Microservices for ITk Pixel Systemtests Status Report

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ATLAS ITk Week
TDAQ-ITk Session
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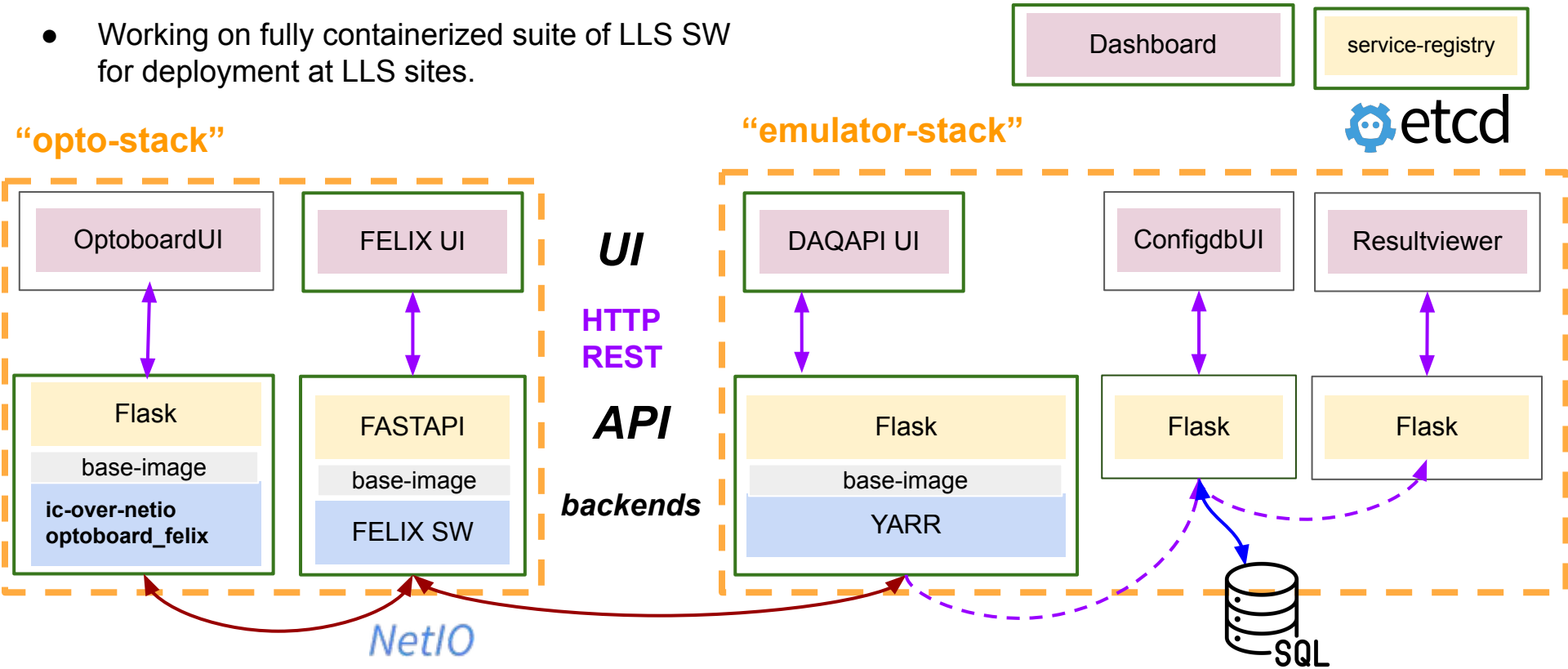
Containerized SR1 Deployment in Progress

- Working on fully containerized suite of LLS SW for deployment at LLS sites.



Standard Base Images

- Provide thin Docker wrapper around backends.
  - Image w. preinstalled base SW (Dockerfile: install script).
- SW installation or version upgrade becomes simple redeploy of container.
- Unified “user interface” with similar features for fast onboarding.
- Features:
  - Preconfigured minimal **`compose.yaml`** example ready to run
    - no need to check out repo to use container!
  - s6 init system
    - run scripts at container start
    - run supervised services
  - Configuration / control via environment variables - generally no build needed to standard op.
  - Shims to run executables based on context (current directory) in Docker (locally or remotely) or natively as fall-back → *containers become completely transparent.*
- More or less complete base images: FELIX (G. Brandt, B. Vormwald, A. Canbay), YARR (A. Korn), OB software (D. Dal Santo), ConfigDB (J. Schmeing), DAQAPI (M. Geyik)

```
docker compose pull &&
docker compose up -d
```

FELIX base image

https://demi.docs.cern.ch/itk-demo-felix/base-image/

- Startup sequence and FELIX app managed by s6 https://skarnet.org/software/s6-linux-init/
- At container start:
  - init FELIX
  - convert FELIX configuration file
  - configure FELIX
  - start felixcore
- Previously:
  - Manually ran sequence of scripts
  - Manual restart of FELIX app needed if crashed
  - Needed to be killed eventually
  - Unclear who was running what (many checked out versions, single user account for everybody)

→ *none of this a problem when running in container*

Envvar	Purpose	Default
FELIX_DATA_INTERFACE	DATA_INTERFACE	lo
FELIX_CARD_NUMBER	Set Felix device	0
FELIX_INITIALIZE	At startup run 0=nothing, 1=flx-init, 2=flx-config	0
FELIX_CONFIG_FILE	Use custom configuration file	/config/flx.cfg
FELIX_APP	Start FELIX Application: 0=none, 1=felixcore, 2=felix-star	0

Environment variables to control FELIX SW using s6 init

see also talk by Leyre Flores about testing in SR1

Studies on Configuration Files

A solution to facilitate the description of the e-links that are in use has been put in place by creating a generator script that accepts a user-friendly JSON file and translates to FELIX configuration.

The main important parameters required to be able to configure FELIX.

```
FELIX Card ID          : 0
Device ID              : 0

LINK ID                : 0
        polarity       : 0
        icec           : 1
        rx channels    : 4
        tx channels    : 0

LINK ID                : 1
        polarity       : 0
        icec           : 1
        rx channels    : 64, 72, 76, 80, 84
        tx channels    : 64, 66, 70

LINK ID                : 2
        polarity       : 0
        icec           : 1
        rx channels    : 132
        tx channels    : 128
```

```json
{
  "FelixID": "01",
  "DeviceID": 0,
  "Links": {
    "0": {
      "polarity": 0,
      "icec": 1,
      "rx": [4],
      "tx": [0]
    },
    "1": {
      "polarity": 0,
      "icec": 1,
      "rx": [64,72,76,80,84],
      "tx": [64,66,70]
    },
    "2": {
      "polarity": 0,
      "icec": 1,
      "rx": [132],
      "tx": [128]
    }
  }
}
```

JSON File

Studies on Configuration Files

The generated user-friendly JSON file needs to be converted to a raw configuration file that FELIX can understand.

