



Liquid Argon Scintillation Studies

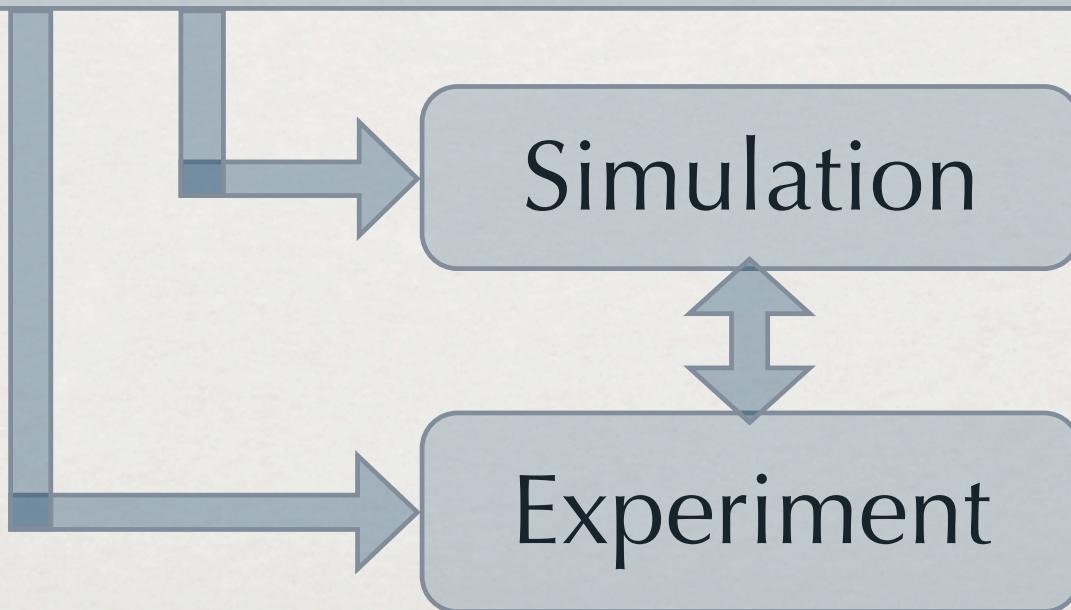
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A. Smolnikov, S. Vasiliev
MPI-K Heidelberg

Programme

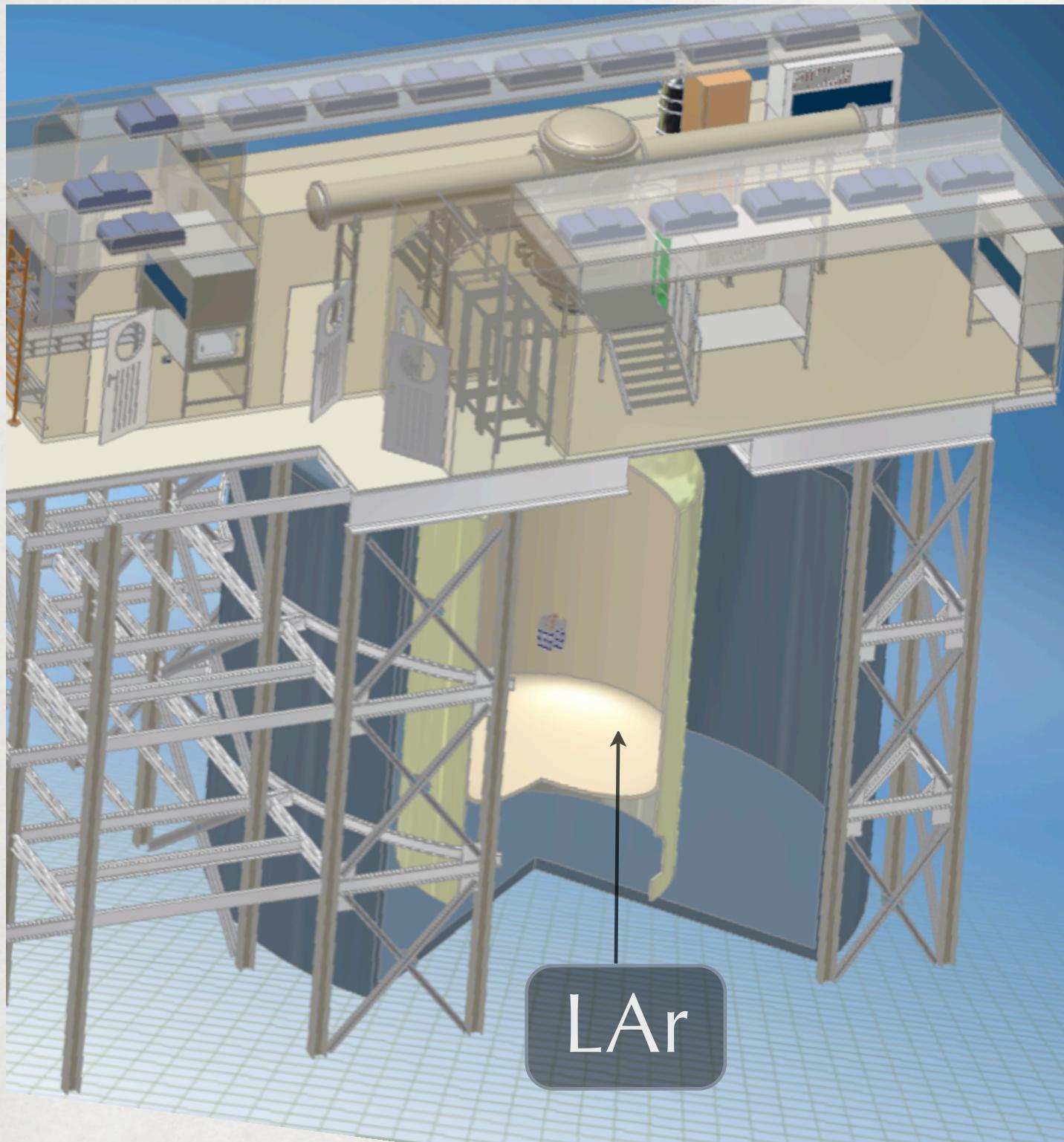


Why is liquid argon interesting?

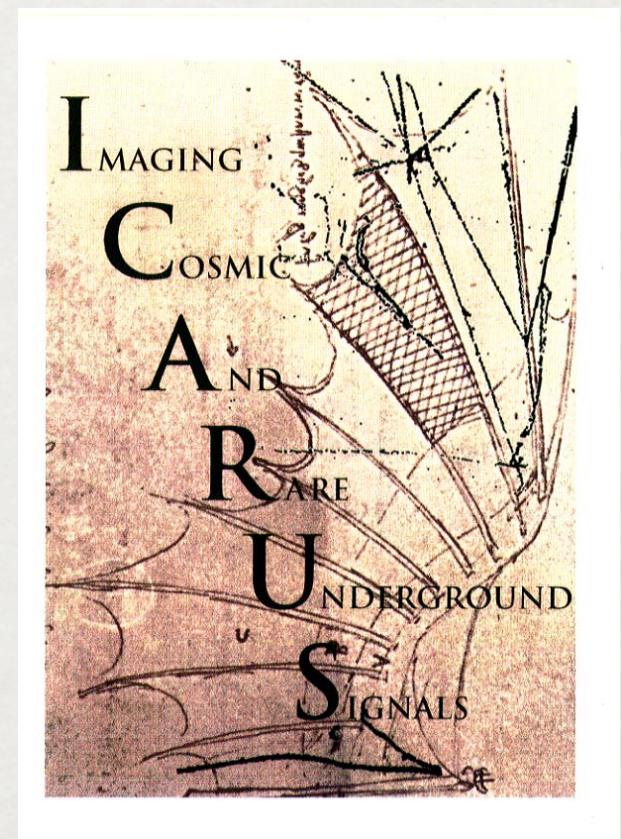
Extracting information from
scintillation pulses:



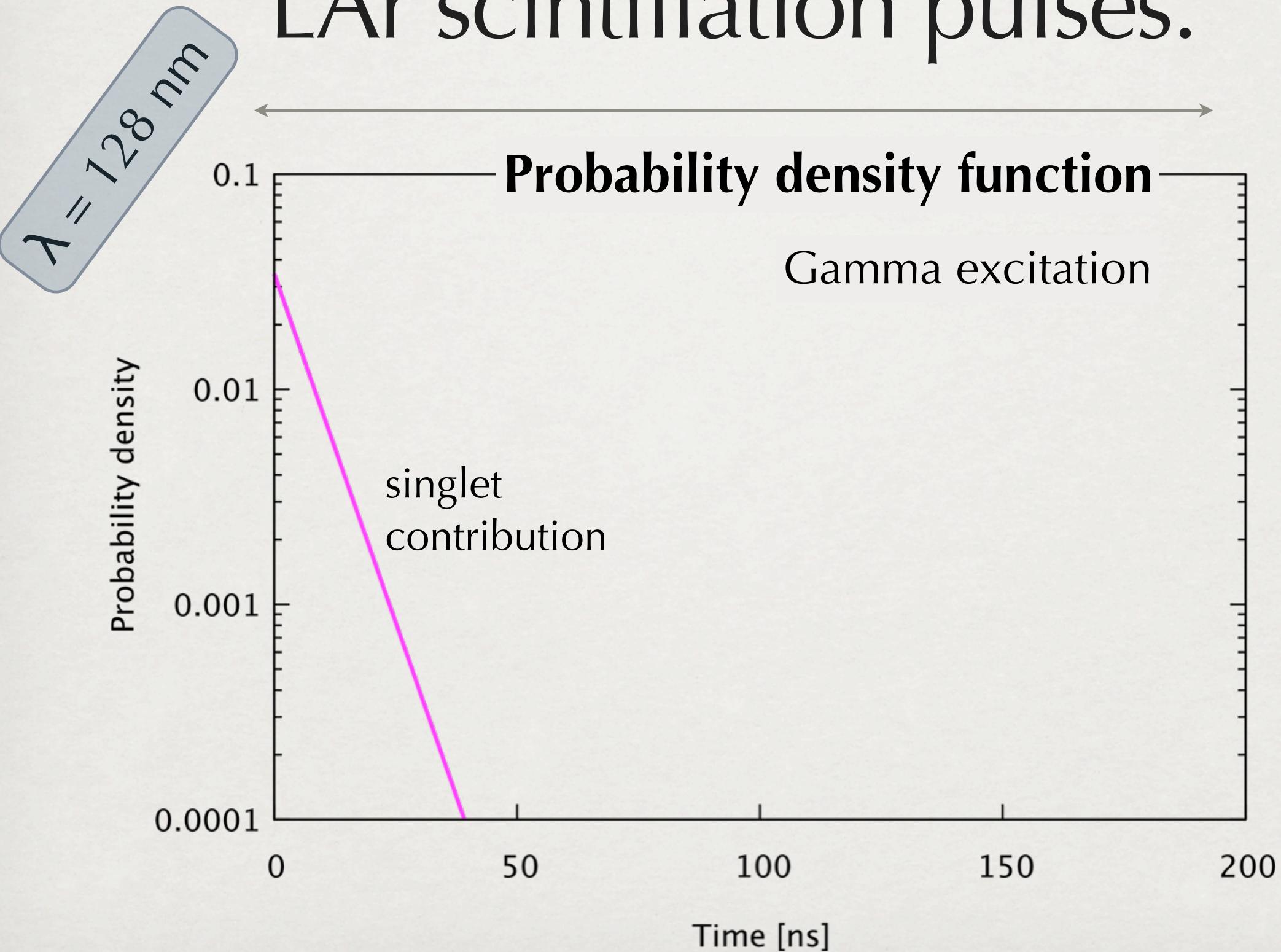
Liquid argon
is used for
passive shielding
in GERDA.



