

Dark Matter experiment ALPS IIc

Setup, DAQ, HDF5 & NeXus

Sven Karstensen,
Control System for the F-Devision (research)
DESY

DMA ST1 synergy workshop
09.11.2023

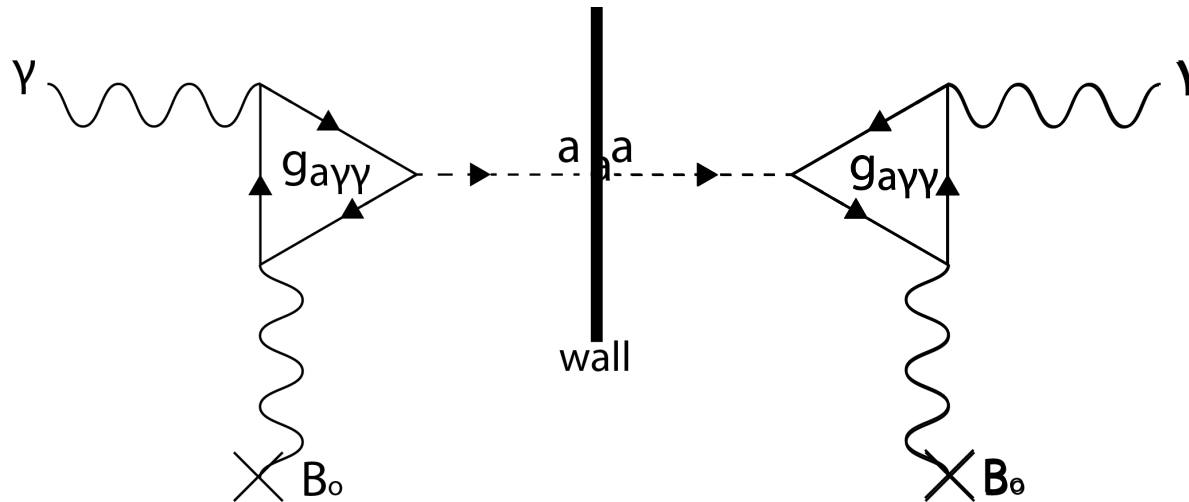


ALPS IIc

an experiment for finding Axions



Axion detection method



