



LIPAc Operation Log –

a monitoring and reporting asset for operation supervision

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Introduction

Accelerator-based high energy neutron sources are foreseen to characterize the material of future fusion reactors. The Linear IFMIF Prototype Accelerator (LIPAc) is a fullscale prototype aiming at validating the production of a deuteron beam of 125 mA at 9 MeV in continuous wave under the Broader Approach (BA) agreement between Japan and Europe.

Just as an orchestra needs a conductor, LIPAc operation team needs an **Operation Supervisor (OS)**. A dedicated monitoring tool was developed to support the person assigned to this role: the **LIPAc Operation Log (LOL)**. This new asset can be summed up as a synthetic and user-friendly **ELog (Electronic Logbook) for operation supervision**. It centralizes the main information and events related to the on-going operation, including objective of the day, assigned operators, beam status, key parameters, alarms, and interlocks.

System objectives		GUI – initial target
To ease the reporting during and after operation shifts.	Main attributes:	

- Sharing a compact view on the learns meeting for operation
- Easily open the Event Report Management System



- To **display key information** about the ongoing operation, including:
- Title and objectives of the experiment in progress
- Information on operators (names, roles)
- Key parameters of the experiment (type of particles, current, etc.)

To **record key events** during operation, including:

- Beam status (Permission, Destination, ON/OFF)
- Major alarms/interlocks
- Protection Systems statuses (Personal "PPS" and Machine "MPS")
- Key Process Variables (PVs) values when inserted by the OS (ex: Timings etc.)
- Comments submitted by the OS



- All-In-one GUI
- View only access for all
- Input access for OS only

Panels dedicated to:

- Operation general info
- Beam condition
- Operation Team
- Event display
- Manual comments/inputs
- Insertion of EPICS PV data
- Links to other tools

UPAR Operat	ion	
Phase B+ Logs	Transmission; (/LEBT)	" []% []% []% Output: [] Mev
Date: YYYY-MM-DD hhimmiss Title of the op Operation objecti	eration	Beam Conditions H+ D+ DC: []7% FC Current: [] mA CW BD Repetition: [] ms Pulse Width: [] ms
MOM : Person A A OS : Person B	09:03:05 [PPS] 09:06:10 [PPS] 09:10:15 [PV]	Beam permit IS: ECR=400W, D2=3.0 sccm, COIL1/2=75A/83A, LEBT: SOL1/2=230A/310A, Steering=
System Operators INJ : Person C & RFQ : Person D &	09:10:20 [TS] 09:15:20 [TS] 09:18:56 [MPS] 09:18:56 [TS]	ECR=3ms, T1=20us, T2=300us, chopper=250us, Repetition=100ms, Beam ON MPS-153 (RF RFQ LLRF) Beam OFF
RFPS : Person E & BT : Person F &	09:20:20 [TS] 09:22:56 [MPS] 09:23:56 [TS]	Machine Down, Severity 1 Image: Primaselected Beam ON Image: Primaselected MPS-135 (LEBT focalization error) Image: Primaselected Beam OFF Image: Primaselected Machine Down, Severity 1 Image: Primaselected
Buncher: Person C & Diag #1: Person H & Diag #2: Person I &	09:24:21 09:24:25 Machine : DOWN	LEBT SOL PS damaged. Severity 4 Add selected PVs
Change Ready >	> Plain text input	

Tools

EPICS – Experimental Physics and Industrial Control System, framework often used on large scientific facilities like particle accelerators, including LIPAc.
CS-Studio / CSS Phoebus – Control System Studio, collection of tools and applications for developing and running GUI on EPICS framework
BEAST – Best Ever Alarm System Toolkit, developed by EPICS community
BUZZER – LIPAc Alarm System, in-house dev., intended for customizing alarm sounds
Kafka – Event Streaming Platform, used by CSS Phoebus Alarm System