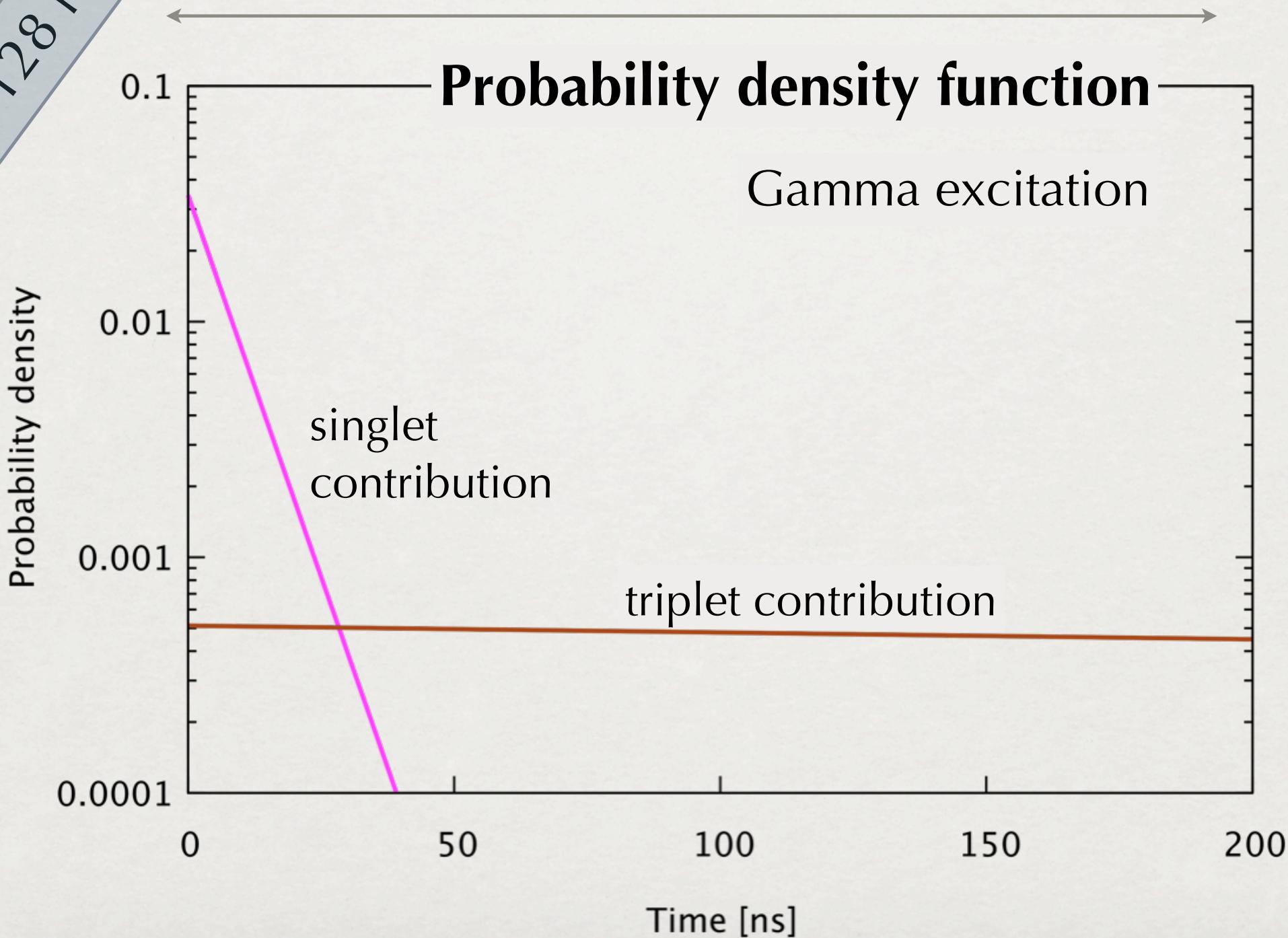
Liquid argon in action.



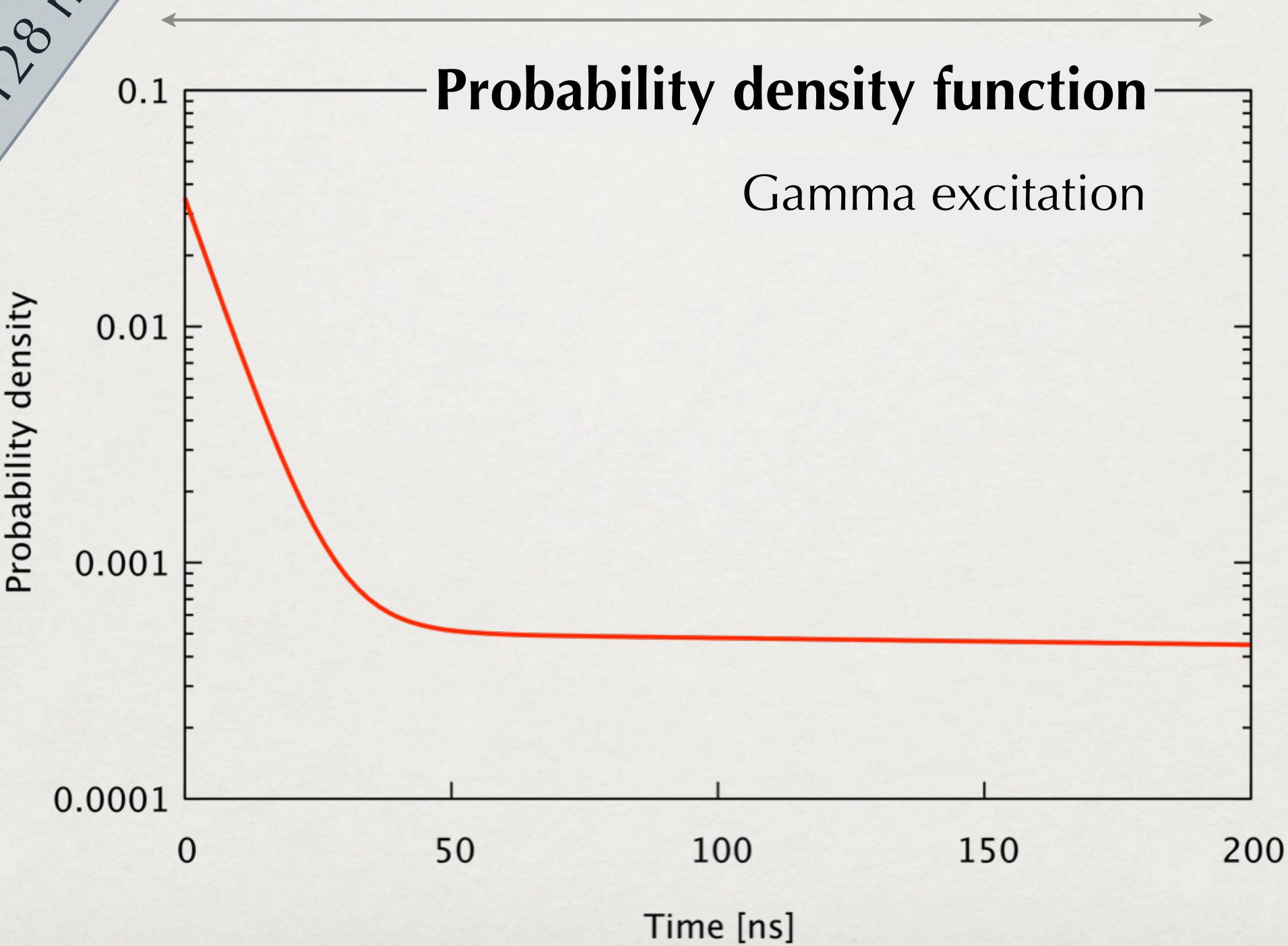
LAr scintillation pulses.



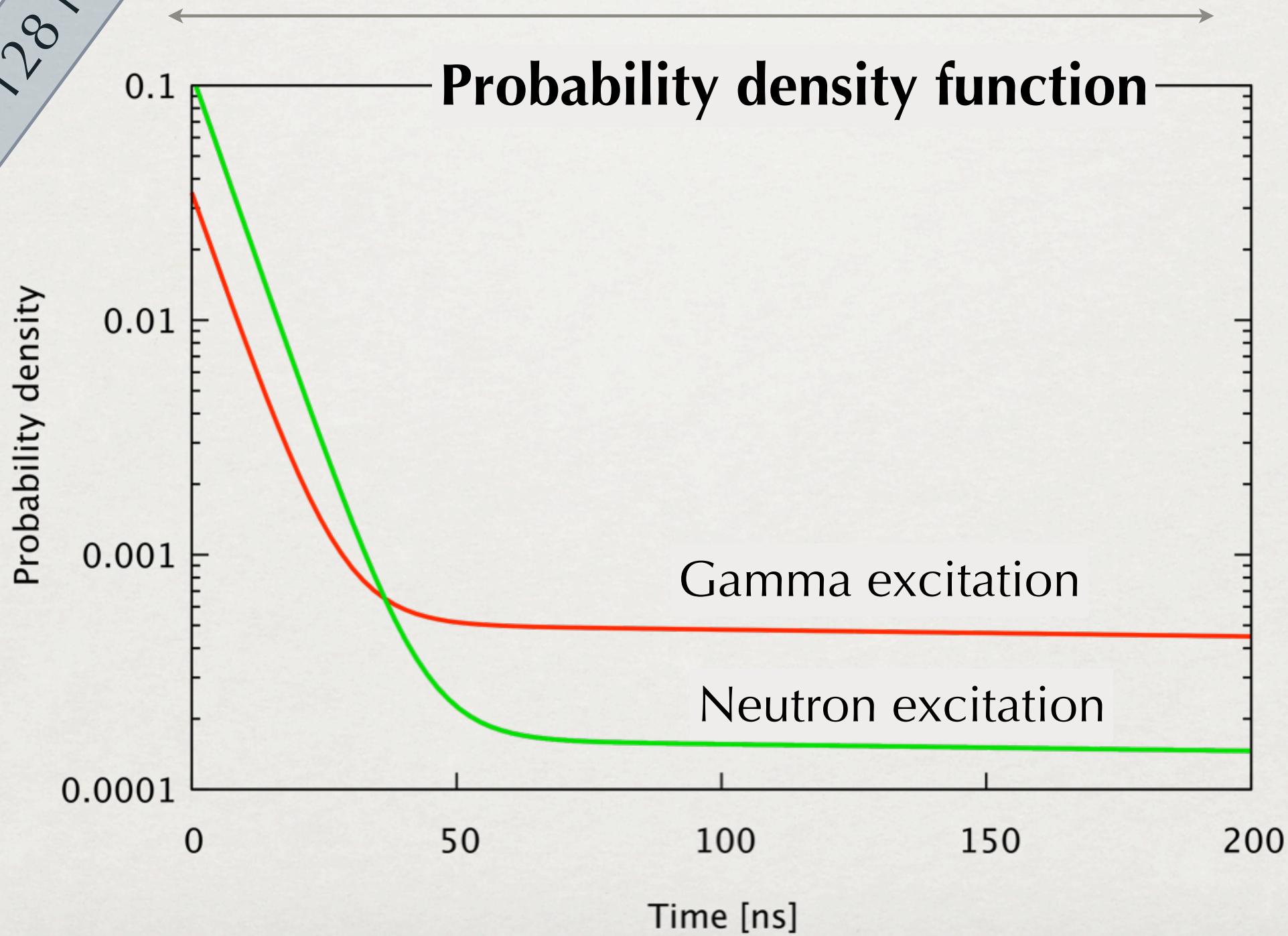
LAr scintillation pulses.