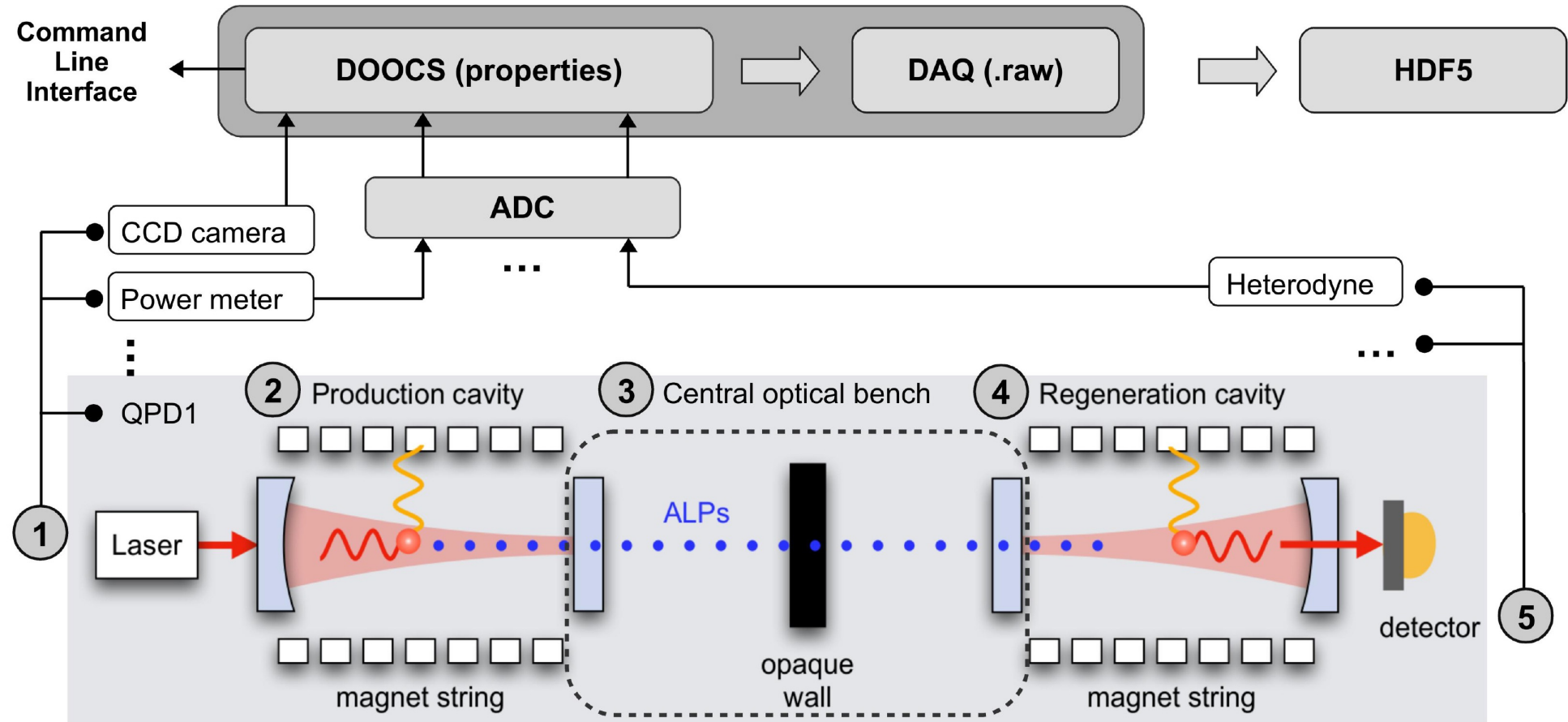
a = Axion

B_0 = magnetic field

γ = Photon

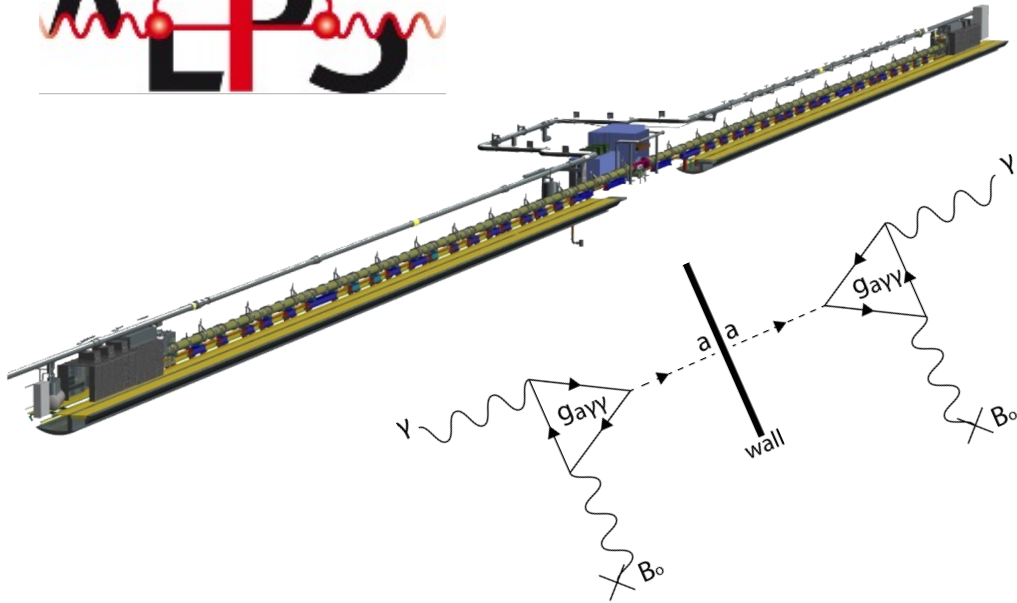
g = interaction coupling constant

Experiment Setup

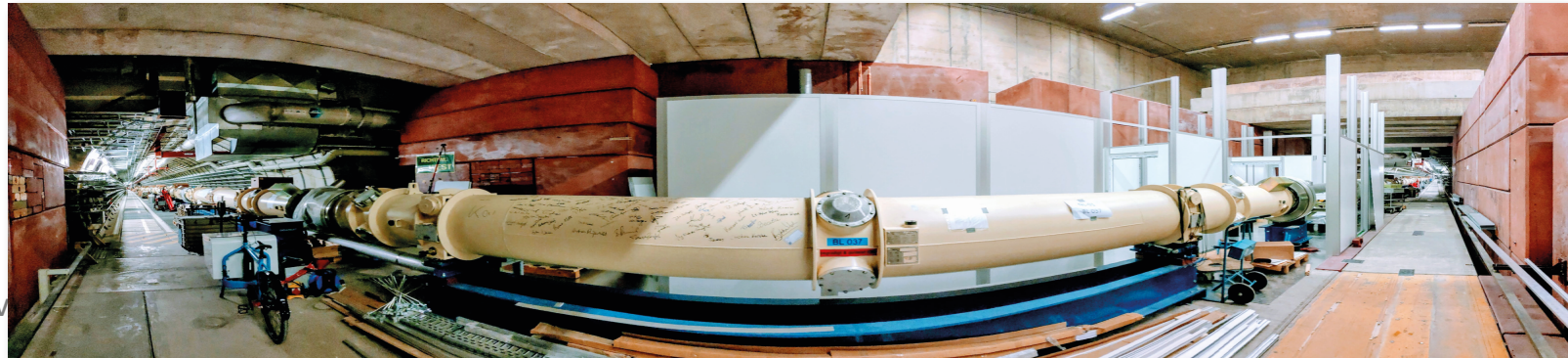


About ALPS IIc

Light Through The Wall experiment



