Dark Matter experiment ALPS IIc

Setup, DAQ, HDF5 & NeXus

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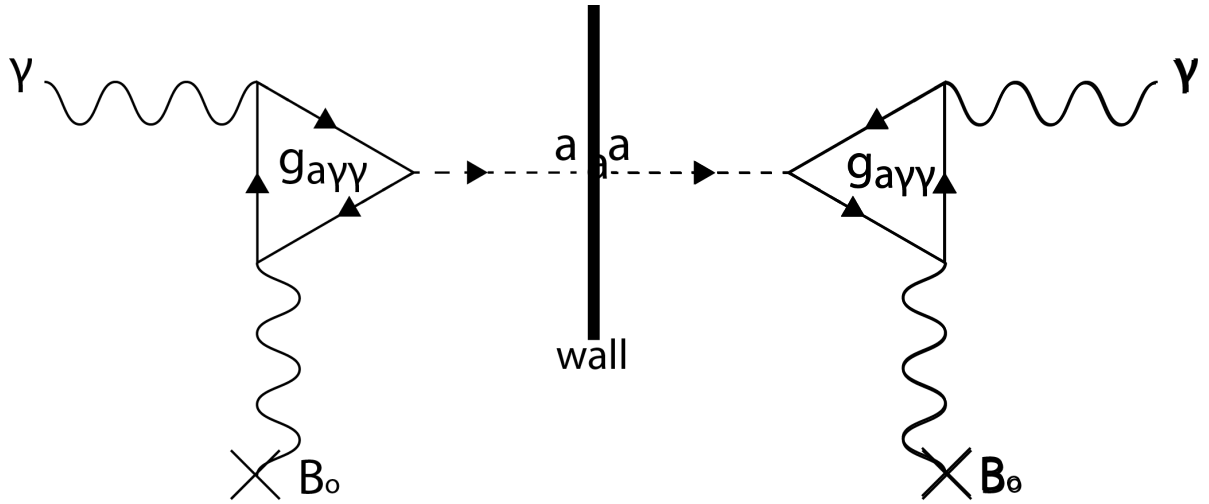
Control System for the F-Devision (research)
DESY

DMA ST1 synergy workshop
09.11.2023

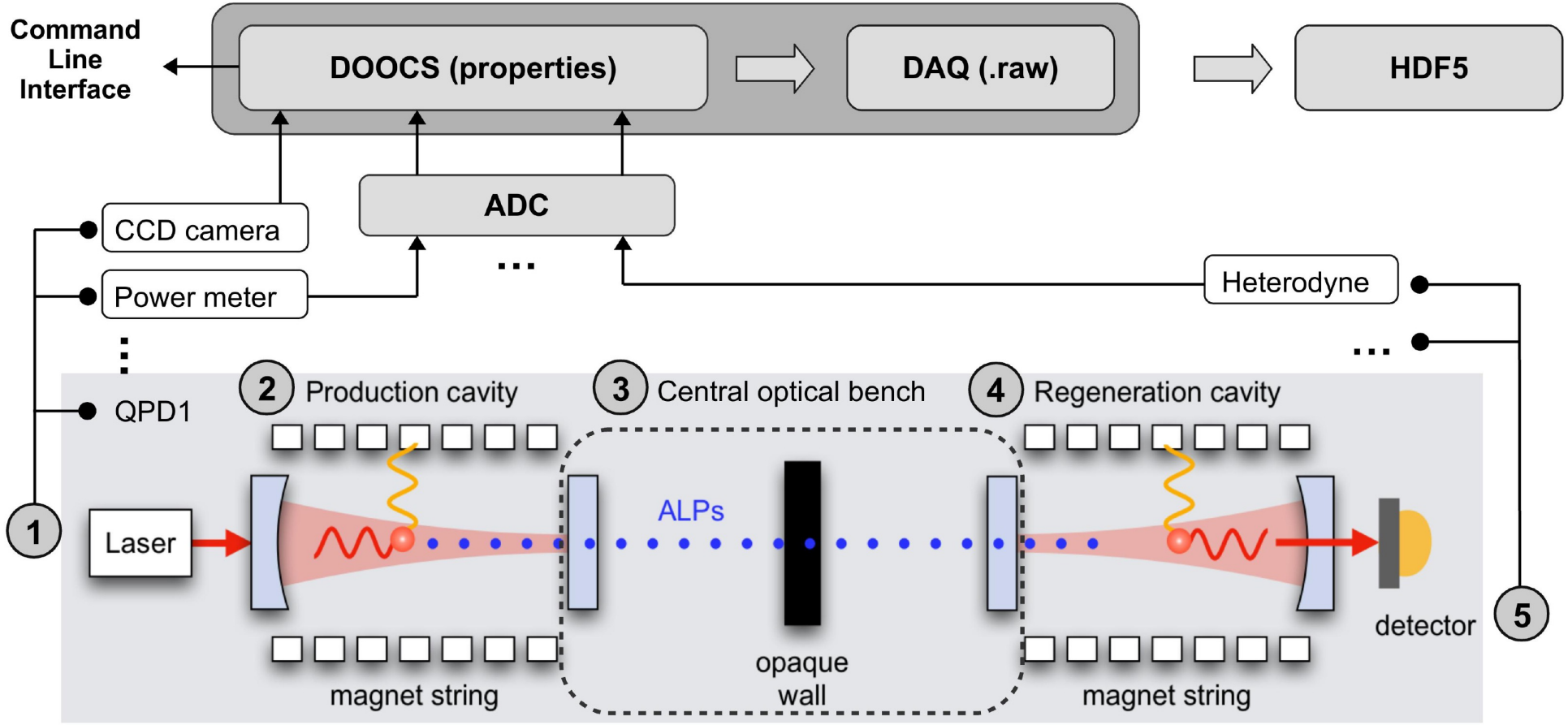
ALPS IIc
an experiment for finding Axions