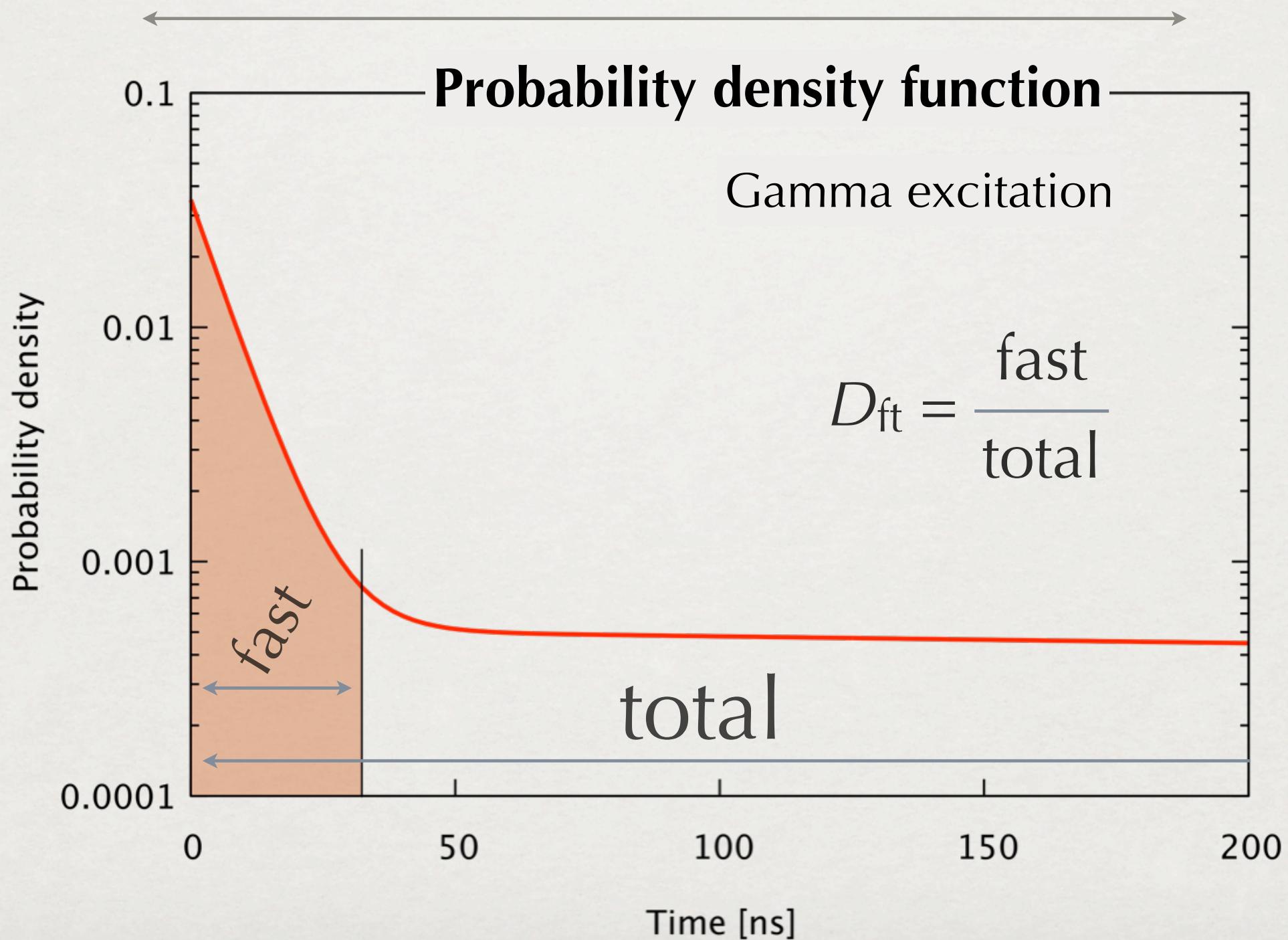
LAr scintillation pulses.



LAr scintillation pulses.



PSA with “fast to total”



The following parameters were used in the simulation:

