



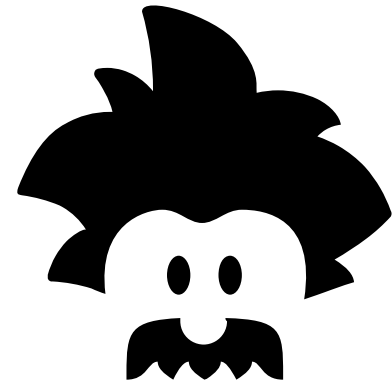
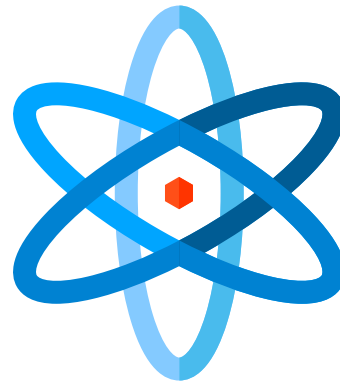
# Some F.A.I.R. aspects from storage ring experiments

Shahab Sanjari

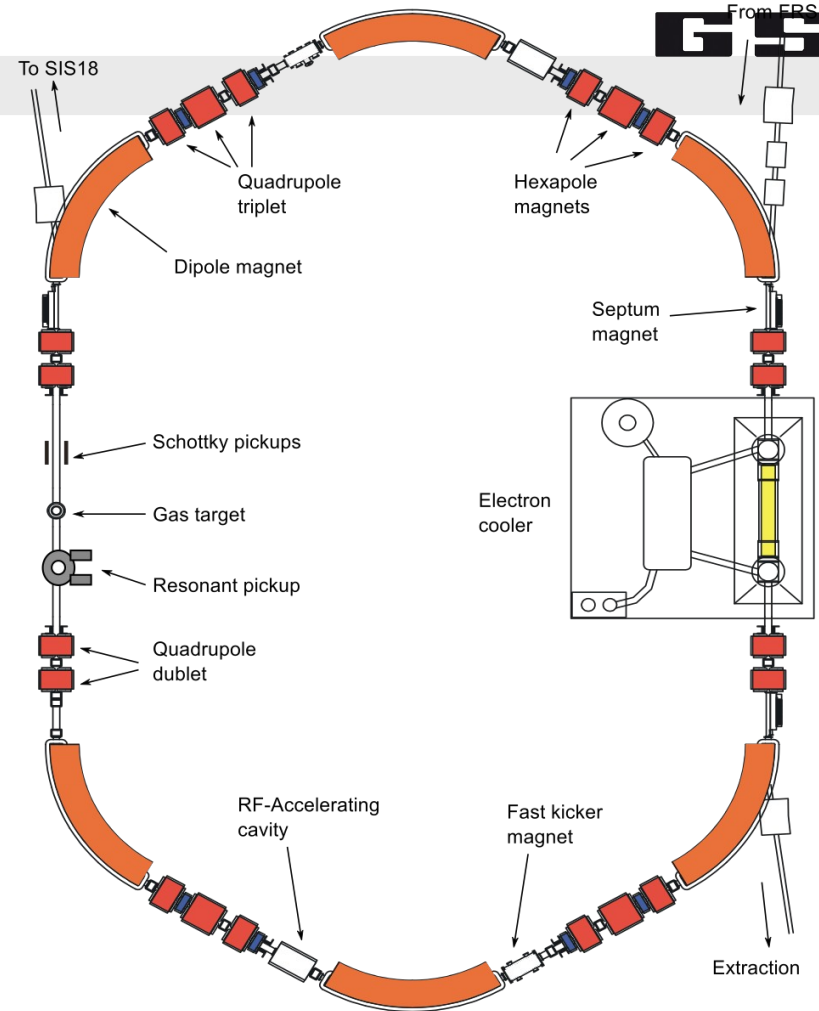
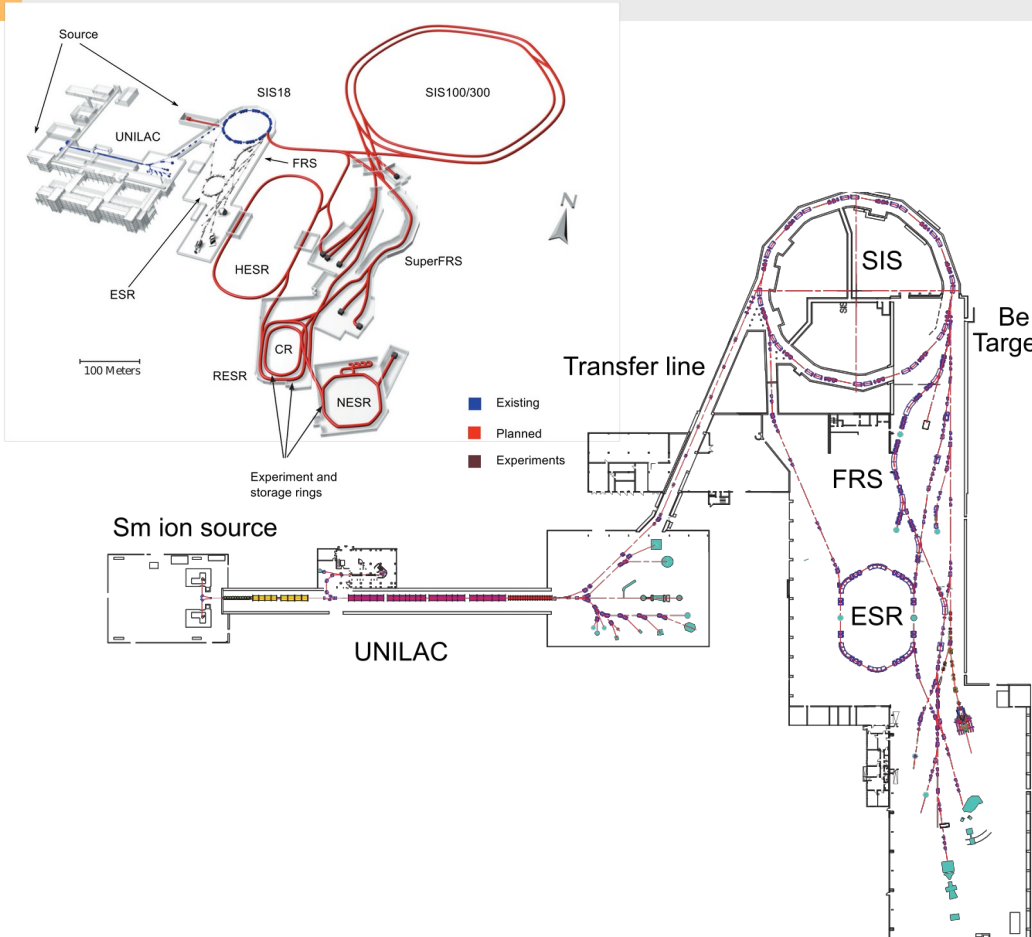
1st Workshop on Open Science at GSI/FAIR

