



## PhantasyCalc

Integrating EPICS Data into a Spreadsheet Application

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**MICHIGAN STATE**  
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**ENERGY**

Office of  
Science

# Outline

## 1 Introduction

- Background
- Motivation

## 2 Software Implementation

- Architecture
- Web Service
- LibreOffice Calc

## 3 Features

- User-defined Functions
- Tools

## 4 Summary

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# Data Perspective from High-level Physics Controls

## Machine Tuning

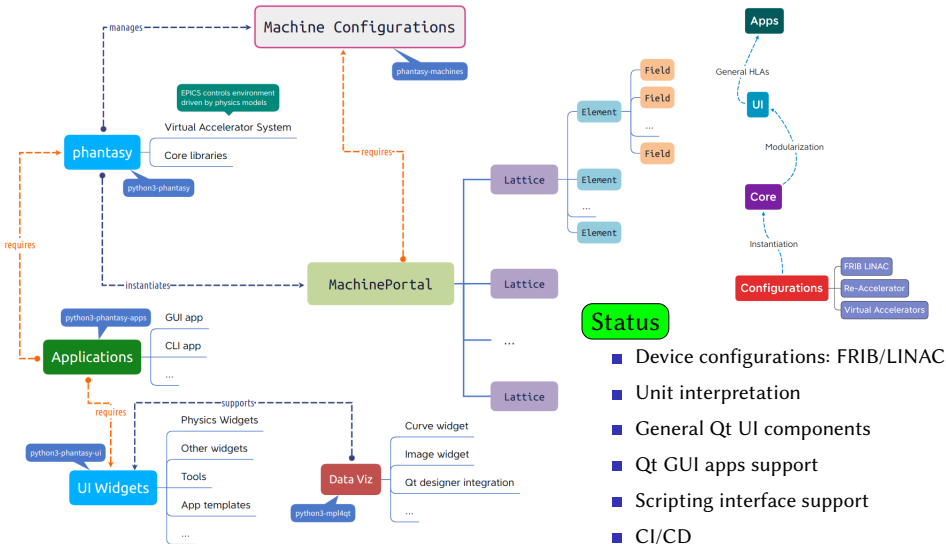
- Get time-correlated EPICS data for device readings from the live machine
- Optimize physics model to generate device settings as a solution
- Apply the solution to the live machine

## Data Sources

- EPICS CA, Archiver, static configurations
  - (live/archived) Power supply in Amp for a quadrupole, ...
  - (live/archived) Electric static dipole corrector in Volt, ...
- Physics lattice configuration data, field map data, ...
  - A series of device layout info for building physics lattice, ...
  - Rules for Amp  $\Leftrightarrow$  T/m interpretation, ...
  - Effective length from field map data, ...



# PHANTASY: Physics High-level Applications and Toolkit for Accelerator System



▷ T. Zhang, et al, "Manage the Physics Settings on the Modern Accelerator", ICALEPCS 2021, WEBL04.

# Manage Tabular Data in a Spreadsheet Application

## Spreadsheet

- Easy yet powerful tool for data collection and analysis
- Excellent application for Linux: LibreOffice Calc, a great MS Excel alternative
- Users: focus on problem-solving
- Developers: extend the capability with unified interface

## Why not Python?

- Need environment support on users' side, usually not a problem
- Powerful, and convenient for expert, requires programming skills
- Too much flexible, things can be done in many ways
- Inspirations: Hide the complexities from the users by all means!

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# The Motivation Behind Spreadsheet-centric Platform

- Targeting non-programmer user groups
- Integrating data from diverse sources
- Delivering functionalities with a consistent interface
  - Enhance the existing development of "phantasy-project"
  - Consolidate the complex physics calculation tasks
  - Make the most of conventional spreadsheet-based data analysis

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# PhantasyCalc: Extend LibreOffice Calc

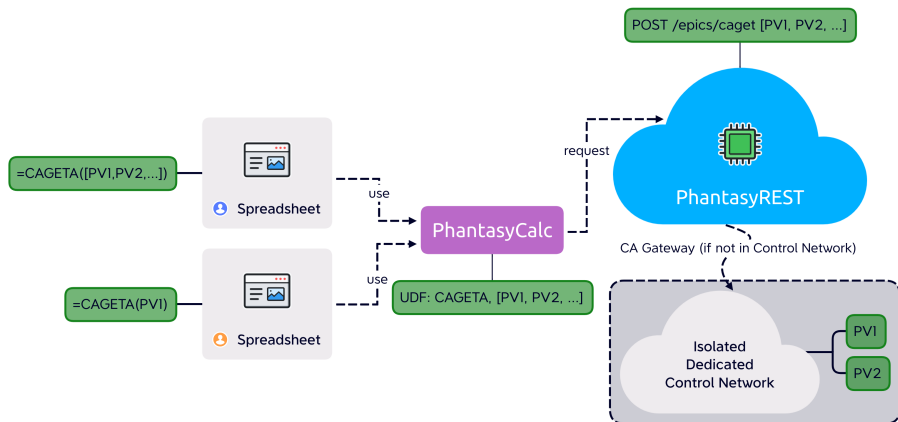
**Initial ideas** Expose PHANTASY functions to LibreOffice Calc through User-defined Functions (UDFs)

**Bigger picture** Streamline the data integration to Spreadsheet application, including MS Excel, to break platform barrier

## Development Status

- Support LibreOffice Calc Linux/Windows, and MS Excel on Windows (early-stage).
- UDFs for EPICS CA operations, PHANTASY functions, numerical functions, other physics simulations
- Tools for fetching data, controlling devices; integrated into menu, toolbar, Ribbon menu (Excel only, early-stage)
- Documentation site

# Architecture Diagram



- **PhantasyRest** could be deployed in Control Network
- Or communicate with Control Network through CA Gateway system
- **PhantasyCalc** is available as packages for both Linux and Windows