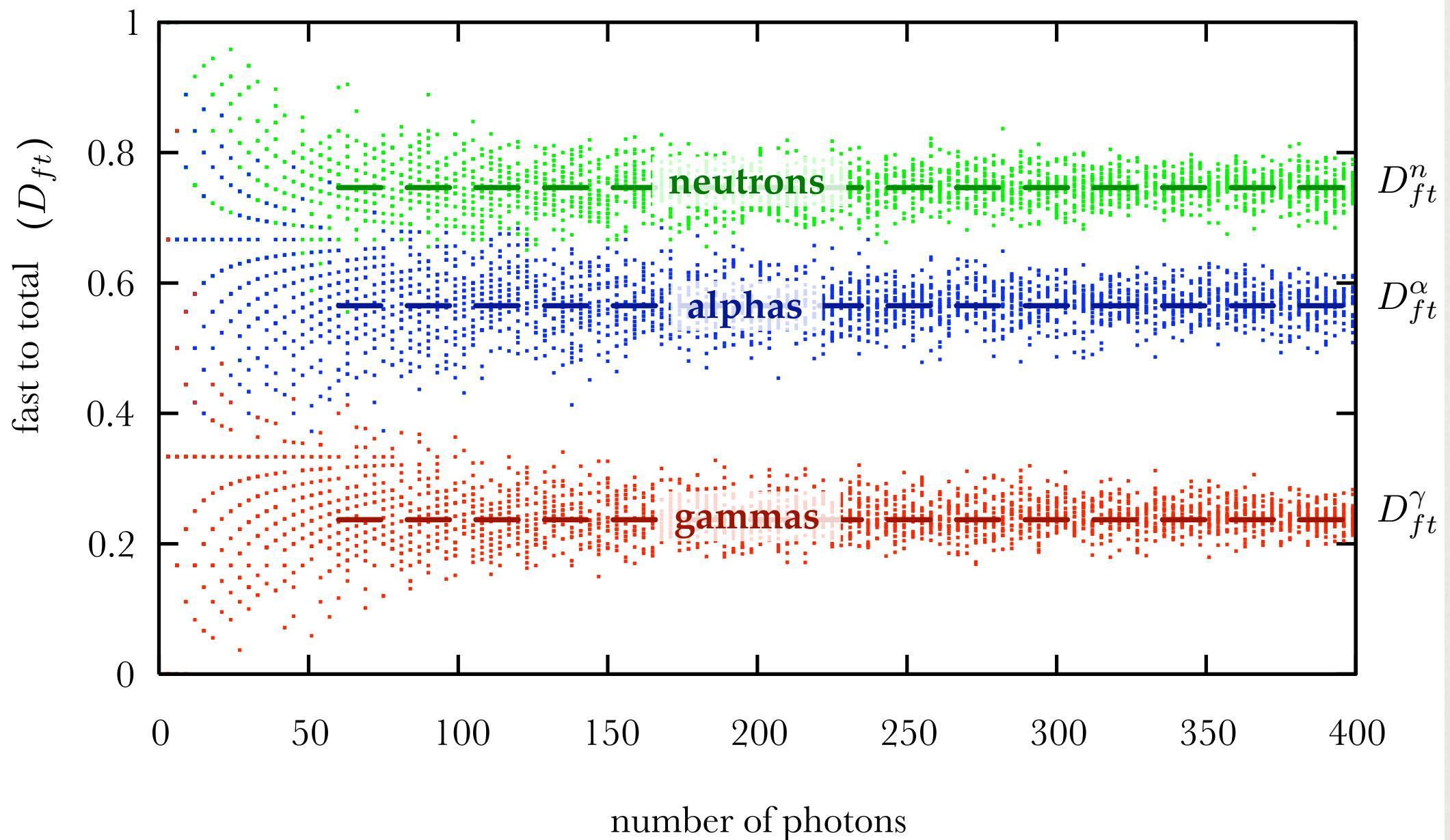


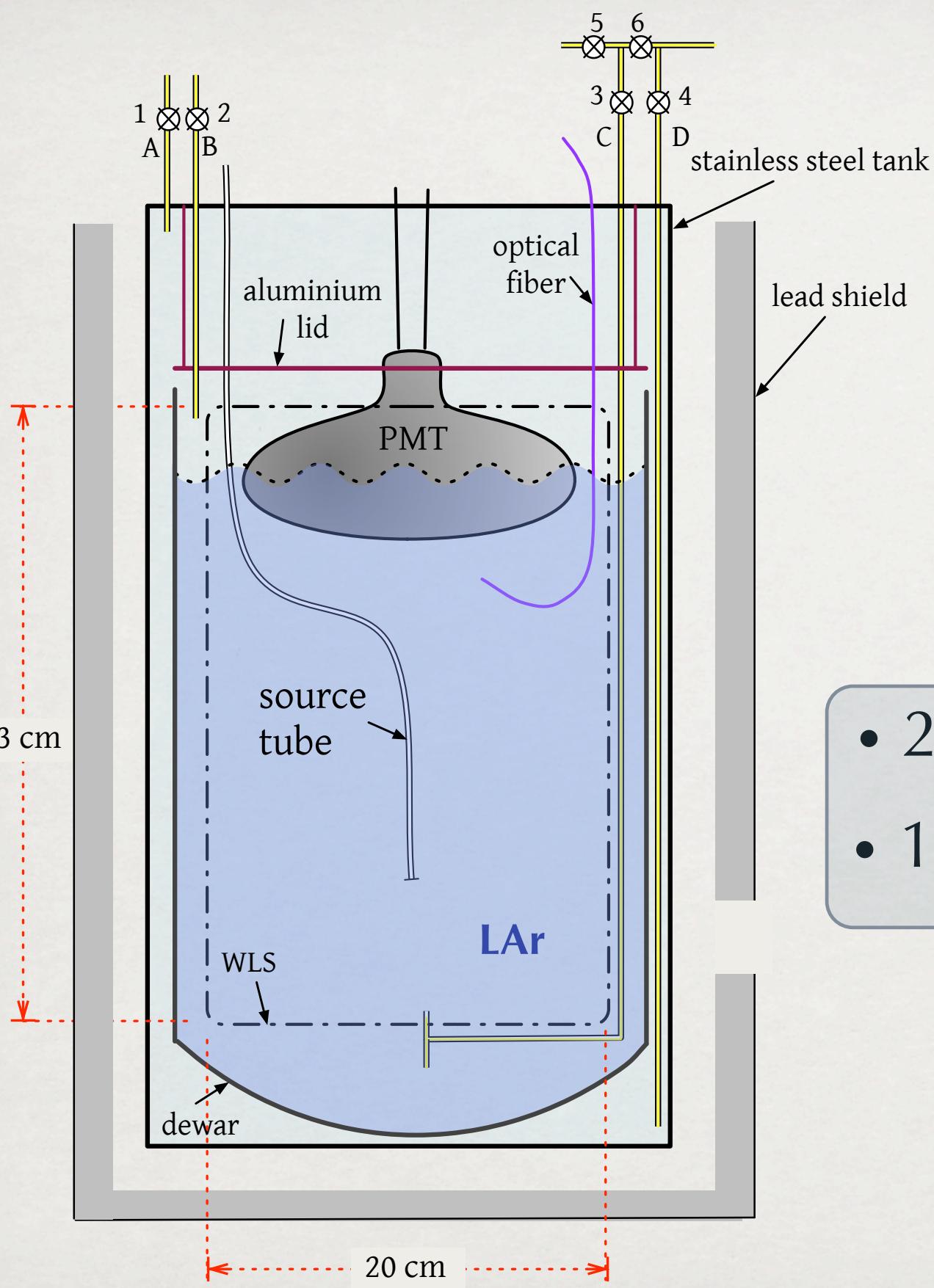
- $\tau_{\text{fast}} = 6.7 \text{ ns}$
- $\tau_{\text{slow}} = 1600 \text{ ns}$
- gamma R = 0.3
- alpha R = 1.3
- neutron R = 3.0

