

R&D of Extruded Scintillator

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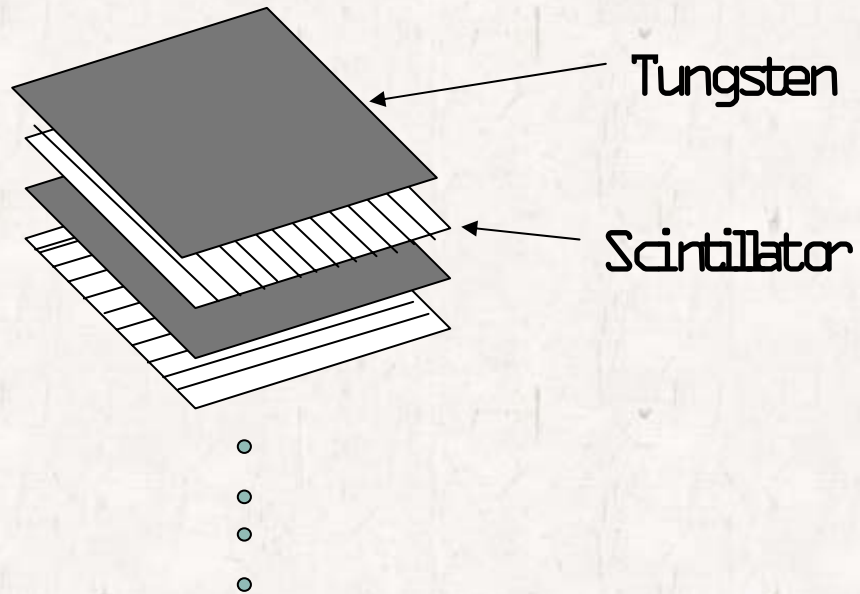
Basic Configuration

➤ Prototype for EM Calorimeter

One Layer : Tungsten 20cm X 20cm X 0.3cm

(example) Scintillator 1cm X 20cm X 0.2cm X 20 strips

➔ Total : 30 Layers
(~ 26 Xo)



➤ Strip scintillator → possible with extruded scintillator !
moreover, it is cheap!

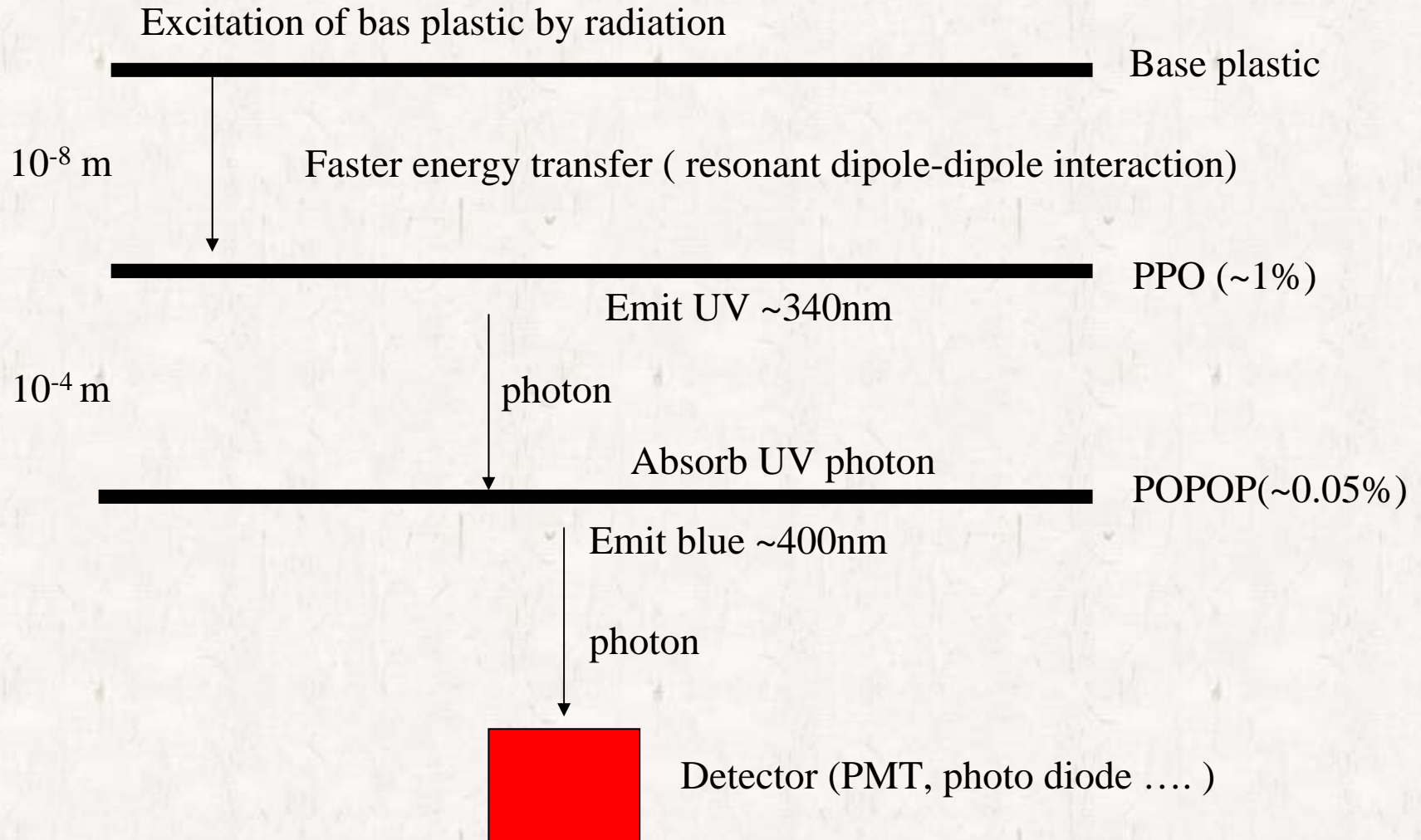
Current R&D Status

- At first, the pure polystyrene bar was produced without PPO, POPOP
 - The mechanical process has been established
- At second, PPO and POPOP were mixed up with polystyrene
 - The 1st scintillator had been produced.
- Many scintillators have been produced with different situations since then.
 - different dopings of PPO and POPOP, various mix-up methods, temperatures etc..

