



Manage the Physics Settings on the Modern Accelerator

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U.S. DEPARTMENT OF
ENERGY

Office of
Science

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1 Introduction

- Facility for Rare Isotope Beams
- PHANTASY Project

2 Manage the Data in Controls Network

- Perspective
- Data for Machine Tuning

3 Conclusions

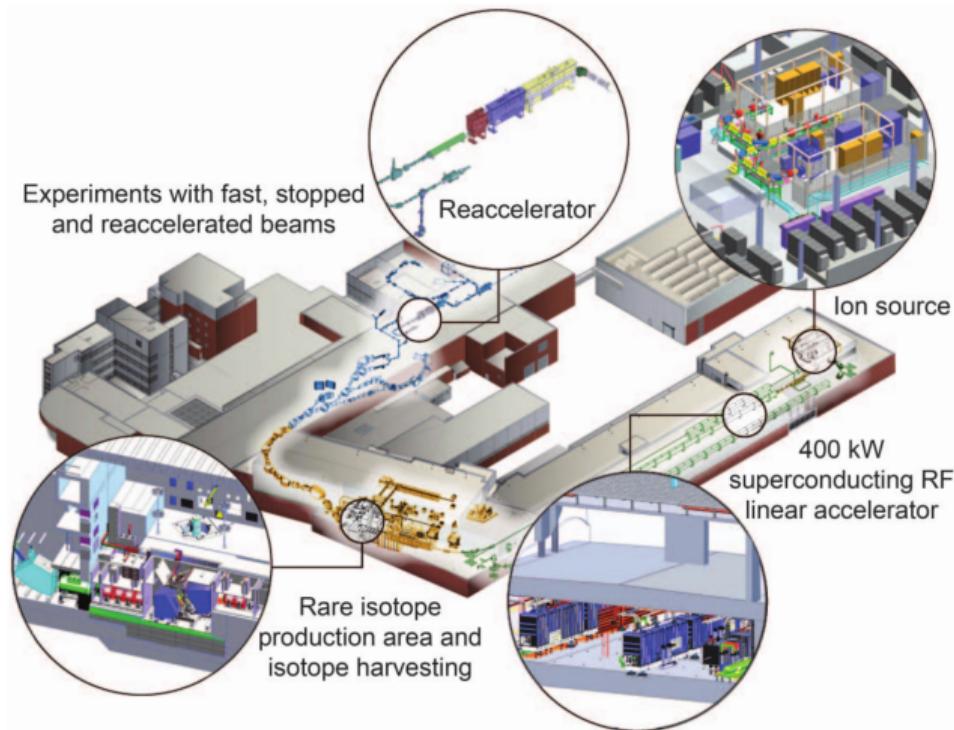
1 Introduction

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2 Manage the Data in Controls Network

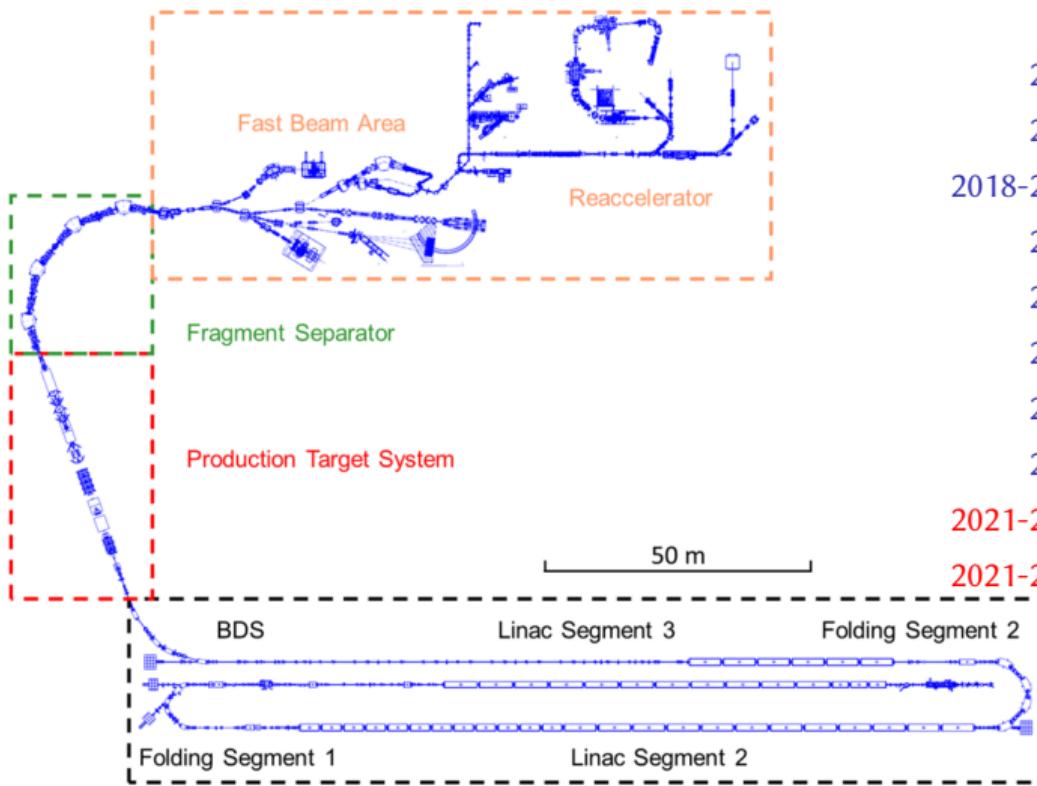
3 Conclusions

Facility for Rare Isotope Beams



▷ T. Glasmacher et al., "Facility for Rare Isotope Beams Update for Nuclear Physics News", Nuclear Physics News, 27 (2017) 2, 28-33.

Facility for Rare Isotope Beams



Accelerator Segments, staged commissioning:

2017 ECR ion source

2017 Front-End (FE), 0.5 MeV/u

2018-2019 Linac Segment 1 (LS1), 20 MeV/u

2020 Folding Segment 1 (FS1)

2020 Linac Segment 2 (LS2), 200 MeV/u

2021 Folding Segment 2 (FS2)

2021 Linac Segment 3 (LS3), > 200 MeV/u

2021 Beam Delivery System (BDS)

2021-2022 Target Systems, rare isotope beams!

2021-2022 Fragment Separator (ARIS)

PHANTASY

Physics High-level Applications aNd Toolkit for Accelerator SYstem
<https://github.com/phantasy-project>

Features Highlight

- Device configuration management: [maintainability](#), [portability](#)
- Device abstraction: [object-oriented](#)
- Online modeling: [physics model-depends machine representation](#)
- Python interactive scripting environment for high-level controls: [development and control](#)
- Virtual accelerator based on EPICS and physics model: [test physics algorithms](#)
- Web service integration (channelfinder, scanserver, archiver appliance, UNICORN ...): [extendability](#)

