Scintillator Material Study

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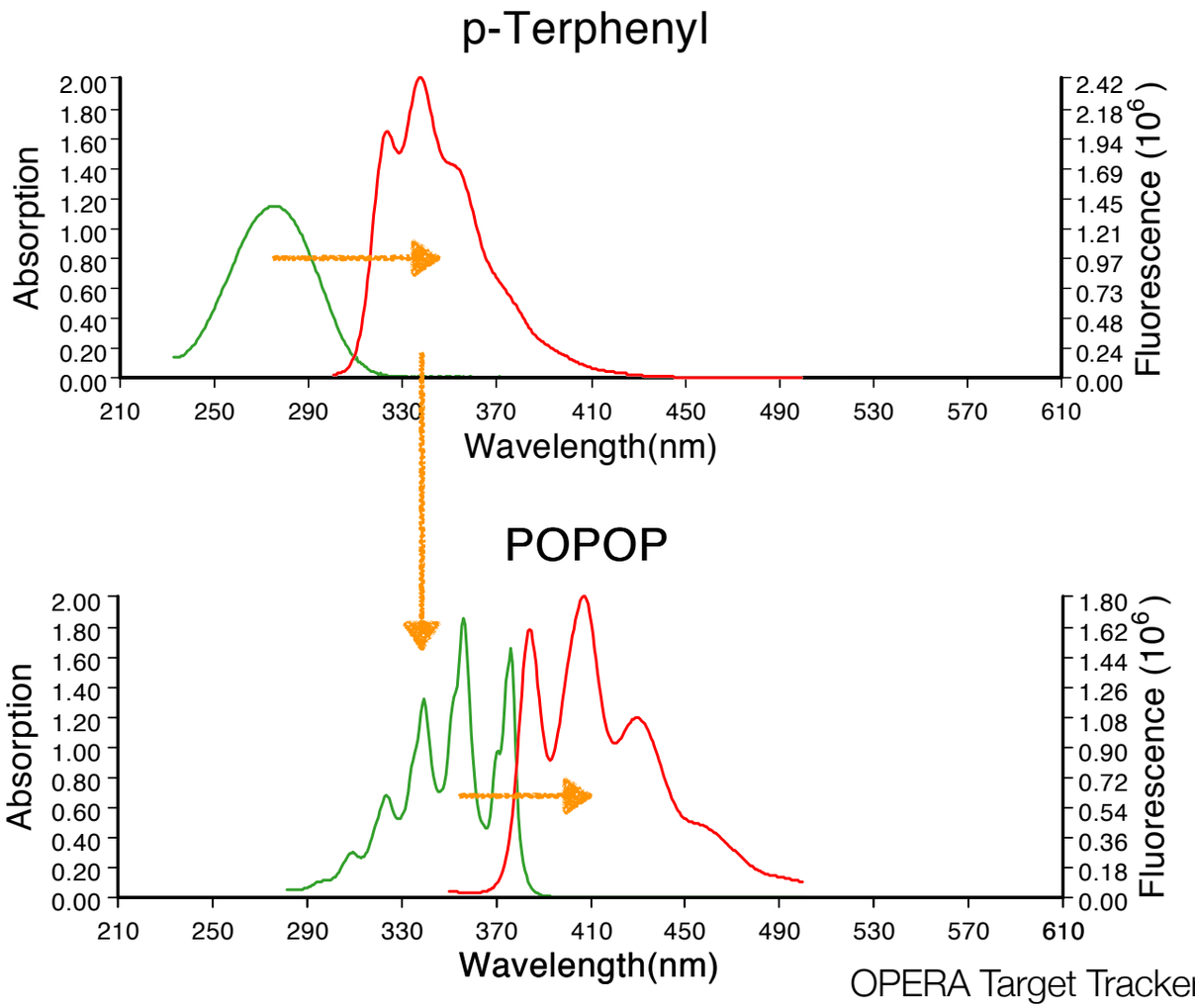
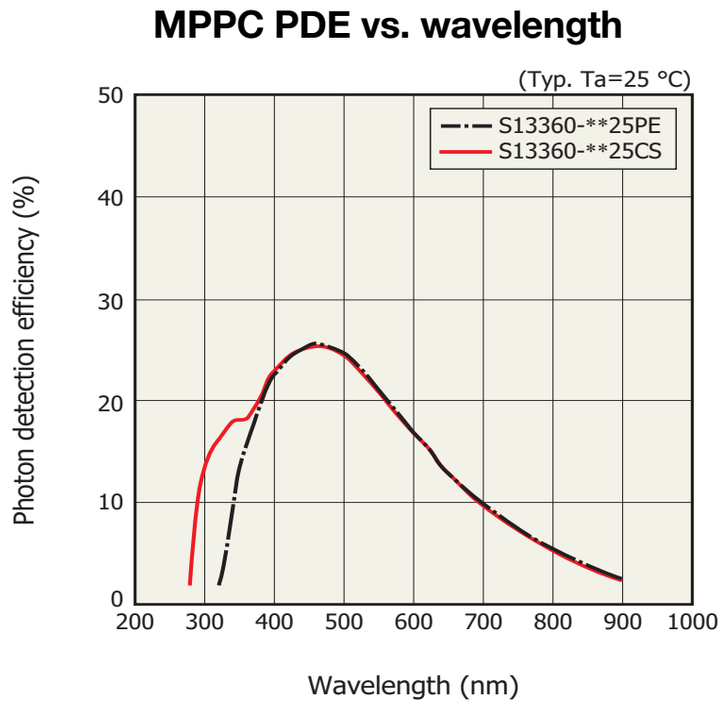
Scintillator Material Study