# PhantasyREST: A REST API Web Service for PHANTASY

## What is it?

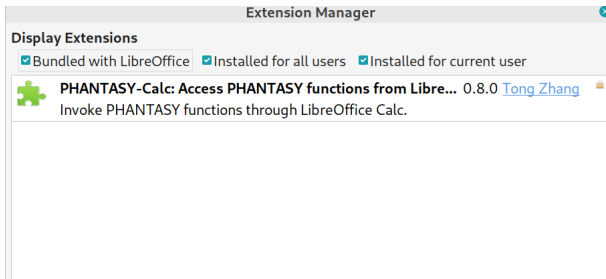
- **PhantasyREST** is a REST API service providing PHANTASY functions
- Support asynchronous HTTP requesting
- Can work with CA gateway to provide EPICS data
- Add new entrypoints to support new functionality
- Streaming data to **PhantasyCalc** in the form of UDFs or threaded callbacks

## Benefits

- Server-client development mode
- Break the barrier of OS requirements for PHANTASY and other physics simulation code
- Support any kind of web FrontEnd development activities with EPICS data

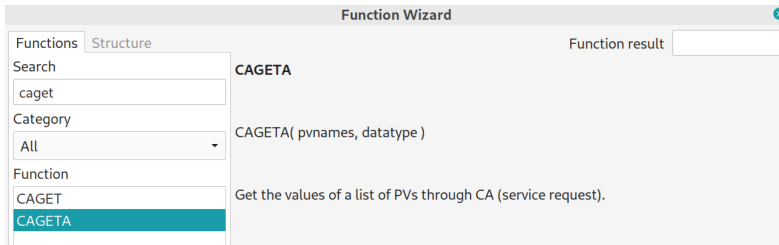
# LibreOffice Calc Integration

- Install "phantasy-calc" package (.deb), see in "Extension Manager" (**Tools** → **Extension Manager...**)
- Function Wizard, see all deployed UDFs (**Insert** → **Function...**)
- Tools, either in a floating dialog or docked into the toolbar



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undock/dock



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# UDF: User-defined Functions

## What is an UDF?

- UDFs allow users to perform calculations that are not included in Calc or Excel's built-in functions.
- Can be developed with BASIC, C/C++, JAVA, Python

## Function Category

- Phantasy Provides functionality that can also be scripted by using the 'phantasy' Python package
- EPICS Provides functionality regarding EPICS CA and PVA (to be supported)
- Physics Provides functionality that entails intricate physics simulations
- Others Provides functionality that is not available from built-in list

# UDF: Category Phantasy

## Phantasy

`elem` is an object instantiated from `phantasy`, e.g.:

```
>>> import phantasy
>>> mp = phantasy.MachinePortal("FRIB", "LINAC")
>>> elem = mp.get_elements(type='QUAD', name='*D2194*')[0]
>>> elem.name # device name, FS1_CSS:QH_D2194
>>> elem.sb # device position, 219.295
>>> elem.family # device type, QUAD
>>> elem.I # current readback of I, 39.014 A
>>> elem.current_setting("I") # current setpoint of I, 39.1 A
>>> # put name string in cell A1
```

UDF	Array? [1]	Python API	Description
<code>=PHGETELEMPOS1(A1)</code>	Yes	<code>elem.sb</code>	Get the global position in meter along the beam line
<code>=PHGETELEMTYPE(A1)</code>	Yes	<code>elem.family</code>	Get the device type
<code>=PHGETREADING(A1, "I")</code>	Yes	<code>elem.I</code>	Get the live readback of a field
<code>=PHGETSETTING(A1, "I")</code>	Yes	<code>elem.current_setting("I")</code>	Get the live setpoint of a field
<code>=PHCONVERT(A1, 100, "I", "B2")</code>	Yes	<code>elem.convert(100, "I", "B2")</code>	Interprete value from one field to another
...			

1. Pass a range of cells to the UDF to return results in a range of cell, execute with `CTRL` + `SHIFT` + `ENTER`.



**Facility for Rare Isotope Beams**

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# UDF: Category Phantasy

## Phantasy

`elem` is an object instantiated from `phantasy`

```
>>> import phantasy
>>> mp = phantasy.MachinePortal("FRIB")
>>> elem = mp.get_elements(type='QUAD')
>>> elem.name # device name, FS1_CSS:1
>>> elem.sb # device position, 219.291
>>> elem.family # device type, QUAD
>>> elem.I # current readback of I, 39.014 A
>>> elem.current_setting("I") # current setpoint of I, 39.1 A
>>> # put name string in cell A1
```

Device Name	Type	Begin	End	Live Set	I [A] →	B3 [T/m <sup>2</sup> ]	Type Alias
		Pos [m]	Pos [m]	I [A]	B3 [T/m <sup>2</sup> ]	→ I [A]	
FS1_BBS:S_D2419	SEXT	241.849	241.999	1.305	-7.151	1.305	H3
FS1_BBS:S_D2469	SEXT	246.777	246.927	1.305	-7.151	1.305	H3
FS2_BBS:S_D4000	SEXT	399.918	400.018	2.380	-35.700	2.380	H1
FS2_BBS:S_D4007	SEXT	400.681	400.781	0.000	0.000	0.000	H1
FS2_BBS:S_D4098	SEXT	409.785	409.885	0.000	0.000	0.000	H1
FS2_BBS:S_D4106	SEXT	410.549	410.649	2.380	-35.700	2.380	H1
BDS_BBS:S_D5606	SEXT	560.497	560.697	2.150	36.555	2.150	SEXT_H2
BDS_BBS:S_D5703	SEXT	570.197	570.397	2.150	36.555	2.150	SEXT_H2

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# UDF: Category EPICS

## EPICS

Put a pv name string in cell A1

UDF	Array? <sup>[1]</sup>	Description
=CAGETA(A1)	Yes	Get a [list of] reading from CA get request (service request from <code>PhantasyRest</code> )
=CAGET(A1)	Yes	Get a [list of] reading from CA get request (local EPICS environment)