Deployment

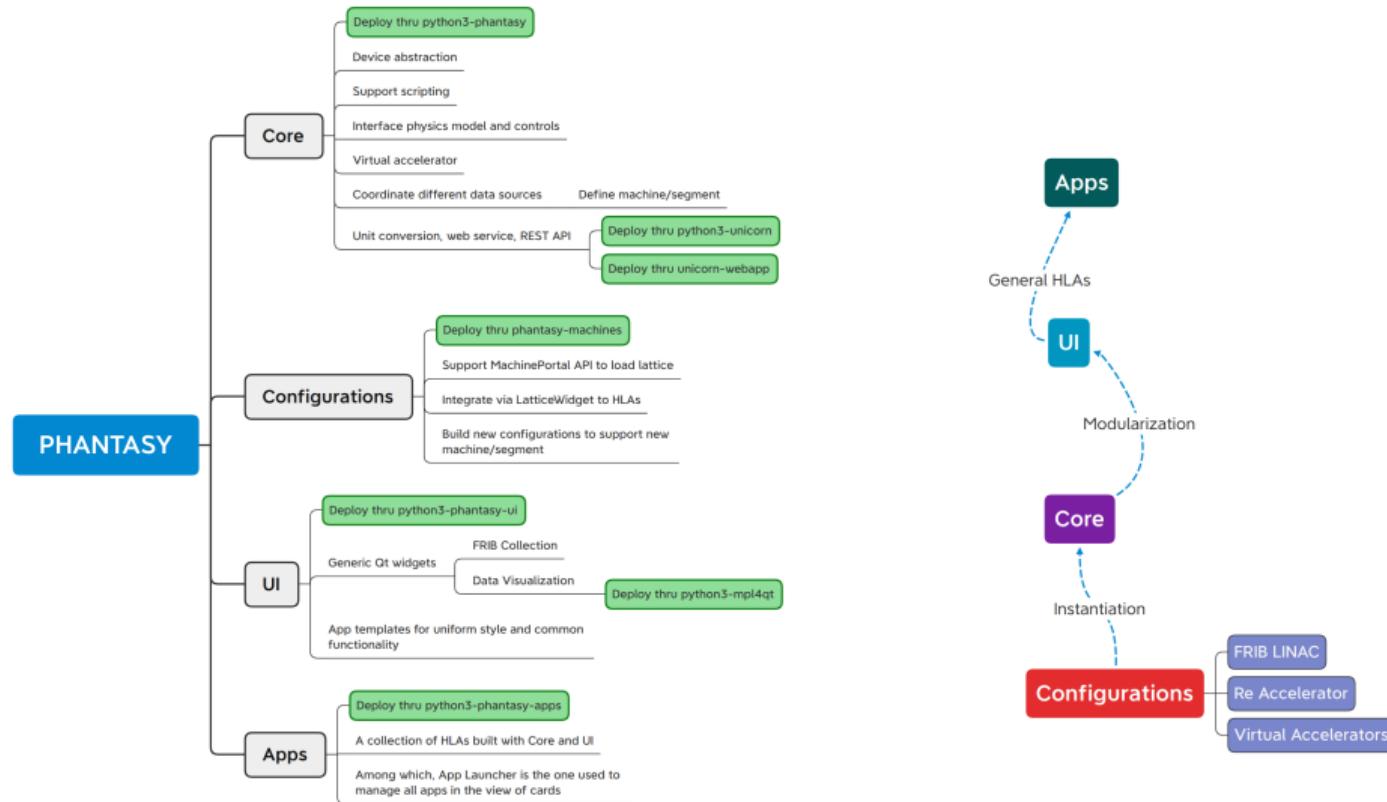
- Target OS: Debian Linux, to support PyPI, conda
- Only support Python 3.x
- Meta package: [phantasy](#) (~20 packages)
- Physics model engines: [FLAME](#)



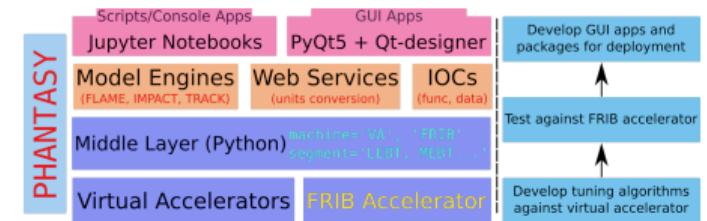
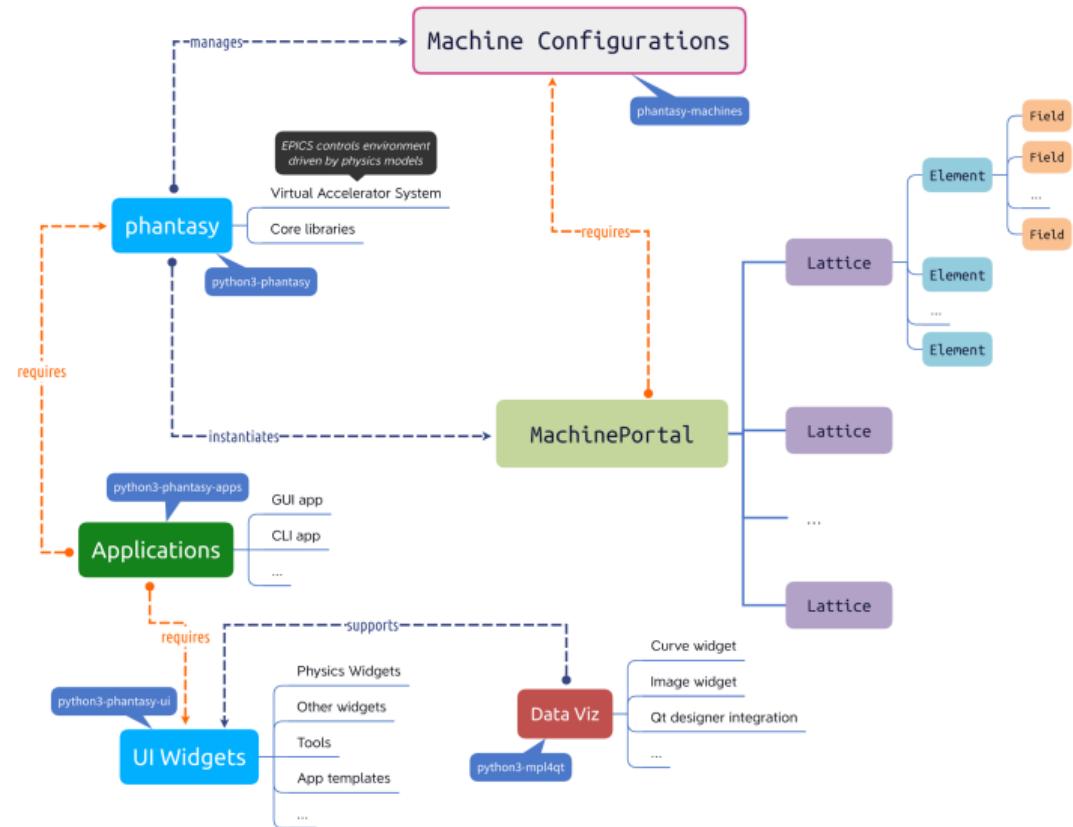
Jenkins



Evolution of PHANTASY Project



Evolution of PHANTASY Project



Code Facts

- Python 3, Debian Linux OS
- PHANTASY (core) ~20k LOC
- UI widgets: ~18k LOC (incl. dataviz, excl. ui)
- Apps: ~40k LOC (excl. ui)

Development Guide

- Device → Python object
- List of devices → Lattice
- Lattice manipulation
- Scripting/GUI apps (facility-agnostic)
- Package → deployment

Global Entry for All the Apps: Present and Manage the Information in A Better Way

