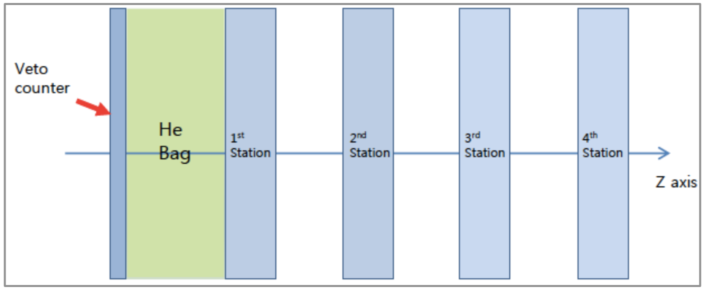
Neutron Detector Simulation For $LAMPS_H$

CFD Results for:

- $f = 0.3$
- $f = 0.2$
- $f = 0.1$
- $f = 0.05$



Optimum Timing-CFD Circuit

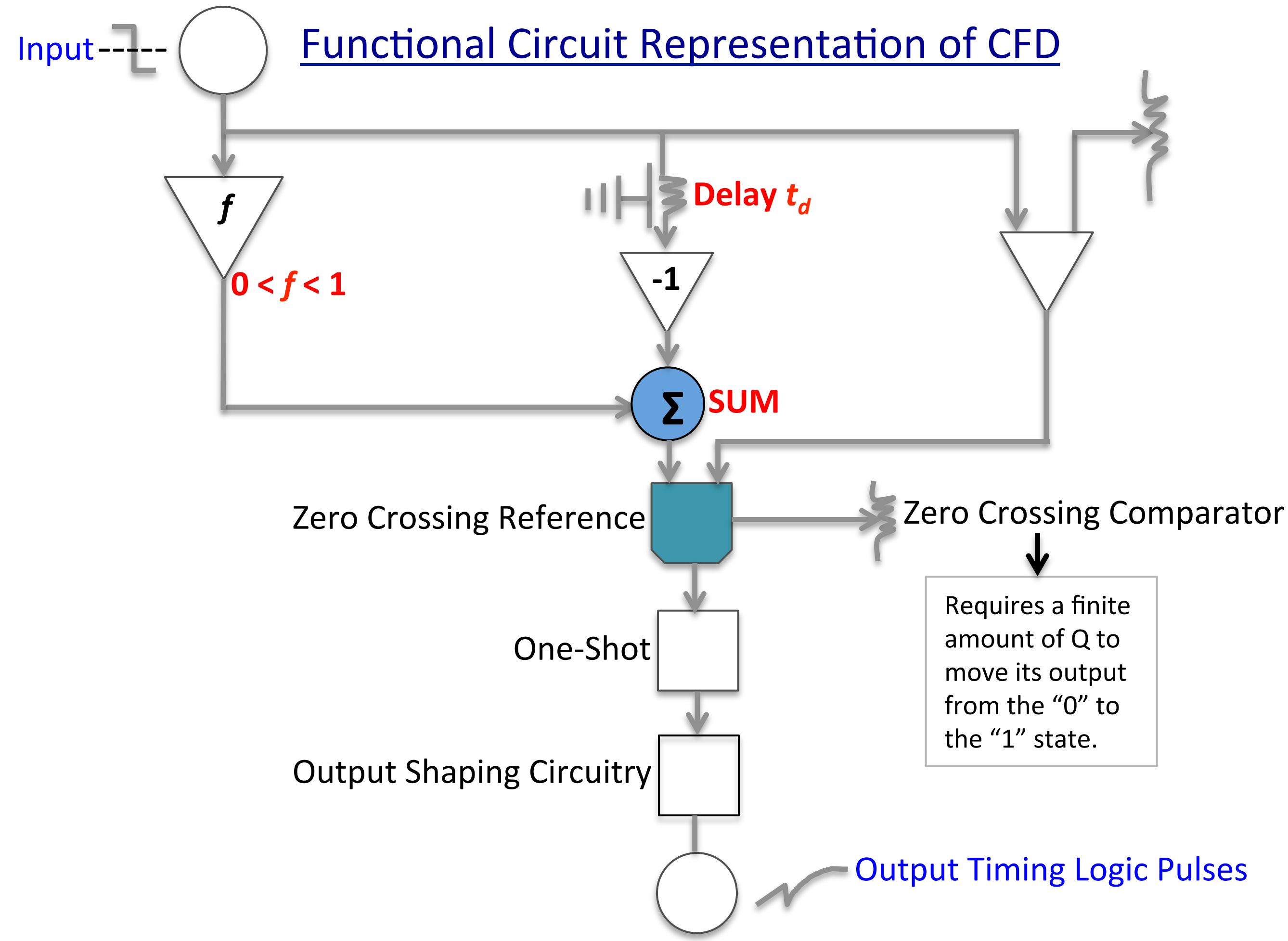


Fig.1: Functional Representation of Constant-Fraction Discriminator

CFD Simulation Result [1]