Location: HERA North
Overall length: ~280m



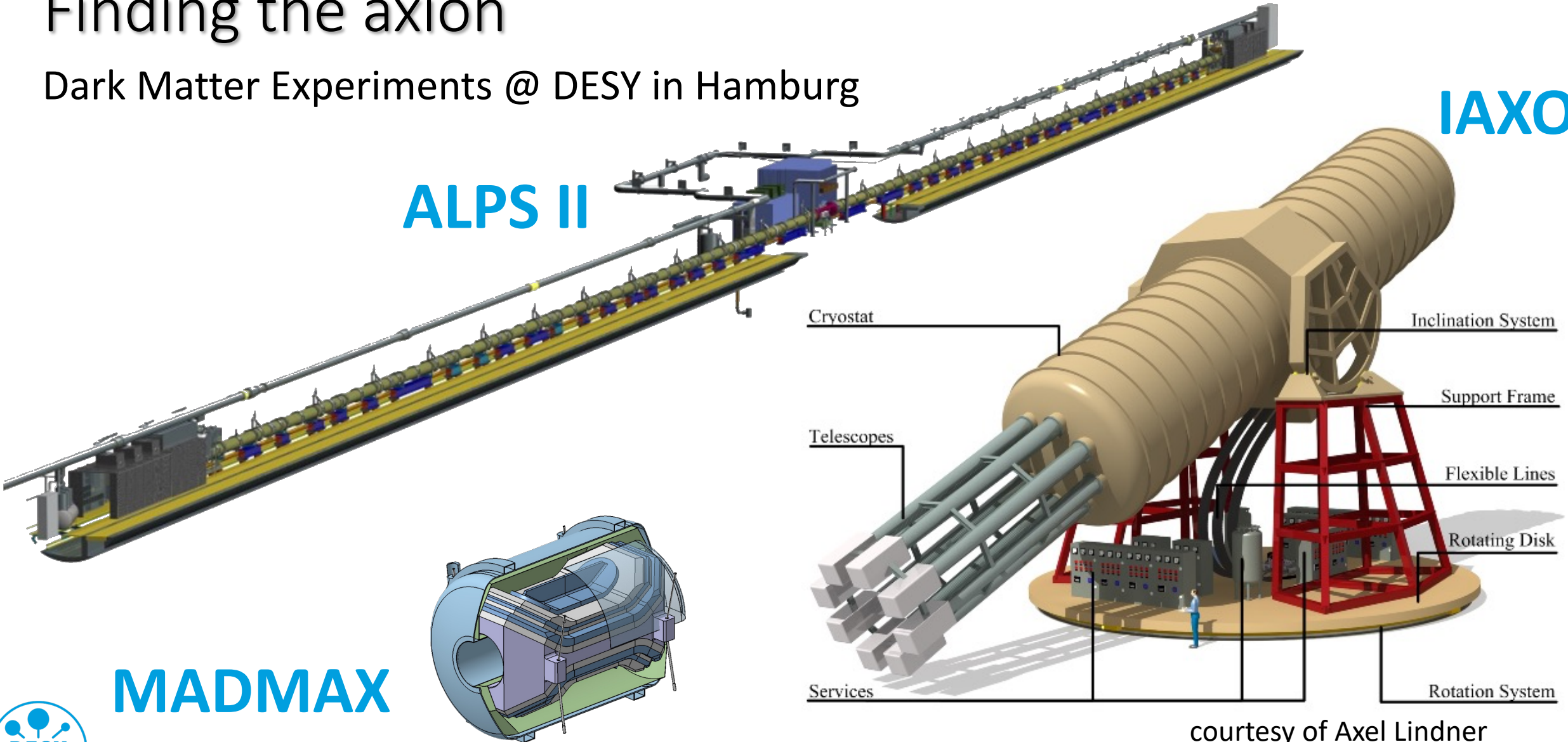
HELMHOLTZ RESEARCH FOR
GRAND CHALLENGES

Finding the axion

Dark Matter Experiments @ DESY in Hamburg

ALPS II

IAXO



MADMAX

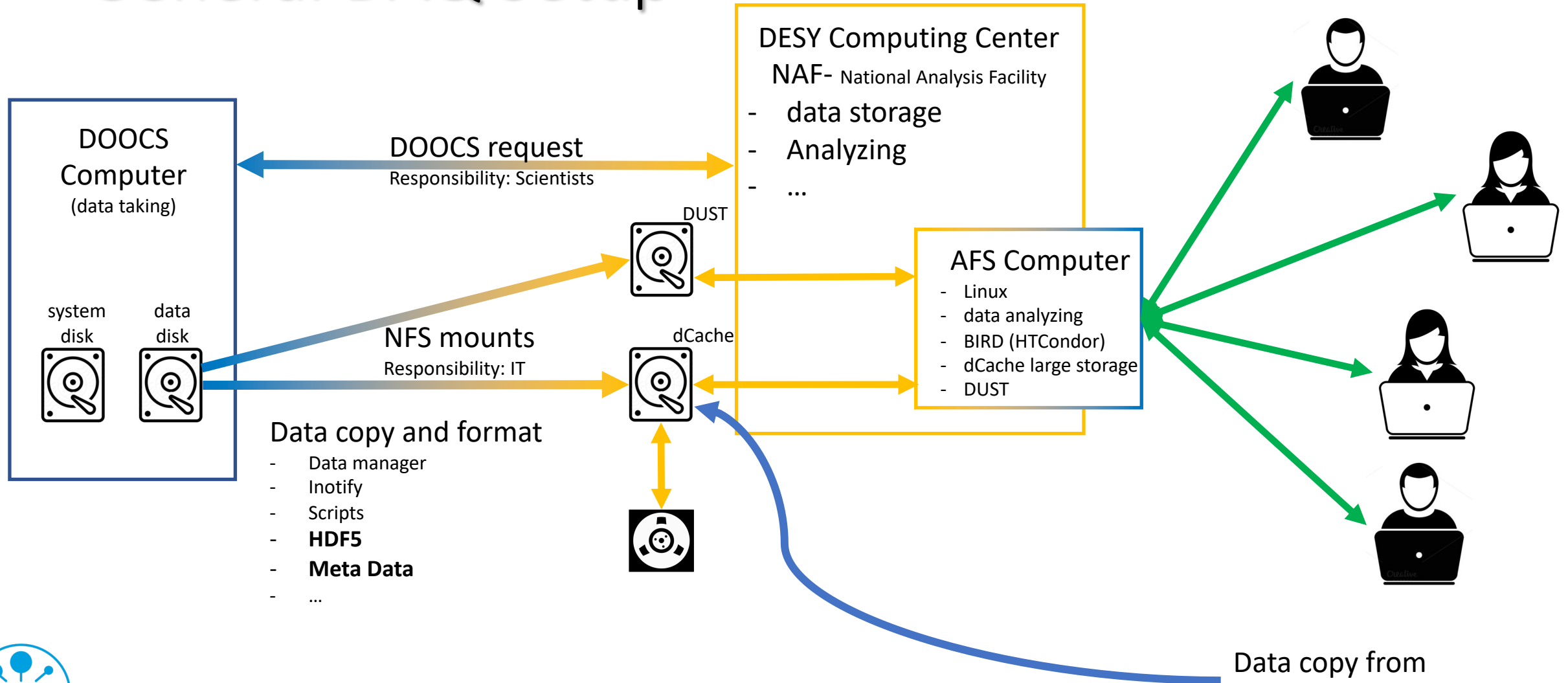
courtesy of Axel Lindner