The screenshot shows the 'Apps' section of the FRIB App Launcher. At the top, there are 'Home' and 'Apps' navigation buttons. Below that, a 'Apps' section header and three tabs: 'All (28)', 'Favorites (10)', and 'Groups'. The main area displays a grid of application cards. Each card contains the app's name, version, developer status, icon, and a star rating. Some cards also show a brief description. The cards are arranged in two rows. The first row includes: 'Unknown' (version 0.2, ALPHA devel), 'Achromat Tuning' (version 3.5, Achromat Tuning devel), 'Allison Scanner' (version 3.5, Allison Scanner Emittance Measurement), 'Unknown' (version Unknown, BETA devel), and 'BPM Averaging' (version Unknown, BPM Averaging devel). The second row includes: 'Unknown' (version Unknown, BPM Plot devel), 'Correlation Visualizer' (version 6.1, Correlation Visualizer General), 'Device Viewer' (version 3.0, Device Viewer Data Viewer), 'Unknown' (version Unknown, Energy Gain Calculator devel), and 'ISAAC' (version Unknown, ISAAC devel). At the bottom, there is a footer with the Facility for Rare Isotope Beams logo, Michigan State University text, 'App Launcher (v4.2)' with a refresh icon, a search bar, and the date/time '2021-09-15 14:45:35 EDT'.

- Global entrypoint: right-clicking context menu → ‘Physics Apps’
- Managed by a configuration file
- Present each app in one card, click to launch it
- User favored apps as the main page
- Another page for all apps (grouped)
- Support search
- Expanded card for more actions/info: documentation, contact...

1 Introduction

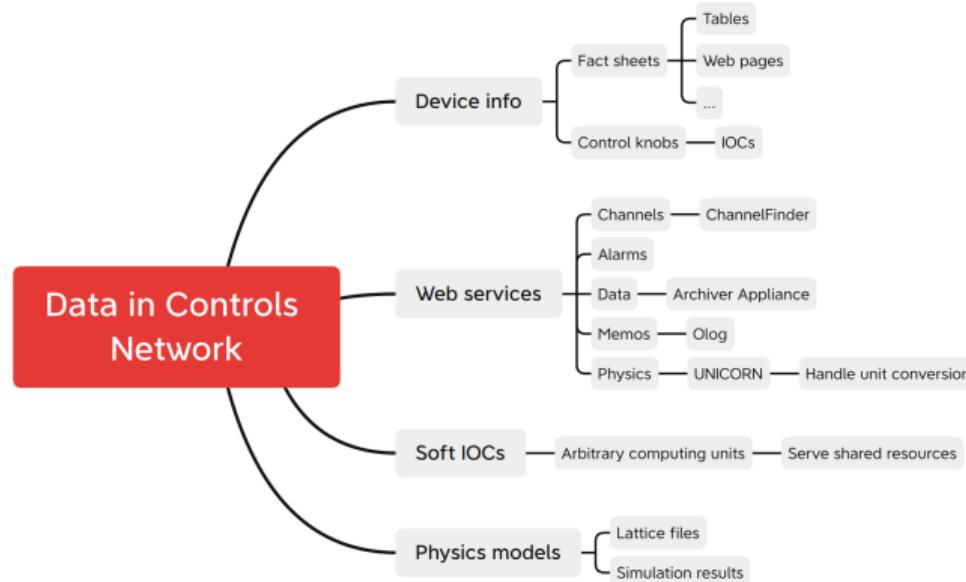
2 Manage the Data in Controls Network

- Perspective
- Data for Machine Tuning

3 Conclusions

Data in the Controls Network

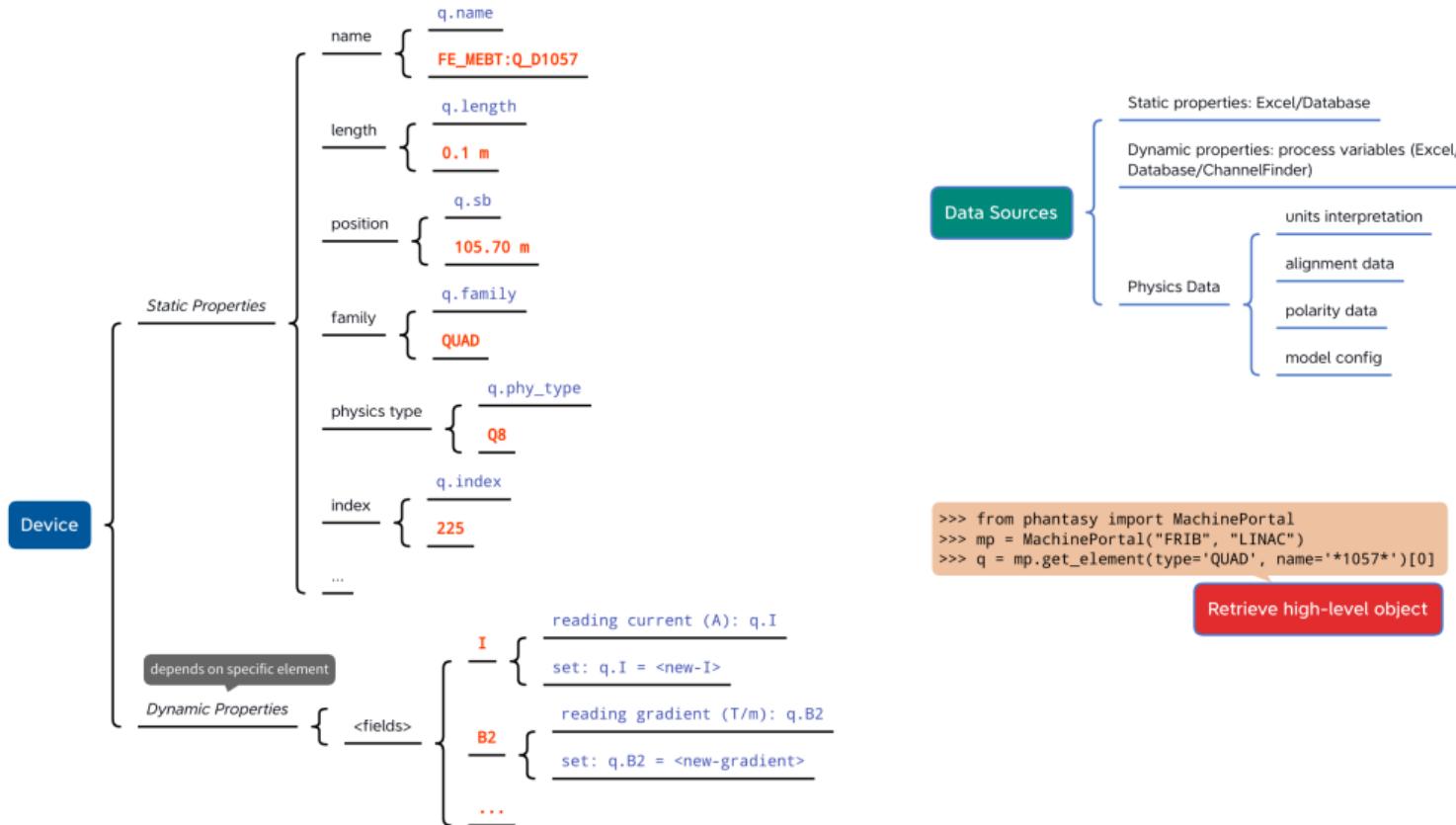
- Device information: static properties → databases/files → handled in phantasy
- Device control knobs: IOCs → distributed → handled in phantasy
- Web services: request/response → distributed → Python client packages
- Soft IOCs: support HLAs → presented as additional attributes in phantasy
- Physics models: simulation, machine tuning → support FLAME



