



The Hardware Database

M.Potekhin

BNL Nuclear and Particle Physics Software Group (NPPS)

October 2nd 2026

A brief history of this project

- © The need of the “Detector/Component/Hardware” DB has existed for some time.
- © Clearly, this is not specific to ePIC but applies to most experiments and projects.
- © In early 2026, we actively tested and evaluated the “**Component Database**” system originally created at ANL, using an instance managed by the BNL CAD (credits: S.Nemesure and his team)
- © Since then, we performed an analysis of this system functionality and status, including *compliance with the ePIC requirements*, maintenance and deployment issues.
- © In summary, most of the “Component Database” functionality was evaluated quite positively. At the same time, a few issues had been identified (next slides).

Operational and development cost

- ◎ The technology used in the original **Component Database** is a *Java application server*. Code fixes and updates require builds and packaging, and knowledge of the requisite toolchain, which is a bit of a niche these days.
- ◎ Compared to Java, physicists and detector simulation developers already work in Python, so more people can read, fix, and extend the code; the pool of developers who are comfortable with a Java enterprise stack is much smaller on a physics collaboration.
- ◎ Consequently it is hard to create the critical mass of expertise necessary for customization, bug fixes and system evolution which can be reasonably expected over the expected timeline of the EIC project and the ePIC experiment.
- ◎ Database schema evolution in Java depends on extra tooling.

Deployment Considerations

- © We realized - *proper deployment at a computing facility* (e.g. SCDF) *will be needed*, given the “*precious*” character of these data and critical importance of this database. This provides in particular:
 - Agile support and maintenance, best industry-standard practices with regards to backup, disaster recovery, network connectivity, uninterruptible power supply etc
 - A separate issue is proper authentication/authorization (e.g. *federated*), which is a prerequisite for hosting a system at BNL (or anywhere) which is open to external members and organizations. Hosting at the facility makes this possible with minimal investment of effort and minimal friction.
- © Leveraging the existing experience – local expertise in standing up and optimal deployment of the Apache and NGINX servers should be used to our advantage.

Migration to Python

- © As a result of this study, we decided to evaluate the following path forward: migrate the **useful design patterns and functionality** of the ANL Component Database to a more modern, customizable and easier to maintain platform; explore its integration with the facility services, support procedures and the front-end auth/auth.
- © A standard and proven solution is to use a **Python**-based framework such as **Django**, fronted by a modern web server (nginx or Apache). This approach is used in critical applications by experiments such as ATLAS, and for which there is existent and plentiful expertise in the community.
- © Therefore, the **application logic was migrated** to the new platform, while keeping all the positive features of the design and functionality (**see the backup slide**).

Keeping and enhancing existing features

- ◎ Location hierarchy: institution/building/room.
- ◎ Integrated QR support (based on unique IDs).
- ◎ Group-level edit rights. A user can be a member of **multiple groups**.
- ◎ Transfer of ownership to/from authorized users.
- ◎ Change of location, **supporting the design/assembly integrity**.
- ◎ **Strong version control of the assembly templates**.
- ◎ Search capability (by partial name, tag).
- ◎ Ability to attach custom attributes and documents in any format, to the records in the database.
- ◎ Filters for tabulated data, to provide focus on items of interest.

Features TBD

- © The “[Measurement and Analysis Archive](#)” — instead of a custom solution, it is optimal to leverage the existing and Lab-supported document repository systems, such as Invenio RDM. It features durable identifiers (DOIs). Adding links to items in the Hardware Database is trivial.
- © [eTravelers](#) – need to collect requirements from groups and individuals using that feature. In the current version of the CDB there is not enough content to generate useful examples. On the technical side, adding this to the HDB does not present any problems as the schemas are easy to augment.
- © An initial version of the MCP interface has been added to the system, paving the way to potential future use with AI agents.

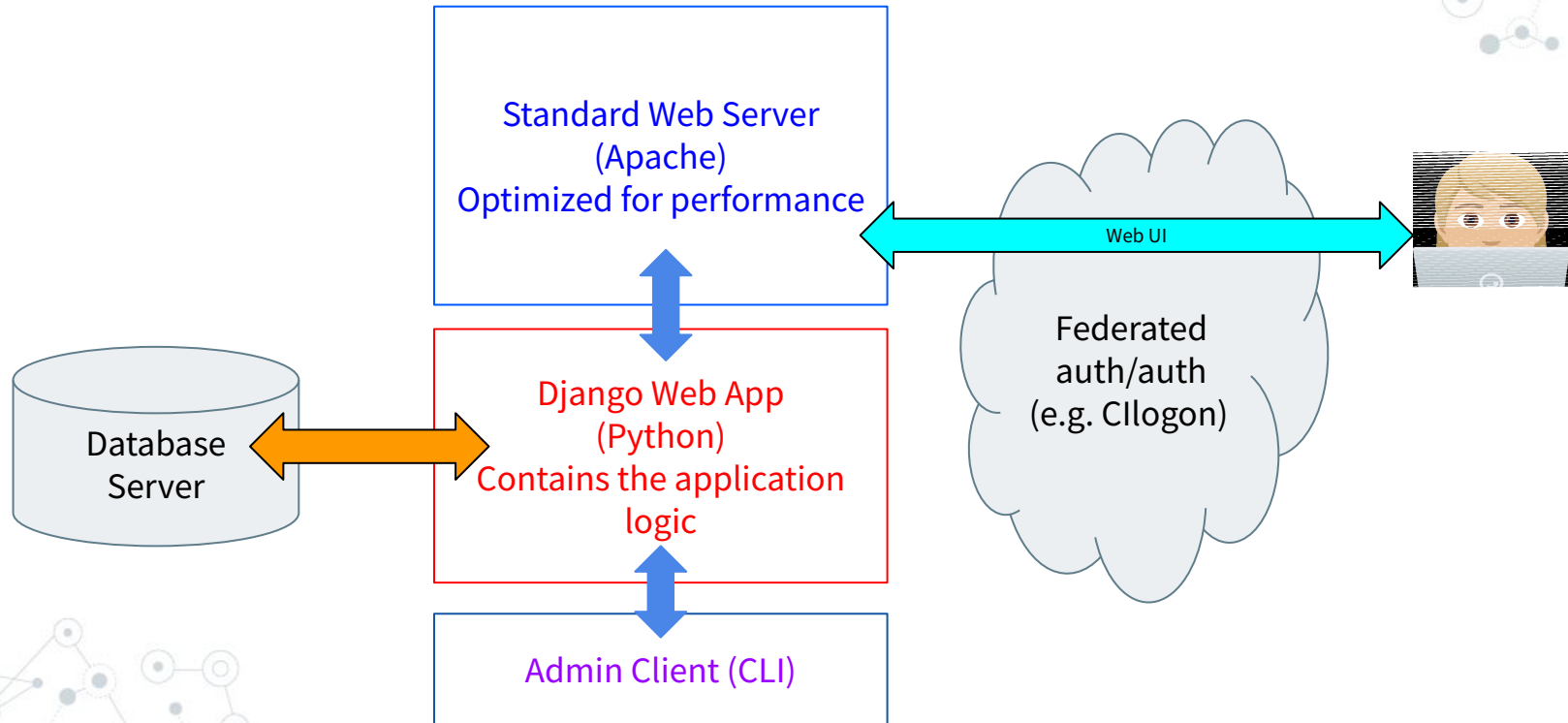
Django: bonus feature

- © The database schema evolution is automated. An object model expressed in Python is automatically translates into SQL commands that adjust the schema without detailed user involvement.
- © This simplifies additional development, especially in the long run.

