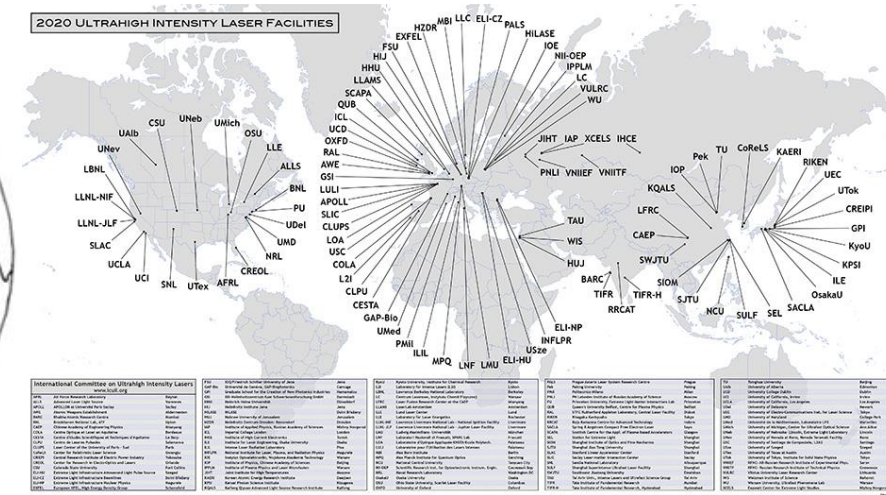
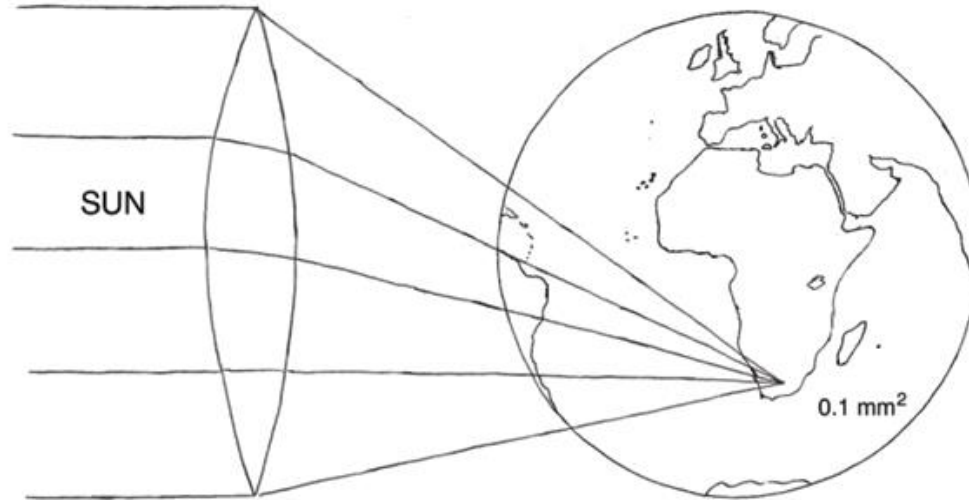


