HELMHOLTZ

HMC

RESEARCH FOR
GRAND CHALLENGES

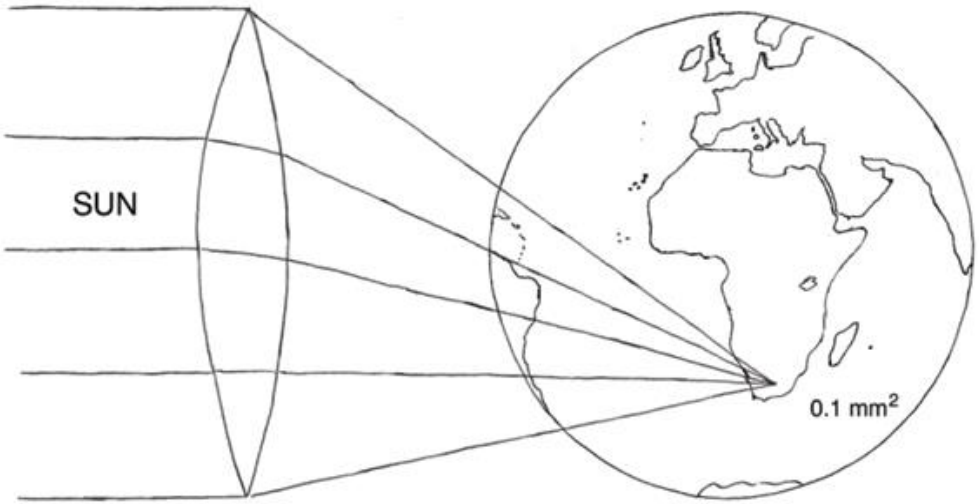
HELPMI:
the Helmholtz Laser-Plasma Metadata Initiative

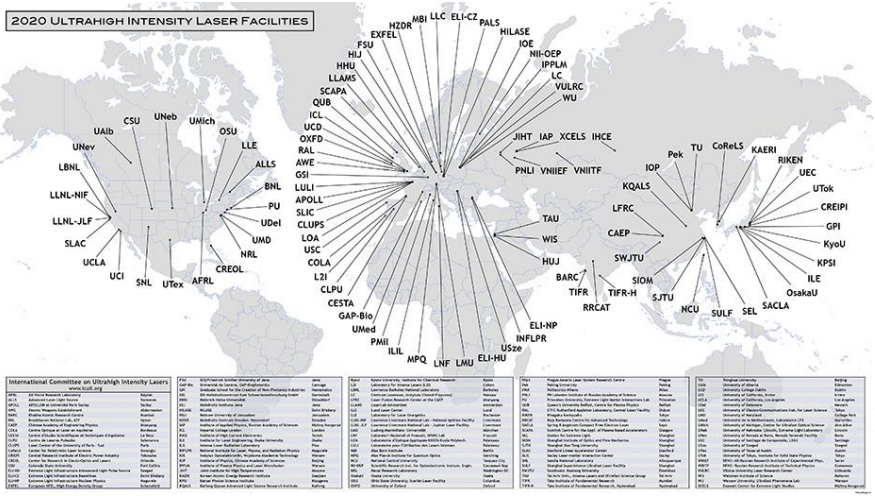
Start developing a data standard for the global LPA community

LPA Community

Lasers…

- Ultra-intense lasers can transform plasmas into particle-accelerating structures
  - Ultra-short (fs-ps), Joule-kJ laser facilties: high peak-power, ICUIL.org
  - Chirped pulse amplification (invented 1985, Nobel prize awarded 2018)