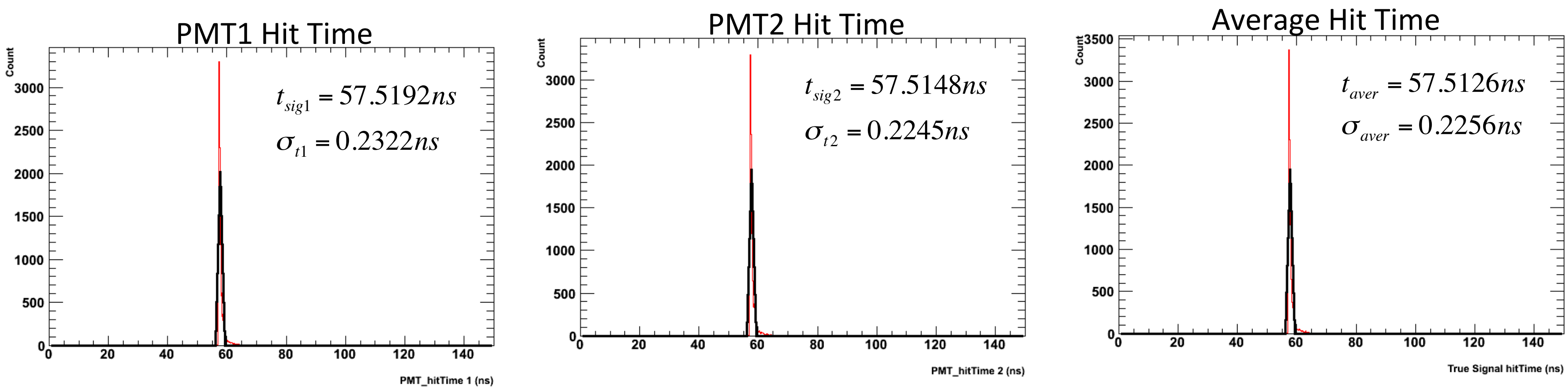


Fig.2: Time resolution for: f = 0.3, t_d = 2 ns, E_N = 300 MeV, z = 1000 mm

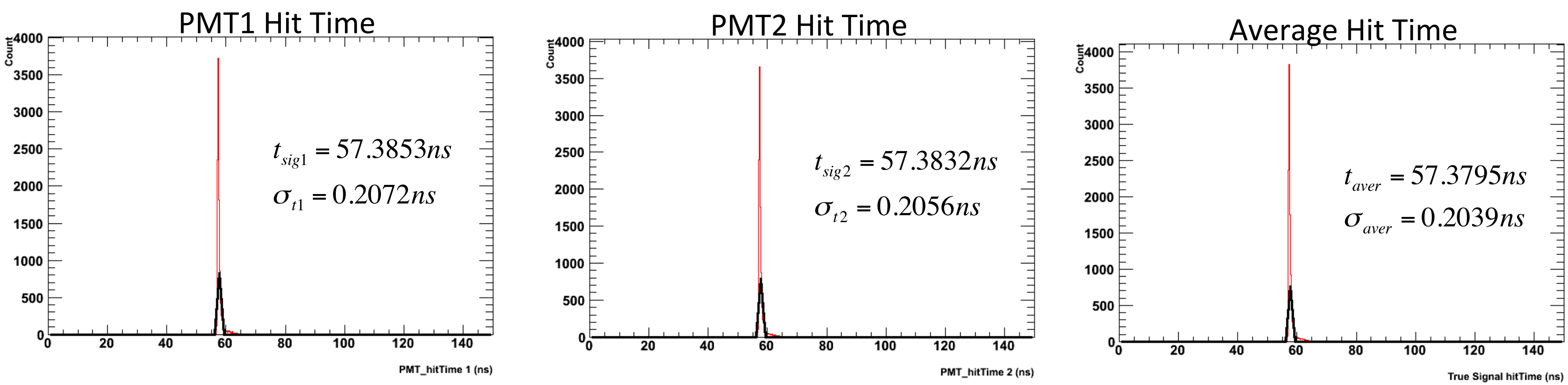


Fig.3: Time resolution for: f = 0.2, t_d = 2 ns, E_N = 300 MeV, z = 1000 mm

CFD Simulation Result [2]

