SIMULATION OF A HYBRID PIXEL SEMICONDUCTOR DETECTOR

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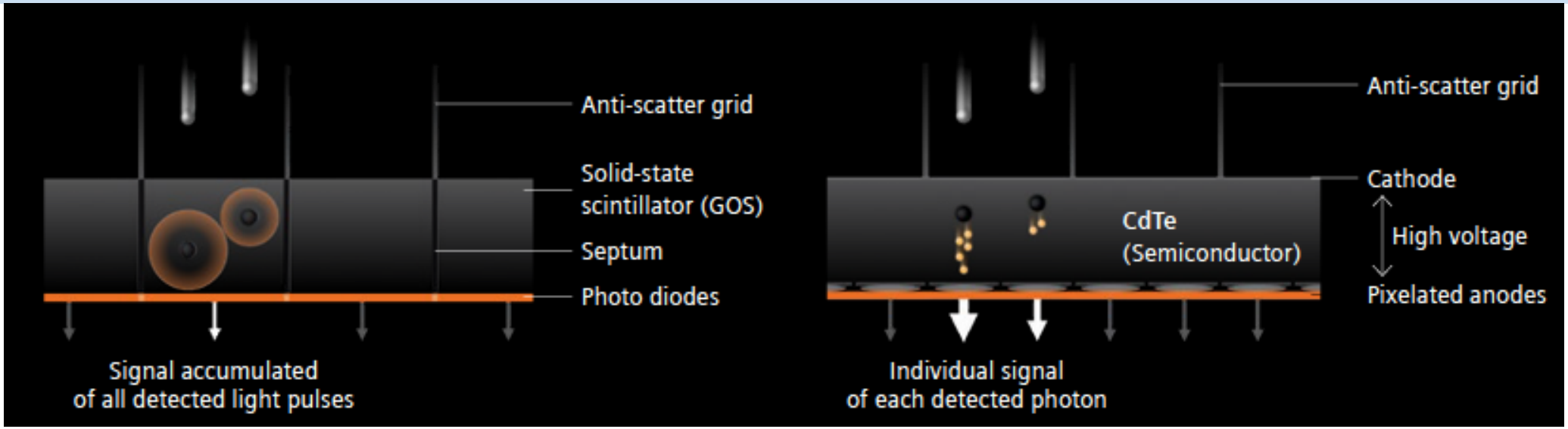
Scope of the study



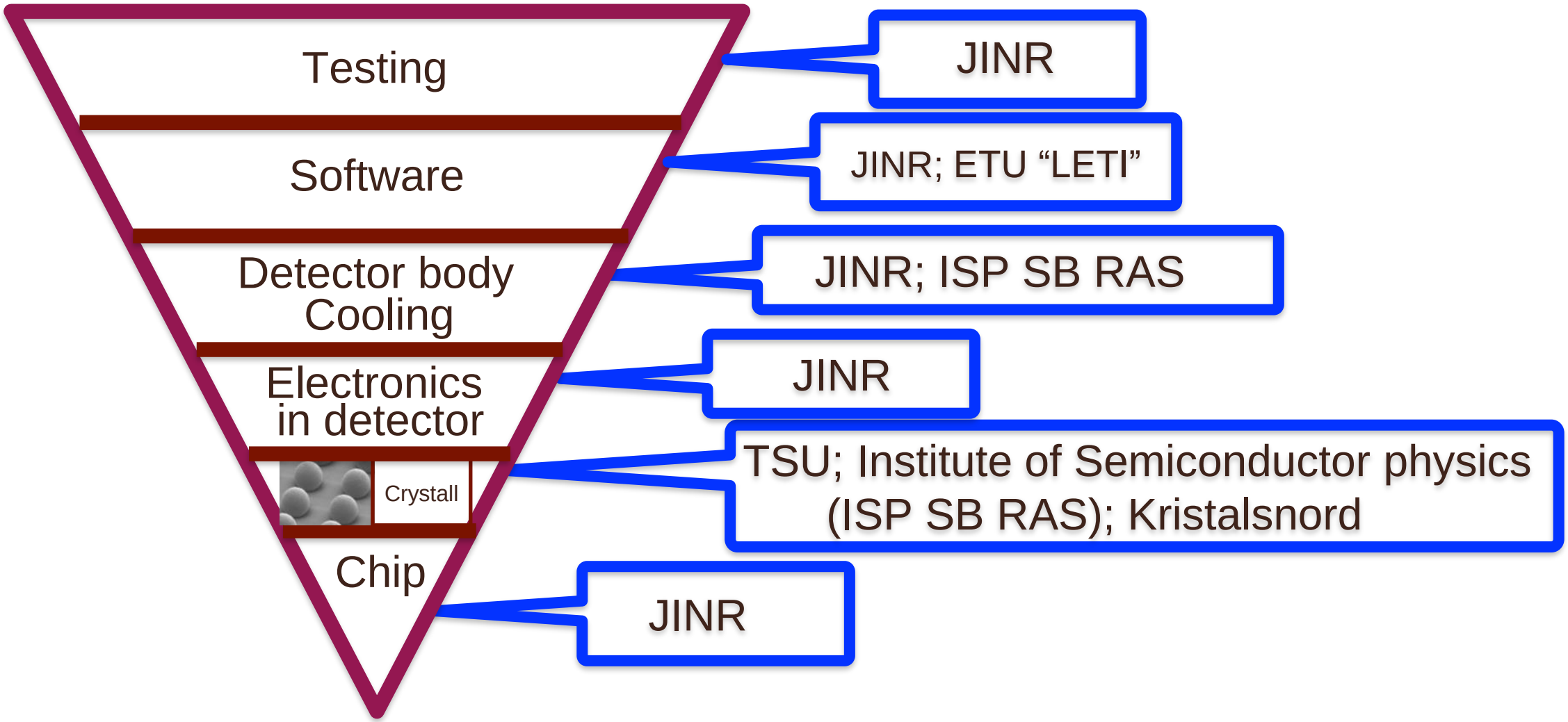
Conception of photon counting detectors[1]

