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Using ALMA

concepts and tools of science operations, interaction with and support to the users

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Meaning of ALMA Operations and the Joint ALMA Observatory

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Science Operations Astronomer's perspective

Principles:

- Non-experts should be able to use ALMA
- Dynamic scheduler to match observing conditions
- Reliable and consistent calibration
- Data public in timely fashion

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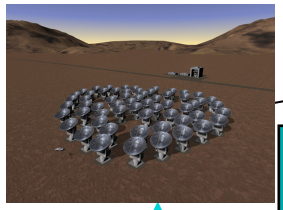
ALMA Sites in Chile



Antenna Operations Site (AOS)

40 MB/s (peak)

Operation Support Facility (OSF)

6 MB/s (average)

Santiago Central Office (SCO)

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High-level concepts for Science Operations

- Observations will be done in service observing mode with flexible (dynamic) scheduling.
- Observations 24h/day interrupted by maintenance periods.
- All observations are executed in the form of scheduling blocks (SBs), each of which contains all information necessary to schedule and execute the observations.
- The default output to the astronomer are reliable images, calibrated according to the calibration plan.
- The Joint ALMA Observatory (JAO) is responsible for the data product quality.
- All science and calibration raw data are captured and archived.

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Science Deliverables:

- uv-plane astronomical source and calibration data.
- Processed images, with supporting information on the data processing and quality assurance.
- Off-line data reduction software, including user support for installation and basic usage.
- Software tools for proposal and observation preparation, including user documentation.
- ALMA users manual.

User support:

- Helpdesk
- f2f support

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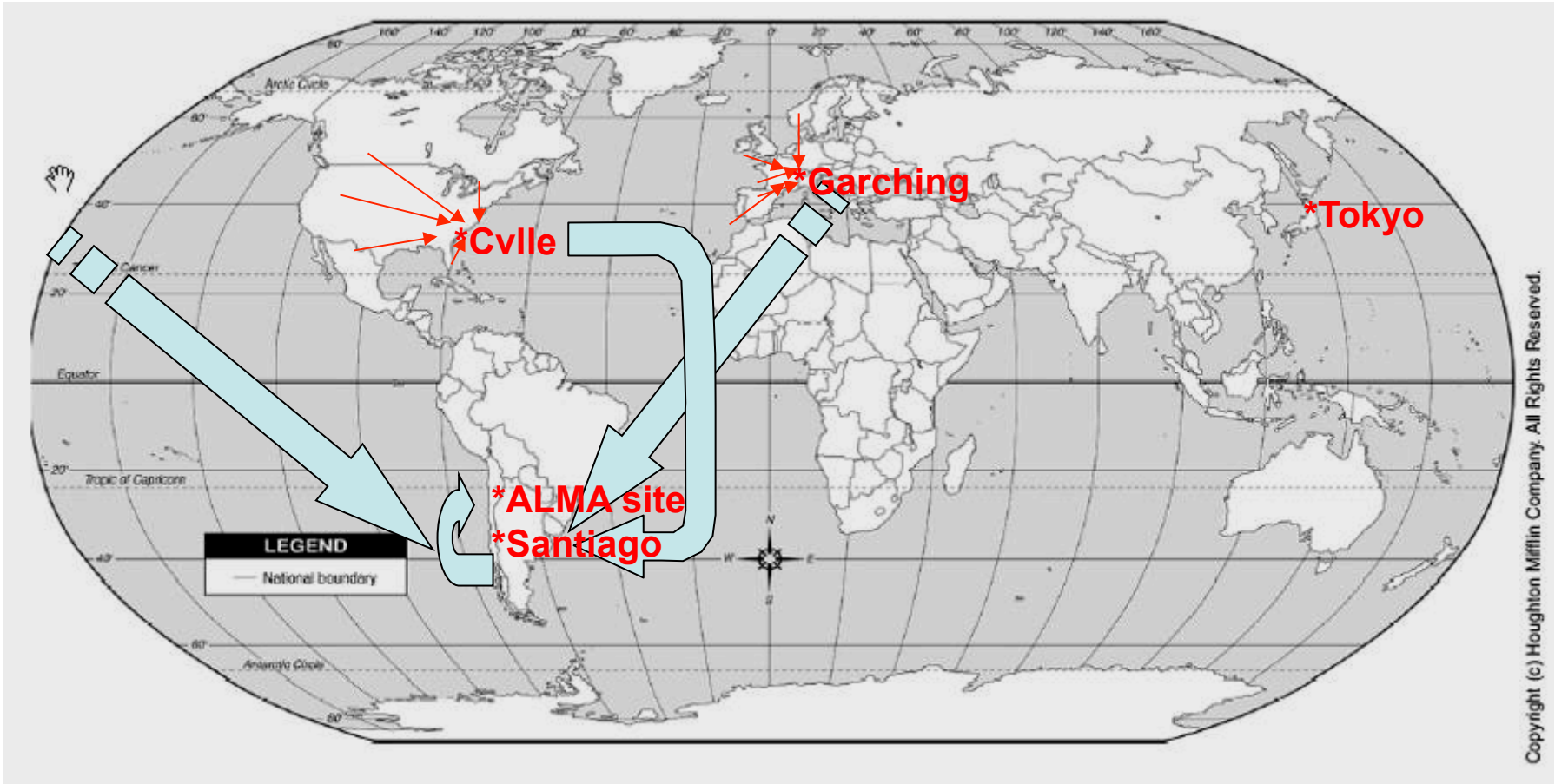
ALMA Science Operations sites
OSF, Santiago and the ARCs