$$R = \frac{\# \text{ singlet states}}{\# \text{ triplet states}}$$

simulation

Scatterplot: D_{ft} - Energy



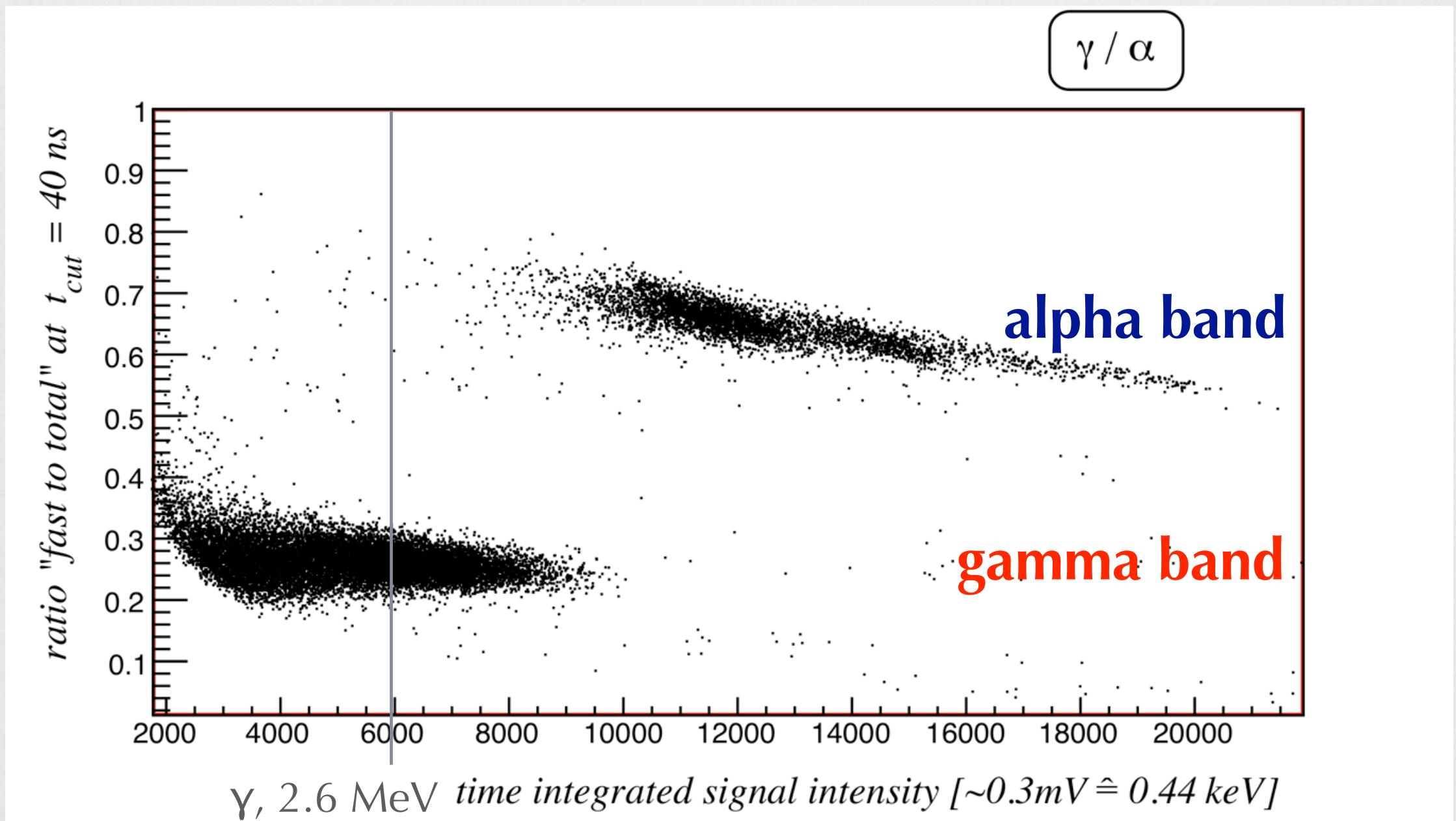


Mini-LArGe

- 21 l active volume
- 1.2 photo electrons / keV

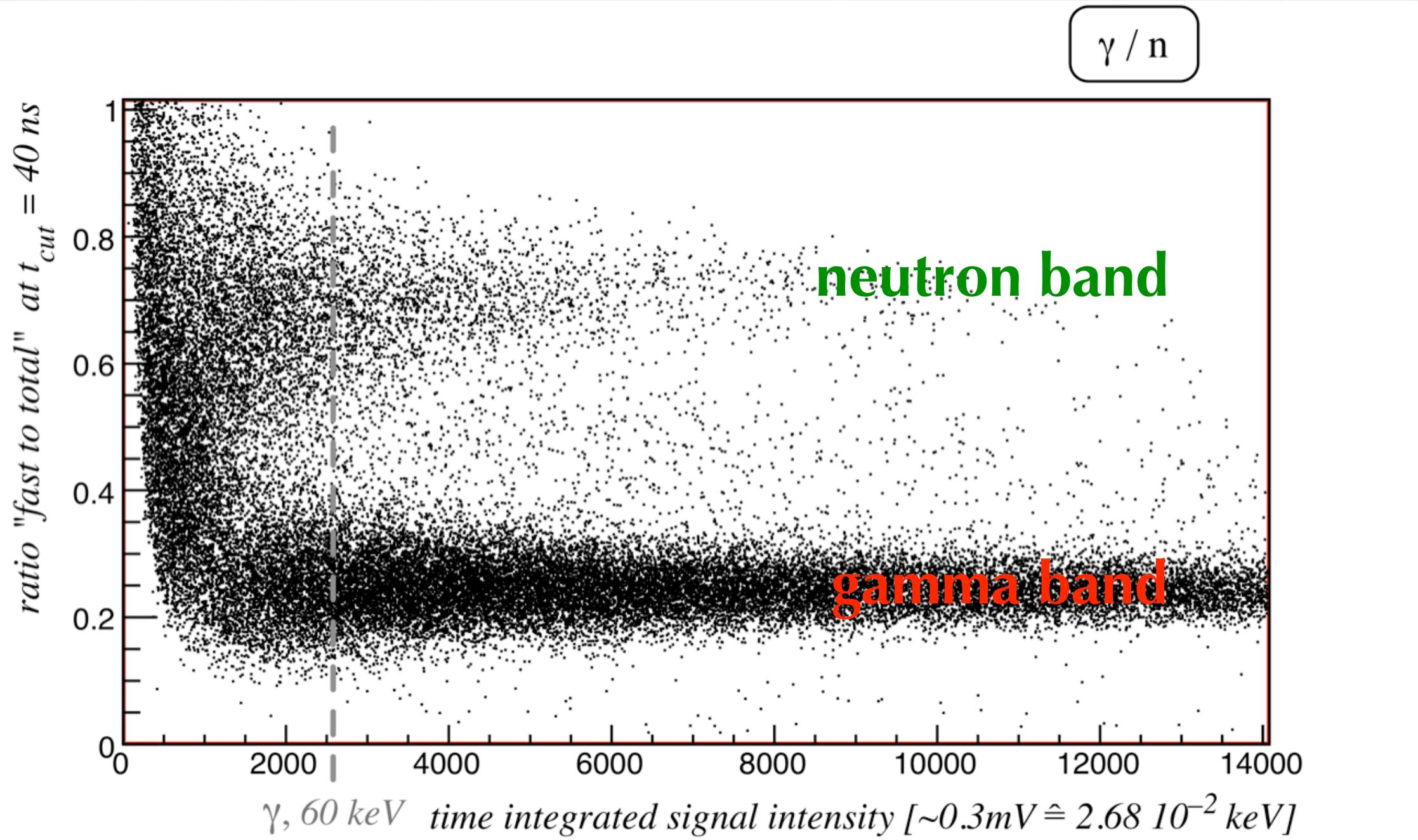
measurement

Experimental result: gamma-alpha separation



measurement

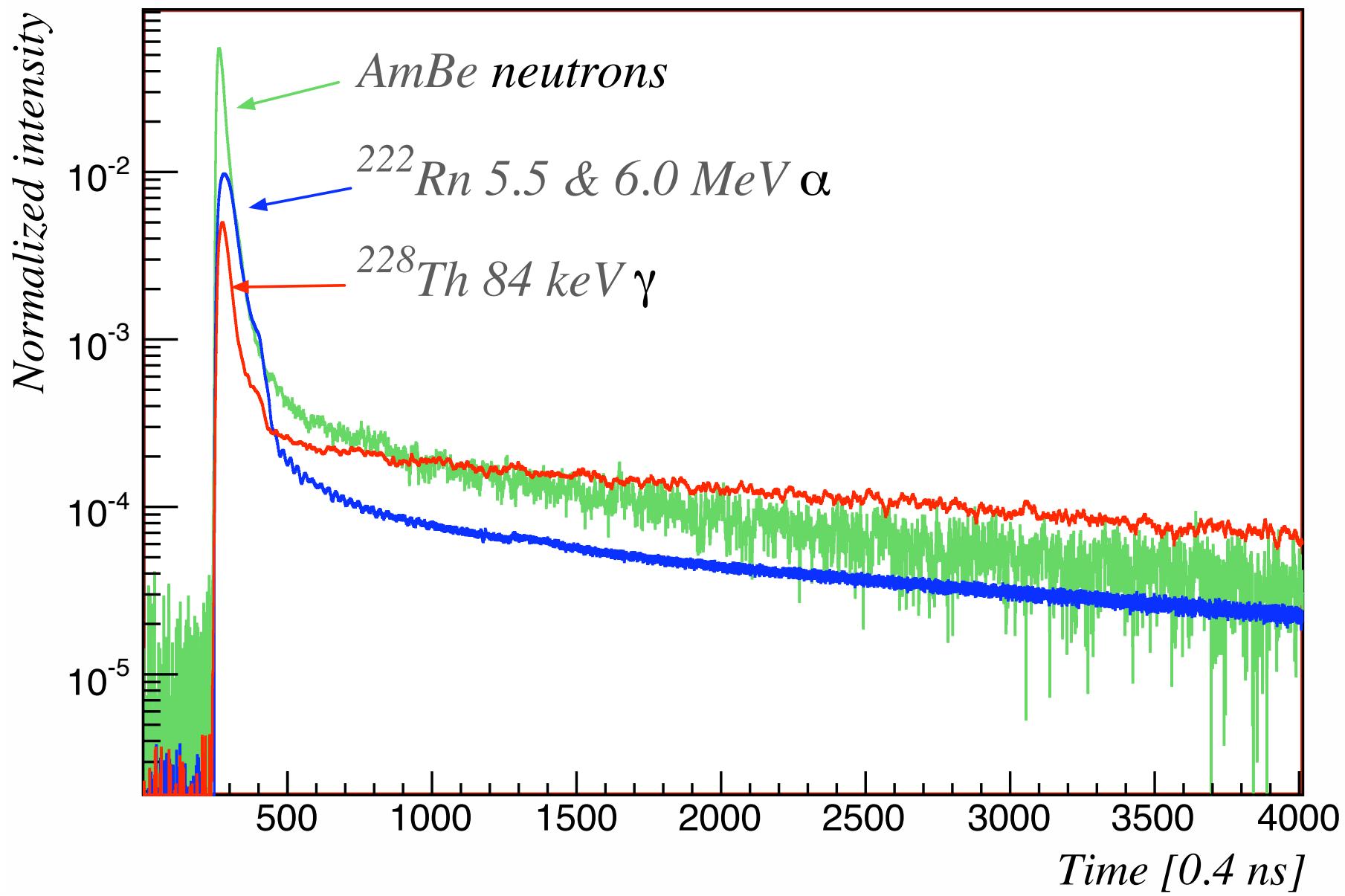
Experimental result: gamma-neutron separation



measurement

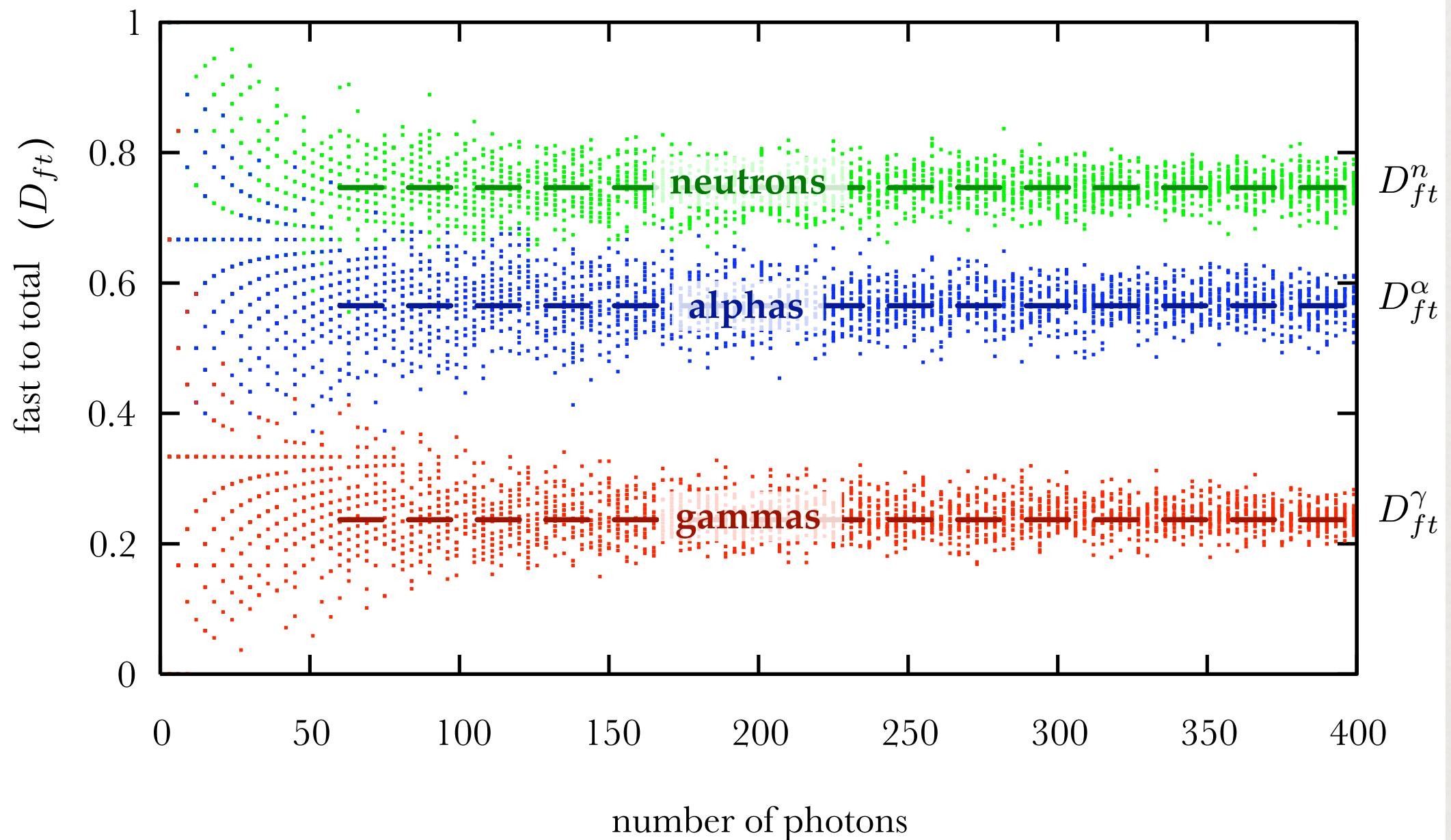
Some actual pulseshapes.

Pulse shapes



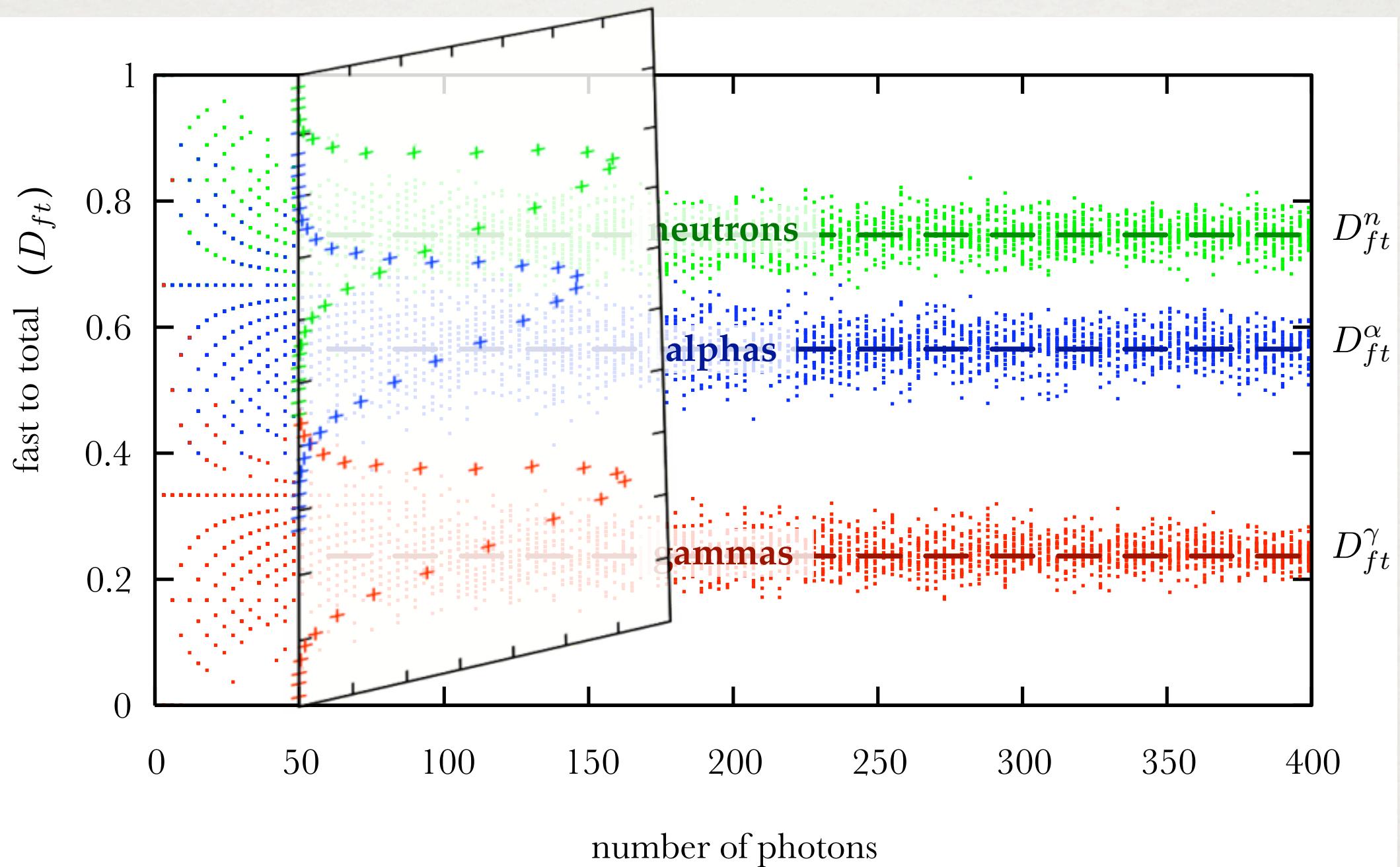
simulation

For a quantitative analysis, upgrade scatterplot to 3 dimensions.



