A Radioassay, Simulations and Backgrounds Database for XLZD

Bram Miles, Albert Baker
University College London, King's College London

Motivation

- The XLZD experiment will be a **next generation, low-background rare event observatory,** capable of searches for dark matter, $0\upsilon\beta\beta$ decay, solar pp neutrinos.
- Stricter radiopurity requirements and larger scale implies far higher demand than current xenon detectors (LZ had ~ 2,000 assays [1]).
- This volume of assay data requires a **single, centralised store accessible to the full collaboration**.

System Architecture

- Deployed on **King's College London (KCL) servers** [2] and accessible via **slack OAuth** to XLZD workspace members.
- **Streamlit** front-end over a PostgreSQL database (Fig. 1).
- **Superset and NocoDB**, data visualisers for users and admins, respectively [4].

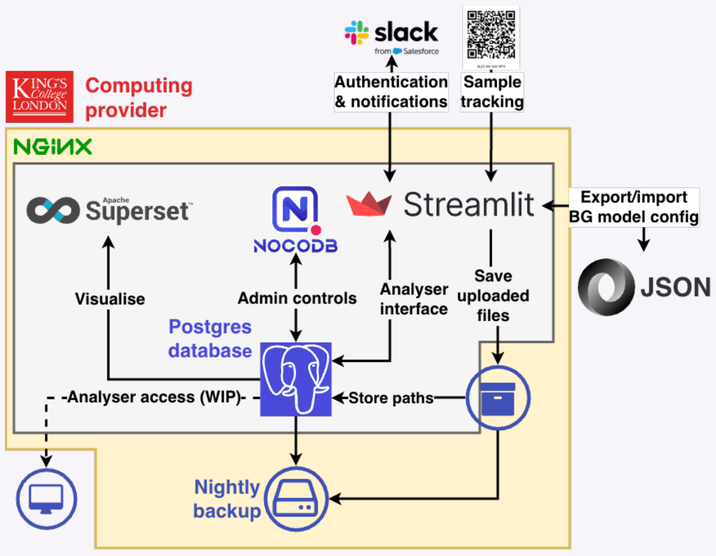

Figure 1: Software and network architecture.

Material & Assay Management

- Accepts both **direct measurement results** and **literature values** via validated web forms.
- Materials and assays are assigned **standardised** IDs; nightly backups.
- Each sample has an associated **QR code** (Fig. 2).
- **Scanning a QR** code retrieves **all information** for that sample.
- Location, bagging status, and analysis logged with timestamp – a full custody chain for radon plate-out.

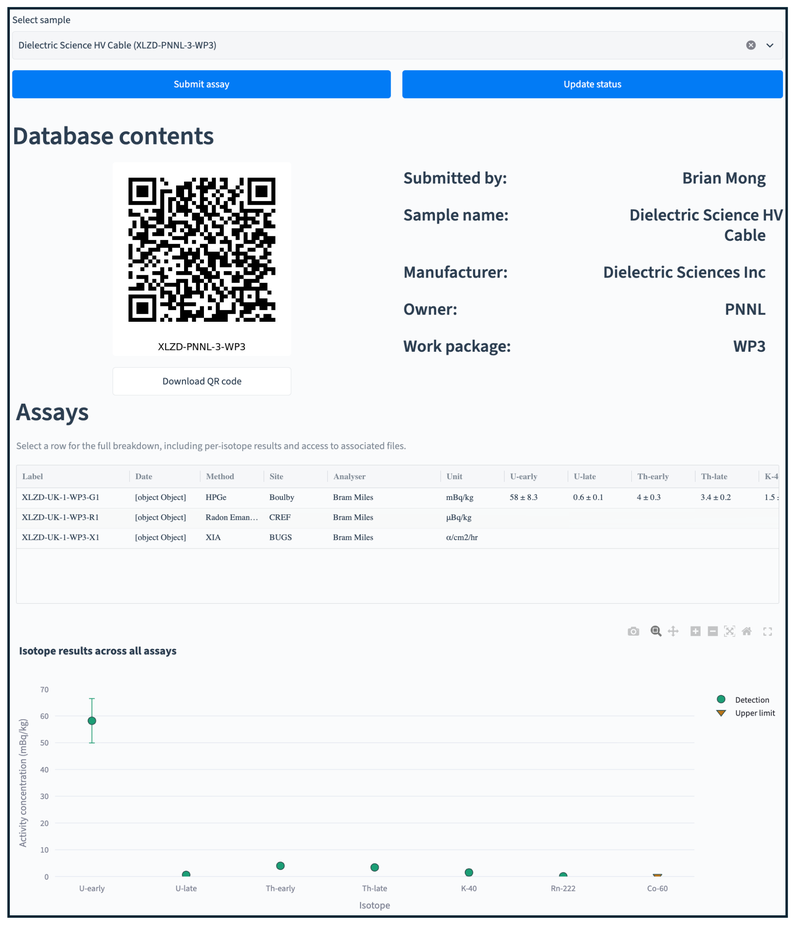

Figure 2: Snapshot of sample options page giving all current information on chosen sample.

Simulations Management

- XLZD simulation files are clustered into x, y, z energy/hit bins before upload.
- Resulting **.parquet files** carry **embedded simulation JSON metadata,** auto-extracted into database.

Detector Configuration & Background Evaluation

- **Custom detector configurations** link assay results to named components (Fig. 4).
- Activity and mass are **freely adjustable**, explore alternate material scenarios.
- Configurations can be saved and **reuploaded as JSON**.