HELPMI: the Helmholtz Laser-Plasma Metadata Initiative

Start developing a data standard for the global LPA community

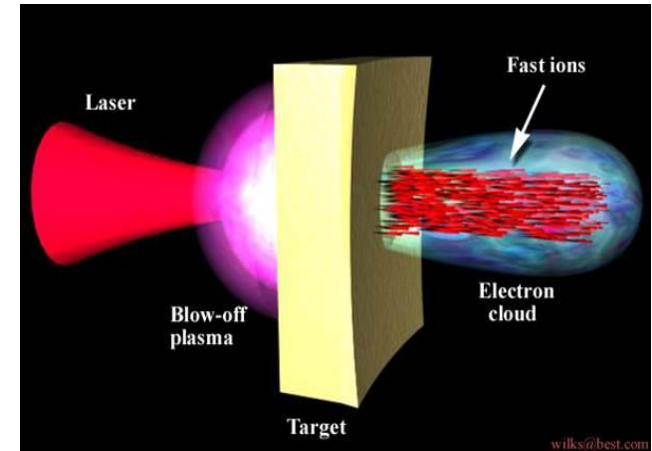
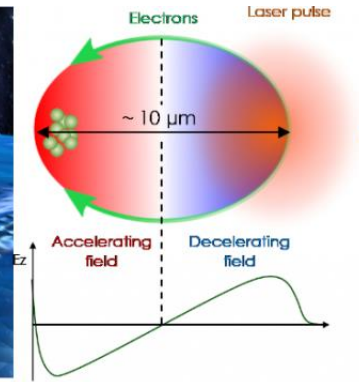
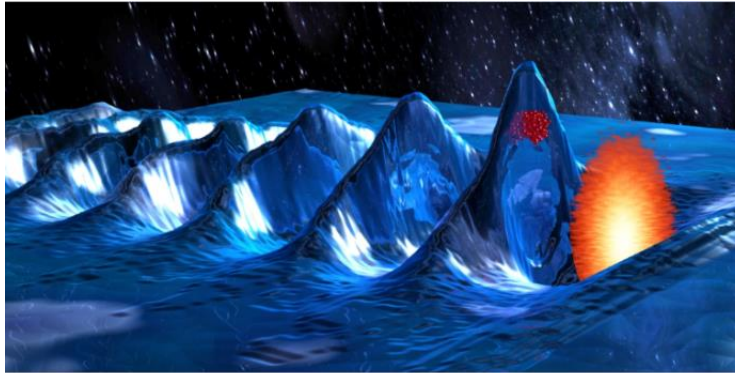
- Ultra-intense lasers can transform plasmas into particle-accelerating structures
 - Ultra-short (fs-ps), Joule-kJ laser facilities: high peak-power, ICUIL.org
 - Chirped pulse amplification (invented 1985, Nobel prize awarded 2018)



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

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

- 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

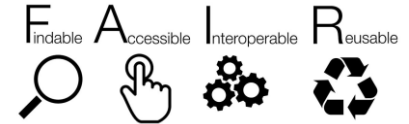


<https://loa.ensta-paris.fr/research/upx-research-group/laser-wakefield-acceleration-lwfa/>

