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Title: Study of Viability and Challenges of using SiPMs as an Alternative to PMT's in Scintillation Detectors for Nuclear Safeguards

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Intended for: Summary of proposal for NA241

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SENSITIVITY LEVEL

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

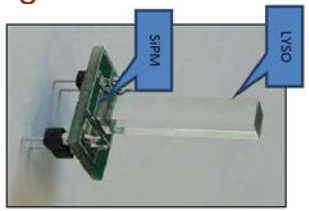
OFFICE OF NONPROLIFERATION AND ARMS CONTROL (NPAC)

INTERNATIONAL NUCLEAR SAFEGUARDS

Study of Viability and Challenges of using SiPMs as an Alternative to PMT's in Scintillation Detectors for Nuclear Safeguards

Clear understanding of the potential and challenges of using SiPMs as replacement for PMTs for radiation detectors.

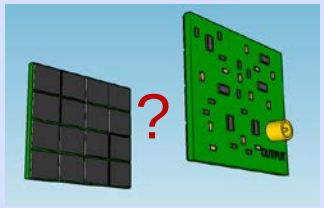
Background/State of the Art



Small area LYSO detector with SiPM readout (figure adapted from Theremino System publication)

- Most scintillation detectors use PMTs
- Silicon photomultipliers (SiPMs) are used in small area detectors and PET scan detectors
- Large area SiPMs produce noise that is temperature and amplifier dependent
- SiPMs can benefit many detector applications due to their compactness, simpler powered supply and decreasing cost

Innovation



- Do a comprehensive and useful scoping study on the viability, challenges and advantages of SiPMs photodetectors as PMT replacement in radiation detectors for safeguards
- Will provide good understanding and roadmap for future SiPM integration and availability in COTS detectors

Approach, Metrics and Outcomes

MAIN GOAL

- What is your end goal and how will you measure success?
- The measure of success will be the clarity and comprehensiveness of the finding of this scoping study. We would like to identify how far and for which applications SiPM technology has been taken towards deployment with real world detectors used for safeguards. In addition We want to identify what issues prevent SiPM integration into some detectors, and if these are surmountable.
- We what to give clear recommendations and a roadmap for SiPM deployment.

HOW IT WORKS

- The study will explore fundamental and practical problems of SiPMs, which often arise from the noise of larger area SiPM arrays needed for many radiation detectors
- Given the identified problems, the study will review published work on how well SiPMs are deployed and how the problems are handled.
- Some important findings will be reproduced with simulations and experiment (to a limited extent).

ASSUMPTIONS, LIMITATIONS & CONSTRAINTS

- Most of the work will be reviewing the literature, analytical work and conclusions based on the team's expertise
- Some simulations and experiments are foreseen, but this effort will be limited by the budget and scope of the project

Impact

- Safeguards relevance
  - Very pertinent to improving compactness/portability, reducing complexity and modernization of scintillator based safeguards instruments
  - Identifies a roadmap for new technology integration into standard safeguards instruments
- Long-Term R&D STR-375: Long Term Capability 6 and 12. Milestones 6.1 and 12.2
- IAEA STR-382 SGTS-008 Objectives 2 and 3; SGTS-001 objective 6
- **Start of FY TRL = 5**
- **End of FY TRL (Planned) = 5**

Goals/Action Plan

FY (2018)

- Identify fundamental and practical problems and features with SiPMs as they relate to IAEA detector needs.
- Identify published results and implementations of scintillation detectors tat use SiPMs that are of interest to IAEA.
- Asses how effectively the fundamental problems were addresses.
- Perform simulations and experiments as needed to reproduce crucial results and make recommendations.

Team

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