Contribution ID: **24** Type: **Oral**

RF shielding on scintillator level for highly-integrated PET/MRI systems

Tuesday, 31 May 2022 08:30 (20 minutes)

The combination of PET and MRI to a simultaneous system poses challenges concerning the integration and optimization of both subsystems' performance. One crucial part of the integration process is a good RF shielding of the PET modules to reduce mutual interferences. The PET modules are typically completely enclosed and restrict the system configuration. We propose an approach with RF shielding on scintillator level to achieve a higher level of integration and to reduce the PET module's RF housing size. The scintillator is excluded from the shielded volume as it is not influenced by the electromagnetic fields, and the created opening is closed using the scintillator with integrated RF shielding material to maintain the shielding effectiveness (SE). This is done by wrapping copper foil around the scintillator segments to create waveguides operating below their cut-off frequency. To prove the feasibility, prototypes were assembled using 2×32 mm^2 PVC slabs with a height of 7 or 12 mm, and 12.5 μm copper foil inserted between every or every second slab. The directional SE was evaluated using a network analyzer and field probes, where the receive field probe surface normal was oriented in segmented, monolithic and DOI direction, analog to the orientations used for the PET detector performance evaluation. The influence of the integrated material on the PET detector performance was evaluated using semi-monolithic LYSO arrays (eight $3.9 \times 32 \times 12$ mm^3 slabs) and digital SiPM arrays by comparing the performance of three scintillator configurations: Slab$_{\mathrm{ESR}}$ with a double layer of ESR as crystal separation; Slab$_{\mathrm{ESR+Cu}}$ with a double layer of ESR and copper foil inserted in-between; and Slab$_{\mathrm{Cu}}$ with only copper foil wrappings. The positioning performance was evaluated using a fan-beam-collimator setup and the machine learning technique gradient tree boosting. The energy and timing resolution were evaluated using flood irradiation measurements without a collimator.

The prototypes with copper foil between each slab reached the highest attenuation for 12 mm height (SE of about 20 dB, 0.3 dB and 6 dB, in segmented, monolithic and DOI orientation). We achieved the overall best positioning performance for Slab$_{\mathrm{Cu}}$, followed by Slab$_{\mathrm{ESR}}$ and Slab$_{\mathrm{ESR+Cu}}$. The best energy resolution was seen for Slab$_{\mathrm{ESR}}$, followed by Slab$_{\mathrm{ESR+Cu}}$ and Slab$_{\mathrm{Cu}}$ (10.6%, 11.2% and 12.6%, respectively). For the timing resolution, Slab$_{\mathrm{ESR}}$ (279 ps) was followed by Slab$_{\mathrm{Cu}}$ (288 ps). Slab$_{\mathrm{ESR+Cu}}$ performed worst with 293 ps.

In summary, we have seen a minor impact of the introduced copper foil on the PET detector performance. In combination with the achieved SE, we have shown the feasibility of this shielding approach and have found two potential integration methods for system applications (integration between a double layer of ESR foil or directly wrapping scintillator segments with copper foil).

Primary author: YIN, Laiyin (Department of Physics of Molecular Imaging Systems, Institute for Experimental Molecular Imaging, RWTH Aachen University)

Co-authors: MÜLLER, Florian (Department of Physics of Molecular Imaging Systems, Institute for Experimental Molecular Imaging, RWTH Aachen University); KUHL, Yannick (RWTH Aachen University); NAUNHEIM, Stephan Niklas (Department of Physics of Molecular Imaging Systems (PMI), Institute of Experimental Molecular Imaging (ExMI), RWTH Aachen University); SCHRANK, Franziska (Department of Physics of Molecular Imaging Systems, Institute for Experimental Molecular Imaging, RWTH Aachen University); SCHUG, David (Department of Physics of Molecular Imaging Systems, Institute for Experimental Molecular Imaging, RWTH Aachen University); SCHULZ, Volkmar (RWTH Aachen University, Hyperion Hybrid Imaging Systems, Fraunhofer MEVIS)

Presenter: YIN, Laiyin (Department of Physics of Molecular Imaging Systems, Institute for Experimental Molecular Imaging, RWTH Aachen University)

Session Classification: New technologies for PET/MR and TB-PET

Track Classification: New technologies for PET/MR and TB-PET