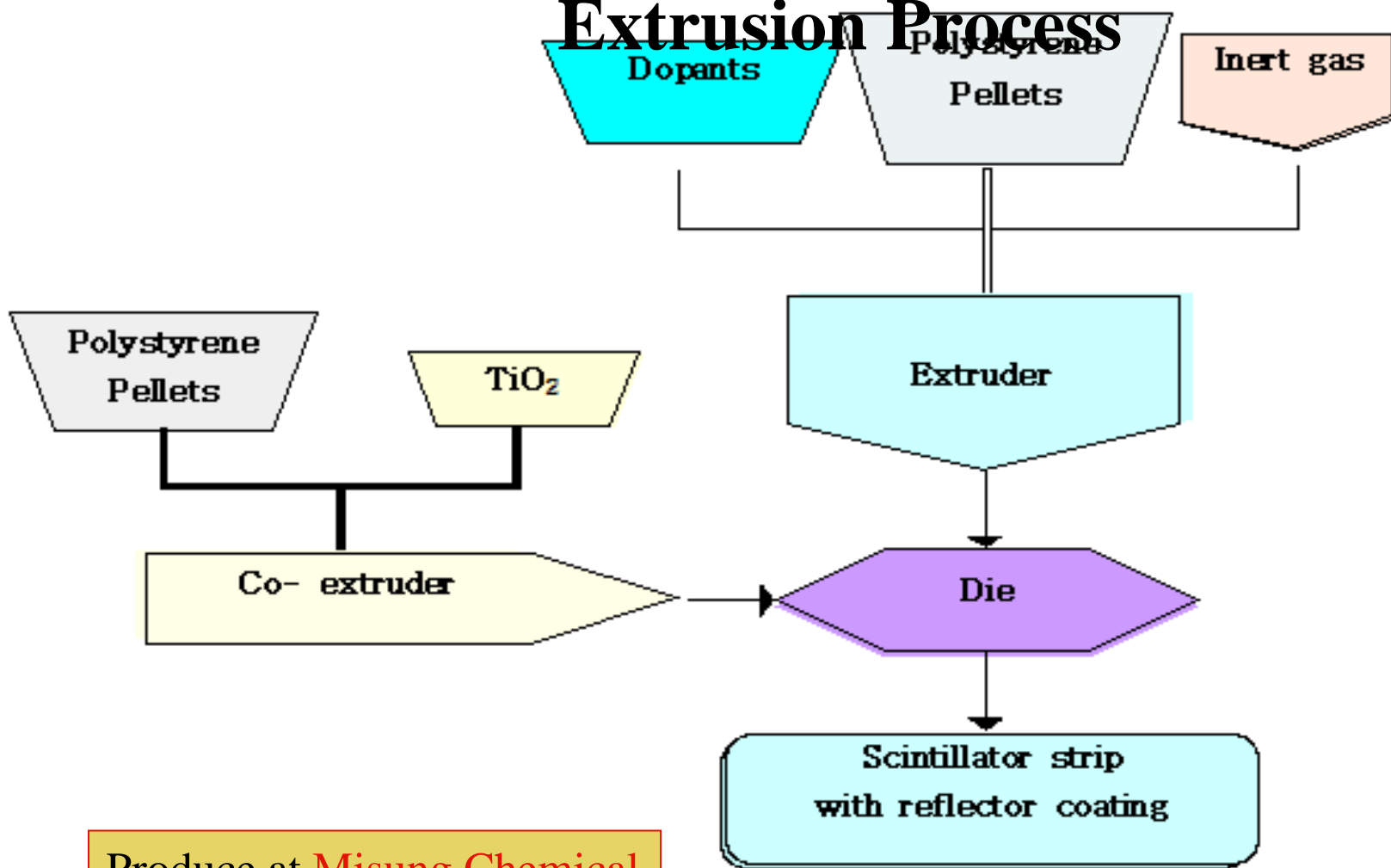
Plastic Scintillator

- Component: Polystyrene pellets + Dopants (primary & secondary)
- Dopants
 - Primary dopants (blue-emitting)
PPO(2,5-biphenyloxazole) , **PT**(p-Teraphenyl)
1-1.5% (by weight) concentration
 - Secondary dopants (green-emitting)
POPOP(1,4-bis(5-Phenyloxazole-2-yl)benzene),
bis-**MSB**(4-bis(2-Methylstyryl)benzene)
0.01-0.03% (by weight) concentration
- Production : Extrusion method
extrusion is easy to make numerous type of scintillator

Plastic Scintillator – how does it work ?