Human readable configuration file

```
{
  "FelixID": "01",
  "DeviceID": 0,
  "Links": {
    "0": {
      "polarity": 0,
      "icec": 1,
      "rx": [4],
      "tx": [0]
    },
    "1": {
      "polarity": 0,
      "icec": 1,
      "rx": [64,72,76,80,84],
      "tx": [64,66,70]
    },
    "2": {
      "polarity": 0,
      "icec": 1,
      "rx": [132],
      "tx": [128]
    }
  }
}
```

convertJSON.py

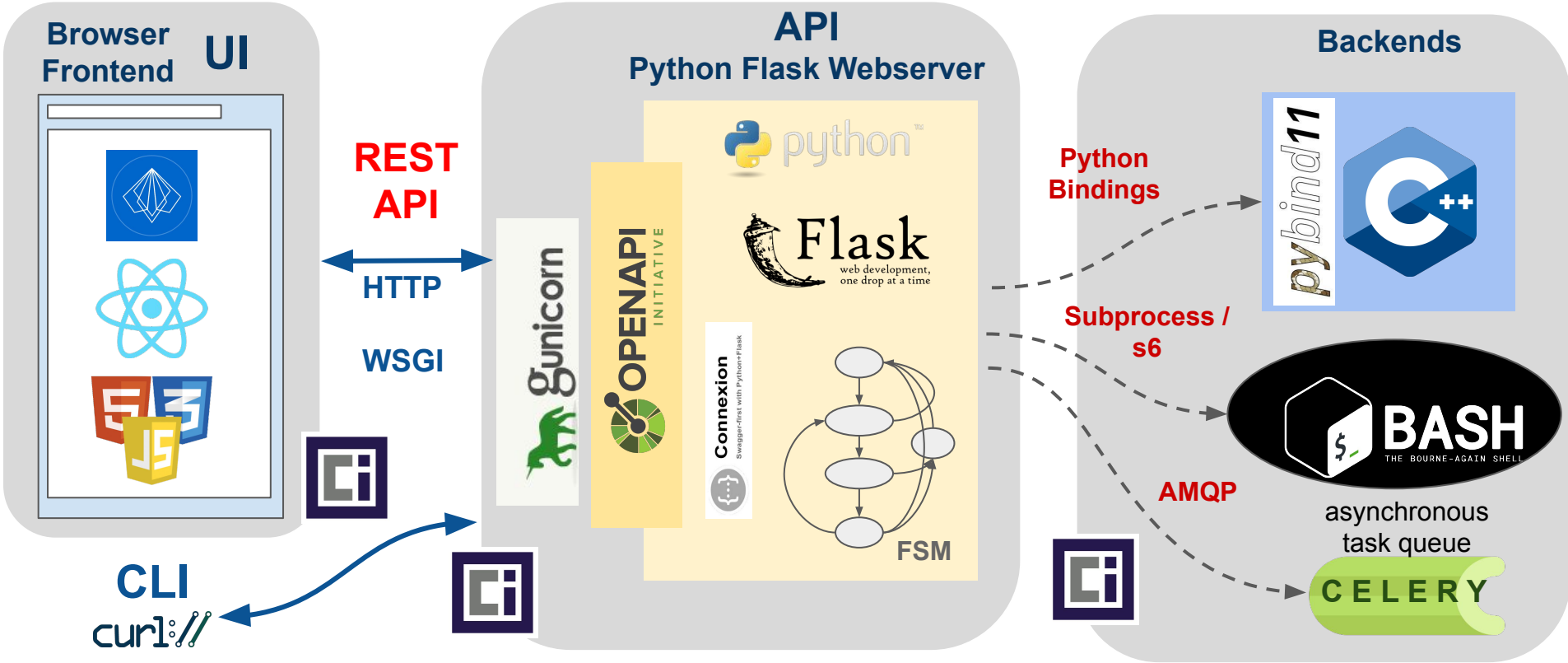
Based on Vakhtang's script

Raw configuration file

```
GBT_DATA_RXFORMAT2=0xFF
GBT_RXPOLARITY=0x0
DECODING_REVERSE_10B=0x1
MINI_EGROUP_FROMHOST_00_IC_ENABLE=0x1
MINI_EGROUP_TOHOST_00_IC_ENABLE=0x1
MINI_EGROUP_FROMHOST_00_EC_ENABLE=0x1
MINI_EGROUP_TOHOST_00_EC_ENABLE=0x1
ENCODING_LINK00_EGROUP0_CTRL_EPATH_ENA=0x1
ENCODING_LINK00_EGROUP0_CTRL_EPATH_WIDTH=0x1
ENCODING_LINK00_EGROUP0_CTRL_PATH_ENCODING=0x4
ENCODING_LINK00_EGROUP1_CTRL_EPATH_ENA=0x0
ENCODING_LINK00_EGROUP1_CTRL_EPATH_WIDTH=0x1
ENCODING_LINK00_EGROUP1_CTRL_PATH_ENCODING=0x0
ENCODING_LINK00_EGROUP2_CTRL_EPATH_ENA=0x0
ENCODING_LINK00_EGROUP2_CTRL_EPATH_WIDTH=0x1
ENCODING_LINK00_EGROUP2_CTRL_PATH_ENCODING=0x0
ENCODING_LINK00_EGROUP3_CTRL_EPATH_ENA=0x0
ENCODING_LINK00_EGROUP3_CTRL_EPATH_WIDTH=0x1
ENCODING_LINK00_EGROUP3_CTRL_PATH_ENCODING=0x0
DECODING_LINK00_EGROUP0_CTRL_EPATH_ENA=0x0
DECODING_LINK00_EGROUP0_CTRL_EPATH_WIDTH=0x4
DECODING_LINK00_EGROUP0_CTRL_PATH_ENCODING=0x0
. . .
```

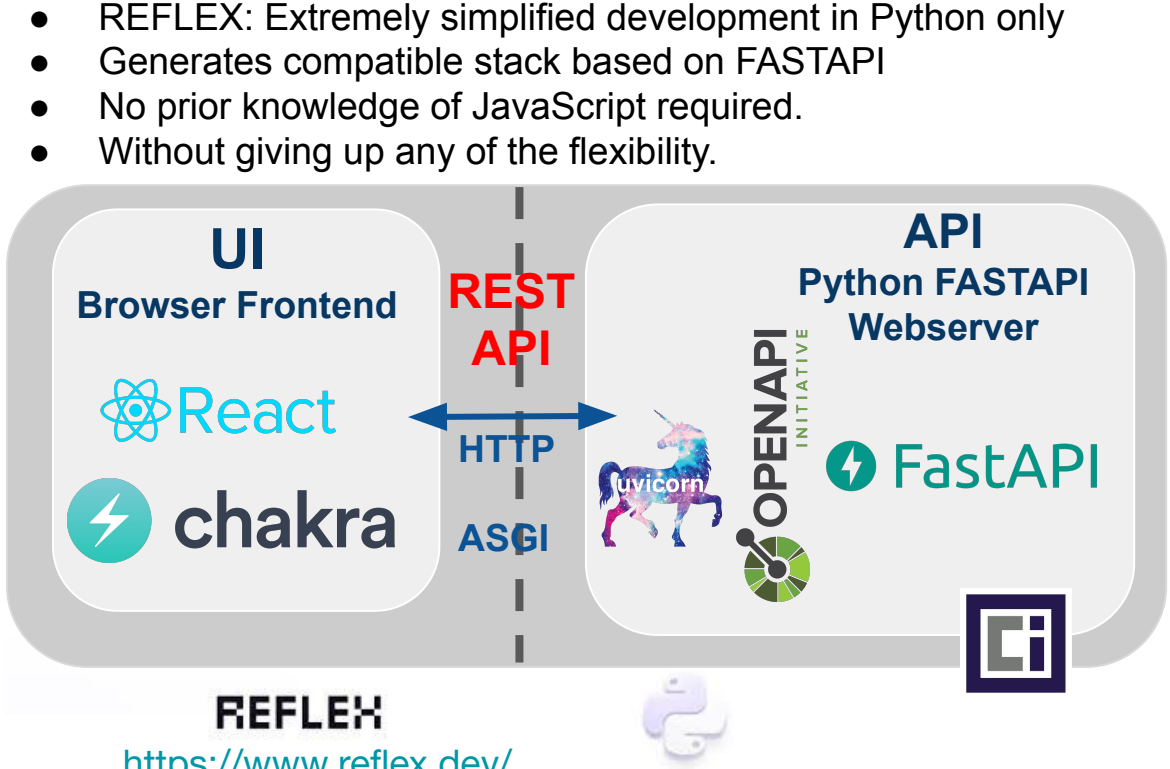
flx-config load FILENAME efficient way to configure

