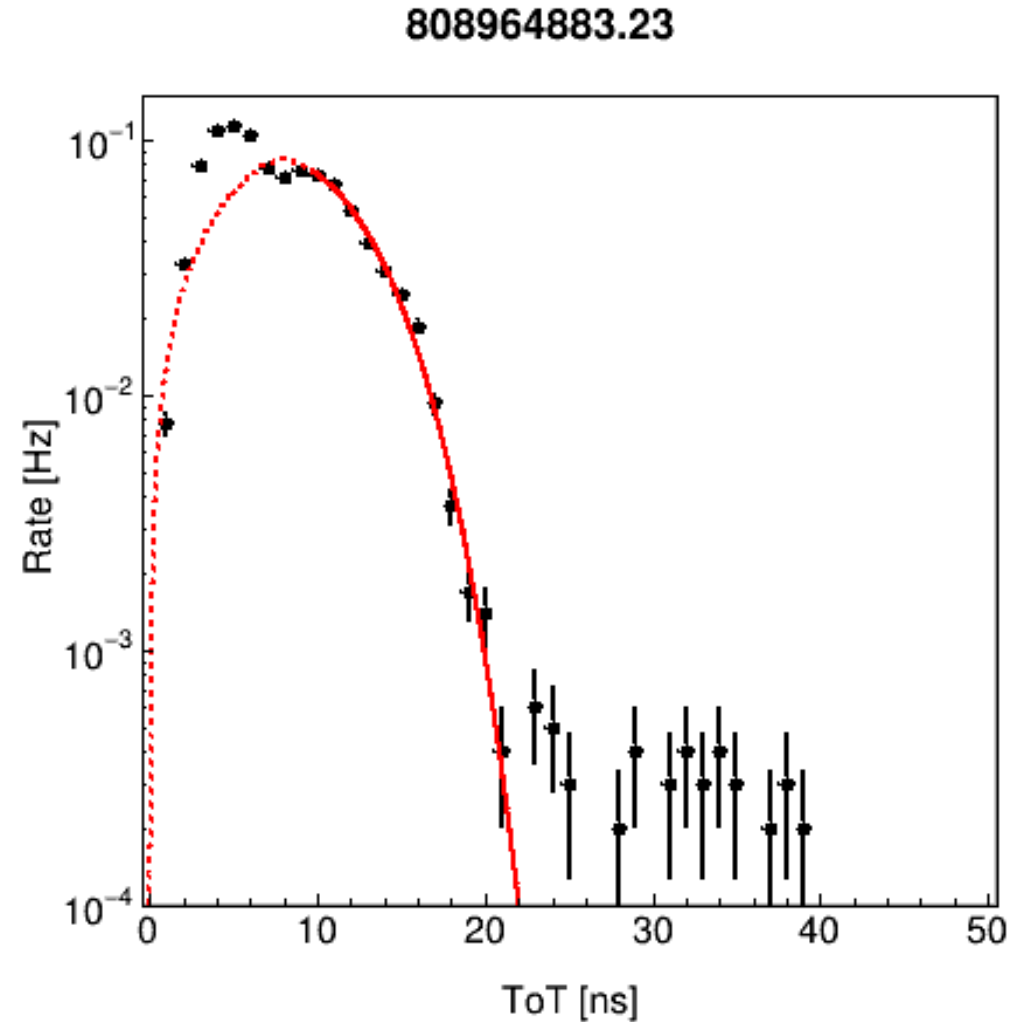
Cause

- Noise band which pushes photon hits over the threshold
- 3 figures to keep in mind:
 1. Pulse-diagram