HELPMI: Main Goals

2023-2025, GSI+HIJ+HZDR

- 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

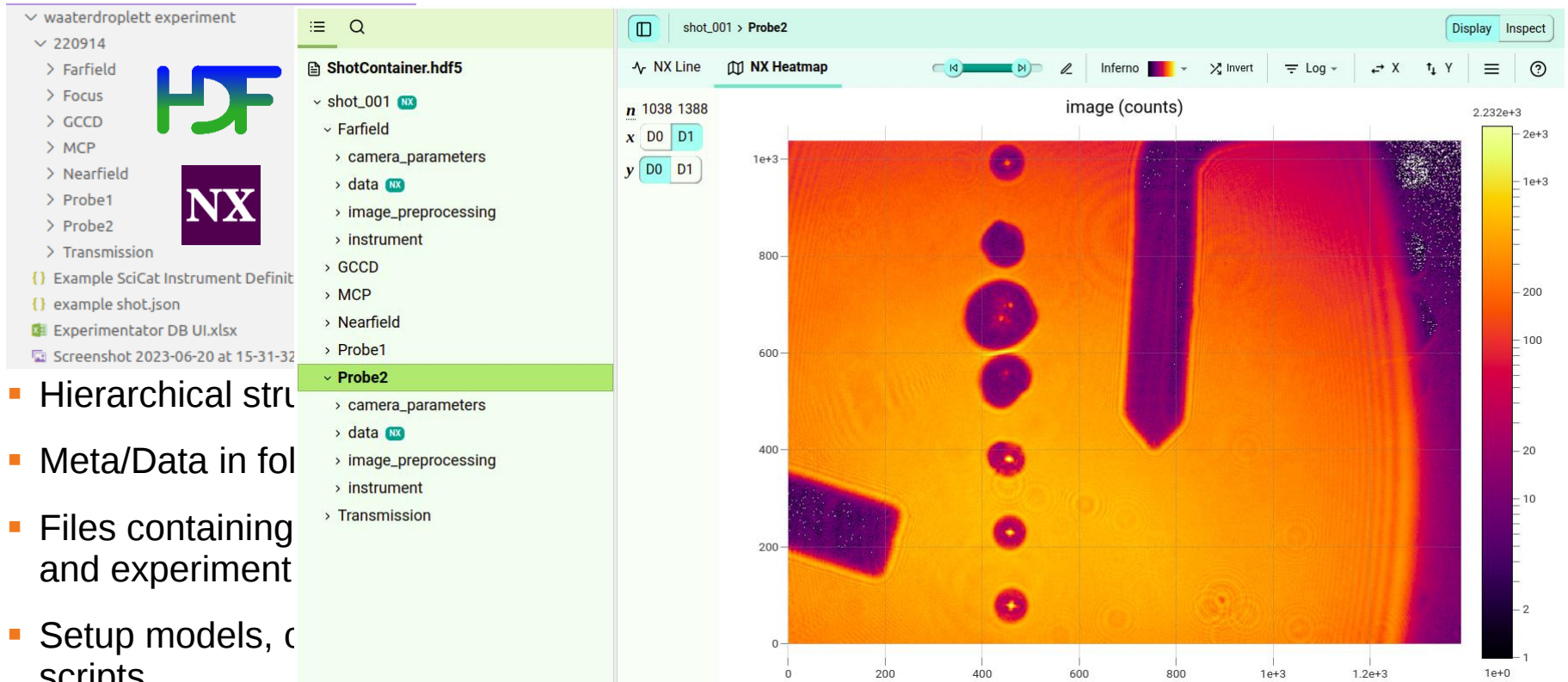


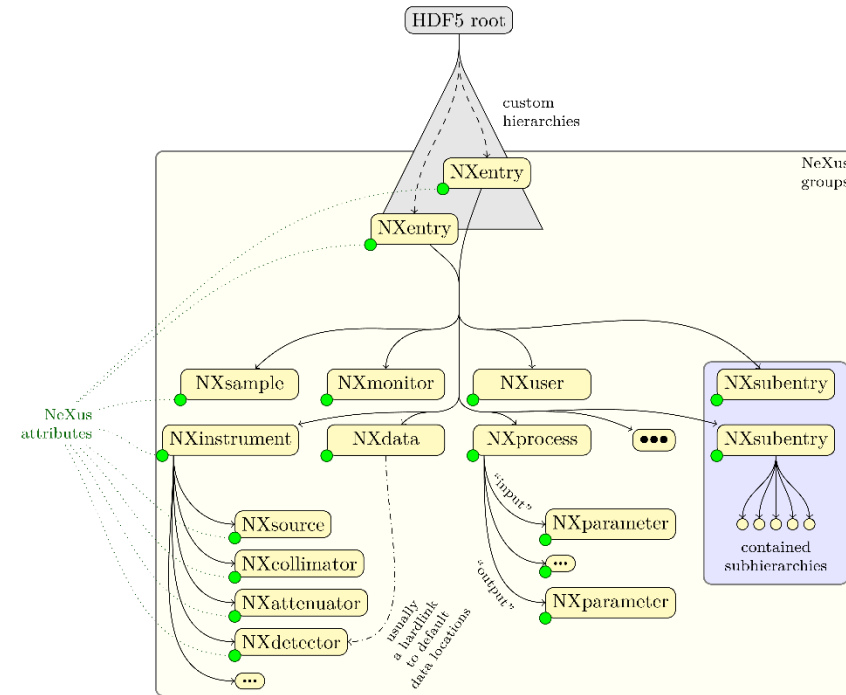
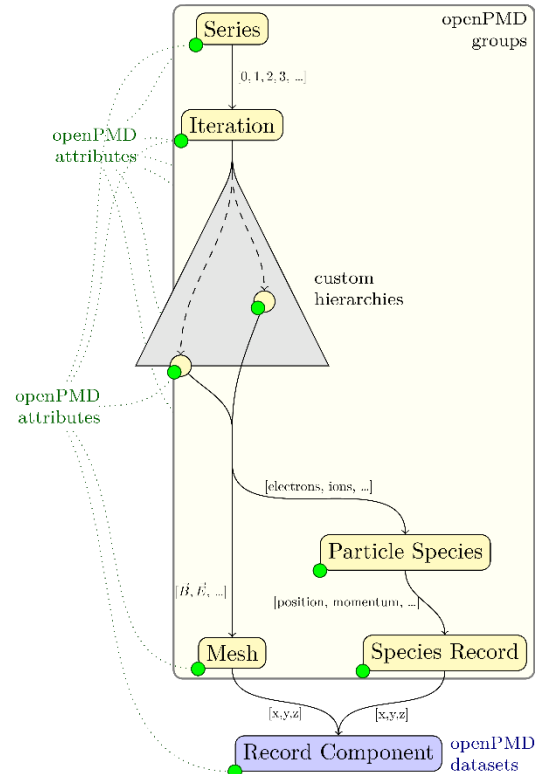
„an umbrella over a family of standards, currently for experiment data in the Photon and Neutron science community“