Advantages of photon-counting computed tomography:

- Intrinsic spectral sensitivity
- Equal contribution of lower energy quanta
- Smaller detector pixels
- Elimination of electronic noise

[1] *Whitepaper: The technology behind photon-counting CT. http://siemens-healthineers.us/naeotom-alpha*

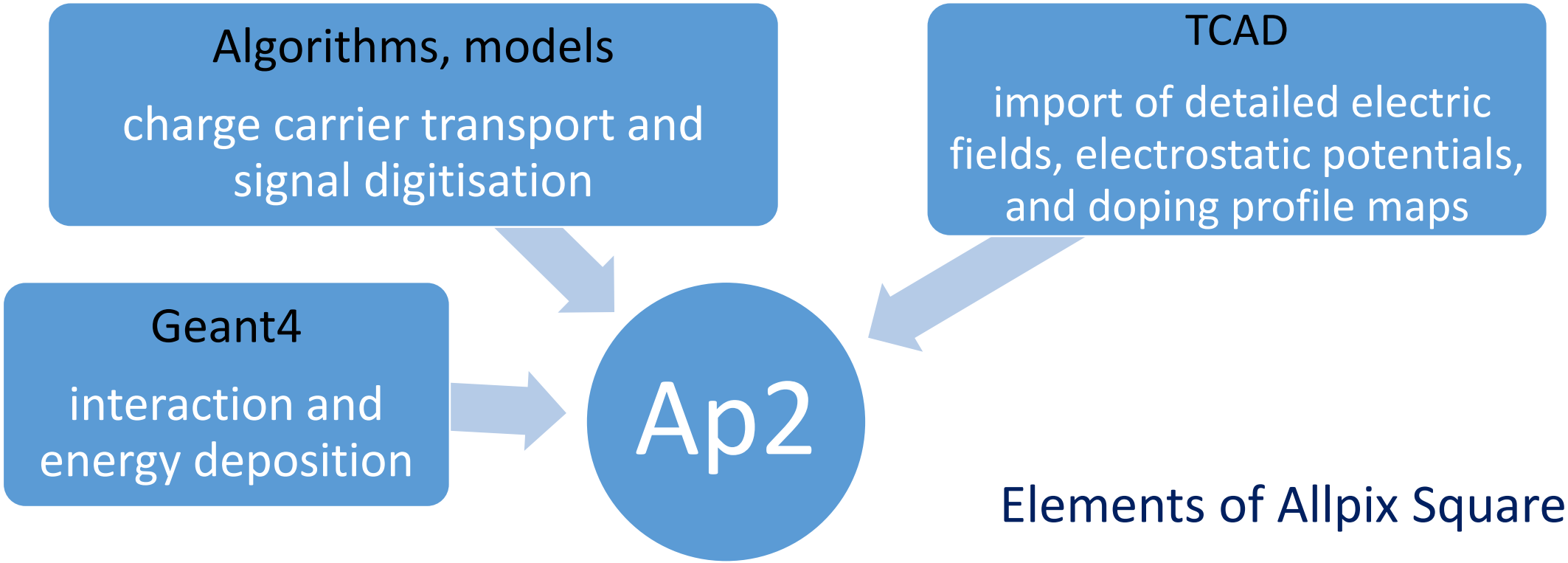
- Project 08-2-1126-4-2015/ 2028



Allpix Squared (ap2)

A Monte Carlo simulation framework for pixel semiconductor detectors

- End-to-end simulation: starting with the passage of ionizing radiation through the sensor and finishing with the digitization of hits in the readout chip.
- Designed as a modular framework, allowing for an easy extension to more complex and specialized detector simulations.