Axion detection method



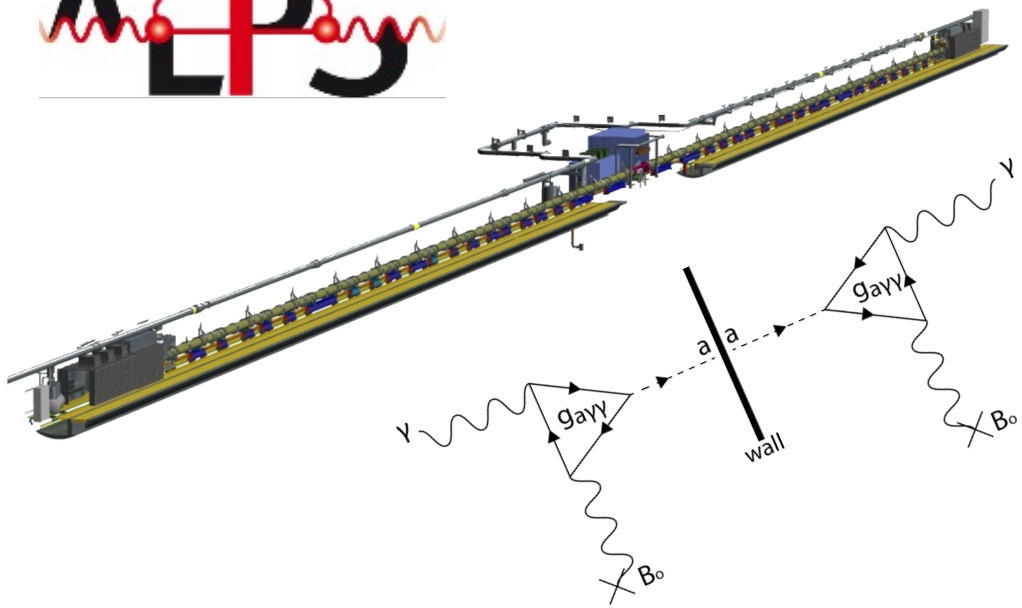
a = Axion
B_0 = magnetic field
γ = Photon
g = interaction coupling constant