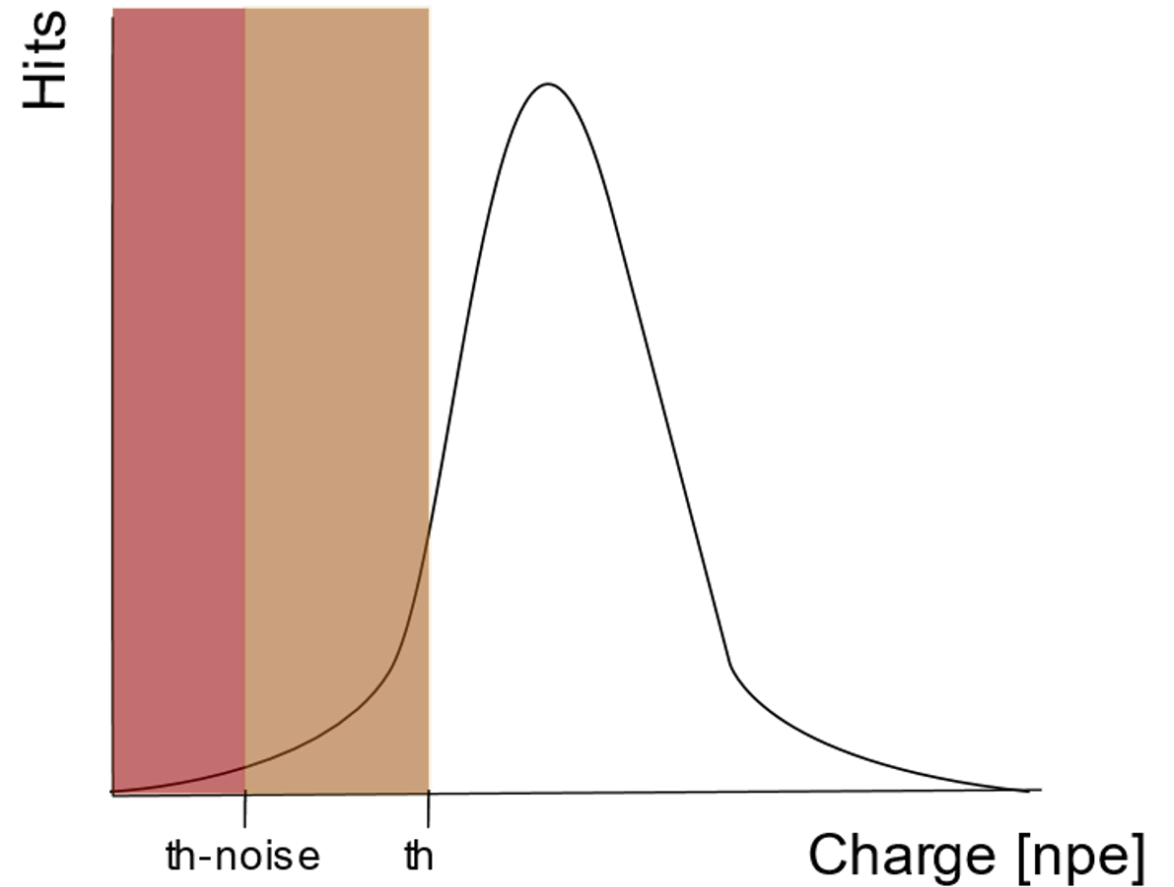
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 1. Pulse-diagram
 2. ToT-diagram



Cause

- Noise band which pushes photon hits over the threshold
- 3 figures to keep in mind:
 1. Pulse-diagram
 2. ToT-diagram
 3. Charge-diagram