Key Points to Address

- Device information accessibility
- Physics tuning repeatability
- Machine state data integrity

Device Information Accessibility



```
>>> from phantasy import MachinePortal  
>>> mp = MachinePortal("FRIB", "LINAC")  
>>> q = mp.get_element(type='QUAD', name='*1057')[0]
```

Retrieve high-level object

Requirements

- Manage accelerator physics settings segment by segment
- Correlate various kinds of accelerator data in one place
- Quickly model with physics code
- Scaling for working with different ion species
- Features for data accessibility and availability

Design Ideas

- Manage device entities rather than process variables
 - PHANTASY defines each device has multiple controllable ‘fields’
- Manage different data from different sources: live, archived
 - Aggregate data to expressive tables
- One snapshot should have all the information for:
 - Data investigation, visualization
 - Physics modeling

Settings Manager: Manage Physics Settings with Machine State and More

File Tools View Help

Load Lattice Add Devices Take Snapshot Capture Machine State Physics Fields Engineering Fields Preferences Exit

Working Directory /files/shared/app/settings_manager

NOTAG (172) golden (5) merged (3) LS3-phasing (2) to-scale (1) scaled (2) LEBT_MEBT (1) TO_BDS (5) LEBT_F52 (2) DIAG (1)

LS1-phasing (70) LEBT_F5B (1) LEBT (2) LS2-phasing (13)

Select Tags: None All

Filter between 2021-05-14 and 2021-05-14 ... Filter Note

Timestamp Ion Z A Q User Tags Note

- 2021-05-14 Friday

2021-05-14T17:02:51 Xe 54 124 26 zhangt Input note ...

- 2021-05-13 Thursday

2021-05-13T23:08:48 Xe 54 124 26 maruta TO BDS Twiss matching to L51 and trajectory in L51 are tuned, Load 22:11:11 setting and then o...

Snapshots

A A ↔ Check All Invert Checkstate

Device Field Type Pos [m] Setpoint(x₀) Live Readback(x₀) Live Setpoint(x₂) Δ(x₀,x₂) Δ(x₁,x₂) x₂/x₀ Power

Device	Field	Type	Pos [m]	Setpoint(x ₀)	Live Readback(x ₀)	Live Setpoint(x ₂)	Δ(x ₀ ,x ₂)	Δ(x ₁ ,x ₂)	x ₂ /x ₀	Power
FE_ISRC1:BEAM	A	ION	0.0000	124.000	124.000	0.000	0.000	0.000	1.000	1.000
FE_ISRC1:BEAM	Q	ION	0.0000	26.000	26.000	26.000	0.000	0.000	1.000	1.000
FE_ISRC1:BEAM	Z	ION	0.0000	54.000	54.000	54.000	0.000	0.000	1.000	1.000
FE_ISRC1:HVP_D0679	V	HVP	67.9000	15000.000	14978.819	15000.000	0.000 ▲	-21.181	1.000	1.000
FE_ISRC1:PSEL_D0679	V	SEL	67.9000	0.000	0.000	0.000	0.000	0.000	inf	1.000
FE_ISRC1:PSX_D0679	V	SX	67.9000	0.000	0.000	0.000	0.000	0.000	inf	1.000
FE_ISRC1:PSB_D0679	V	SB	67.9000	-200.000	-200.000	-200.000	0.000	0.000	1.000	1.000
FE_ISRC1:SOLR_D0682	I	SOL	68.2000	518.000	517.836	518.000	0.000 ▲	-0.164	1.000	1.000
FE_ISRC1:SOLR_D0685	I	SOL	68.5000	513.000	512.910	513.000	0.000	-0.090	1.000	1.000
FE_ISRC1:PSE_D0686	V	SE	68.6000	-2000.000	-2000.978	-2000.000	0.000 ▲	-0.978	1.000	1.000
FE_ISRC1:DRV_D0686:POS	POS	PV	68.6000	0.000	39.897	0.000	0.000 ▲	39.897	inf	1.000
FE_ISRC1:SOLR_D0690	I	SOL	69.0000	93.626	93.550	93.626	-0.000	-0.076	1.000	1.000
FE_ISRC1:DCH_D0695	I	HCOR	69.4794	-0.000	0.000	-0.000	0.000	0.000	inf	1.000
FE_ISRC1:DCV_D0695	I	VCOR	69.4794	0.000	0.000	0.000	-0.000	-0.000	inf	1.000
FE_ISRC1:PSEL_D0698	V	SEL	69.8000	-2000.000	-2000.000	-2000.000	0.000	-0.000	1.000	1.000
FE_ISRC1:HVP_D0698	V	HVP	69.8000	42286.000	42291.300	42286.000	0.000 ▲	5.300	1.000	1.000
FE_SCS1:SOILR_D0784	I	SOL	70.2078	0.000	0.009	0.000	0.000	0.009	inf	1.000
FE_SCS1:DCH_00709	I	HCOR	70.9469	-0.306	-0.306	-0.306	0.000	0.000	1.001	1.000
FE_SCS1:DCV_00709	I	VCOR	70.9469	-2.143	-2.149	-2.143	0.000	-0.006	1.000	1.000
FE_SCS1:DCH_00717	I	BEND	71.1819	77.897	77.953	77.897	0.000	0.056	1.000	1.000
FE_SCS1:DCH_00723	I	HCOR	72.3442	-0.797	-0.801	-0.797	-0.000	-0.004	0.999	1.000
FE_SCS1:DCV_00723	I	VCOR	72.3442	0.560	0.564	0.560	-0.000	0.004	1.000	1.000
FE_SCS1:QHE_00726	V	EQUAD	72.5293	3290.610	3290.603	3290.610	-0.000	-0.007	1.000	1.000
FE_EEL1:QHE_00730	I	EDUAD	73.0645	3000.000	3000.000	3000.000	0.000	0.000	1.000	1.000

Loaded Lattice FRIB LINAC

Update Rate 1.0 Hz Refresh Data Apply x 1

Auto Precision number 3 Initialize with loaded lattice

2021-05-14 17:04:00 EDT

Settings Manager (v8.0) -

- Pull device info and live state, refer to phantasy project
- ‘Take Snapshot’: fetch machine state or not
- Fetched machine state presented as a new table along with the physics settings
- Both are stored in one new database record
- Users can export it to various file formats: XLSX, CSV, HDF5, etc.
- Filter buttons for snapshot records and physics settings
- Integration for Archiver Appliance through pyarchapp!