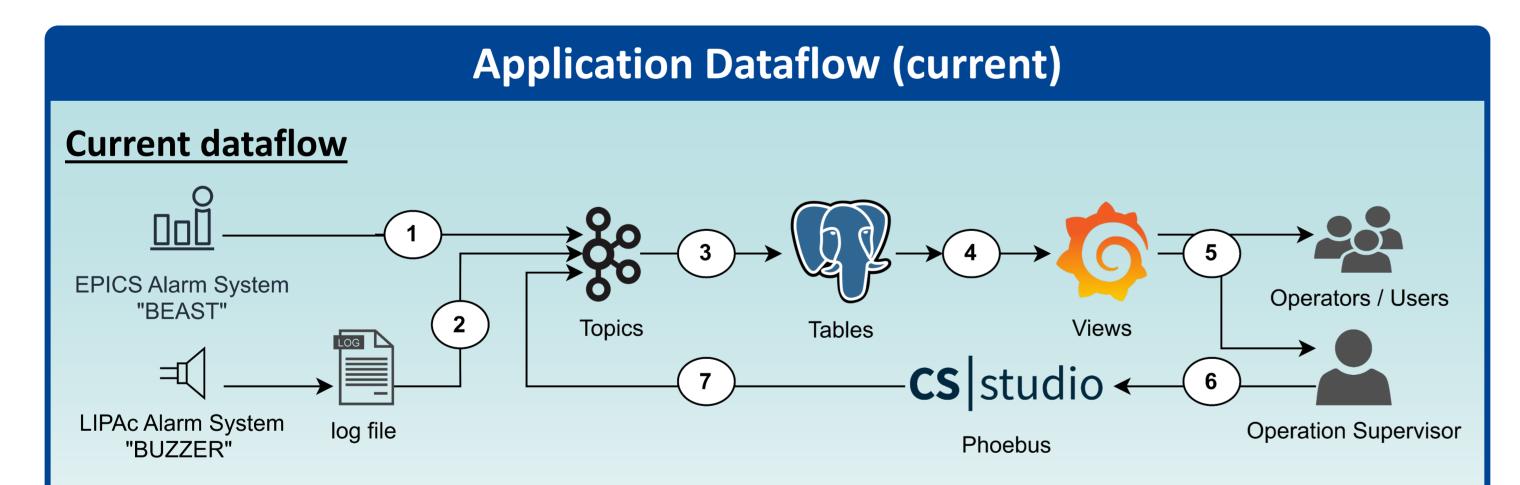
PostgreSQL – Database System already used in most applications for the project **Grafana** – data analytics and visualization platform

GUI – today's status

Two interfaces: CS studio Phoebus display (OS side): Automatic data recording

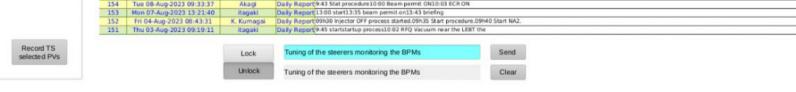
PV record functions

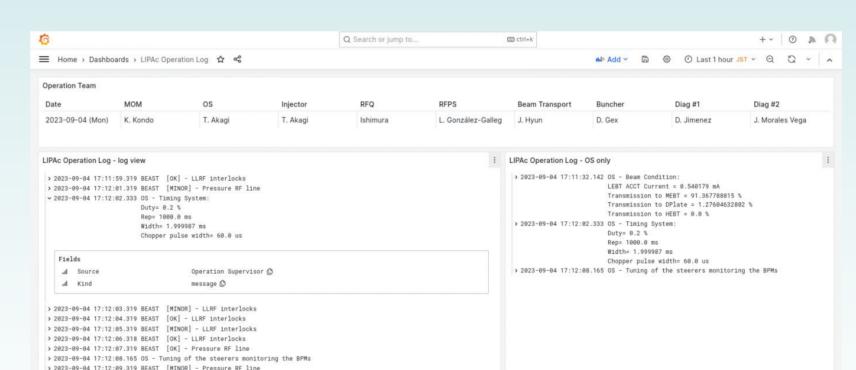




- 1. BEAST writes directly to Kafka topics
- 2. Ingestion of BUZZER output (raw log file) into Kafka
- 3. Kafka connectors transfer the data to PostgreSQL tables
- 4. A Grafana dashboard queries and aggregates the data from PostgreSQL
- 5. The Grafana server is accessible both from the LIPAc network and the Internet
- 6. Acquisition of OS inputs from a Phoebus display in the Control Room
- 7. Python scripts embedded in the display to stream data into Kafka