---

1. Pass a range of cells to the UDF to return results in a range of cell, execute with `CTRL` + `SHIFT` + `ENTER` .

# UDF: Category EPICS

## EPICS

Put a pv name string in cell A1

UDF	Array? <sup>[1]</sup>	Description
=CAGETA(A1)	Yes	Get a [list of] reading from CA get request (service request from <a href="#">PhantasyRest</a> )
=CAGET(A1)	Yes	Get a [list of] reading from CA get request (local EPICS environment)

Formula of "X [mm]" column		=CAGETA(B4:B16)	
2023-04-19 13:42:58 EDT X [mm]		2023-04-19 13:42:58 EDT Y [mm]	
FE_MEBT:BPM_D1056:XPOS_RD	1.85	FE_MEBT:BPM_D1056:YPOS_RD	-0.84
FE_MEBT:BPM_D1072:XPOS_RD	-0.14	FE_MEBT:BPM_D1072:YPOS_RD	-0.10
FE_MEBT:BPM_D1094:XPOS_RD	0.23	FE_MEBT:BPM_D1094:YPOS_RD	0.29
FE_MEBT:BPM_D1111:XPOS_RD	-0.15	FE_MEBT:BPM_D1111:YPOS_RD	0.16
LS1_CA01:BPM_D1129:XPOS_RD	0.30	LS1_CA01:BPM_D1129:YPOS_RD	-0.18
LS1_CA01:BPM_D1144:XPOS_RD	0.58	LS1_CA01:BPM_D1144:YPOS_RD	-0.91
LS1_WA01:BPM_D1155:XPOS_RD	-0.49	LS1_WA01:BPM_D1155:YPOS_RD	-0.76
LS1_CA02:BPM_D1163:XPOS_RD	-0.15	LS1_CA02:BPM_D1163:YPOS_RD	-0.37
LS1_CA02:BPM_D1177:XPOS_RD	0.10	LS1_CA02:BPM_D1177:YPOS_RD	0.28
LS1_WA02:BPM_D1188:XPOS_RD	0.64	LS1_WA02:BPM_D1188:YPOS_RD	0.21
LS1_CA03:BPM_D1196:XPOS_RD	1.06	LS1_CA03:BPM_D1196:YPOS_RD	0.12
LS1_CA03:BPM_D1211:XPOS_RD	1.06	LS1_CA03:BPM_D1211:YPOS_RD	-0.60
LS1_WA03:BPM_D1222:XPOS_RD	0.09	LS1_WA03:BPM_D1222:YPOS_RD	-0.39

1. Pass a range of cells to the UDF to return results in a range of cell, execute with **CTRL** + **SHIFT** + **ENTER** .

# UDF: Category Physics and others

## Physics and others

UDF	Array? <sup>[1]</sup>	Description
<code>=CALCENERGYLOSS()</code>	Yes	Calculate the energy loss from the interaction between beam and material
<code>=INTERP1D()</code>	No	1D data interpolation
<code>=STRFTIME()</code>	Yes	Format datetime from timestamp
...		

1. Pass a range of cells to the UDF to return results in a range of cell, execute with **CTRL** + **SHIFT** + **ENTER**.



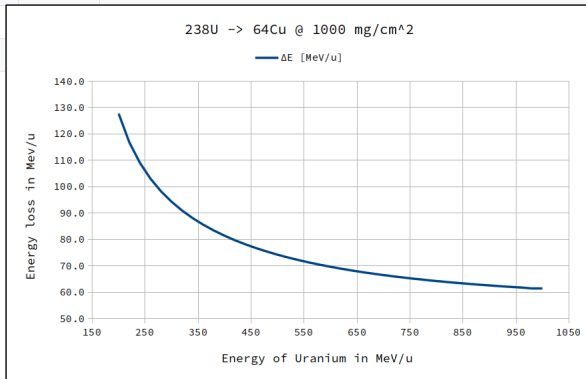
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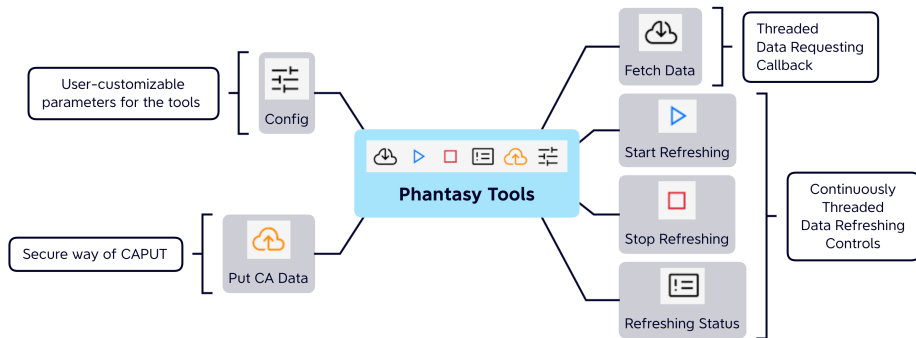
# Caveats for UDF Applications

- LibreOffice Calc: Execute UDF in array mode can get the data with aligned timestamps, which is essential for EPICS data, and is also a more efficient way of data requesting from a list of PVs
- Make UDF volatile seems more accurate to the EPICS data, but may impact the performance, so threaded callback tools are developed to handle the case of fetching dynamically changing and large dataset
- Recalculation of cells in LibreOffice Calc can be triggered with F9 (selected cell) or Ctrl + Shift + F9 (global).
- About “auto-calculation on file is loaded”:
  - Save as .ods will do auto-calculation after opening the spreadsheet
  - Has option to disable auto-calculation when file loaded, but save as .xlsx
  - See the menu of Tools → Options → LibreOffice Calc: “Formula Recalculation on File Load”
- Thus, additional tools are developed as enhancements