Rebranding

- © It is natural to abbreviate the “Component Database” as “CDB”
- © In practice, this creates an unfortunate confusion vis a vis Conditions Database and Calibrations Database, also often referred to as “CDB”
- © Given that, and the ongoing rebuild, it makes sense to pick another moniker, such as “**Hardware Database**” which is aligned with the domain.
- © So, now this is the working title, also abbreviated as **HDB**.

Conceptual diagram of the Hardware Database elements



Hardware Database: landing page

The screenshot shows the ePIC Hardware Database landing page. On the left is a dark sidebar with navigation links: ePIC Hardware Database, MAIN (Dashboard), CATALOG (Components), INVENTORY (Inventory), DESIGNS (Designs, Design Templates), and REFERENCE (Systems, Institutions, Users & Groups, Activity Log). The main content area is titled 'Dashboard' and 'ePIC Hardware Database overview'. It features five summary cards: Components (11 Catalog entries), Inventory (27 Physical Items), Designs (1 Assemblies), Log Entries (26 Events recorded), and Institutions (4 Collaborating sites). Below these is a 'Recent Activity' section with a list of events, each starting with a timestamp and a category (Inventory). The events describe the movement of BTOF-READOUT-002 and BTOF-READOUT-004 between various locations (BNL, UIC, CUA) and the transfer of ownership. To the right of the activity list is an 'Institutions' section listing four collaborating sites: Brookhaven National Laboratory, Catholic University of America, University of Hawaii, and University of Illinois Chicago, each with a logo and location.

Dashboard
ePIC Hardware Database overview

Components
11
Catalog entries

Inventory
27
Physical Items

Designs
1
Assemblies

Log Entries
26
Events recorded

Institutions
4
Collaborating sites

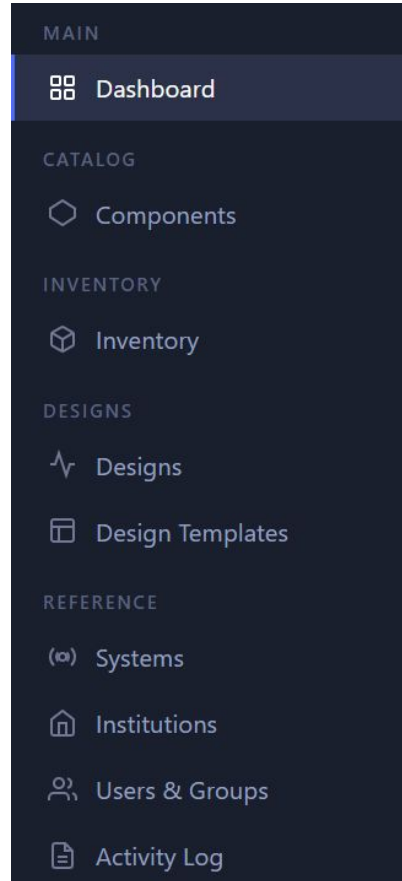
Recent Activity

- Sept. 1, 2026, 10:22 p.m. • **Inventory**
BTOF-READOUT-002 moved from BNL / Bldg.510A to UIC / Test Lab by Maxim Potekhin (batch update).
- Sept. 1, 2026, 10:22 p.m. • **Inventory**
BTOF-READOUT-004 moved from BNL / Bldg.510A to UIC / Test Lab by Maxim Potekhin (batch update).
- Sept. 1, 2026, 10:05 p.m. • **Inventory**
BTOF-READOUT-002 moved from unassigned to BNL / Bldg.510A by Maxim Potekhin.
- Sept. 1, 2026, 10:02 p.m. • **Inventory**
BTOF-READOUT-002 moved from BNL / Bldg.510A to unassigned by Maxim Potekhin (batch update).
- Sept. 1, 2026, 10:01 p.m. • **Inventory**
BTOF-READOUT-002 moved from CUA / Storage Room to BNL / Bldg.510A by Maxim Potekhin (batch update).
- Sept. 1, 2026, 10:01 p.m. • **Inventory**
BTOF-READOUT-004 moved from CUA / Storage Room to BNL / Bldg.510A by Maxim Potekhin (batch update).
- Sept. 1, 2026, 9:59 p.m. • **Inventory**
Ownership of BTOF-READOUT-002 transferred from Grigory Nigmatkulov to Maxim Potekhin by Maxim Potek...
- Sept. 1, 2026, 9:59 p.m. • **Inventory**
Ownership of BTOF-READOUT-004 transferred from Grigory Nigmatkulov to Maxim Potekhin by Maxim Potek...

Institutions

- BNL** Brookhaven National Laboratory
Upton, NY, USA
- CUA** Catholic University of America
Washington, DC, USA
- UH** University of Hawaii
Honolulu, HI, USA
- UIC** University of Illinois Chicago
Chicago, USA

Hardware Database: details of the navigation bar



The Component Catalog (“shopping catalog”)

 **ePIC**
Hardware Database

MAIN

Dashboard

CATALOG

Components

INVENTORY

Inventory

DESIGNS

Designs

Design Templates

REFERENCE

Systems

Institutions

Users & Groups

Activity Log

Component Catalog

Reference library of component types

All Systems

All Groups

Search

NAME

AC-LGAD Sensor

MODEL NO.

AC-LGAD-v1

SYSTEM

BTOF-Sensor

INSTANCES

2

GROUP

BTOF

OWNER

Grigory Nigmatkulov

DESCRIPTION

AC-coupled Low Gain Avalanche Diode sensor for BTOF.

BTOF Carbon Honeycomb Support

BTOF-SUPPORT-01

BTOF-Mechanical

0

BTOF

—

Stave backbone structure, carbon honeycomb, active-cooling ...

BTOF Cooling Pipe Segment

BTOF-COOL-01

BTOF-Mechanical

0

BTOF

—

Half-stave-length active cooling pipe, carbon-honeycomb emb...