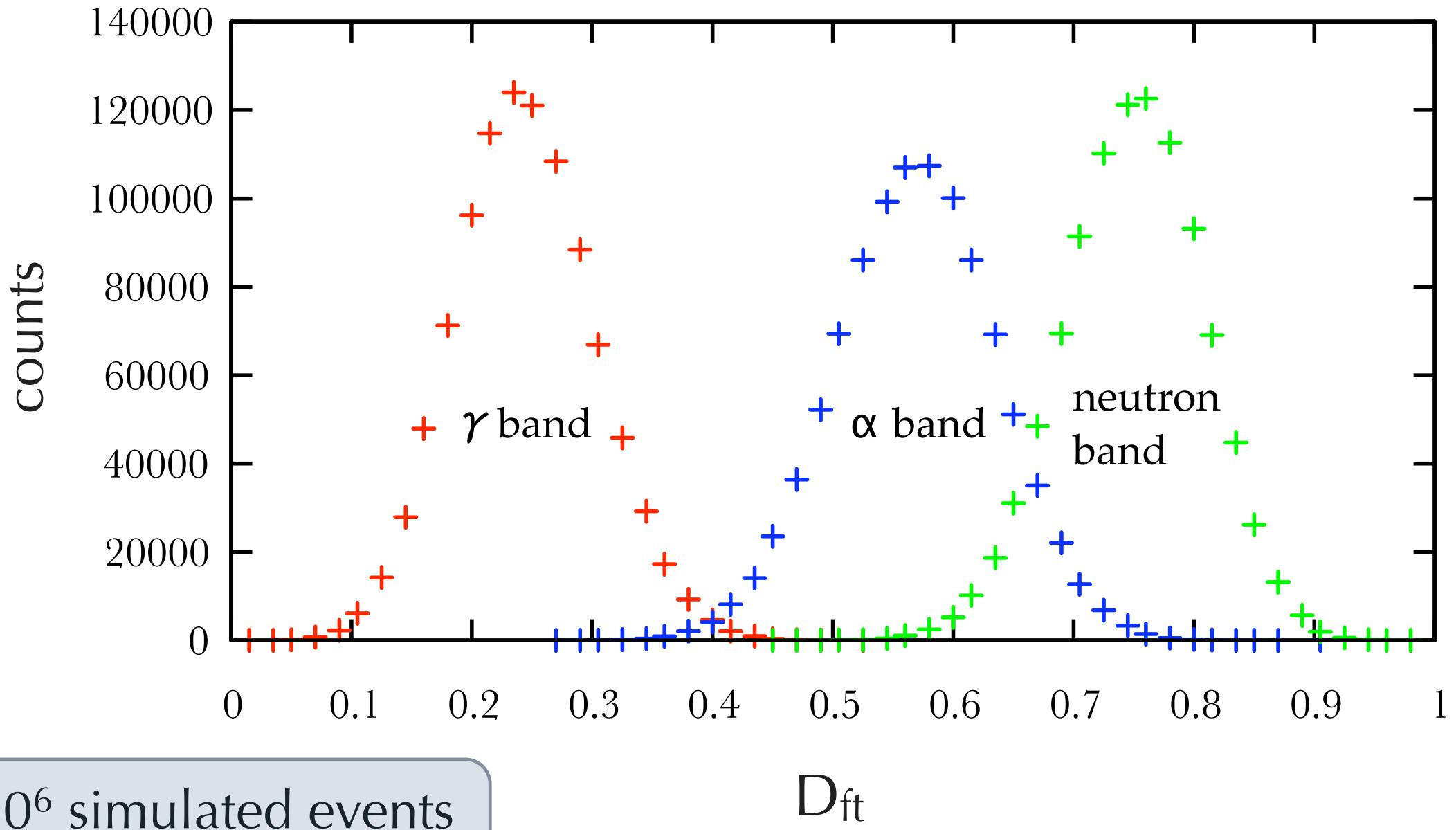
simulation

For a quantitative analysis, upgrade scatterplot to 3 dimensions.

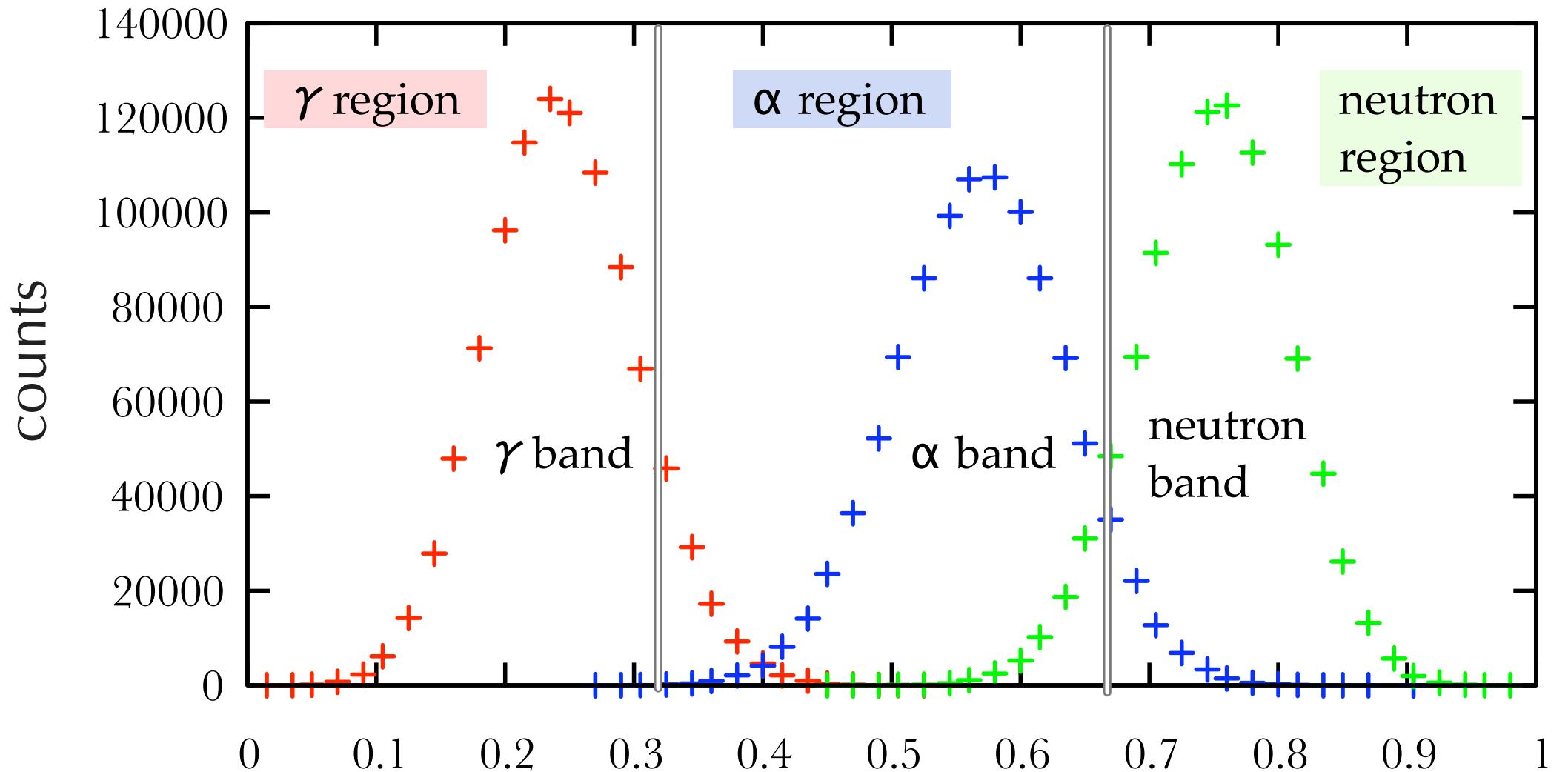


simulation

A cut through the scatterplot at 50 photons.



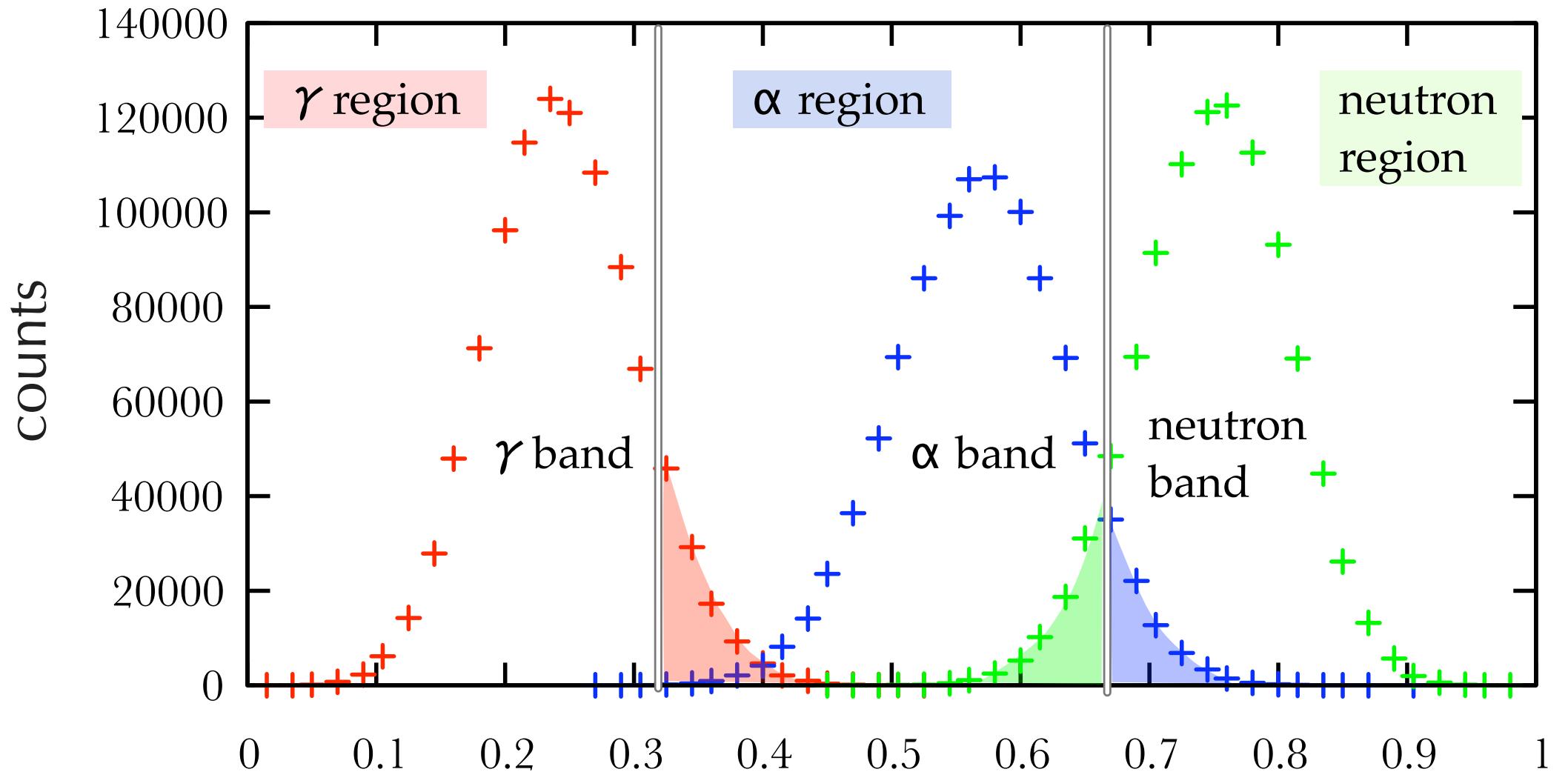
A cut through the scatterplot at 50 photons.