Settings Manager: Manage Physics Settings with Machine State and More

Snapshots

Working Directory /files/shared/ap/settings_manager

NOTAG (230) LEBT_FS2 (2) to-scale (1) merged (3) LSI-phasing (70) phasing (16) DIAG (1) ARIS (1) test (0) LEBT_FS1B (2) golden (6) TO_BDS (6) scaled (2) LS2-phasing (13) LEBT (2) LS3-phasing (2) LEBT_MEBT (1)

Select Tags: None All

Filter between 2021-09-15 and 2021-09-15 ... Filter Note

Total 358

Timestamp	Ion	Z	A	Q	User	Tags	Note
2021-09-15 Wednesday							
2021-09-15T16:37:36	Xe	54	129	35	zhangt	ARIS,test	Snapshot template for ARIS/F1 devices.
- 2021-08-18 Wednesday	Kr	36	78	17	maruta		78Kr17+, stiff mode optics calculated from previous 40Ar9+
- 2021-08-17 Tuesday	Kr	36	78	17	maruta		Input note ...
2021-08-17T14:14:41	Kr	36	78	17	maruta		78Kr17+, 25 euA, only U-LEBT, trajectory tuned, QE_D0770 and D0776 are wrong setting
- 2021-08-12 Thursday							
2021-08-12T21:04:41	Kr	36	78	17	maruta		78Kr17+, Front-end, DCHV_D0948, D0964, D0979 and D0992 are tuned to get same MEBT BPM pos
2021-08-12T20:44:22	Kr	36	78	17	maruta		78Kr17+, Front-end, DCHV_D0964, D0979 and D0992 are tuned to get same MEBT BPM pos and ...
2021-08-12T20:21:46	Kr	36	78	17	maruta		78Kr17+, Front-end, DCHV_D0769 and D0723 are tuned to get same MEBT BPM pos and phase a...
2021-08-12T16:47:41	Kr	36	78	17	maruta		78Kr17+, Front-end, 27euA@LEBT, 23euA@MEBT, snapshot with setting at 2021-08-10 22:20:20
- 2021-08-11 Wednesday							
2021-08-11T16:51:16	Kr	36	78	17	maruta		78Kr17+, Front-end, snapshot with setting at 2021-08-10 22:20:20
2021-08-11T16:33:29	Kr	36	78	17	maruta		78Kr17+, Front-end, snapshot with setting at 2021-08-10 22:20:20 but HVP_D0698 is differ...
- 2021-08-10 Tuesday							
2021-08-10T22:31:07	Kr	36	78	17	maruta		Input note ...
2021-08-10T22:20:20	Kr	36	78	17	maruta	golden	78Kr17+, Front-end, 22 euA@U-LEBT, 18.7 euA@MEBT, L-LEBT trajectory was tuned by a pyth...
2021-08-10T21:59:48	Kr	36	78	17	maruta		78Kr17+, Front-end, 22 euA@U-LEBT, 18 euA@MEBT
2021-08-10T19:49:58	Kr	36	78	17	maruta		Input note ...
2021-08-10T19:06:20	Kr	36	78	17	maruta		78Kr17+, 22 euA, tmp
2021-08-10T18:51:33	Kr	36	78	17	maruta		78Kr17+, 22 euA. After loading scaled setting of 86Kr17+ at 2021-07-14

Snapshots

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Click to view one captured snapshot in xlsx



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

Settings Manager: Manage Physics Settings with Machine State and More

File Tools View Help

Load Lattice Add Devices Take Snapshot Capture Machine State Physics Fields Engineering Fields Preferences Exit

Working Directory /files/shared/ap/settings_manager

NOTAG (230) LEBT_F52 (2) scaled (2) golden (6) LS2-phasing (13) LS1-phasing (70) phasing (16) LEBT_MEBT (1) test (0) to-scale (1) 129 Xe 54 Ar 35+
ARIS (1) merged (3) DIAG (1) LEBT_F51B (2) LEBT (2) TO_BDS (6) LS3-phasing (2)

Select Tags: None All

Filter between 2021-09-15 and 2021-09-15 Filter Note

Snapshots

Timestamp	Ion	Z	A	Q	User	Tags	Note
2021-09-15T16:17:36	I	Ar	36	17	zhangt	ARIS, test	Snapshot template for ARIS/F1 devices.
2021-08-18 16:17:36	I	Ar	36	17	maruta		78Kr17+, stiff mode optics calculated from previous 40Ar9+
2021-08-17 16:17:36	I	Ar	36	17			

A A ↔ Check All Invert Checkstate

Device Field Type Pos [m] Setpoint(x0) Live Readback(x1) Live Setpoint(x2) Δ(x0,x2) Δ(x1,x2) Δ(x0,x2) x2/x0 Power

FE_ISRC1:BEAM	A	ION	0.0000	129.000	129.000	0.000	0.000	1.000	0.000
FE_ISRC1:BEAM	Q	ION	0.0000	35.000	35.000	0.000	0.000	1.000	0.000
FE_ISRC1:BEAM	Z	ION	0.0000	54.000	54.000	0.000	0.000	0.000	0.000
FS_F51:Q_D1013	I	QUAD	0.9882	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:Q_D1024	I	QUAD	1.9768	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:OCT_D1024	I	OCT	2.3750	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:S_D1024	I	SEXT	2.3750	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:Q_D1035	I	QUAD	3.8760	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:OCT_D1035	I	OCT	3.4750	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:S_D1035	I	SEXT	3.4750	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:DV_D1064	I	BEND	5.4000	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:DV_D1108	I	BEND	9.7704	0.000	0.000	0.000	0.000	inf	0.000
FS_F51:Q_D1137	I	QUAD	13.2533	0.000	-0.012	0.000	0.000	-0.012 inf	0.000
FS_F51:OCT_D1137	I	OCT	13.6638	0.000	-0.000	0.000	0.000	-0.000 inf	0.000
FS_F51:S_D1137	I	SEXT	13.6638	0.000	0.003	0.000	0.000	0.003 inf	0.000
FS_F51:Q_D1148	I	QUAD	14.3410	3.000	-0.015	3.000	0.000	▲ -3.015 1.000	0.000
FS_F51:OCT_D1148	I	OCT	14.7515	3.003	-0.000	3.000	0.003	▲ -3.008 0.999	0.000
FS_F51:S_D1148	I	SEXT	14.7515	2.999	0.000	3.000	-0.001	▲ -2.992 1.000	0.000
FS_F51:Q_D1170	I	QUAD	16.6283	3.000	0.011	3.000	0.000	▲ -2.989 1.000	0.000
FS_F51:OCT_D1170	I	OCT	17.0388	3.003	-0.001	3.000	0.003	▲ -3.001 0.999	0.000
FS_F51:S_D1170	I	SEXT	17.0388	2.999	-0.031	3.000	-0.001	▲ -3.031 1.000	0.000
FS_F52:Q_D1195	I	QUAD	19.1764	0.000	0.000	0.000	0.000	0.000 inf	0.000
FS_F52:OCT_D1195	I	OCT	19.5293	0.000	0.000	0.000	0.000	0.000 inf	0.000
FS_F52:S_D1195	I	SEXT	19.5293	0.000	0.000	0.000	0.000	0.000 inf*	0.000

Loaded Lattice ARIS F1

Update Rate 1.0 Hz Refresh Data Apply

Auto Precision number 3 Initialize with loaded lattice

2021-09-15 17:14:05 EDT

Settings Manager (v8.0)

- Pull device info and live state, refer to phantasy project
- ‘Take Snapshot’: fetch machine state or not
- Fetched machine state presented as a new table along with the physics settings
- Both are stored in one new database record
- Users can export it to various file formats: XLSX, CSV, HDF5, etc.
- Filter buttons for snapshot records and physics settings
- Integration for Archiver Appliance through pyarchappl