BTOF Flex Cable (FPC)

BTOF-FPC-01

BTOF-Mechanical

0

BTOF

—

Flexible printed circuit, stavelet-to-half-stave signal/pow...

BTOF Half-Stave

BTOF-HALFSTAVE-R1

BTOF-Mechanical

1

BTOF

Grigory Nigmatkulov

1316 mm BTOF half-stave, 8 stavelets (see BTOF Half-Stave t...

BTOF Interposer Board

BTOF-INT-01

BTOF-Mechanical

0

BTOF

—

Sensor-to-FCFD interposer board for one BTOF stavelet chann...

BTOF Peripheral Board

BTOF-PERIPH-01

BTOF-Mechanical

0

BTOF

—

Half-stave edge peripheral board -- power distribution and ...

BTOF Stavelet

BTOF-STAVELET-R1

BTOF-Mechanical

0

BTOF

—

162 mm double-sided AC-LGAD stavelet module (see BTOF Stave...

FCFDv2 Readout

FCFDv2

BTOF-Readout

5

BTOF

Grigory Nigmatkulov

Fast Constant-Fraction Discriminator readout ASIC for BTOF.

Hamamatsu S14160-3010PS

S14160-3010PS

BEMC-PM

16

BEMC

Casey Crafts

3x3mm 10um-pitch SiPM photosensor for BEMC readout.

PbWO4 Crystal

PWO-BEMC-01

BEMC-CRYSTAL

3

BEMC

Casey Crafts

Lead tungstate scintillating crystal for the Backward EMCal.

The Hardware Database and Collaboration between Groups - October 2nd 2026

13

Component page in the catalog – an example

ePIC
Hardware Database

MAIN
Dashboard

CATALOG
Components

INVENTORY
Inventory

DESIGNS
Designs
Design Templates

REFERENCE
Systems
Institutions
Users & Groups
Activity Log

< Back to Components

Hamamatsu S14160-3010PS

BEMC-PM ePIC

Details

MODEL NUMBER
S14160-3010PS

DESCRIPTION
3x3mm 10um-pitch SiPM photosensor for BEMC readout.

OWNER GROUP
BEMC

CURRENT OWNER
Casey Crafts Save

CREATED
Aug. 5, 2026

Properties + Add Property

G
Weight 2.1 g Save X

MM
Length 3 mm Save X
Width 3 mm Save X

NO UNITS
Image X

Sources
No sources recorded

Log Entries
No log entries

Inventory Instances (16) All Sites + Add Instance

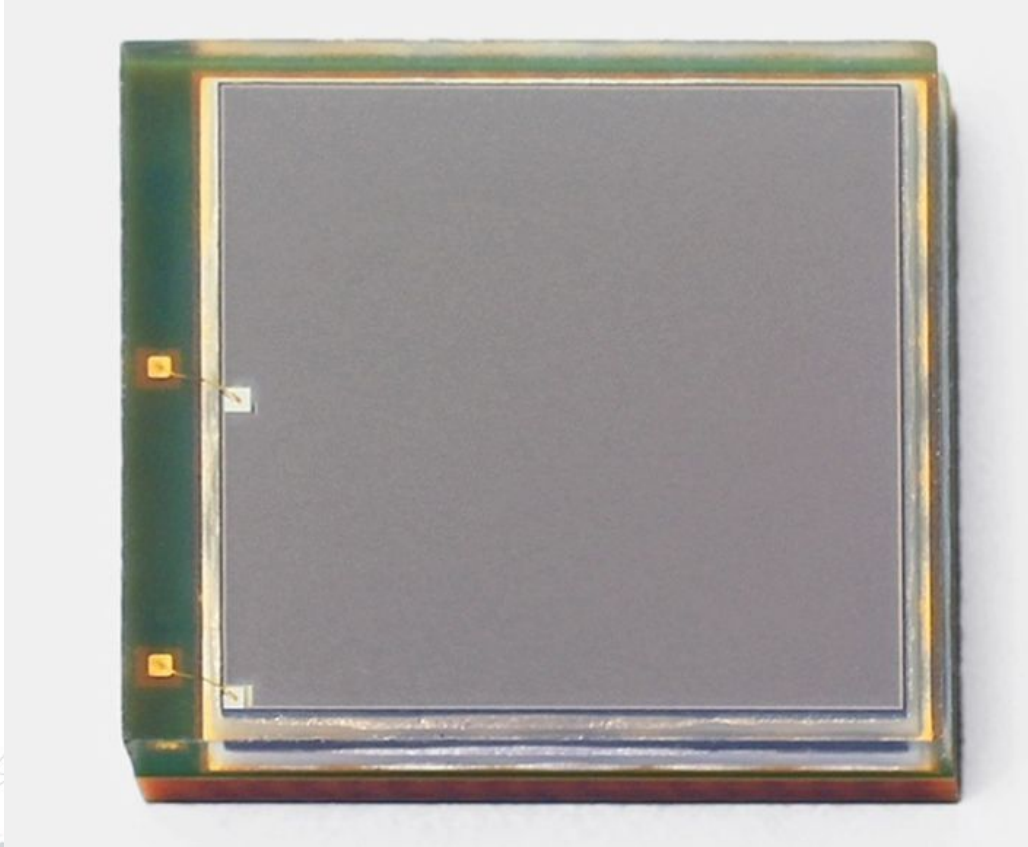
TAG	LOCATION
BEMC-PM-016	CUA / Main building / Storage Room
BEMC-PM-015	CUA / Main building / Storage Room
BEMC-PM-014	CUA / Main building / Storage Room
BEMC-PM-013	CUA / Main building / Storage Room
BEMC-PM-012	CUA / Main building / Storage Room
BEMC-PM-011	CUA / Main building / Storage Room
BEMC-PM-010	CUA / Main building / Storage Room

● Properties

● Images

● Links to inventory

Component page: image detail



Properties and attached documents

- © **Properties** can be added, deleted and modified by authorized personnel (currently defined by the group membership).
- © There is no hard limit on the number of properties to be assigned to any given entity.
- © Images, documents – anything can be added. A caveat: *HDB is not a content storage and/or delivery service. For that reason, large documents and files should be committed to other storage solutions including **Invenio**, and a link provided. The Hardware Database has some local storage in the system intended for small or medium sized files, and it should be used as such. Using a system like Invenio provides the important versioning capability. Same goes for the “MAARC” type materials.*

Users, groups, systems

- © Users and groups *are supported organically* in Django, with possibilities of customization at every level – we take advantage of that.
- © There is a powerful “admin interface” already baked into the system, allowing the administrators to perform maintenance and sensitive operations on the database without additional security risk.
- © Users can only perform operations allowed for his/her group and if necessary, limited to a particular account (can also be used to control items’ visibility).
- © Since individual subsystems are still fairly large, there is an additional qualifier in the database, called “technical system”. For example, the BEMC group is responsible for multiple components of this detector. One can access technical systems such as BEMC-Crystal, BEMC-SiPM, BEMC-mechanical etc. This makes accessing and modifying information easier.