Model adjustment

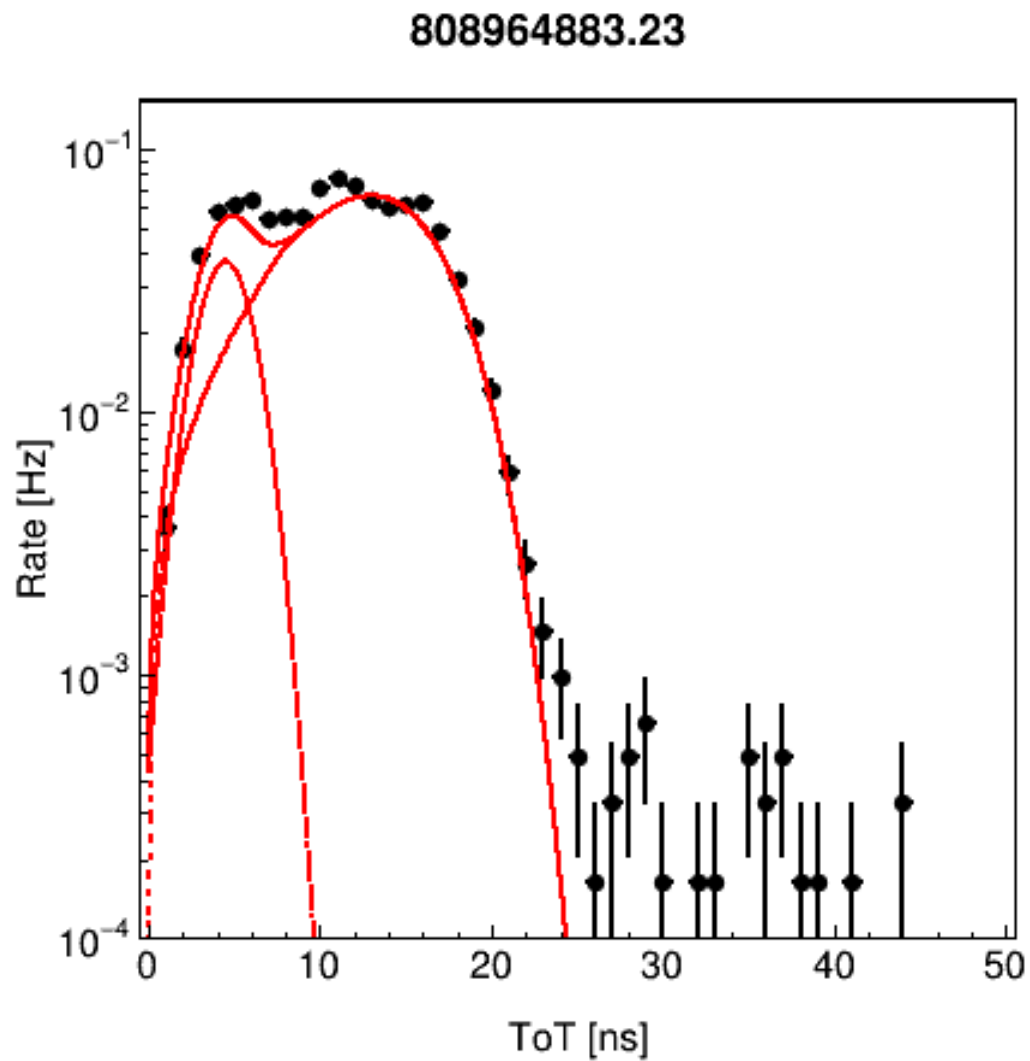
- Include Gaussian to account for the noise-bump
- Currently use:
 - Mean @ 4.5 ns
 - Sigma @ 2 ns
- Fix height using charge-fraction in noise-band