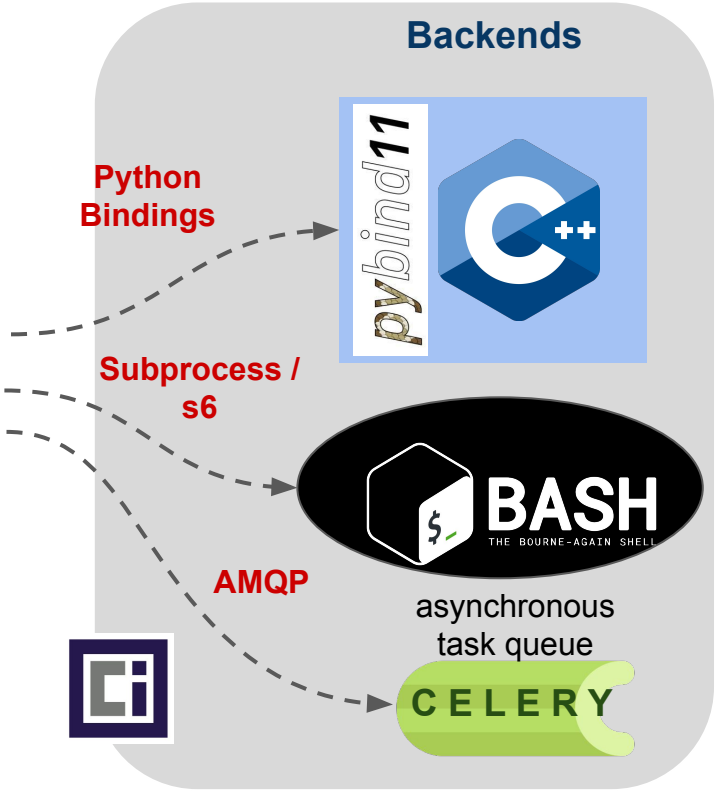
Reminder: Standard Architecture of a Microservice



Architecture of a Microservice using REFLEX

- REFLEX: Extremely simplified development in Python only
- Generates compatible stack based on FASTAPI
- No prior knowledge of JavaScript required.
- Without giving up any of the flexibility.





API Part

- "Swagger UI" + openapi.yaml automatically generated by Reflex / FASTAPI
- Previously need to be written by hand.
- Manual modification still possible.

OPENAPI INITIATIVE

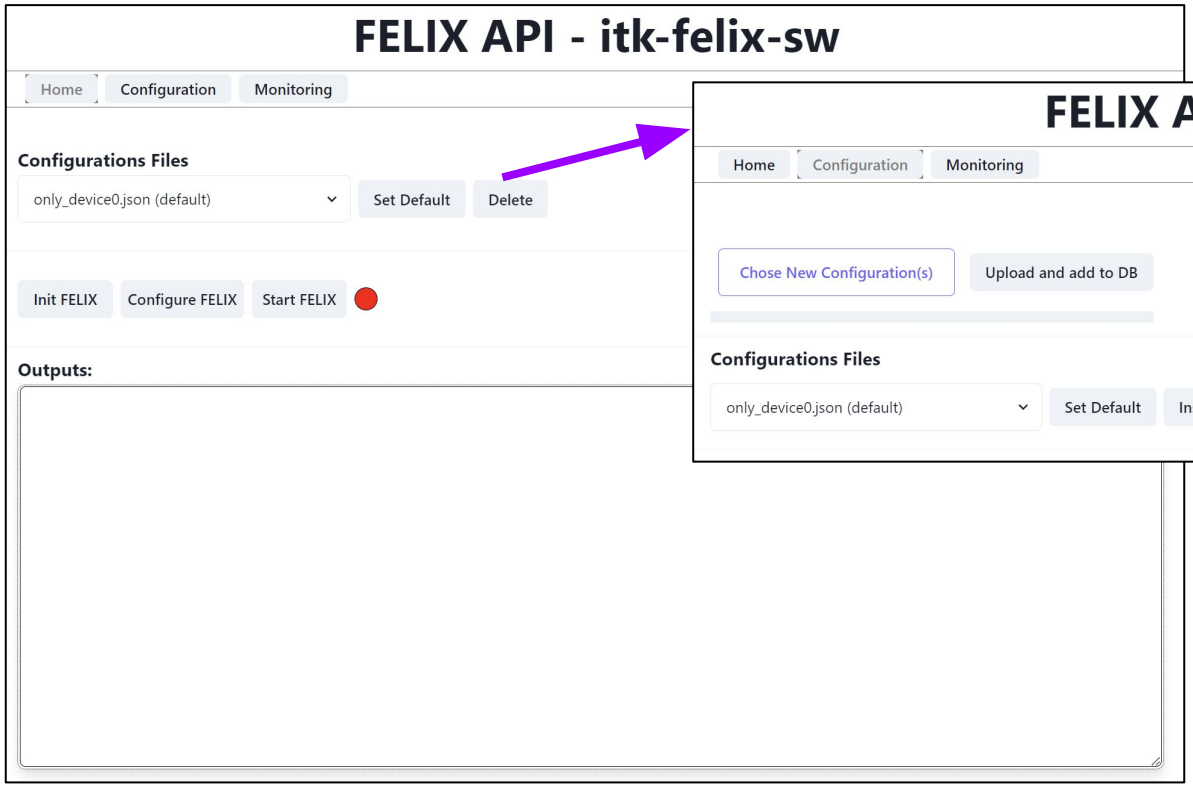
http://localhost:8000/infoconfig : shows information about configuration files
http://localhost:8000/getconfigs : shows existing configuration files
http://localhost:8000/getconfigs/File_Name : inspects the given configuration file (File_Name)
http://localhost:8000/setdefault/File_Name : makes the given configuration file default
http://localhost:8000/deleteconfig/File_Name : deletes the given configuration file default

http://localhost:8000/infofelix : shows information about FELIX status
http://localhost:8000/initfelix : initializes FELIX
http://localhost:8000/configurefelix : configures FELIX with default configuration file
http://localhost:8000/startfelix : starts FELIX
http://localhost:8000/stopfelix : stops FELIX

http://localhost:8000/getelink : shows information about electrical links
http://localhost:8000/getolink : shows information about optical links
http://localhost:8000/getpod : shows information about optical power

GUI Part

- Manual FELIX control per web GUI if startup sequence does not handle needed workflow