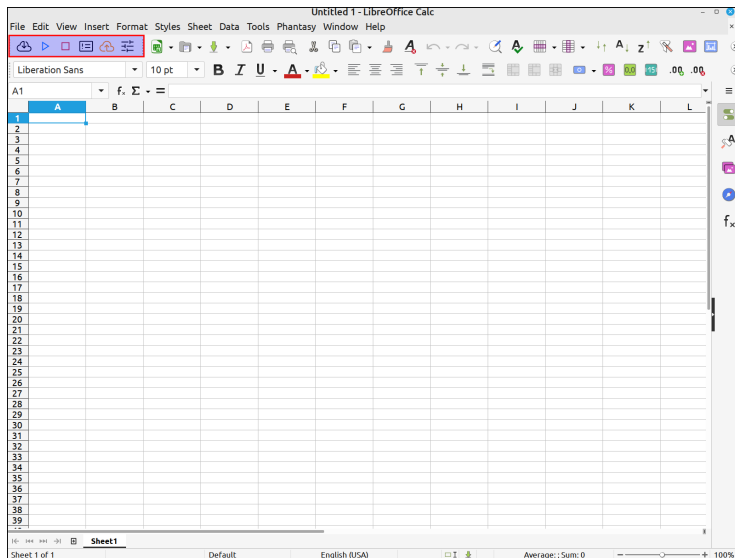
# Tools Integration

## Design Philosophy

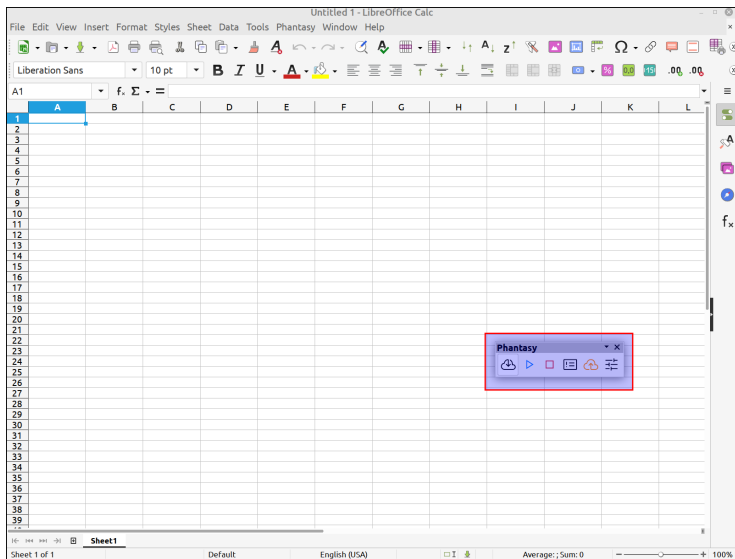
- Easy to find → Floating or docked tool buttons
- Easy to use → Clicking a tool button to apply some feature on the selected cell(s)/sheet
- Seamlessly integrated into LibreOffice Calc



# Tools Integration

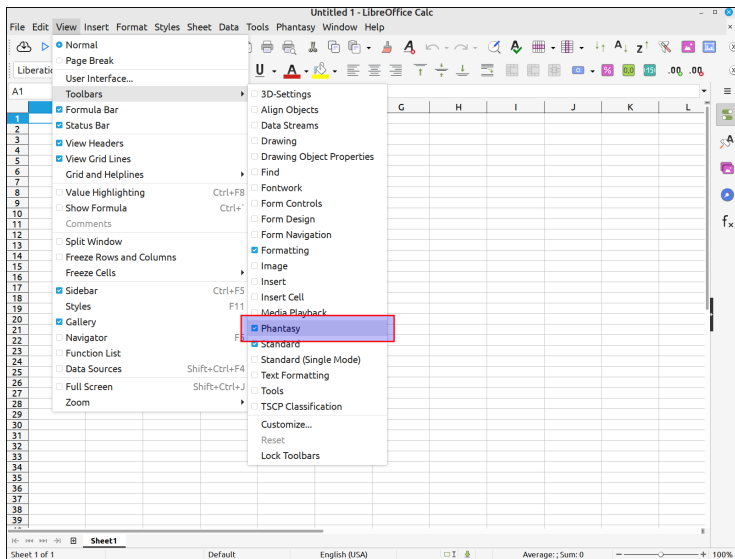


# Tools Integration





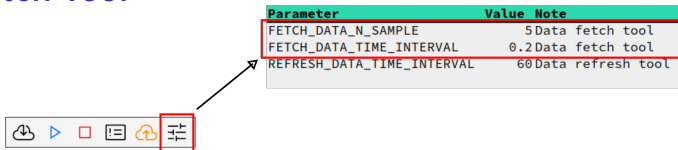
# Tools Integration



# Data Fetch Tool



# Data Fetch Tool

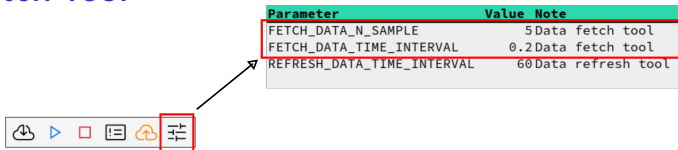


The diagram illustrates the configuration process for the Data Fetch Tool. On the left, a toolbar contains several icons: a download icon, a play icon, a stop icon, a list icon, a refresh icon, and a configuration icon (represented by a gear or settings symbol). The configuration icon is highlighted with a red box, and an arrow points from it to a table on the right. The table, titled 'Parameter', 'Value', and 'Note', lists the following parameters:

Parameter	Value	Note
FETCH_DATA_N_SAMPLE	5	Data fetch tool
FETCH_DATA_TIME_INTERVAL	0.2	Data fetch tool
REFRESH_DATA_TIME_INTERVAL	60	Data refresh tool

