



Institute for Nuclear Research and Nuclear Energy  
Bulgarian Academy of Sciences



# Status and perspectives for WP5 Processing technologies

D. Tonev

- Participants (it is not a closed society)

- INFN
- CNRS/IN2P3
- CIEMAT - Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas;
- IFIC - Instituto de Física Corpuscular, Edificio Institutos de Investigación
- TUBITAK
- INRNE

# Present status

There are several groups working on the subject of Processing technologies:

The present list is only a part of groups which are working and interested in work related to the WP5.

- Digital neutron-gamma discrimination -Delaunay Frank;
- Signal treatment - timing for liquid scintillators – Victor Modamio;
- "EXOGRAM/NEDA FADC Mezzanine hardware and firmware design" - Francisco Javier Egea Canet;
- "EXOGRAM/NEDA FADC Mezzanine qualification setup and results" Marcin Jastrzab
- "Scintillator readout methods and pulse shaping selection for the purpose of neutron detection " Mikhail Mikhailov

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SEM\*

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EC

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High Energy

Particle Physics & Astrophysics

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Nuclear Spectroscopy

Nuclear Reactions

Positron Spectroscopy

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Neutron & Reactor Physics

EC

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Neutron Data

Neutron Generator

Reactor Physics

Nuclear Energy

EC

SEM

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EC

SEM

Radio-analytical Methods

Radiation Protection

Radio-chemistry and Radioecology

BEO\* Moussala

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Radiation Safety and Protection

Control of Illegal Nuclear Materials

Tuition in Radiation and Nuclear Safety

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Legal Consultation

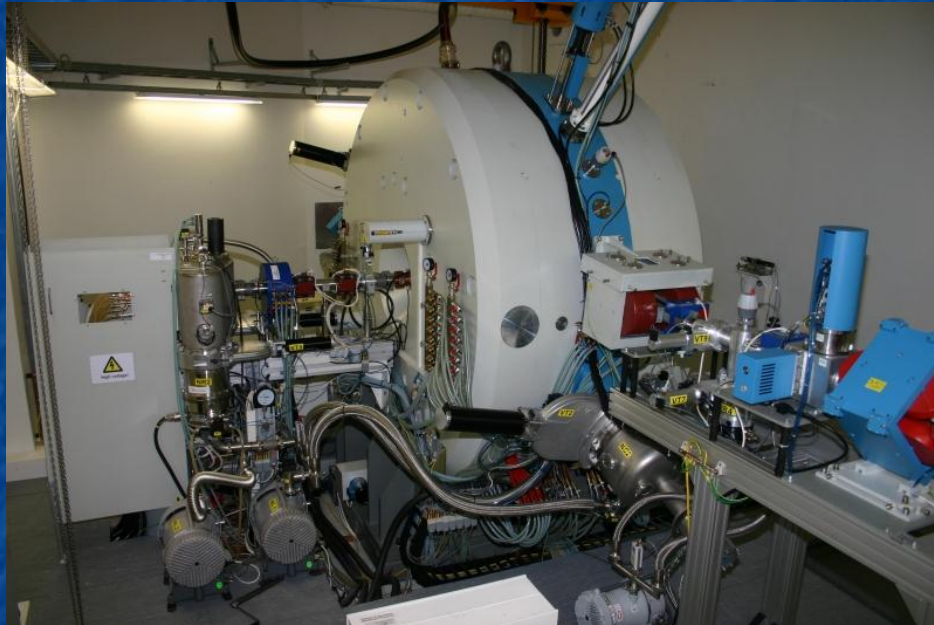
Labor Protection

Library

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SCIENTIFIC AND  
EXPERIMENTAL FACILITIES

# National Cyclotron Centre



Циклотрон МСС 30/15; Архитектурен вид на Циклотронна лаборатория

**Since 4 months**

# Mars Rover (NASA)





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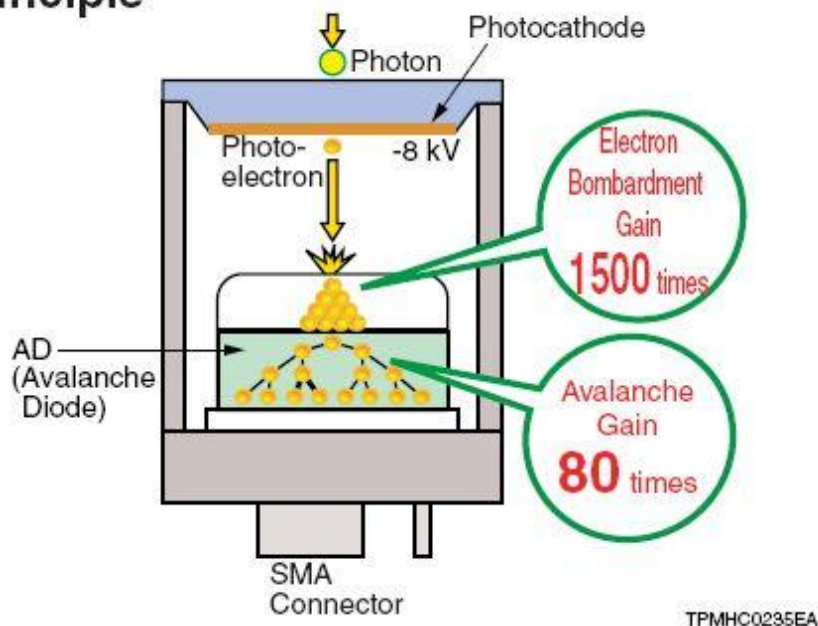


