iPadPix - A Novel Educational Tool to Visualise Radioactivity Measured by a Hybrid Pixel Detector

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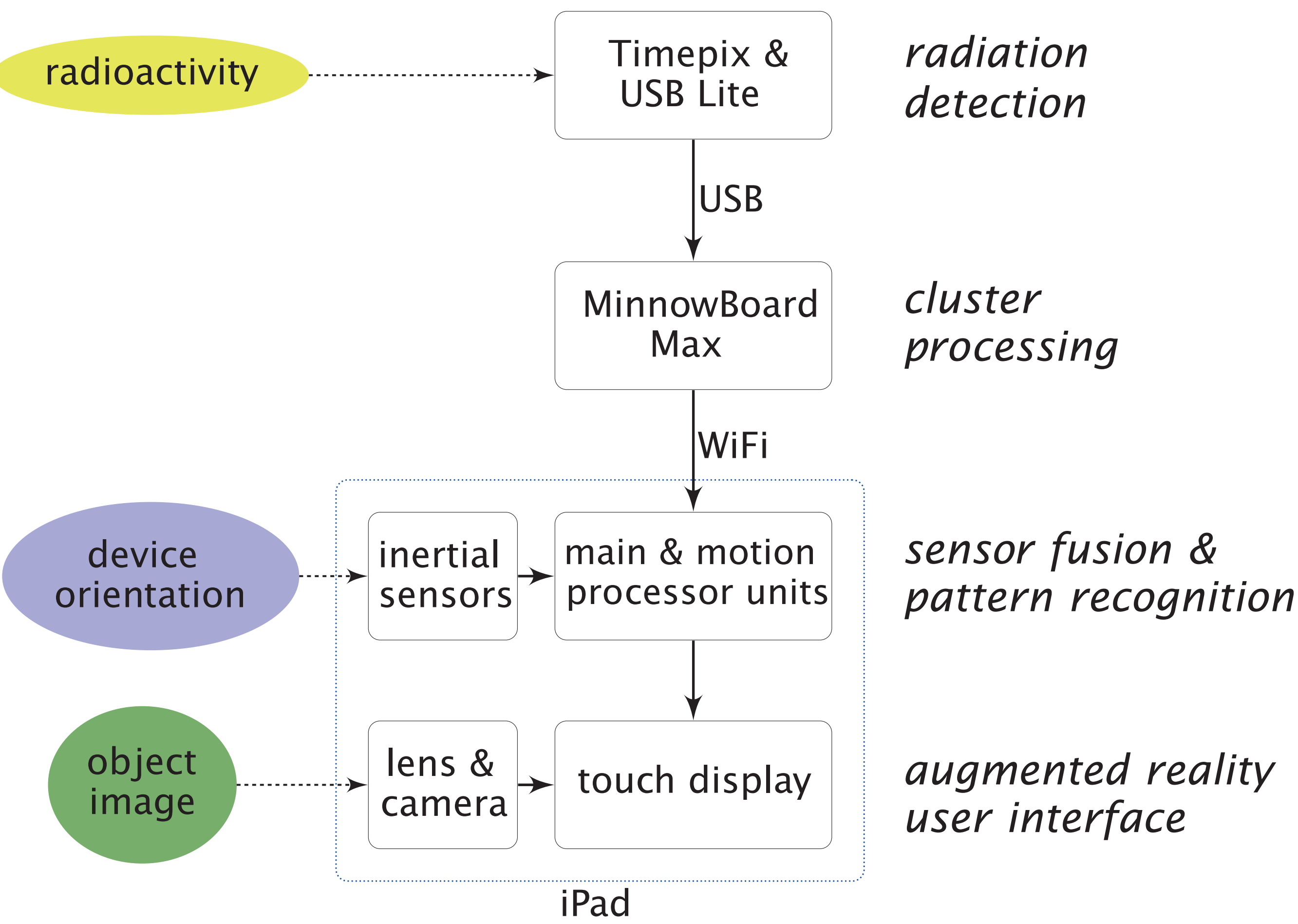Mathieu Benoit (University of Geneva), Sascha Schmeling (CERN), Andreas Müller (University of Geneva)