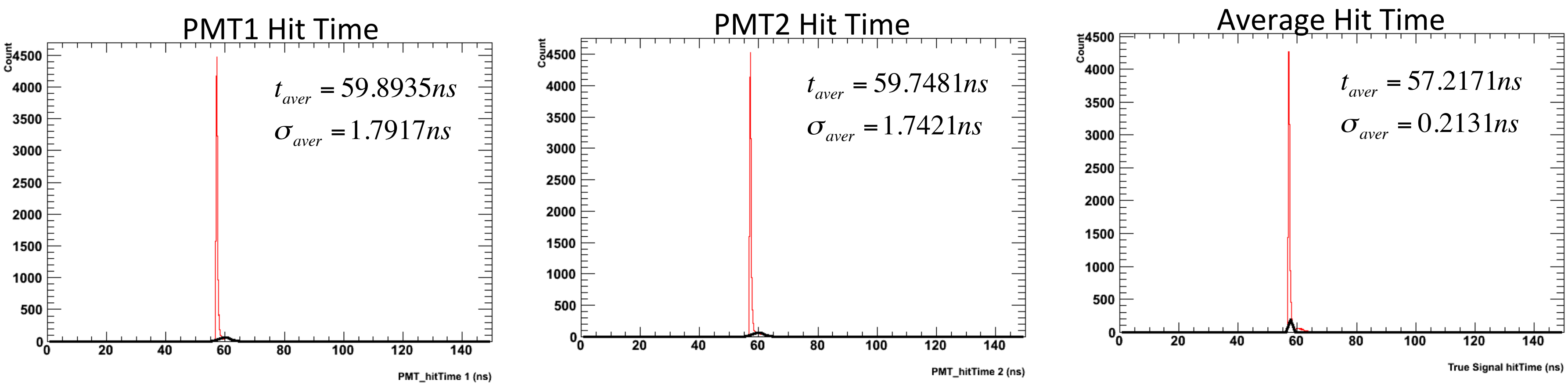


Fig. 4: Time resolution for: f = 0.1, t_d = 2 ns, E_N = 300 MeV, z = 1000 mm

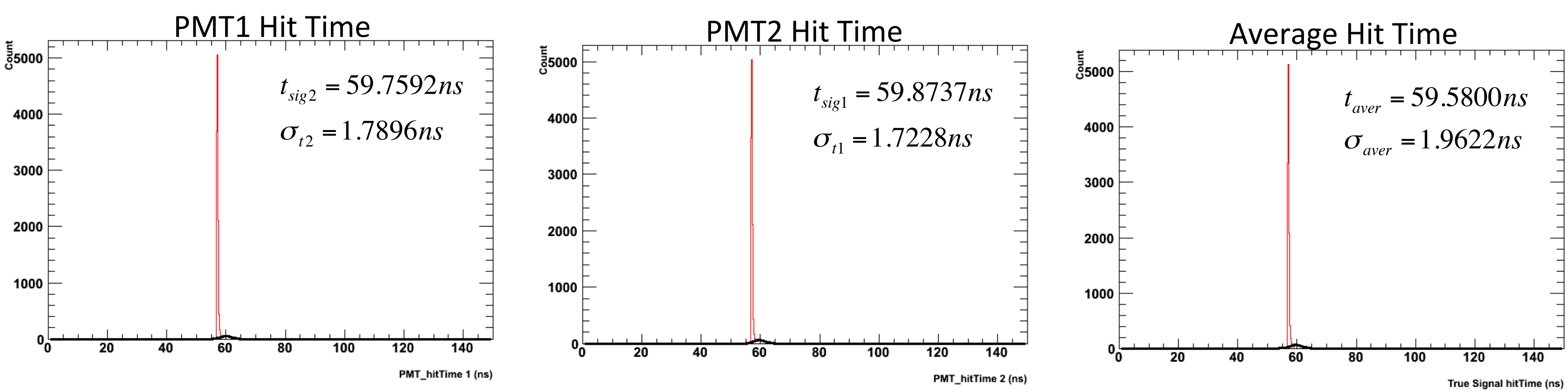


Fig. 5: Time resolution for: f = 0.05, t_d = 2 ns, E_N = 300 MeV, z = 1000 mm

CFD Simulation Result [3]

Time Resolution Results for various CFD Fractions