Elements of Allpix Squared

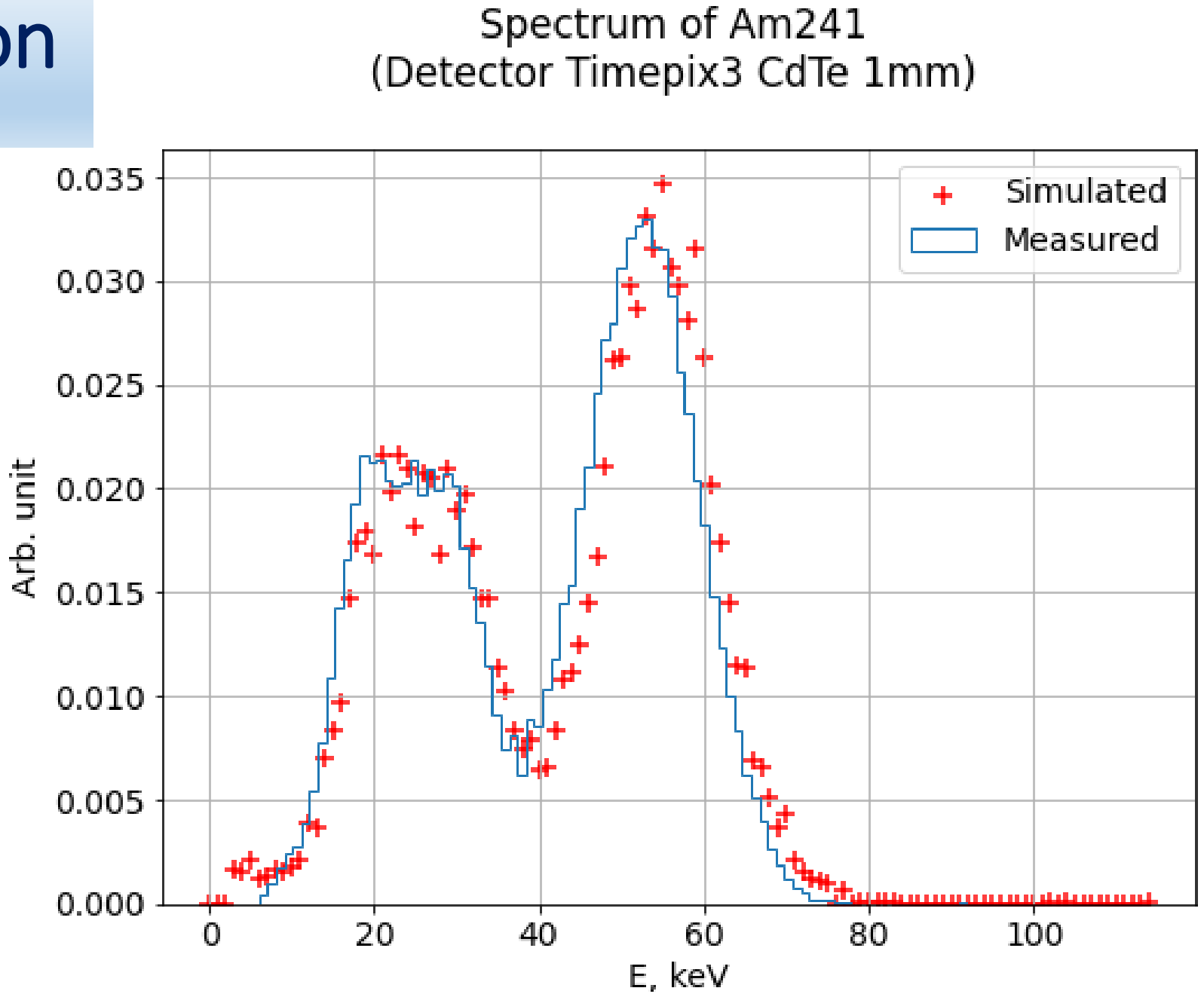
Simulation

Timepix3 – an object to simulate

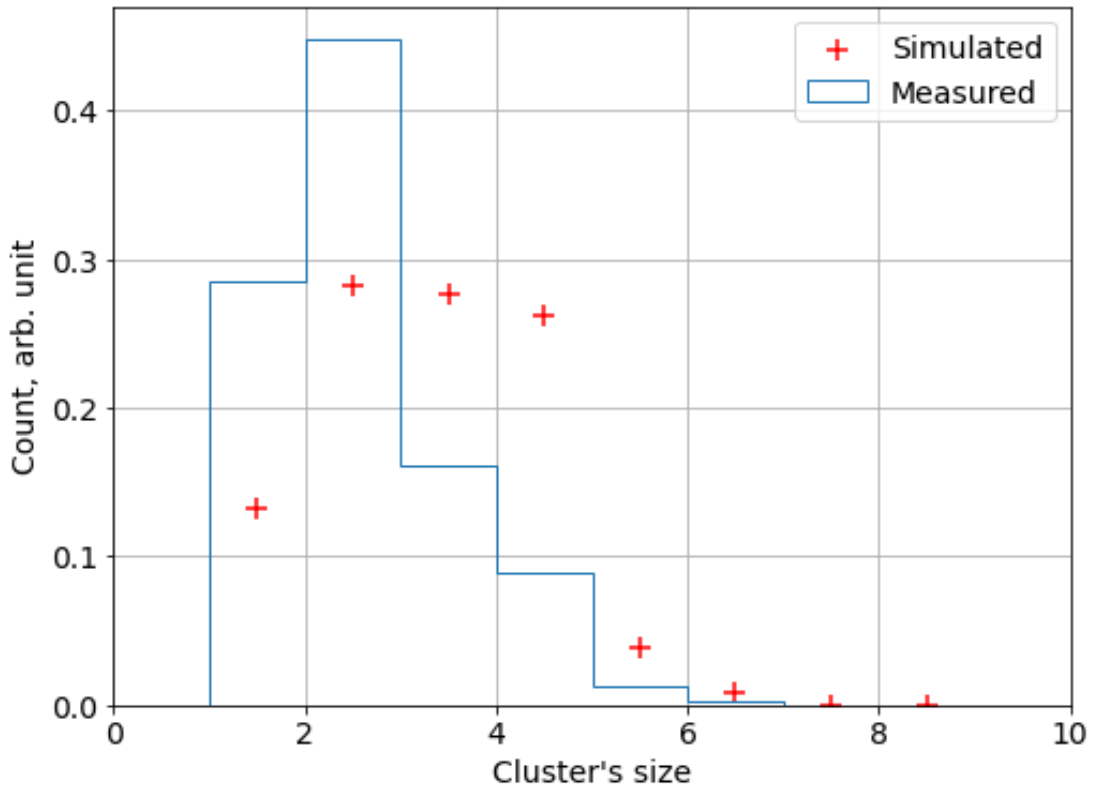
```
[Allpix]
number_of_events = 1000
detectors_file = "geometry_CdTe.conf"
[GeometryBuilderGeant4]
[DepositionGeant4]
[ElectricFieldReader]
[GenericPropagation]
[PulseTransfer]
[DetectorHistogrammer]
[ROOTObjectWriter]
```