· Visualisation of radioactivity in real-time

· Using means of Augmented Reality

· Designed for educational settings

· Sensor: 300 µm silicon on Timepix chip

Inspired by cloud chambers, this novel tool allows an intuitive exploration of natural and other sources of low radioactivity. Different particle types are distinguished by evaluating their interaction with a pixel detector. Recorded traces of radiation are displayed on top of the live video feed from a tablet's camera. The mobility of iPadPix enables new experimental activities to observe radioactivity from every-day objects and the environment over time and space.
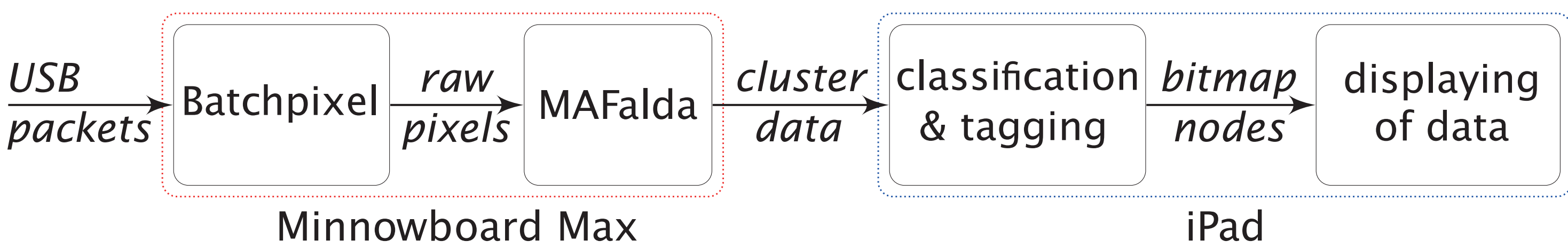
github.com/ozel/iPadPix

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iPadPix Overview

radioactivity → Timepix & USB Lite — *radiation detection*

USB

MinnowBoard Max — *cluster processing*

WiFi

device orientation → inertial sensors → main & motion processor units — *sensor fusion & pattern recognition*

object image → lens & camera → touch display — *augmented reality user interface*

iPad

Software & Data Flow

USB packets → Batchpixel — *raw pixels* → MAFalda — *cluster data* → classification & tagging — *bitmap nodes* → displaying of data