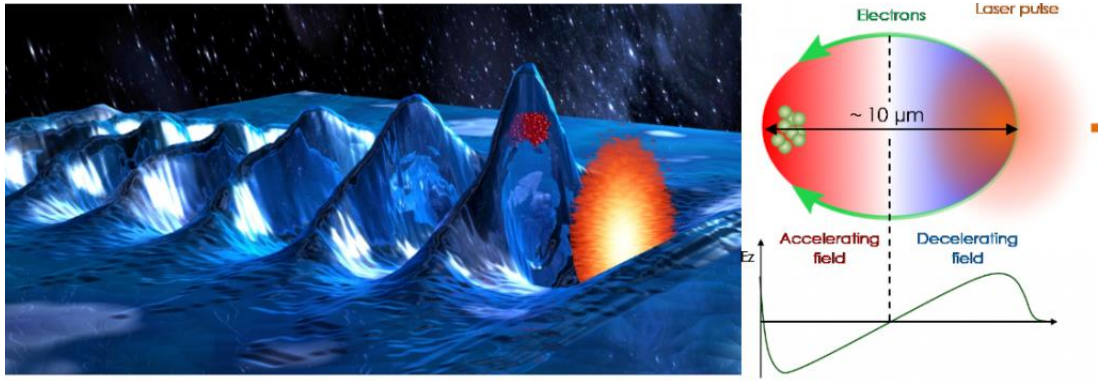
https://www.icuil.org/activities/laser-labs.html, Interactive map

Schwoerer H. (2008). Particle acceleration with lasers. *S. Afr. J. Sci.* **104**, 299–304.

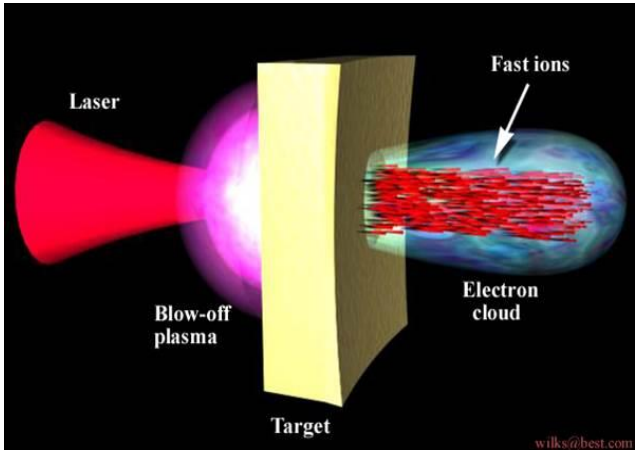
LPA Community

… and plasma accelerators

- Ultra-intense lasers can transform plasmas into µm-scale particle-accelerating structures
  - Electron acceleration and ion acceleration in high gradients
  - Inherent ultra-short time structure and thus high peak currents



https://loa.ensta-paris.fr/research/upx-research-group/laser-wakefield-acceleration-lwfa/

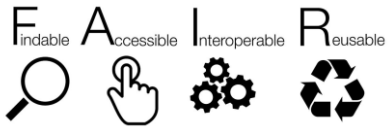


HELPMI: Main Goals

2023-2025, GSI+HIJ+HZDR

HELMHOLTZ Metadata Collaboration

- Initiative: **start** the development of a data standard for LPA experiments
  - Consulting and assistance from HMC community
  - Concepts, tools, trends, best practices, lessons learned…
- **Adopt NeXus** standard from PaN experimental community
  - Use existing base classes, possibly define new ones
  - Propose application definition
- **Extend openPMD** standard and API for arbitrary hierarchies
  - Currently established for simulations in LPA community
  - Fileformat-agnostic
- **Start** the development of a **glossary**
  - Uncharted territory in LPA experiments
  - Community must be involved