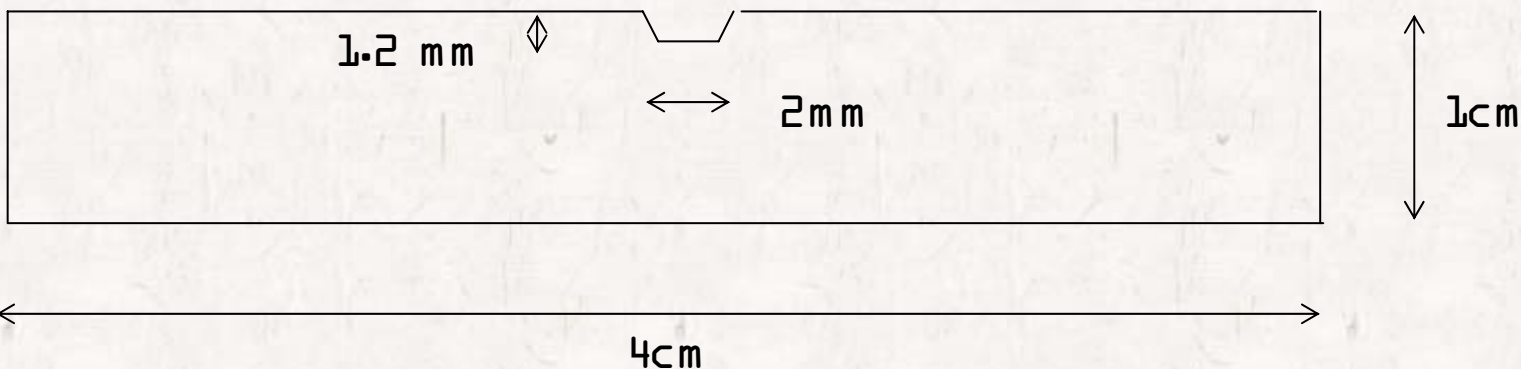
Extrusion Process



Produce at **Misung Chemical company** In Korea

Die and Materials

➤ Die profile



➤ Mixture of dopants

Polystyrene : 3 kg
PPO : from 1.3 %
POPOP : from 0.03%

- This was originally for MINOS tile
- We start to produce this tile for a reference
- produce and compare the light yield with reference tile

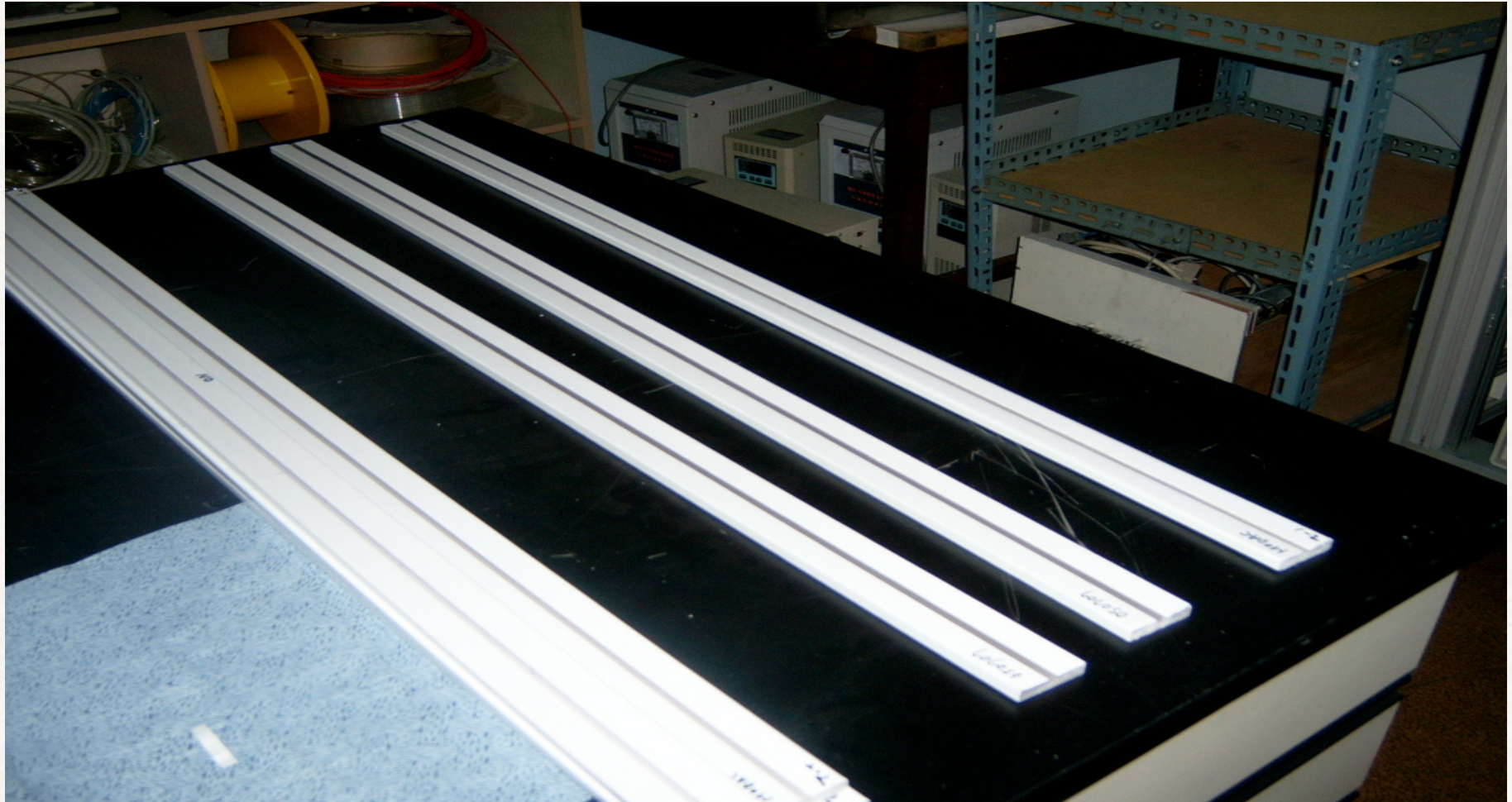
Mechanical establishment of tile

- Produce polystyrene bar without PPO for mechanical establishment
- TiO_2 was coextruded to make reflector for test.
- The first product had big groove and rough surfaces → die and method had problems
- but soon, the excellent bars were produced → assure mechanically
- Then, 1st batch came with PPO and POPOP.



