HELIPORT use case POLARIS: Integration of a High Intensity Laser in a complete data life cycle workflow

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The HELIPORT project aims at developing a platform which accommodates the complete life cycle of a scientific project and links all corresponding programs, systems and workflows to create a more FAIR and comprehensible project description.
The POLARIS Experiment @ HI Jena

— The Petawatt Optical Laser Amplifier for Radiation Intensive Experiments (POLARIS) is the only fully diode-pumped, double-CPA laser system worldwide.

— Used for Laser Particle Acceleration Experiments

— Research project of the Faculty of Physics and Astronomy at the University of Jena and the Helmholtz Institute Jena (HI-Jena).

— Key features:
  • Energy on target: $E_L = 16.7 \text{ J, } t_L < 100 \text{ fs}$
  • Repetition rate: $1/50 \text{ Hz}$
  • Optimized peak intensity
  • Full suppression of short pre-pulses

The POLARIS Experiment Chain

Important Diagnostics:
- CCD cameras
- Photodiodes
- Oscilloscopes
- Spectrometer
- Energy meter


In the HELIPORT project, our goal is to bring all together: images, settings, target metadata and everything else.

HELIPORT and the Infrastructure at Helmholtz Institute Jena

— HELIPORT was initially developed to provide access to the computing Infrastructure at the HZDR.

— The infrastructure at Jena is different, but the important systems are available:
  • HPC Infrastructure and Data Management*
  • Data Acquisition
  • Git Repositories

— And others are in development:
  • Lab Documentation
  • Data Repository

*Sponsored by the Thüringer Aufbaubank, Projekt 2019 FGI 0013 HDA
HELIPORT System Infrastructure for POLARIS

— HELIPORT is a future service on a HIJ server.
— Other services or systems are configurable.
— The HELIPORT Web-App itself is based on Django:
  • HELIPORT communicates with various system through REST APIs,
  • The metadata is stored in a PostgreSQL database.
  • The HELIPORT graph and integrated systems are configurable.
— The CWL workflows are managed in HELIPORT and can be executed on various machines using SSH:
POLARIS Experiment Database

- The Metadata of the POLARIS experiment is managed by a modified version of the PHELIX Shot DB.
- Top-level project metadata is available within HELIPORT.
- Additionally a separate (POLARIS) Laser Metadata Plugin in HELIPORT is required:
  - (Meta)Data can be exchange with various system through REST APIs,
  - The experiment specific metadata will be exchanged with the PHELIX Shot DB and referenced in HELIPORT.
- The Laser Metadata Plugin provides a view in HELIPORT to configure laser specific metadata.
Modular HELIPORT Design (Django Apps)

Project & Infrastructure
- Core Resources
- HELIPORT Project
- Proposal Management (HZDR Gate)
- HELIPORT HZDR (HZDR About Page)

Systems
- Version Control
- Data Management Plan (RDMO)
- Basic Documentation
- Digital Objects

Resources
- Data Sources
- Tools
- Arbitrary CWL
- General Workflows
- Aiida Workflows

Automation
- Slurm Job
- Unicore

Results
- Publication
- Dataexport Invenio
- Internal Archive

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Integration of a Custom Plugin

```
GRAPH = {
    'Project': ['project_configuration', 'gate_connection'],
    'Systems': ['version_control', 'data_management_plan', 'documentation',
                'digital_objects', 'sharelatex', 'lasermeta'],
    ...
}
```
POLARIS Metadata — Laser Metadata Plugin

— The idea is to collect the experiment specific metadata with a flexible Laser Metadata Plugin
— The data columns are can be configured flexible using the HELIPORT website:
  • An extendable vocabulary for specific field can be extended during the experiment
  • Rows can be added using web interface or REST API.
  • Fields can be configured with pre-filled (but editable) content.
— The resulting schema can be used in other future projects and also published in a data repository using a workflow in Heliport.

(Meta)data can be exported in an uniform community standard and also be exchanged within the HELIPORT components
Enhancing POLARIS Experiments with Simulations (Digital Twins)

The Heliport Project-Level Metadata Scheme

```json
{
    "namespaces": {
        "datacite": "http://purl.org/spar/datacite/",
        "rdfs": "http://www.w3.org/2000/01/rdf-schema",
        "heliport": "https://heliport/schema/",
        "time": "http://www.w3.org/2006/time#",
        "dc": "http://purl.org/dc/terms/"
    },
    "heliport:project_id": 9,
    "datacite:hasIdentifier": "HZDR.FWCC.2021.95018",
    "heliport:uuid": "8fab8a14-df2f-414d-bbe0-747c38129bc4",
    "datacite:handle": "https://hdl.handle.net/20.500.12865/HZDR.FWCC.2021.95018",
    "heliport:label": "An Example Project",
    "time:hasBeginning": "2021-05-18 13:03:34.378458+00:00",
    "datacite:hasDescription": "This Project has the sole purpose of demonstrating the functionality of HELIPORT",
    "heliport:group": "FWCC",
    "heliport:owner": {
        "datacite:hasIdentifier": "141575",
        "datacite:orcid": "https://orcid.org/0000-0001-5556-838X",
        "rdfs:label": "Voigt, Martin (FWCC) - 141575"
    },
    "heliport:co_owners": [
        {
            "datacite:hasIdentifier": "132739",
            "datacite:orcid": "https://orcid.org/0000-0001-8174-7795",
            "rdfs:label": "Knodel, Dr. Oliver (FWCC) - 132739"
        },
        ...
    ],
    "heliport:has_GATEProject": [
        {
            "heliport:gate_id": 283747364,
            "dc:title": "An Example GATE Project",
            "heliport:status": "Continuously Improving",
            "dc:abstract": "There is an urgent need to ... (ref.: 10.1038/sdata.2016.18)"
        },
        ...
    ],
    "heliport:responsible_experimentalist": {
        ...
    }
}
```
Conclusions

— HELIPORT provides a comprehensible top-level view on the project and all corresponding systems
— With plugins additional services or systems can be integrated
— The metadata can be used in integrated workflows to enable high interoperability
— With our Laser Metadata Plugin we can collect and customize metadata and publish it in a data repository like Rodare.