Sven Karstensen, DESY, DMA ST1 synergy workshop

DAQ



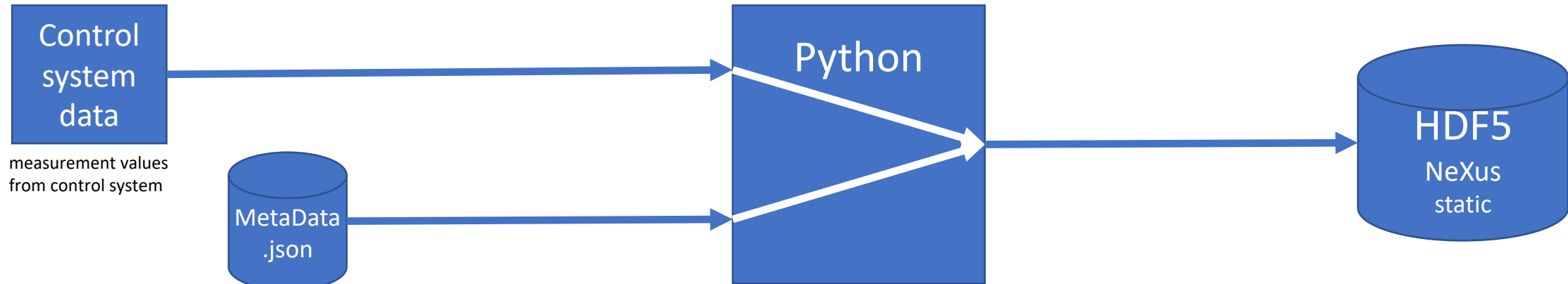
General DAQ Setup



Creating HDF5 files from DOOCS control system data



Status today



measurement values
from control system

MetaData
.json

Python

HDF5
NeXus
static

Manual metadata:

Manual program code:

```
{
  "name": "alps_mokupro1",
  "type": "Moku:Lab ",
  "manufacturer": "Liquid Instruments",
  "model": "Moku:Pro",
  "serialNo": "187",
  "firmware": "",
  "productionDate": "",
  "version": "",
  "installation_date": "",
  "documentation": "https://www.liquidinstruments.com/product/mokupro/",
  "installation_location": "HERA NL; PMC laser lock box",
  "formfactor": "desktop device",
  "miscellaneous": {
    "hardware": {
      "hostname": "alps_mokupro1.desy.de",
      "mac_address": "78-69-79-B0-03-50",
      "D00CS_server1": "tcp_fed_server"
    }
  },
  "data": [
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Sven Karstensen

HDF structure – NeXus format

The screenshot shows the HDFView 3.1.2 application window. The left pane displays a hierarchical tree of the HDF5 file structure. The right pane shows the 'Object Attribute Info' for the selected object, 'ADC.HN.1', listing 13 attributes.

HDFView 3.1.2

File Window Tools Help

Recent Files: /home/sven/python_scripts/doocsdaq_raw2hdf5_mpi/hdf5out/471

Object Attribute Info General Object Info

Attribute Creation Order: Creation Order NOT

Number of attributes = 13

Name	Type
DOOCS_name	String, length = variable, pa
NXclass	String, length = variable, pa
documentation	String, length = variable, pa
firmware	String, length = variable, pa
formfactor	String, length = variable, pa
installation_date	String, length = variable, pa
installation_location	String, length = variable, pa
manufacturer	String, length = variable, pa
model	String, length = variable, pa
productionDate	String, length = variable, pa
serialNo	String, length = variable, pa
type	String, length = variable, pa
version	String, length = variable, pa

HDFView root - /home/sven/python_scripts/doocsdaq_raw2hdf5_mpi
User property file - /home/sven/.hdfview3.1.2



new software for HDF5 / NeXus production



Motivation

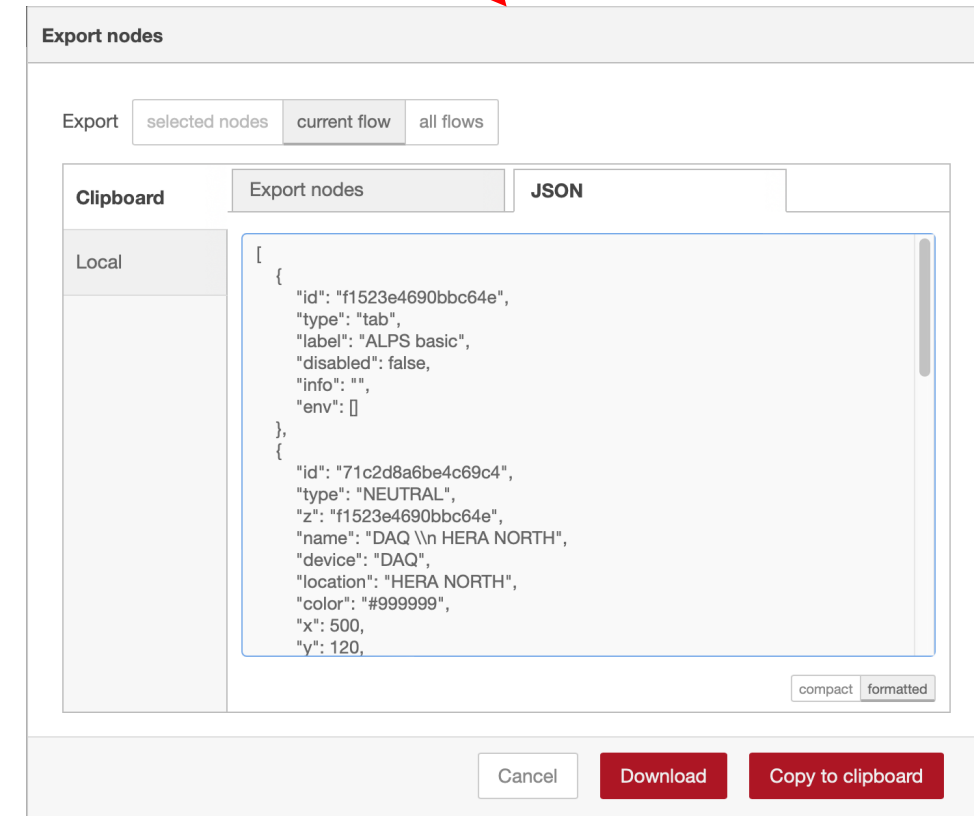
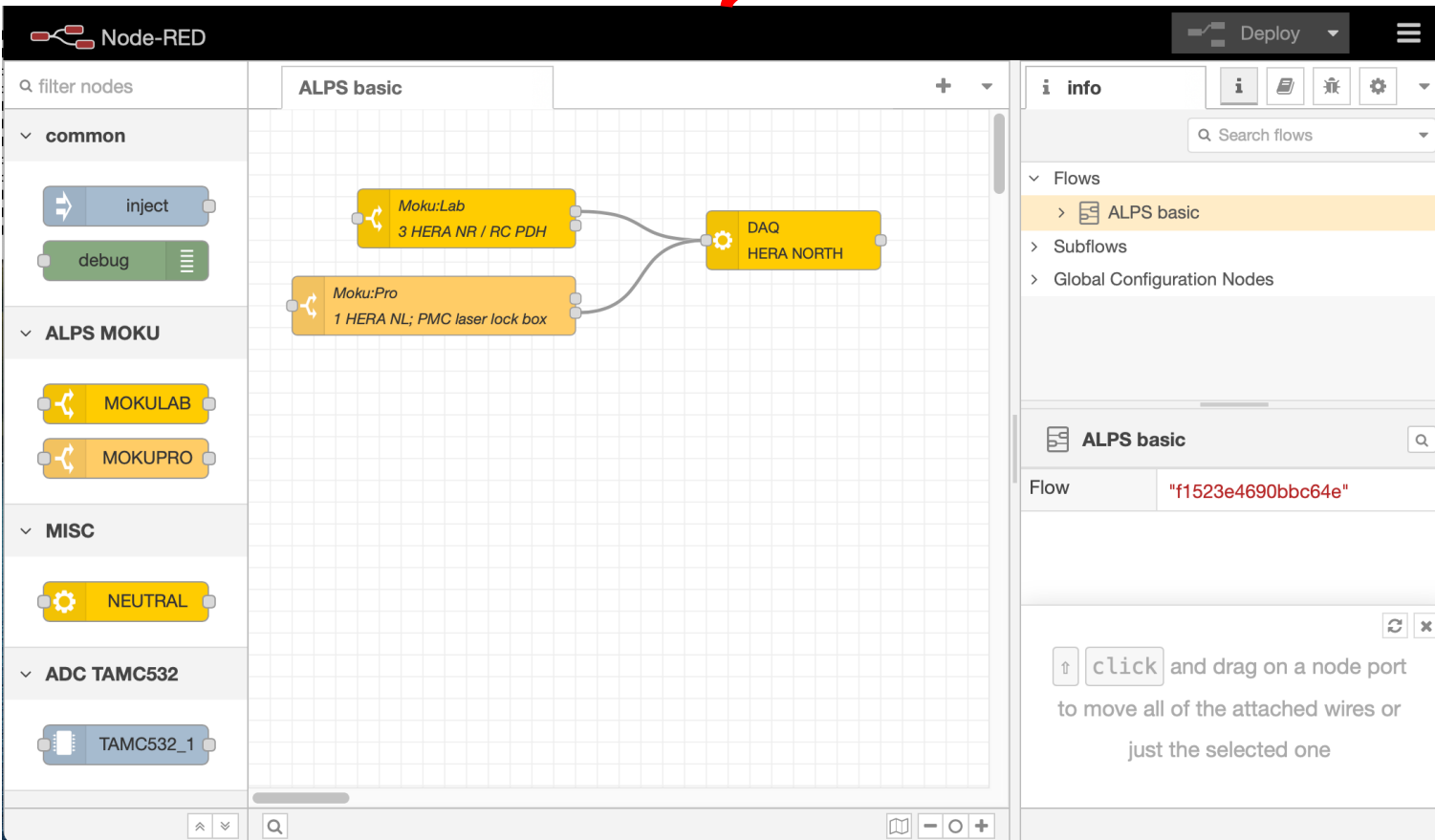
- Creating flexible HDF5 files
- Up to now everything is manual
- High error vulnerability
- Long development time
- Experts needed