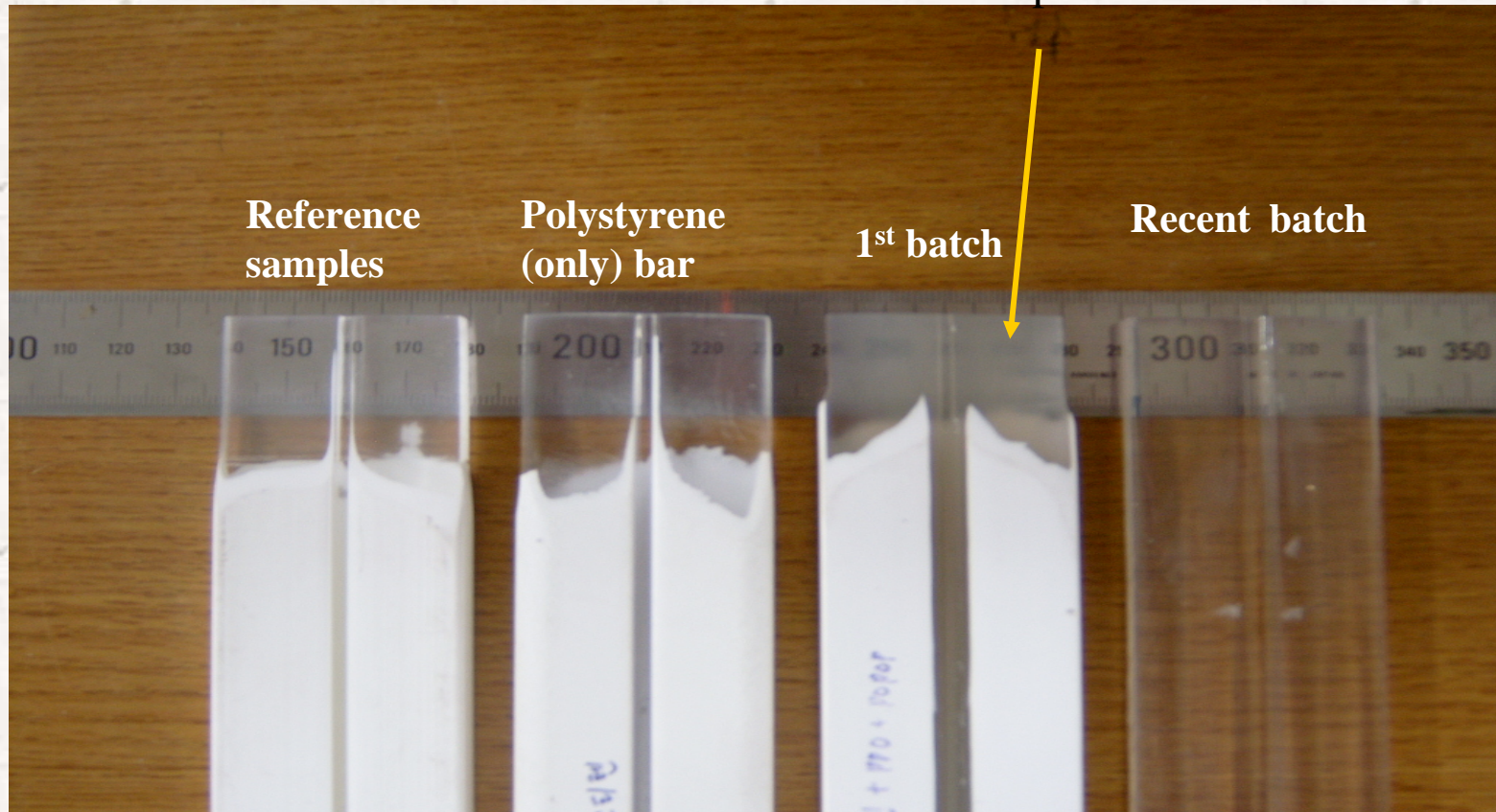
Evolution

Production of Scintillator bar



Comparision of transparency

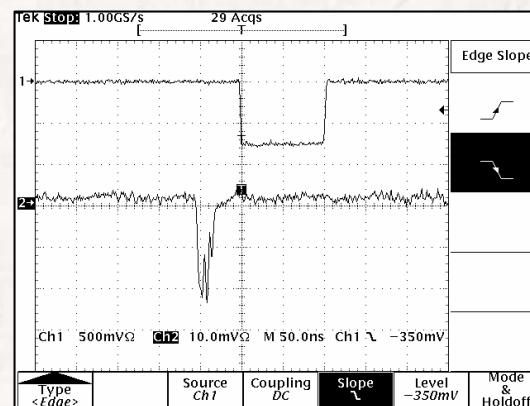
Oxidation made the sample opaque because of production in air.