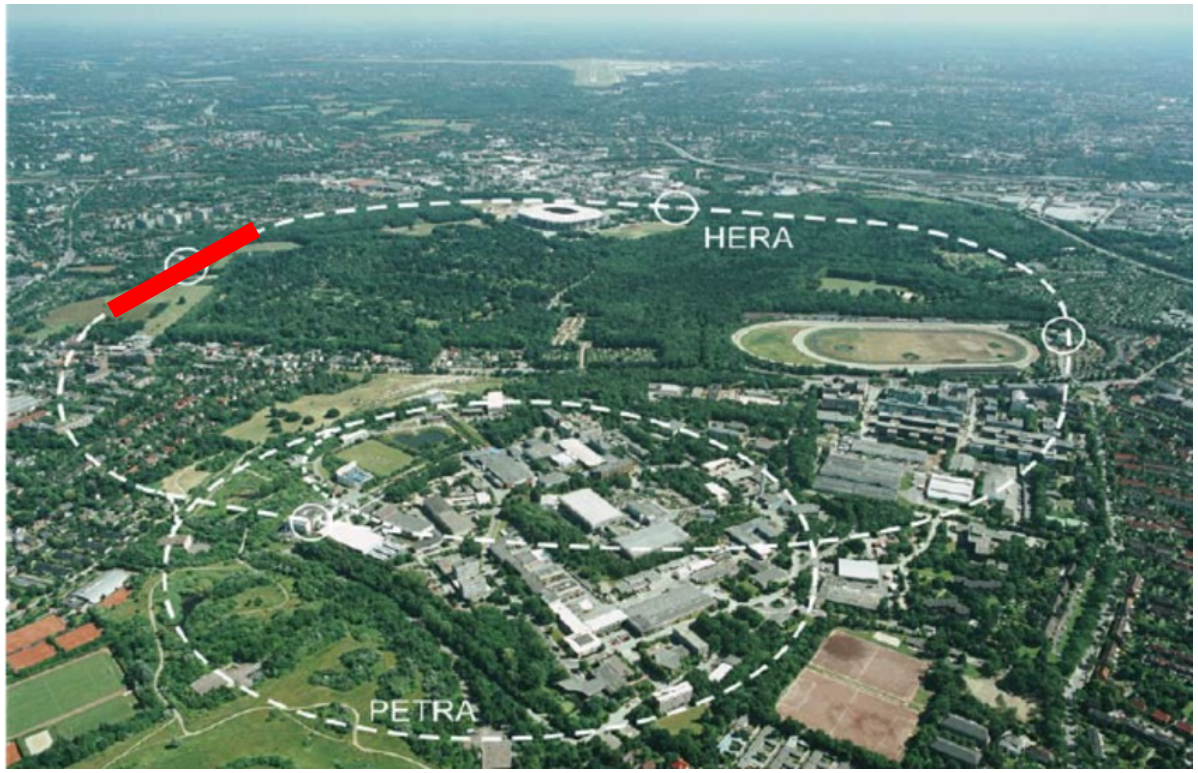
Experiment Setup



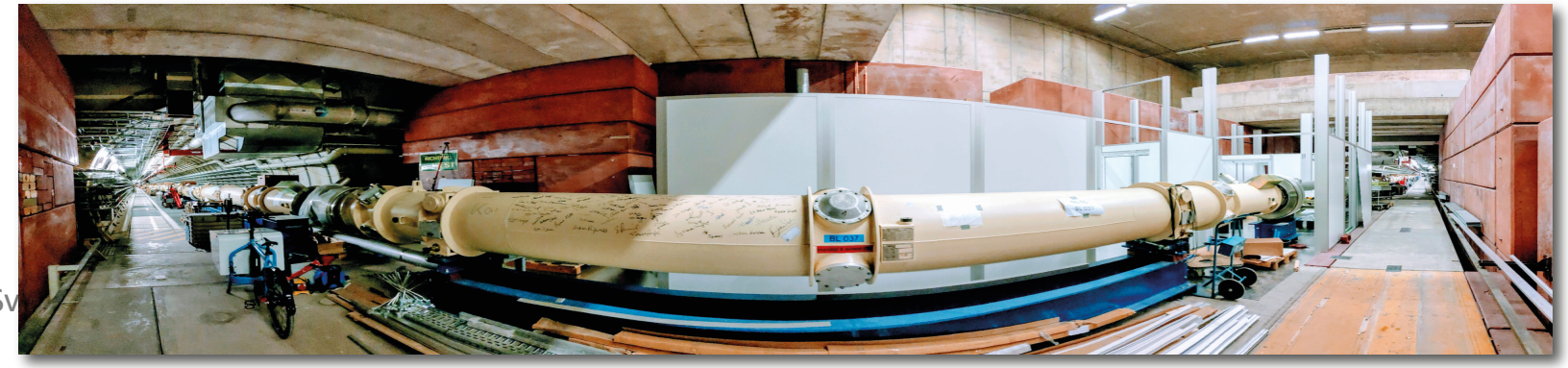
About ALPS IIc

Light Through The Wall experiment





Location: HERA North
Overall length: ~280m

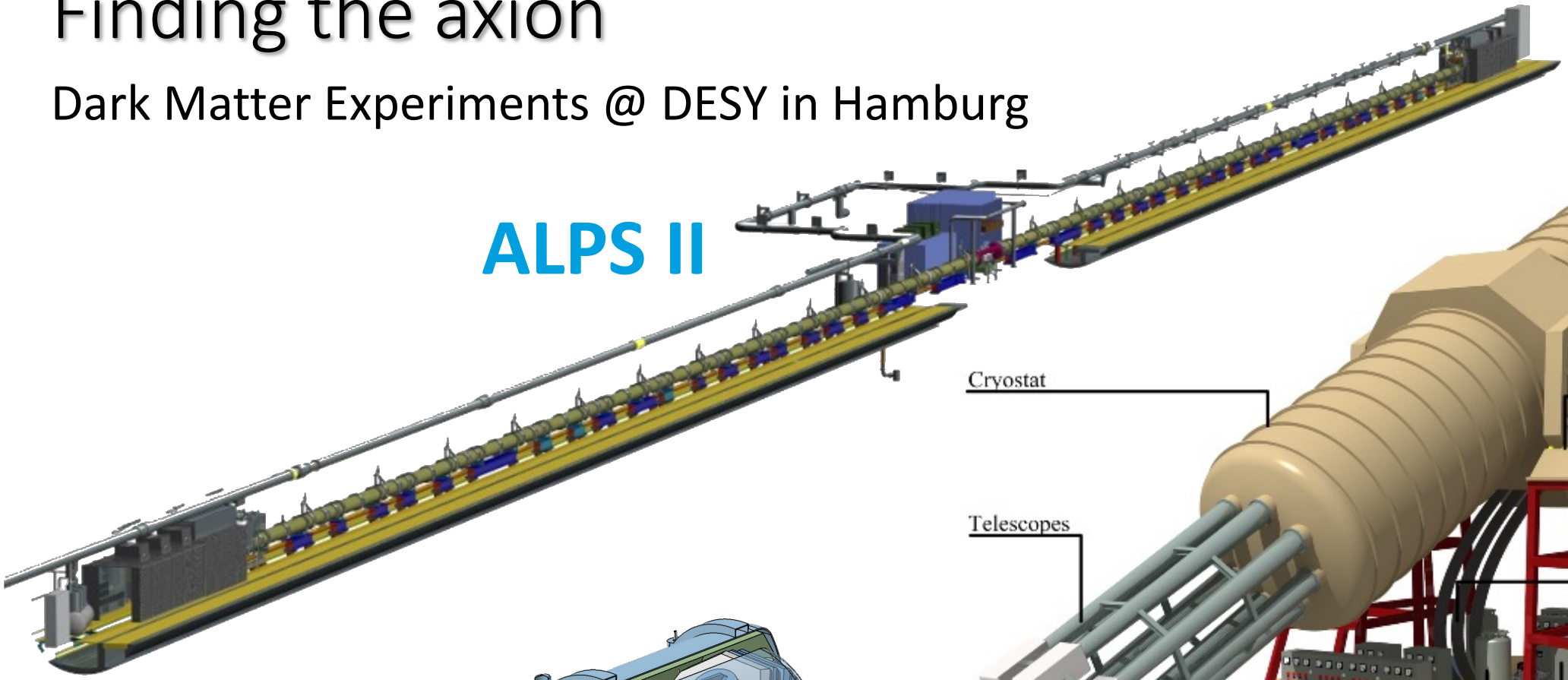


DESY. HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

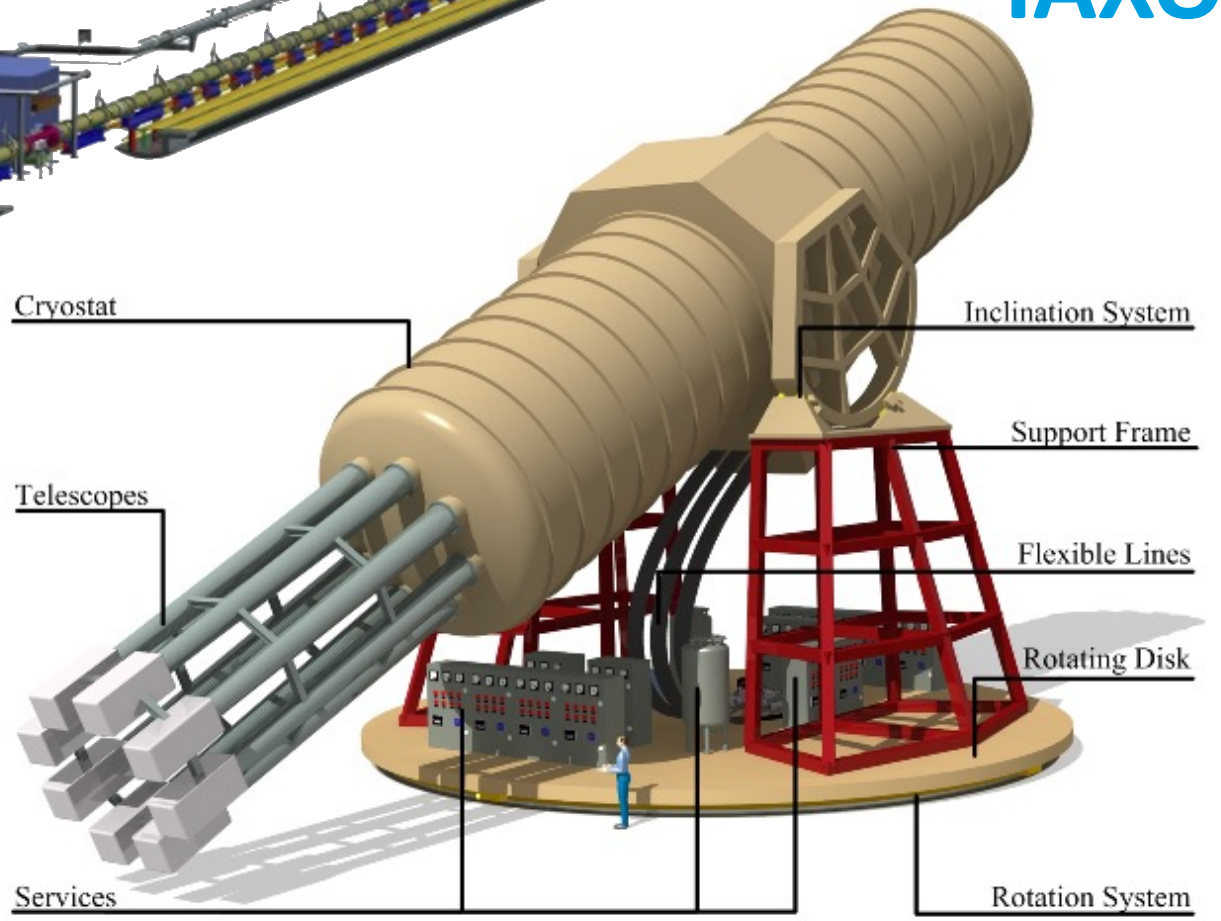
Finding the axion

Dark Matter Experiments @ DESY in Hamburg

ALPS II

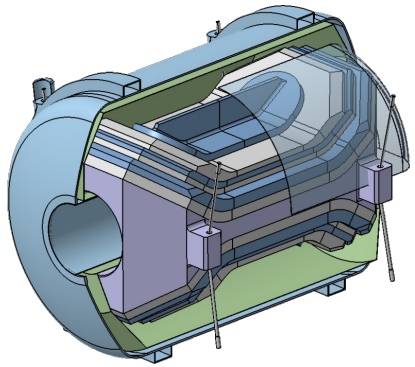


IAXO



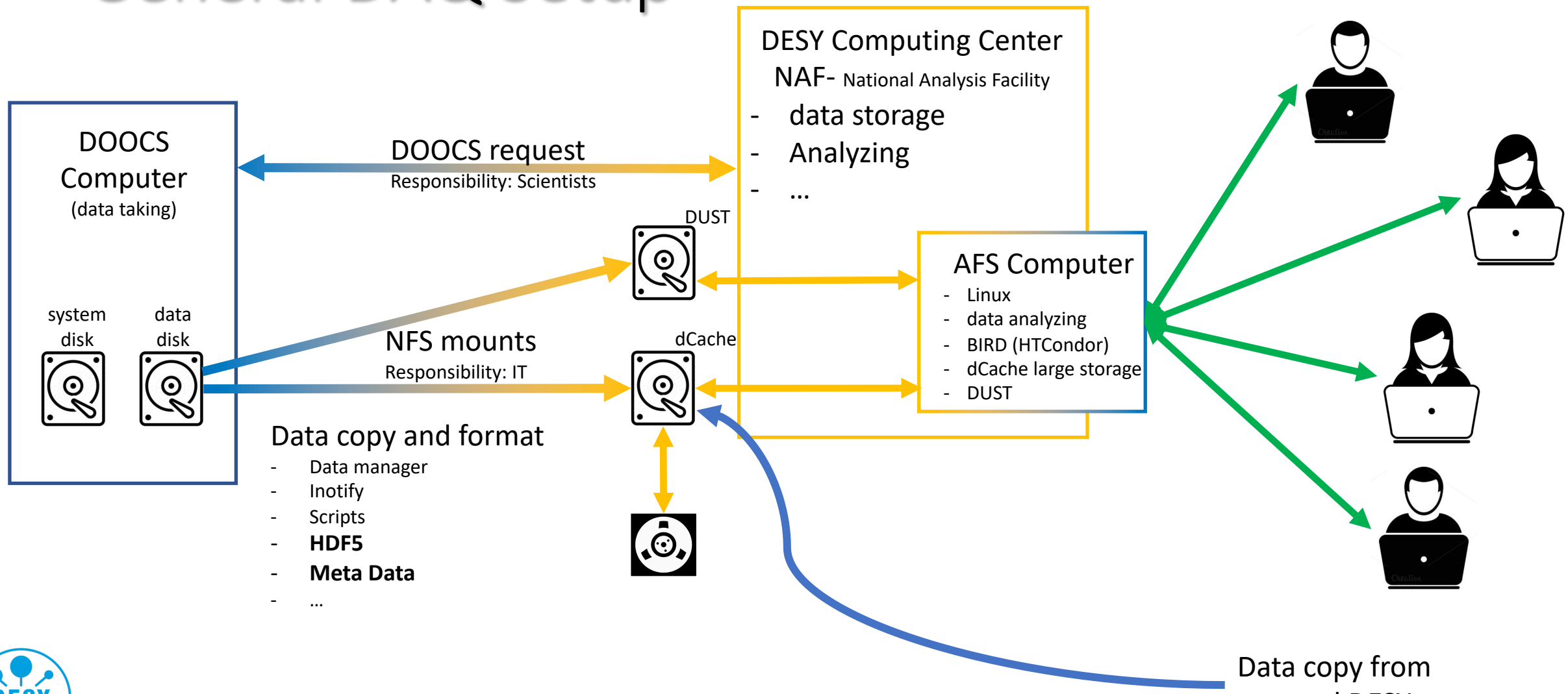
courtesy of Axel Lindner

MADMAX



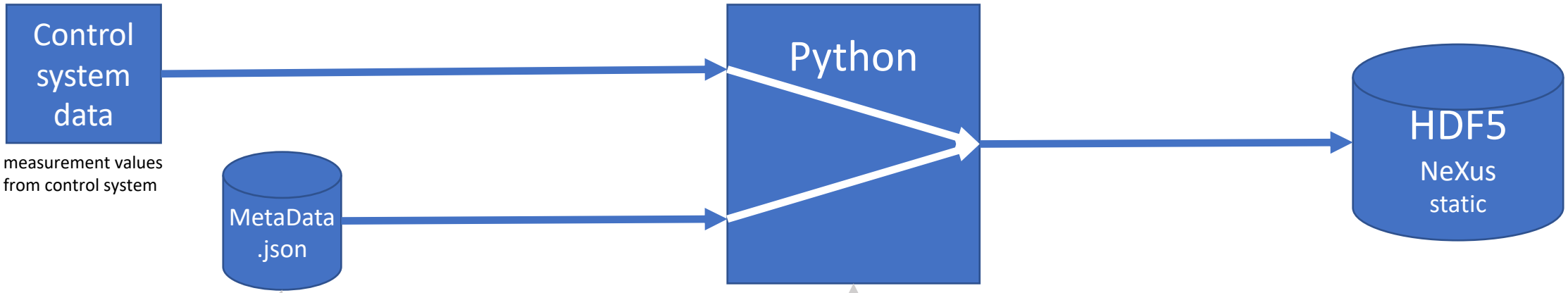
DAQ

General DAQ Setup



Creating HDF5 files from DOOCS control system data

Status today



Manual metadata:

```
"name": "alps_mokupro1",
"type": "Moku:Lab ",
"manufacturer": "Liquid Instuments",
"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": "70-69-79-B0-03-50",
    "DOOCS_server1": "tcp_fed_server"
  },
  "data": [
```

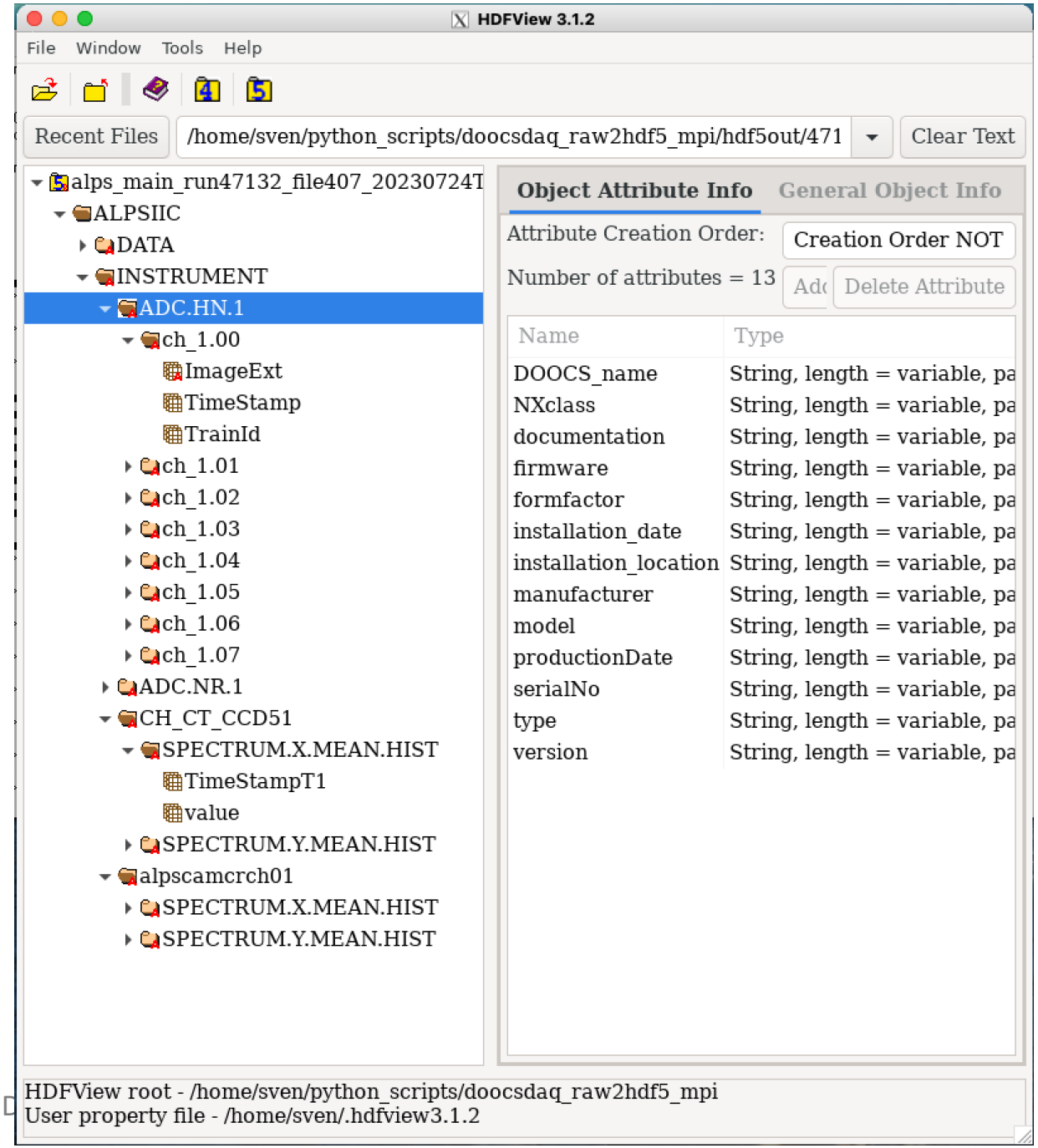
Manual program code:

```
            found = True
    else:
        # check if run mode exists
        if runmode.upper() == 'ALL':
            runmode = None
        else:
            runid = rcdbo.get_run_type_id(runmode)
            if runid == -1:
                print("Run mode '%s' doesn't exist "%runmode)
                sys.exit()
            else:
                runmode = runid

    if runmode:
        print("Run mode selected: ", rcdbo.get_run_type_name(runmode))
    else:
        print("Run mode selected: all runs")

    start = time.time()
    if None:
        descr = rcdbo.get_channel_descriptions(runmode, channels, owners[linac])
        if descr == None:
            print("No channel desriptions found")
        else:
            xml = descr.GetDescriptionListAsXML([])
            finish = time.time()
            print(xml,end='')
            print("Done in %d seconds"% (finish - start))
            print("Found descriptions:")
            print("Total: %d channels"%len(descr.GetDescriptionList()))
    else:
        props =   rcdbo.get_included_channels(runmode, channels, owners[linac])
```