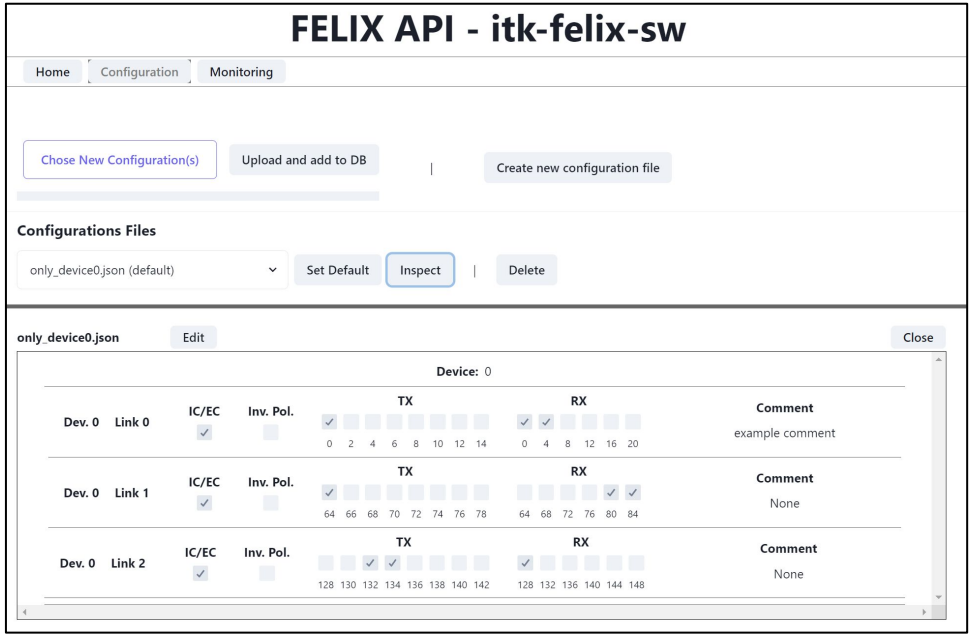


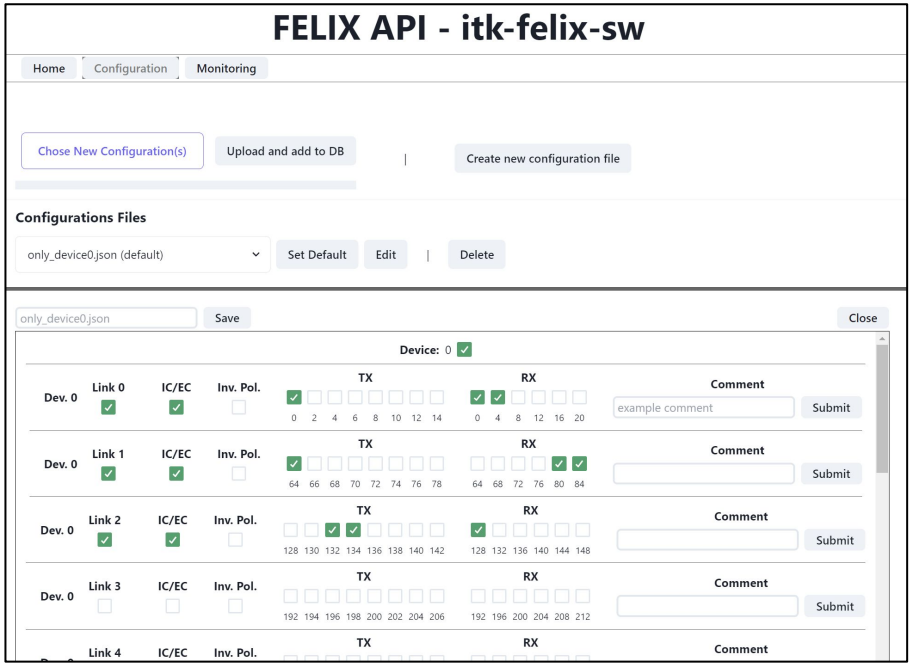
- Set default/delete the existing configuration files

- Initializing FELIX
- Configuring FELIX
- Starting/stopping FELIX

GUI Part

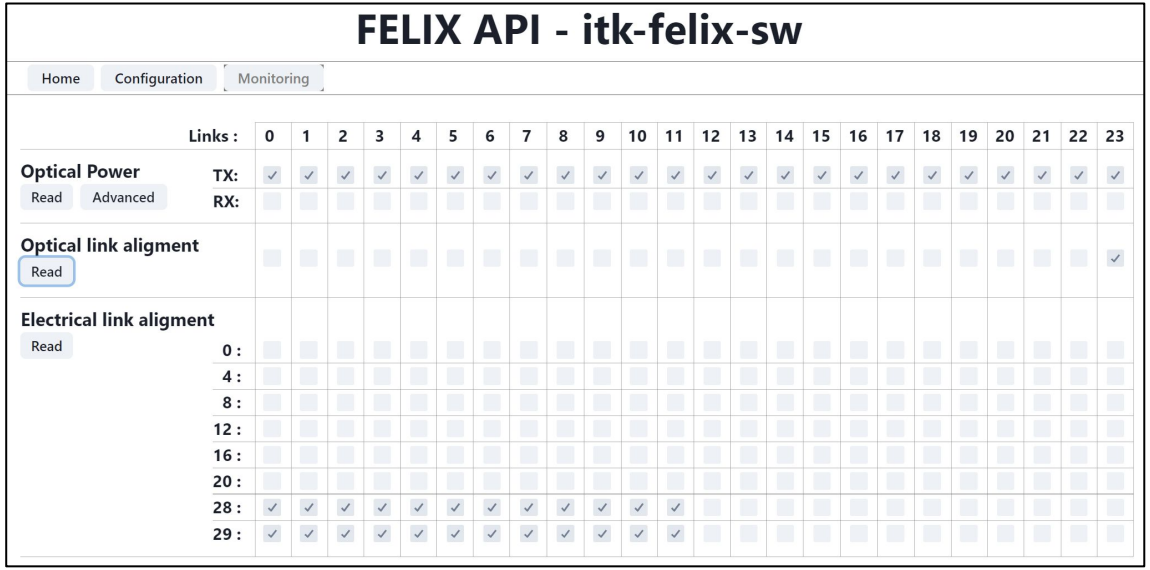
- Graphical FELIX configuration editor pages
- Created within few weeks over summer ‘23 without previous knowledge of JavaScript

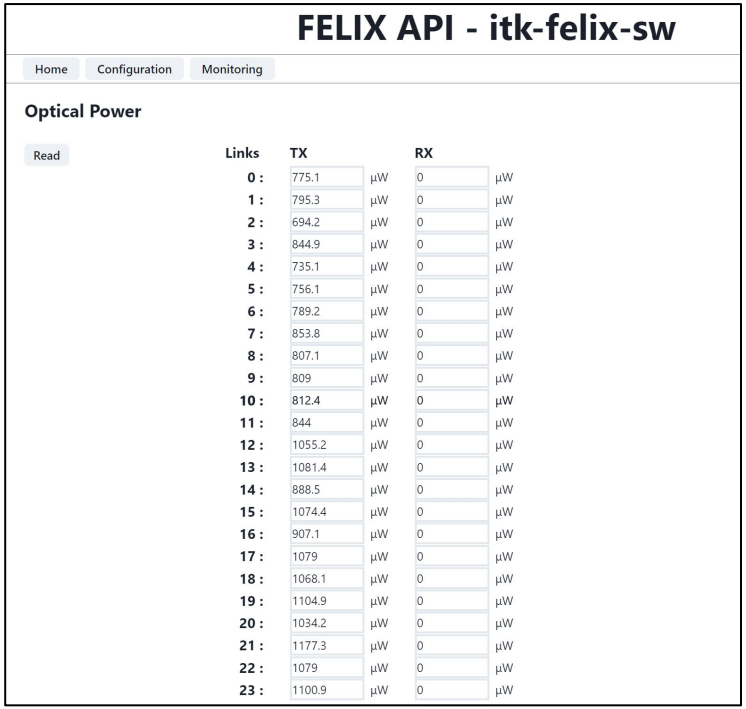




GUI Part

- Graphical FELIX monitoring page
  - Show information about electrical links
  - Show information about optical links
  - Show information about optical power





OptoBoard SW Container Status

https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/containers/optoboard-container

- Packaged Bern optoboard_FELIX Python script
- ic-over-netio communication tool (felixcore)
- Lots of testing in SR1 to confirm containerized OB configuration just as efficient as native configuration
  - Huge time difference (60s vs. 18s) was traced to “fixes” in ic-over-netio in recommended itk-felix-sw TDAQ version.
  - Reverted back to NSW version using a standalone build.
    → Problem not container related. DeMi team need to dig into backends almost everywhere.
- lpgbt-comm backend (using felix-star) using same build chain ready but not yet tested.
- Very advanced base-image with full configuration control at startup.
- *Ready for OB users.*

Compilation Wrappers for FELIX Libraries

- Felix release depends on LCG installation
  - **Monolithic** dependencies mostly not needed at run-time
- Modified *cmake_tdaq* for compilation
  - **neither compatible with cmake standards**
  - **nor TDAQ cmake system**
  - external libraries, e.g. libfabric, provided as **binaries in gitlab**
    - no consistent full build possible
    - depends on gcc version and OS
    - Slow cloning due to **complex submodule structure** and GB of binaries
- Compilation wrappers for Felix libraries allow to “build only what you need” for specific application
  - Real dependency management with *CPM-cmake*
  - YARR is already a similar mechanism to just build Felix client libraries on-the-fly
- Results in **very small installations**, e.g. opto stack, ideal for container use

- Wrapper repos: https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/external
- CPM-cmake for dependency management: https://github.com/cpm-cmake/CPM.cmake

```
CPMAddPackage(
        NAME simdjson
        GITHUB_REPOSITORY "simdjson/simdjson"
        GIT_TAG "v3.2.0"
        OPTIONS "CMAKE_CXX_FLAGS -fPIC"
)
```