Settings Manager: Manage Physics Settings with Machine State and More

```
tong ~ ➤ pyarchappl-get -h
usage: pyarchappl-get [-h] [--url URL] [-pv PV_LIST] [--pv-file PV_FILE]
                      [--from FROM_TIME] [--to TO_TIME] [--resample RESAMPLE]
                      [--verbose] [-o OUTPUT] [-f FMT]
                      [--format-args FMT_ARGS]

Retrieve data from Archiver Appliance and export as a file.

optional arguments:
  -h, --help            show this help message and exit
  --url URL            URL of Archiver Appliance, default is FRIB FTC
  --pv PV_LIST          List of PVs for retrieval, each define with --pv
                       (default: None)
  --pv-file PV_FILE    A file for PVs, one PV per line (skip line starts with
                       #), append each to pv_list (default: None)
  --from FROM_TIME     A string of begin time in ISO8601 format (default:
                       None)
  --to TO_TIME          A string of end time in ISO8601 format (default: None)
  --resample RESAMPLE  The offset string/object representing target
                       conversion, e.g. '1S' for resample with 1 second
                       (default: None)
  --verbose, -v         Verbosity level of the log output, 0: no output,
                       1(-v): output progress, 2(-vv): output progress with
                       description (default: 0)
  -o OUTPUT, --output OUTPUT
                       File path for output data, print to stdout if not
                       defined (default: None)
  -f FMT, --output-format FMT
                       File format for output data, supported: csv, hdf,
                       excel, html, ... (default: csv)
  --format-args FMT_ARGS
                       Additional arguments passed to data export function in
                       the form of dict, e.g. '{"key": "data"}' (for hdf
                       format) (default: {})

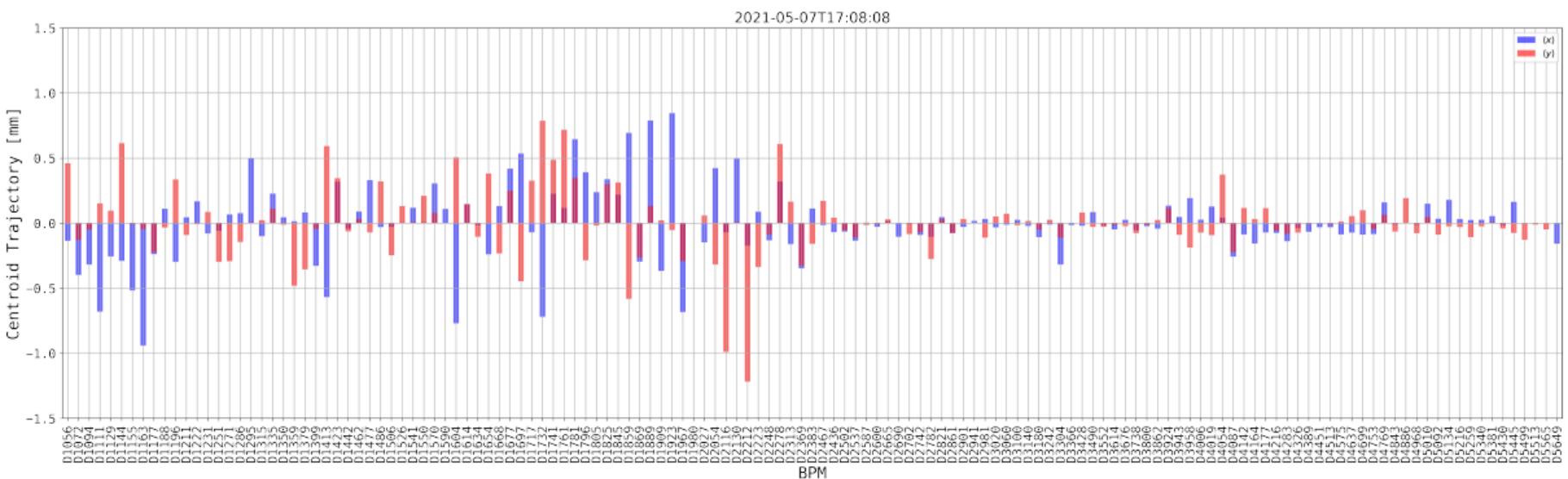
Examples:
# Retrieve raw PV data in the defined time frame
$ pyarchappl-get -o data.csv -v \
  --pv LS1_CAO1:BPM_D1129:XPOS_RD --pv LS1_CAO1:BPM_D1129:YPOS_RD \
  --from 2021-04-15T20:10:00.000Z --to 2021-04-15T21:25:00.000Z \
  --resample 1S

# Align the timestamps, resample at 1 second
$ pyarchappl-get -o data.csv -v \
  --pv LS1_CAO1:BPM_D1129:XPOS_RD --pv LS1_CAO1:BPM_D1129:YPOS_RD \
  --from 2021-04-15T20:10:00.000Z --to 2021-04-15T21:25:00.000Z \
  --resample 1S
```

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- Filter buttons for snapshot records and physics settings
- Integration for Archiver Appliance through **pyarchappl**



Settings Manager: An Example of Machine State Data (BPM group)



Settings Manager: Pre-generate Settings from Physics Model for Commissioning

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	Y
-4	L52_Transport	#1	19.0	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
-5	L52_CCB8	#1	20.31	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
6		#2	20.52	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
7		#3	20.53	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
8		#4	21.05	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
9		#5	21.16	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
10		#6	21.58	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
11	L52_CCB9	#1	22.32	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
12		#2	22.33	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
13		#3	23.11	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
14		#4	23.47	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
15		#5	24.23	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
16		#6	24.24	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
17	L52_CCB9	#1	25.30	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
18		#2	25.31	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
19		#3	26.35	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
20		#4	27.77	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
21		#5	27.78	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
22		#6	28.10	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
23	L52_CCH4	#1	28.90	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
24		#2	29.30	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
25		#3	29.31	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
26		#4	30.71	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
27		#5	31.32	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
28		#6	31.93	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
29	L52_CCB5	#1	32.42	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
30		#2	33.03	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
31		#3	33.36	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
32		#4	34.36	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
33		#5	34.38	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
34		#6	35.30	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
35	L52_CCB6	#1	36.12	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
36		#2	36.73	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
37		#3	37.36	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
38		#4	37.48	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80
39		#5	38.80	73.61	104.74	77.70	78.46	97.48	71.83	86.82	91.27	69.97	81.36	83.02	37.98	41.64	45.92	50.16	54.29	44.45	48.81	36.80

From Physics Model

Significantly saved effort to set the optics during cavity tuning to maintain beam envelope

Check device to apply the settings, w/ scaling factor if needed

The screenshot shows the 'Settings Manager: Manage Physics Configurations of Accelerator System' window. On the left, there's a table titled 'L52_FEA_14_250' with columns for Type, Pos [m], Setpoint(x), Live Readback(x), and various tolerance values. On the right, a 'Load Settings File' dialog box is open, showing the path 'Loaded data from /files/shared/api/settings_support_cavity_tuning/L52/173-Full acceleration-0-250.569.csf'. At the bottom, there are buttons for OK and Cancel.