Used modules

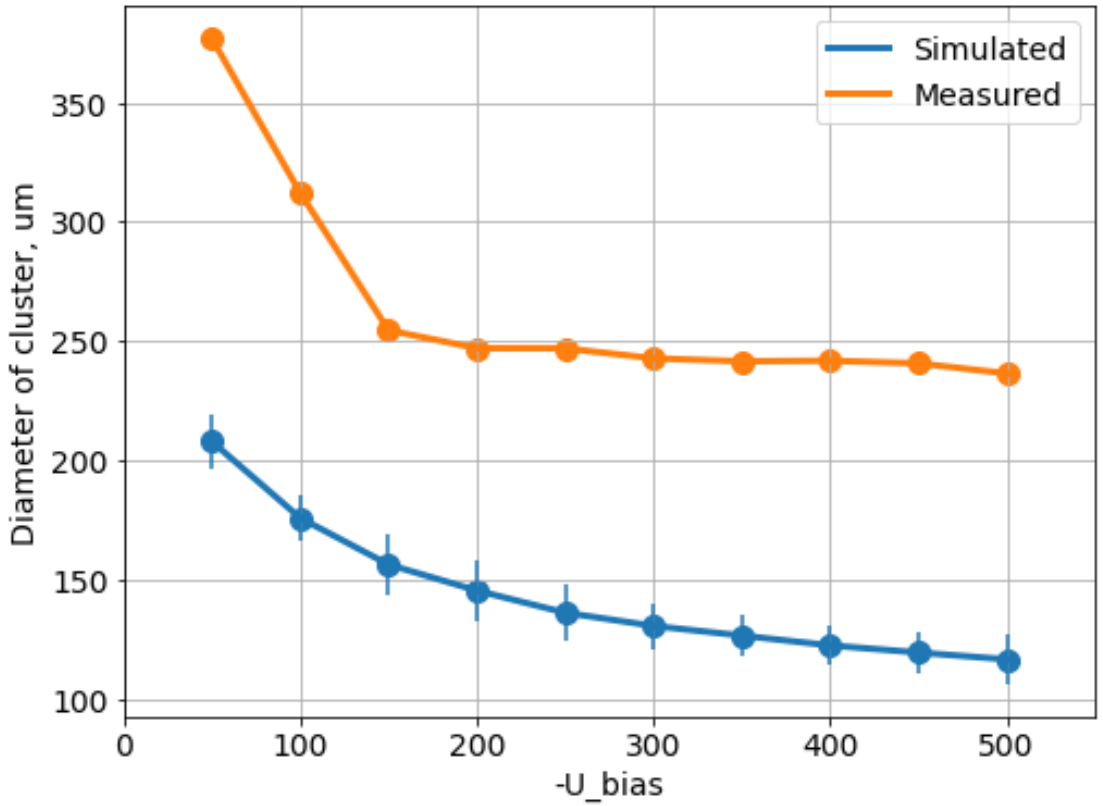
Verification



Limitation



Cluster size distribution: comparison between simulation and measurement. Radioisotope 241Am placed on distance of 7mm from detector Timepix3 (1mm CdTe) with a thin sheet of aluminium.



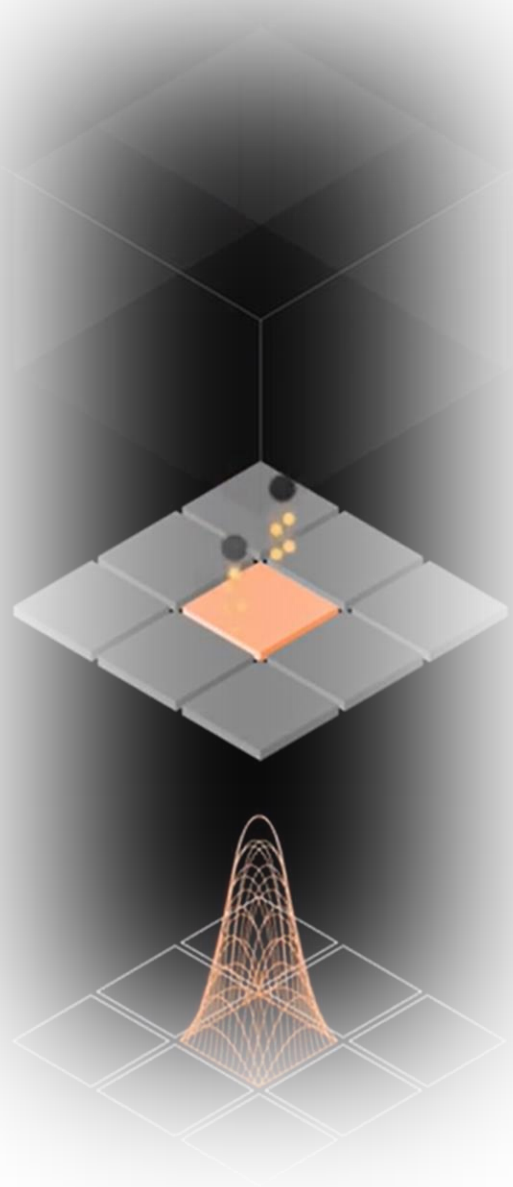
Dependence of cluster size on the applied bias voltage: comparison between simulation and measurement. Source of 5.5MeV alpha ray placed on distance 4mm from detector Timepix3 with 1mm CdTe sensor.

**Cluster: group of neighbouring pixels that register the same event. Clusters are created by charge sharing effect between neighbouring pixels.*