HDF structure – NeXus format



new software for HDF5 / NeXus production

Motivation

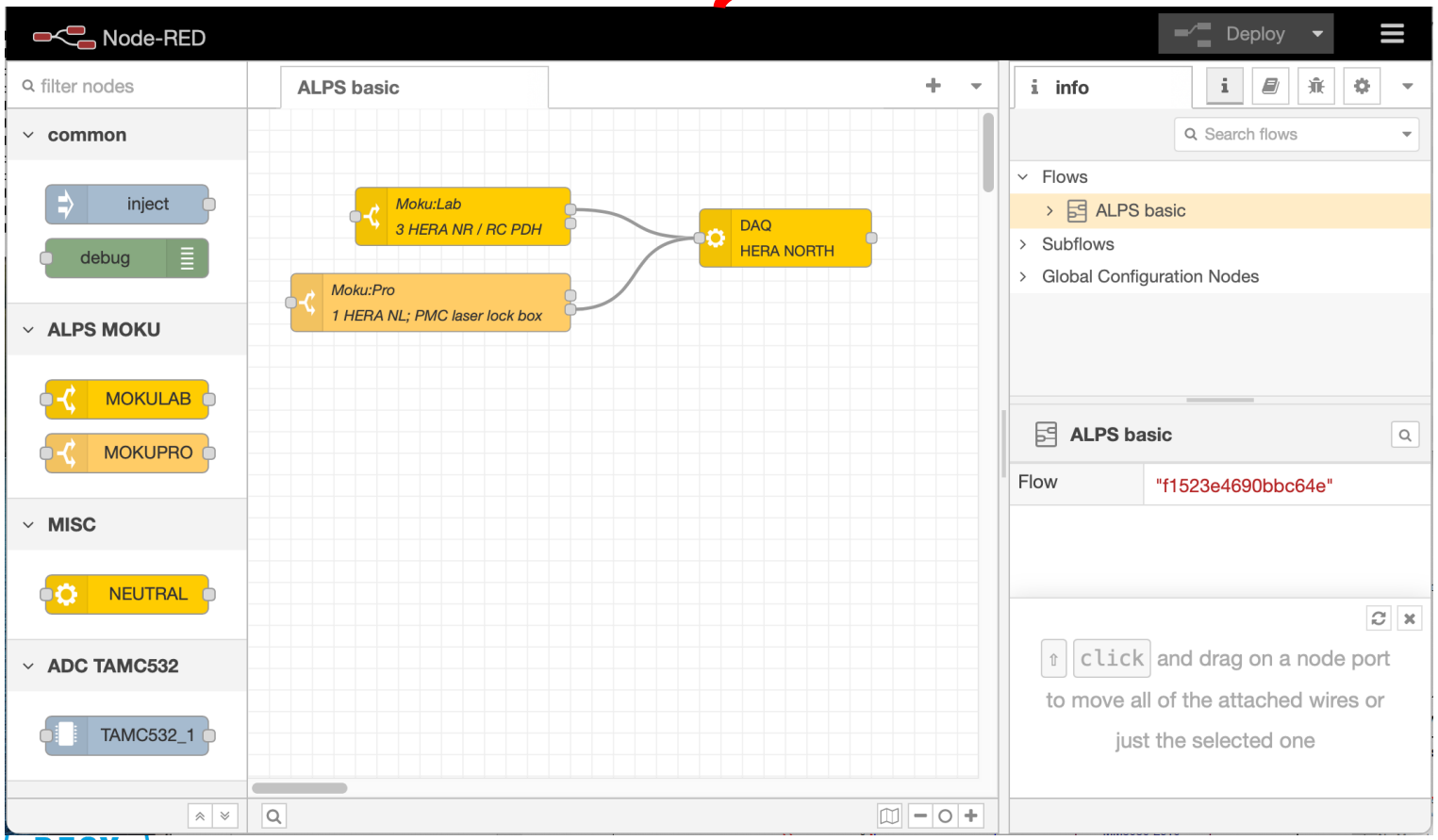
- Creating flexible HDF5 files
- Up to now everything is manual
- High error vulnerability
- Long development time
- Experts needed