- **Development of plastic scintillator material of better performance**
- **Base scintillator material candidates**
  - **Poly-vinyl toluene (PVT)**
    - 😊High light yield
    - 😥Production (casting+machining) is cumbersome.
  - **Polystyrene (PS), Estyrene-MS (MS)**
    - 😐Moderate light yield
    - 😊Production (injection moulding) is easier.
- **Performance of PS-based scintillator is being optimised.**
- **Performance measured with AHCAL tile configuration ($30\times30\times3mm^3$).**

Optimisation of Fluor Concentration

- **Test sample**
  - Scintillator base: **Polystyrene (PS)**
  - 1st fluor: **p-Terphenyl**
  - 2nd fluor: **POPOP**
- **Reference sample**
  - **Poly-vinyl toluene (PVT): EJ-212 (ELJEN)**





OPERA Target Tracker TDR

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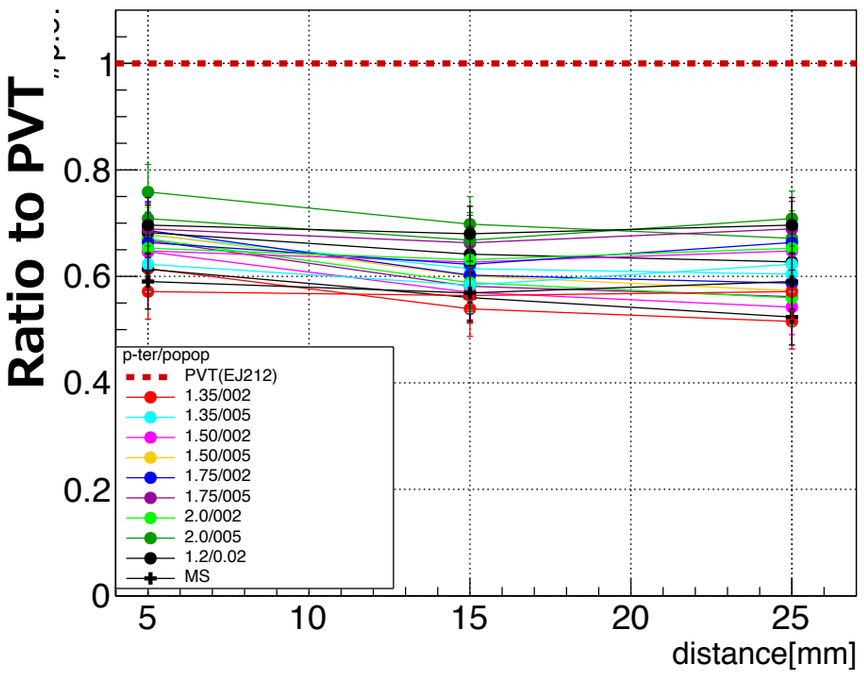
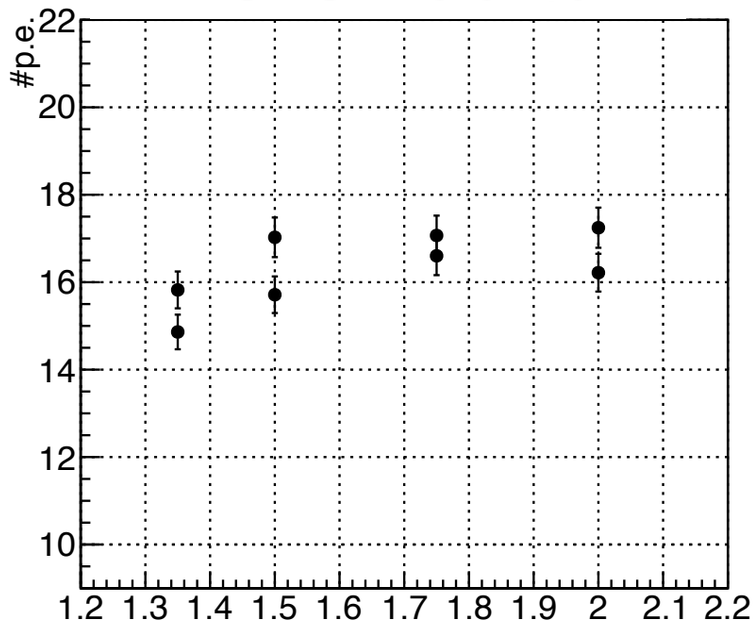
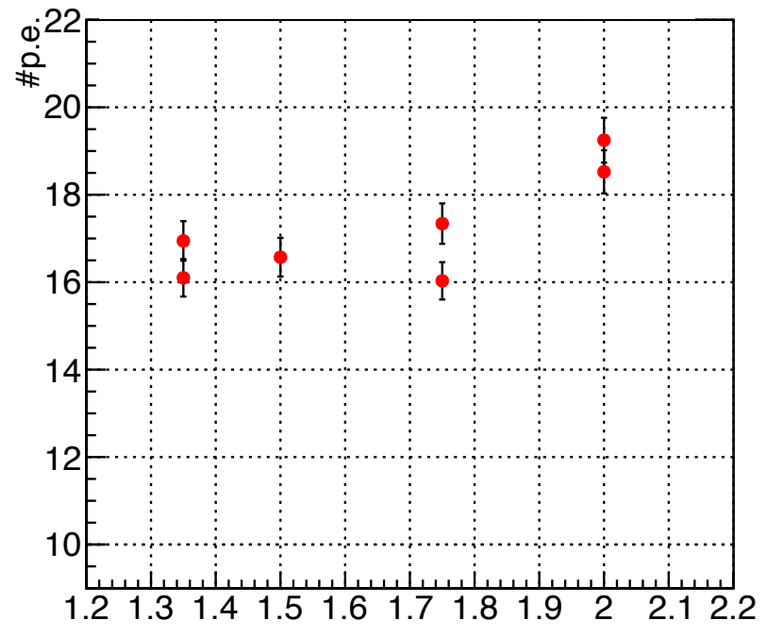
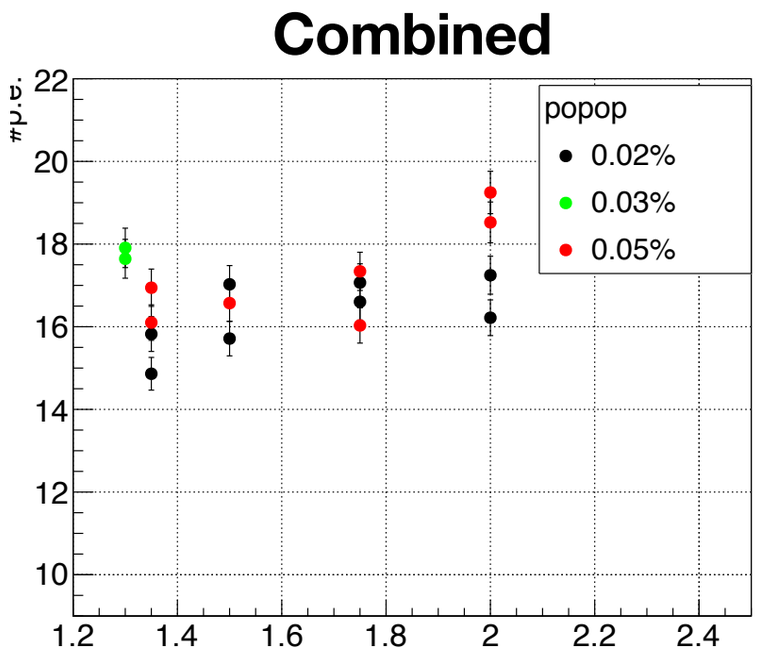
Previous Results

