Electronic Supplementary Information (ESI)

Development of radiodetection systems towards miniaturised quality control of PET and SPECT radiopharmaceuticals

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1. SiPM detector design and setup

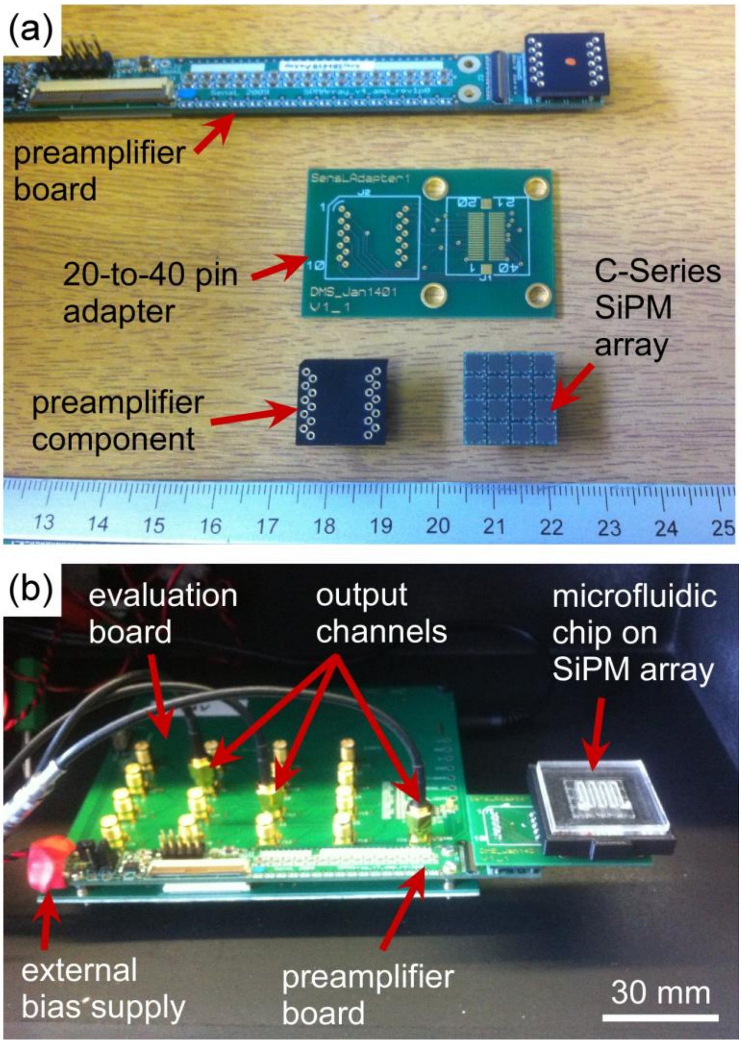

Fig. S1 (a) Photograph of the disassembled SiPM setup, showing the various components of the platform including the ArraySB4-EVB-PreAmp preamplifier (SensL, Ireland), a C-Series MicroFC-SMA-30035 4x4 SiPM array (SensL), and an adapter board (LabLogic Systems Ltd., UK) to connect the two components. The scale is in millimetres. (b) Assembled SiPM platform with a microfluidic chip placed over the SiPM array, which was connected to an ArraySB4-EVB-PixOut evaluation board (SensL) via the preamplifier board. The output channels were selected by connecting the gold connectors on the evaluation board to a discriminator (CAEN N841) and quad scaler (CAEN N1145) system for counting. A bias voltage was supplied via an external power supply unit (Aim-TTi, UK).

2. ^{22}Na source for Geant4 penetrability simulation comparisons

Fig. S2 The standard ^{22}Na disk source used as a positron emitter (546 keV positron energy) source, providing the anti-parallel 511 keV annihilation γ rays used to initially test the SiPM setup, and to compare to the Geant4 penetrability simulations.

3. Effect of material type

Table S1 Physical properties of the substrates selected for studies in this work.

