PROCEEDINGS OF SCIENCE

DarkSide-20k Production Database for the SiPM Detectors Construction and Characterisation

Paolo Franchini[a,b,*] **on behalf of the DarkSide-20k collaboration**

[a] *Royal Holloway University of London, Egham, TW200EX, UK*
[b] *University of Lancaster, Lancaster, LA14YB, UK*

E-mail: paolo.franchini@rhul.ac.uk

DarkSide-20k is an underground direct dark matter search experiment designed to reach a total exposure of 200 tonne-years nearly free from instrumental backgrounds. The detector's core is a dual-phase Time Projection Chamber (TPC) filled with 50 tonnes of low-radioactivity liquid argon. The TPC wall is surrounded by PMMA acting as a neutron Veto, immersed in a 35-tonne argon bath.

The key technological innovation consists in instrumenting the TPC and Veto volume with silicon photomultiplier (SiPM) arrays, for a total area of 27 m^2. The whole production comprises around 250,000 single components to be assembled in the 648 photo-detector units that will instrument the TPC and the Veto. The proceeding focuses on describing the database infrastructure solution used to keep track of all the photo-detector components during the construction phase and the relative tests, in order to ensure a precise quality assurance and quality control through all the production.

ICHEP 2024,
17–24 July 2024,
Prague, Czech Republic

*Speaker

PoS(ICHEP2024)770

1. Introduction

DarkSide-20k [1] is the next world-leading dark matter direct detection experiment, constituted by a dual-phase argon TPC surrounded by a neutron veto volume. DarkSide-20k is being assembled in the LNGS underground laboratory (Italy). Both the TPC optical planes and the Veto volume will be instrumented with Photo-Detector Units (PDUs) with an active Silicon Photo-Multiplier (SiPM) area of $32\times32\,\mathrm{cm}^2$. Each unit is made out of 16 single readout units (so-called Tiles) which are formed by a mosaic of 24 SiPMs integrated on a single PCB.

For the assembly of the TPC and the Veto, 648 (528+120) (v)PDUs will be produced, for a total of 250,000 single components to be tracked during the whole construction, testing and integration phases, between 3 countries and 9 institutes.

A production database (DB) service is maintained within the DarkSide-20k collaboration to store and ensure the access to all the data.

The single components of the PDUs (independent elements which are uniquely identified and will undergo stand-alone tests) are, in order of production assembly:

- wafer of SiPMs
- pre-amplifier
- SiPM (knowing the initial position on the wafer)
- (v)PCB (with components and connectors, no amplifier, nor SiPM)
- (v)Tile (a fully dressed PCB with 24 SiPMs, amplifier and components)
- (v)Motherboard (fully mounted ready to mate with the vTiles)
- (v)PDU = (v)Motherboard + 16 (v)Tiles (the final object that will be integrated in DarkSide-20k).

The tables are almost equivalent between the TPC and the Veto productions, reflecting the differences in the assembly and testing.

2. Production Database Infrastructure

The service infrastructure is constituted by a PostgreSQL database hosted in the INFN-CNAF infrastructure (Italy), with various levels of backup and replication in place. The database is made by a set of tables which could be grouped in the following categories:

- Items: each single component is identified and described as in the list in Section 1; some other tables give a description of how the components are assembled in any stage of the production (e.g. which SiPMs are mounted on a (v)Tile, which (v)Tiles form a (v)PDU);
- Measurements and acceptance limits: tests performed on the components;
- Locations: geographical position of a component with a status describing the condition of the object (e.g. damaged, integrated, shipped);
- Institutes and manufacturers: used to identify where a component has been assembled and tested.

The main unique identifier of the objects is a QR code (corresponding to a 17-digit integer), which is laser-etched on the (v)PCBs, to identify (v)Tiles and on the (v)Motherboards to identify (v)PDUs.

Read and write access to the database is done via a RESTful API on a NGINX https web-server which permits to access any table using commands like

`curl -u <user:pwd> https://ds20kdbi.cloud.cnaf.infn.it/<endpoint>`,
`curl -u <user:pwd> -F "file=@filename" https://ds20kdbi.cloud.cnaf.infn.it/<endpoint>`,
respectively for retrieving and inserting, where: (i) the authentication is done using the credentials administered by INFN-CNAF; (ii) the filename can be in the CSV or JSON format; (iii) the `endpoint` corresponds to a PostgreSQL table's name.

To enhance ease of use, a cross-platform Python API [2, 3] has been created to facilitate the interaction with the DB, wrapping the interaction with the Python `urllib3` and `aiohttp` HTTP clients. Therefore, queries to the DB can be easily made, returning Python Pandas DataFrames, e.g.

```
>>> from ds20kdb import interface
>>> dbi = interface.Database()
>>> dbi.get('wafer').data
    wafer_pid  manufacturer      lot  ...  dose               description   checksum
0           5             2  9262109  ...     3  backside: Au2 L pressure         E0
1           6             2  9262109  ...     3  backside: Au1 H pressure         D3
2           2             2  9262109  ...     3  backside: Au1 H pressure         C1
...       ...           ...      ...  ...   ...                       ...        ...
```

while inserts to a DB `table` can be made using Python dictionaries, e.g. `dbi.post_generic(dict, table)`.

Additional static and Java-based dynamic web interfaces have been created to provide a graphical access to the content of the tables and to show views and plots to assist during the assembly and the testing of the components, in particular to facilitate the quality control and quality assessment of the production.

3. Conclusion

The bespoke DarkSide-20k Production Database has proven to be a robust and valuable service during the ongoing construction of the photo-detectors, covering the full set of tests and measurements to select the detector units that will be instrumenting the experiment for the imminent dark matter investigation campaign.

References

[1] C. E. Aalseth et al. DarkSide-20k: A 20 tonne two-phase LAr TPC for direct dark matter detection at LNGS. *European Physical Journal Plus*, 133(3):131, March 2018.

[2] Alan Taylor, Paolo Franchini, and Seraphim Koulosousas. A cross-platform Python interface to the DarkSide-20k production database. https://doi.org/10.5281/zenodo.10817039, 2024.

[3] DarkSide-20k Collaboration. DarkSide-20K Production DB Software. https://gitlab.in2p3.fr/darkside/productiondb_software/.