Users and groups

 **ePIC**

Hardware Database

MAIN

 Dashboard

CATALOG

 Components

INVENTORY

 Inventory

DESIGNS

 Designs

 Design Templates

REFERENCE

 Systems

 Institutions

 **Users & Groups**

Users

Click on a table row to see the inventory owned by the user.

All Groups ▾

All Institutions ▾

Filter

FIRST NAME	LAST NAME ^{TL}	INSTITUTION ^{TL}	GROUPS	EMAIL
Alexander	Kiselev	BNL	PFRICH	ayk@bnl.gov
Brian	Page	BNL	PFRICH	bpage@bnl.gov
Casey	Crafts	CUA	BEMC	crafts@cua.edu
Grigory	Nigmatkulov	UIC	BTOF	gnigmat@uic.edu
Jennifer	Ott	UH	BTOF	ottjenni@hawaii.edu
Maxim	Potekhin	BNL	—	potekhin@bnl.gov
Thomas	Ullrich	BNL	BEMC BTOF	thomas.ullrich@bnl.gov

Click on a user shows the inventory owned by them

 **ePIC**
Hardware Database

MAIN

 Dashboard

CATALOG

 Components

INVENTORY

 **Inventory**

DESIGNS

 Designs

 Design Templates

REFERENCE

Inventory: Grigory Nigmatkulov

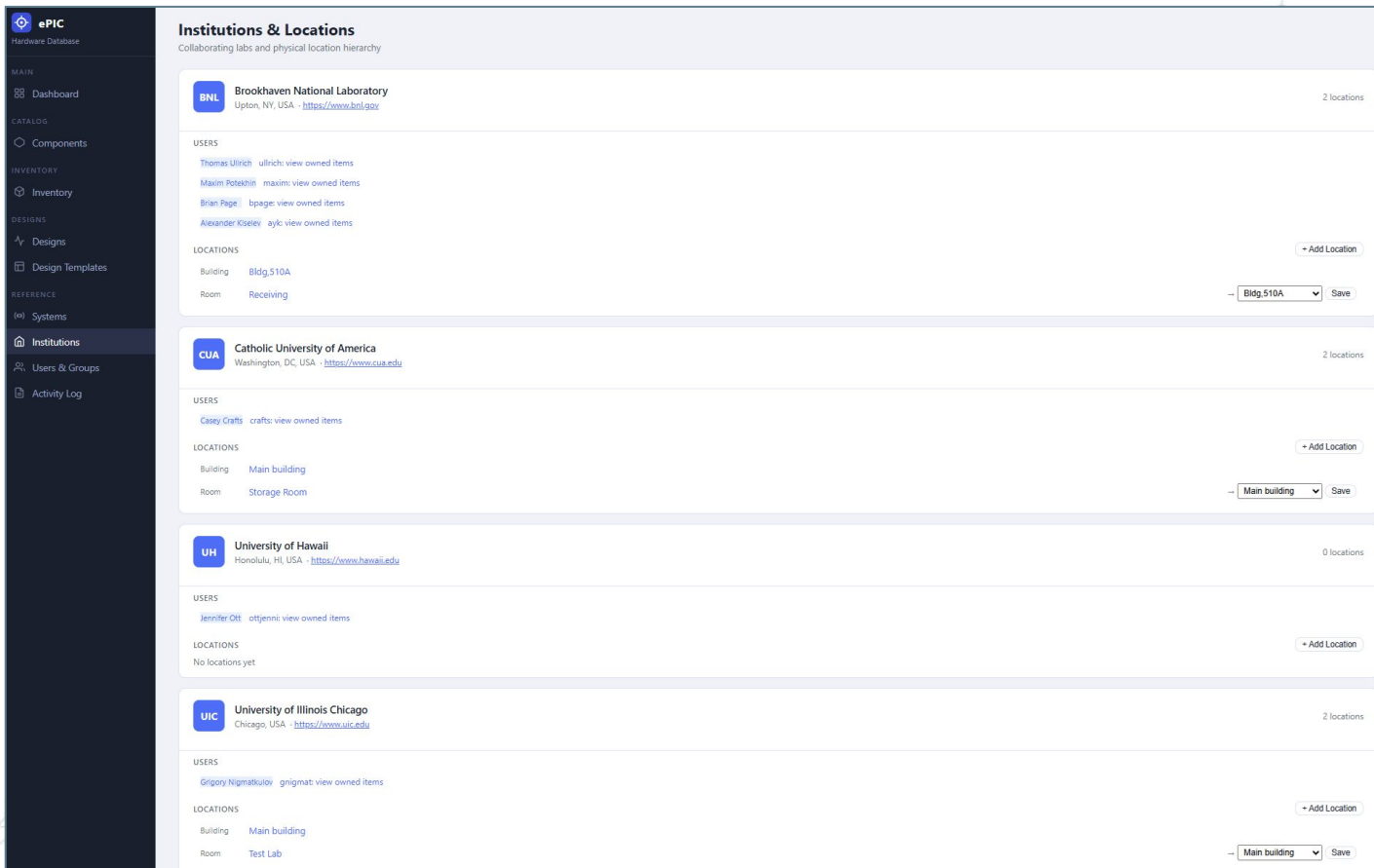
Component instances owned by **gnigmat**

[← Institutions](#)

ID	TAG	COMPONENT	SYSTEM	SERIAL NO.	LOCATION	GROUP
130ae1a1...	BTOF-SENSOR-001	AC-LGAD Sensor	BTOF-Sensor	LGAD-0001	UIC / Main building / Test Lab	BTOF
2027e3dd...	BTOF-SENSOR-002	AC-LGAD Sensor	BTOF-Sensor	LGAD-0002	CUA / Main building / Storage Room	BTOF
28766297...	TEST	BTOF Half-Stave	BTOF-Mechanical	1	BNL / Bldg,510A	BTOF
e0d4599a...	BTOF-READOUT-001	FCFDv2 Readout	BTOF-Readout	FCFD-0001	UIC / Main building / Test Lab	BTOF
a4c7f245...	BTOF-READOUT-003	FCFDv2 Readout	BTOF-Readout	FCFD-0003	UIC / Main building / Test Lab	BTOF
a49a23c8...	BTOF-READOUT-005	FCFDv2 Readout	BTOF-Readout	FCFD-0005	UIC / Main building / Test Lab	BTOF