Type	Pos [m]	Setpoint(x)	Live Readback(x)	Δ(x ₀ ,x ₁)	Δ(x ₀ ,x ₂)	Δ(x ₁ ,x ₂)	Tolerance
QUAD	105.6954	68.588	68.588	0.000	68.588	0.000	▲ -68.588 0.150
QUAD	105.8954	76.076	76.076	0.000	76.076	0.000	▲ -76.076 0.150
FE_MBT	D10862	I	I	73.699	73.699	0.000	▲ -73.699 0.150
FE_MBT	D10784	I	I	57.186	57.186	0.000	▲ -57.186 0.150
FE_MBT	D10766	I	I	57.186	57.186	0.000	▲ -57.186 0.150
FE_MBT	D10787	I	I	57.186	57.186	0.000	▲ -57.186 0.150
FE_MBT	D10788	I	I	66.364	66.364	0.000	▲ -66.364 0.150
FE_MBT	D10789	I	I	64.673	64.673	0.000	▲ -64.673 0.150
FE_MBT	D10985	I	I	66.283	66.283	0.000	▲ -66.283 0.150
FE_MBT	D10988	I	I	59.912	59.912	0.000	▲ -59.912 0.150
FE_MBT	D11113	I	I	59.224	59.224	0.000	▲ -59.224 0.150
FE_MBT	D11117	I	I	42.166	42.166	0.000	▲ -42.166 0.150
L51_CAO01	L1.01132	I	I	30.265	20.211	▲ -9.994 0.150	
L51_CAO01	L1.01146	I	I	33.316	23.320	▲ -9.996 0.150	
L51_CAO01	L1.01165	I	I	36.395	26.398	▲ -9.997 0.150	
L51_CAO01	L1.01180	I	I	39.389	29.393	▲ -9.996 0.150	
L51_CAO01	L1.01199	I	I	32.245	22.253	▲ -9.992 0.150	
L51_CAO01	L1.01214	I	I	33.961	23.968	▲ -9.993 0.150	
L51_CBO01	L1.01235	I	I	20.695	16.785	▲ -9.998 0.150	
L51_CBO01	L1.01255	I	I	28.324	18.329	▲ -9.995 0.150	
L51_CBO01	L1.01275	I	I	32.460	22.487	▲ -9.993 0.150	
L51_CBO02	L1.01299	I	I	33.139	23.147	▲ -9.992 0.150	
L51_CBO02	L1.01319	I	I	34.222	24.227	▲ -9.995 0.150	
L51_CBO02	L1.01339	I	I	38.390	28.396	▲ -9.994 0.150	
L51_CBO02	L1.01363	I	I	40.445	30.447	▲ -9.998 0.150	
L51_CBO02	L1.01383	I	I	38.894	28.894	▲ -10.000 0.150	
L51_CBO02	L1.01403	I	I	43.699	33.704	▲ -9.995 0.150	
L51_CBO04	L1.01426	I	I	43.297	33.301	▲ -9.996 0.150	
L51_CBO04	L1.01446	I	I	42.285	32.295	▲ -9.998 0.150	
L51_CBO04	L1.01466	I	I	46.779	36.785	▲ -9.994 0.150	
L51_COB01	L1.01490	I	I	46.749	36.754	▲ -9.995 0.150	
L51_COB05	L1.01510	I	I	41.867	31.812	▲ -9.995 0.150	
L51_CBO05	L1.01530	I	I	47.989	37.994	▲ -9.995 0.150	
L51_CBO06	L1.01554	I	I	47.462	37.474	▲ -9.988 0.150	
L51_CBO06	L1.01574	I	I	46.877	36.880	▲ -9.997 0.150	

Update Rate: 0.1 Hz Apply: 1.0

Loaded Lattice: FRIB_STRIPPER_FS2A Total Elements: 131 Setpoint PVs: 129 Readback PVs: 129

Loaded data from /files/shared/api/settings_support_cavity_tuning/L52/173-Full acceleration-0-250.569.csf

2020-03-16 10:59:34 EDT

Convert xlsx sheet settings as files/database records for

Settings Manager to load

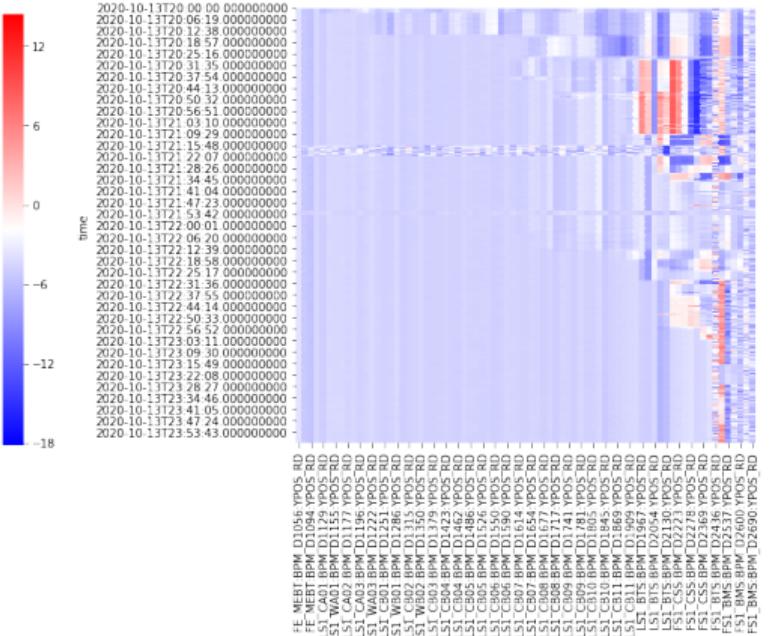
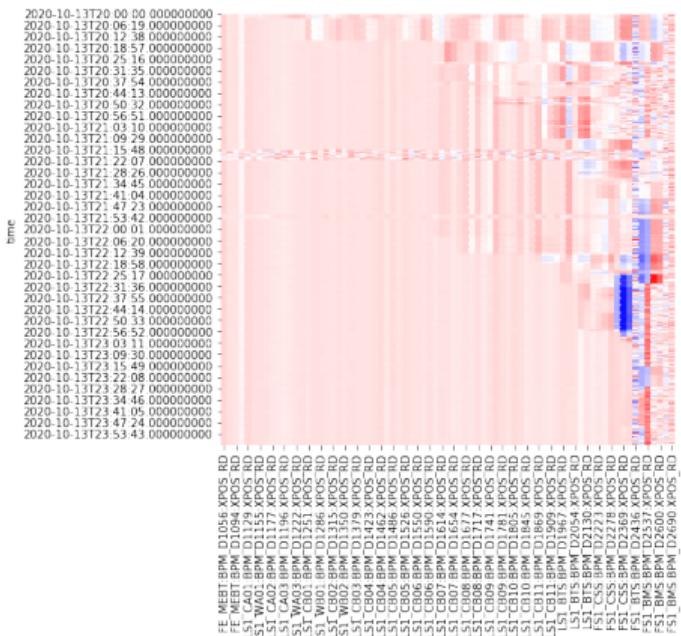
Retrieve Archived Data: Machine State and Physics Settings

```
pvlist.txt buffers
1 # a column of 150 PVs
2 # each row for one PV
3 # line starts with # is bypassed
4 VA:LS1_CA01:BPM_D1129:X_RD
5 VA:LS1_CA01:BPM_D1129:Y_RD
6 VA:LS1_CA01:BPM_D1144:X_RD
7 VA:LS1_CA01:BPM_D1144:Y_RD
8 VA:LS1_WA01:BPM_D1155:X_RD
9 VA:LS1_WA01:BPM_D1155:Y_RD
10 VA:LS1_CA02:BPM_D1163:X_RD
11 VA:LS1_CA02:BPM_D1163:Y_RD
12 VA:LS1_CA02:BPM_D1177:X_RD
13 VA:LS1_CA02:BPM_D1177:Y_RD
14 VA:LS1_WA02:BPM_D1188:X_RD
15 VA:LS1_WA02:BPM_D1188:Y_RD
16 VA:LS1_CA03:BPM_D1196:X_RD
17 VA:LS1_CA03:BPM_D1196:Y_RD
18 VA:LS1_CA03:BPM_D1211:X_RD
19 VA:LS1_CA03:BPM_D1211:Y_RD
20 VA:LS1_WA03:BPM_D1222:X_RD
21 VA:LS1_WA03:BPM_D1222:Y_RD
22 VA:LS1_CB01:BPM_D1231:X_RD
23 VA:LS1_CB01:BPM_D1231:Y_RD
24 VA:LS1_CB01:BPM_D1251:X_RD
25 VA:LS1_CB01:BPM_D1251:Y_RD
26 VA:LS1_CB01:BPM_D1271:X_RD
27 VA:LS1_CB01:BPM_D1271:Y_RD
28 VA:LS1_WB01:BPM_D1286:X_RD
29 VA:LS1_WB01:BPM_D1286:Y_RD
30 VA:LS1_CB02:BPM_D1295:X_RD
31 VA:LS1_CB02:BPM_D1295:Y_RD
32 VA:LS1_CB02:BPM_D1315:X_RD
33 VA:LS1_CB02:BPM_D1315:Y_RD
34 VA:LS1_CB02:BPM_D1335:X_RD
35 VA:LS1_CB02:BPM_D1335:Y_RD
36 VA:LS1_WB02:BPM_D1350:X_RD
37 VA:LS1_WB02:BPM_D1350:Y_RD
38 VA:LS1_CB03:BPM_D1359:X_RD
39 VA:LS1_CB03:BPM_D1359:Y_RD
40 VA:LS1_CB03:BPM_D1379:X_RD
```

```
run.sh buffers
3 # CAUTION: run the following script after removing all the trailing comments!
4 # here is to explain the command
5 pyarchappl-get -vv \
6   --pv-file pvlist.txt \
7   --from 2021-04-15T20:10:00.000Z \
8   --to 2021-04-15T17:25:00.00-04:00 \
9   \                                         # usually use the same timezone, i.e.
10  \                                         # 2021-04-15T21:25:00.000Z
11  --url http://127.0.0.1:17665 \
12  --resample 1S \
13  --output data.h5 \
14  --output-format hdf \
15  --format-args '{"key":"Trajectory"}' # required for 'hdf' format
```

```
tong ➤ ⚡ master ➤ ... > main > scripts > examples ➤ pyarchapp1-get -vv \
--pv-file pvlist.txt \
--from 2021-04-15T20:10:00.000Z \
--to 2021-04-15T17:25:00.00-04:00 \
--url http://127.0.0.1:17665 \
--resample 1S \
--output data.h5 \
--output-format hdf \
--format-args '{"key": "Trajectory"}'
Fetched VA:FS1_BMS:BPM_D2702:Y_RD: 100%|██████████| 150/150 [00:13<00:00, 11.28it/s]
[2021-04-20T17:01:33.889305] Fetched all, time cost: 14.8 seconds.
tong ➤ ⚡ master ➤ ... > main > scripts > examples ➤ pyarchapp1-get -vv --pv-file pvlist.txt \
--from 2021-04-15T20:10:00.000Z --to 2021-04-15T17:25:00.00-04:00 --url http://127.0.0.1:17665 \
--resample 1S --output data.csv
Fetched VA:LS1_CB07:BPM_D1634:X_RD: 46%|██████████| 69/150 [00:03<00:03, 22.37it/s]
```