OCT-2023

- Some example of Open Science and F.A.I.R-ness from the experimentalists's perspective
  - Typical experimental cases that produce data
  - Type of data
  - Analysis software
  - Documentation / Communication
  - Open hardware

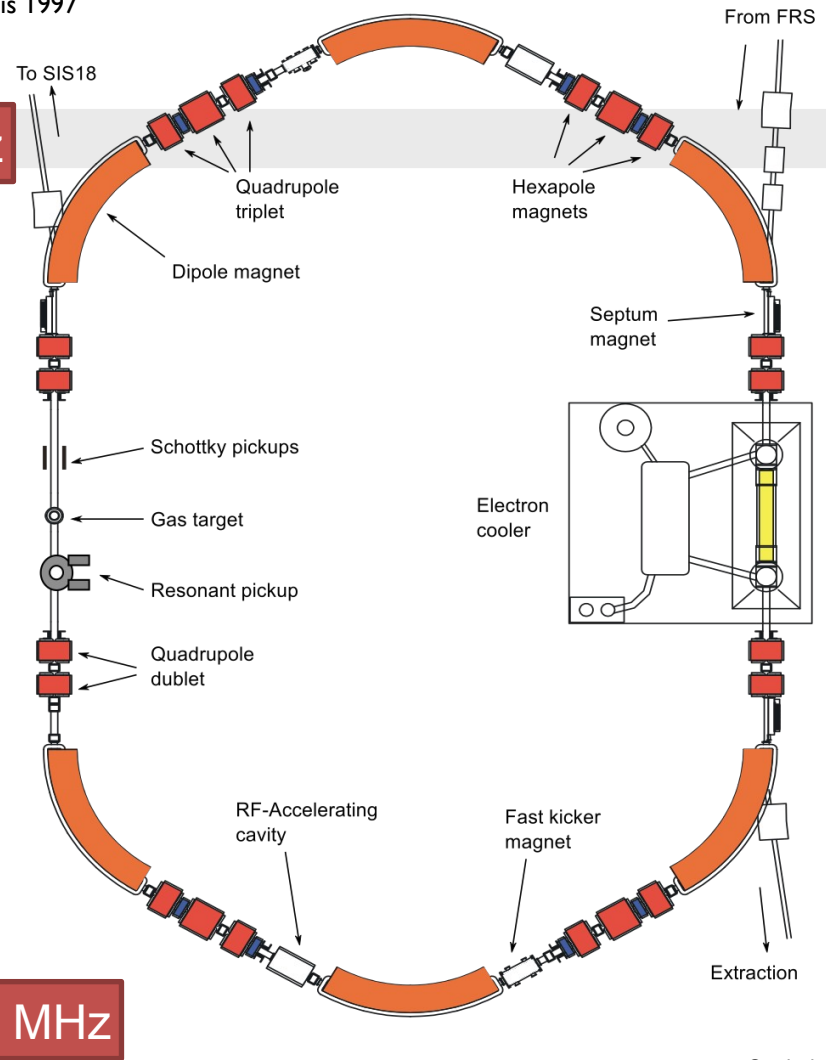


# Storage ring example: ESR

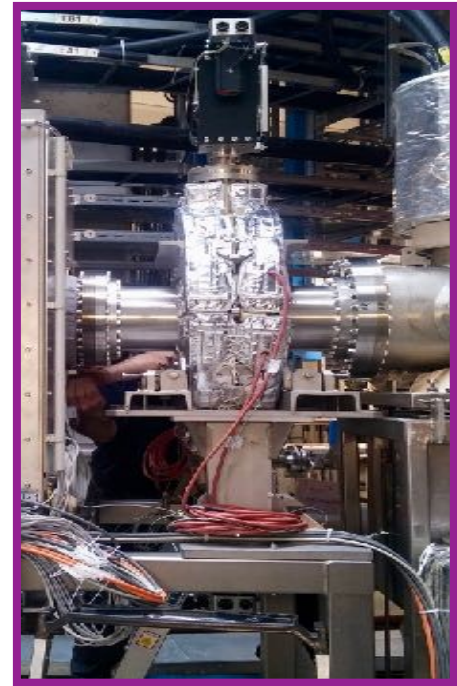




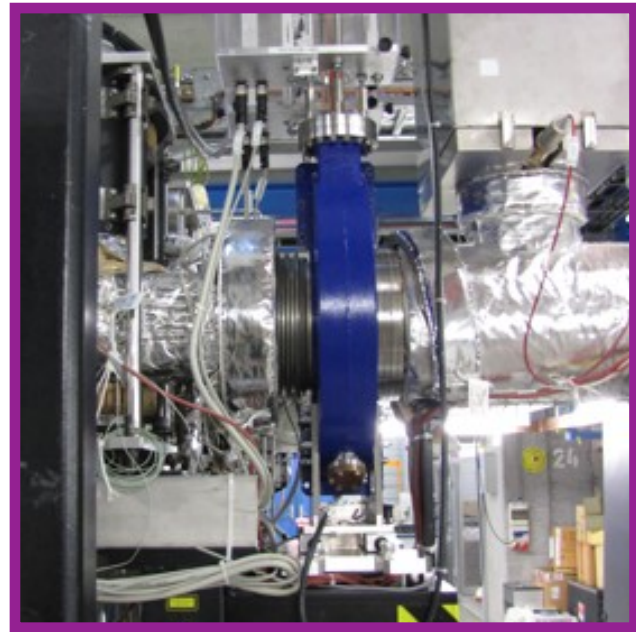