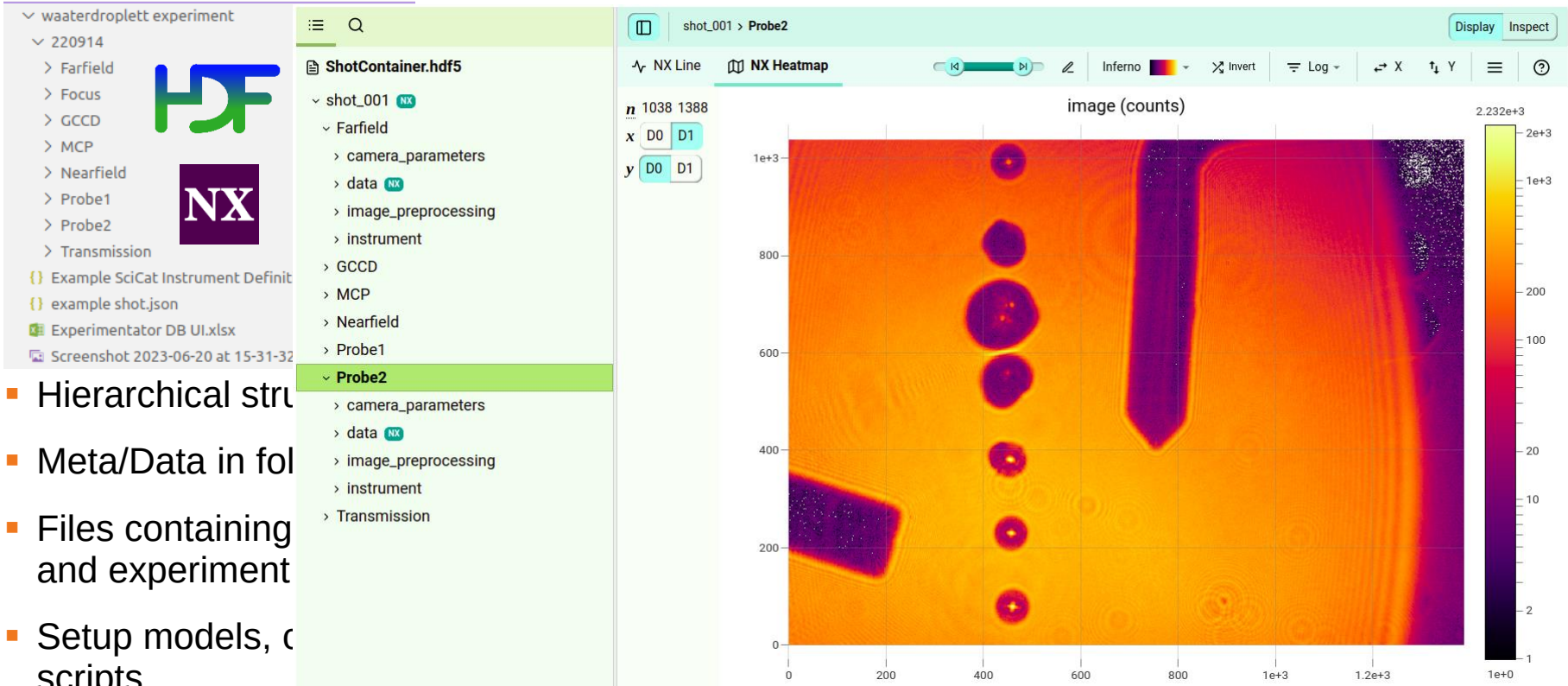


„an umbrella over a family of standards, currently for experiment data in the Photon and Neutron science community“

