LOFAR processing software

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ASTRON

E-OSSR Onboarding Presentation

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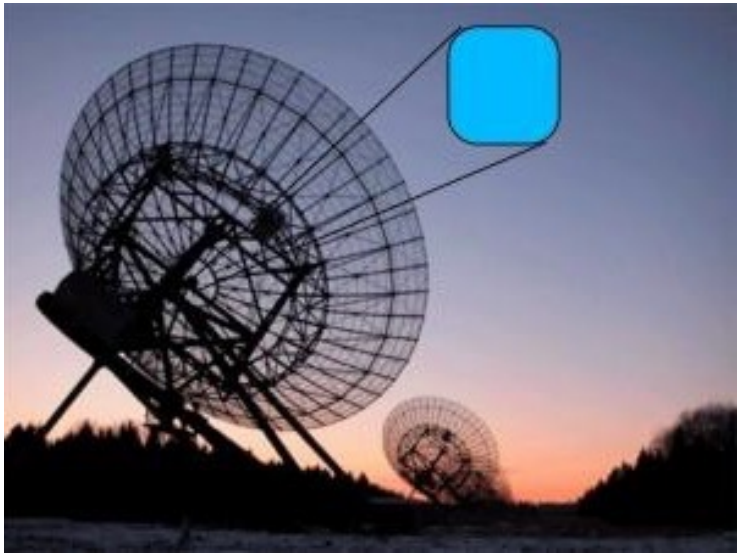
ESCAPE
European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures

ASTRON

“Making discoveries in radio astronomy happen”

2 main facilities operational right now



LOFAR

ASTRON
Netherlands Institute for Radio Astronomy

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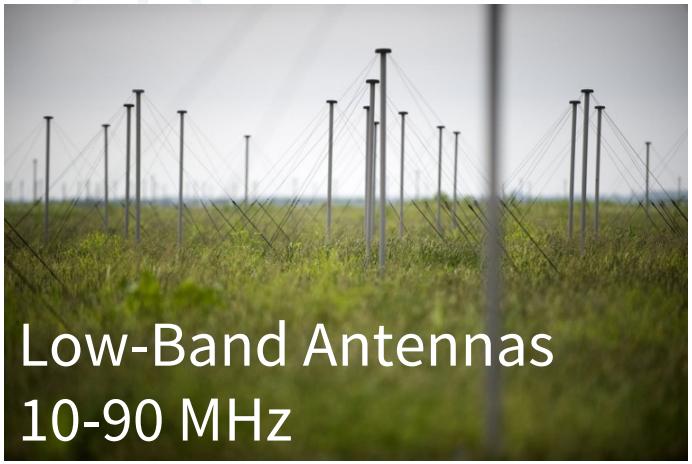
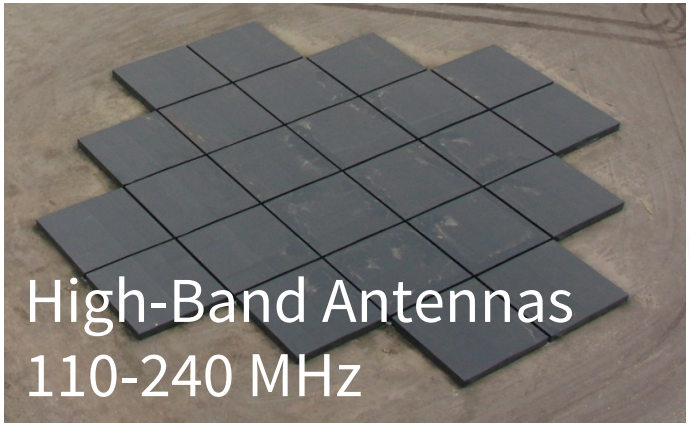
LOFAR - instrument

The International Lofar Telescope is the formal entity managing the telescope.
ASTRON is one of the partners and takes care of its day to day operations.