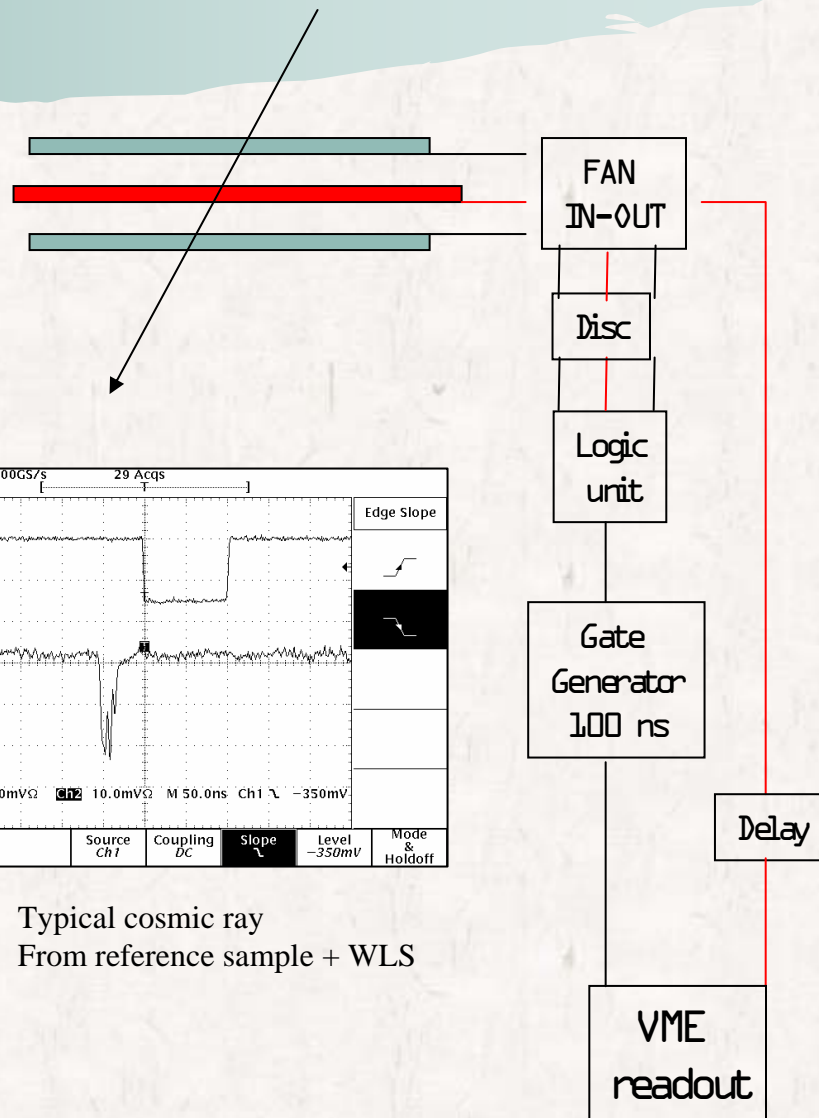
Evolution

Scintillator test setup

- 5 reference samples and new samples with the same geometrical shape and size were used to compare the light yield



Typical cosmic ray
From reference sample + WLS

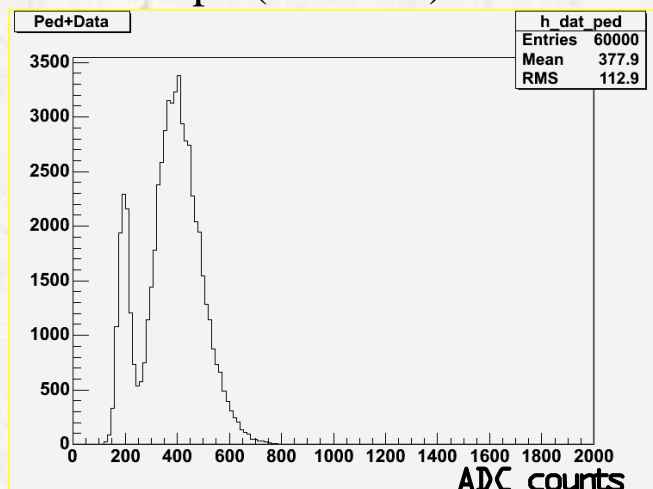


Preparation of test samples



Pulse Height (1st batch)

New sample(1st batch)



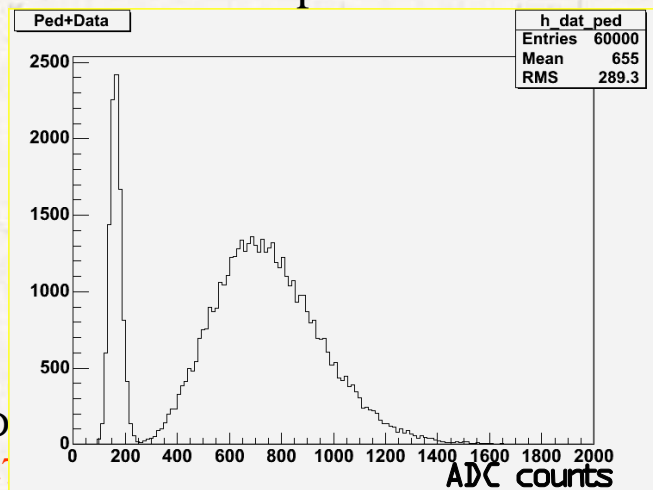
New scintillator bars (5 samples)

$$\langle \text{ADC counts} \rangle = 225.9 \pm 24.9$$

Reference scintillator bars(5 samples)