HELPMI: NeXus adoption

HELMHOLTZ Metadata Collaboration

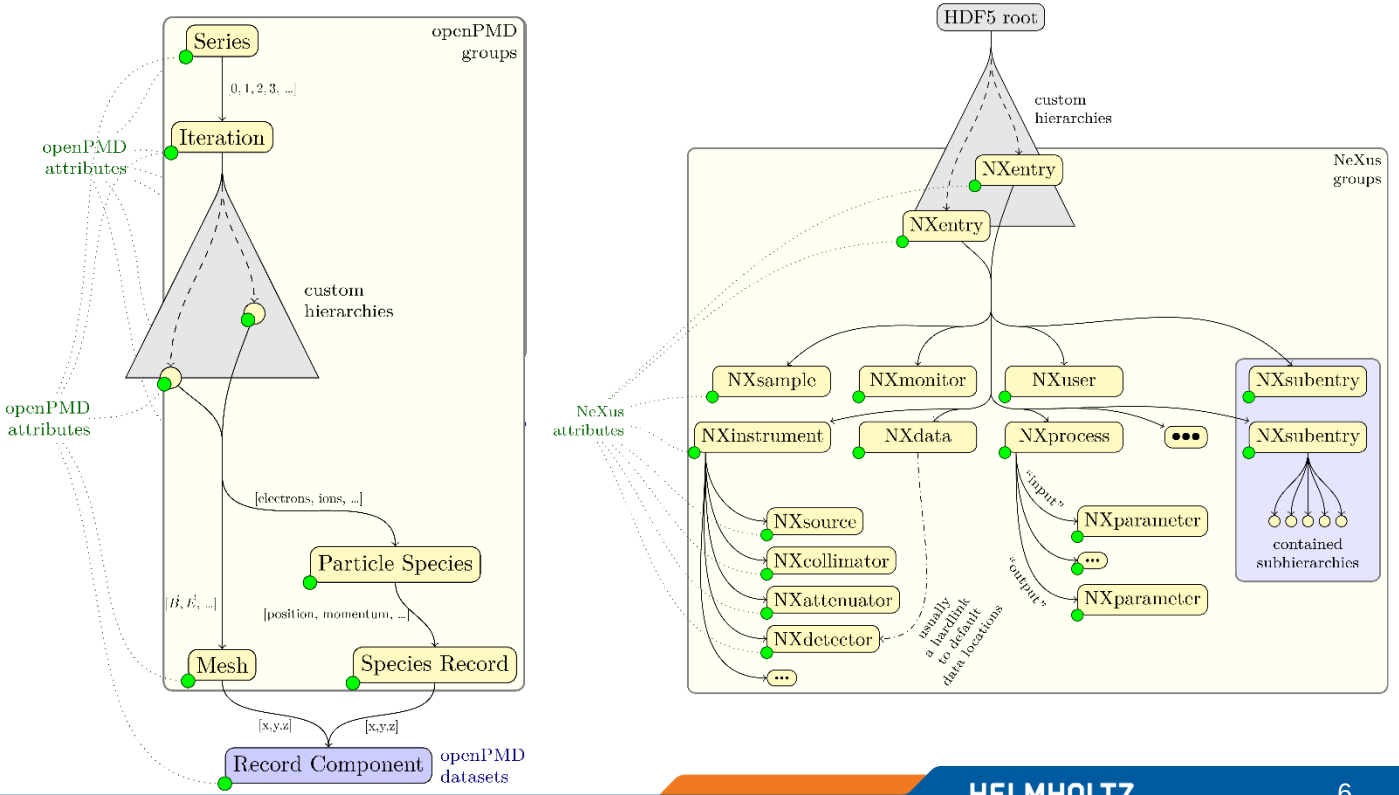
NXdata is awesome feature, scientific classes strongly bound to PaN



- Hierarchical stru
- Meta/Data in fol
- Files containing and experiment
- Setup models, c scripts