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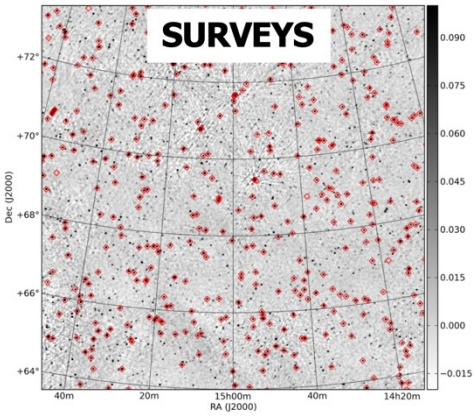
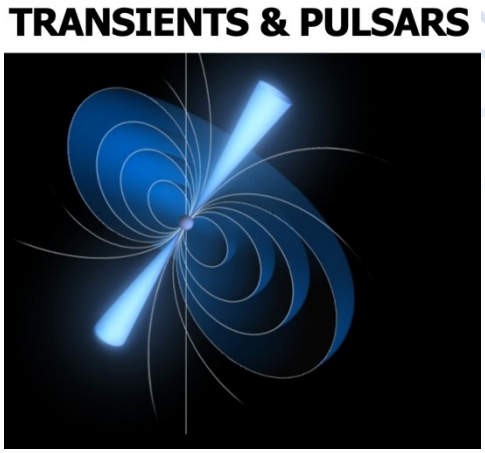
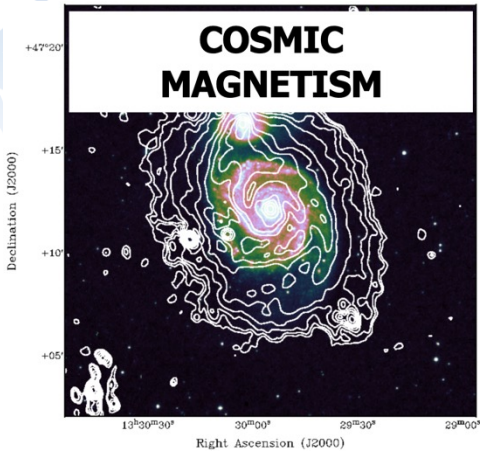
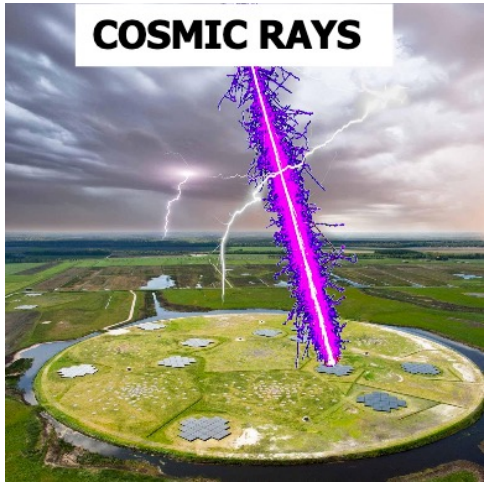
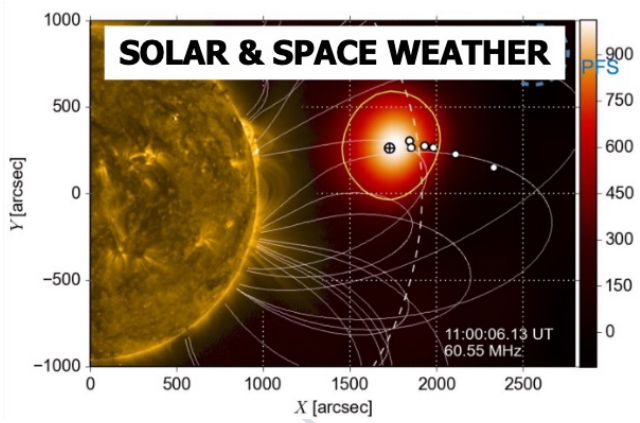
LOFAR - Science