Graphical generation

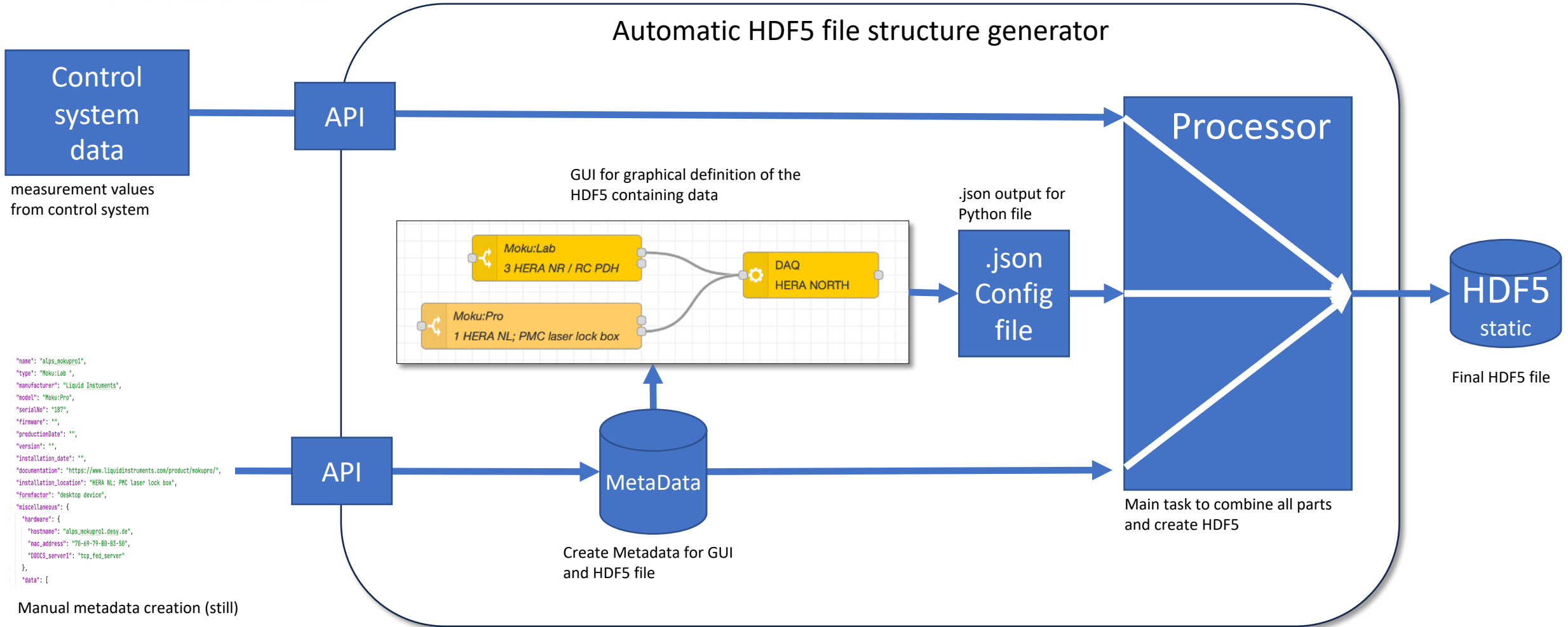
Automatic .json file
generation

.json description file

GUI



Phase 1



Summary



Summary

- following FAIR principals
- NAF
- CentOS → Alma Linux 9
- dCache
- Metadata (different for every usecase)(json)
- new tool for HDF5 creation

Thank you!



100 MHz ADC – continuous sampling rate

Measurement of 100MHz data continuously with a 4 ADC channel system

Task:

Measurement of analog signals

Sample rate: 100MHz

Trigger rate: continuously

Resolution: 16 bit

Number of channels: 4

Length of measurement: seconds - months

Expected data per one channel:

$\text{data} = 100 \text{ MHz} * 2 \text{ byte} * t$

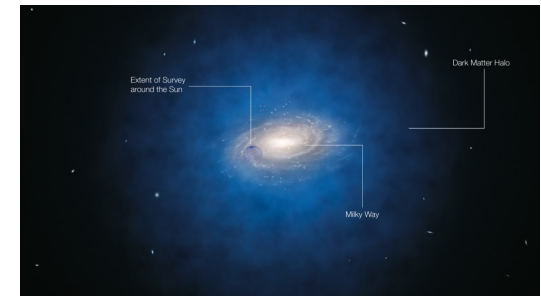
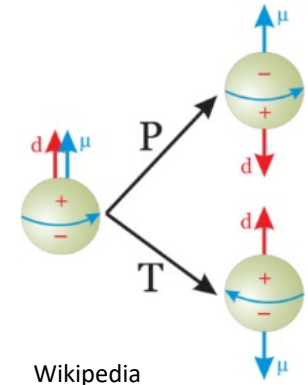
t	data (approx.) for one channel
1 sec	200 MByte
1 min	12 GByte
30 min	360 GByte
1 h	720 GByte
1 d	17.3 TByte
1 w	121 TByte
1 m	519 TByte



Why are we searching for Axions?

Axions

- could explain why neutrons do not show any electric dipole moment (“CP conservation in QCD”) (Charge + Parity; Quantum ChromoDynamics)
