ESS BILBAO

In-kind contribution: status and prospectives

by Marita Mosconi

ESS Bilbao

- **Official representation of Spain** in the **ESS ERIC**.
- **Coordination** of the Spanish **in-kind** contributions to **ESS ERIC**
- **Connection** to the **Spanish industry**
- **56 professionals**
- **Activities on**
  - **ECR** ion source, **LEBT, RFQ**
  - **MEBT** (beam diagnostic & control)
  - **RF systems**
  - **Target**
  - **Instruments**

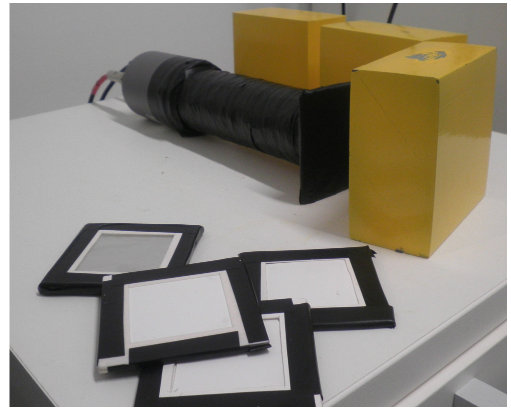
Scintillation detector laboratory

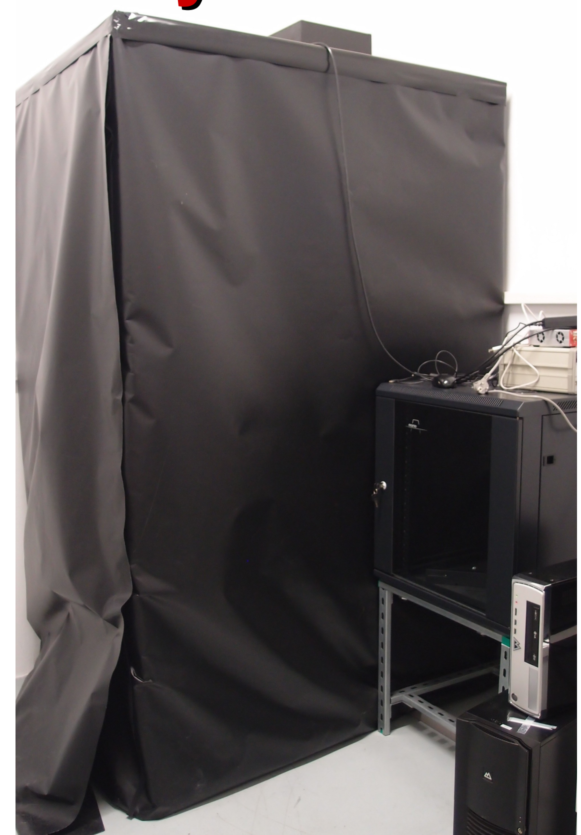
✔ Selection of scintillators:
- ZnS(Ag), ZnS(Cu,Au,Al)
- ^{6}Li glass: GS20, KG2

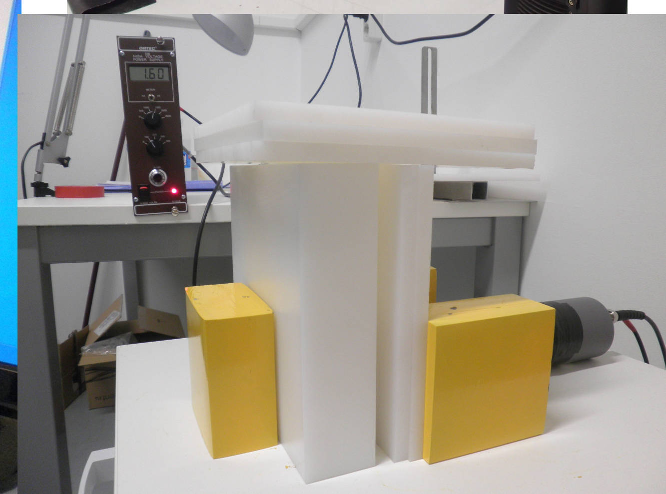
✔ ^{252}Cf source 7.8 kBq on 01.12.2015
- 6 MeV alphas
- soft gammas
- Neutron fission spectrum