10^6 simulated events

D_{ft}

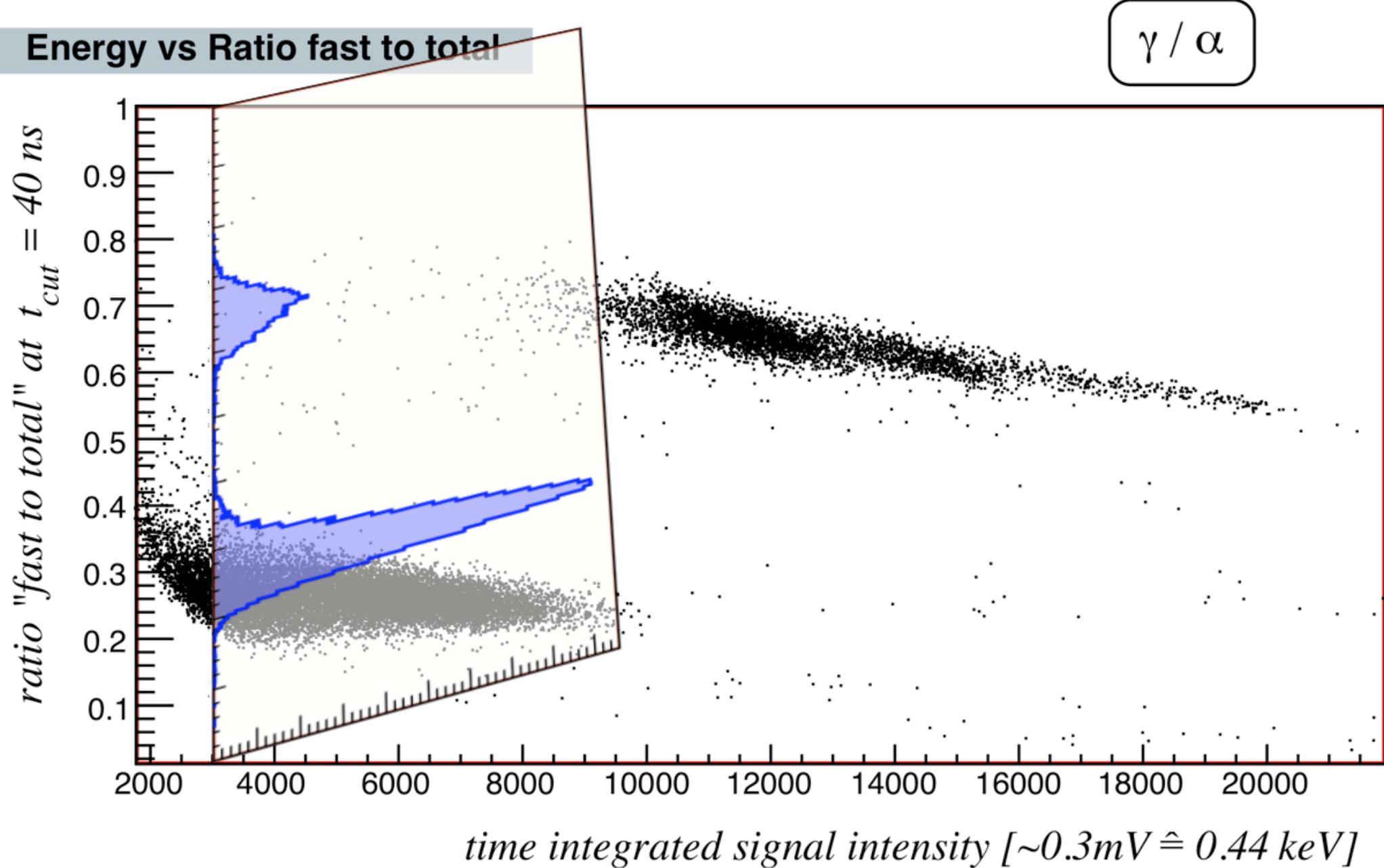
A cut through the scatterplot at 50 photons.



10^6 simulated events

measurement

Going 3D with the experimental data.



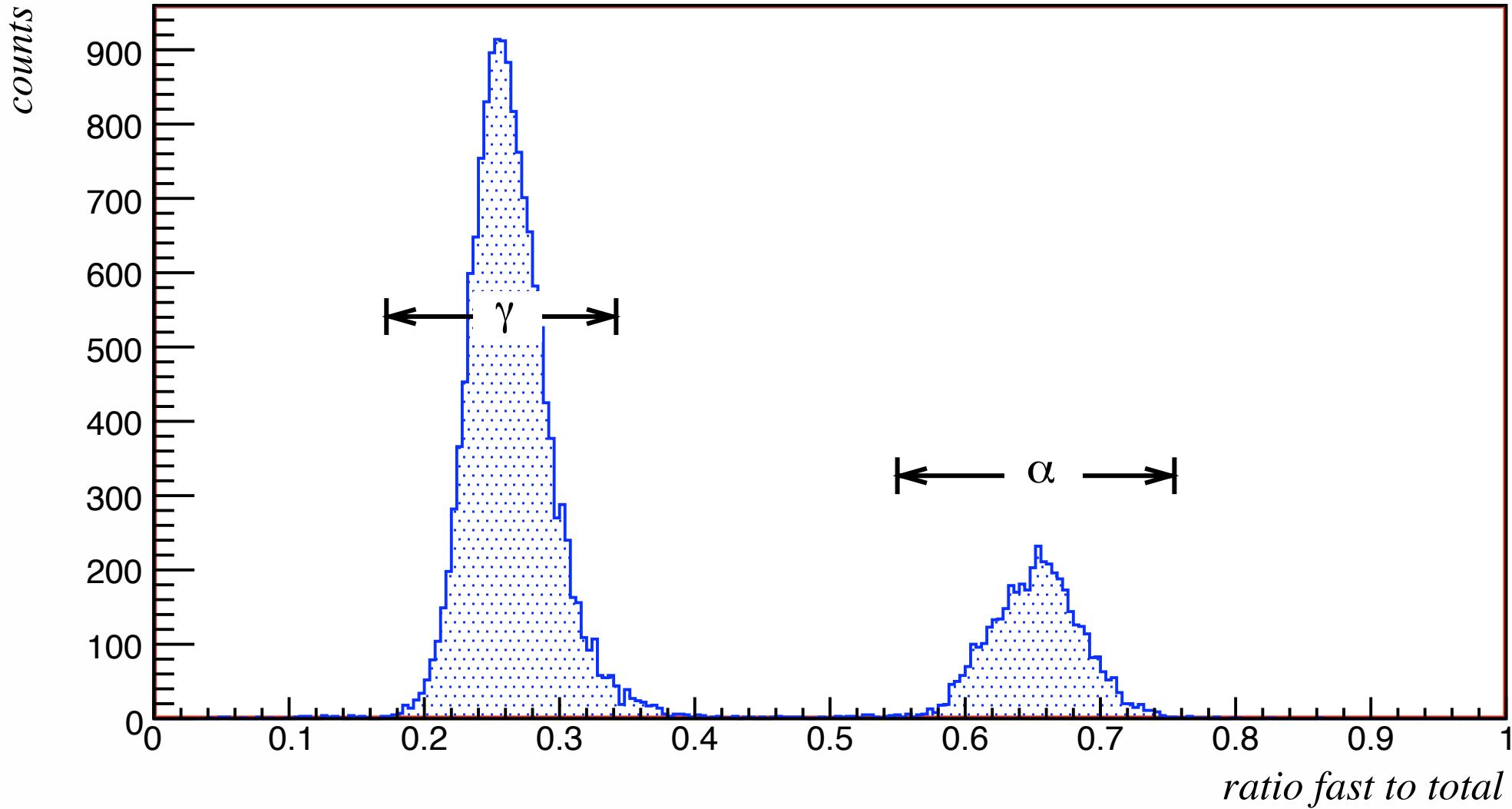
measurement

An excellent α - γ separation (at typical α energies).