# Scintillator readout methods and pulse shaping selection for the purpose of neutron detection

M. Mikhailov, D. Tonev

# Hybrid Photo Detector (HPD) and Avalanche Photo Diode (APD)

## ■ Principle

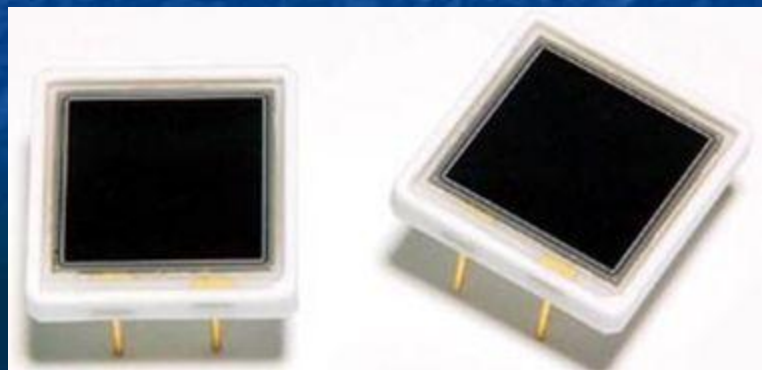


- Fast Time Response
- Excellent Time Resolution
- High Sensitivity  
QE: 45 % Typ. (at 500 nm)
- Capable of Photon Counting



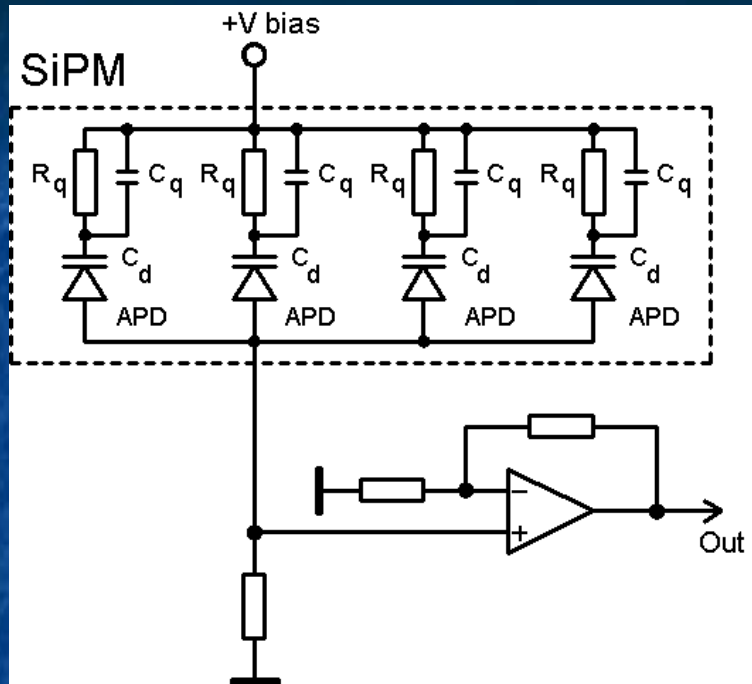
Some experimental data shows that HPD is inferior to PMT in scintillation light detection

The Avalanche Photo Diode used in HPD can itself be a good readout sensor



- Obtainable gain – 30 to 300
- Quantum efficiency – 60 to 80%
- Biasing voltage and temperature sensitive