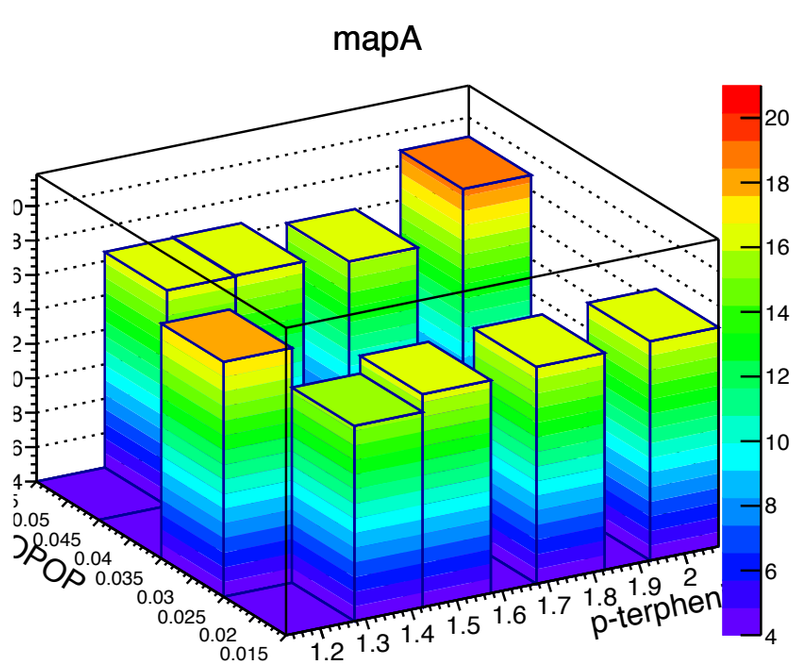
Relative light yield











- **Light yield improved up to 75% w.r.t. PVT scintillator**
- **Not obvious, but suggesting higher light yield with higher fluor concentration**

Further Optimisation of Fluor Concentration

- **Even higher concentrations are tried.**
  - **p-Terphenyl:** [1.75%, 3%]
  - **POPOP:** [0.05%, 0.1%]
- **Reference**
  - **Poly-vinyl toluene (PVT): EJ-212 (ELJEN)**
- **No obvious degradation found in eye inspection**
  - **Still transparent**
  - **Good surface quality after injection moulding**

# of samples (previous test)

p-Terphenyl

POPOP	1.2%	1.35%	1.5%	1.75%	2%
0.02%		2	2	2	
0.03%	2				
0.05%		2	2	2	

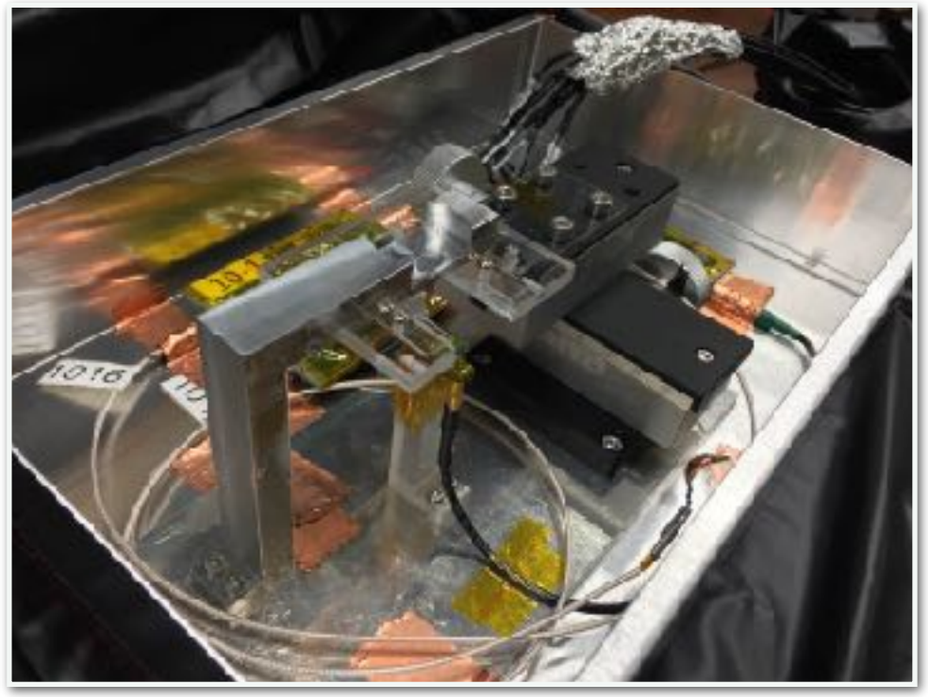
# of samples (this test)