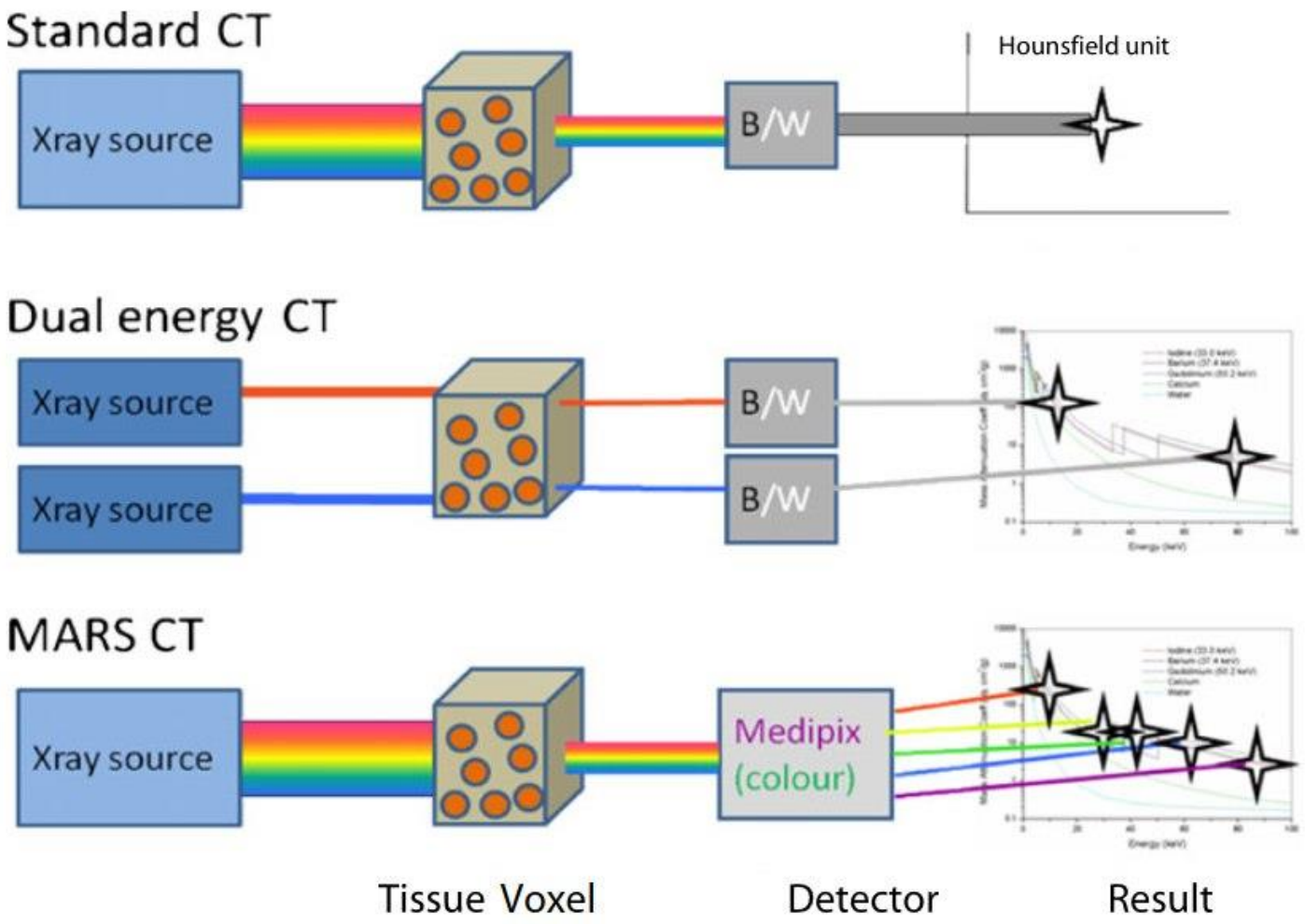
Conclusions

- Based on Allpix Squared, a model of a hybrid pixel semiconductor detector was built.
- Comparison between simulated and measured spectra was carried out, demonstrated that model has a fine performance in spectroscopy.
- A limitation in simulation of charge tranfer was found and can become a topic for a further study.