60 MHz



410 MHz



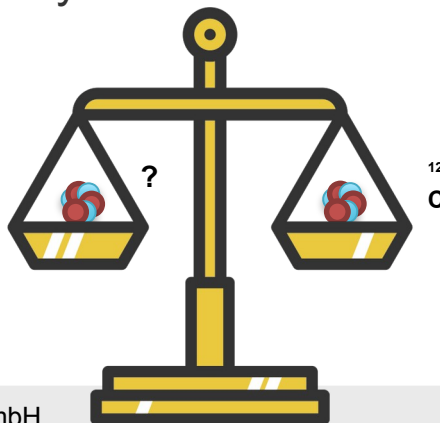
Sanjari et. al. Phys. Scr. 014088 (2013)



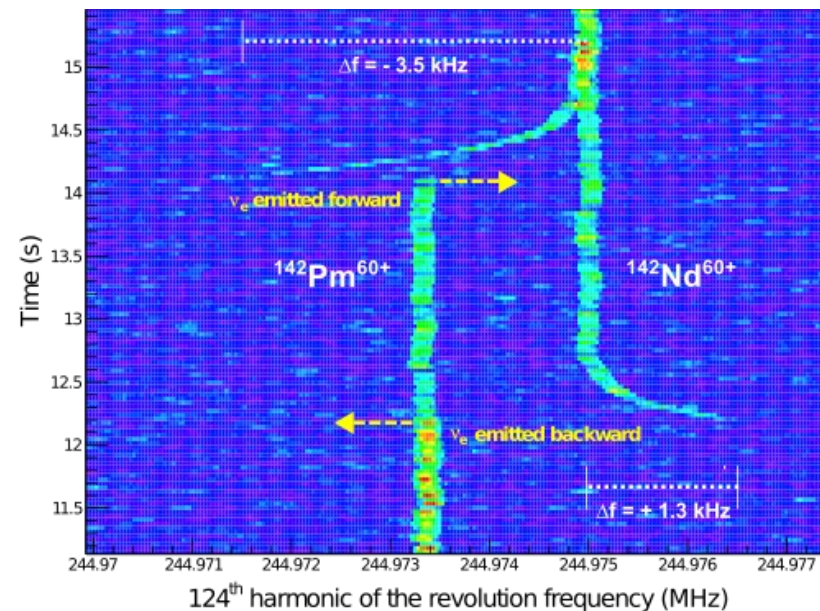
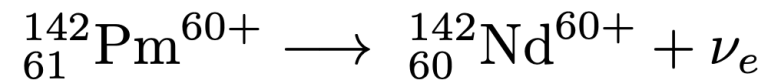
245 MHz

Sanjari et. al. Rev. Sci. Inst. 91(8), pp. 083303 (2020)

- Preparation of exotic nuclei (Target / FRS)
- Inside ESR
  - Schottky Detectors as primary detectors
  - Time resolved Fourier analysis

