Joint HSE-JINR plans for muon scintillator system R&D

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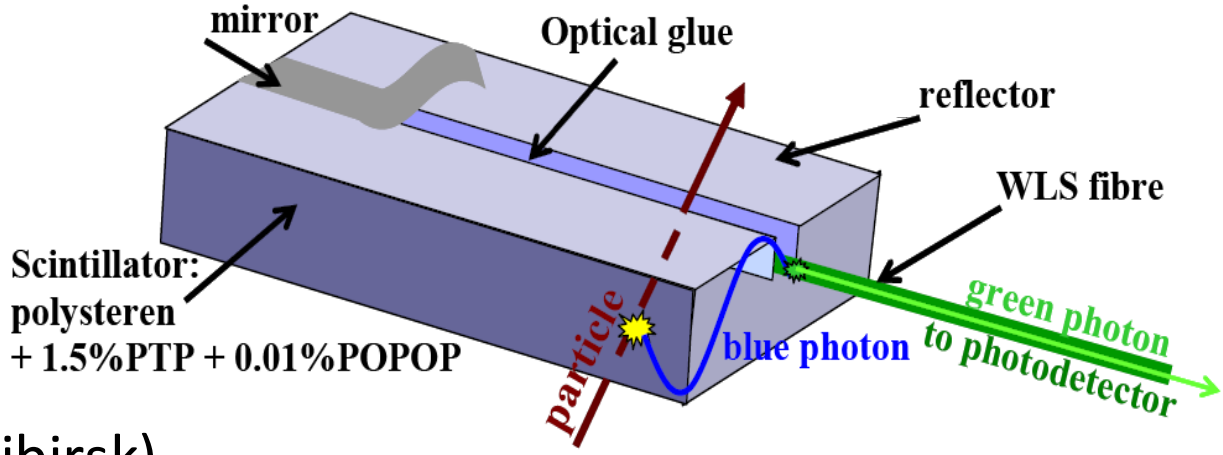
Organic scintillator muon detector

Muon system based on organic scintillator+WLS+SiPM technology is the baseline option for several current and future projects

- Current:
  - Belle II
- Planned:
  - CEPC (China)
  - STCF (China)
  - VEPP modernization (Novosibirsk)



This technology was elaborated by our (HSE) team in 2007-2014 for Belle II endcap KLM detector. Finally, we constructed, assembled, installed and launched whole Belle II EKLM

Technology test

Last strip for Belle II KLM detector was produced more than 10 years ago:

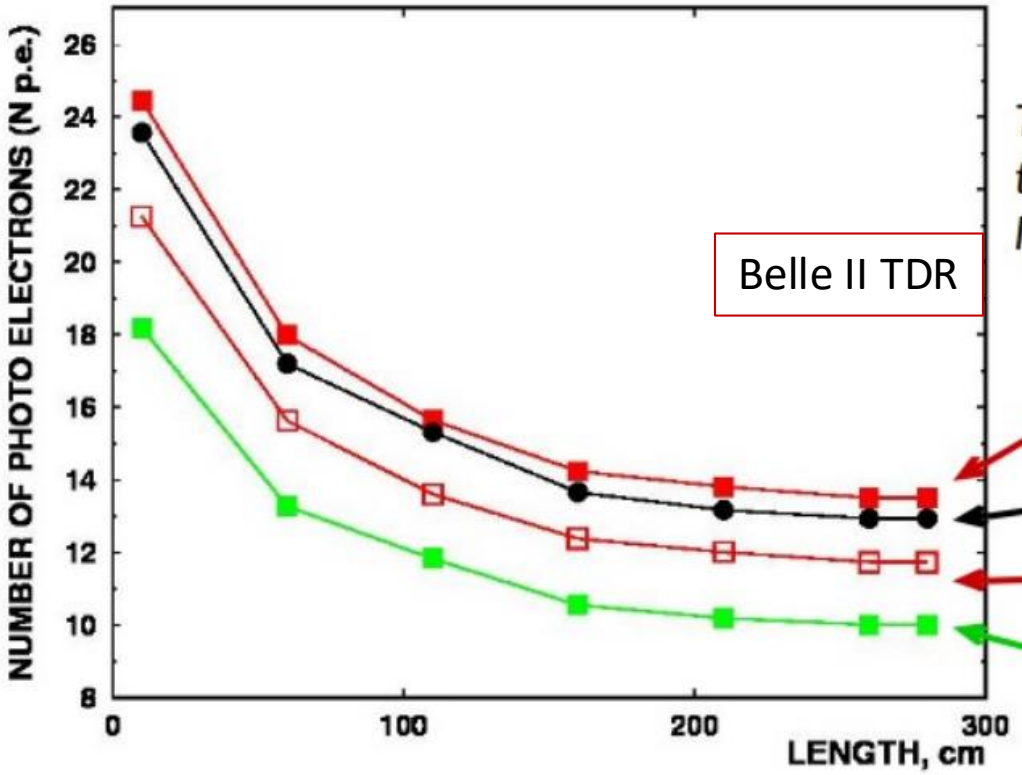
- Outstanding stability (no observed degradation of lightyield/ efficiency) and good performance (efficiency >95%, negligible bg rate few 2D-hits/event) of the Belle II KLM demonstrates advantages of the technology