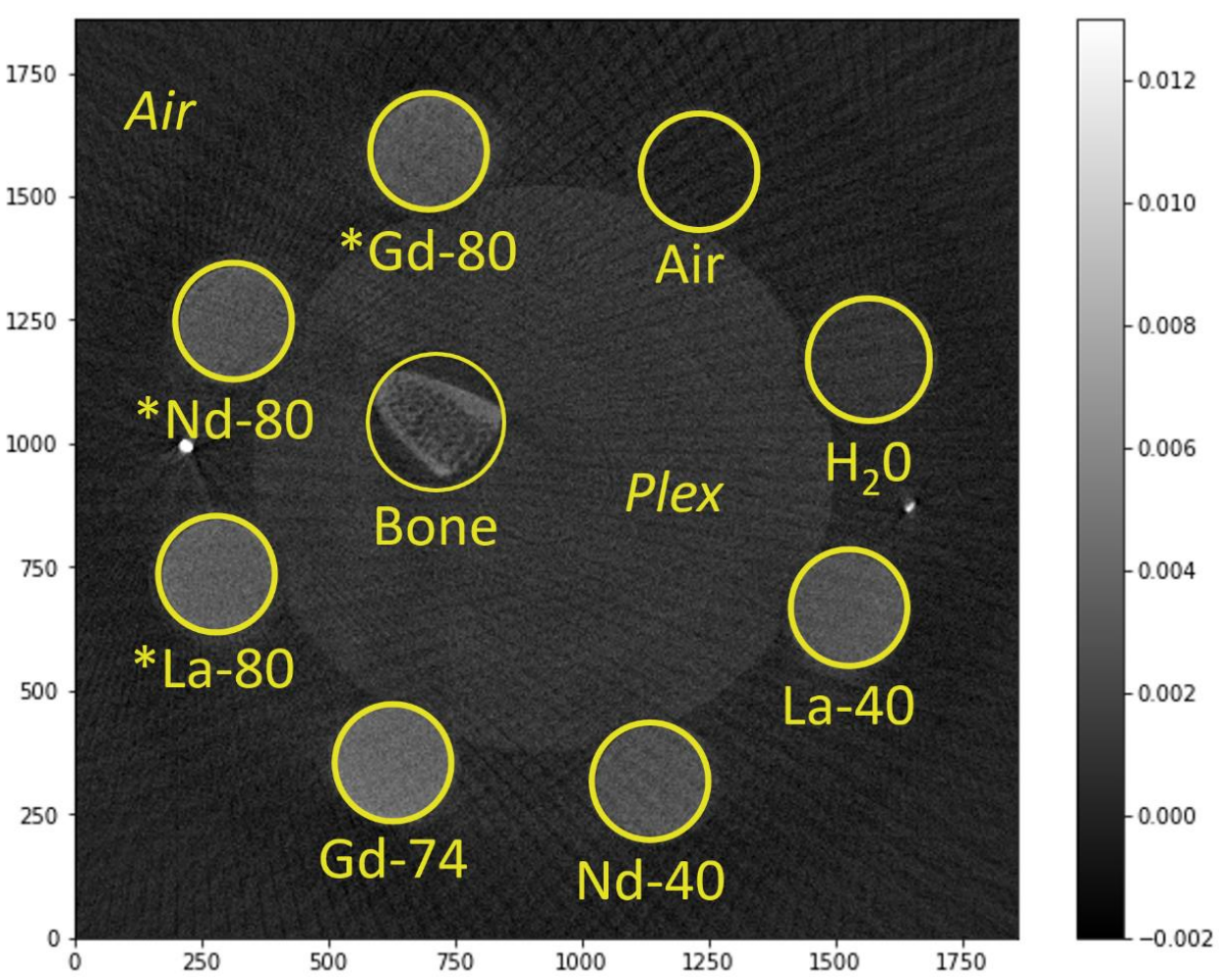

Thank you for your attention!
Any burning questions?