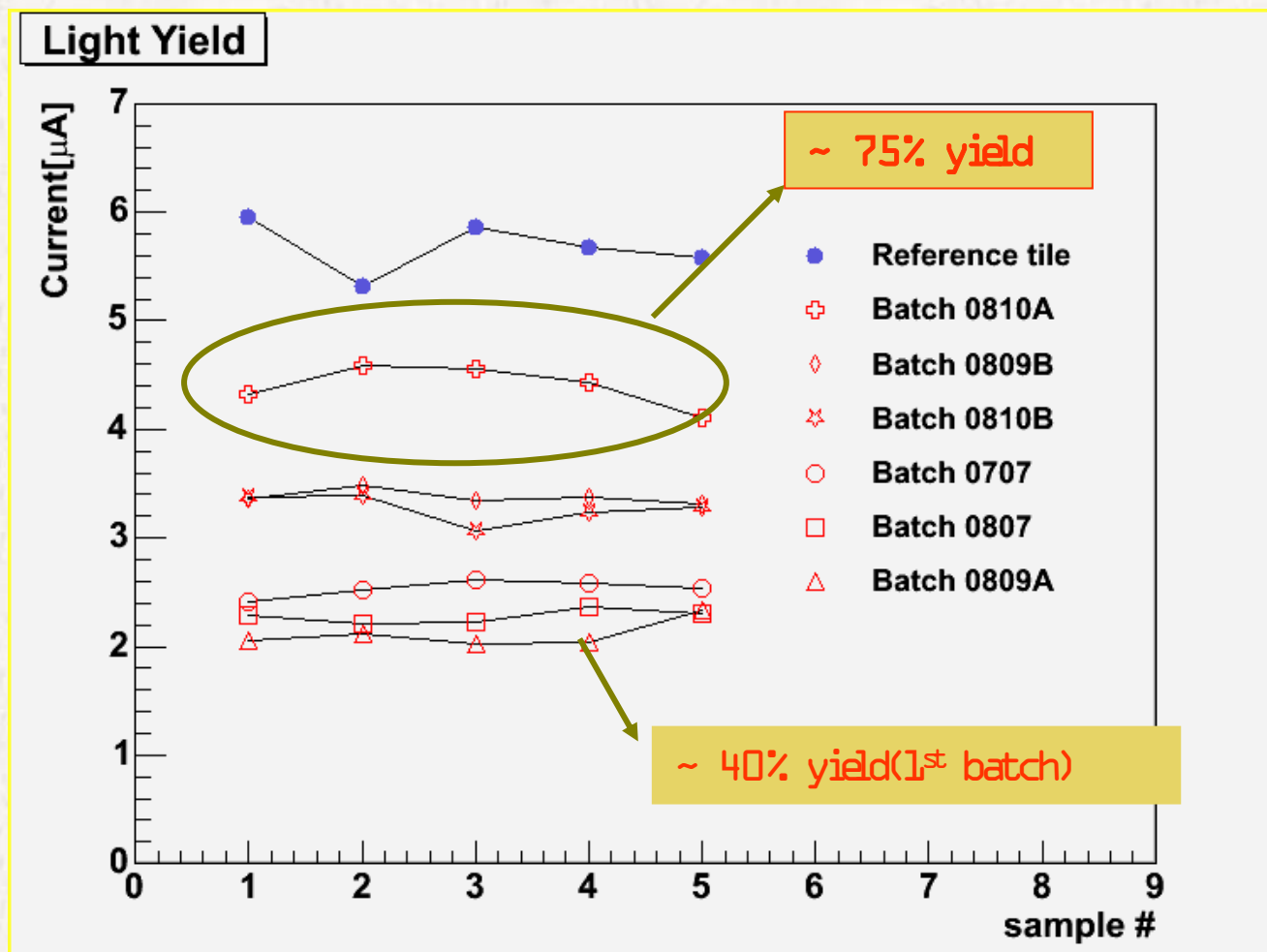
$$\langle \text{ADC counts} \rangle = 534.8 \pm 56.9$$

Reference sample



Relative Light Yield of new samples
shows **42.3%** of reference samples

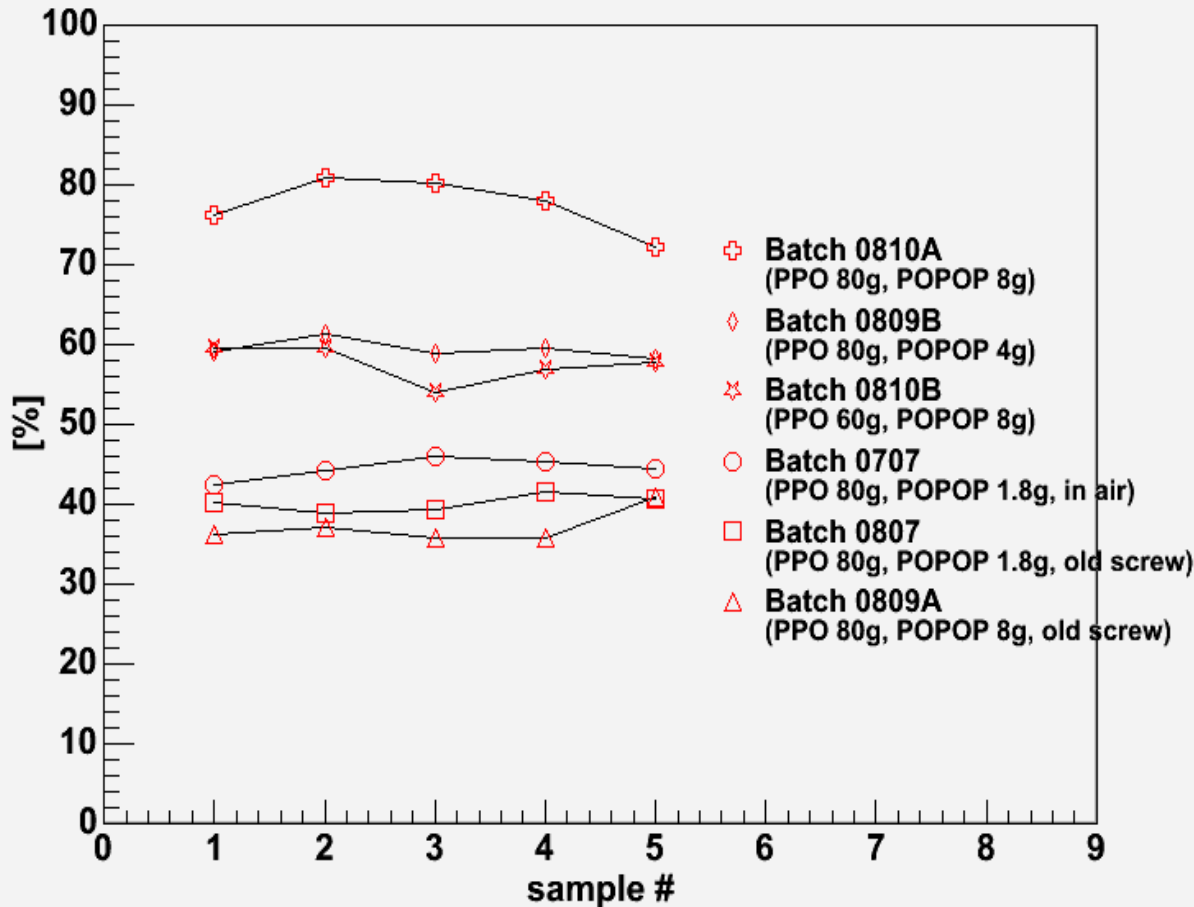
Light Yield



- 5 sample chosen
- evolve from 40%
- currently ~ 75%
- seems achievable to 100% or ??
- more R & D anyway
- but expect to get soon