6 items

Institutions and locations



ePIC
Hardware Database

MAIN
Dashboard

CATALOG
Components

INVENTORY
Inventory

DESIGNS
Designs
Design Templates

REFERENCE
Systems

Institutions
Users & Groups
Activity Log

Institutions & Locations

Collaborating labs and physical location hierarchy

BNL **Brookhaven National Laboratory**
Upton, NY, USA · <https://www.bnl.gov> 2 locations

USERS
[Thomas Ulrich](#) ulrich: view owned items
[Maxim Potekhin](#) maxims: view owned items
[Brian Page](#) bpage: view owned items
[Alexander Kiselev](#) ayle: view owned items

LOCATIONS

Building	Bldg.510A
Room	Receiving

+ Add Location

Bldg.510A Save

CUA **Catholic University of America**
Washington, DC, USA · <https://www.cua.edu> 2 locations

USERS
[Casey Crafts](#) crafts: view owned items

LOCATIONS

Building	Main building
Room	Storage Room

+ Add Location

Main building Save

UH **University of Hawaii**
Honolulu, HI, USA · <https://www.hawaii.edu> 0 locations

USERS
[Jennifer Ott](#) ottjenni: view owned items

LOCATIONS
No locations yet

+ Add Location

UIC **University of Illinois Chicago**
Chicago, USA · <https://www.uic.edu> 2 locations

USERS
[Grigory Nigmatulov](#) grigmat: view owned items

LOCATIONS

Building	Main building
Room	Test Lab

+ Add Location

Main building Save

Institutions and locations – detail

 **ePIC**
Hardware Database

MAIN

- Dashboard

CATALOG

- Components

INVENTORY

- Inventory

DESIGNS

- Designs
- Design Templates

REFERENCE

- Systems

Institutions & Locations

Collaborating labs and physical location hierarchy

BNL

Brookhaven National Laboratory
Upton, NY, USA · <https://www.bnl.gov>

2 locations

USERS

- Thomas Ullrich ullrich: view owned items
- Maxim Potekhin maxim: view owned items
- Brian Page bpage: view owned items
- Alexander Kiselev ayk: view owned items

LOCATIONS

- Building Bldg,510A
- Room Receiving

+ Add Location

→ Bldg,510A Save

Adding locations

Add Location — Brookhaven National Laboratory

Name *

Type

Room ▼

Parent Location

— None (top level) — ▼

— None (top level) —

BNL / Bldg,510A

BNL / Bldg,510A / Receiving

Cancel Create

The Inventory

 **ePIC**
Hardware Database

MAIN

 Dashboard

CATALOG

 Components

INVENTORY

 Inventory

DESIGNS

 Designs

 Design Templates

REFERENCE

 Systems

 Institutions

 Users & Groups

 Activity Log

Component Inventory

Physical component instances

All Locations

All Systems

All Groups

All Users

All Designs

Search

☐	TAG TI	COMPONENT ▲	SYSTEM TI	SERIAL NO. TI	LOCATION TI	USED IN DESIGN	GROUP TI	OWNER TI	CREATED TI
☐	BTOF-SENSOR-001	AC-LGAD Sensor	BTOF-Sensor	LGAD-0001	UIC / Main building / Test Lab	—	BTOF	Grigory Nigmatkulov	2026-08-05
☐	BTOF-SENSOR-002	AC-LGAD Sensor	BTOF-Sensor	LGAD-0002	CUA / Storage Room	—	BTOF	Grigory Nigmatkulov	2026-08-05
☐	TEST	BTOF Half-Stave	BTOF-Mechanical	1	BNL / Bldg.510A	—	BTOF	Grigory Nigmatkulov	2026-08-08
☐	BTOF-READOUT-001	FCFDv2 Readout	BTOF-Readout	FCFD-0001	UIC / Main building / Test Lab	—	BTOF	Grigory Nigmatkulov	2026-08-05
☐	BTOF-READOUT-002	FCFDv2 Readout	BTOF-Readout	FCFD-0002	UIC / Main building / Test Lab	—	BTOF	Maxim Potekhin	2026-08-05
☐	BTOF-READOUT-003	FCFDv2 Readout	BTOF-Readout	FCFD-0003	UIC / Main building / Test Lab	—	BTOF	Grigory Nigmatkulov	2026-08-05
☐	BTOF-READOUT-004	FCFDv2 Readout	BTOF-Readout	FCFD-0004	UIC / Main building / Test Lab	—	BTOF	Maxim Potekhin	2026-08-05
☐	BTOF-READOUT-005	FCFDv2 Readout	BTOF-Readout	FCFD-0005	UIC / Main building / Test Lab	—	BTOF	Grigory Nigmatkulov	2026-08-05
☐	BEMC-PM-001	Hamamatsu S14160-3010PS	BEMC-PM	HAM-0001	BNL / Bldg.510A	bemc2	BEMC	Casey Crafts	2026-08-05
☐	BEMC-PM-002	Hamamatsu S14160-3010PS	BEMC-PM	HAM-0002	BNL / Bldg.510A	bemc2	BEMC	Casey Crafts	2026-08-05
☐	BEMC-PM-003	Hamamatsu S14160-3010PS	BEMC-PM	HAM-0003	BNL / Bldg.510A	bemc2	BEMC	Casey Crafts	2026-08-05
☐	BEMC-PM-004	Hamamatsu S14160-3010PS	BEMC-PM	HAM-0004	BNL / Bldg.510A	bemc2	BEMC	Casey Crafts	2026-08-05
☐	BEMC-PM-005	Hamamatsu S14160-3010PS	BEMC-PM	HAM-0005	CUA / Storage Room	—	BEMC	Casey Crafts	2026-08-05
☐	BEMC-PM-006	Hamamatsu S14160-3010PS	BEMC-PM	HAM-0006	CUA / Storage Room	—	BEMC	Casey Crafts	2026-08-05

Inventory Detail

The screenshot shows the 'Inventory Detail' page for a component named 'BTOF-READOUT-005'. The left sidebar contains navigation links for 'MAIN' (Dashboard), 'CATALOG' (Components), 'INVENTORY' (Inventory), 'DESIGNS' (Designs, Design Templates), and 'REFERENCE' (Systems, Institutions, Users & Groups, Activity Log). The main content area has a 'Back to Inventory' link and buttons for 'Delete' and 'View Component'. The 'Instance Details' section includes fields for ID (a49a23c8-f97d-4e1e-a98e-e8709c03ca08), COMPONENT (FCFDv2 Readout), SYSTEM (BTOF-Readout), TAG (BTOF-READOUT-005), SERIAL NUMBER (FCFD-0005), INSTITUTION (University of Illinois Chicago), LOCATION (UIC / Main building / Test Lab), OWNER GROUP (BTOF), CURRENT OWNER (Grigory Nigmatkulov), and CREATED date (Aug. 5, 2026). A red dashed circle highlights a QR code icon next to the ID field. The 'Properties' section on the right shows 'No properties' and a '+ Add / Override' button.