## An alternative photo sensor could be the Silicon Photomultiplier (SiPM)



$R_q$  – the quenching resistor  $\sim 300\text{k}\Omega$

$C_q$  – the  $R_q$  stray capacitance

$C_d$  – the APD capacitance  $\sim 200\text{fF}$

$\Delta V$  – overvoltage, the portion of biasing voltage above the breakdown

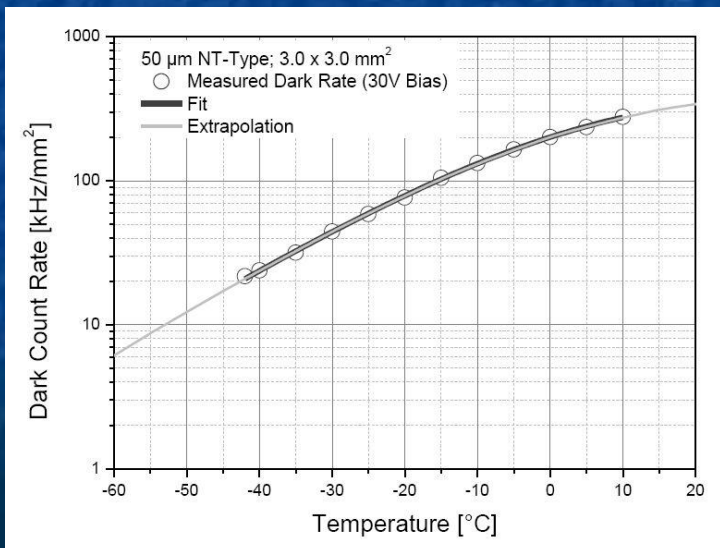
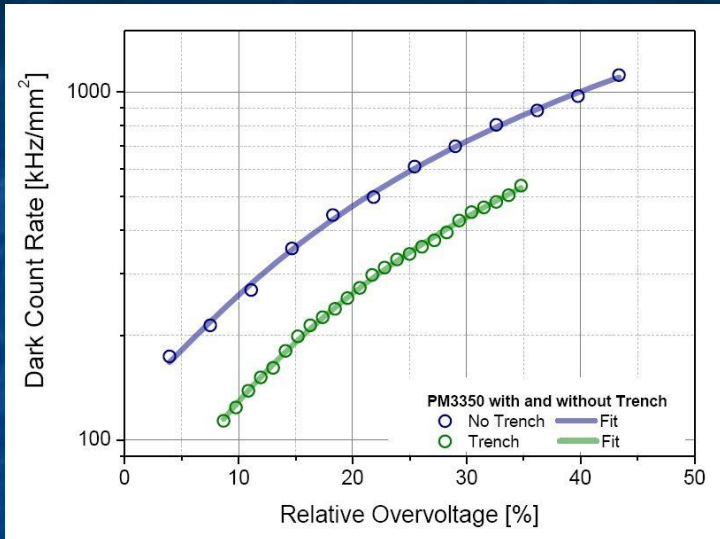
$e$  – the electron charge

- The SiPM is a matrix of microcells
- Microcell = quenching resistor + APD
- The microcells number can be several thousand
- SiPM area – up to  $40\text{mm}^2$
- Geometrical efficiency (the percentage of the light sensitive area) – 50 - 80%
- All microcells are biased above breakdown – Geiger mode
- A single photon absorbed in an APD triggers its discharge
- The gain for a single photon is given by  $C_d \cdot \Delta V / e \sim 2 \cdot 10^6$
- If several microcells are triggered simultaneously, the output pulse is the sum of all discharged APDs

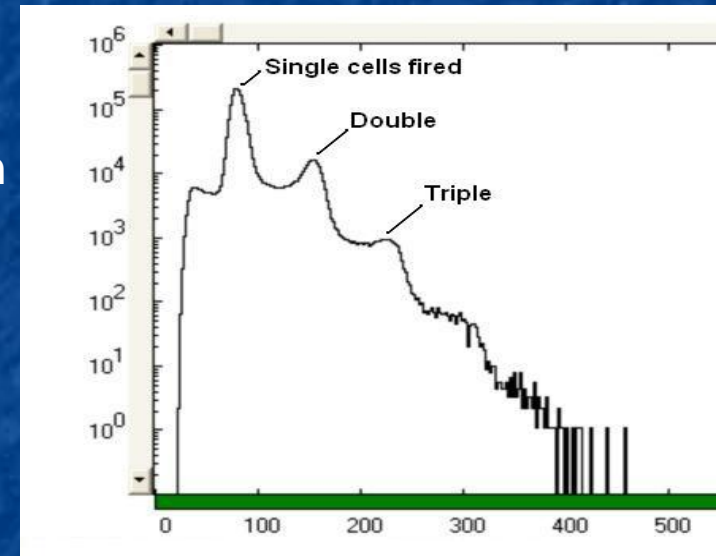
# Dark pulses

Significant disadvantage of the SiPM is the presence of dark pulses.

They are triggered by thermally generated electrons. The dark count rate is temperature and overvoltage dependant.



Multiple microcells can be fired by thermally generated electrons.



There are other ways fake pulses to be produced – crosstalk and after-pulsing. They can be induced by both dark pulses and incoming light pulses



Thank You very much for  
your attention!