✔ Dark room

✔ Electronics for n/γ discrimination of PMT pulses

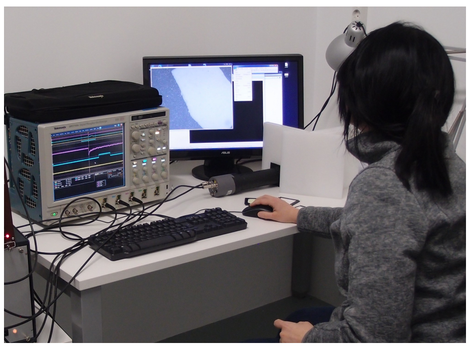




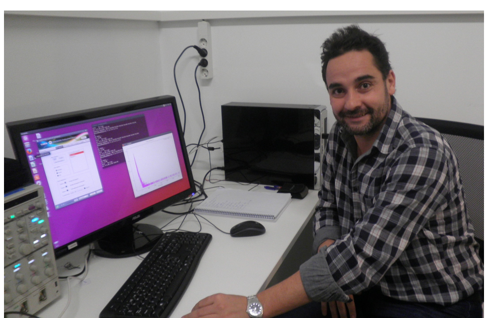


Crew

Estefania Abad Project Manager

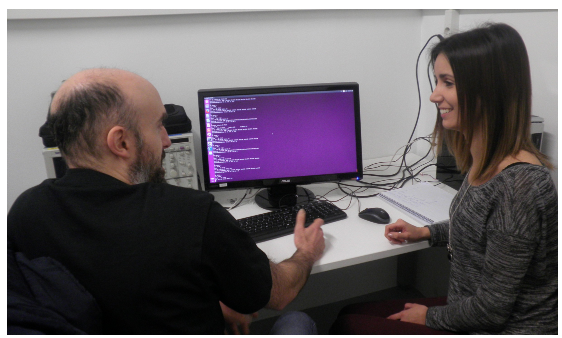


Marita Mosconi detector scientist



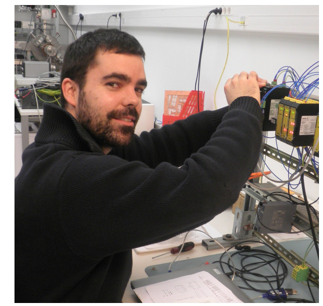
Carlos Cruz electronics

Xabier Gonzalez, Gorka Mujika mechanics



Victor Guijarrubia, Yolanda Fernandez IT

Monica Huerta simulations



Jon Bilbao electrical installations

Roberto Martinez data analysis

Detector development: proposed in-kind contribution

Identification of the best technology for neutron detection based on **scintillators** for applications in **diffractometry**

1) Evaluation of the mature technologies:

- ZnS(Ag) coupled with PMTs by clear fibers with coincidence encoding
- ^{6}Li-glass Anger cameras
- ZnS(Ag) coupled with PMTs by WLS fibers with coincidence encoding
- ZnS(Ag) coupled with SiPMs by WLS fibers

2) Evaluation of the feasibility of visualization of single events of neutron detection in scintillators by silicon sensors

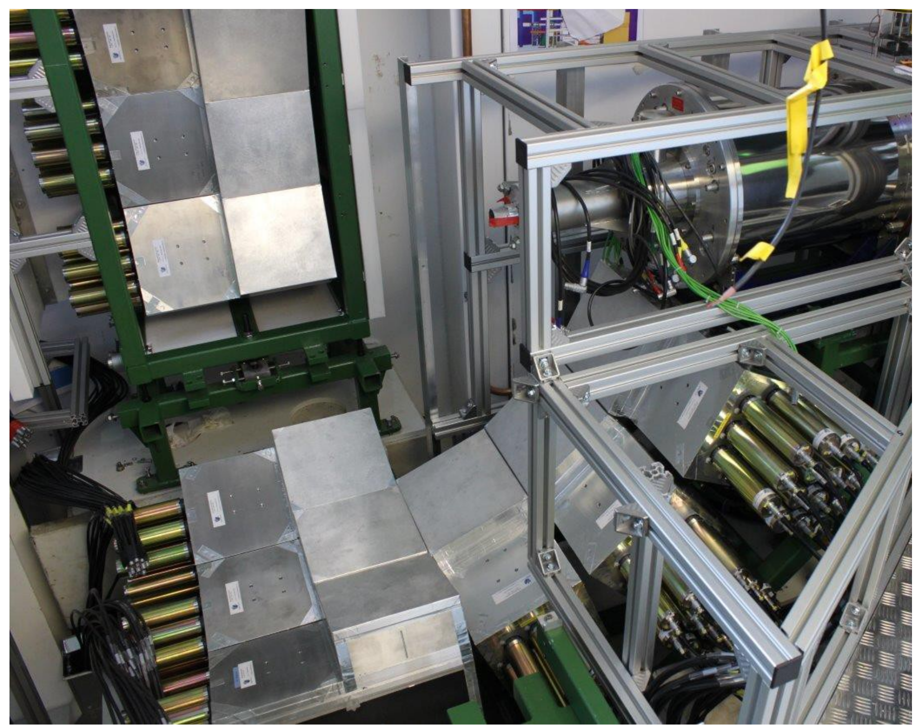
3) Direct coupling of scintillators to SiPMs (or with a short light guide)

SCIENTIFICA prototype

Company which constructed the **detector of the ISIS instrument PEARL**

Commercial position sensitive detector with DAQ suitable for fiber encoding mounting:
PEARL pixels (clear fibers)
WLSF pixels

Evaluation of the performances and characterisation in accelator facilities or reactors



Research Motivation

Problems of the current scintillation detectors for diffractometry:

- ^{6}Li-glass Anger cameras
  i. Expensive
  ii. Low gamma rejection
- ZnS and fibres
  i. High dead time (from 20 μs to 100 μs)
  ii. Expensive 2d detection

Can pixelated light detectors improve performances?

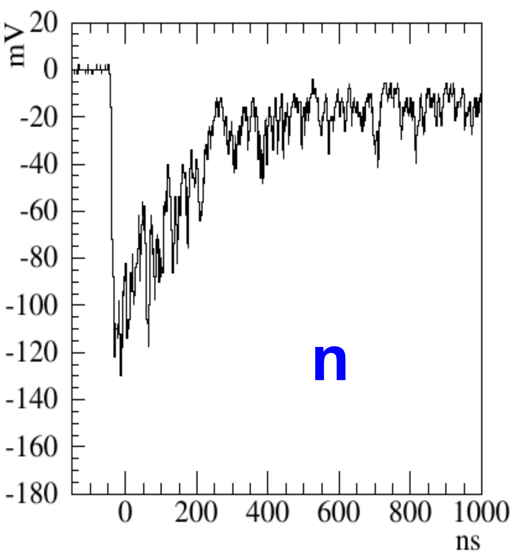
➢ Can μm pixilated sensors (cameras) allow large detector units?

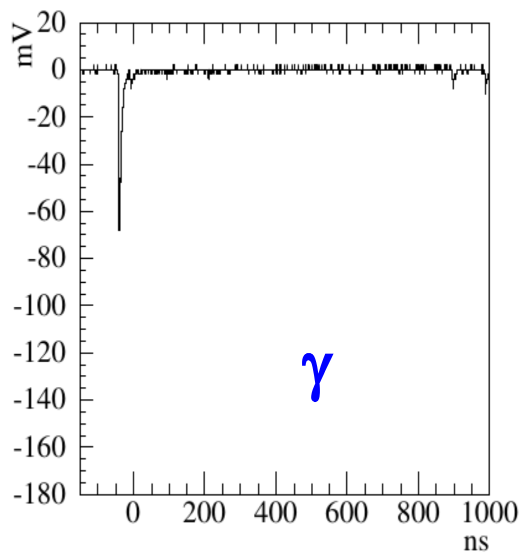
➢ Can arrays of SiPMs be used with short light guides?