- could make up the dark matter of the universe
- could even be the cause behind dark energy
- could explain strange effect in the propagation of gamma rays in the universe
- could explain strange effects in the evolution of stars
- could be the last new elementary particle to be discovered in the foreseeable future
- are predicted by string theories and other “beyond standard model” theories



Three kinds of light-shining-through-walls @ DESY

Axion-photon mixing in magnetic fields

- Purely laboratory experiments, “light-shining-through-walls”, microwaves, optical photons (ALPS)
model independent axion results

- Helioscopes (IAXO)
ALPs emitted by the sun, X-rays
slightly model dependent axion results.

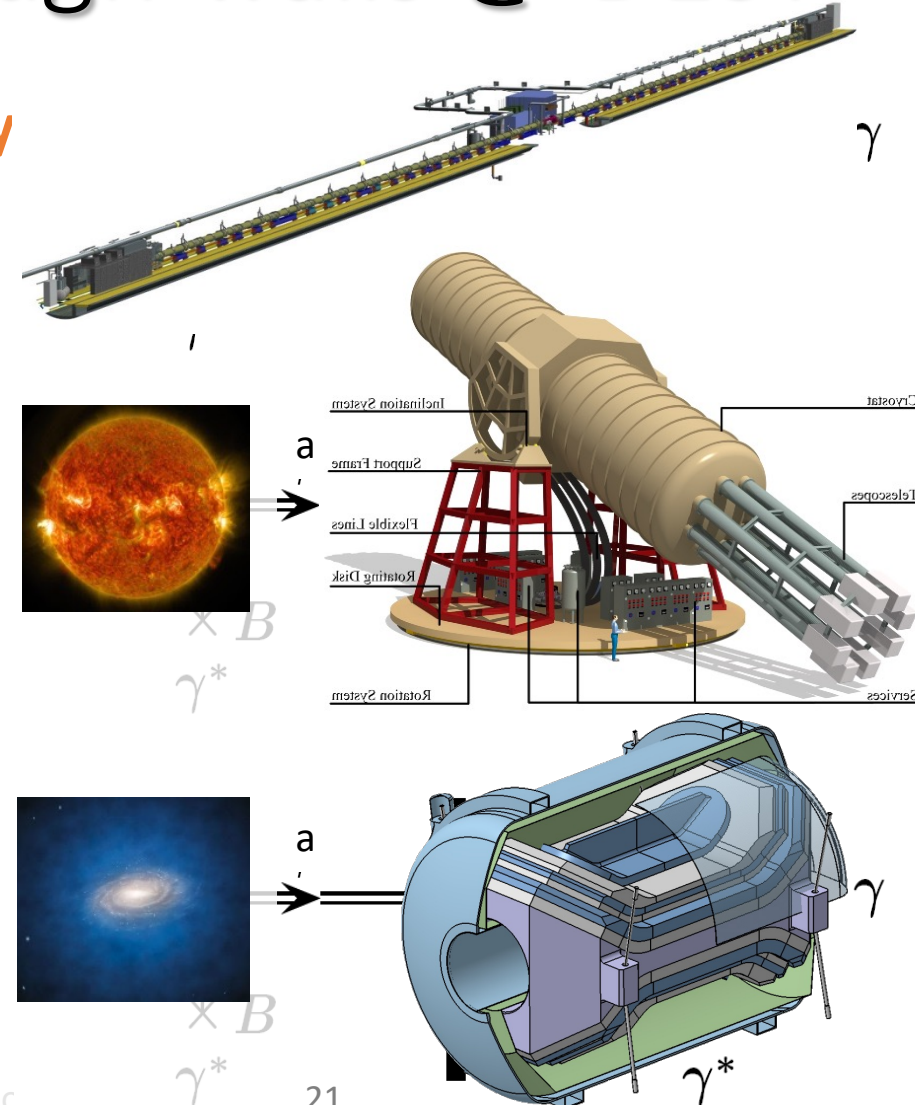
- Haloscopes (MADMAX)
looking for dark matter constituents, microwaves
model dependent axion results.

Target sensitivity

1 photon/day
exploit resonant
detection

1 photon/year

10^{-22} W
exploit resonant
detection



21
courtesy of Axel Lindner