0. Click config button to adjust parameters for Data Fetch tool

# Data Fetch Tool

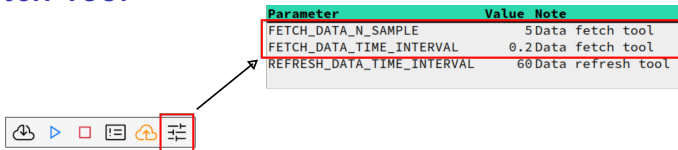


Parameter	Value	Note
FETCH_DATA_N_SAMPLE	5	Data fetch tool
FETCH_DATA_TIME_INTERVAL	0.2	Data fetch tool
REFRESH_DATA_TIME_INTERVAL	60	Data refresh tool

1. Fill out a list of PV names +  
one row before for timestamps

```
Datetime
Timestamp
LS1_CA01:BPM_D1129:XPOS_RD
LS1_CA01:BPM_D1144:XPOS_RD
LS1_WA01:BPM_D1155:XPOS_RD
LS1_CA02:BPM_D1163:XPOS_RD
LS1_CA02:BPM_D1177:XPOS_RD
LS1_WA02:BPM_D1188:XPOS_RD
LS1_CA03:BPM_D1196:XPOS_RD
LS1_CA03:BPM_D1211:XPOS_RD
LS1_WA03:BPM_D1222:XPOS_RD
```

# Data Fetch Tool

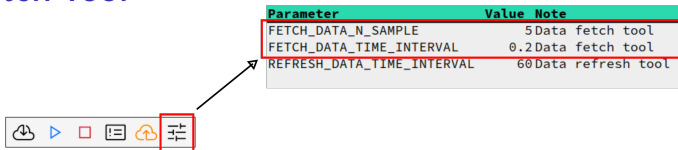


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1. Fill out a list of PV names