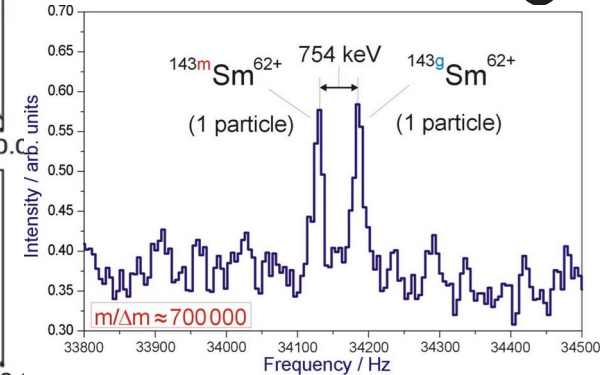
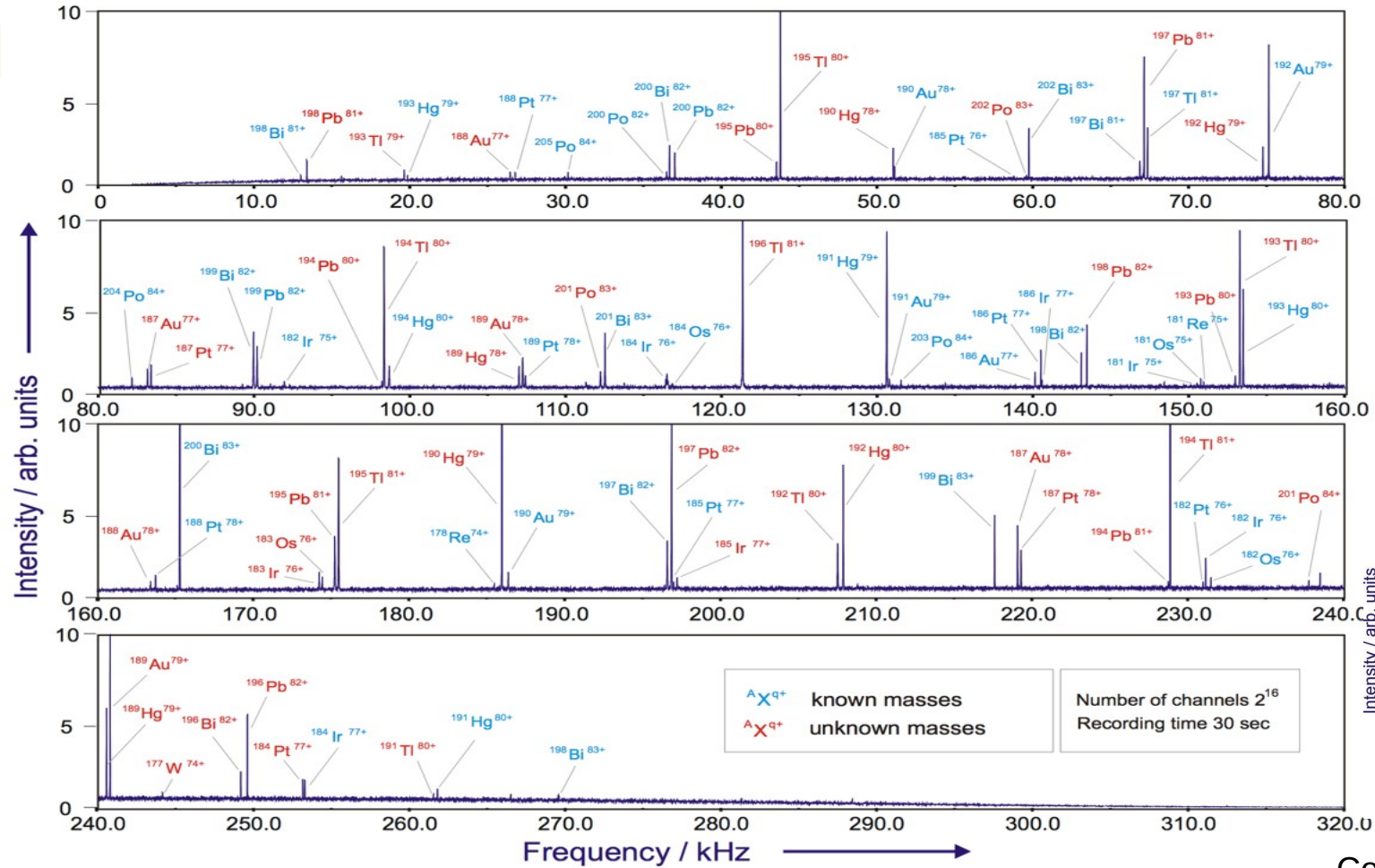