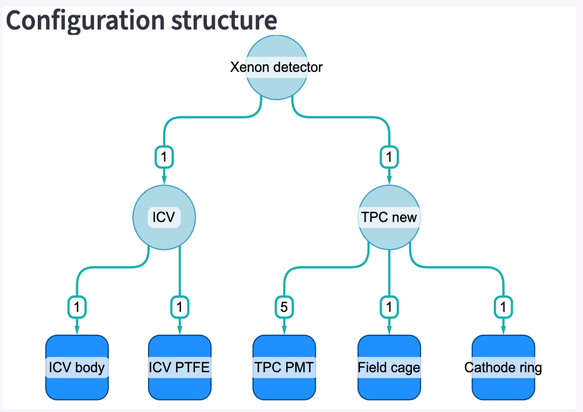

Figure 3: Example detector configuration.

- Fiducial-volume and ROI cuts give component-by-component background in evts/t/yr (Fig. 4).

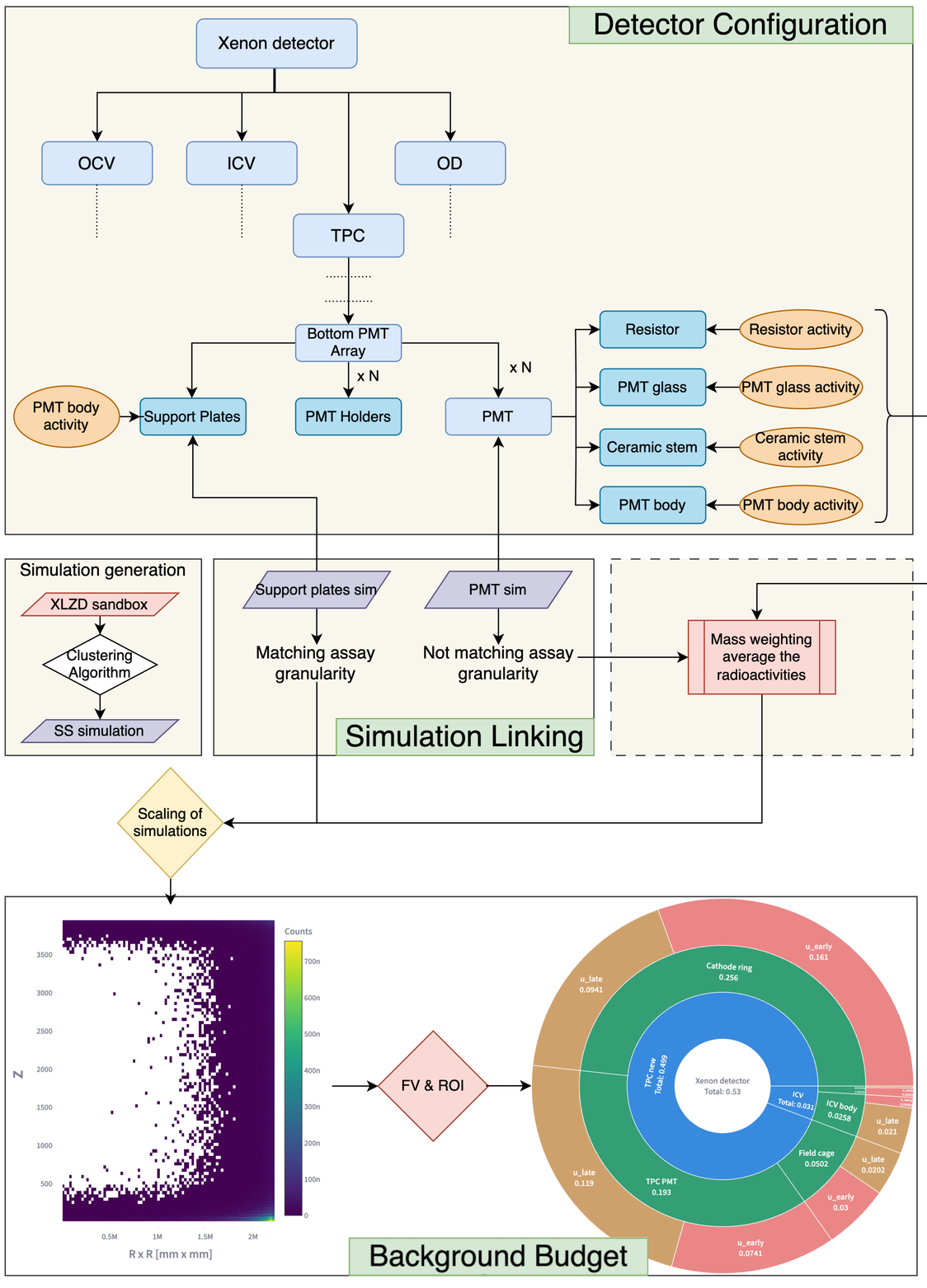

Figure 3: Pipeline overview. The detector hierarchy (top) breaks down into components, linked to a measured activity sample. Simulations are (middle left) linked to components at matching granularity, or mass-weighted where granularity differs (middle right). Hits are visualised by R^2 vs Z (bottom left), with FV and ROI cuts applied to produce the final background budget (bottom right).

Summary & Outlook

- A **centralised, web-based database for XLZD** material screening and background budgeting, live on KCL servers.
- Covers the **full pipeline** from sample submission to a component-level background breakdown in evts/t/yr.
- Next: merging in legacy screening databases and onboarding analysers, building toward a collaboration-wide standard ahead of the XLZD conceptual design report.

[1] D.S. Akerib., *et al.* The LUX-ZEPLIN (LZ) radioactivity and cleanliness control programs., 2020
[2] King's College London. (2022). King's Computational Research, Engineering and Technology Environment (CREATE), 2022
[3] PostgreSQL Global Development Group, PostgreSQL 18.4 Documentation, University of California.
[4] Apache Software Foundation. 2026 *Apache Superset* (Version 4.1.1) https://superset.apache.org/