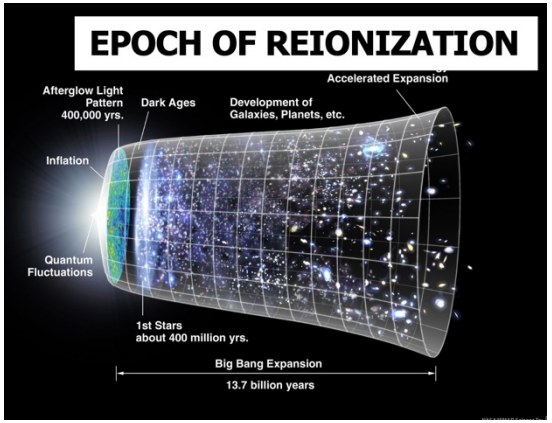












In essence: we can observe anything between the processes in our atmospere and the formation of the first stars…

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LOFAR - software

- LOFAR is a ”software telescope” so ”the LOFAR software” can be anything of:
  - Station software (signal processing of antenna outputs)
  - Correlator software (combining outputs of all antennas)
  - Processing software (RFI, calibration, imaging, RM cubes, etc.) ← **This is what we talk about here!**
  - Long-term data archiving, data access for users, processing on cloud/grid (e.g. ESCAPE services)
- LOFAR has (currently) ~ 150 users across the globe.

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LOFAR – processing software

- Use case is imaging based on raw data:
  - RFI mitigation (mostly suppressing humans)
  - Calibration
  - Imaging
  - Source catalogs
- Workflow
  - Each step is a different module, which run one after the other.
  - Currently running using custom-built pipeline framework.
  - CWL implementation is on its way
- The package contains a bit more than only the “LOFAR processing software”. Mostly separate tools used in the pipeline for e.g. imaging (WSClean)

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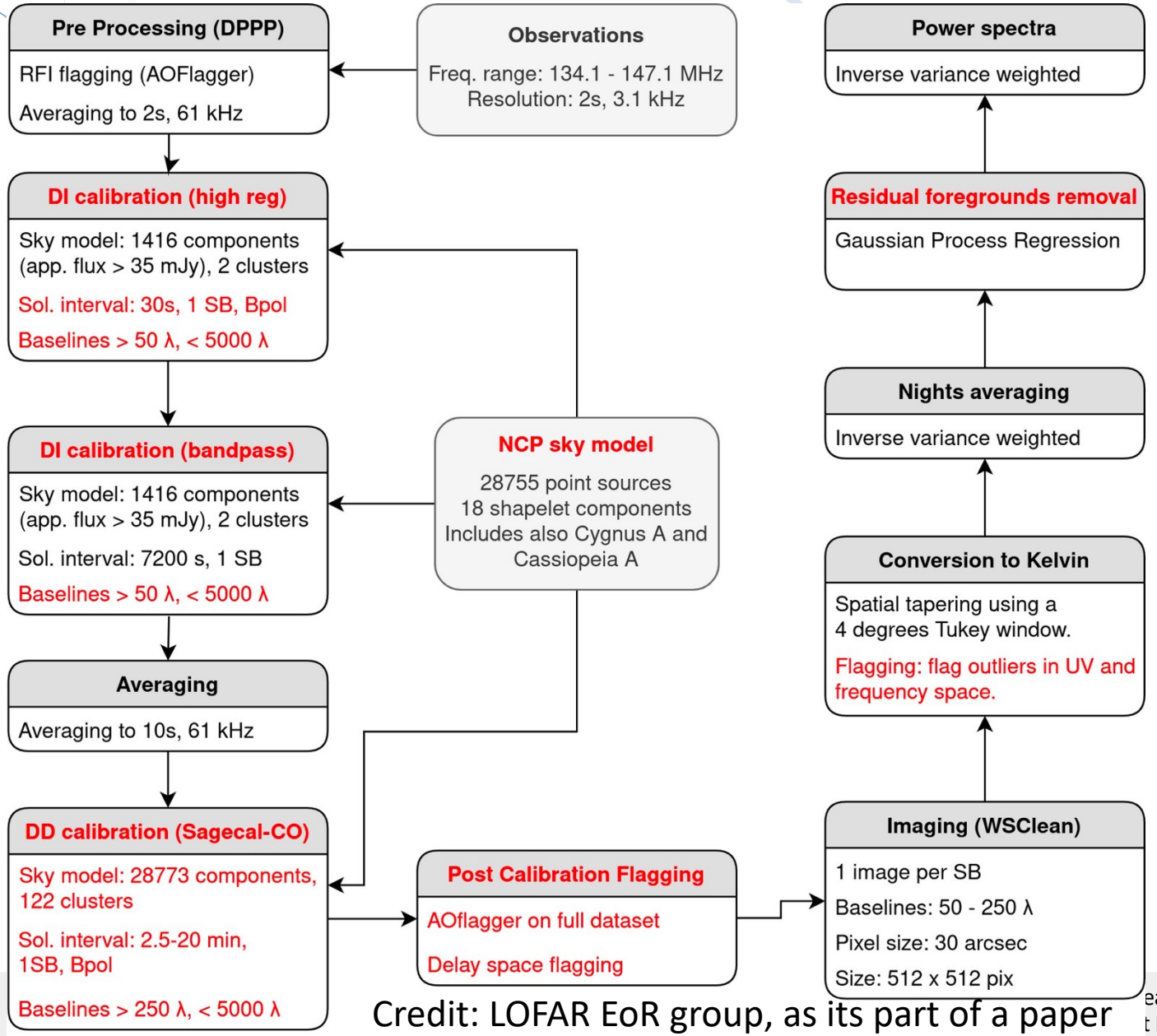
EOR processing pipeline