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Datetime
Timestamp
LS1_CA01:BPM_D1129:XPOS_RD
LS1_CA01:BPM_D1144:XPOS_RD
LS1_WA01:BPM_D1155:XPOS_RD
LS1_CA02:BPM_D1163:XPOS_RD
LS1_CA02:BPM_D1177:XPOS_RD
LS1_WA02:BPM_D1188:XPOS_RD
LS1_CA03:BPM_D1196:XPOS_RD
LS1_CA03:BPM_D1211:XPOS_RD
LS1_WA03:BPM_D1222:XPOS_RD
```

# Data Fetch Tool



Parameter	Value	Note
FETCH_DATA_N_SAMPLE	5	Data fetch tool
FETCH_DATA_TIME_INTERVAL	0.2	Data fetch tool
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1. Fill out a list of PV names
2. Select all + One row for timestamps

Datetime  
Timestamp  
LS1\_CA01:BPM\_D1129:XPOS\_RD  
LS1\_CA01:BPM\_D1144:XPOS\_RD  
LS1\_WA01:BPM\_D1155:XPOS\_RD  
LS1\_CA02:BPM\_D1163:XPOS\_RD  
LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

# Data Fetch Tool

Parameter	Value	Note
FETCH_DATA_N_SAMPLE	5	Data fetch tool
FETCH_DATA_TIME_INTERVAL	0.2	Data fetch tool
REFRESH_DATA_TIME_INTERVAL	60	Data refresh tool



1. Fill out a list of PV names
2. Select all + One row for timestamps
3. Click "Fetch Data" tool

Datetime  
Timestamp  
LS1\_CA01:BPM\_D1129:XPOS\_RD  
LS1\_CA01:BPM\_D1144:XPOS\_RD  
LS1\_WA01:BPM\_D1155:XPOS\_RD  
LS1\_CA02:BPM\_D1163:XPOS\_RD  
LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

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LS1\_CA02:BPM\_D1163:XPOS\_RD  
LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

Fetches data appears column by column

Datetime  
Timestamp  
LS1\_CA01:BPM\_D1129:XPOS\_RD  
LS1\_CA01:BPM\_D1144:XPOS\_RD  
LS1\_WA01:BPM\_D1155:XPOS\_RD  
LS1\_CA02:BPM\_D1163:XPOS\_RD  
LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD



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LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

Fetch data appears column by column

Datetime  
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LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

2023-04-20 09:06:09.777469  
1681995969.777470  
-0.81  
0.18  
-0.53  
-0.25  
-0.72  
-0.30  
0.21  
0.49  
-0.08

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LS1\_CA01:BPM\_D1129:XPOS\_RD  
LS1\_CA01:BPM\_D1144:XPOS\_RD  
LS1\_WA01:BPM\_D1155:XPOS\_RD  
LS1\_CA02:BPM\_D1163:XPOS\_RD  
LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

Fetch data appears column by column

Datetime	2023-04-20 09:06:09.777469	2023-04-20 09:06:09.977640
Timestamp	1681995969.777470	1681995969.977640
LS1_CA01:BPM_D1129:XPOS_RD	-0.81	-0.81
LS1_CA01:BPM_D1144:XPOS_RD	0.18	0.17
LS1_WA01:BPM_D1155:XPOS_RD	-0.53	-0.53
LS1_CA02:BPM_D1163:XPOS_RD	-0.25	-0.25
LS1_CA02:BPM_D1177:XPOS_RD	-0.72	-0.72
LS1_WA02:BPM_D1188:XPOS_RD	-0.30	-0.30
LS1_CA03:BPM_D1196:XPOS_RD	0.21	0.21
LS1_CA03:BPM_D1211:XPOS_RD	0.49	0.49
LS1_WA03:BPM_D1222:XPOS_RD	-0.08	-0.08

# Data Fetch Tool

Parameter	Value	Note
FETCH_DATA_N_SAMPLE	5	Data fetch tool
FETCH_DATA_TIME_INTERVAL	0.2	Data fetch tool
REFRESH_DATA_TIME_INTERVAL	60	Data refresh tool



1. Fill out a list of PV names
2. Select all + One row for timestamps
3. Click "Fetch Data" tool

Datetime  
Timestamp  
LS1\_CA01:BPM\_D1129:XPOS\_RD  
LS1\_CA01:BPM\_D1144:XPOS\_RD  
LS1\_WA01:BPM\_D1155:XPOS\_RD  
LS1\_CA02:BPM\_D1163:XPOS\_RD  
LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

Fetches data appears column by column

Datetime	2023-04-20 09:06:09.777469	2023-04-20 09:06:09.977640	2023-04-20 09:06:10.177841
Timestamp	1681995969.777470	1681995969.977640	1681995970.177840
LS1_CA01:BPM_D1129:XPOS_RD	-0.81	-0.81	-0.81
LS1_CA01:BPM_D1144:XPOS_RD	0.18	0.17	0.17
LS1_WA01:BPM_D1155:XPOS_RD	-0.53	-0.53	-0.53
LS1_CA02:BPM_D1163:XPOS_RD	-0.25	-0.25	-0.25
LS1_CA02:BPM_D1177:XPOS_RD	-0.72	-0.72	-0.72
LS1_WA02:BPM_D1188:XPOS_RD	-0.30	-0.30	-0.31
LS1_CA03:BPM_D1196:XPOS_RD	0.21	0.21	0.21
LS1_CA03:BPM_D1211:XPOS_RD	0.49	0.49	0.49
