NEW GENERATION OF LARGE SCALE
SCINTILLATION COUNTERS FOR DETECTION
OF EAS AND USE IN GUARD SYSTEMS OF
EXPERIMENTAL PHYSICS SETUPS

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Photo of the completed counter of 500×500 mm² with front-end unit

Commercial clear PS granules with PTP and POPOP melted in a mirror mold were used

1 mm Kuraray Y-11(200 ppm) WLS fibers. Total length is 5,2 m.
Fibers are glued with PK-68 Rexant transparent silicone compound into 1.5 mm wide grooves up to 4 mm deep.
Solid counters based on scintillating PS plates

Mean light output – 82 PE
Raw detection efficiency – 99.5%
Event rate (controlled) – 100 ev/s
Time resolution (sigma) – 3-4 ns
Peak/valley ratio:
2.6 (30 mm thick)
~4 (50 mm thick)

SiPM:
SensL (Ireland)
MicroFC-30035-SMT
3×3 mm²
Bias voltage – 30 V
ADC gate – 80 ns

50 mm thick counters light output histogram
Solid counters based on scintillating PS plates

External trigger
Amplitude spectra of the counter with 5 cm Sci plate and 2 WLS fibers in a groove (8 edges and 10.4 m in total)
Calibration – 16 ADC ch. per PE

Self-triggering

Pedestal - 236.3
Peak offset - 2530
PE number - 158
Det. eff. - 99,3%

Pedestal - 235.1
Peak offset - 2509
PE number - 157
Threshold - 34 PE
Peak/valley - 6
Solid counters based on scintillating PS plates

Counter with 2 layers of WLS:
Top and bottom of the Sci plate and 2 SiPM (SensL)

Self-triggering:
Top/bottom coincidence (fixed threshold)
and analogue sum of top and bottom layers

1 PE ⇒ 10 ADC ch.
Solid counters based on scintillating PS plates

New configuration of WLS fibers (shown in different color) for 0.5×0.5 m² counter. Total length of 5 fibers is 10.8 m. Minimal radius of fiber curvature is not less than 50 mm.

Counter amplitude spectrum
Number of PE is 180
Solid counters based on scintillating PS plates

1 m² counter composed of four sections.

WLS fibers with a total length of 20.8 m are shown in green, the location of the 4 SiPM in red color.

SiPMs may be utilized separately or connected in series with a common front-end.
Counters based on PS scintillation granules

Extruder for scintillation granules manufacturing

Granules volume density
0.6 g/cm³

Relative light yield

The thickness of the layer of granules, cm

Light output of the granules layer as a function of its thickness
Counters based on PS scintillation granules

<table>
<thead>
<tr>
<th>Type of scintillation granules</th>
<th>10x10 cm² trigger counter position</th>
<th>Number of photoelectrons</th>
<th>Granule layer thickness, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lentil shaped, Made in Protvino</td>
<td>Detector center</td>
<td>49</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Far corner</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Close corner</td>
<td>69.5</td>
<td></td>
</tr>
</tbody>
</table>
Counter based on PS scintillation granules

- WLS fibers with 26 m working length are shown in green.
  - 6×6 mm² SiPM
- Radius of fiber curvature is not less than 100 mm
- Granule layer thickness – 8 cm
- Light output – 130±6 PE
- Peak/valley ratio – 2.8

Single section 1 m² counter.
Counters based on PS scintillation granules

External trigger, 133 PE.

Self triggering, 128 PE.
LED calibration. Left peak is pedestal, SER is 2.5 pQ.
Hip roof counters with PS scintillation granules

Counter sketch (view from the bottom)

with 4 blue scintillator (or Sci granules layer)  
50×50 cm² plates

PMT – FEU-125 with 170 mm in diameter photocathode
Amplitude spectrum of the pulses of FEU-125 PMT mounted on top of the tent reflector of the Kharkov scintillator 50 mm thick.
External trigger, 140 PE

Amplitude spectrum of PMT signals of 8 cm thick layer of granules.
External trigger, 110 PE
The amplitude spectrum of the Kharkov scintillator (50 mm) for self-triggering PMT.

The amplitude spectrum of 8 cm thick layer of scintillation granules for self-triggering PMT.
Scintillating granules with WLS plate and WLS fibers

Detector structure

Photo of the green WLS plate with glued 1 mm orange WLS fibers
Amplitude spectra with ex. Trigger (left) and self-trig. (right) for the 5 mm thick green WLS plate with glued 3 WLS fibers (O2 Kuraray) loops (6 edges) connected with SiPM
Light output – 50 PE (32ch/pe), Peak/valley – 1.6

40 + 40 mm granule layers, 180 ns ADC gate
Amplitude spectra with ex. Trigger (left) and self-trig. (right) for the 3 mm thick transparent PMMA plate with 2 WLS fibers (Y11 Kuraray) “snake” (4 edges) connected with SiPM

Light output – 54 PE (19 ch/pe), Peak/valley – 1.2

40 + 40 mm granule layers, 180 ns ADC gate
The use of polystyrene granules (both melted in a block and separate) with WLS fibers and SiPM readout allows one to make inexpensive and reliable detectors for wide applications in Cosmo- and experimental physics especially if time resolution and high rate at hard radiation load are not required.

Minimal gap between solid counters made of melted granules is important for quality improvement of the guard systems of large area.

The light output of the detector may be controlled (improved) with a larger amount of WLS fibers.

The uniform parameters of SensL SiPMs allow one to create a multichannel detector with common bias voltage to simplify detecting system.