Credit: LOFAR EoR group, as its part of a paper

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Software – development process

- ‘We’ have been working on it for a while

```
commit 0a343975ad89ac435a205160a072b93dfdce7070
Author: (no author) <anonymous@astron.nl>
Date:   Thu Dec 21 14:33:22 2000 +0000
    New repository initialized by cvs2svn.
```

- Nowadays we use git.
- LOFAR software currently being developed in a SCRUM team (“with all roles and meetings”; 3wk sprints)
  - Two sprints per year for maintainance
  - Support, fix bugs, etc based on schema and wiki for documentation
  - CI/CD using Jenkins
  - Start using Docker more often in production
- Mostly supported on our local systems. 6 roll-out moments per year (not all necessarily used). Manual testing before roll out

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Software – methods

- General guidelines: there is not much written down on how our workflow is but I've asked around.
  - Unit tests and integration tests on all new code. If old code is crucial, tests added
  - Code reviews, juniors activelt supervised
  - Coding styles: PEP8 for python. Not much more than that.
- Not very modular, mostly one big package. Work ongoing to make it more modular
- Licenses: ASTRON standardised on Apache 2.0, some external libraries are GPL (e.g. Casacore). LOFAR is also GPLv3 to make life easier.

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Software - requirements

- Development mostly happens for Centos (some parts Ubuntu).
  - Since the software is packed in a container that should not be an issue
- For the pipelines, we use our custom framework
  - CWL version is being developed
- Data access using gridftp with X509 certificates, working on replacing that with webdav with macaroons.

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Hardware requirements

- HW requirements are very much use case dependent.
  - Data sets can be rather big (~150GB per file. Often 244 files per observation).
  - Some parts need (Nvidia) GPUs to execute (in finite time).
- Processing is very often embarassingly parallel (each file is a wave band).
  - However after each wave band is calibrated, the solutions are smoothened/averaged to prevend weird jumps. So some communication between nodes is needed.
  - Smaller runs (using a subset of data, trying out calibration parameters, etc) can be done on a single node.
  - Full imaging runs could (and pronbably: should) run on a cluster.
- Some, more complex pipelines do hoever highly rely on MPI

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OSSR Integration

- Source code, container-based images to be onboarded.
  - We haven't yet defined a test work flow. If the goal is mainly to show that all components work a limited data set and pipeline configuration can be added to the package.
- User story
  - As a LOFAR user I want to create an image based on raw data in the LOFAR Long-Term Archive so that I can use it to do science.
  - Access to LTA data, processing raw data to image and making a source list from that image

