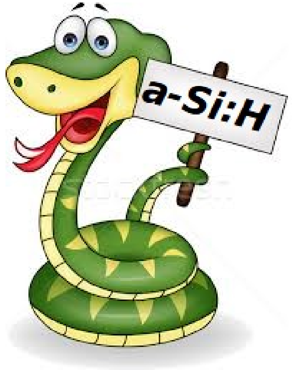
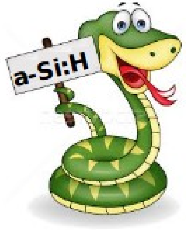
HASPIDE WP5

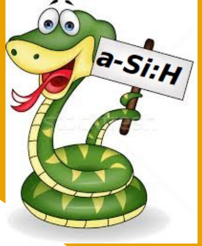


Detector Validation for ASI Proposal

L. Servoli



What means validation?



→ *Ideally to have a duplication of incoming radiation fluxes and expose a sensor to them (quite difficult in this case….)*

→ *fast evaluation using some experimental results not optimized for the task (we are here)*

→ *more accurate study using simulations of detector and radiation fluxes.*

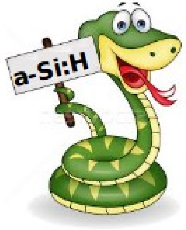
→ *some measurement of detector response to real well known radiation fluxes to feed to simulation.*

Which measurements we have?

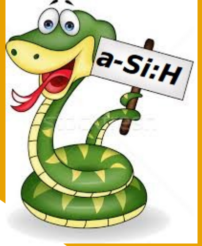
1) specific SEPs fluxes (photons, electrons, protons)

October 28, 2021

Onset 15:35-16:35 UT	$1319649771E^{2.8058}$	$0.02 \leq E \leq 0.042$
	$2124407E^{0.7821442}$	$0.042 \leq E \leq 0.08$
	$7499891\exp(-E/0.135)E^{1.06}$	$0.08 \leq E \leq 0.898$
	$5728E^{-4.583910749}$	$0.898 \leq E \leq 2.41$
Peak(NM) 17:30-18:20 UT	$9659222E^{-0.087462841}$	$0.02 \leq E \leq 0.04$
	$644779E^{-0.928365512}$	$0.04 \leq E \leq 0.0726$
	$1029025\exp\left(-\frac{E}{0.157129681}\right)E^{-0.940836137}$	$0.0726 \leq E \leq 0.484$
	$2554E^{-4.715116675}$	$0.484 \leq E \leq 2.25$
Peak(space) 20:35-22:35 UT	$311105E^{-1.3}$	$0.02 \leq E \leq 0.0357$
	$41837E^{-1.90255}$	$0.0357 \leq E \leq 0.0717$
	$15749E^{-2.273}$	$0.0717 \leq E \leq 0.580$



Which measurements we have?

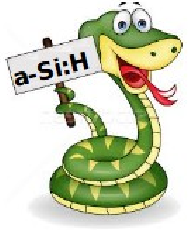


2) probability of interaction of single ionizing particle with a-Si:H material

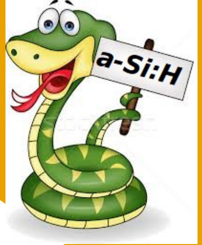
→ NIST tables

3) average energy deposition in the material

→ SRIM for protons, …….

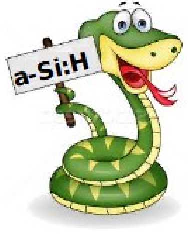


Which measurements we have?

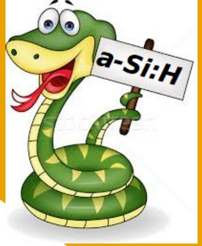


4) *specific sensitivities and noise for a given detector (photons, electrons, protons)*

Ionizing Radiation	Sensor Name	Bias [V]	Sensitivity [nC cGy^{-1}]	5σ detection value [cGy]	Linearity [%]
γ X-ray	A2AB1	0.0	0.052	0.260	$\sim$ 1.6
γ 50 kV X-ray	A2AB1	20.0	0.657	0.040	$\sim$ 1.6
γ 50 kV X-ray	A3AC2	30.0	2.040	0.045	$\sim$ 1.0
γ Clinical (6 MV)	UOW429	0.0	0.049	0.245	$\sim$ 1.5
e^- 6 MeV Clinical	UOW429	0.0	0.065	0.325	$\sim$ 1.5
Protons 3 MeV	PAD_V2	20.0	0.025	0.400	$\sim$ 5
Protons 3 MeV	PAD_V4	20.0	0.030	0.330	$\sim$ 5



We need to combine them for a device



5) CSC 4x4 mm^2 area, 8.2 μm thickness

25 x 25 sensors arranged in a square, readout in parallel.

Sensitivity 10 nA/(cGy/s) , single device noise 5 pA

estimation of total noise 25 pA

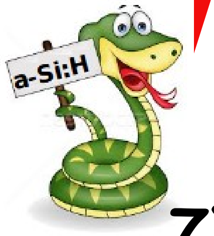
detection limit @ 5σ → 125 pA

We need to combine them for a device

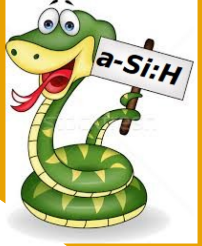
6) Using monochromatic radiation we could then produce the tables like this (photons):

Detection limits at 5σ for monochromatic photon fluxes.

Photon Energy [keV]	Minimum detectable flux $[\gamma/(cm^2\ sr\ s)]$
3.0	$2.4 \cdot 10^3$
5.0	$3.8 \cdot 10^3$
10.0	$10.2 \cdot 10^3$
15.0	$20.2 \cdot 10^3$
20.0	$33.0 \cdot 10^3$
25.0	$47.8 \cdot 10^3$
30.0	$79.8 \cdot 10^3$
35.0	$150.0 \cdot 10^3$
40.0	$237.0 \cdot 10^3$



We need to combine them for a device



7) Integrating the energy spectra with the expected energy deposition for each particle at a given energy and folding it with sensitivity we could obtain the lower limit of the flux for 5σ detection.

and compare with absolute fluxes recorded for past SEPs.

We need to combine them for a device

8) What we obtain for the 28 october 2021 SEP:

→ photons : using 3-40 keV part of spectrum

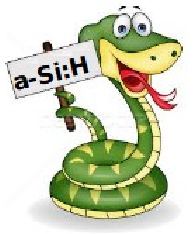
less than 10^6 photon flux (well below actual flux)

→ electrons : using > 50 keV part of spectrum

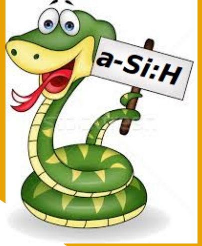
barely noticeable signal (S/N 1.8)

→ protons : using the whole spectrum we obtain

~ 2500 protons/s detected → S/N > 4



Future work



→ Simulation of the actual device and radiation fluxes.
Started….

→ Measurement of specific sensitivities for monochromatic or well known radiation sources.
Started…..