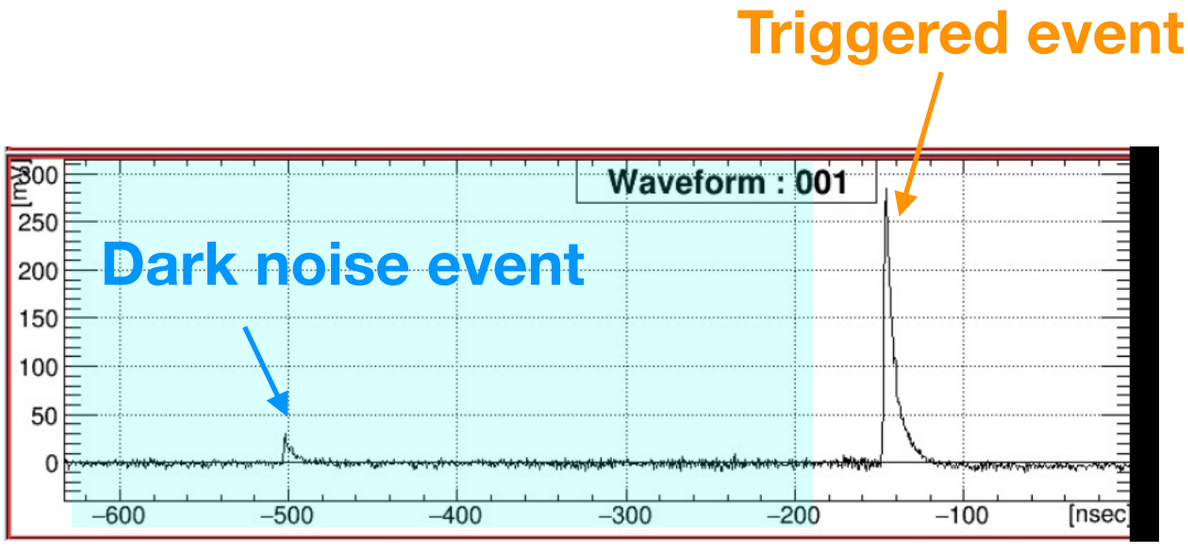
p-Terphenyl

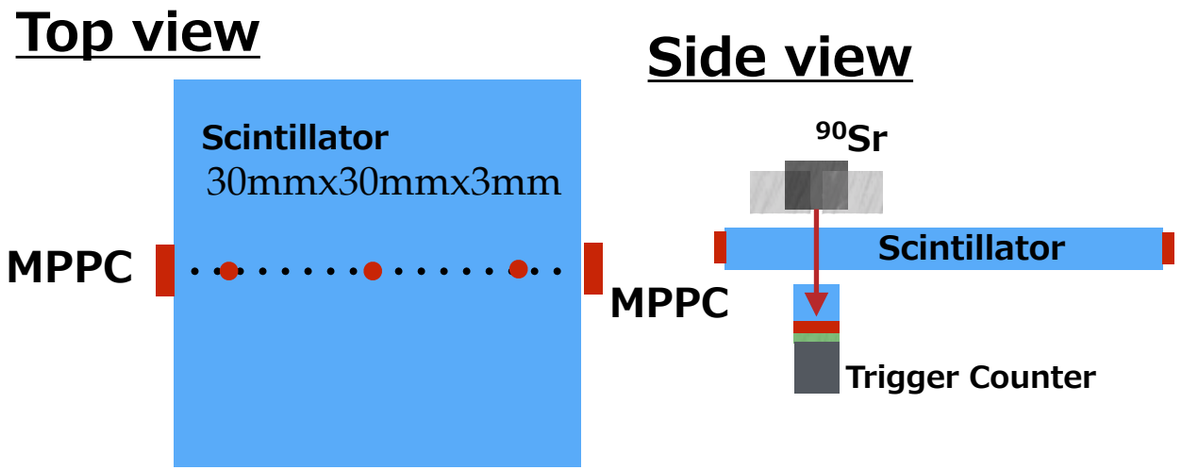
POPOP	1.75%	2%	2.5%	3%
0.05%	3	3	3	3
0.07%	3	3	3	3
0.1%	3	3	3	3