Substrate	Density ($g\ cm^{-3}$)	Refractive index	Composition	References
B270 crown glass	2.55	1.523	SiO_2 (69.1 %) B_2O_3 (10.8 %) BaO (3.1 %) Na_2O (10.4 %) K_2O (6.3 %) As_2O_3 (0.4 %)	[1]
Soda-lime glass	2.52	1.518 - 1.520	SiO_2 (70-73 %) Na_2O (14-16 %) CaO (5-10 %) MgO (3-4 %) Al_2O_3 (1 %) K_2O (0.5-1 %)	[2-4]
Borofloat glass	2.20	1.469 - 1.480	SiO_2 (81 %) B_2O_3 (13 %) Al_2O_3 (2 %) Na_2O/K_2O (4 %)	[5]
Polycarbonate	1.20	1.584 - 1.586	$(C_{16}H_{14}O_3)_n$	[6]
PMMA	1.19	1.49	$(C_5H_8O_2)_n$	[7]
PTFE	2.20	1.38	$(C_2F_4)_n$	[8]

4. Effect of material thickness

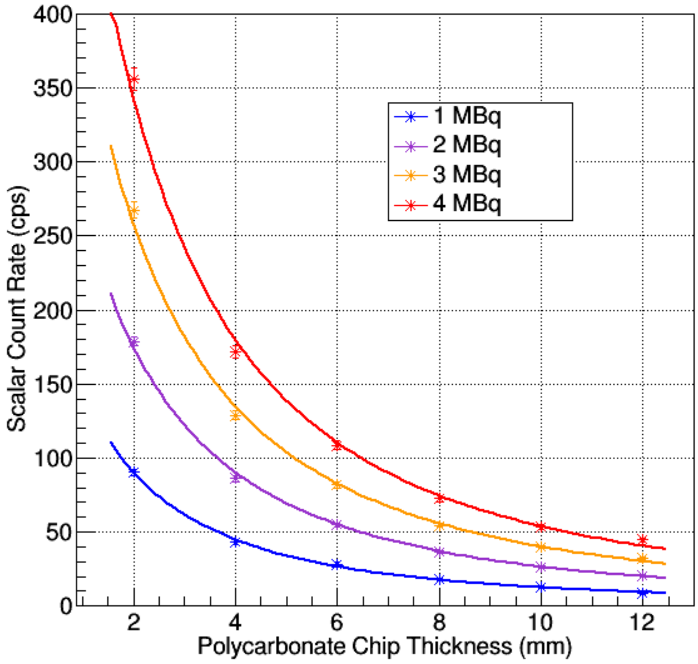

Fig. S3 SiPM signal plotted against chip thickness at different levels of radioactivity. The data points were calculated from line equations obtained from Fig. 3b in the main paper.