HELPMI: NeXus adoption

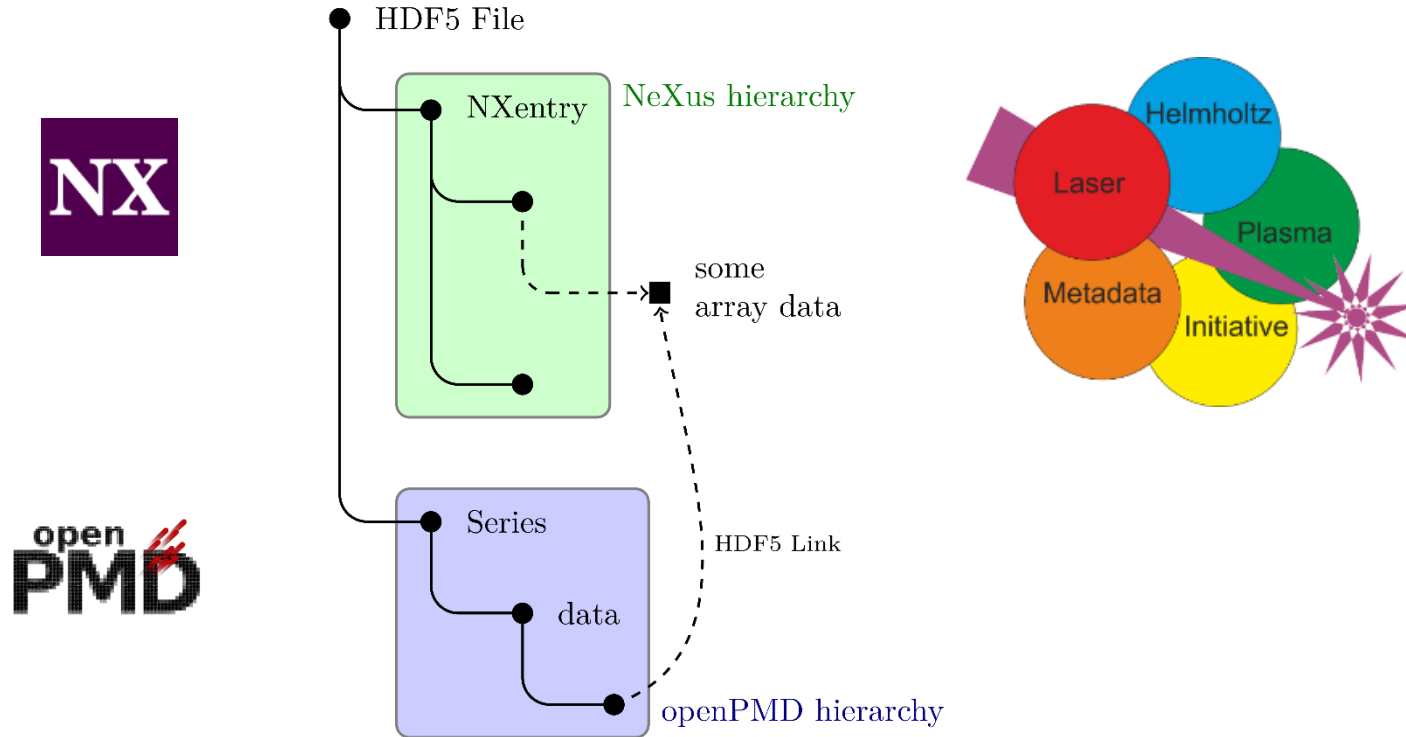
NXdata is awesome feature, scientific classes strongly bound to PaN