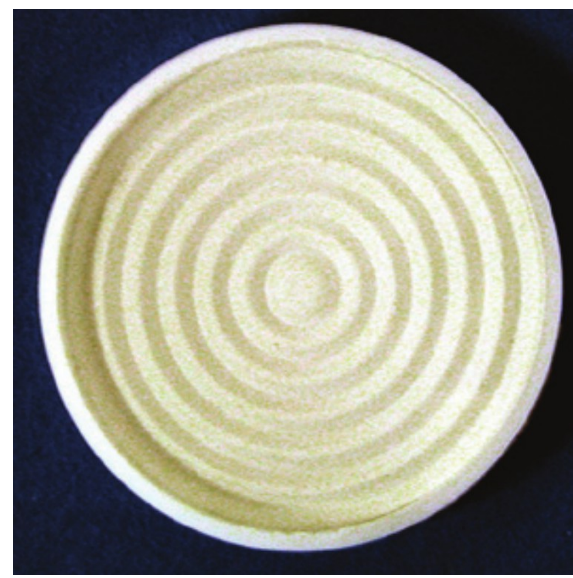
Scintillators: ^{6}Li-ZnS(Ag)

- 0.45 mm maximal thickness
- Up to 55 % efficiency for 25 meV neutrons in a grooved layer
- Fast rising, but afterglow up to several tens of μs
- 160000 blue photons per neutrons

PMT pulses, **direct coupling**: n/γ discrimination (Am/Be source)



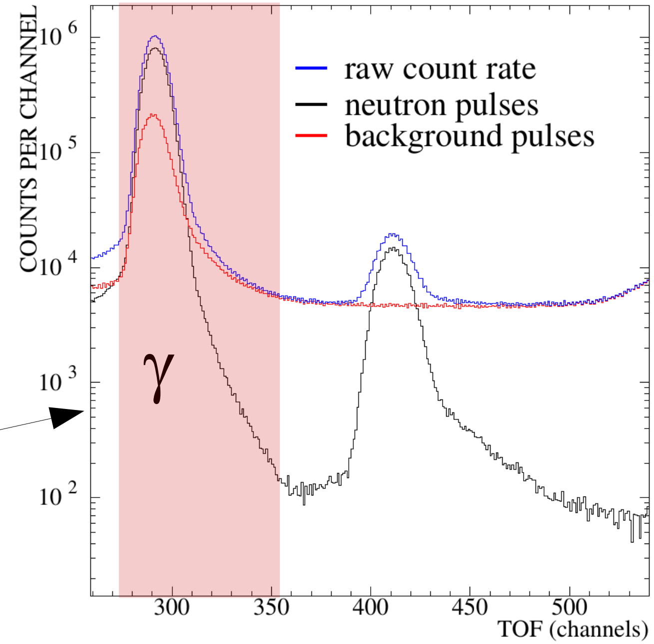




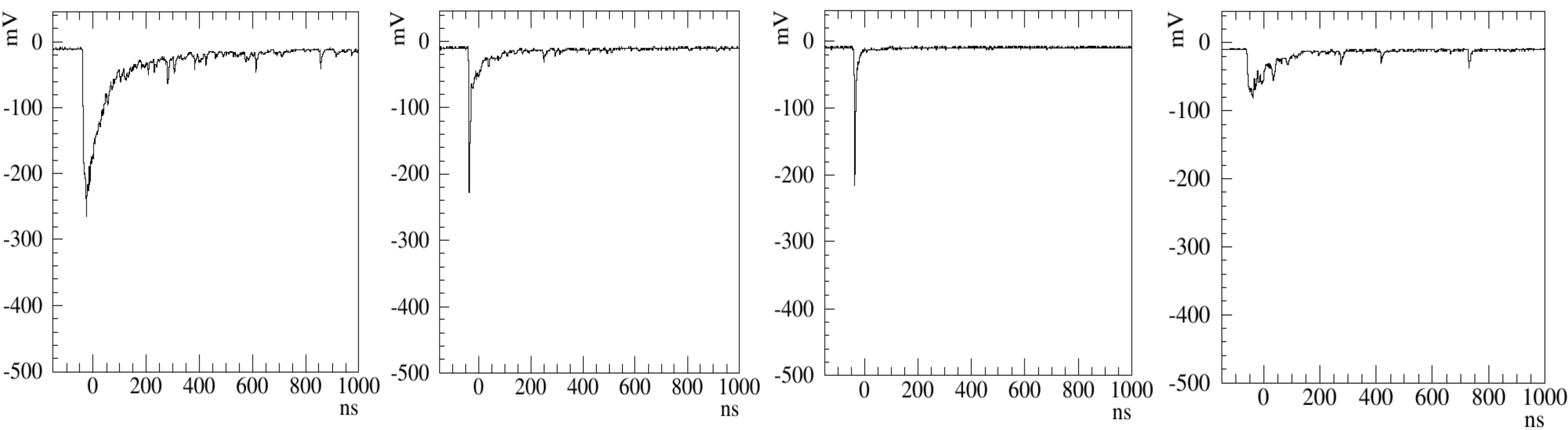
Scintillators: ^{6}Li-glass

- 1 mm thick: 77% efficiency at 25 meV
- Quite sensitive to γ-rays
- 6000 UVA photons per neutron

Time-of-flight n/γ discrimination with pulse shape discrimination



PMT pulses, direct coupling: n/γ discrimination (Am/Be source)