Minnowboard Max   iPad
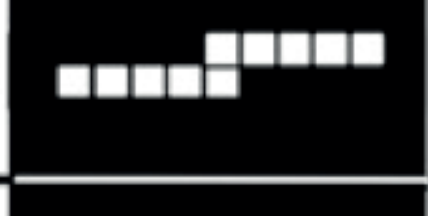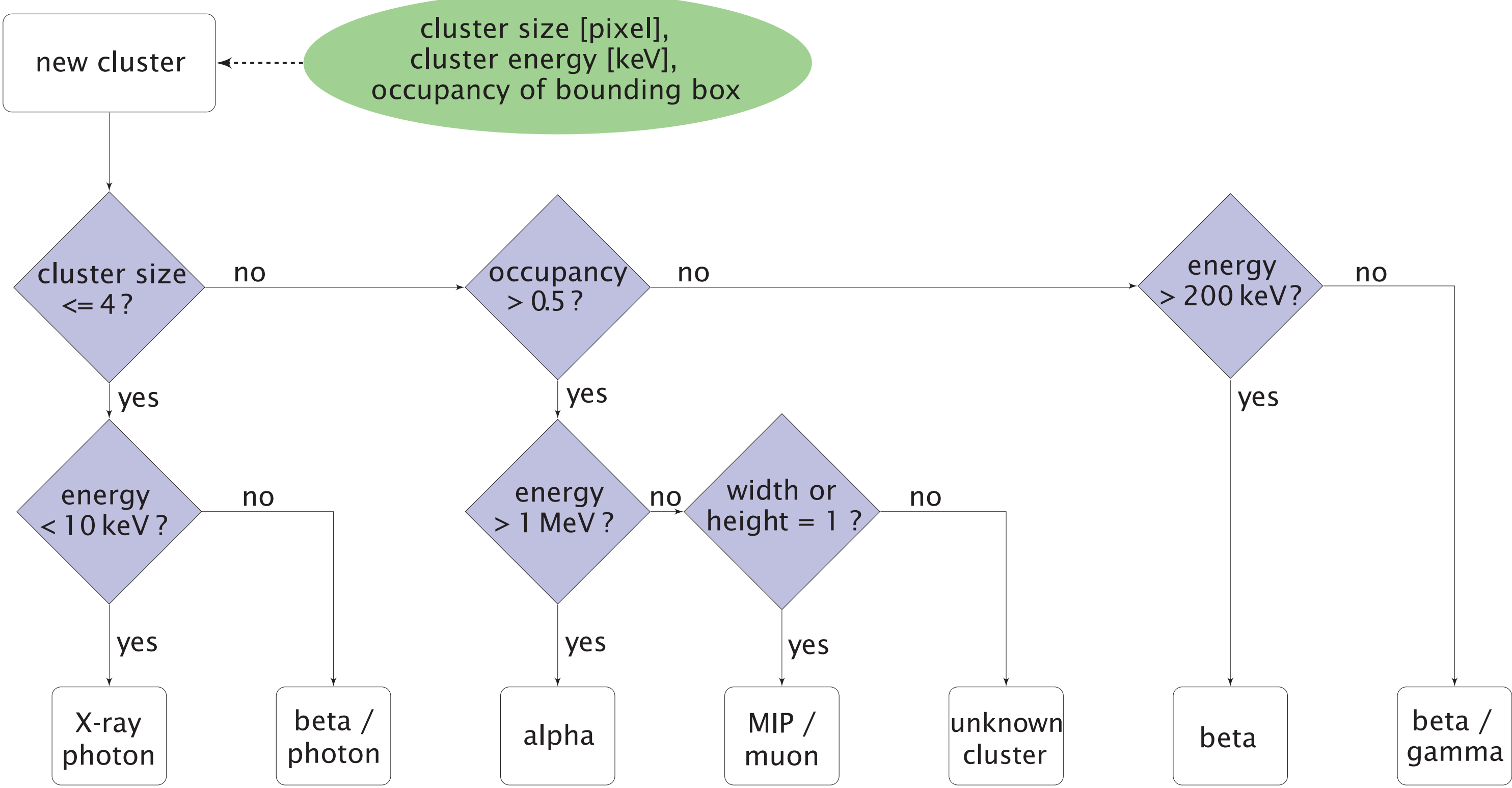
· Debian Linux on embedded Intel x86, Minnowboard Max

· modified Batchpix forwards hits into special fifo file

· modified MAFalda analyses each cluster in real-time

Cluster data send to tablet using several network layers:

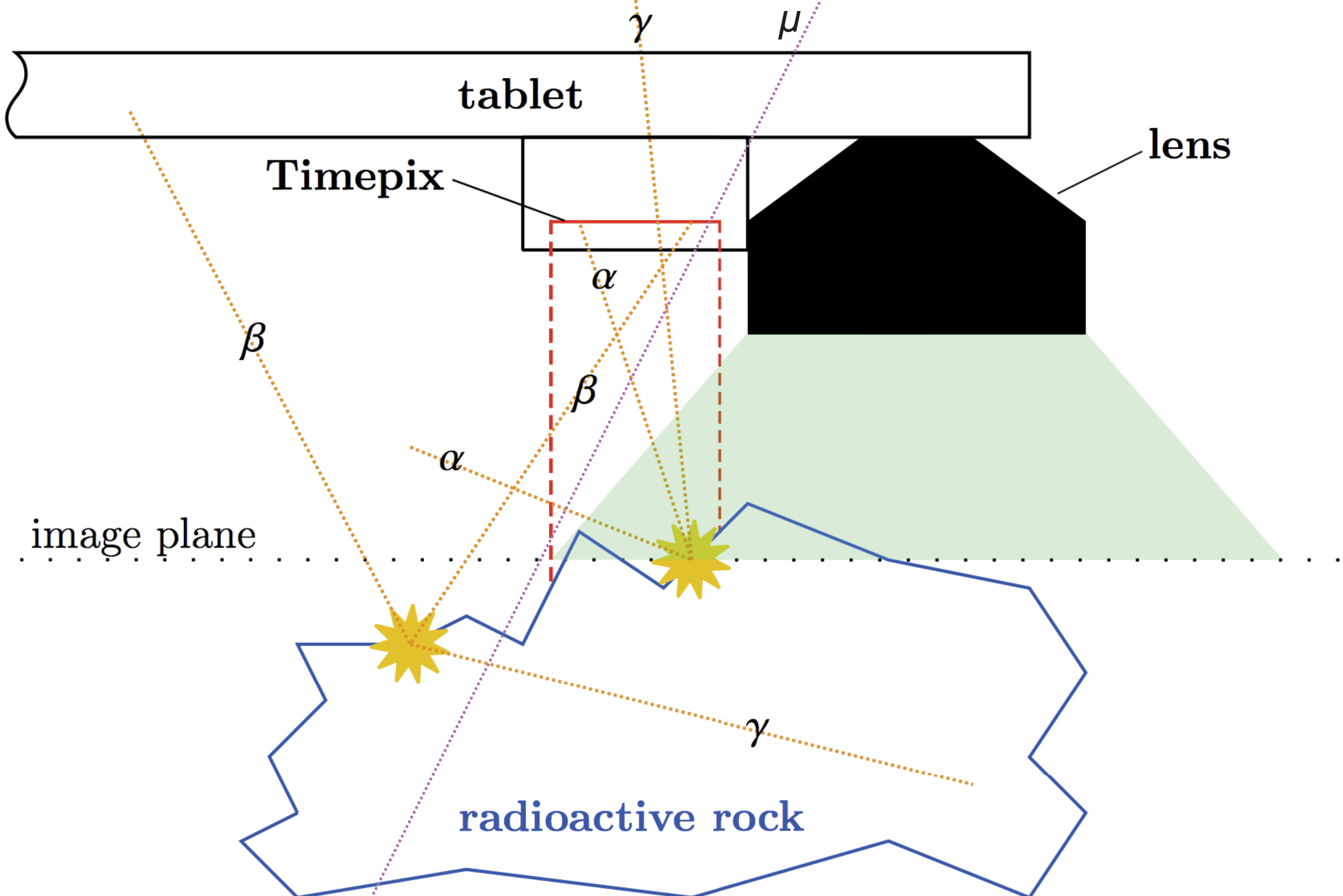1. WiFi access point
2. IP/UDP
3. AVRO serialisation protocol