LS1_WA03:BPM_D1222:XPOS_RD	-0.08	-0.08	-0.08

# Data Fetch Tool

Parameter	Value	Note
FETCH_DATA_N_SAMPLE	5	Data fetch tool
FETCH_DATA_TIME_INTERVAL	0.2	Data fetch tool
REFRESH_DATA_TIME_INTERVAL	60	Data refresh tool



1. Fill out a list of PV names
2. Select all + One row for timestamps
3. Click "Fetch Data" tool

Datetime  
Timestamp  
LS1\_CA01:BPM\_D1129:XPOS\_RD  
LS1\_CA01:BPM\_D1144:XPOS\_RD  
LS1\_WA01:BPM\_D1155:XPOS\_RD  
LS1\_CA02:BPM\_D1163:XPOS\_RD  
LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

Fetches data appears column by column

Datetime  
Timestamp  
LS1\_CA01:BPM\_D1129:XPOS\_RD  
LS1\_CA01:BPM\_D1144:XPOS\_RD  
LS1\_WA01:BPM\_D1155:XPOS\_RD  
LS1\_CA02:BPM\_D1163:XPOS\_RD  
LS1\_CA02:BPM\_D1177:XPOS\_RD  
LS1\_WA02:BPM\_D1188:XPOS\_RD  
LS1\_CA03:BPM\_D1196:XPOS\_RD  
LS1\_CA03:BPM\_D1211:XPOS\_RD  
LS1\_WA03:BPM\_D1222:XPOS\_RD

2023-04-20 09:06:09.777469	2023-04-20 09:06:09.977640	2023-04-20 09:06:10.177841	2023-04-20 09:06:10.378029
1681995969.777470	1681995969.977640	1681995970.177840	1681995970.378030
-0.81	-0.81	-0.81	-0.81
0.18	0.17	0.17	0.17
-0.53	-0.53	-0.53	-0.53
-0.25	-0.25	-0.25	-0.25
-0.72	-0.72	-0.72	-0.72
-0.30	-0.30	-0.31	-0.31
0.21	0.21	0.21	0.20
0.49	0.49	0.49	0.49
-0.08	-0.08	-0.08	-0.08

# Data Fetch Tool

Parameter	Value	Note
FETCH_DATA_N_SAMPLE	5	Data fetch tool
FETCH_DATA_TIME_INTERVAL	0.2	Data fetch tool
REFRESH_DATA_TIME_INTERVAL	60	Data refresh tool



1. Fill out a list of PV names
2. Select all + One row for timestamps
3. Click "Fetch Data" tool

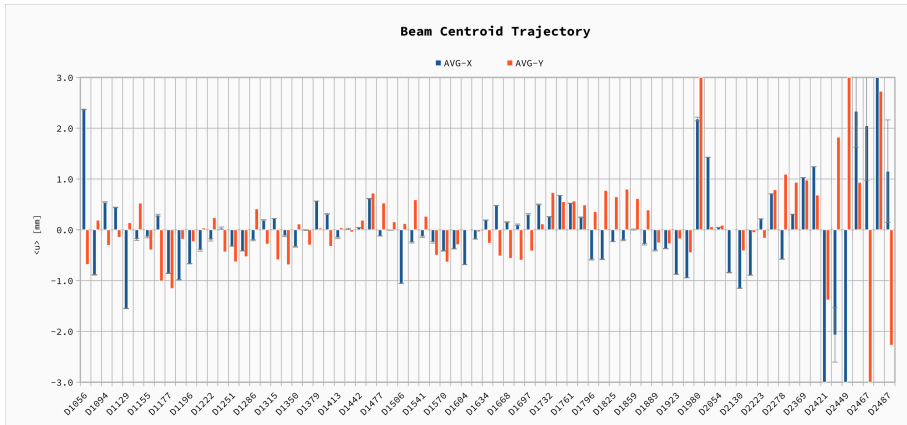
Datetime
Timestamp
LS1_CA01:BPM_D1129:XPOS_RD
LS1_CA01:BPM_D1144:XPOS_RD
LS1_WA01:BPM_D1155:XPOS_RD
LS1_CA02:BPM_D1163:XPOS_RD
LS1_WA02:BPM_D1177:XPOS_RD
LS1_CA02:BPM_D1188:XPOS_RD
LS1_CA03:BPM_D1196:XPOS_RD
LS1_CA03:BPM_D1211:XPOS_RD
LS1_WA03:BPM_D1222:XPOS_RD

Fetch data appears column by column

Datetime	2023-04-20 09:06:09.777469	2023-04-20 09:06:09.977640	2023-04-20 09:06:10.177841	2023-04-20 09:06:10.378029	2023-04-20 09:06:10.578181
Timestamp	1681995969.777470	1681995969.977640	1681995970.177840	1681995970.378030	1681995970.578180
LS1_CA01:BPM_D1129:XPOS_RD	-0.81	-0.81	-0.81	-0.81	-0.81
LS1_CA01:BPM_D1144:XPOS_RD	0.18	0.17	0.17	0.17	0.18
LS1_WA01:BPM_D1155:XPOS_RD	-0.53	-0.53	-0.53	-0.53	-0.53
LS1_CA02:BPM_D1163:XPOS_RD	-0.25	-0.25	-0.25	-0.25	-0.25
LS1_CA02:BPM_D1177:XPOS_RD	-0.72	-0.72	-0.72	-0.72	-0.72
LS1_WA02:BPM_D1188:XPOS_RD	-0.30	-0.30	-0.31	-0.31	-0.30
LS1_CA03:BPM_D1196:XPOS_RD	0.21	0.21	0.21	0.20	0.21
LS1_CA03:BPM_D1211:XPOS_RD	0.49	0.49	0.49	0.49	0.49
LS1_WA03:BPM_D1222:XPOS_RD	-0.08	-0.08	-0.08	-0.08	-0.08

# Data Fetch Tool

Visualization: Insert a Chart for bar plot with errorbars (20 samples for X and Y signals of 76 BPMs)



# Data Fetch Tool

## The dimension of the fetched dataset

Fetch  $m$  samples of  $n$  PVs:

- Arrange PVs in a column  $\rightarrow (n + 1) \times m$
- Arrange PVs in a row  $\rightarrow m \times (n + 1)$  (see below)
- '1' is for the 'Timestamp' row or column

Timestamp	LS1_CA01:BPM_D1129:XPOS_RD	LS1_CA01:BPM_D1144:XPOS_RD	LS1_WA01:BPM_D1155:XPOS_RD	LS1_CA02:BPM_D1163:XPOS_RD	
1681995941.335810	-0.81	0.17	-0.53	-0.25	
1681995941.535930	-0.81	0.17	-0.53	-0.24	
1681995941.736140	-0.81	0.17	-0.53	-0.25	
1681995941.936380	-0.81	0.17	-0.53	-0.25	
1681995942.136600	-0.81	0.18	-0.54	-0.25	

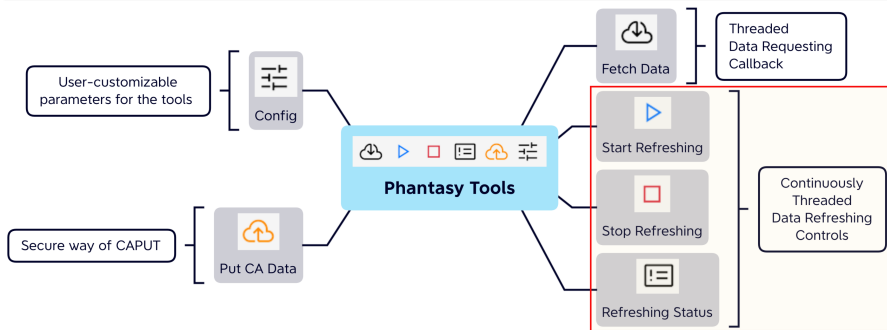
  

LS1_CA02:BPM_D1177:XPOS_RD	LS1_WA02:BPM_D1188:XPOS_RD	LS1_CA03:BPM_D1196:XPOS_RD	LS1_CA03:BPM_D1211:XPOS_RD	LS1_WA03:BPM_D1222:XPOS_RD	
-0.71	-0.30	0.22	0.50	-0.08	
-0.71	-0.30	0.21	0.48	-0.08	
-0.71	-0.31	0.20	0.48	-0.08	
-0.71	-0.30	0.21	0.49	-0.08	
-0.72	-0.30	0.22	0.49	-0.08	

# Threaded Data Refreshing Tools

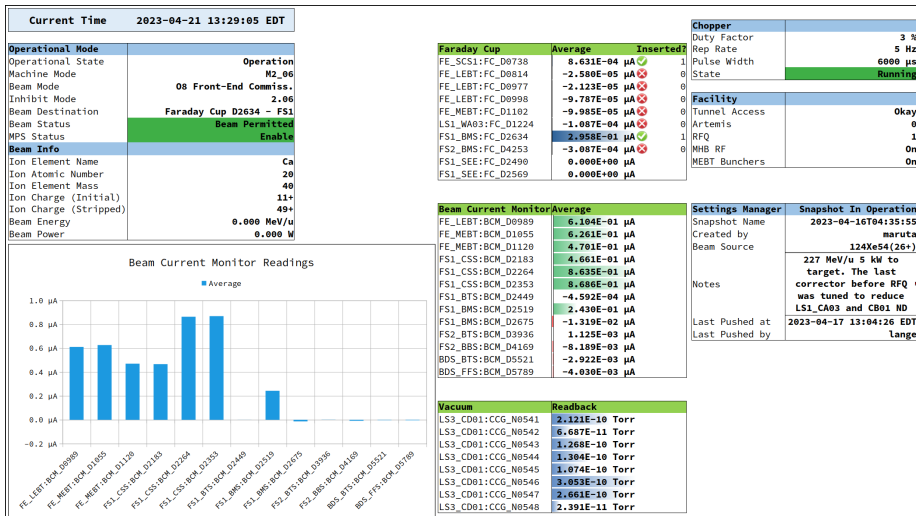
## Usecases

- Update formulae at a defined interval, see **REFRESH\_DATA\_TIME\_INTERVAL**