Optical coupling / light collection

I. Direct (optical grease-cement)

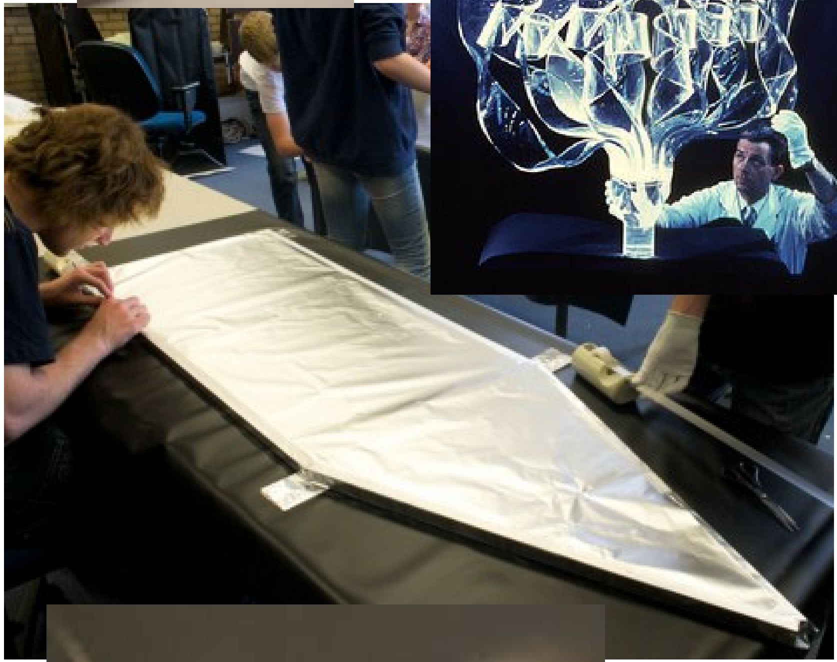
II. Light guides

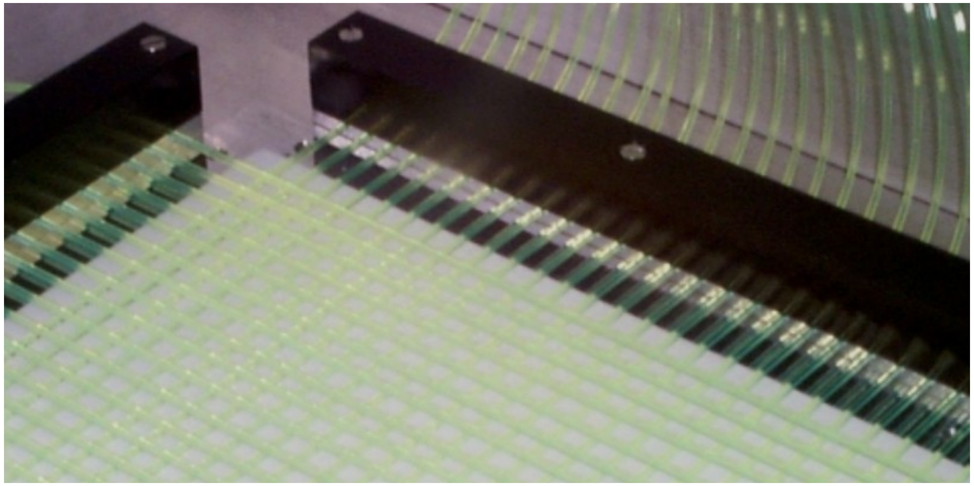
III. Fiber optic tapers

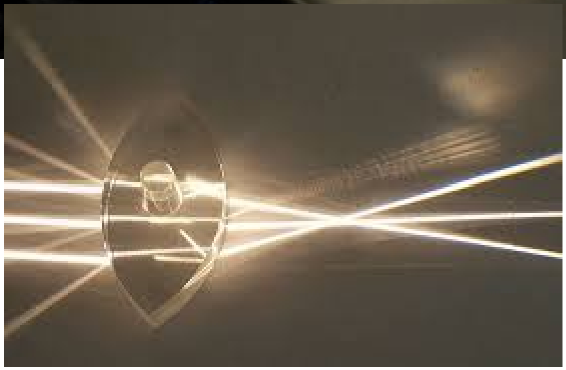
IV. Clear light fibers

V. Wave length shifting fibers

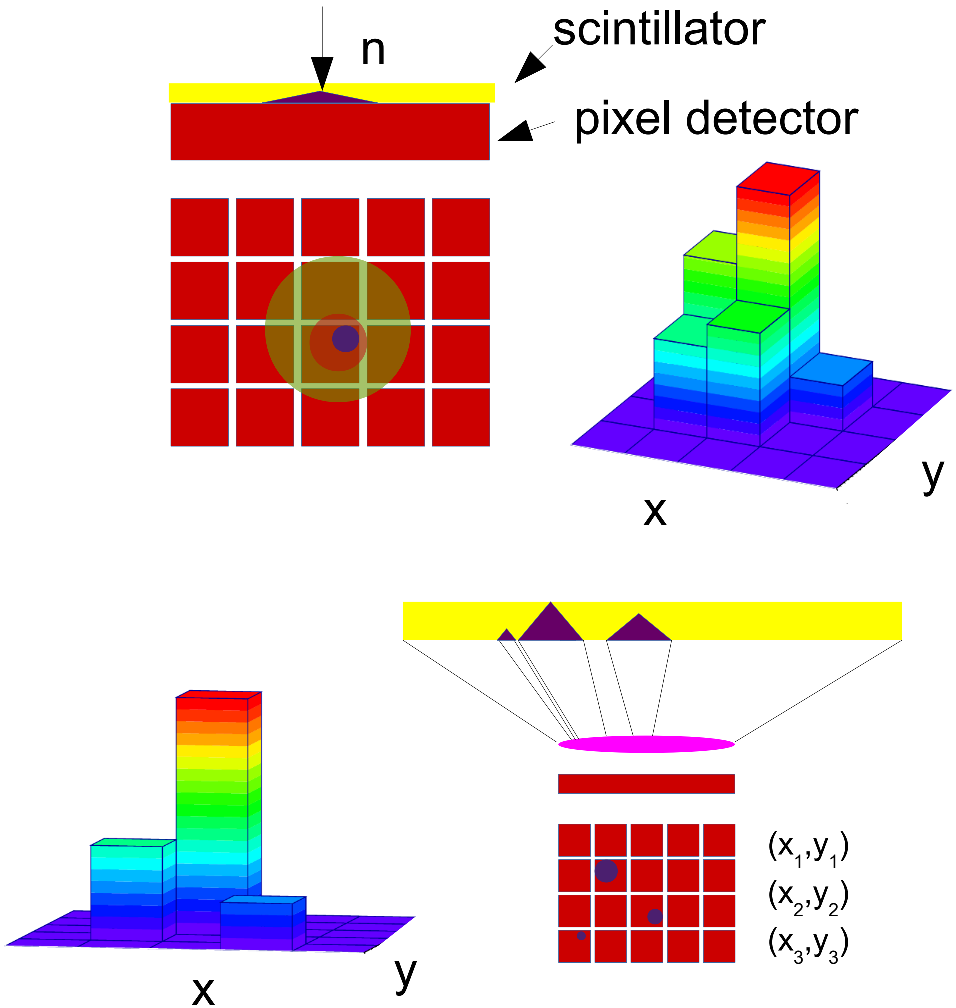
VI. Lenses