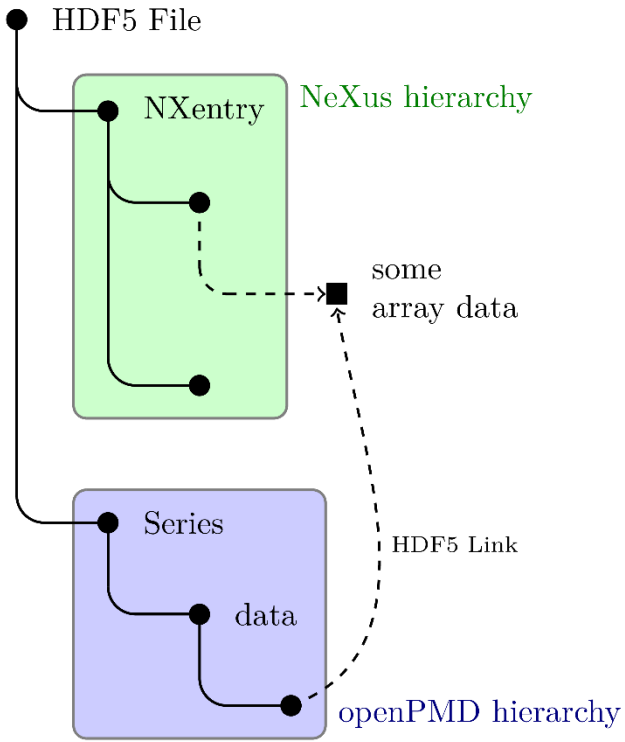
HELPMI: openPMD

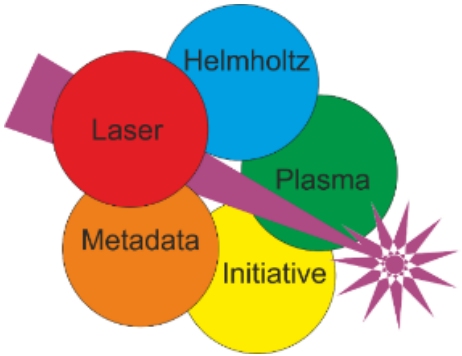
Extend for any custom hierarchy



HELPMI: F.A.I.R. container for LPA data

Bi-lingual hdf5 file





HELPMI: draft glossary

Devices-Detectors-Components-Library: https://doi.org/10.5281/zenodo.11143947

HELPMI Common Phrases/Categories

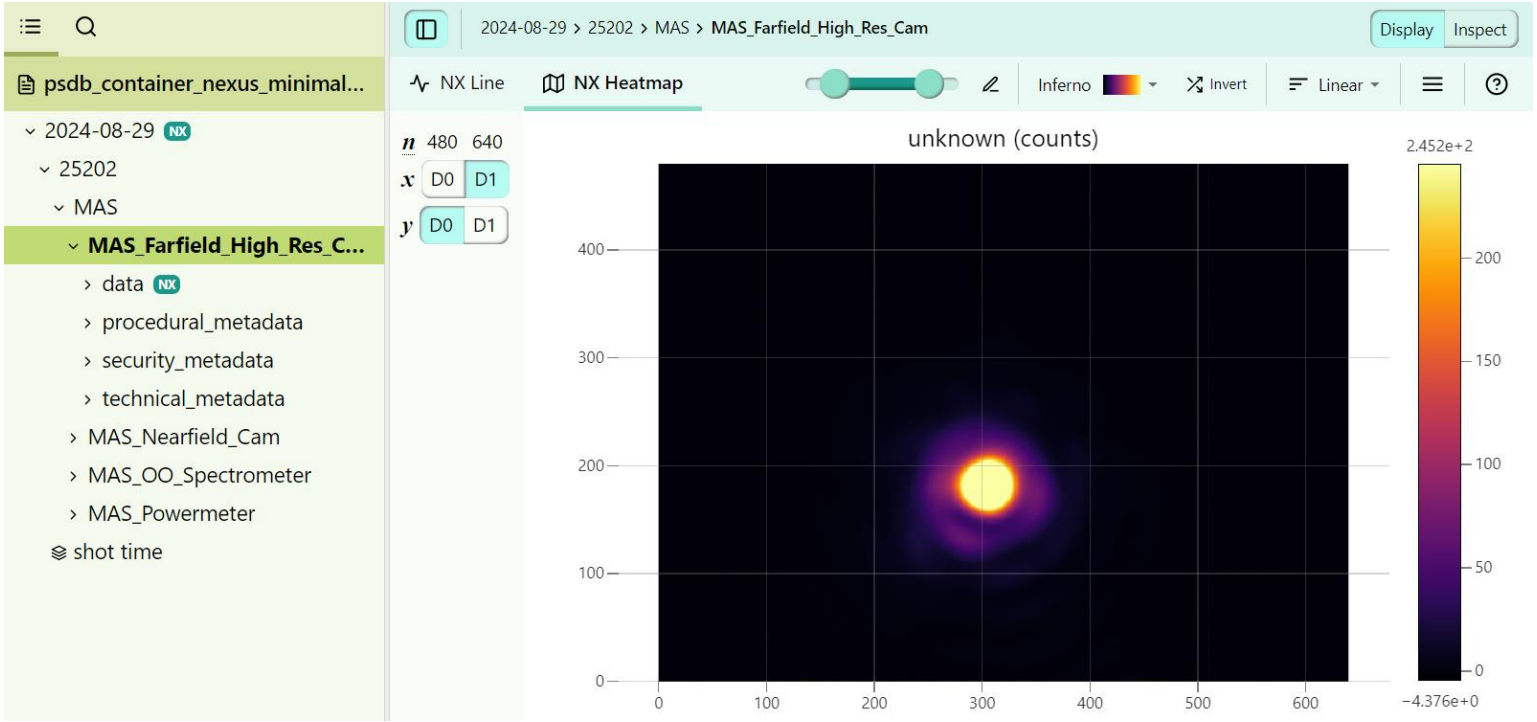
1. Technical Metadata
   a. Manufacturer or in-house design
   b. Model name/number
   c. Serial number
   d. Operating software and version number, dependencies (Win, Linux?, .NET?)
   e. Calibration data (Manufacturer)
   f. Last calibration date
   g. Pixel count in horizontal direction
   h. Pixel count in vertical direction
   i. Pixel size and/or pitch
   j. Noise measurement
   k. Technical drawing/file of device/setup
2. Procedural Metadata
   a. Name of detector/device as used in experiment
   b. Location of detector/device as used in experiment
   c. Schematic of detector's/device's setup
   d. Schematic of imaging/focusing setup
      i. Lens, objectives, filters, etc.
      ii. Imaging distances
   e. Custom calibration, Point Spread Function (PSF), Flatfield, Gainmap (links to data)
   f. Exposure, Shutter mode (rolling/global)
   g. Gain
   h. Binning
   i. Trigger and Timing (Delay)
3. Security/Access Metadata
4. Data
   a. Input/output energy
   b. Input/output polarization
   c. Input/output FWHM beam diameter
   d. Input/output spectrum
   e. Input/output spectral FWHM
   f. Input/output central wavelength
   g. 2D array of pixel values

Needs involvement of (interested) community.

Unclear what kind of format and platform.