- All data are timesatamp-aligned
- Start and Stop threads
- Style cells per users' desire
- But NOT for real-time monitoring!

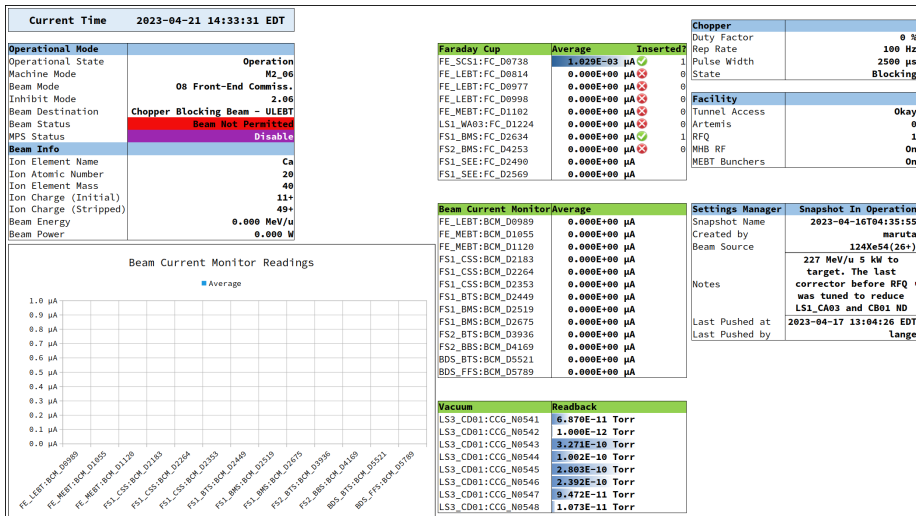




# Dashboard Example

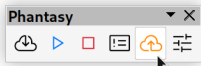


# Dashboard Example



# Put Data Tool: Control Devices from Spreadsheet

PV	New Set	Sentinel	Readback
TST:PV1	1	ON	2
TST:PV2	2	ON	3
TST:PV3	-1	OFF	3

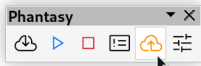


Put Data via Channel Access

- Three columns: “PV”, “Set”, “Sentinel” (ON → Allows put, or skip)
- Select the three columns, and click the “Put Data” tool button
- Restore from the putlogs if needed

# Put Data Tool: Control Devices from Spreadsheet

PV	New Set	Sentinel	Readback
TST:PV1	1	ON	2
TST:PV2	2	ON	3
TST:PV3	-1	OFF	3



Put Data via Channel Access

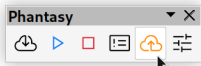
- Three columns: “PV”, “Set”, “Sentinel” (ON → Allows put, or skip)
- Select the three columns, and click the “Put Data” tool button
- Restore from the putlogs if needed

See the putlogs in another sheet as guided:

Time	Message	PV	Last Set	Sentinel
2023-04-20T16:04:05.396	Set TST:PV1 from 2.0 to 1.0	TST:PV1	2	ON
2023-04-20T16:04:05.398	Set TST:PV2 from 3.0 to 2.0	TST:PV2	3	ON
2023-04-20T16:04:05.398	Skip set TST:PV3 to -1.0	TST:PV3		OFF

# Put Data Tool: Control Devices from Spreadsheet

PV	New Set	Sentinel	Readback
TST:PV1	1	ON	2
TST:PV2	2	ON	3
TST:PV3	-1	OFF	3



Put Data via Channel Access

- Three columns: “PV”, “Set”, “Sentinel” (ON → Allows put, or skip)
- Select the three columns, and click the “Put Data” tool button
- Restore from the putlogs if needed

Select the last three columns, do the restore:

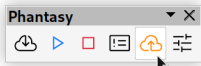
Time	Message	PV	Last Set	Sentinel
2023-04-20T16:04:05.396	Set TST:PV1 from 2.0 to 1.0	TST:PV1	2	ON
2023-04-20T16:04:05.398	Set TST:PV2 from 3.0 to 2.0	TST:PV2	3	ON
2023-04-20T16:04:05.398	Skip set TST:PV3 to -1.0	TST:PV3		OFF



Put Data via Channel Access

# Put Data Tool: Control Devices from Spreadsheet

PV	New Set	Sentinel	Readback
TST:PV1	1	ON	2
TST:PV2	2	ON	3
TST:PV3	-1	OFF	3



Put Data via Channel Access

- Three columns: “PV”, “Set”, “Sentinel” (ON → Allows put, or skip)
- Select the three columns, and click the “Put Data” tool button
- Restore from the putlogs if needed

See the putlog after restore:

Time	Message	PV	Last Set	Sentinel
2023-04-20T16:04:05.396	Set TST:PV1 from 2.0 to 1.0	TST:PV1	2	ON
2023-04-20T16:04:05.398	Set TST:PV2 from 3.0 to 2.0	TST:PV2	3	ON
2023-04-20T16:04:05.398	Skip set TST:PV3 to -1.0	TST:PV3		OFF
2023-04-20T16:05:41.078	Set TST:PV1 from 1.0 to 2.0	TST:PV1	1	ON
2023-04-20T16:05:41.079	Set TST:PV2 from 2.0 to 3.0	TST:PV2	2	ON
2023-04-20T16:05:41.080	Skip set TST:PV3 to	TST:PV3		OFF

# Outline

- 1 Introduction
- 2 Software Implementation
- 3 Features
- 4 Summary

# Summary

- PhantasyCalc is a versatile software solution that streamlines the integration of EPICS data into spreadsheet applications, including LibreOffice Calc, MS Excel.
- The REST API developed by leveraging the existing PHANTASY project enables seamless integration PHANTASY into web applications and beyond, enables more possibilities.
- The formula interface of PhantasyCalc enables users to access complex functionality via user-defined functions (UDFs), offering a powerful and flexible approach.
- With PhantasyCalc's tools and UDFs, one can develop decent data-driven spreadsheet applications with ease.
- However, development effort needs to address:
  - Explore a neat solution to stream EPICS data in the subscribe mode.
  - Explore fully asynchronous IO ways for UDF execution to boost the performance.



Thank you for your attention!



**Facility for Rare Isotope Beams**  
U.S. Department of Energy Office of Science  
Michigan State University