12  
C

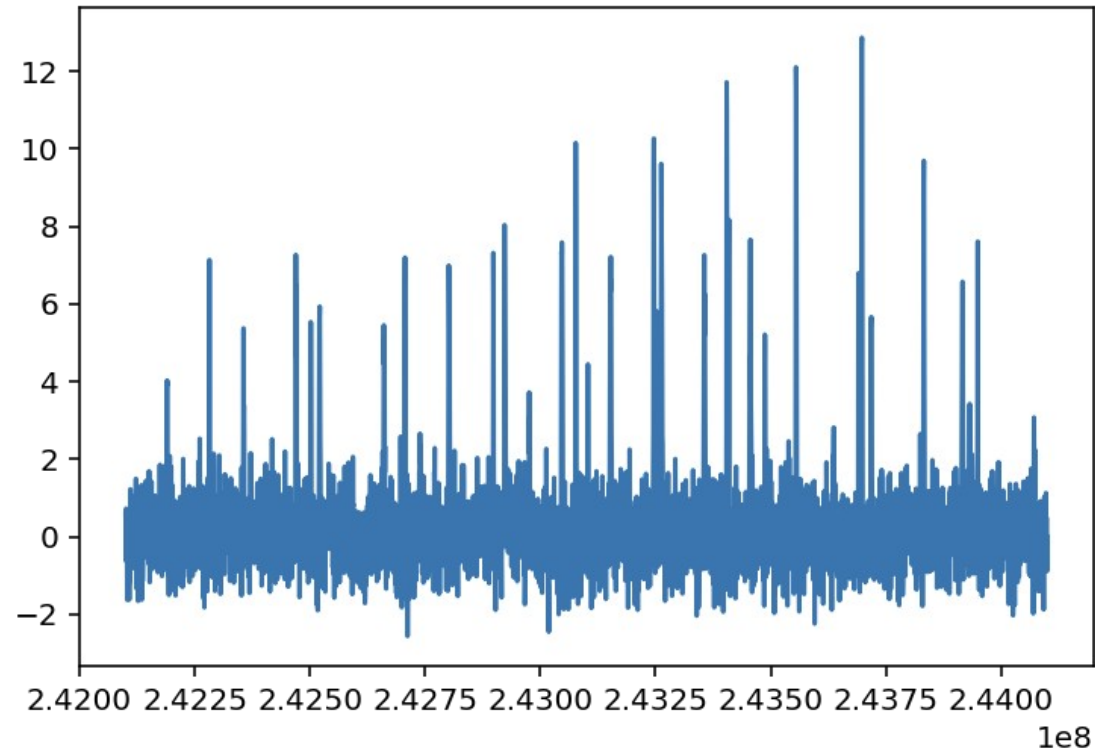


Kienle, Bosch et. al., Phys. Lett. B 726 (2013) 4–5, p.638



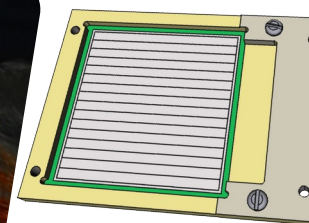
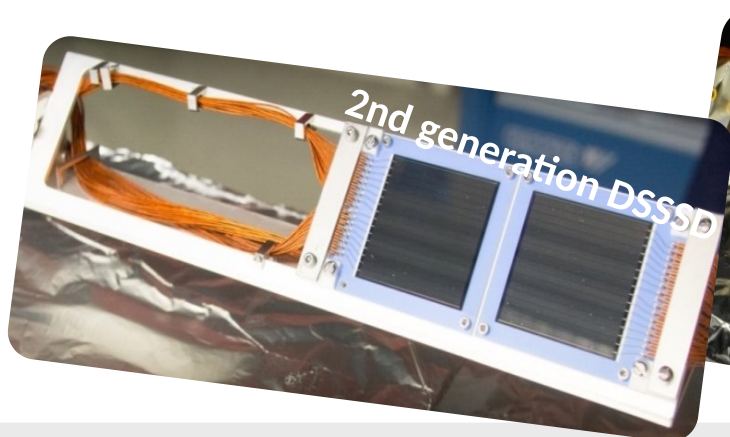
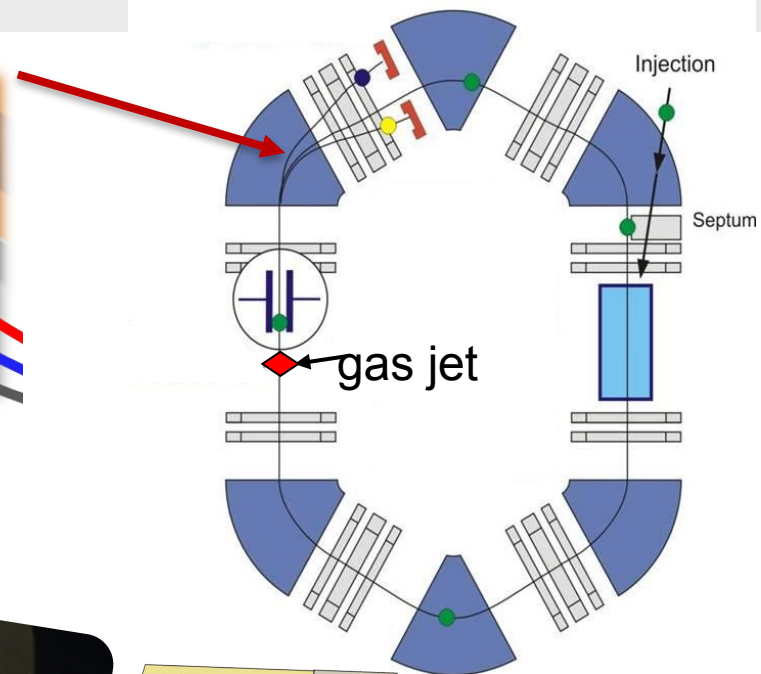
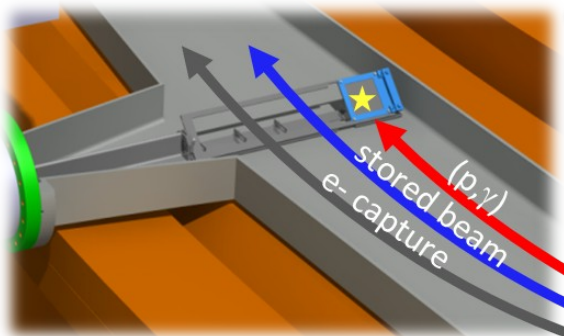
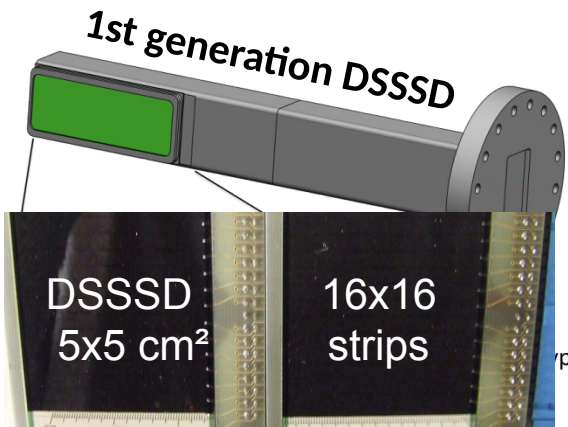


Courtesy: Yuri Litvinov @ GSI



Reality looks like this!