Measurement Setup

- **Setup**
  - MPPC: S12571-025P (1×1mm^2, 25μm cell pitch)
  - Collimated β from Sr-90 (E<2.2MeV) + trigger counter on the other side
  - Light yield measured at several positions to check attenuation
- **Waveform analysis to measure light yield**
  - Single photoelectron gain estimated using off-time dark noise event
  - Light yield measured from triggered event

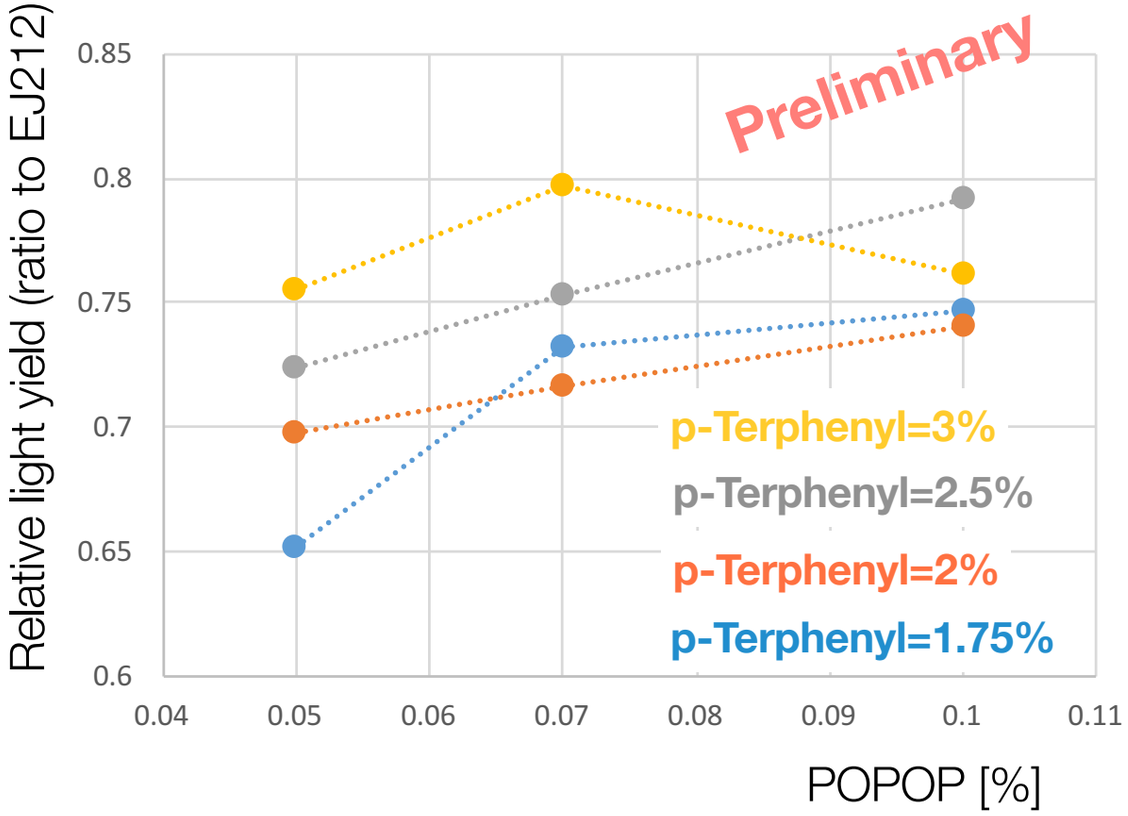


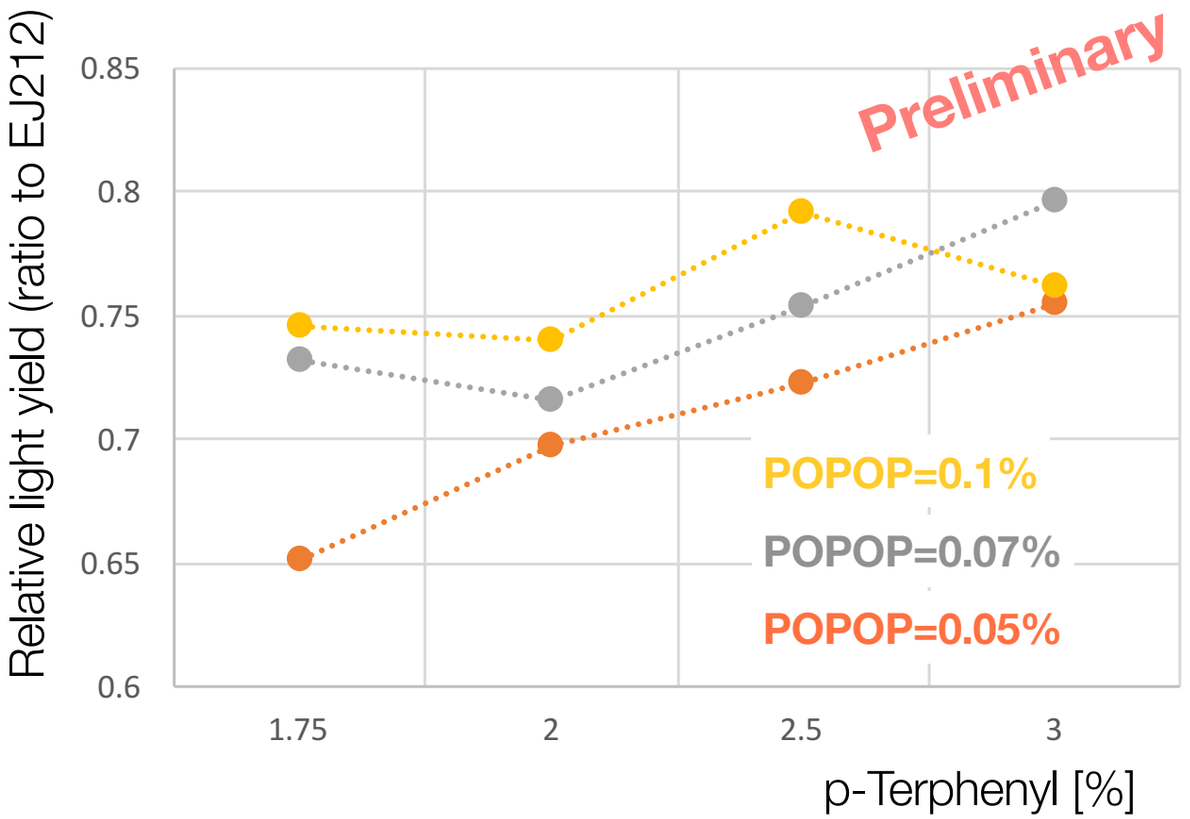




Results

- **Relative light yield w.r.t PVT(EJ-212)**
  - Averaged over repeated measurements with three samples
    - Uncertainties
      - Sample-by-sample variation: 10-15%
      - Reproducibility of measurement: 10%
- **Best light yield reaching up to 80% of PVT**
- **Not totally saturated for higher concentrations**