- Manual inputs from the OS







Grafana dashboard

- read-only
- customizable queries
- multiple boards

Defects/Problems to be solved in the current system

Phoebus

.al Message

.d Descripti

al Details

al Source

al Kind

.d Value

023-00-04 17-12-22 310 REAST [OK] - Pressure RE]ir

2023-09-04 17:12:25.319 BEAST [OK] - LLRF interl

2023-09-04 17:12:26.319 BEAST [OK] - Pressure RF line

MINOR (C)

-1.0 0

BEAST O

LOW_ALARM (C

LLRF interlocks f

/LIPAc/RFPS/AL_RF:LLRF2_CavB:LoadAttenDiff

 Automatic data recording runs on the Phoebus display: no information recorded if the GUI is not opened.

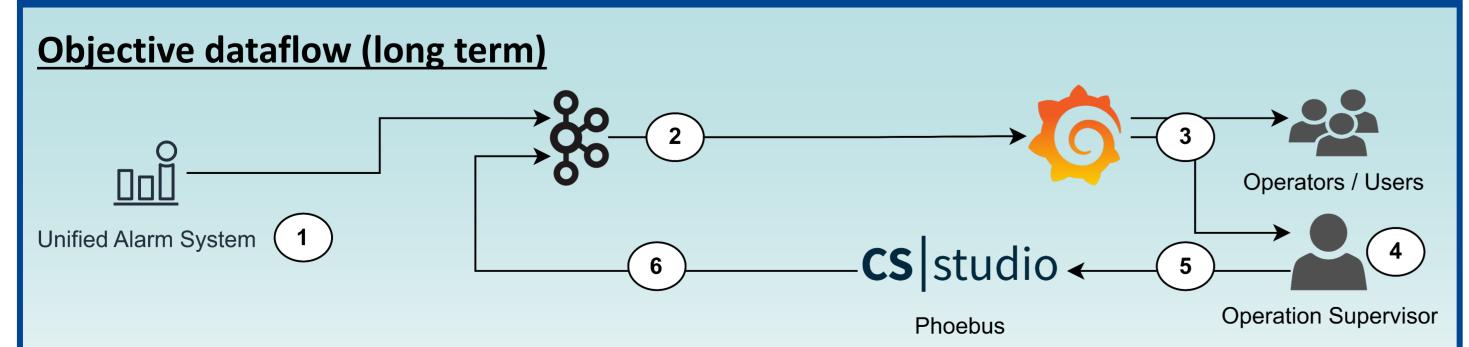
Check Dummy Load in RFO RF Module 2B. Alarm configuration (dB) LL:23. L:25 f

 No direct feedback about the outputs (Grafana could be embedded but is too

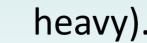
Grafana

- Maximum refresh rate of 5 seconds.
- More than one hour time window for the query is too heavy: should be

"Ideal" dataflow (long term)



- 1. If LIPAc was to ever use a unified Alarm System, it would simplify data ingestion.
- 2. Ideally, Grafana could directly read data from Kafka topics.
- 3. Better queries and dashboards will ease users' access to information.
- 4. An export stage could support the OS to easily generate a final report.
- 5. Experience and feedback will greatly improve the content of the Phoebus display.
- 6. Embedded scripts are to be avoided. We should develop a Phoebus application.



Alarm Systems

- Two very different systems to integrate.
- Non-homogeneous use of Warnings and Alarms among accelerator subsystems.

optimised.

 Only raw information from the alarms: they should be sorted, filtered and displayed more pertinently.

Conclusion

The LIPAc Operation Log tool is still at a development stage, but several shortcuts were chosen to quickly provide a prototype for current LIPAc operation stage. Even if the overall design is well defined, there is still a lot of evolution to come, in a near and further future. Yet, it could be interesting to reach an alpha version that could be tested by LIPAc OS before the end of the Operation stage.



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