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

Bi-lingual hdf5 file



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

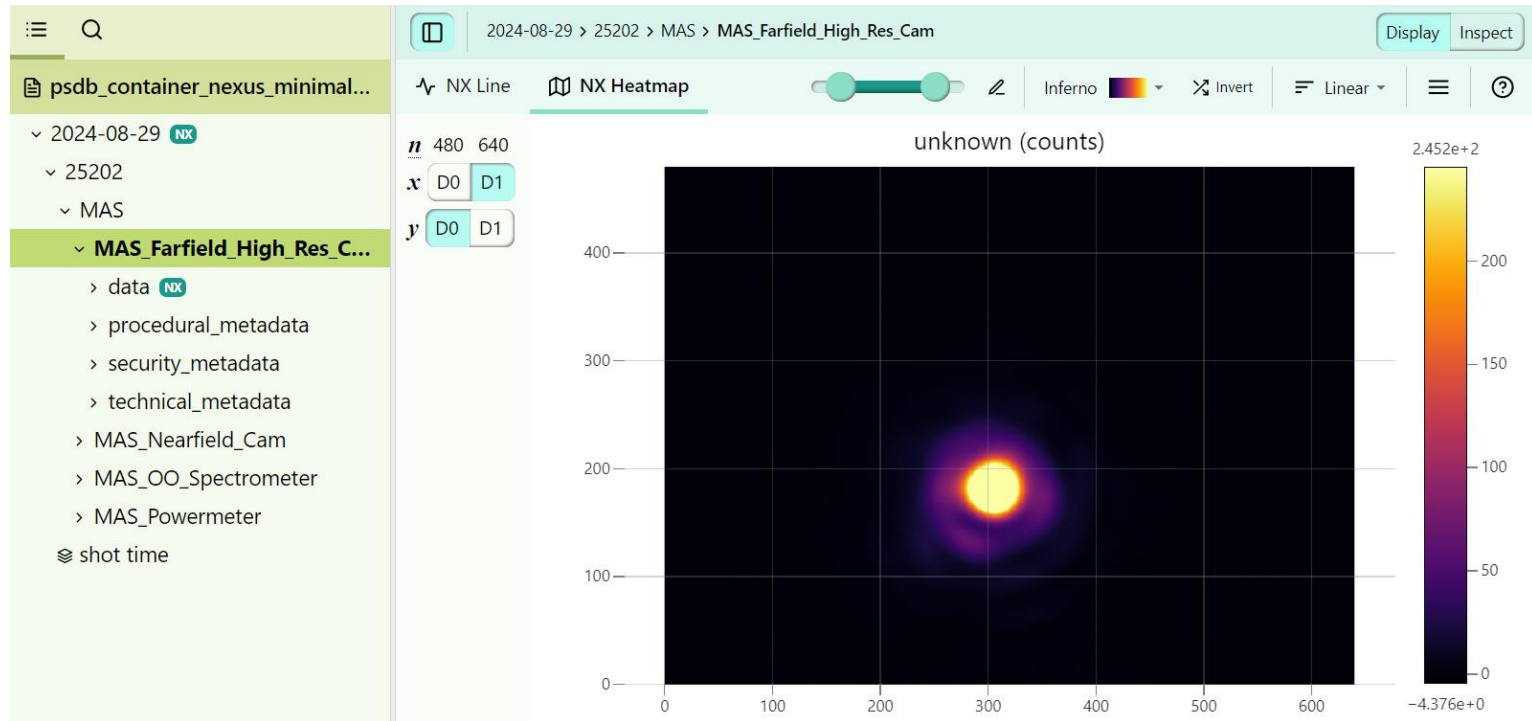
Needs involvement of
(interested) community.

Unclear what kind of format
and platform.

Template.....	2
Feedback.....	3
Detectors.....	3
Standard CCD/CMOS.....	3
Focus Diagnostic.....	4
Wavefront Sensor.....	4
Gateable CCD.....	5
Streak Camera.....	6
Spectrometer – Photon.....	6
Spectrometer – Electron.....	7
Spectrometer – Proton/Ion.....	8
Thomson Parabola Spectrometer.....	8
Wizzler.....	9
WFA.....	10
HAULE.....	10
FROG.....	11
2 nd Order Autocorrelator.....	12
2 nd Order Autocorrelator for Measurement of Pulse Front Tilt, e.g., TiPa from Light Conversion.....	12
3 rd Order Autocorrelator (Sequoia, Tundra).....	13
Scintillator Screen (electron pointing diagnostic).....	13
Temperature Sensor.....	13
Vibration Sensor.....	14
Humidity Sensor.....	14
Photodiode.....	14
Quadrant Detector.....	15
Vacuum Sensor.....	15
Devices.....	15
Linear Motor Stage (stepper, piezo, etc.).....	15
Rotation Stage.....	16
Mechanical Shutter (only template).....	16
Electro-Optical Shutter (only template).....	17
Spatial Filter.....	17
Spectral Filter (only template).....	18
Amplitude Filter (only template).....	18
Polarizer Filter.....	18
Beam Splitter (only template).....	19
Generic Optic (only template).....	19
Targets.....	19

HELPMI: Current status

Example data out of PSBD with DDC key-value pairs



DAPHNE4NFDI – TA1: ExL

Experiment Logging (without Excel)