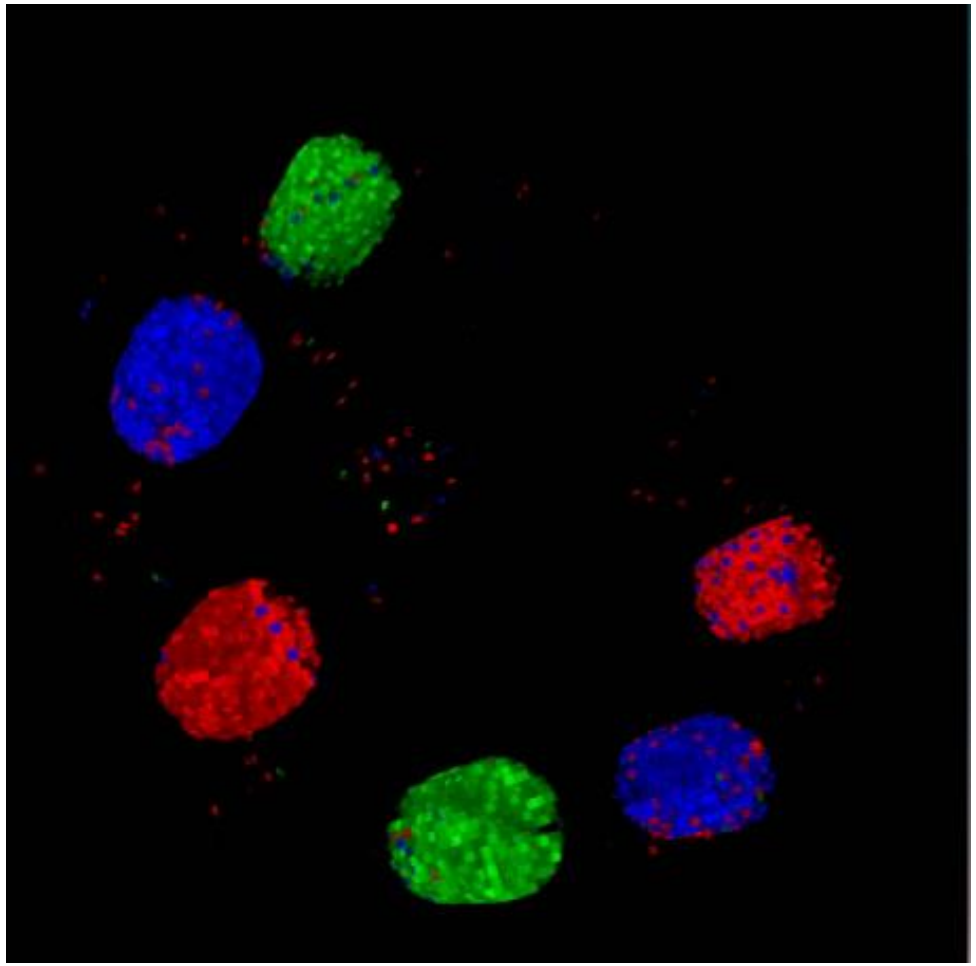


Extra slides

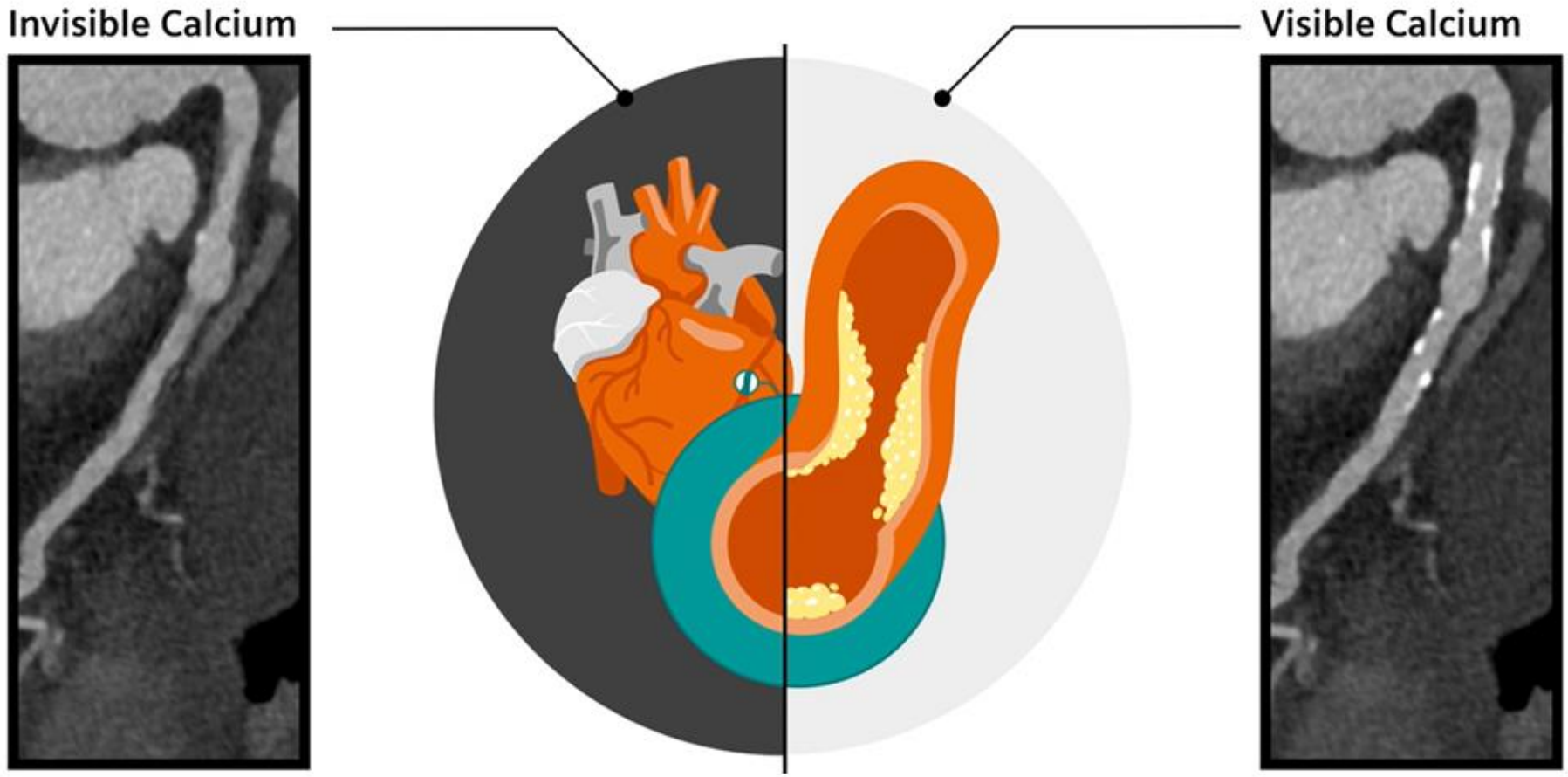


Anderson, Nigel G. et al. “Spectroscopic (multi-energy) CT distinguishes iodine and barium contrast material in MICE.” European Radiology 20 (2010): 2126-2134.





R.V. Sotenskii et al 2024 JINST 19 P04009. Novel algorithm for qualitative and quantitative material analysis by the K-edges for photon-counting computed tomography.



http://siemens-healthineers.us/naeotom-alpha