ePIC
Hardware Database

MAIN
Dashboard

CATALOG
Components

INVENTORY
Inventory

DESIGNS
Designs
Design Templates

REFERENCE
Systems
Institutions
Users & Groups
Activity Log

< Back to Inventory

BTOF-READOUT-005

FCFDv2 Readout BTOF

Instance Details

ID
a49a23c8-f97d-4e1e-a98e-e8709c03ca08 

COMPONENT
[FCFDv2 Readout](#)

SYSTEM
BTOF-Readout

TAG
BTOF-READOUT-005

SERIAL NUMBER
FCFD-0005

INSTITUTION
University of Illinois Chicago

LOCATION
UIC / Main building / Test Lab Save

OWNER GROUP
BTOF

CURRENT OWNER
Grigory Nigmatkulov Save

CREATED
Aug. 5, 2026

Properties + Add / Override

No properties

Delete View Component

Inventory Detail: QR integration

QR Code



a49a23c8-f97d-4e1e-a98e-e8709c03ca08

Close

REFERENCE

Systems

Institutions

Users & Groups

Activity Log

SERIAL NUMBER

FCFD-0005

INSTITUTION

University of Illinois Chicago

LOCATION

UIC / Main building / Test Lab

Save

OWNER GROUP

BTOF

CURRENT OWNER

Grigory Nigmatkulov

Save

CREATED

Aug. 5, 2026

Delete

Properties

No properties

Technical Systems – for more structured access:

One group can manage multiple systems

ePIC
Hardware Database

MAIN

- Dashboard

CATALOG

- Components

INVENTORY

- Inventory

DESIGNS

- Designs
- Design Templates

REFERENCE

- Systems**
- Institutions
- Users & Groups
- Activity Log

Technical Systems

Engineering subsystems — click one to browse its inventory

All Groups

SYSTEM	DESCRIPTION	GROUP	COMPONENTS	INVENTORY ITEMS	
BEMC-CRYSTAL		BEMC	1	3	View inventory →
BEMC-PM		BEMC	1	16	View inventory →
BTOF-Mechanical		BTOF	7	1	View inventory →
BTOF-Readout		BTOF	1	5	View inventory →
BTOF-Sensor		BTOF	1	2	View inventory →
PFRICH-HRPPD		PFRICH	0	0	View inventory →

“Designs”: aggregate entities

ePIC
Hardware Database

MAIN

- Dashboard

CATALOG

- Components

INVENTORY

- Inventory

DESIGNS

- Designs**
- Design Templates

REFERENCE

- Systems
- Institutions
- Users & Groups
- Activity Log

< Back to Designs

bemc2

BEMC

Delete Design

Bill of Materials

Assembly Location: Brookhaven National Laboratory

BNL / Bldg.510A Save

COMPONENT	TAG	TYPE	QUANTITY
Crystal — COMPONENT PbWO4 Crystal MODEL PW0-BEMC-01	TAG BEMC-CRYSTAL-001	Instance 1/1	×1
SiPM — COMPONENT Hamamatsu S14160-3010PS MODEL S14160-3010PS	TAG BEMC-PM-001 TAG BEMC-PM-002 TAG BEMC-PM-003 TAG BEMC-PM-004	Instances 4/4	×4

Description

One BEMC tower: a PbWO4 crystal read out by four SiPMs.

Template

Instantiated from **BEMC tower**

Properties

+ Add Property

No properties

Log Entries

Aug. 31, 2026, 10:15 p.m. · design · Maxim Potekhin
Element SiPM: inventory instance BEMC-PM-004 installed (4 of 4) by Maxim Potekhin.

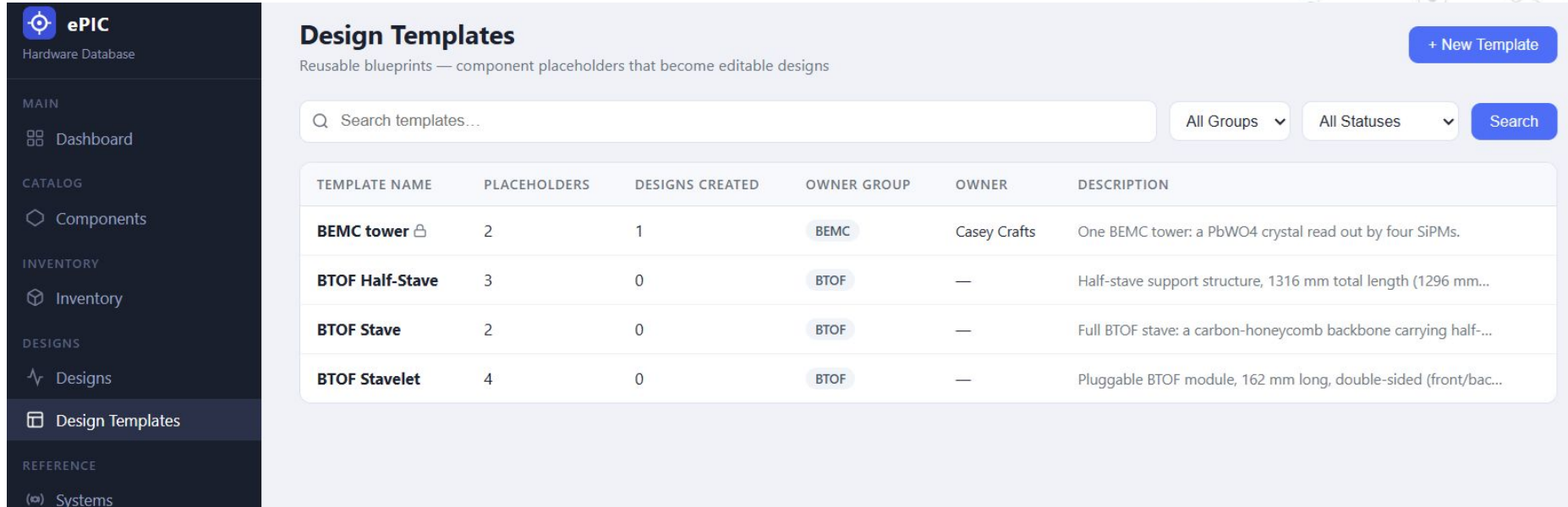
Aug. 31, 2026, 10:15 p.m. · design · Maxim Potekhin
Element SiPM: inventory instance BEMC-PM-003 installed (3 of 4) by Maxim Potekhin.

Aug. 31, 2026, 10:15 p.m. · design · Maxim Potekhin
Element SiPM: inventory instance BEMC-PM-002 installed (2 of 4) by Maxim Potekhin.