$$f_{\text{noiseband}} = \frac{1}{N} \int_{Q_{th}-Q_n}^{Q_{th}} Q(\text{ToT}, G, GS) dQ$$

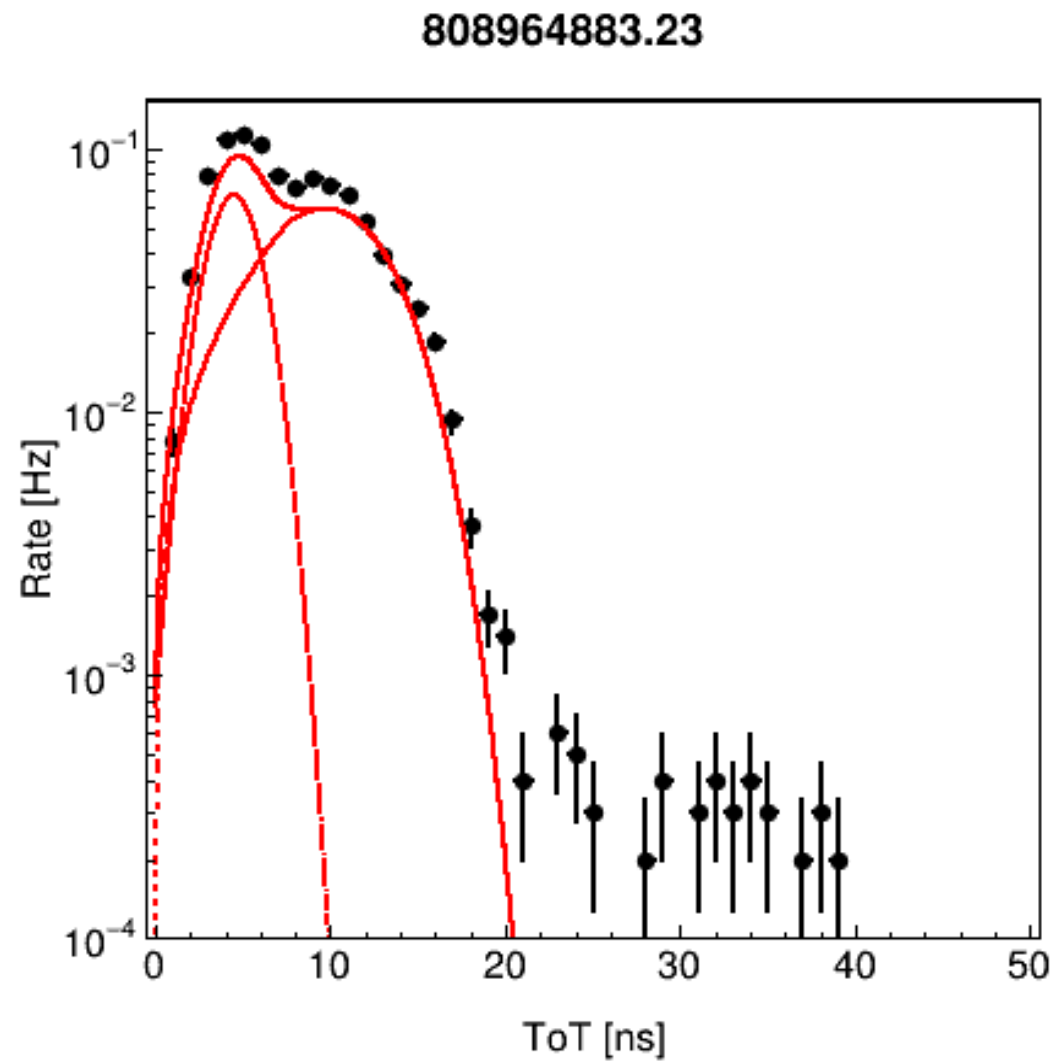
$$N = \int_{Q_{th}-Q_n}^{\infty} Q(\text{ToT}, G, GS) dQ$$

