MACE - Monitoring, Alarming and Control for ELIADE

Outline

• Introduction
• ELIADE
• MACE Structure
• Conclusion
MACE Functionalities

- Improves the monitoring of the HPGe CLOVER Detectors array present at ELIADE;
- Allows the modification of management parameters, using a browser GUI;
- Monitors the state of the detectors: temperature, and the state of the High-Voltage Source: High-Voltage and Current;
- Issues alarms and actions in case of specific events.
The ELI-NP array of HPGe CLOVER detectors (ELIADE)

8 HPGe Detectors

- Need LN2 Cooling;
- MACE monitors the temperatures of these detectors and triggers alarms;
- The ideal temperature of around -180 degrees Celsius is kept with the help of the MACE system;
- The power supply of the detectors is also closely monitored.
The ELI-NP array of HPGe CLOVER detectors (ELIADE)

The Cooling System
Technology used in the creation of MACE

MACE has been programmed in Python, using the following libraries:

<table>
<thead>
<tr>
<th>Library</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flask</td>
<td>runs GUI and server</td>
</tr>
<tr>
<td>SmtpLib</td>
<td>allows email alerts</td>
</tr>
<tr>
<td>Redis</td>
<td>keeps running code memory in a temporary database</td>
</tr>
<tr>
<td>InfluxDB</td>
<td>allow permanent database insertions</td>
</tr>
<tr>
<td>PyEpics</td>
<td>initiates server-hardware communication for reading data</td>
</tr>
<tr>
<td>Json</td>
<td>manipulates json files</td>
</tr>
<tr>
<td>Threading</td>
<td>allows for complex code architecture</td>
</tr>
</tbody>
</table>
Technology used in the creation of MACE

Along with Python, other languages and software were also used for the:

1. Creation of the graphical user interface:
   - HTML
   - CSS
   - Javascript

2. Good management of data:
   - InfluxDB
   - Json files
   - Redis
   - Open-source Plotting Software
Motivation for using these technologies

- Python – allows for a diversity of libraries that helped the creators to implement various types of alarms and modes of communication;
- Web browser GUI – allows access from anywhere in the internal network through ip and port;
- Json configuration files – easier to implement with the Python programming language;
- InfluxDB databases – is a good query language for storing large amounts of scientific data.
MACE Code Structure
Consists of two sub-systems:

• Action sub-system:
  - reads-out the values that are being compared
  - changes alarm levels
  - triggers alarms
  - runs the graphical user interface server
  - controls the in-memory database: Redis

• Monitoring sub-system:
  - controls the plotting software
  - reads-out data that is going to be displayed
  - records data in a persistent database
MACE Structure

MACE Code Structure - Monitoring

[Diagram showing data flow from data input through HVMonitor and CoolingMonitor, followed by Persistent database, and then Plotting software with Monitoring Sub-System at the bottom]
MACE Structure

MACE Code Structure - Action
MACE Structure

Alarm triggering logic:

• Four levels of alarms are present;

• If a level is surpassed in value, specific actions are taken;

• The user can set up to 4 different alarms per level;

• Only ascending level changes will be taken into consideration.
List of alarm functions currently implemented in MACE

- Email sending;
- GSM Call;
- Trigger LN2 Filling;
- High Voltage Shut down.
Example of alarm triggering logic
MACE Structure

GUI Functionalities

MACE runs a web server which contains a graphical user interface (GUI), used for managing settings and displaying important data.

The GUI has the following characteristics:

<table>
<thead>
<tr>
<th>ID</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Current detector temperature</td>
</tr>
<tr>
<td>2</td>
<td>Temperature intervals for the alarms</td>
</tr>
<tr>
<td>3</td>
<td>Current alarm level</td>
</tr>
<tr>
<td>4</td>
<td>Alarm reset button</td>
</tr>
<tr>
<td>5</td>
<td>Start/Stop buttons for main code</td>
</tr>
<tr>
<td>6</td>
<td>Refresh button</td>
</tr>
<tr>
<td>7</td>
<td>Validate button for validation of data</td>
</tr>
<tr>
<td>8</td>
<td>Detector to HV Source mapping</td>
</tr>
<tr>
<td>9</td>
<td>Activate/Deactivate detectors for monitoring</td>
</tr>
<tr>
<td>10</td>
<td>Table of previously issued alarms</td>
</tr>
</tbody>
</table>
MACE Structure