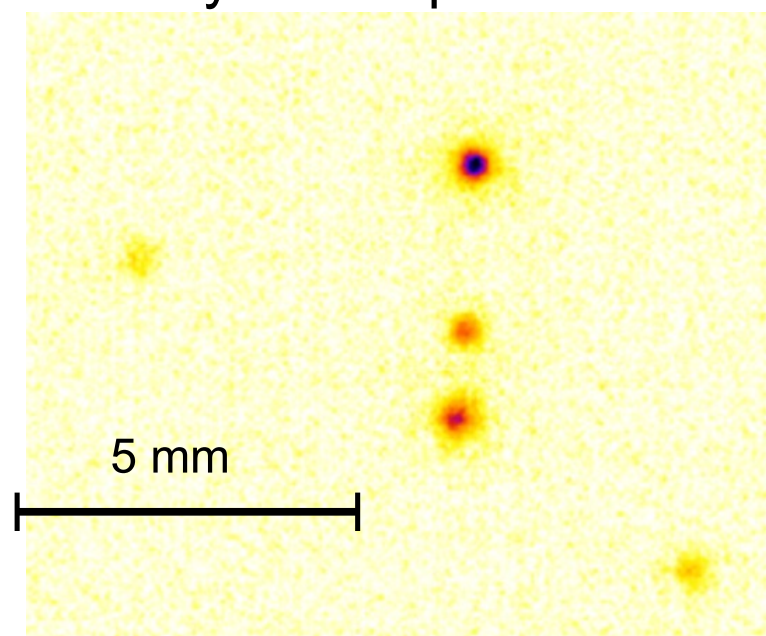




Visualisation through highly pixelated silicon sensors

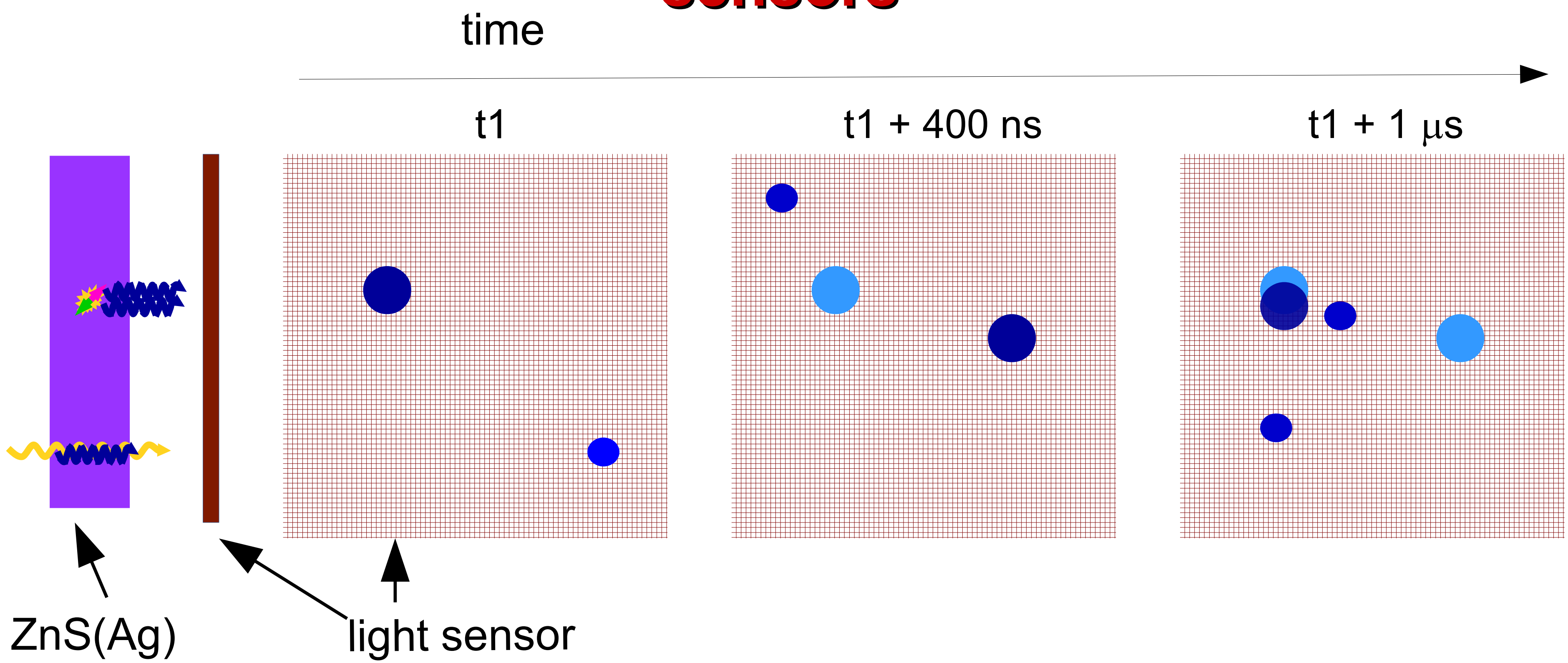


Neutron detection in ZnS(Ag) intensified by MCPs and viewed by a 200 fps camera



B W Miller at al. Nucl. Instr. Meth. A , 767, 2014

Dead time and n/γ discrimination in pixelated sensors



Pixelated light sensors in the market:

- Camera sensors (μm pixels, slow if cheap)
- SiPM (mm pixels, as fast as PMTs)

Work plan

a) Characterisation of different neutron scintillators with respect to different acquisition techniques

i. Efficiency

ii. n/γ discrimination

b) Visualisation with camera sensors

i. Selection of the best light collection

ii. Sequence of pictures

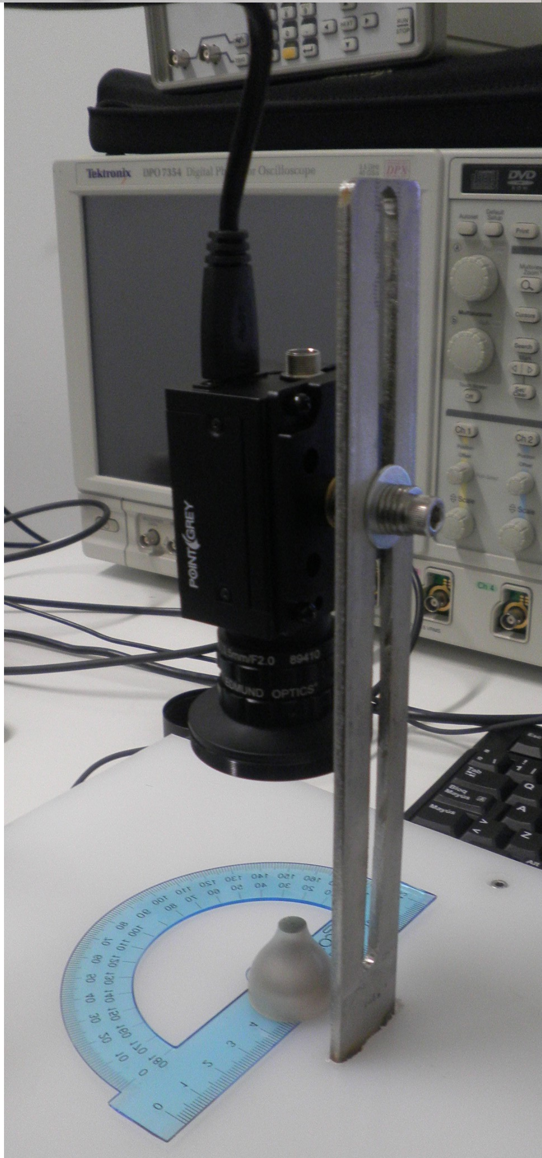
iii. Triggered acquisition

c) Characterisation of different SiPMs

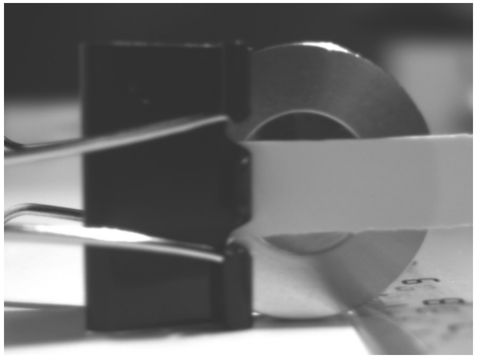
d) Coupling SiPMs to scintillators directly and with light guides.

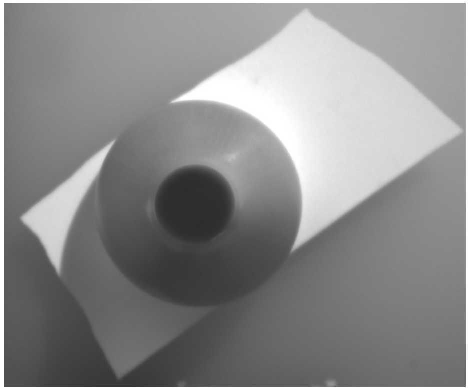
Optical tests

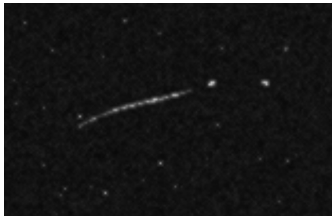
Visualisation of 6 MeV alphas in 250 μm ZnS(Ag) 2:1 by Scintacor