Add external packaged for Felix, e.g. *simdjson*

```
add_library(felix-client SHARED
        ${client_src}/felix_client.cpp
        ${client_src}/felix_client_thread_impl.cpp
        ${client_src}/felix_client_util.cpp
        ${client_src}/felix_client_info.cpp
        ${client_src}/felix_client_context_handler.cpp
        ${client_src}/clog.c)
```

Re-define Felix libraries definitions

```
FetchContent_Declare(felix-def
        GIT_REPOSITORY https://gitlab.cern.ch/atlas-tdaq-felix/felix-def.git
        # GIT_TAG
        GIT_SHALLOW YES
        GIT_SUBMODULES include
)
```

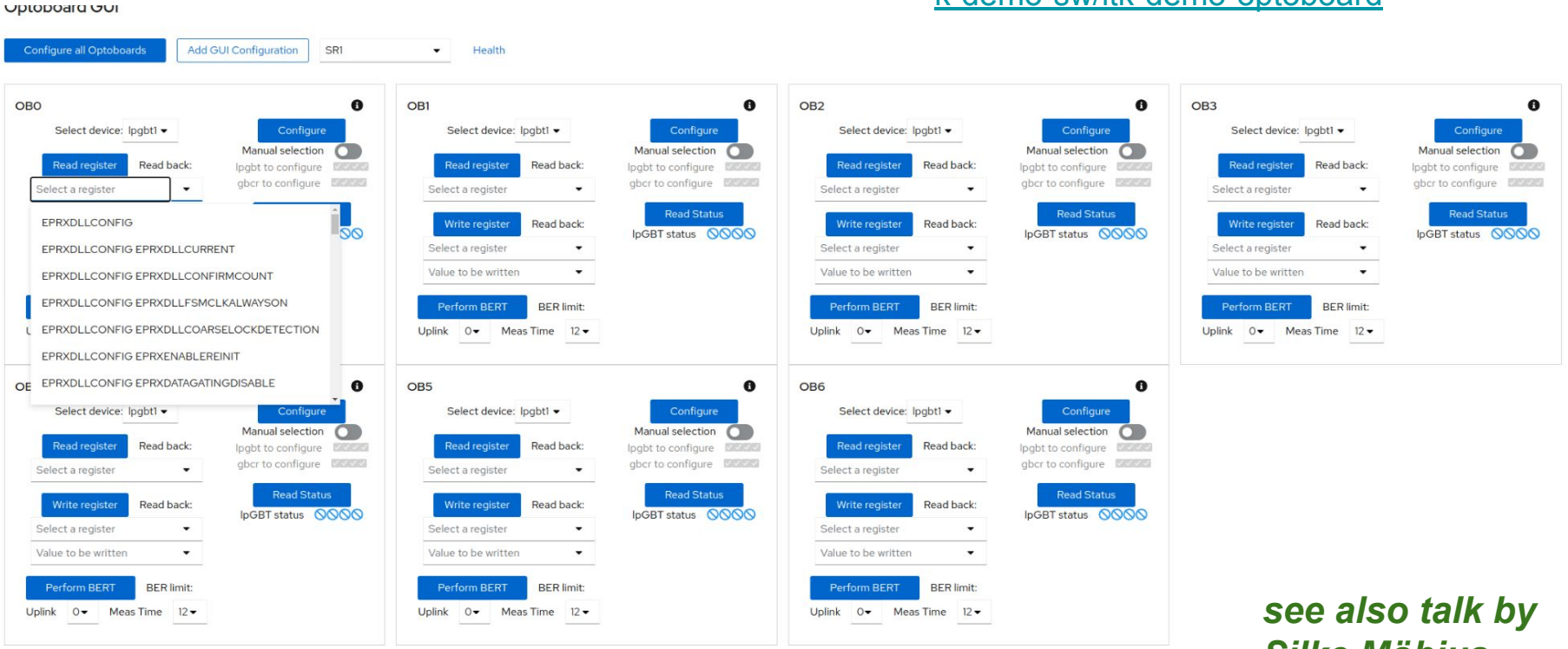
Fetch a Felix repo from original sources, shallow clone without resolving submodules

```
add_executable(link_test tests/link_text.cc)
target_link_libraries(link_test felix-client)
```

Definition link library sufficient to manage link and include paths

Optoboard Microservice UI Status

https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/itk-demo-optoboard



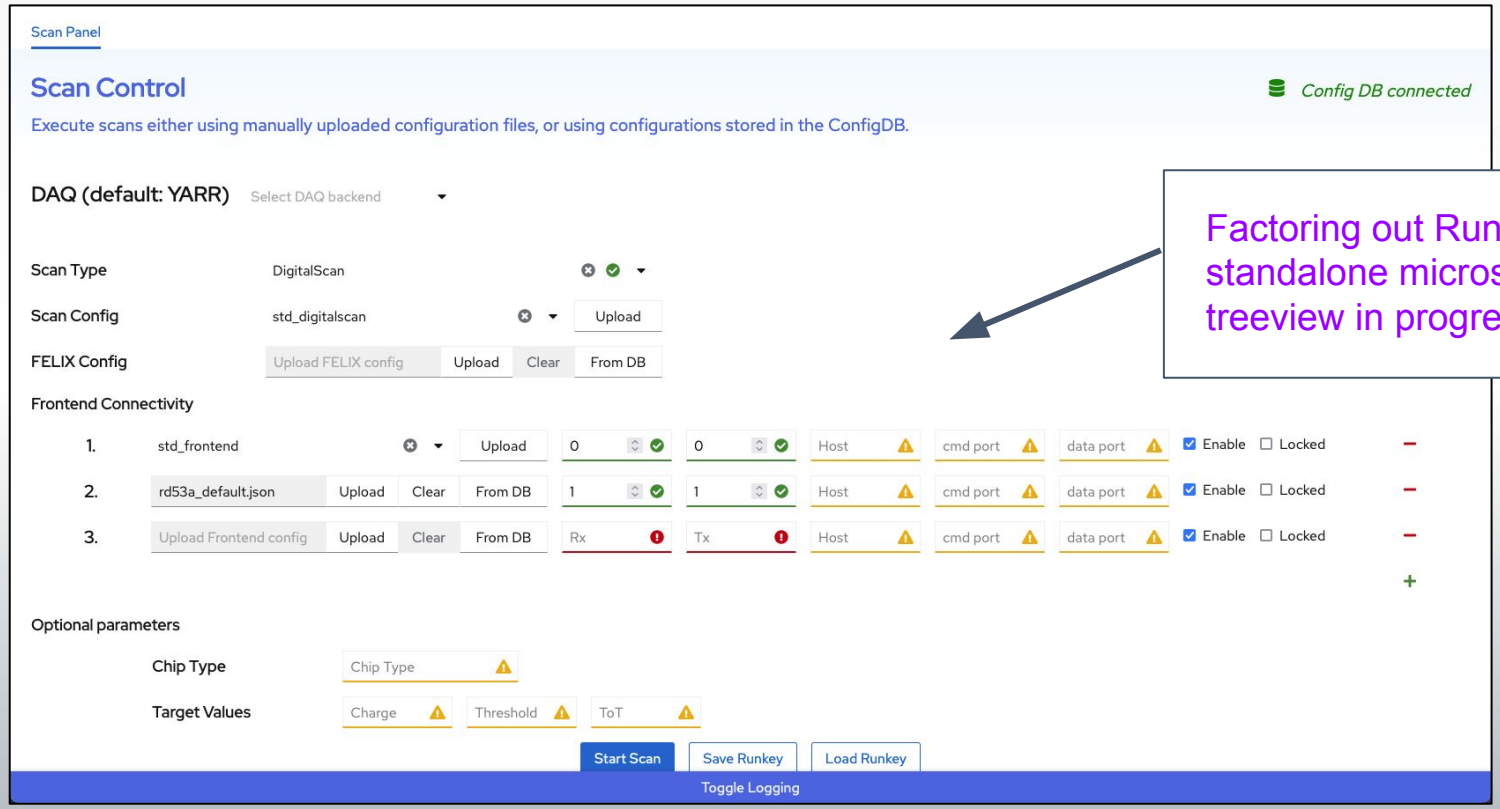
Daniele Dal Santo

see also talk by Silke Möbius

Status of DAQ API microservice

- Provides generalised, Python-based interface to DAQ software
- Currently maintaining **YARR** backend
- Fully integrated with the ConfigDB
  - Reading of config files or entire runkeys as scan configuration
  - Saving of scan results:
    - Post-fit configs to be used in later scans
- Dockerization allows for easy deployment of DAQ software without necessity for local installation
- Currently two interfaces exist for the DAQ API:
  - **Browser GUI** consistent with other itk-demo-sw microservice GUIs
  - **CLI** in the style of the YARR scanConsole for easy integration ← **NEW**