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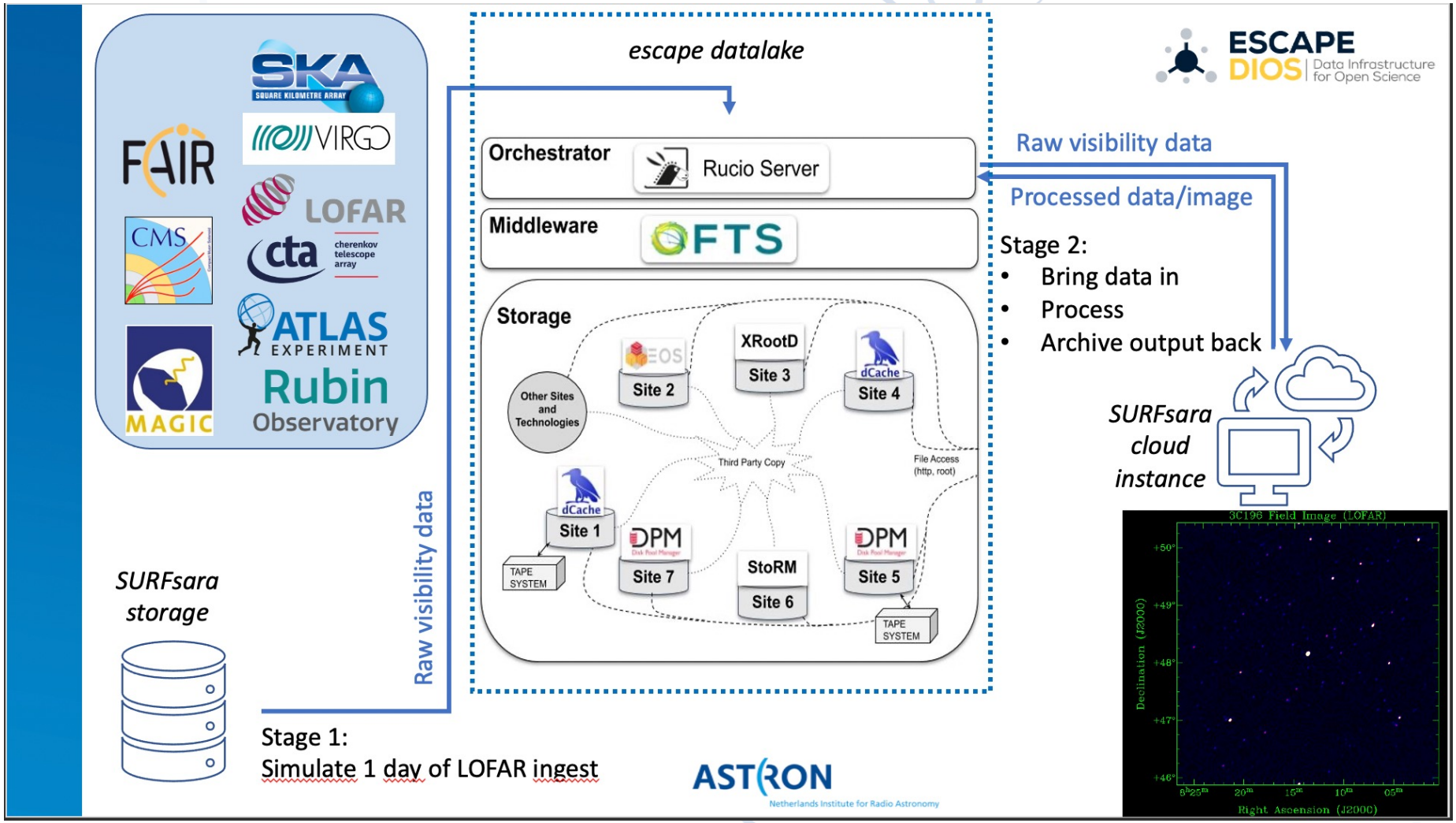
Time for a short demo (~10 min)



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Time for a short demo (~10 min)

- (did a live demo)

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Open Points and Discussion Time

- Would be nice to have it integrated in a Jupyter notebook environment that plays well with WP2, WP5, WP4.
  - Data input from ESAP shopping basket, through Rucio and VO tooling.
  - What is the WP3 vision on how to handle supporting software in entries? (i.e. hierarchy of notebooks)
- Platform integration and metadata => I guess we want to discuss that. I have little opinion on that…

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