Fraction, f	Resolution (ps)
0.4	260.294
0.3	225.645
0.2	203.865
0.1	213.148
0.05	1962.160

Table 1

Simulation Parameters:

- $f = 0.2$
- $t_d = 2$ ns
- $E_N = 300$ MeV
- $z = 1000$ mm

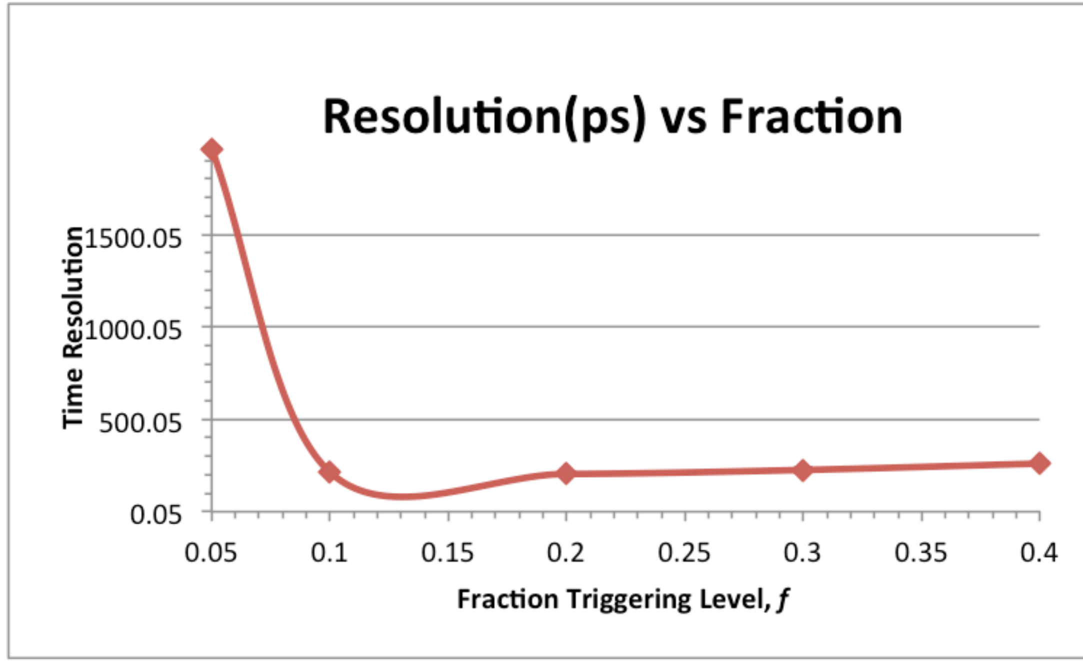


Fig.6: Detector Response to different CFD Triggering Fraction Levels

Detector response seems good for:

- Constant fraction range (0.2 < f < 0.4) as expected.
- $f = 0.3$ and $t_d = 0.3$ seem to give an optimum time resolution i.e. $\sigma = 226$ ps.
- Below *f = 0.2 (pulse amplitude < 200 mV)*, σ_t is weird since the zero-crossing comparator *(Fig.1)* requires finite Q to move its output from "0" to the "1" state.

CFD Simulation Result [4]

Optimum Position Resolution

Simulation Parameters	
E_N	300 MeV
f	0.3
t_d	0.2 ns
z	1000 mm

Table 1

<u>Hit position results</u>

- Position = 1000 mm
- Resolution = 12.8 mm

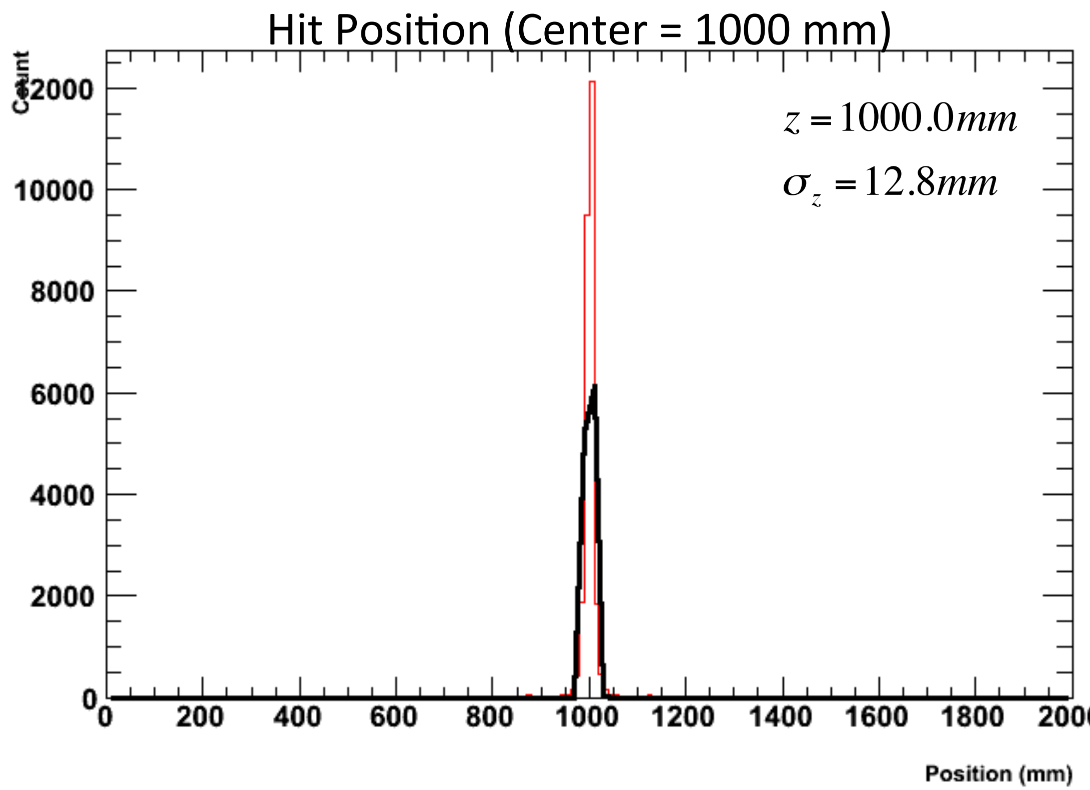


Fig.7: Optimum position resolution for simulation parameters given in Table 1.