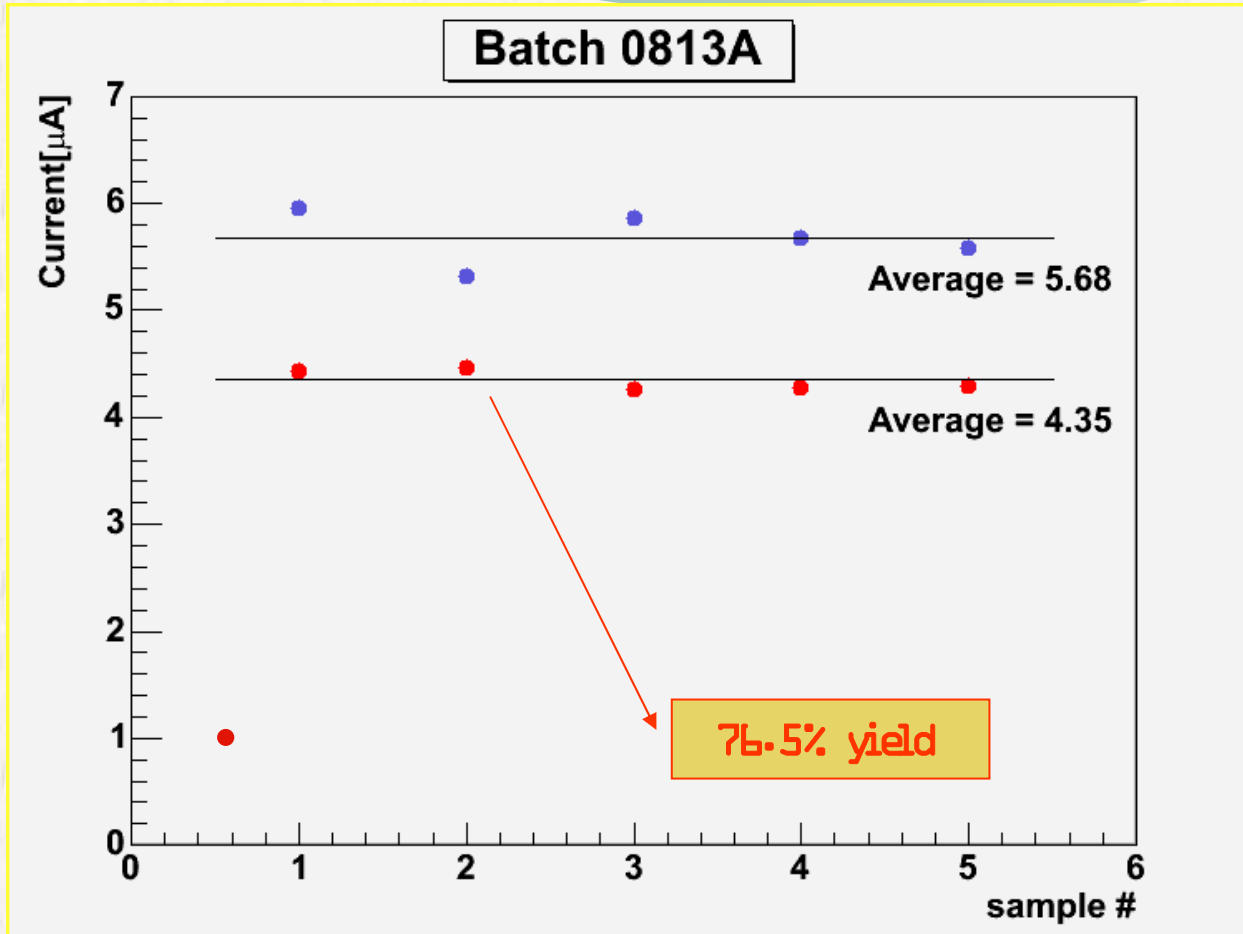
Light Yield(%)

Light Yield



- reference tile to be 100% light yield
- PPO and POPOP amount ratio important to maximize light yield

Light Yield(most recent one)