# Particle detectors for reactions

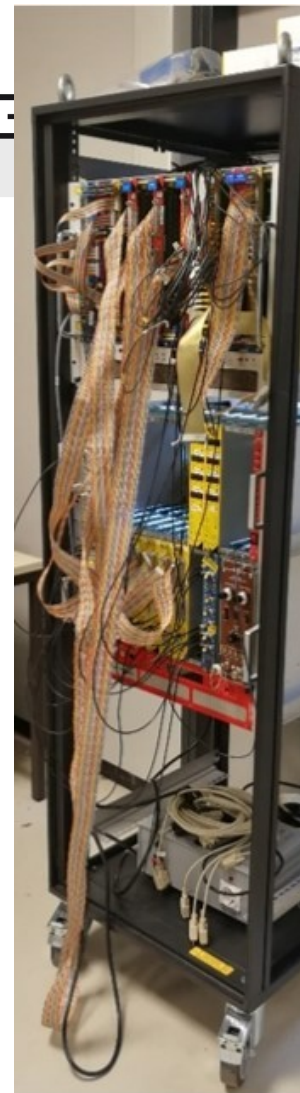
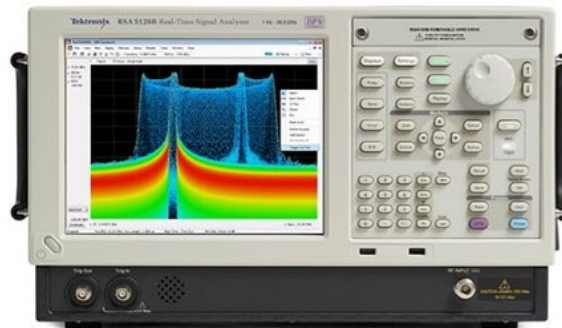


Pictures courtesy: Jan Glorius

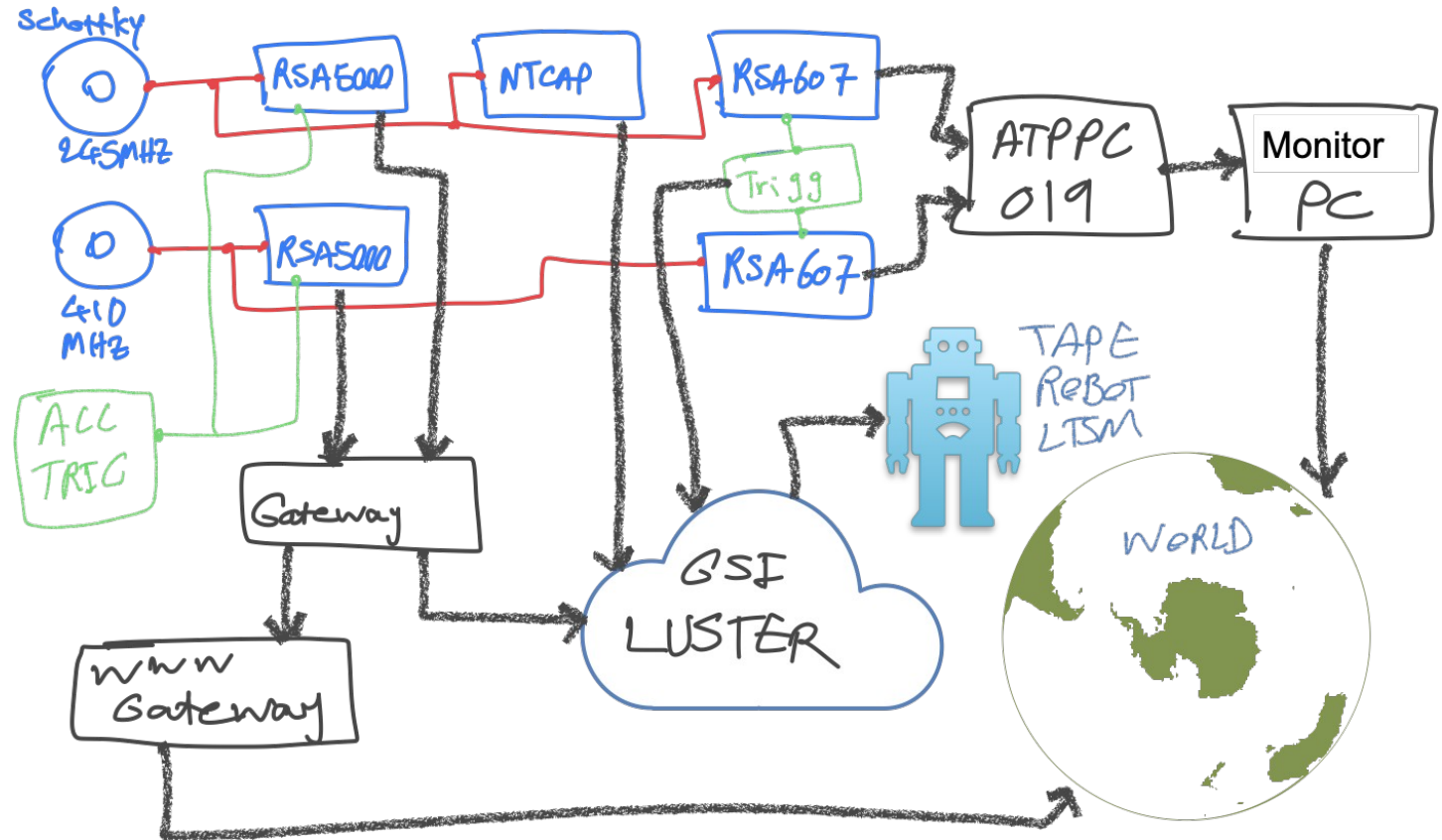


# Data acquisition

- Schottky detectors:
  - Spectrum analyzers
    - Very good for setup / debug
    - Also for shot by shot recording
  - Time Capture devices
    - For continuous recording
    - TCAP: (90s – 2010)
    - NTCAP (2014 – now)
    - Future plans using SDR
- Particle detectors:
  - MBS



- More realistic scenarios!