DAQ API GUI Status



Factoring out Runkey Editor as standalone microservice based on treeview in progress

DAQ API CLI

- CLI can be used outside of the Docker container
  - internally using docker exec / shims
  - transparent for user
- Can take configs on the local filesystem as input
  - Files are mounted into Docker and stored in the Config-DB
  - Scan is executed using the provided config files
  - Results are saved in the Config-DB and can be viewed with the resultviewer
- Syntax similar to YARR scanConsole:

```
[geyik@daqdev11 example]$ runScan -c connectivity.json -r ctrl_emulator.json -s std_digitalscan.json
Successfully executed scan with ID 2.
Results have been saved to the database.
```

YARR base-image

https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/containers/yarr-containers

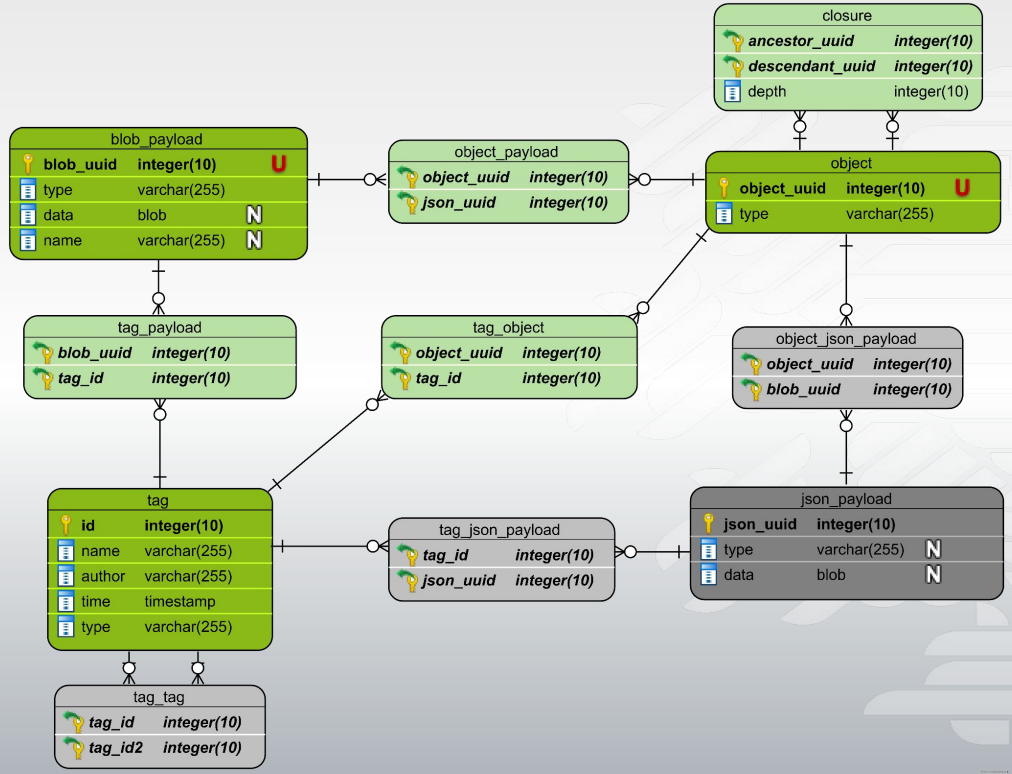
- Much progress over summer by A. Korn (UCL)
- Image builds and tags based on latest tags available in YARR repo
- Standard repo workflow scripts implemented (bootstrap, setup, config)
- Many base-image features implemented
  - s6-init
  - shims
- Needs testing, limited access to full FELIX DAQ chains
- Not yet used in DAQAPI microservice

itk-demo-configdb: overview

- Microservice that acts as an interface to a database storing:
  - Runkeys (connectivity and configuration data)
  - Scans and their results
- Tree based database schema
  - Connectivity tree, whose nodes have configuration data payloads
  - Runkey trees include connectivity trees and additional branches for scans and results
- Supports SQL Databases like MariaDB, SQLite and ORACLE
  - Flexible architecture, more backends can be added
  - Also file system export / import

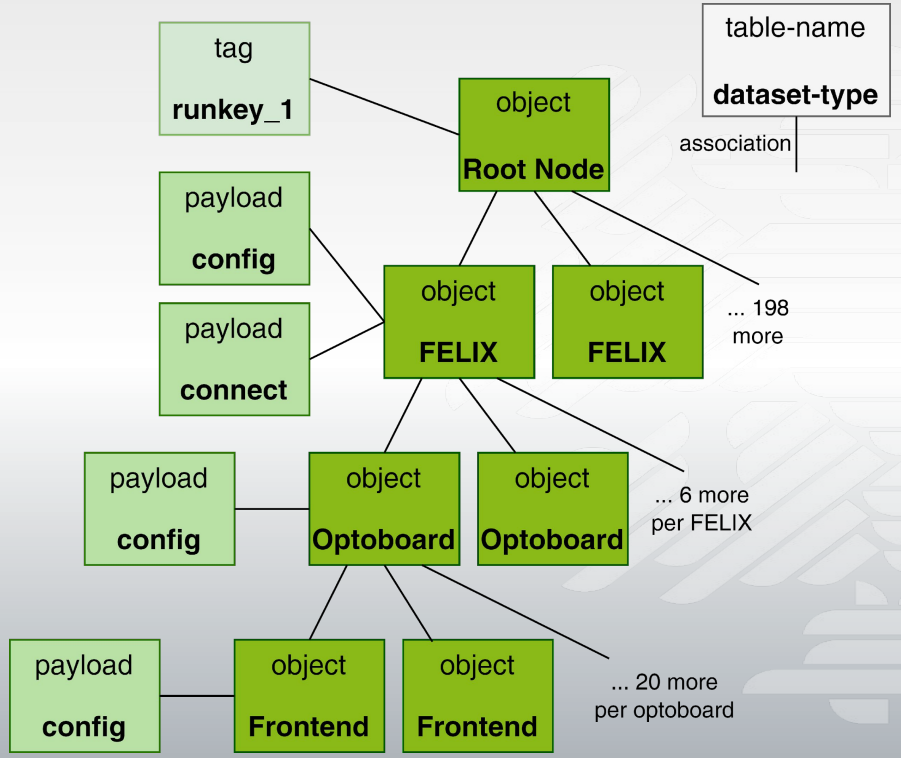
itk-demo-configdb: current database schema

- Objects point at each other
  - In this way they can span a tree
  - Root nodes of these trees are called runkeys
- Objects can point to multiple payloads
  - JSON
  - (BLOB)
- Tags describe or group objects, runkeys and payloads
- Final model will be normalized



itk-demo-configdb: runkey data model

- Estimate for a runkey for the full ITk pixel detector:
  - Root node
  - 200 FELIXs
  - 1.500 optoboards
  - 34.000 frontends
- Amount of payload files per object is customizable
- Current size estimate:
  - 3,1 GB with compressed payloads
  - Uncompressed: about 20 GB