CREATED
Aug. 31, 2026

LAST MODIFIED
Aug. 31, 2026

Design templates and version control



The screenshot shows the 'Design Templates' section of the ePIC Hardware Database. The left sidebar contains navigation links: MAIN (Dashboard), CATALOG (Components), INVENTORY (Inventory), DESIGNS (Designs, Design Templates), and REFERENCE (Systems). The main content area is titled 'Design Templates' with a subtitle 'Reusable blueprints — component placeholders that become editable designs'. A '+ New Template' button is in the top right. Below the title is a search bar and two dropdown menus for 'All Groups' and 'All Statuses', followed by a 'Search' button. A table lists four templates: BEMC tower, BTOF Half-Stave, BTOF Stave, and BTOF Stavelet. Each row shows the template name, number of placeholders, designs created, owner group, owner, and a description.

TEMPLATE NAME	PLACEHOLDERS	DESIGNS CREATED	OWNER GROUP	OWNER	DESCRIPTION
BEMC tower 🔒	2	1	BEMC	Casey Crafts	One BEMC tower: a PbWO4 crystal read out by four SiPMs.
BTOF Half-Stave	3	0	BTOF	—	Half-stave support structure, 1316 mm total length (1296 mm...
BTOF Stave	2	0	BTOF	—	Full BTOF stave: a carbon-honeycomb backbone carrying half-...
BTOF Stavelet	4	0	BTOF	—	Pluggable BTOF module, 162 mm long, double-sided (front/bac...

- Referential integrity of designs is critically important
- Templates are managed with strict version control, and kept in a system like GitHub
- The format of the template definition is in YAML — no editing in GUI, for that reason

Design template: a simple example

```
template:
  name: "BEMC tower"
  project: "ePIC"
  owner_group: BEMC
  owner_user: crafts
  description: >
    One BEMC tower: a PbW04 crystal read out by four SiPMs.
  elements:
    - element_name: "Crystal"
      quantity: 1
      description: "The lead tungstate scintillating crystal itself."
      component: "PbW04 Crystal"

    - element_name: "SiPM"
      quantity: 4
      description: "Four photosensors read out this one crystal."
      component: "Hamamatsu S14160-3010PS"
```

Populating a design template

 **ePIC**

Hardware Database

MAIN

 Dashboard

CATALOG

 Components

INVENTORY

 Inventory

DESIGNS

 Designs

 Design Templates

REFERENCE

 Systems

 Institutions

 Users & Groups

 Activity Log

[< Back to Designs](#)

BEMC tower

BEMC

Delete Design

Bill of Materials

Assembly Location:

Catholic University of America

CUA / Storage Room

Save

COMPONENT	TAG	TYPE	QUANTITY
Crystal — COMPONENT PbWO4 Crystal MODEL PWO-BEMC-01	Not installed yet — 0/1 — pick from inventory — Add	Component	×1
SiPM — COMPONENT Hamamatsu S14160-3010PS MODEL S14160-3010PS	Not installed yet — 0/4 — pick from inventory — Add	Component	×4

Log Entries

Oct. 2, 2026, 6:48 p.m. ·

design

 · admin

Assembly location of BEMC tower set to CUA / Storage Room by admin.

Sept. 27, 2026, 8:53 p.m. ·

design

 · Casey Crafts

BEMC Tower Definition added

Description

One BEMC tower: a PbWO4 crystal read out by four SiPMs.

Template

Instantiated from **BEMC tower**

Properties

+ Add Property

No properties

CREATED

Sept. 27, 2026

LAST MODIFIED

Oct. 2, 2026

Logs

- ◎ The system has built-in support for logging.
- ◎ Any user action can be logged, if necessary, such as additions and deletions of items, modifications of the data etc.
- ◎ For ease of navigation, there are “topic” defined for the logs.
- ◎ In addition to the master “Activity Log” page, recent logs have their own panel on the landing page for quick reference.



Recent Activity

Sept. 1, 2026, 10:22 p.m. · inventory

BTOF-READOUT-002 moved from BNL / Bldg.510A to UIC / Test Lab by Maxim Potekhin (batch update).

Sept. 1, 2026, 10:22 p.m. · inventory

BTOF-READOUT-004 moved from BNL / Bldg.510A to UIC / Test Lab by Maxim Potekhin (batch update).

Sept. 1, 2026, 10:05 p.m. · inventory

BTOF-READOUT-002 moved from unassigned to BNL / Bldg.510A by Maxim Potekhin.

Sept. 1, 2026, 10:02 p.m. · inventory

BTOF-READOUT-002 moved from BNL / Bldg.510A to unassigned by Maxim Potekhin (batch update).

Sept. 1, 2026, 10:01 p.m. · inventory

BTOF-READOUT-002 moved from CUA / Storage Room to BNL / Bldg.510A by Maxim Potekhin (batch update).

Sept. 1, 2026, 10:01 p.m. · inventory

BTOF-READOUT-004 moved from CUA / Storage Room to BNL / Bldg.510A by Maxim Potekhin (batch update).

Sept. 1, 2026, 9:59 p.m. · inventory

Ownership of BTOF-READOUT-002 transferred from Grigory Nigmatkulov to Maxim Potekhin by Maxim Potek...

Sept. 1, 2026, 9:59 p.m. · inventory

Ownership of BTOF-READOUT-004 transferred from Grigory Nigmatkulov to Maxim Potekhin by Maxim Potek...