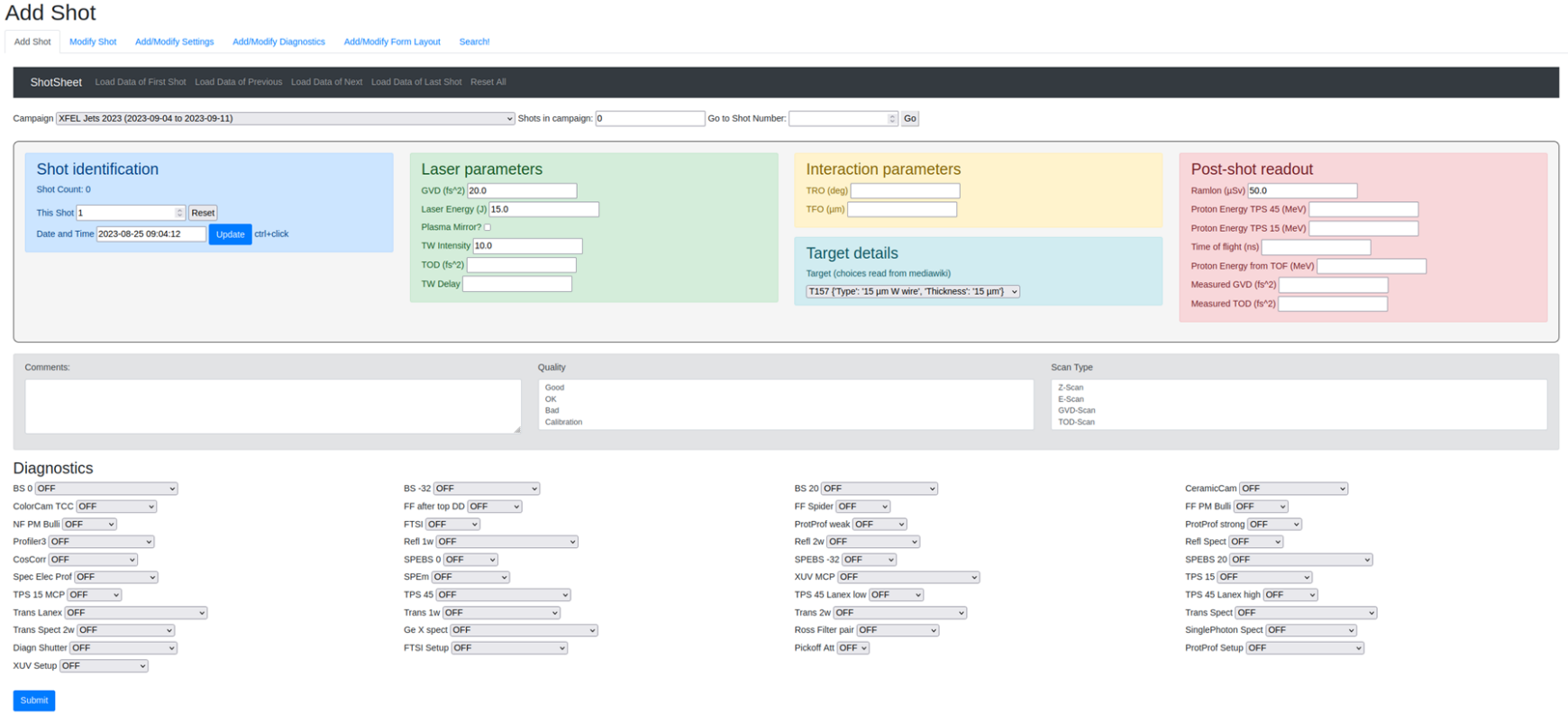
HELPMI: Current status

Example data out of PSBD with DDC key-value pairs



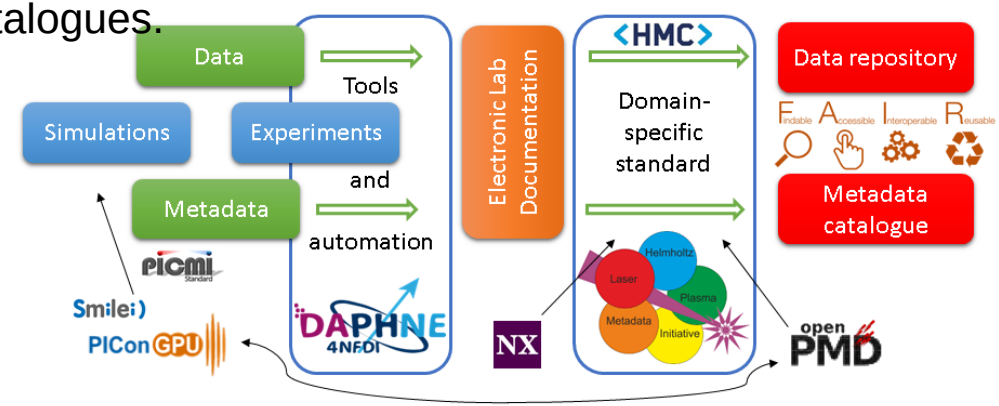
DAPHNE4NFDI – TA1: ExL

Experiment Logging (without Excel)