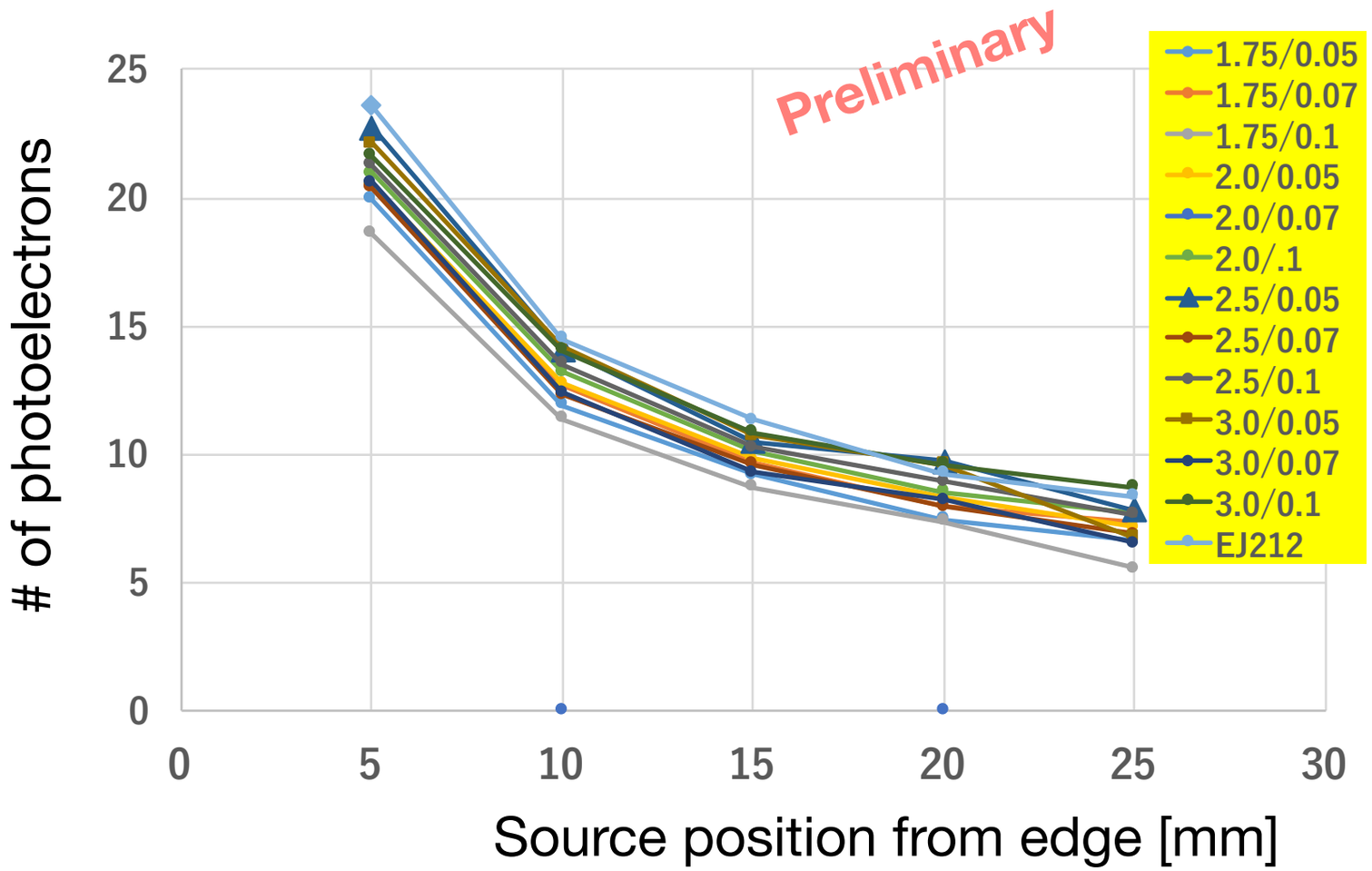




Results

- **Position dependence**
  - No significant difference between PVT and PS with different fluor concentrations

    →No difference in attenuation and surface condition within AHCAL tile size



N.B. **no averaging over different samples**

Summary

- **Fluor concentrations are being optimised to maximise light yield of polystyrene-based scintillator for AHCAL**
- **Tested higher concentrations for p-Terphenyl and POPOP**
  - Slight improvement of light yield for even higher concentrations
  - Not obvious, but still not totally saturated at higher concentrations
- **Need further studies**
  - Still improving with higher concentration?
  - Other properties should also be investigated.
    - Surface quality after injection molding
    - Mechanical stability
    - Light attenuation
    - Reproducibility in production
    - Radiation hardness
    - …
  - Test other fluor?
    - PPO or b-PBD as the 1st fluor instead of p-Terphenyl
      (Better light yield reported for (PPO, POPOP) in NIMA 835(2016)136)