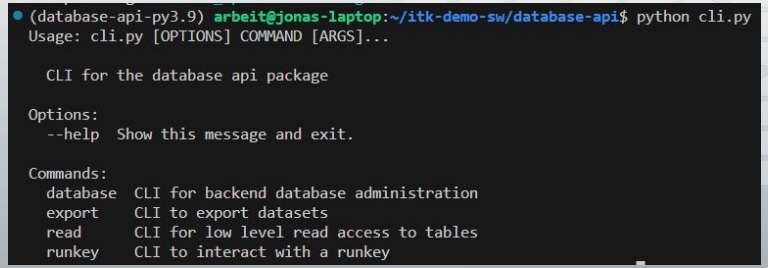


itk-demo-configdb: recent changes

- Rewrite of read and write operations
- Previously recursive operations were used to create and read trees
  - Each node in the tree needed one SQL command when reading or writing
- Bulk insertion for writing → Reduce ORACLE costs
  - SQL feature that allows insertion of multiple datasets at once
  - Only 4 SQL commands (one for each table) are needed to write a runkey of any size
  - Increased write speed by a factor of 30 in first tests
- Closure table for reading
  - Stores every connection between ancestors and descendants (not just direct children)
  - Allows to read entire trees and subtrees with one SQL query
  - Increased read speed by a factor of 10

itk-demo-configdb: GUI and CLI

- New version of ConfigDB GUI
  - Implemented by Dominik Schlothane
  - Main feature is **tag viewer** and **runkey viewer**:
    - Visualizes trees and lists
    - Shows root objects, children and payloads of connectivity tree
    - tree view component is reusable (e.g., for the resultviewer)
- Now working on expanding runkey viewer to a full-blown runkey editor
  - Separate microservice
- In addition to GUI the ConfigDB offers a CLI
  - Database administration, runkey management, dataset read operations and import/export via a python package
  - To Do: Implement shims to make CLI more accessible



itk-demo-configdb: tag overview page

Tags Payloads

Tag Access

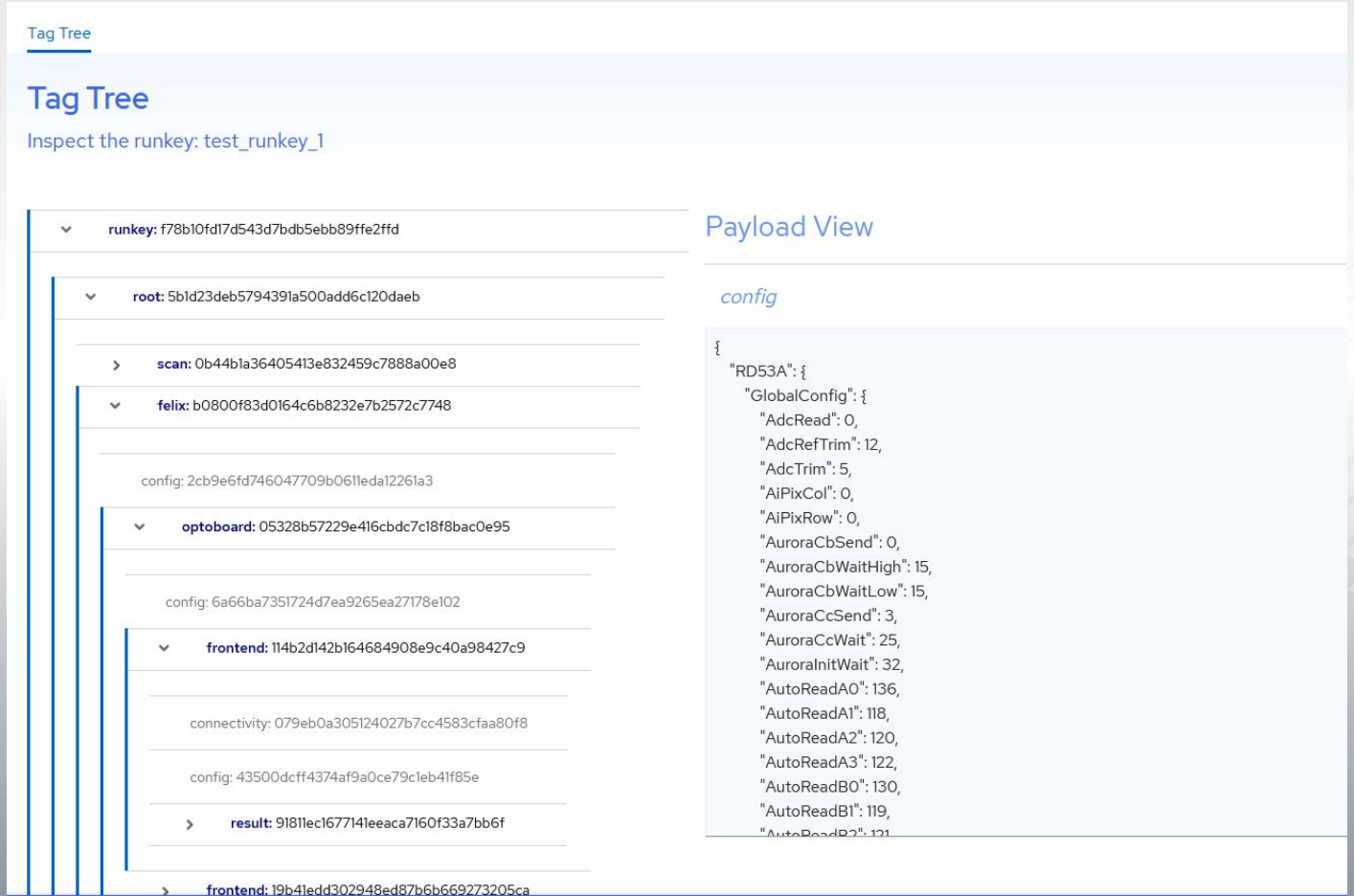
Backend DB connected

Check the status of tags stored in the Database.

Tag Name | Tag Type | 1 - 5 of 5

Name	Type	ID
std_digitalscan	scan	688c95be208041a59d5fc7432d19fa42
my_runkey_yarr	runkey	6ee7718d845c428391cc7ceccf1ba834
my_runkey_yarr2	runkey	a2a00bb0efdc4bc69545cb902ac4c164
my_rk	runkey	dbe7ec2ad4634cf2a8aadf4ee4ce39be
test_runkey_1	runkey	f78b10fd17d543d7bdb5ebb89ffe2ffd

itk-demo-configdb: tag detail page



itk-demo-configdb: Resources

- **GitLab repositiories:**
  - itk-demo-configdb
    - https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/itk-demo-configdb
  - database-api backend
    - https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/pypi-packages/database-api
- **Documentation:**
  - https://demi.docs.cern.ch/itk-demo-configdb/
  - https://demi.docs.cern.ch/deployments/readout-stack/

itk-demo-resultviewer

- Microservice for displaying histograms produced by scans
  - Displays results of scans saved to the configDB
  - Uses Jsroot to plot the histograms -> Fully interactive
  - Two panels to search for scans:
    - Runkey panel: Hierarchical tree view, list scans per runkey
    - AllResults panel: Flat list showing all scans saved in the configDB
  - Additional Jsroot panel: Users can upload their own histograms

- Current status:
  - Integration with new configDB read endpoints finished, all panels fully functional
  - Runkey panel needs graphical overhaul (currently difficult to navigate for large runkeys)