Activity Log

 **ePIC**
Hardware Database

MAIN

 Dashboard

CATALOG

 Components

INVENTORY

 Inventory

DESIGNS

 Designs

 Design Templates

REFERENCE

 Systems

 Institutions

 Users & Groups

 **Activity Log**

Activity Log

Maintenance, inspection, and lifecycle events

All Topics ▾

All Groups ▾

FROM mm/dd/yyyy  - TO mm/dd/yyyy 

Search

DATE	TOPIC	ENTRY	LOGGED BY	RELATED
Sept. 1, 2026 10:22 p.m.	inventory	BTOF-READOUT-002 moved from BNL / Bldg,510A to UIC / Test Lab by Maxim Potekhin (batch update).	Maxim Potekhin	BTOF-READOUT-002
Sept. 1, 2026 10:22 p.m.	inventory	BTOF-READOUT-004 moved from BNL / Bldg,510A to UIC / Test Lab by Maxim Potekhin (batch update).	Maxim Potekhin	BTOF-READOUT-004
Sept. 1, 2026 10:05 p.m.	inventory	BTOF-READOUT-002 moved from unassigned to BNL / Bldg,510A by Maxim Potekhin.	Maxim Potekhin	BTOF-READOUT-002
Sept. 1, 2026 10:02 p.m.	inventory	BTOF-READOUT-002 moved from BNL / Bldg,510A to unassigned by Maxim Potekhin (batch update).	Maxim Potekhin	BTOF-READOUT-002
Sept. 1, 2026 10:01 p.m.	inventory	BTOF-READOUT-002 moved from CUA / Storage Room to BNL / Bldg,510A by Maxim Potekhin (batch update).	Maxim Potekhin	BTOF-READOUT-002
Sept. 1, 2026 10:01 p.m.	inventory	BTOF-READOUT-004 moved from CUA / Storage Room to BNL / Bldg,510A by Maxim Potekhin (batch update).	Maxim Potekhin	BTOF-READOUT-004
Sept. 1, 2026 9:59 p.m.	inventory	Ownership of BTOF-READOUT-002 transferred from Grigory Nigmatkulov to Maxim Potekhin by Maxim Potekhin (batch update).	Maxim Potekhin	BTOF-READOUT-002
Sept. 1, 2026 9:59 p.m.	inventory	Ownership of BTOF-READOUT-004 transferred from Grigory Nigmatkulov to Maxim Potekhin by Maxim Potekhin (batch update).	Maxim Potekhin	BTOF-READOUT-004
Aug. 31, 2026	design	Element SiPM: inventory instance BEMC-DM-004 installed (4 of 4) by Maxim Potekhin	Maxim	home?

Command-line interface

- ◎ For system integration, such as in the QA process done in a lab, it is important to have CLI capabilities.
- ◎ Currently the HDB has a CLI client which runs on the server machine.
- ◎ Network/REST API version in the development pipeline (auth/auth needs extra work)
- ◎ The client has robust search capabilities across the DB domains.
- ◎ And for future development, there is a prototype of a MCP server that can be used for integration with AI agents, if needed. Not a priority now.

Current status of the Hardware Database

- ◎ The prototype already has rich functionality, supporting the full cycle of procurement, inventory management (custody, location) and assembly tracking.
- ◎ Group, technical system and user management is in place.
- ◎ Provision of custom “**properties**” (including **documents**) is in place – crucial for QA.
- ◎ There is a live instance deployed at SCDF: <https://epic-hwdb.sdcc.bnl.gov/>
- ◎ (...see the next slide)
- ◎ For more information please see the detailed README file in the repository: <https://github.com/BNLNPPS/epic-hdb>

Deployment

- © The SCDF provided a VM to us (very much appreciated) which has been configured for hosting the HDB, and it contains a RDBMS (Postgres) and a Web server (Apache). These are very common, well understood infrastructure elements.
- © The HDB code is versioned and managed on GitHub. Updates on the running instance take place via the usual chain, with the [git pull](#) on the server and a restart of the gateway interface, which are both trivial procedures. Releases can be reliably created using the standard GitHub procedure.
- © Auth/auth mechanisms – there is currently the CILogon integration in place, which provides a federated access mechanism. The user must belong to the EIC group defined in the backend.

CILogon auth/auth



CILogon

Consent to Attribute Release

[EIC-Services](#) requests access to the following information. If you do not approve this request, do not proceed.

- Your CILogon user identifier
- Your name
- Your email address
- Your username and affiliation from your identity provider

Select an Identity Provider

Brookhaven National Laboratory ▾ ?

☐ Remember this selection ?

Log On

By logging on to this site, you agree to the [privacy policy](#).

Flexibility of the system

- © There is nothing specific to ePIC, in the design, implementation and deployment of the **HDB**. It's open to reuse.
- © There is already robust compartmentalization of the database, with regards to user and group privileges. In addition, it is straightforward to deploy more instances based on the same code base, but using completely separate database and web servers, for even better isolation.
- © The **HDB** can be deployed anywhere – either inside the facility such as SCDF or other institution, or on an arbitrary Linux machine. Crucial elements of the configuration are kept in a file with the environment variables definitions, so reconfiguring is straightforward. It's easy to add another RDBMS to the sqlite and Postgres already tested – Oracle, MariaDB and others can be used if necessary.

Summary

- ◎ Informed by our prior experience, we conclude that the design of the Component Database is well aligned with the requirements of ePIC and many other experiments and projects. Motivated by the need to have flexibility, updates and ease of long-term maintenance, the core object model and application logic of the CDB were migrated to the industry standard Python-based platform, Django. The working title of the application is “HDB”.
- ◎ Most of the features are in place, others like eTravelers can be added in near time, based on requirements and experience of users.
- ◎ The new platform is AI-compatible, via the MCP interface.
- ◎ The HDB can be installed on a variety of computing systems. Currently, there is an instance of the application hosted by the Scientific Computing and Data Facility at BNL, opening the possibility of robust industry-level support.



Backup Slides

Object model: the three domains

Component Catalog

What type of component is it?

- ▶ One entry per unique component type or design
- ▶ Covers both custom-fabricated and COTS items (can be complex by design)
- ▶ Stores: name, project, owner, owner group – at a minimum
- ▶ May (and should) include model, description, vendor sources, images, and optional “properties”
- ▶ Think of it like an online store catalog

Component Inventory

Which specific units do we have?

- ▶ Each physical item procured or fabricated
- ▶ Every instance gets a unique ID code
- ▶ Tracks location: building, room etc
- ▶ Refers to its Catalog entry
- ▶ Stores inspection, testing, and maintenance data

System Designs

Where does it go in the (sub) system?

- ▶ Placeholders for components at specific locations
- ▶ References inventory items (unit installed). The Inventory item installed at a location will change as components fail or age
- ▶ Supports hierarchical designs
- ▶ Enables Bill of Materials generation

Design and features we want to keep

- ◎ A simple but functional object model, which allows to properly represent
 - descriptions of items (catalog)
 - an inventory of their physical instances
 - assemblies (called “designs”) – [see the backup slide](#)
- ◎ Ability to create [custom properties for items](#) stored in the database, and attach [documents/files in arbitrary formats](#); optional QR capability.
 - Crucial for QA, with potential connection to later calibrations, and also installation and maintenance
- ◎ Managing users, groups, roles, item location and custody.
- ◎ Integrity of assemblies (all items must be in same location)
- ◎ Custody transfer, change of location etc

Properties and attached data

- ◎ It is important that entities in the database can be assigned measured or calculated properties, of arbitrary nature.
- ◎ Examples: weight, linear dimensions, electrical characteristics.
- ◎ This can be naturally extended to data artifacts such as datasheets accompanying electronic components, images, documents, QA records etc.
- ◎ This was an important feature in the ANL CDB and it has been implemented in the new app.
- ◎ Property types are defined in the DB by the system admins, after that they can be attached to any item in the database. Properties of a component (e.g. found in the catalog) can be overwritten where appropriate in the inventory instance – cf. nominal resistance vs measured value.

Interfacing with/migrating to different databases

- © The new DB can be equipped with import/export facilities in any convenient format.
- © This would still require to build interfaces if data exchange is needed.