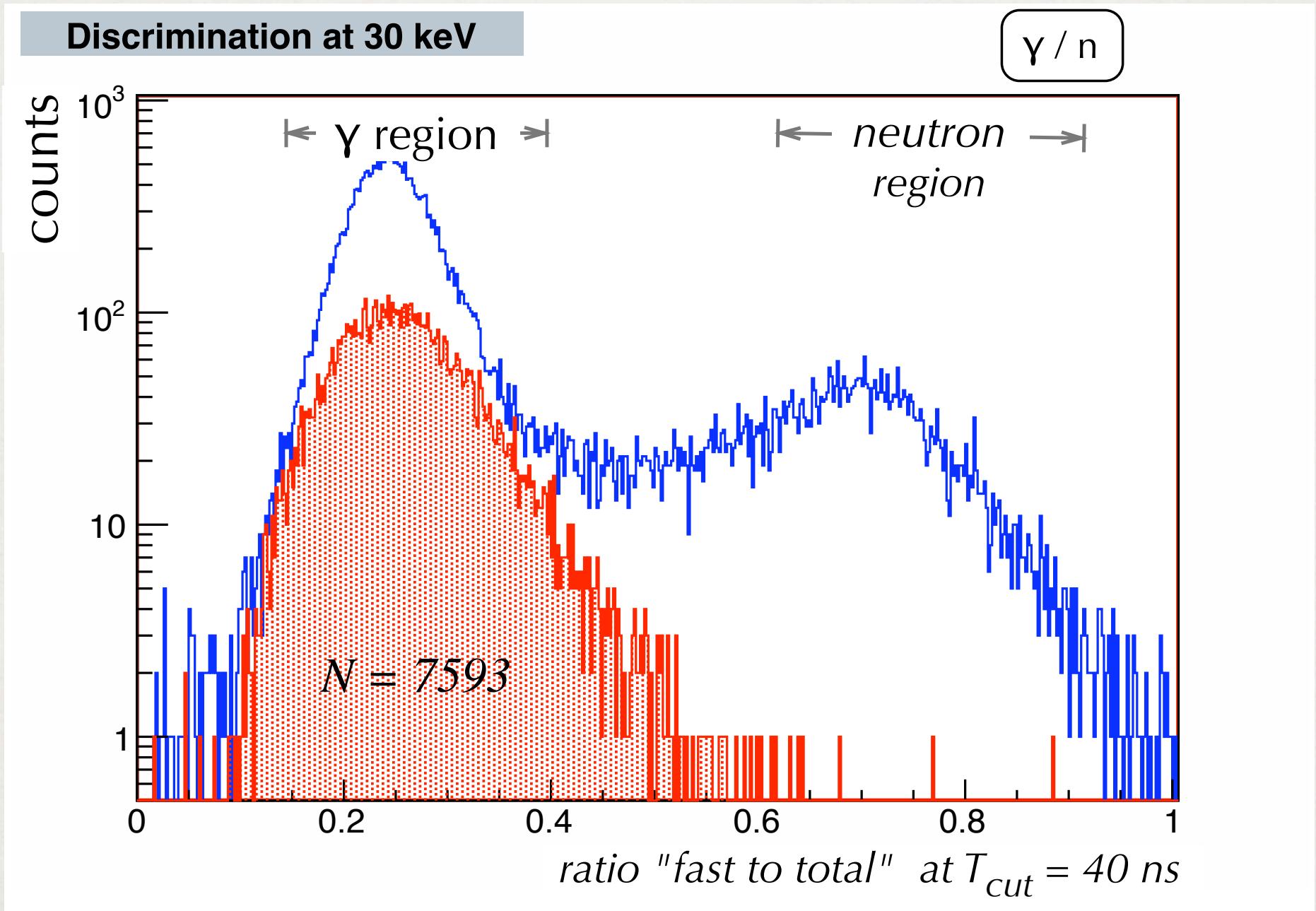
Discrimination at 580 keV

γ / α



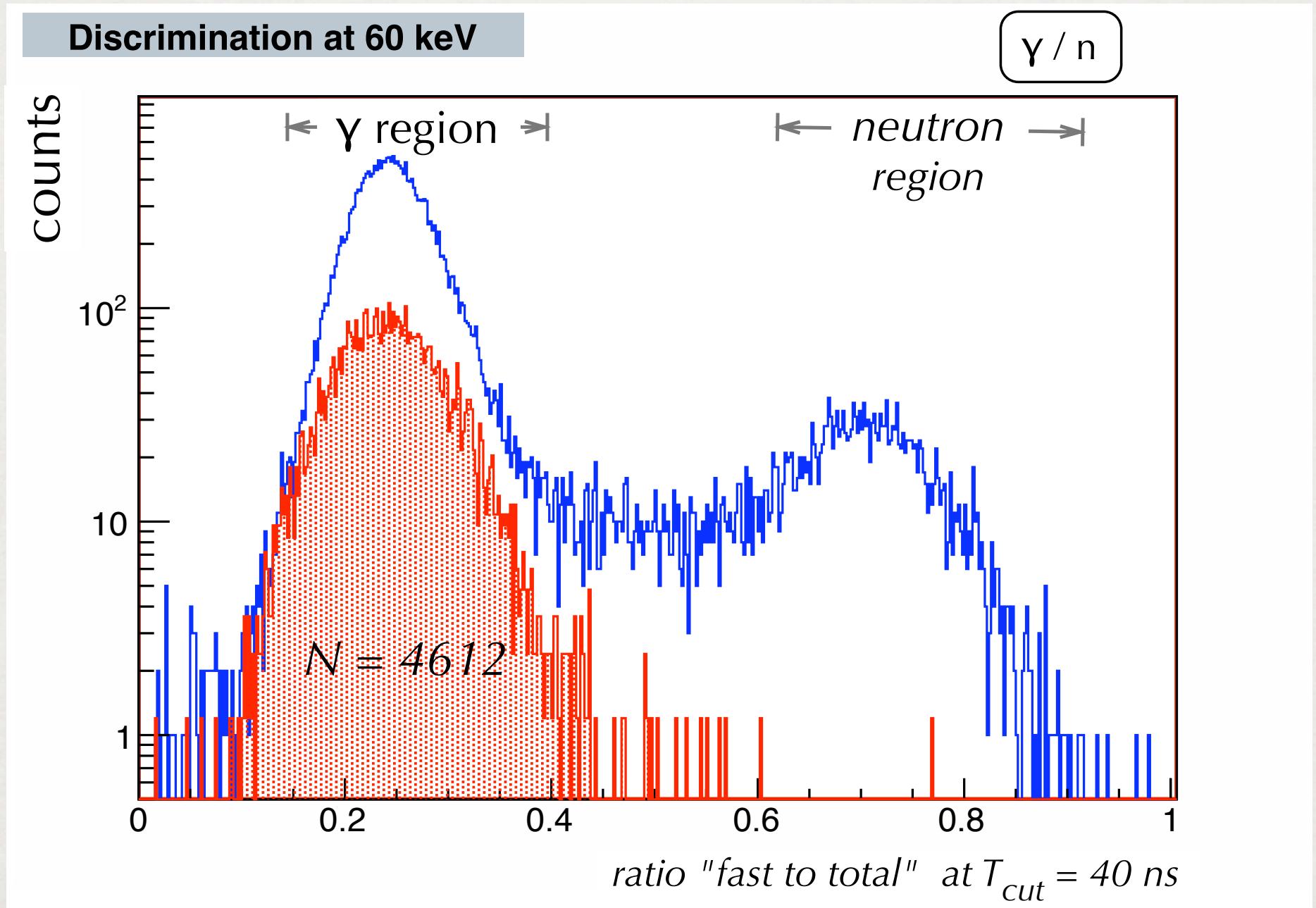
measurement

A decent γ -neutron separation.



measurement

A decent γ -neutron separation.



Showdown: simulation wins by a little more than 1 order of magnitude.

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- γ -neutron discrimination
 - 30 keV threshold energy
 - equal acceptance

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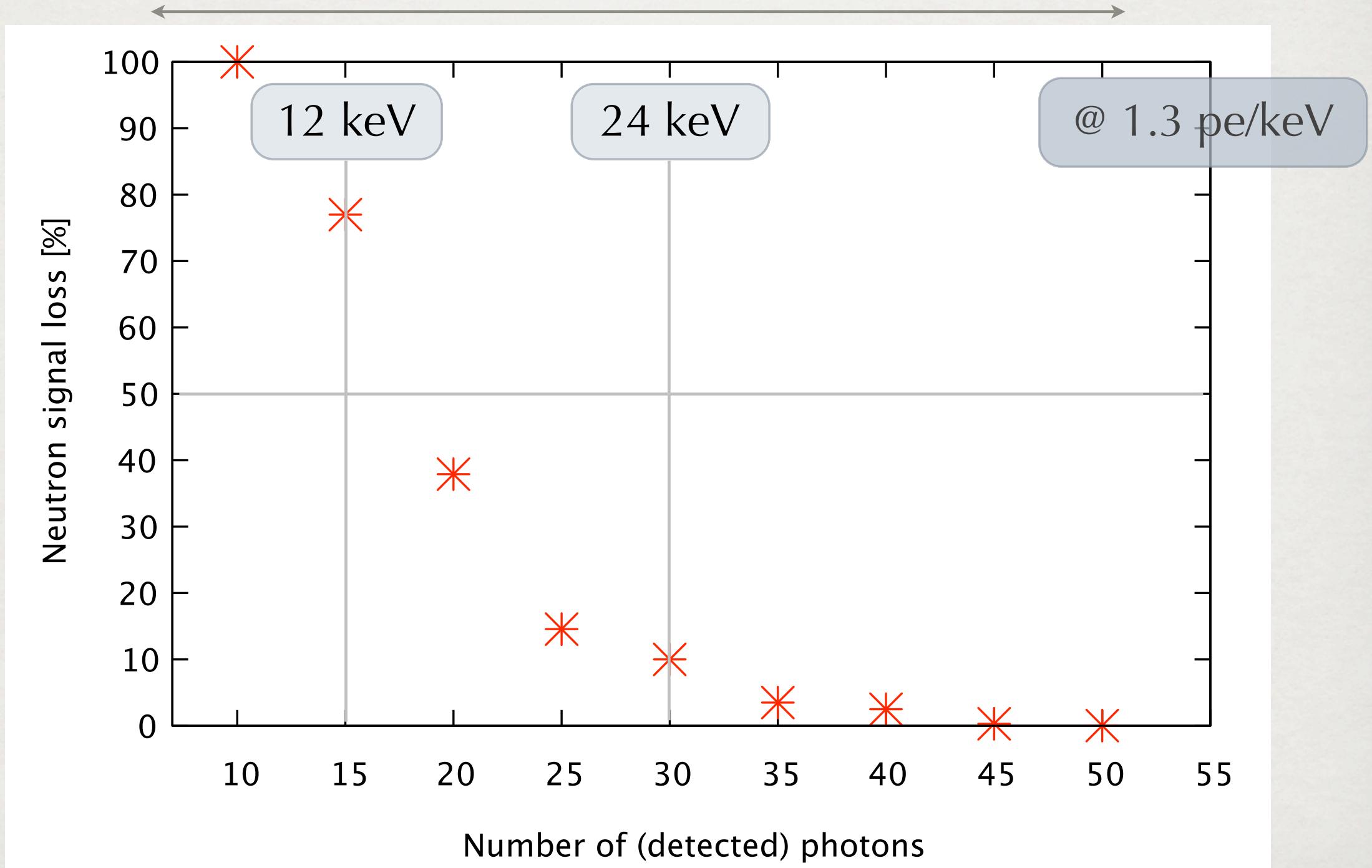


- γ -neutron discrimination
- 30 keV threshold energy
 - equal acceptance

experiment	simulation
$\leq 2.6 \cdot 10^{-3}$	$9.7 \cdot 10^{-5}$

simulation

Letting only 1 in 10^6 γ -events through ...



Conclusion



- Pulse shape discrimination using a simple “fast to total” filter has a lot of potential.
 - High energy (GERDA): background diagnosis
 - Low energy (rare event search): background discrimination