Lessons learned

- Adoption of more specific NeXus classes is not easy: 1) Understand original use case. 2) Conceive your use case. 3) Map to each other.
- How to conceive new NeXus classes, ideally suitable for several communities? Support from NIAC?
- How to include/motivate volunteers from a community? Which basis to choose?
- F.A.I.R. data needs data and metadata catalogues.
- Proper website for community!
  - laser-plasma-metadata.org
- Workshops!
  - indico.gsi.de/e/helpmi-workshop-2024

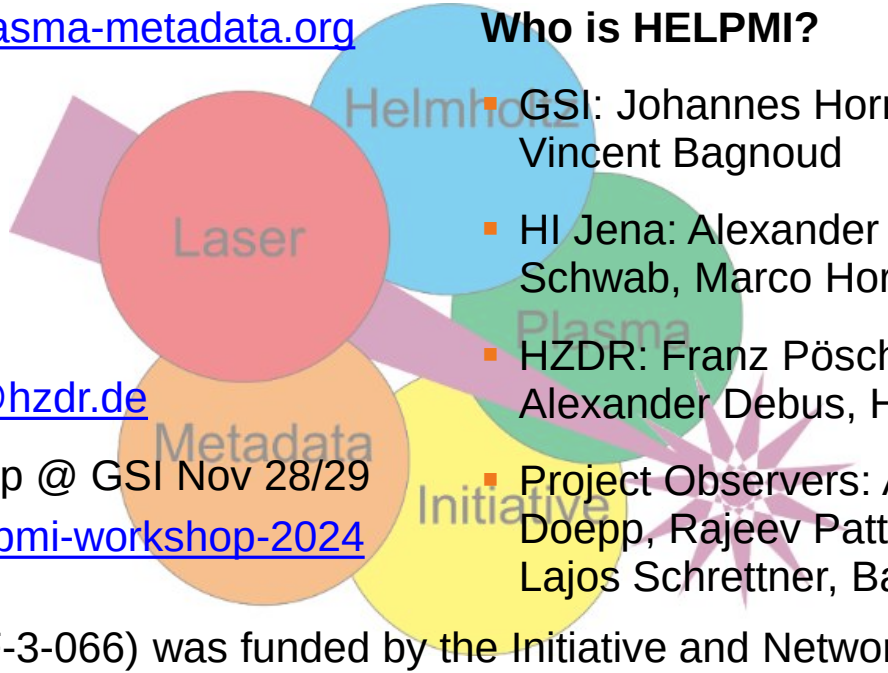


Partners and related projects

- openPMD: open Particle Mesh Data, open standard for PIC (and more)
- NeXus: system of standards from synchrotron and neutron facilities
- LASY.org: package for (standardized) laser pulse modelling in PIC simulations, can take measured data and uses openPMD format → add HELPMI terms
- plasma-MDS: simple schema, partly applicable to LPA, but completely new applications
- NEILS (network of extremely intense laser systems)
- ELI (European research infrastructure)
- THRILL (EU project on high-repetition rate lasers)

Acknowledgements

- Read more: laser-plasma-metadata.org
- Contact us: helpmi@hzdr.de
- Contribute: Workshop @ GSI Nov 28/29
  - indico.gsi.de/e/helpmi-workshop-2024



Who is HELPMI?

- GSI: Johannes Hornung, Udo Eisenbarth, Vincent Bagnoud
- HI Jena: Alexander Kessler, Matthew Schwab, Marco Hornung, Malte Kaluza
- HZDR: Franz Pöschel, Michael Bussmann, Alexander Debus, Hans-Peter Schlenvoigt
- Project Observers: Axel Huebl, Andreas Doepp, Rajeev Pattathil, Birgit Plötzeneder, Lajos Schrettner, Balázs Bagó

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