Cluster Classification Process

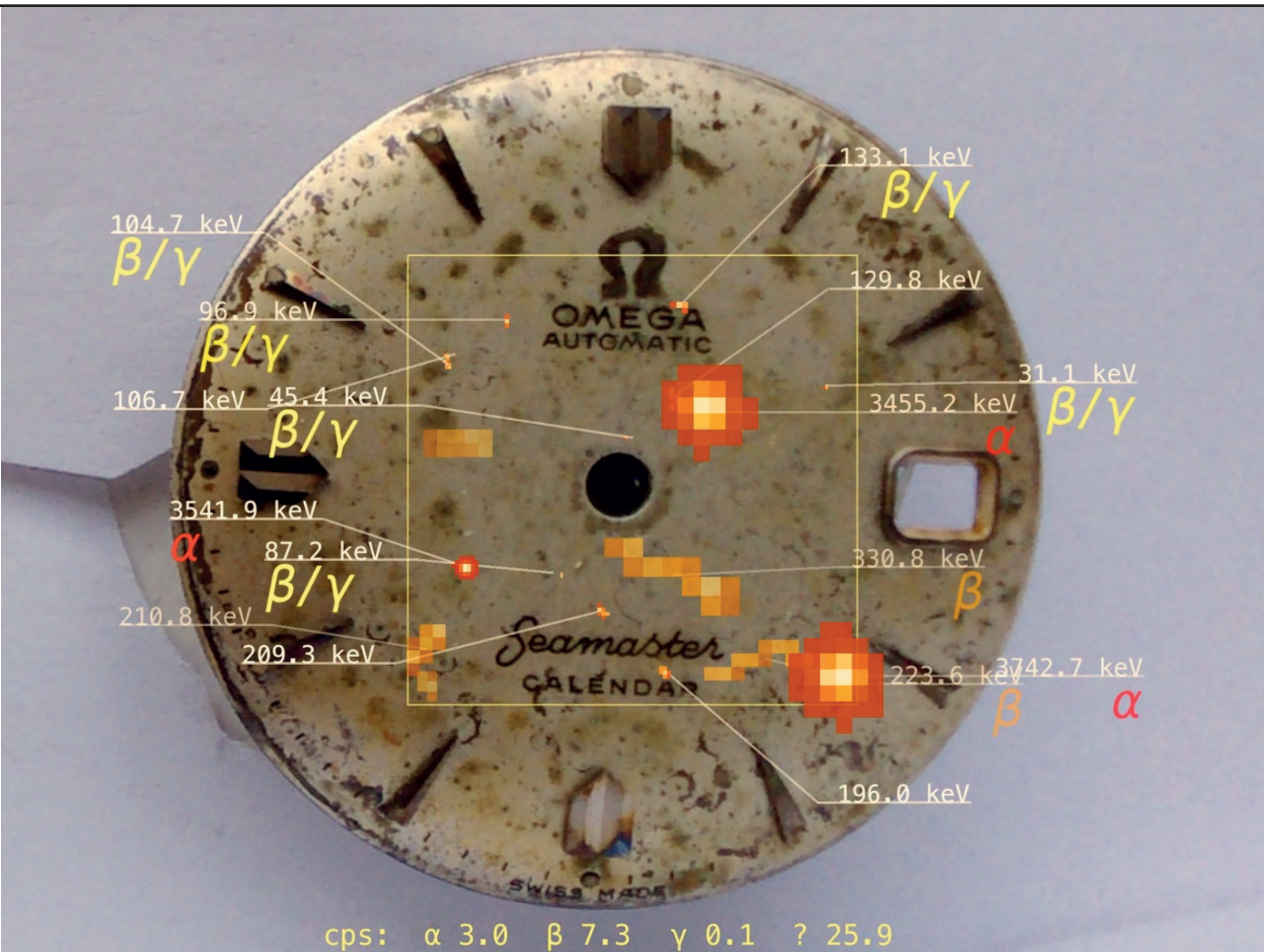|		
Dots		Photons and electrons
Small blobs		Photons and electrons
Heavy blobs		Heavy ionizing particles
Heavy tracks		Heavy ionizing particles → Incidence is not perpendicular to the detector's surface (Bragg curve)
Straight tracks		MIP
Curly tracks		Energetic electrons

Reprint from Bouchami et al. (2011).

cluster size [pixel], cluster energy [keV], occupancy of bounding box

new cluster

cluster size <= 4 ? — no — occupancy > 0.5 ? — no — energy > 200 keV ? — no

yes / yes / yes

energy < 10 keV ? — no
energy > 1 MeV ? — no
width or height = 1 ? — no

X-ray photon | beta / photon | alpha | MIP / muon | unknown cluster | beta | beta / gamma

Optical Setup

γ µ
tablet
Timepix
lens
α
β
β
α
image plane
β
γ
radioactive rock

Some of the shown decay products originate from within the projected area of the Timepix sensor and hit it. Collimation is intentionally omitted, which is why particles from outside of this area can be also recorded.

104.7 keV
133.1 keV β/γ
β/γ
129.8 keV
96.9 keV
β/γ
45.4 keV
106.7 keV
β/γ
31.1 keV
3455.2 keV
β/γ
3541.9 keV
α
87.2 keV
β/γ
330.8 keV
β
210.8 keV
209.3 keV
3223.6 keV 3742.7 keV
α
196.0 keV
cps: α 3.0 β 7.3 γ 0.1 ? 25.9

iPadPix image of an old radioactive watch face with Radium paint on the hour markings. All main decay modes of Radium and its daughters can be observed. The yellow rectangle indicates the projected sensor area (1.4 x 1.4 cm^2).