Plan for the Next Simulation

Examine detector response by:

- Scanning different hit positions.
- Using cosmic rays.

Backup1 [Last Lab Meeting]

◎ Attenuated, delayed and inverted pulses are added and zero crossing computed

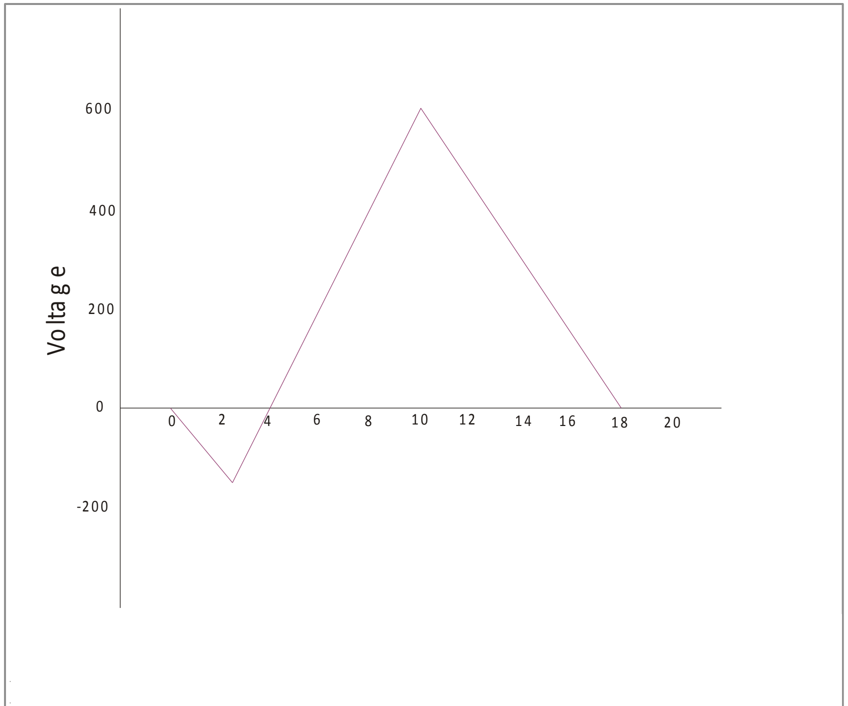


Fig.5: Sum of Attenuated, delayed and inverted pulses

Equations for CFD

- Input pulse, $V_i = -At$
- Attenuated pulse, $V_a = -fAt$
- Delayed & inverted pulse, $V_d = A(t-t_d)$

Where:

- A = *initial amplitude*
- f = *fraction*
- t_d = *delay*

Finding zero-crossing

Set

$0 = V_a + V_d$ [and solve for t]

$$0 = -fAt + A\left(t - t_d\right)$$

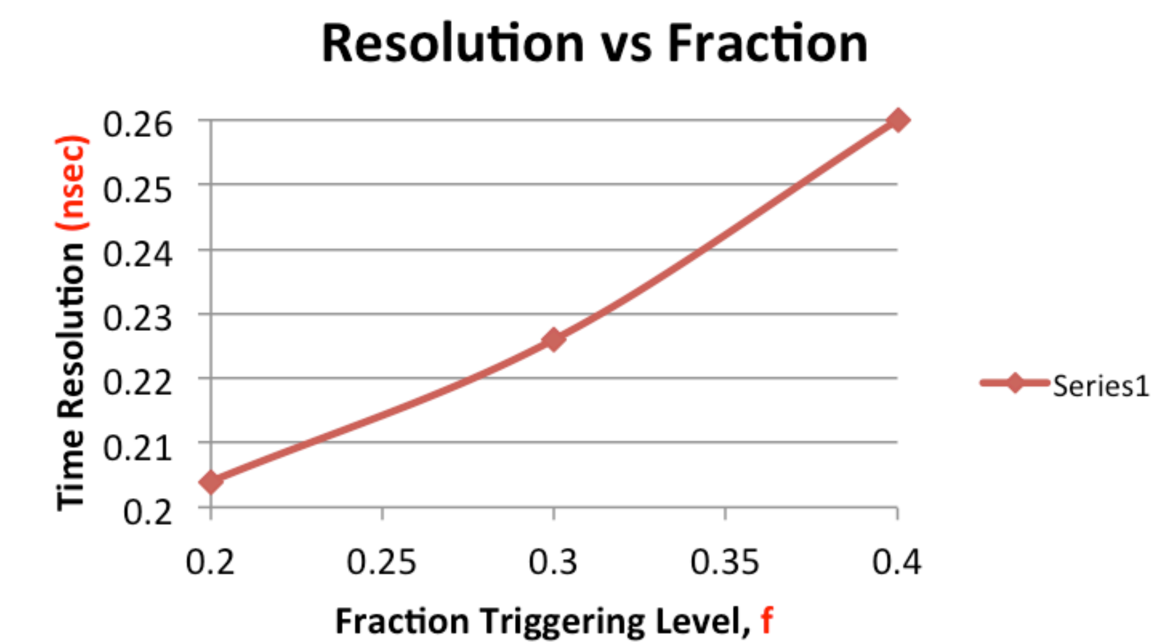
$$\therefore t_{cross} = \frac{t_d}{\left(1 - f\right)}$$