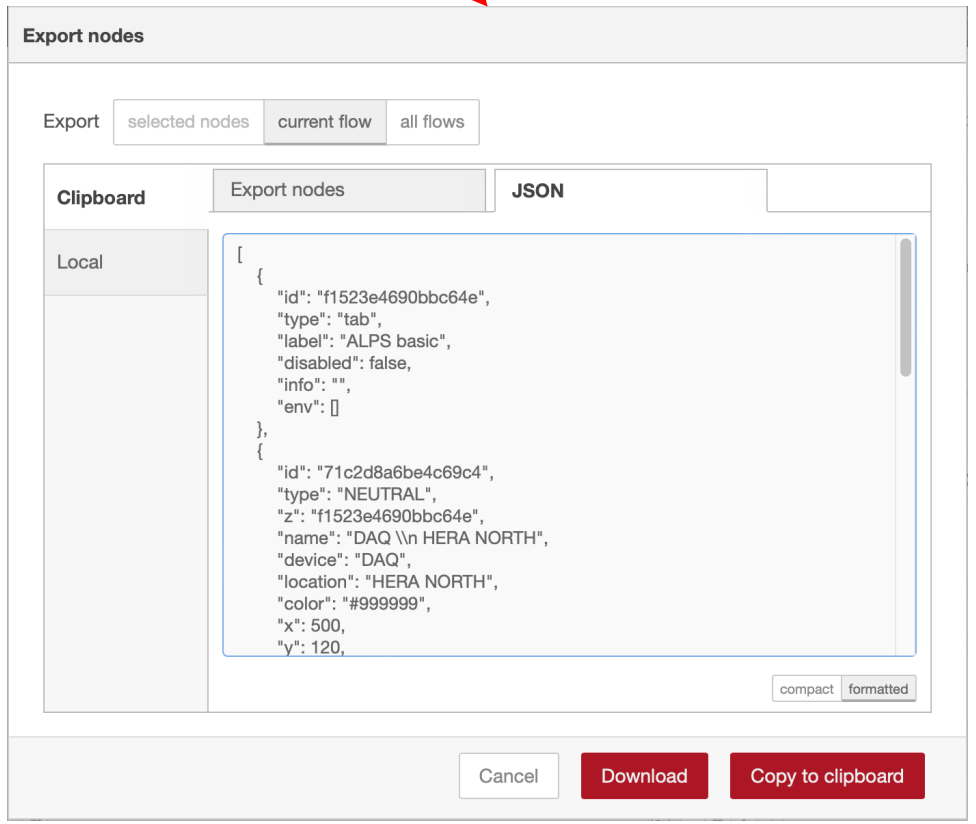
Graphical generation

Automatic .json file generation

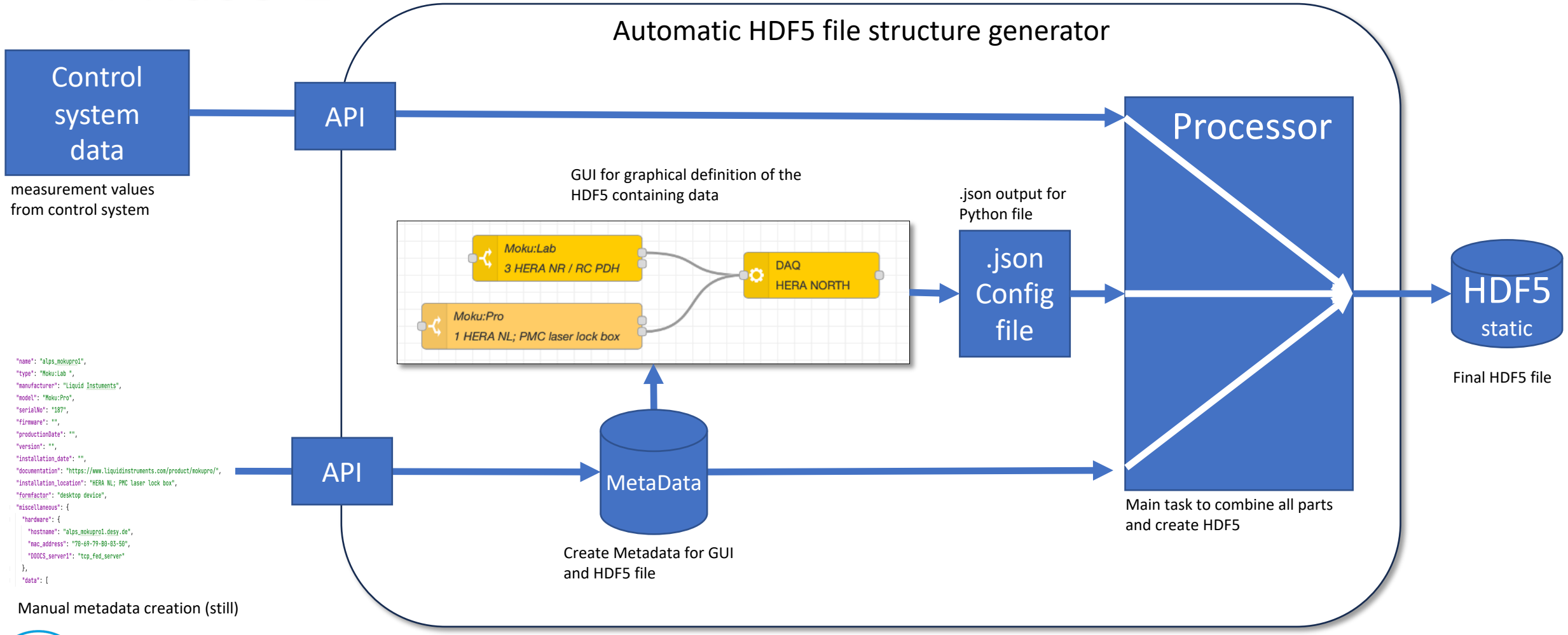
GUI

.json description file





Phase 1



Manual metadata creation (still)

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 – continous sampling rate

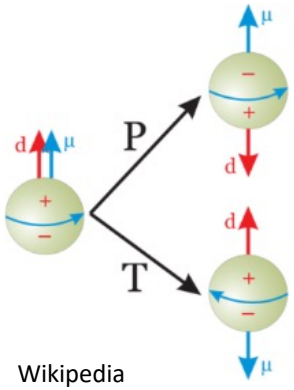
Measurement of 100MHz data continuously with a 4 ADC channel system
Task:
Measurement of analog signals
Sample rate: 100MHz
Trigger rate: continuously
Resolution: 16 bit
Number of channels: 4
Length of measurement: seconds - months
Expected data per one channel:
data = 100 MHz *2 byte * t

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

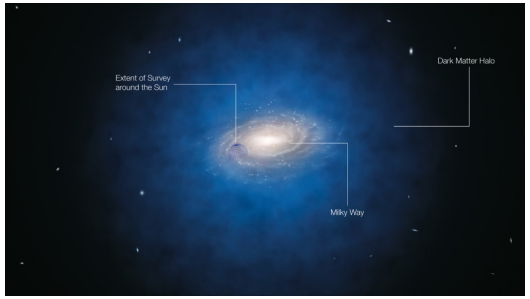
Why are we searching for Axions?

Axions

- could explain why neutrons do not show any electric dipole moment ("CP conservation in QCD") (**C**harge + **P**arity; **Q**uantum **C**hromo**D**ynamics)
- 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



Wikipedia



https://www.eso.org/public/news/eso1217/

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.