Maren Stratmann

Resultviewer GUI, AllResults panel

Results per Runkey | All results from database | Display .root files

Result Viewer

Config DB connected

Display the histograms from scan results stored in the database

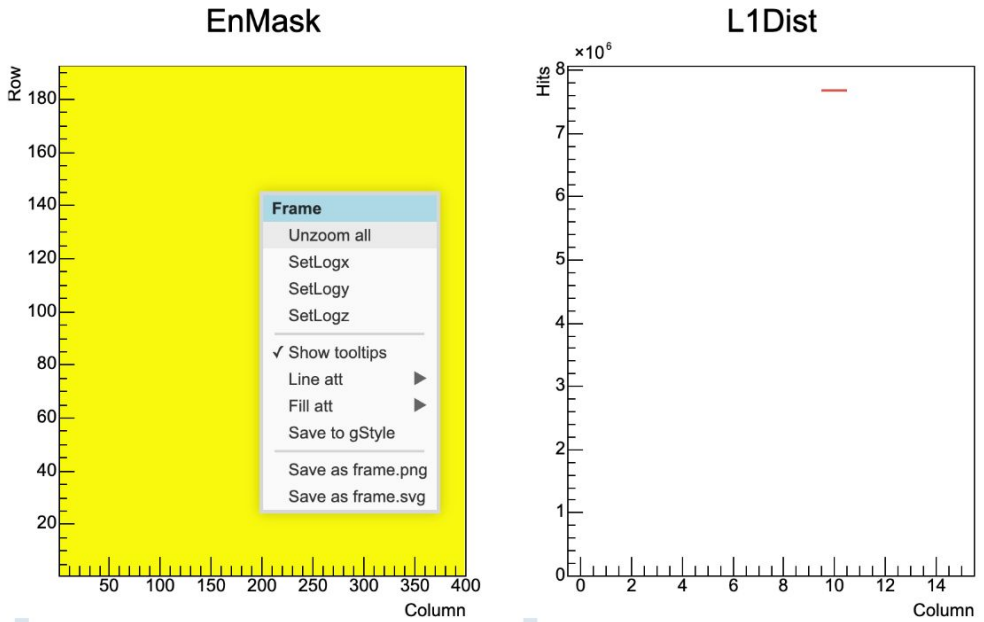
Scan ID | Scan Type

1 - 3 of 3 | 1 of 1

Runkey	Scan ID	Scan Type	Date
runkey_name	66b895ae12da48cbacbd96d3115d0c53	DigitalScan	2023-08-30 09:02
-	ac76f2c36d0f4940b72d944f9f6d9b71	DigitalScan	2023-08-30 09:06
rrrrrr	da8619d7547542a2a14d60a67d24e114	DigitalScan	2023-08-30 10:54

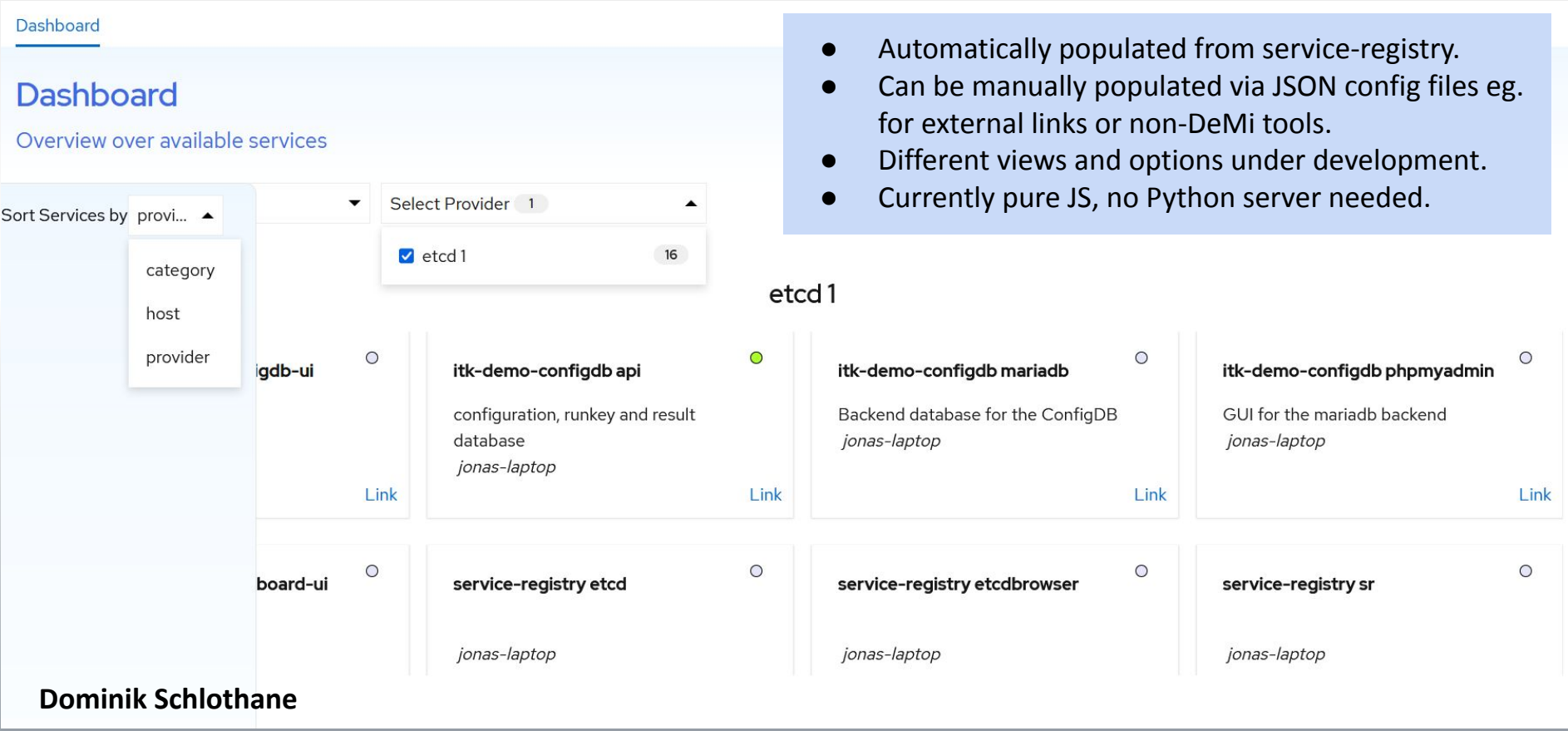
- [x] Enable Mask
- [x] L1 Distribution
- [ ] Occupancy Map

Results View



Maren Stratmann

Itk-demo-dashboard: sidebar menu with sorting options



- Automatically populated from service-registry.
- Can be manually populated via JSON config files eg. for external links or non-DeMi tools.
- Different views and options under development.
- Currently pure JS, no Python server needed.

Dominik Schlothane

Unifying Image Configuration

https://gitlab.cern.ch/groups/atlas-itk-pixel-systemtest/itk-demo-sw/-/wikis/repository/config

- Unify configuration of services across all microservice repos
- Hierarchy of key-value parameters passed to server / backend

(high to low, not all levels shown)

1. command-line parameters
2. service-registry
3. configuration File (JSON / YAML, TOML, …)
4. environment variables
5. Docker labels
6. dotenv file (.env)
7. baked-in / hardcoded value
8. [...]

Unifying Configuration

- **config-checker**
  - Hierarchical configuration loader and checker in Python
  - Wrapper around **ConfZ**
  - **ConfZ** is a wrapper around Pydantic
- Support environment variables, dotenv, service-registry and file (YAML/JSON/TOML).
  - To be added: OKS ;-)
- Examples for all cases provided in repo.
- Use config-checker for uniform configuration behavior across microservice repos
  - Implementation in progress, done for configdb and daqapi

https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/pypi-packages/config-checker

https://github.com/Zuehlke/ConfZ

zühlke empowering ideas

https://github.com/pydantic/pydantic

Pydantic
Bringing schema and sanity to your data

Adrian Miemczyk

Resources

- Docs — demi.docs.cern.ch
- Meeting — ~Weekly Wednesday 1700 CEST.
- Egroup — **atlas-itk-demo-sw-devel**
- Mattermost — https://mattermost.web.cern.ch/itkpixel
  - /itk-demo-sw-users
  - /itk-demo-sw-devel
- GitLab — https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw
  - also hosts Wiki, Issues
  - PyPi and npm package registries.
  - OCI image registry

https://gitlab.cern.ch/groups/atlas-itk-pixel-systemtest/itk-demo-sw/-/wikis/resources