⌘ CFDs give optimum σ_t in fraction range $0.2 \le f \le 0.4$

Backup2 [Last Lab Meeting]

CFD-Fraction Triggering Level Scan

300 MeV Neutron Energy



Fraction, *f*: 02 ≤ 0.4

Fraction, *f*	Resolution
0.2	204 ps
0.3	226 ps
0.4	260 ps

Simulation parameters

- 300 MeV Neutrons
- L_1 = 1000 mm
- L_2 = 1000 mm
- f_{CFD} = 0.2 ≤ 0.4
- T_d = 2 ns

Backup3

BC-400/BC-404/BC-408/BC-412/BC-416
Premium Plastic Scintillators

General Description The premium plastic scintillators described in this data sheet include the most economical (BC-416) as well as those with the highest light output.

General Technical Data

Base .... Polyvinyltoluene
Density .... 1.032 g/cc
Refractive Index 1.58
Coefficient of Linear Expansion .... 7.8×10^{-5}, below 67°C
Atomic Ratio, H/C .... ~1.1
Light Output Temperature Dependence .... At +60°C = 95% of that at +20°C; independent of temperature from -60°C to +20°C
Vapor Pressure .... May be used in a vacuum
Solubility .... Soluble in aromatic solvents, chlorine, acetone, etc. Insoluble in water, dilute acids, lower alcohols, silicone fluid, grease and alkalis.

Radiation Detected	Scintillator
< 100 keV X-rays	BC-404
100 keV to 5 MeV gamma rays	BC-408
>5 MeV gamma rays	BC-400 BC-416
Fast neutrons	BC-408 BC-412
Alphas, betas	BC-400 BC-404
Charged particles, cosmic rays, muons, protons, etc.	BC-408 BC-412 BC-416

Properties

	BC-400	BC-404	BC-408	BC-412	BC-416
Light Output, % Anthracene	65	68	64	60	38
Rise Time, ns	0.9	0.7	0.9	1.0	—
Decay Time, ns	2.4	1.8	2.1	3.3	4.0
Pulse Width, FWHM, ns	2.7	2.2	~2.5	4.2	5.3
Light Attenuation Length, cm*	160	140	210	210	210
Wavelength of Max. Emission, nm	423	408	425	434	434
No. of H Atoms per cm^3, (x10^{22})	5.23	5.21	5.23	5.23	5.25
No. of C Atoms per cm^3, (x10^{22})	4.74	4.74	4.74	4.74	4.73
Ratio H:C Atoms	1.103	1.100	1.104	1.104	1.110
No. of Electrons per cm^3, (x10^{23})	3.37	3.37	3.37	3.37	3.37
Principal uses/applications	general purpose	fast counting	TOF counters, large area	large area	large area economy