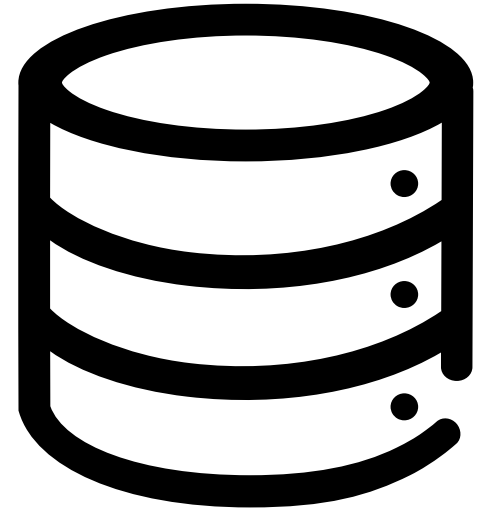
# F.A.I.R. experimental data

- Schottky detectors:
  - Proprietary format
  - Narrow band: GB range
  - Broadband: approx. 50 TB per Week
- Particle detectors:
  - Multi Branch System (LMD files)
  - Size: ~500MB – 1.5 GB per file
- (🙏 to IT) using:
  - Lustre: online and near line analysis
  - LTSM

ZENODO + GSI: 

Already published some smaller tables

Larger data → Waiting...



- Increase F.A.I.R.-ness of data:
  - Make wrappers for commercial formats
  - Either convert data
  - Or keep original + partly converted





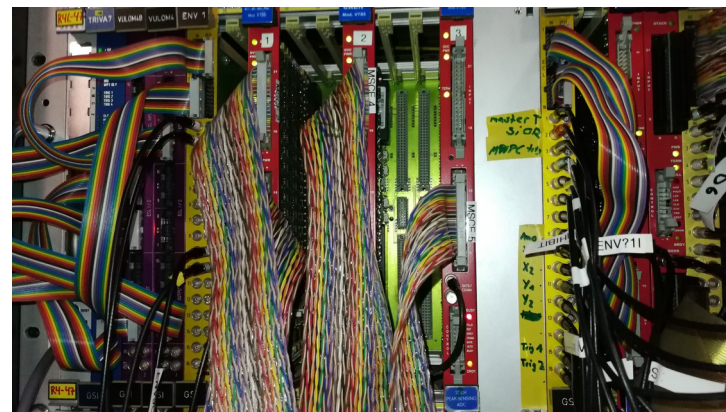
# F.A.I.R. experimental data



- Particle detector files (LMD)
  - Could be very complex
  - Different for every experiment, no general unpacker
  - Needs GO4 or the “unpacker” to access trees



- Increase F.A.I.R.-ness
  - Use docker for unpacking LMD files
  - No installation, no setup, runs everywhere
  - For every experiment one Dockerfile and/or Docker Image




```
docker run -it --rm -v "$(pwd):/pwd" xaratustrah/unpack_e121 --ntuple=SC_DCCT,/pwd/test.root /pwd/test.lmd
```

- Logging
  - Form based input
  - Formless input
- Discussion Channels
  - For detailed discussions during and after experiment
  - Pre analysis of selected spectra
  - Avoid chain of emails?
- Online communication during experiment
  - e.g. Can someone turn off the cooling?



# F.A.I.R. Experiment Documentation / Communication

- ELOG (🙏 to IT)
- Mattermost (Helmholtz)
  - Intl. users can join
  - Bots!
- Telegram 
  - Hides personal info (phone #)
  - Shows chat history to group newcomers
  - Export chat data as open source format → put in ELOG



Helmholtz AAI



Super nice great top secure best wonderful lovely amazing personal messenger App:

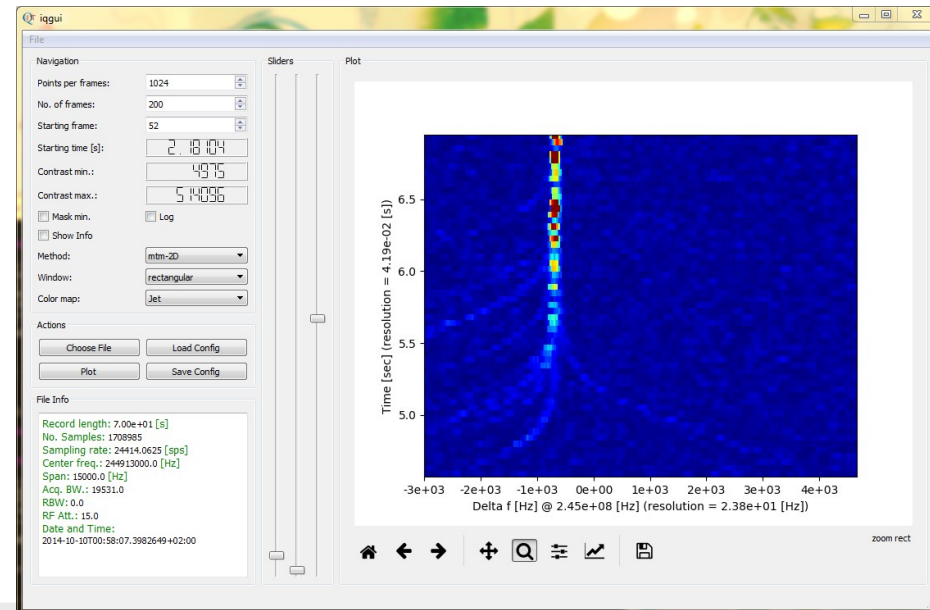
Not suitable for F.A.I.R. experiments!