GUI Presentation

ELIADE MACE CONTROL UNIT

Detector 1
-178.95834

Detector 2
1245.7356

Detector 3
-178.06235

Detector 4
-181.90884

Detector 5
1246.001

Detector 6
1245.7349

Detector 7
1245.8442

Detector 8
1245.3488

Detector Temperature Limits (°C, °C, °C)

Set Set Alarm Reset Button

Code Command Panel
MACE Status:
Not confirmed

Action
Start
Stop
Refresh
Validate Support
### MACE Structure

#### GUI Presentation

![Image of GUI presentation](image-url)

#### Table of Detectors

<table>
<thead>
<tr>
<th>Detector</th>
<th>Slot</th>
<th>Channel</th>
<th>Status</th>
<th>Enable/Disable</th>
<th>Set Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector 1</td>
<td>1</td>
<td>4</td>
<td>Active</td>
<td>Enable/Disable</td>
<td>Set Map</td>
</tr>
<tr>
<td>Detector 2</td>
<td>0</td>
<td></td>
<td>Inactive</td>
<td>Enable/Disable</td>
<td>Set Map</td>
</tr>
<tr>
<td>Detector 3</td>
<td>1</td>
<td>6</td>
<td>Active</td>
<td>Enable/Disable</td>
<td>Set Map</td>
</tr>
<tr>
<td>Detector 4</td>
<td>1</td>
<td>7</td>
<td>Active</td>
<td>Enable/Disable</td>
<td>Set Map</td>
</tr>
<tr>
<td>Detector 5</td>
<td>0</td>
<td></td>
<td>Inactive</td>
<td>Enable/Disable</td>
<td>Set Map</td>
</tr>
<tr>
<td>Detector 6</td>
<td>0</td>
<td></td>
<td>Inactive</td>
<td>Enable/Disable</td>
<td>Set Map</td>
</tr>
<tr>
<td>Detector 7</td>
<td>0</td>
<td></td>
<td>Inactive</td>
<td>Enable/Disable</td>
<td>Set Map</td>
</tr>
<tr>
<td>Detector 8</td>
<td>0</td>
<td></td>
<td>Inactive</td>
<td>Enable/Disable</td>
<td>Set Map</td>
</tr>
</tbody>
</table>

#### Table of Previous Alarms

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021-09-07 14:30:15</td>
<td>Call</td>
</tr>
<tr>
<td>2021-09-07 14:56:16</td>
<td>Call</td>
</tr>
<tr>
<td>2021-09-07 15:56:38</td>
<td>Send/Flush</td>
</tr>
<tr>
<td>2021-09-07 15:56:16</td>
<td>Send/Flush</td>
</tr>
<tr>
<td>2021-09-07 15:56:41</td>
<td>Send/Flush</td>
</tr>
<tr>
<td>2021-09-07 15:55:17</td>
<td>Power Up</td>
</tr>
<tr>
<td>2021-09-07 15:55:16</td>
<td>Power Up</td>
</tr>
<tr>
<td>2021-09-07 15:14:08</td>
<td>Power Up</td>
</tr>
<tr>
<td>2021-09-07 15:14:37</td>
<td>Power Up</td>
</tr>
<tr>
<td>2021-09-07 15:58:25</td>
<td>Power Up</td>
</tr>
<tr>
<td>2021-09-07 15:23:07</td>
<td>Power Up</td>
</tr>
</tbody>
</table>

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MACE Structure

Plotting Real-Time Charts

• Uses a plotting software;
• The action is performed by linking a database to the plotting software;
• The plotting software displays time series of the values in the database;
• The panels are organized, depending on individual need.
MACE Structure

Plotting Real-Time Charts
Conclusion

MACE has the following advantages:

- Any bad event can be dealt with in an efficient manner;
- The system is scalable allowing for monitoring other array of detectors;
- Alarms can be modified.

Future planned improvements:

- Designing more alarms;
- Improving the code efficiency;
- Scaling the code for different arrays of detectors.
Thank you!