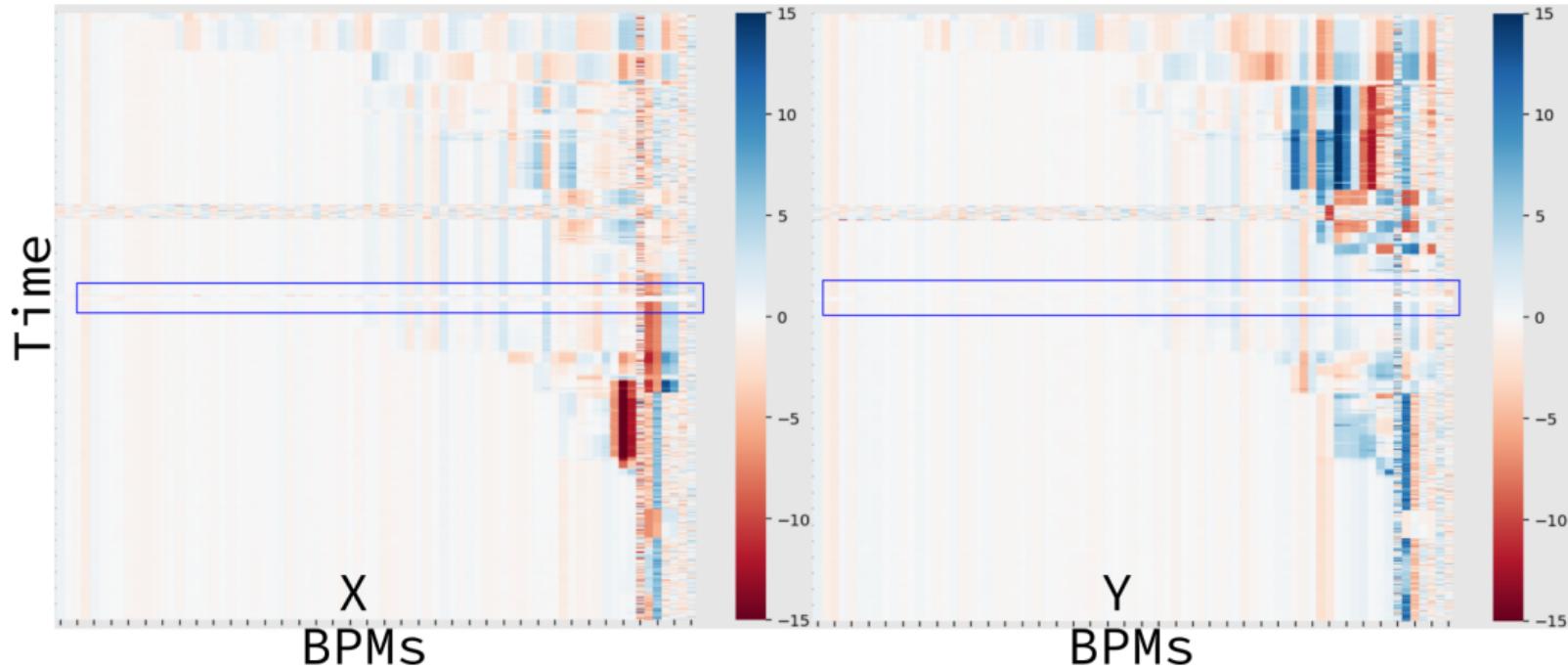
Retrieve Archived Data: Machine State and Physics Settings



A vertical color bar representing the parameter α . The scale ranges from -10 at the top (red) to -1 at the bottom (blue), with intermediate values -8, -6, -4, -2, and -0 marked along the axis.

▷ pyarchapp1 project, “Pull, Visualize and Play the data from Archiver Appliance”

Retrieve Archived Data: Machine State and Physics Settings



1 Introduction

2 Manage the Data in Controls Network

3 Conclusions

- Overviewed the status of Python-based software framework “phantasy” project for the high-level physics controls for FRIB LINAC
- Overviewed the different data categories in the controls network
- Proposed and developed software for the data management for machine tuning
- Overviewed the developed tools for machine state data management

Thank you for your attention!