# F.A.I.R experimental software



- Extensive use of GitHUB for analysis code
- Example IQTools:
  - For time resolved Fourier analysis
  - Published:
    - <https://helmholtz.software/software/iqtools>
    - <https://doi.org/10.5281/zenodo.7615693>
  - Conversion:
    - Intermediate / open source formats
  - Scripting etc...





- Processing several 1000 data sets
- Different cuts / conditions
- Use of HPC
  - Parallel analysis of data in arrays
  - Using **Singularity** Container Runtime Engine
  - Good connection to Lustre file system
  - Works really good!
    - (🙏 to IT)



# F.A.I.R experimental software



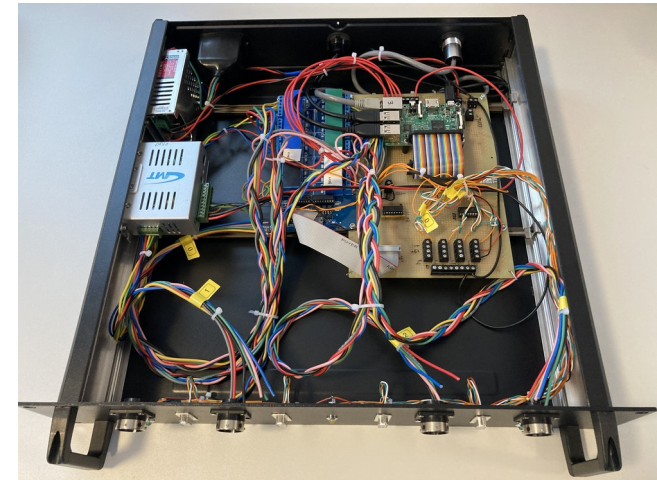
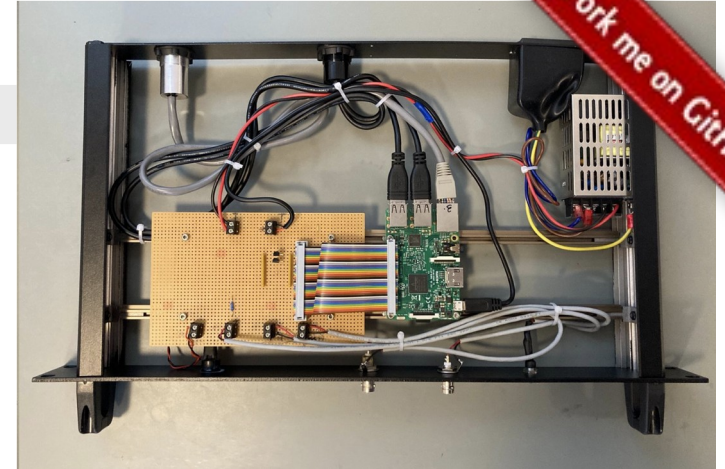
Fork me on GitHub

- Other available codes also published:
  - **Barion** storage ring calculator
  - Experiment specific scripts
    - Anonymized
  - Dockerfiles
  - Particle identifier ( → PhD student: David Freire-Fernandez)
  - Many more
- We try as far as possible:
  - Modular / reusable code
  - Use open source components
  - Make wrappers for commercial formats



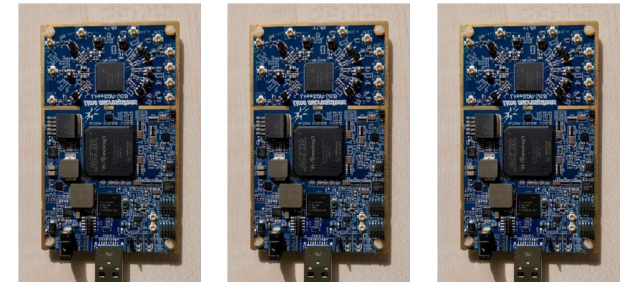
# F.A.I.R. hardware?

- Experiment specific needs
  - control system connection (not yet)
  - But still compatible!
- Examples:
  - Motor controllers for detectors
  - Asynchronous DAQ trigger systems
  - Standalone readouts
  - Mostly Python (also some VHDL)
- Advantage:
  - ZMQ, database etc...



# F.A.I.R. hardware?

- GNU-Radio based **Software Defined Radio**:
  - GSI / FAIR is now officially part of GNU Radio dev team!
  - Is used in FAIR control system
  - Growing expertise @GSI control system development
  - Unified underlying system for different classes of DAQ:
    - Time Data: (Oscilloscopes)
    - Frequency: (Spectrum Data)
  - Connection to long term storage systems
- Future plans:
  - Upgrade for our broad band DAQ
  - Open Hardware / Open Software





Thank you!