Add Shot

[Add Shot](#) [Modify Shot](#) [Add/Modify Settings](#) [Add/Modify Diagnostics](#) [Add/Modify Form Layout](#) [Search](#)

ShotSheet [Load Data of First Shot](#) [Load Data of Previous](#) [Load Data of Next](#) [Load Data of Last Shot](#) [Reset All](#)

Campaign **[XFEL Jets 2023 (2023-09-04 to 2023-09-11)]** Shots in campaign: **0** Go to Shot Number: **Go**

Shot identification

Shot Count: 0

This Shot **1**

Date and Time **2023-08-25 09:04:12** ctrl+click

Laser parameters

GVD (fs²)

Laser Energy (J)

Plasma Mirror? ☐

TW Intensity

TOD (fs²)

TW Delay

Interaction parameters

TRO (deg)

TFO (μm)

Target details

Target (choices read from mediawiki)

T157 (Type: '15 μm W wire', Thickness: '15 μm')

Post-shot readout

RamIon (μSv)

Proton Energy TPS 45 (MeV)

Proton Energy TPS 15 (MeV)

Time of flight (ns)

Proton Energy from TOF (MeV)

Measured GVD (fs²)

Measured TOD (fs³)

Comments:

Quality

Good
OK
Bad
Calibration

Scan Type

Z-Scan
E-Scan
GVD-Scan
TOD-Scan

Diagnostics

BS 0

ColorCam TCC

NF PM Bulli

Profiler3

CosCorr

Spec Elec Prof

TPS 15 MCP

Trans Lanex

Trans Spect 2w

Diagn Shutter

XUV Setup

BS -32

FF after top DD

FTSI

Ref1 1w

SPEBS 0

SPEM

TPS 45

Trans 1w

Ge X spect

FTSI Setup

BS 20

FF Spider

ProtProf weak

Ref1 2w

SPEBS -32

XUV MCP

TPS 45 Lanex low

Trans 2w

Ross Filter pair

Pickoff Att

CeramicCam

FF PM Bulli

ProtProf strong

Ref1 Spect

SPEBS 20

TPS 15

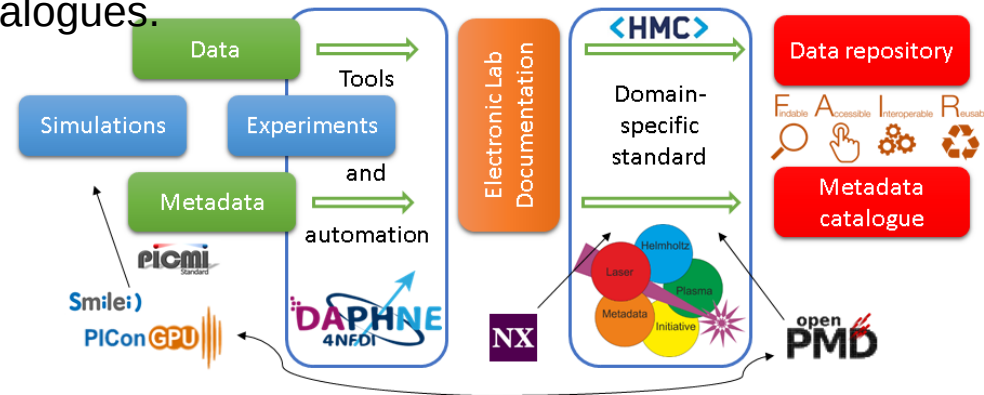
TPS 45 Lanex high

Trans Spect

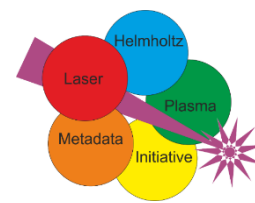
SinglePhoton Spect

ProtProf Setup

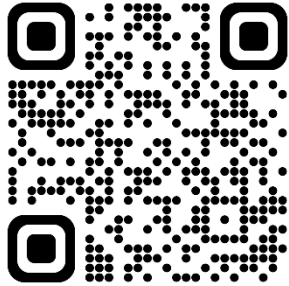
- Adoption of more specific NeXus classes is not easy: 1) Understand original use case. 2) Conceive your use case. 3) Map to each other.
- How to conceive new NeXus classes, ideally suitable for several communities? Support from NIAC?
- How to include/motivate volunteers from a community? Which basis 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



- [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)



- 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
- This project (ZT-I-PF-3-066) was funded by the Initiative and Networking Fund of the Helmholtz Association in the framework of the Helmholtz Metadata Collaboration project call.