- Similarly, weigh Jpp-model fit according to charge-fraction outside noise-band

Preliminary results



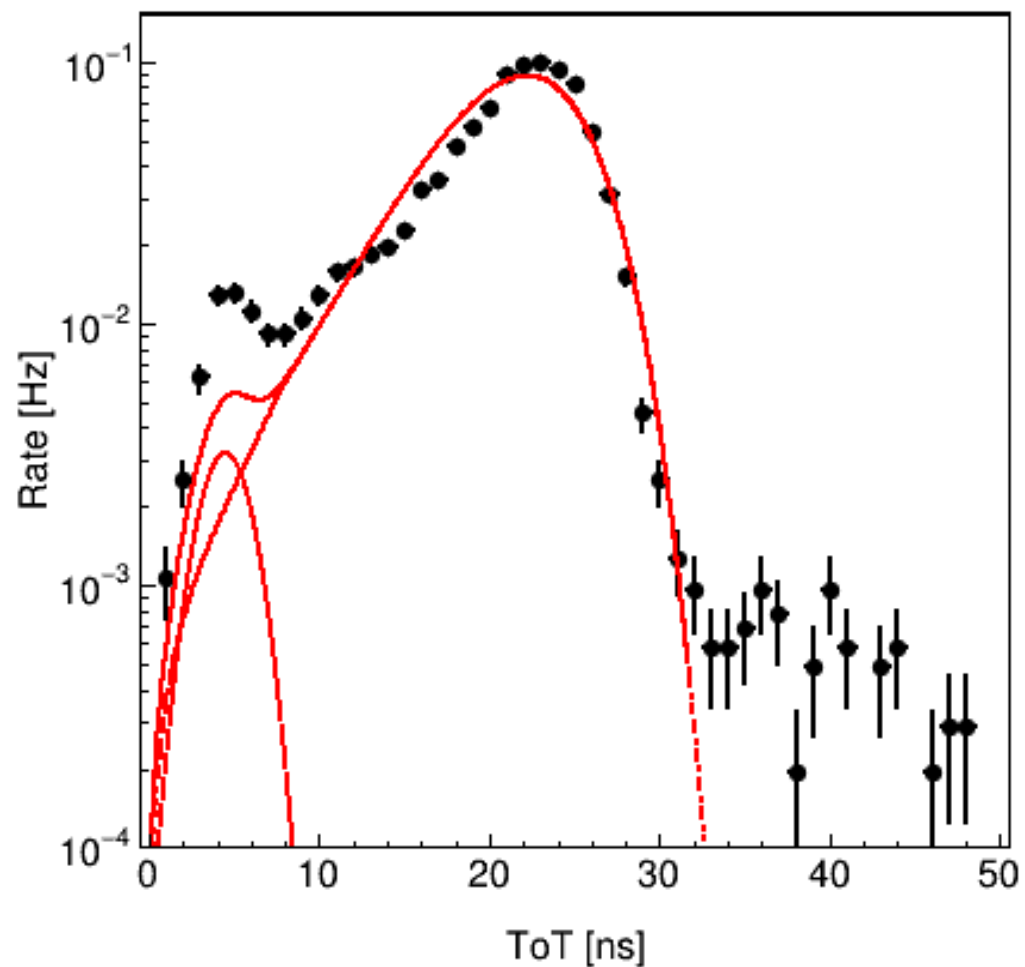
Run 5379



Run 6018

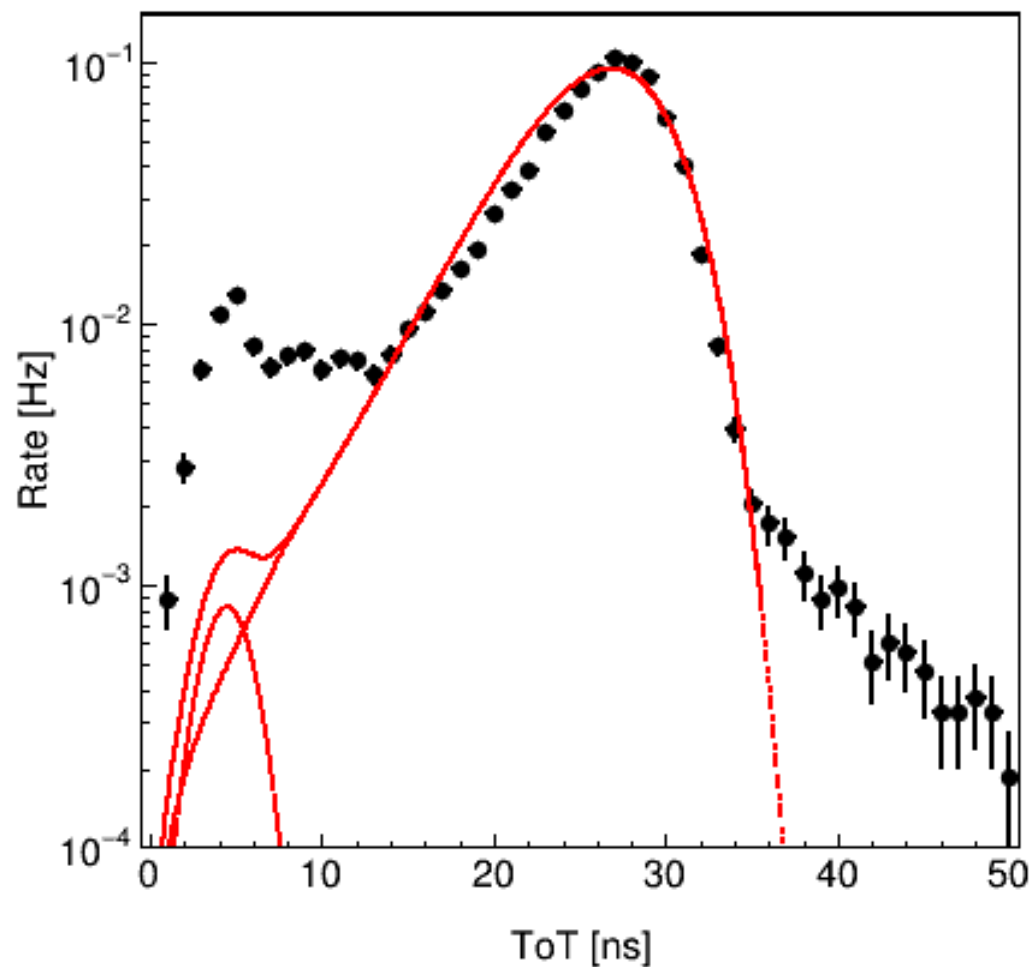
Preliminary results

809526097.27



Run 5379

808981523.6



Run 6018

Discussion

Status:

- Already works quite well for low-gain PMTs!
- Noise-/threshold-values sub-optimal for PMTs with normal gain

To do:

- Evaluate effect on K40-fits
- Find optimal noise- and threshold-values
- Find optimal mean and sigma
- Account for additional bump around 12 ns