5. Material opacity study

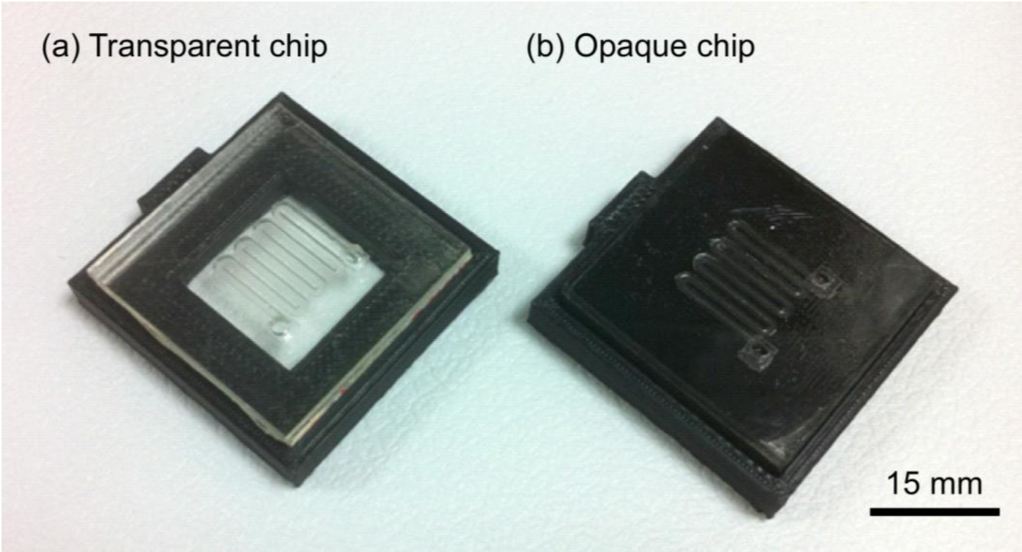

Fig. S4 Microfluidic devices used for the material opacity study. The milled substrates shown were fabricated from 4 mm thick polycarbonate and are shown housed in their chip holders. (a) Transparent polycarbonate microfluidic chip. (b) Opaque polycarbonate chip with its underside spray-painted black, and a layer of black plastic between it and the SiPM array.

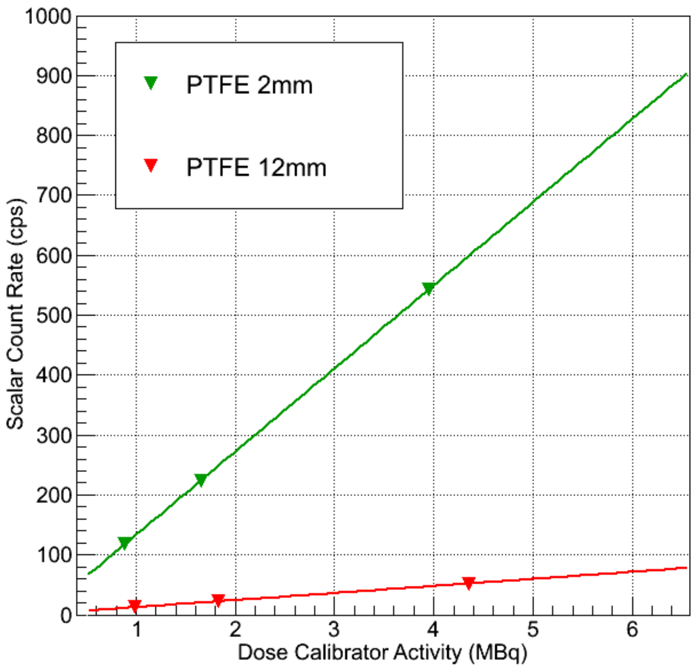

Fig. S5 SiPM signals obtained from opaque PTFE substrates of 2 mm and 12 mm thicknesses, which contained 40 μL of aqueous [^{18}F]fluoride solution.

6. References

1. “Properties of B270 glass“ webpage, GVB GmbH - Solutions in Glass (Herzogenrath, Germany) website: *http://www.g-v-b.de/File/Optische%20Materialien_e(2).pdf*, accessed 2015.
2. “Substrate Material Specifications“ data sheet, Nanofilm, Inc. (Westlake Village, CA, USA) website: *http://www.nanofilm.com/global/pdf/substrate-material.pdf*, accessed 2015.
3. “Chemistry of Glass“ webpage, Corning Museum of Glass (Corning, NY, USA) website: *http://www.cmog.org/article/chemistry-glass*, accessed 2015.
4. “Composition and manufacture: Soda-lime-silicate“ webpage, Saint-Gobain Glass UK Ltd. (Eggborough, UK) website: *http://uk.saint-gobain-glass.com/trade-customers/composition-and-manufacture*, accessed 2015.
5. “BOROFLOAT 33 - General Information“ webpages, Schott North America, Inc. (Duryea, PA, USA) website: *http://www.us.schott.com/borofloat/english/index.html*, accessed 2015.
6. “Polycarbonate (PC) - Material Information“ webpage, Goodfellow Cambridge Ltd. (Huntingdon, England) website: *http://www.goodfellow.com/A/Polycarbonate.html*, accessed 2015.
7. “Polymethylmethacrylate (PMMA, acrylic) - Material Information“ webpage, Goodfellow Cambridge Ltd. (Huntingdon, England) website: *http://www.goodfellow.com/A/Polymethylmethacrylate.html*, accessed 2015.
8. “Polytetrafluoroethylene (PTFE) - Material Information“ webpage, Goodfellow Cambridge Ltd. (Huntingdon, England) website: *http://www.goodfellow.com/E/Polytetrafluoroethylene.html*, accessed 2015.