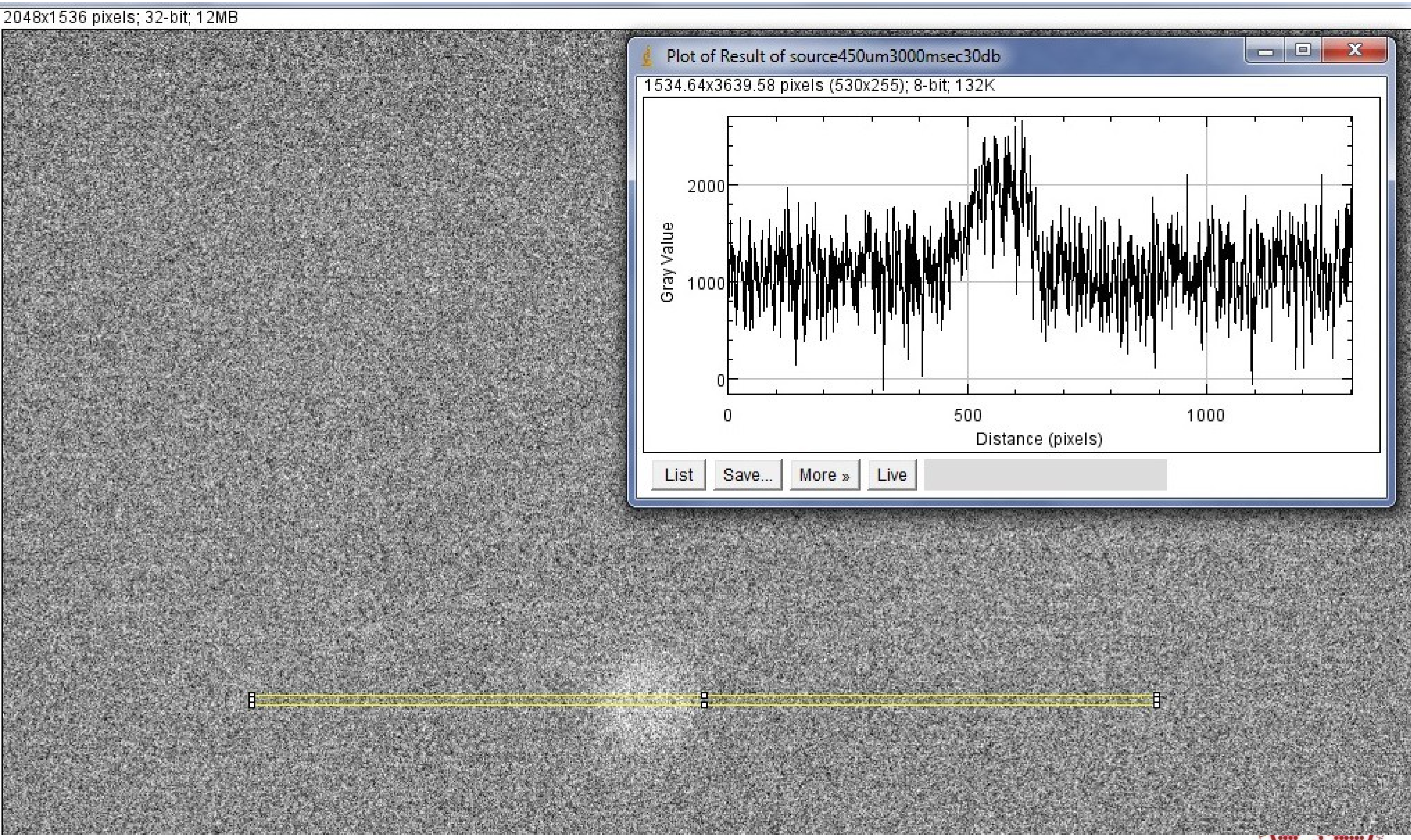
- ✔ Point Grey camera mounting a Sony IMX252 121 fps
- ✔ Optics:
  - Focal length 8 mm, working distance 8 cm
  - Focal length 3.5 mm, working distance 0 mm
  - FOT 3:1