Now we would like to prove, that technology can be reproduced:

- need to check elements (strip/WLS fiber/SiPM) producers
- infrastructure for strip production
- check read-out electronics availability
- update mechanical design

Plastic strip issues

Choice of the producer and production technology



Belle II TDR

Kharkov & Fermilab thickness h = 10 mm
Vladimir thickness h = 7 mm

The reflective cover in case of Vladimir strips is thin, covering with mat white paper increases light yield by 15%

Vladimir, covered with white paper

Fermilab

Vladimir

Kharkov

the figure is done using 1m strips moved along the 3m WLS fiber

- Coating technology: co-extrusion with titanium dioxide paint or chemical etching
- WLS fiber placement: groove or hole?

Scintillator strips testing plans

In collaboration with JINR make a few long (~2-3 meter) strips for long-term stability cosmic test.

Compare different scintillating polystyrene producers:

- *Vladimir*
- *Fermilab*
- *Protvino*
- *Chinese producers(?)*

coating technology:

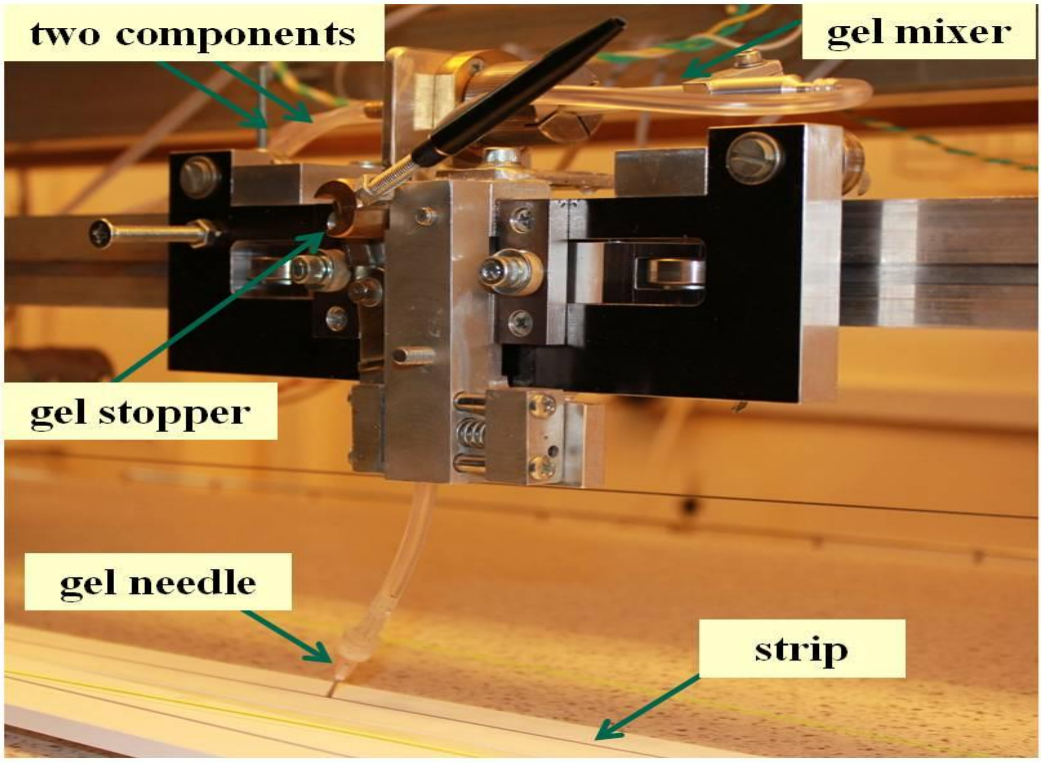
- *etching*
- *co-extrusion*

and WLS fiber mounting technology:

- *hole made during extrusion*
- *milled groove*

Optical gel test

- Use of the optical gel around the WLS fiber is proved to significantly increase the light yield
- SUREL SL-1 gel (used at Belle II) is still at market
- Need to re-test its properties
- Produce 2-3 short strips with glued fiber
- Study accelerated gel aging with thermal-stabilized camera



Neutron flux measurements with KLM

- Neutrons are the main background source for the organic scintillator based muon systems (high concentration of hydrogen)
- Neutron flux is hard to measure, especially inside the detector and during the data taking

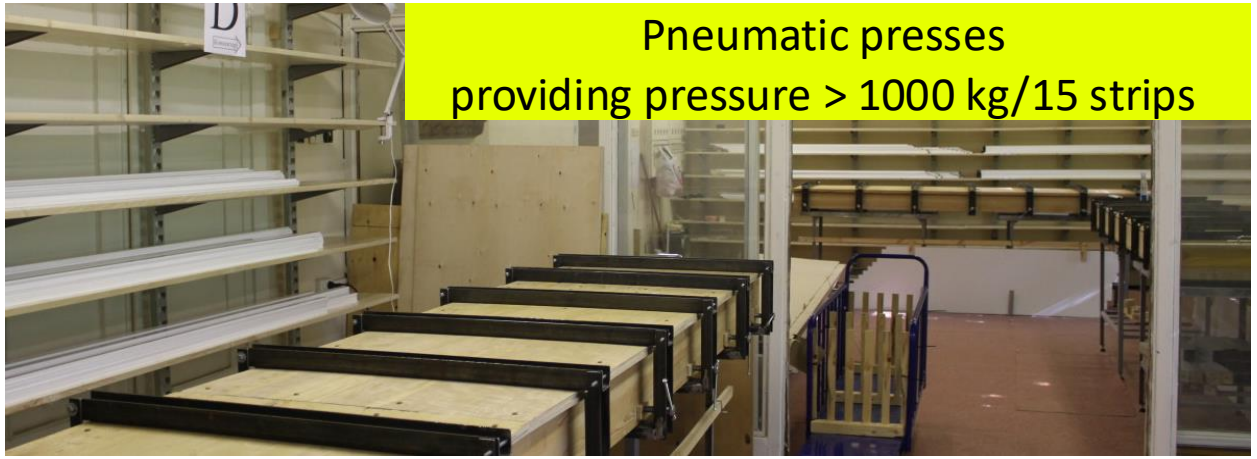
Idea: **use muon system as a neutron detector**

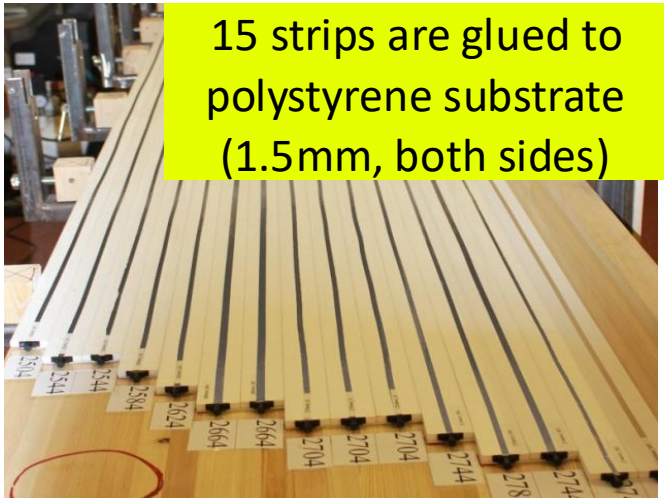
- Produce a few strips identical to those used in KLM at Belle II
- Calibrate its response with the known neutron source (Novosibirsk, JINR?)
- Measure the neutron flux anywhere in the muon system in the self-trigger mode with existing strips in the muon system

This allows to test neutron MC at Belle-II and have a reliable projection for future neutron bg simulation.

Strip assembly into module

At Belle II double-side adhesive tape is used to fix strips at polystyrene substrate then glued to the supporting I-frames using pneumatic presses





Three segments (15 strips each) have fallen down inside the detector due to the weak fixation. Two were repaired.

Check another option: screwing

Produce short strip (20-30cm long) with 5мм hole for the screw. Measure efficiency deterioration near the hole with cosmic stand.