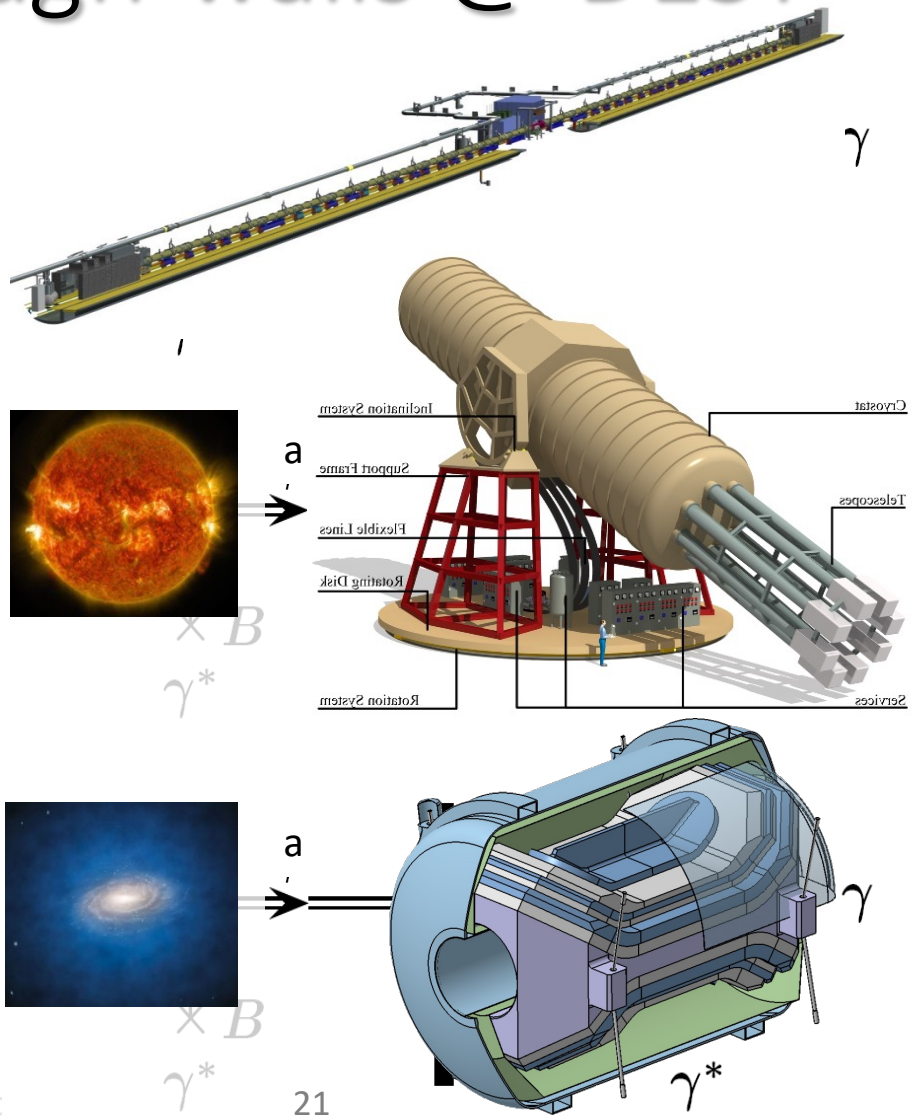
- Haloscopes (MADMAX)
  looking for dark matter constituents, microwaves
  model dependent axion results.

Target sensitivity

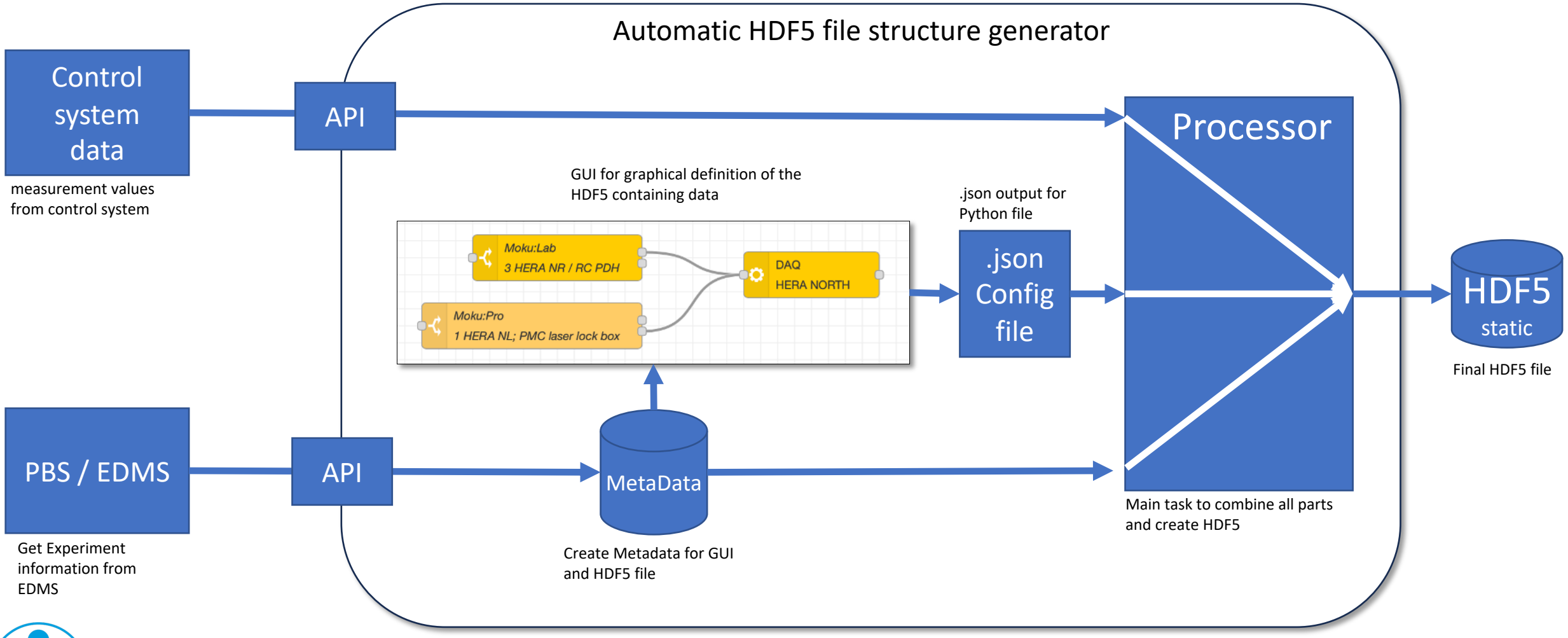
1 photon/day
exploit resonant detection

1 photon/year

10^{-22} W
exploit resonant detection



courtesy of Axel Lindner


Automatic HDF5 file structure generator
Control system data
measurement values from control system
API
GUI for graphical definition of the HDF5 containing data
Moku:Lab
3 HERA NR / RC PDH
Moku:Pro
1 HERA NL; PMC laser lock box
DAQ
HERA NORTH
.json output for Python file
.json Config file
Processor
HDF5
static
Final HDF5 file
PBS / EDMS
Get Experiment information from EDMS
API
MetaData
Create Metadata for GUI and HDF5 file
Main task to combine all parts and create HDF5