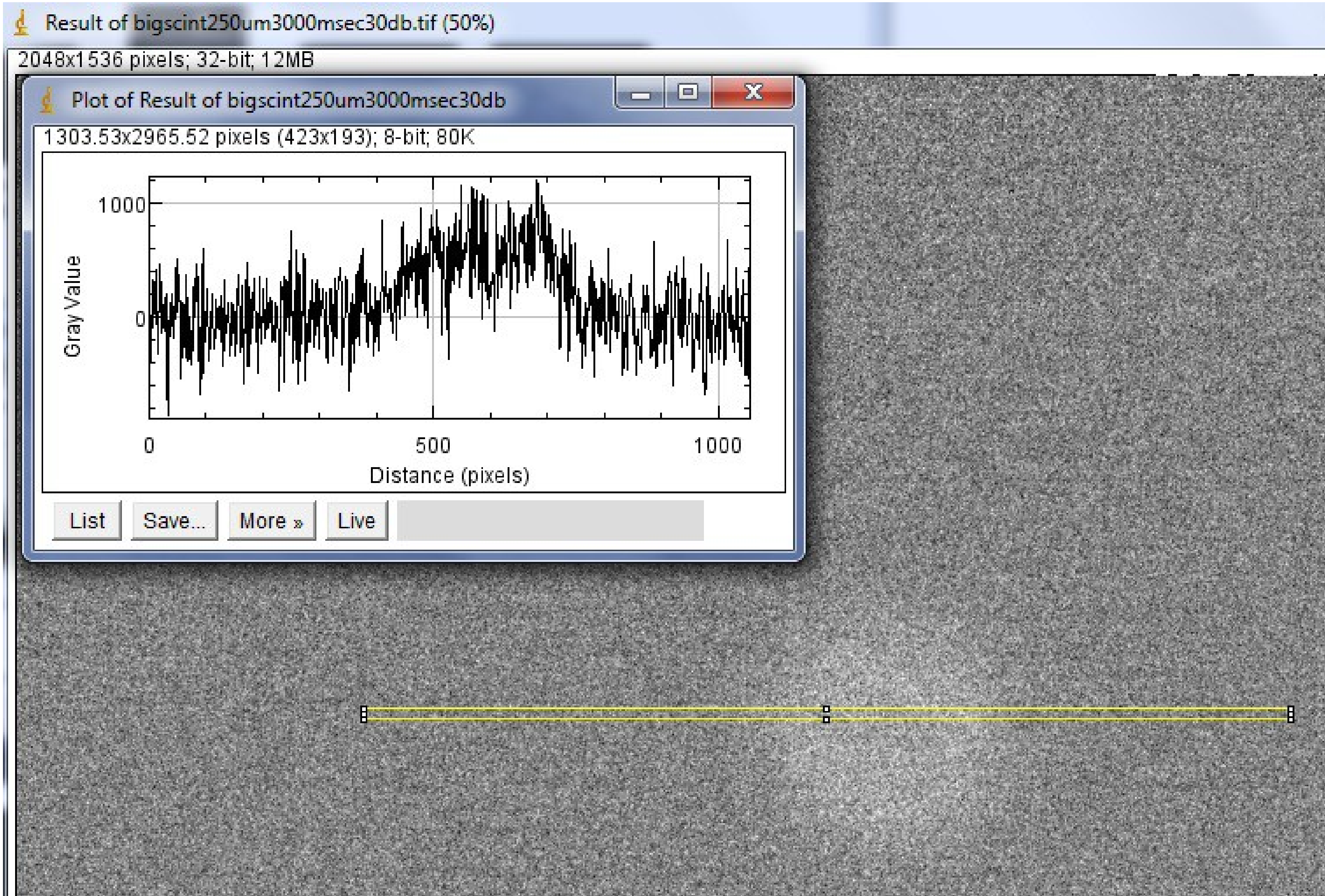




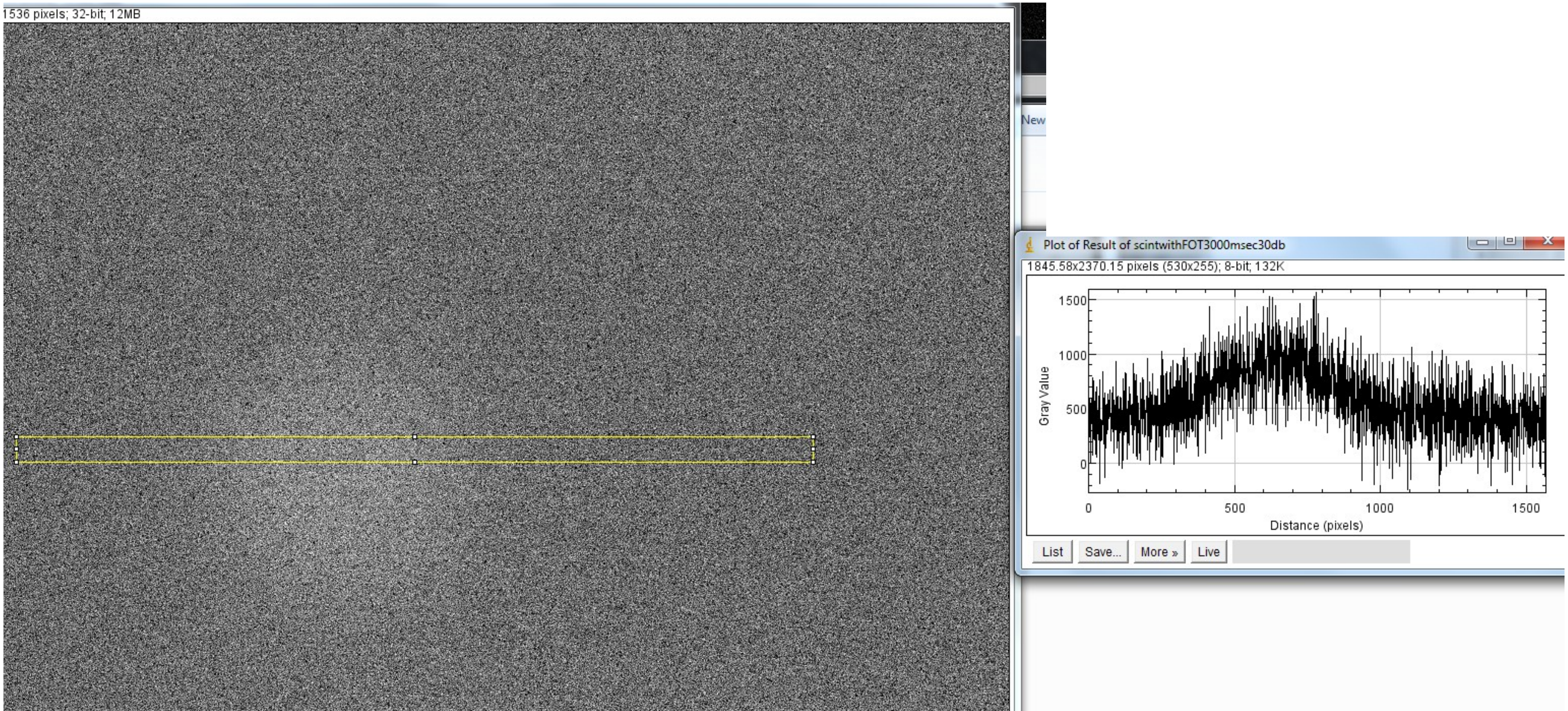
Scintillation light: 8 mm lens

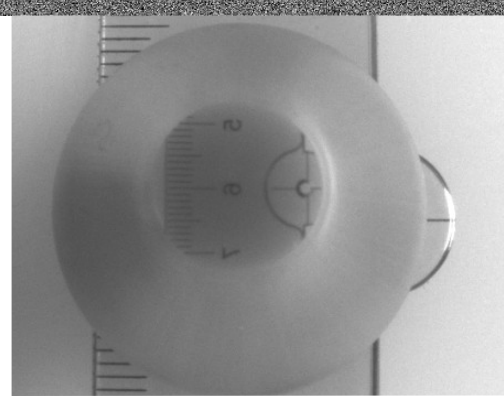


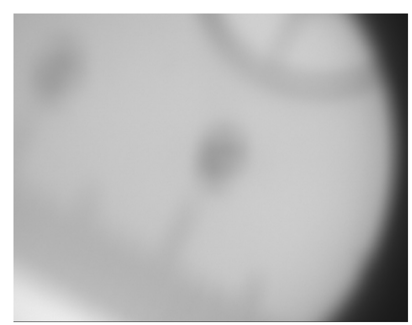
Scintillation light: 3.5 mm lens



Scintillation light: FOT







Conclusion and outlook

- Scintillation light observed with a cheap camera sensor
- Developing suitable optics (simpler optics system with lenses or FOT)
- Triggering the camera on neutron detection events
- Testing more camera sensors
- Developing a DAQ for an array of SiPMs