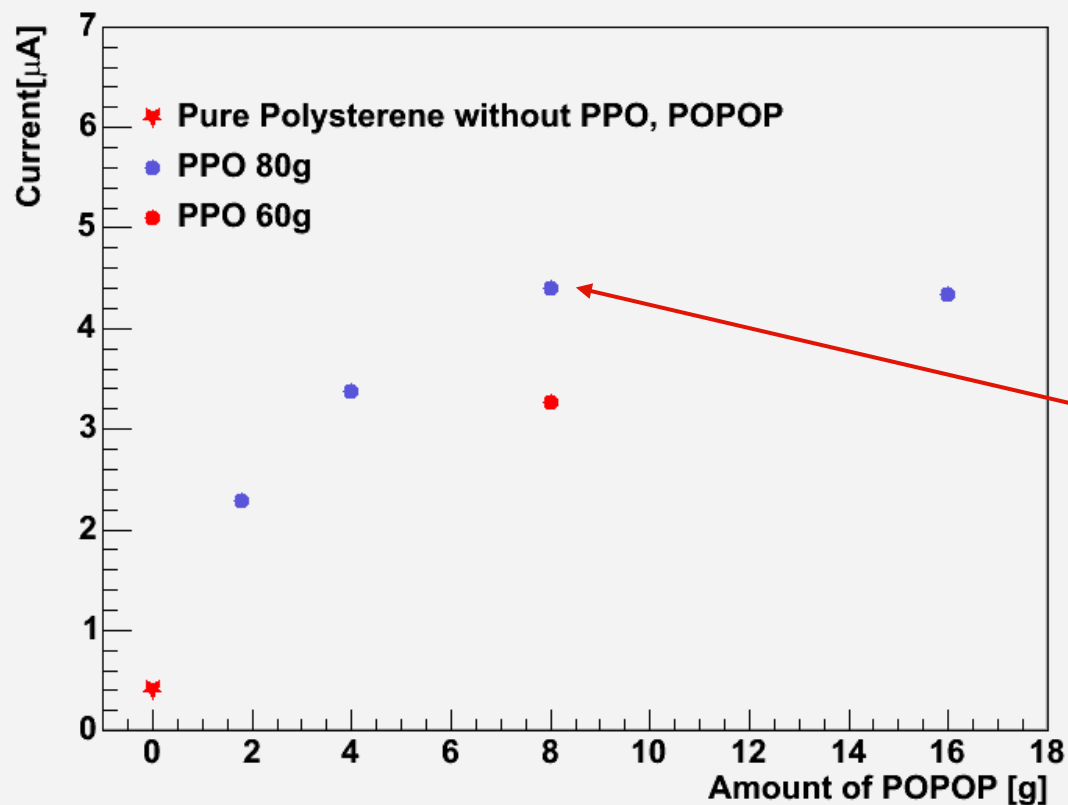


Reference Sample

New Sample

Relative Light Yield of new samples shows **76.5%** of reference samples' one.

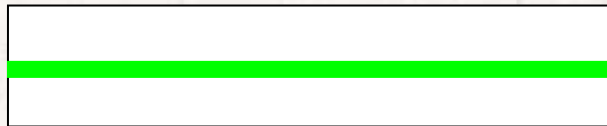
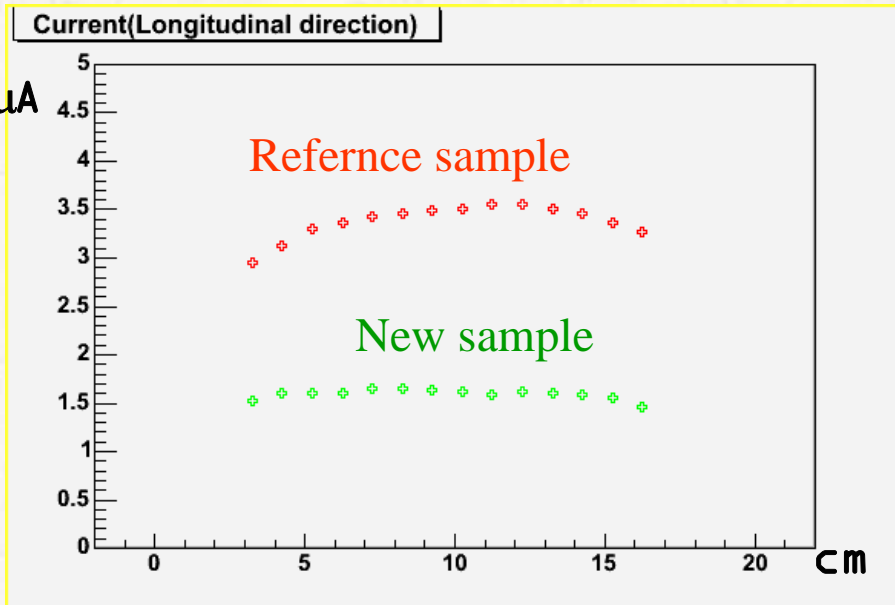
Light Yield (POPOP dependence)



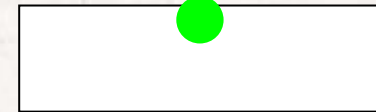
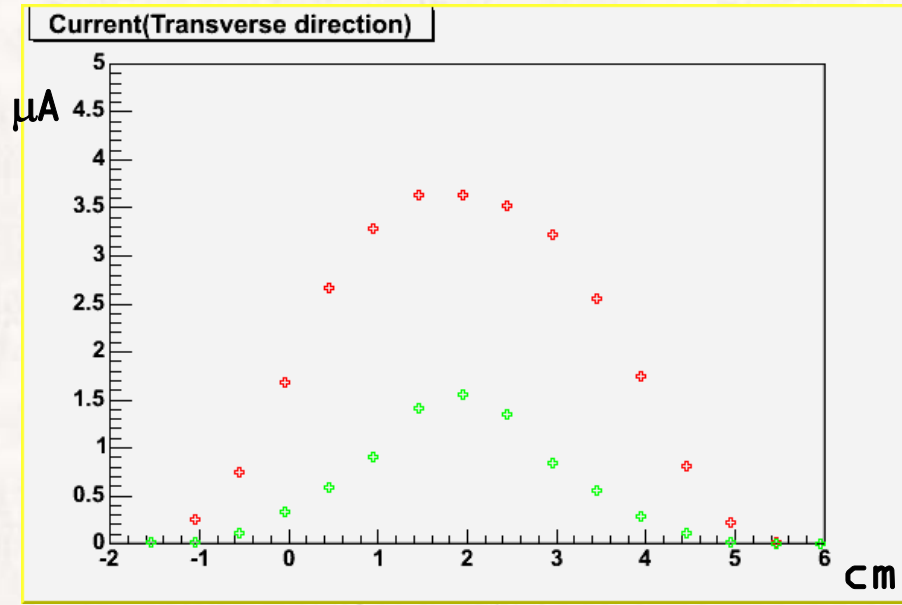
- Clear dependence in POPOP amount
- saturation effect seen

Saturation point

Position Scan



Scan along the fiber



Scan across the fiber

Summary and Plan

- First Polystyrene bar produced with PPO and POPOP
 - The mechanical process has been established
- Light yield measured for new and reference samples
 - the most recent sample shows ~75% light yield of the reference sample
- To avoid oxidation, we changed the process
 - under Nitrogen or vacuum ; it works!
- If we achieve a good light yield, then we will change die to produce “thin” scintillator for Tile/W calorimeter
 - thickness : 2~3 mm , width : 1~2 cm