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The Regional centres

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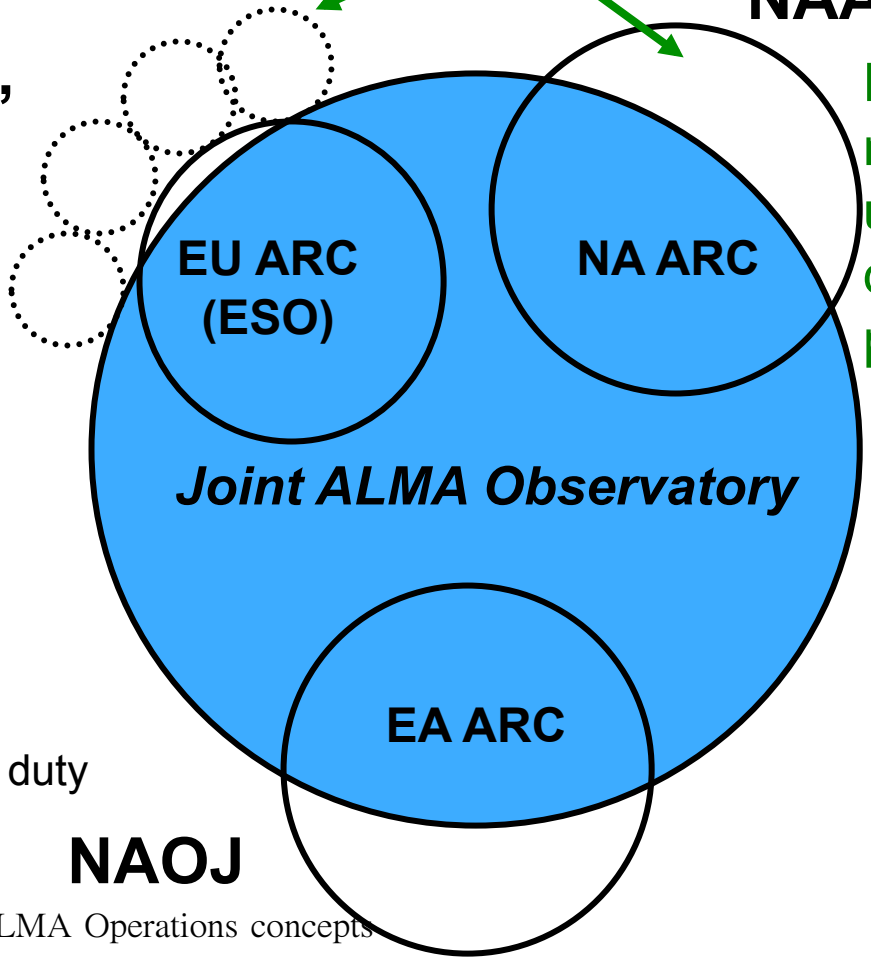
ALMA Operations: Three ALMA Regional Centres - ARCs

Face to face + other user support

NAASC

Enhanced services are needed to provide advanced user support, algorithm development, student programs, EPO, grants

"Satellite" EU ARCs



NAOJ

ARCs provide
user interface,
archive,
software tools
data delivery

Astronomers on duty

DSO provides:
- Array operations
- Scheduling of projects
- Execution of observations
- Data quality assurance and trend analysis
- Calibration plan maintenance
- Delivery of data to the archives
- Archive operations
- Pipeline operations

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Meaning of ALMA Operations

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What does science Operations mean?

- **Phase I + II proposals through ARCs**
  (time estimator, end-to-end data simulator)
- **Create project (scheduling blocks) to OSF**
- **Data taken in service mode, dynamic scheduler selects programmes according to science rating weather conditions, array configuration, consistent calibration**
- **Pipeline data reduction, quality control, archive**
- **Advanced data reduction at ARCs**

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Getting ALMA time

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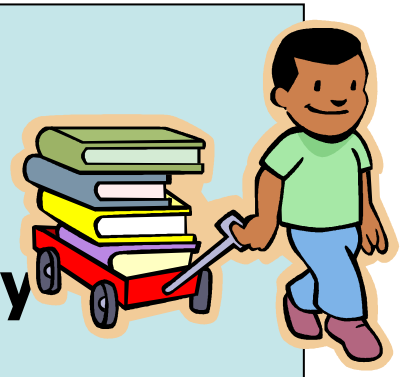
Getting ALMA time

Phase I

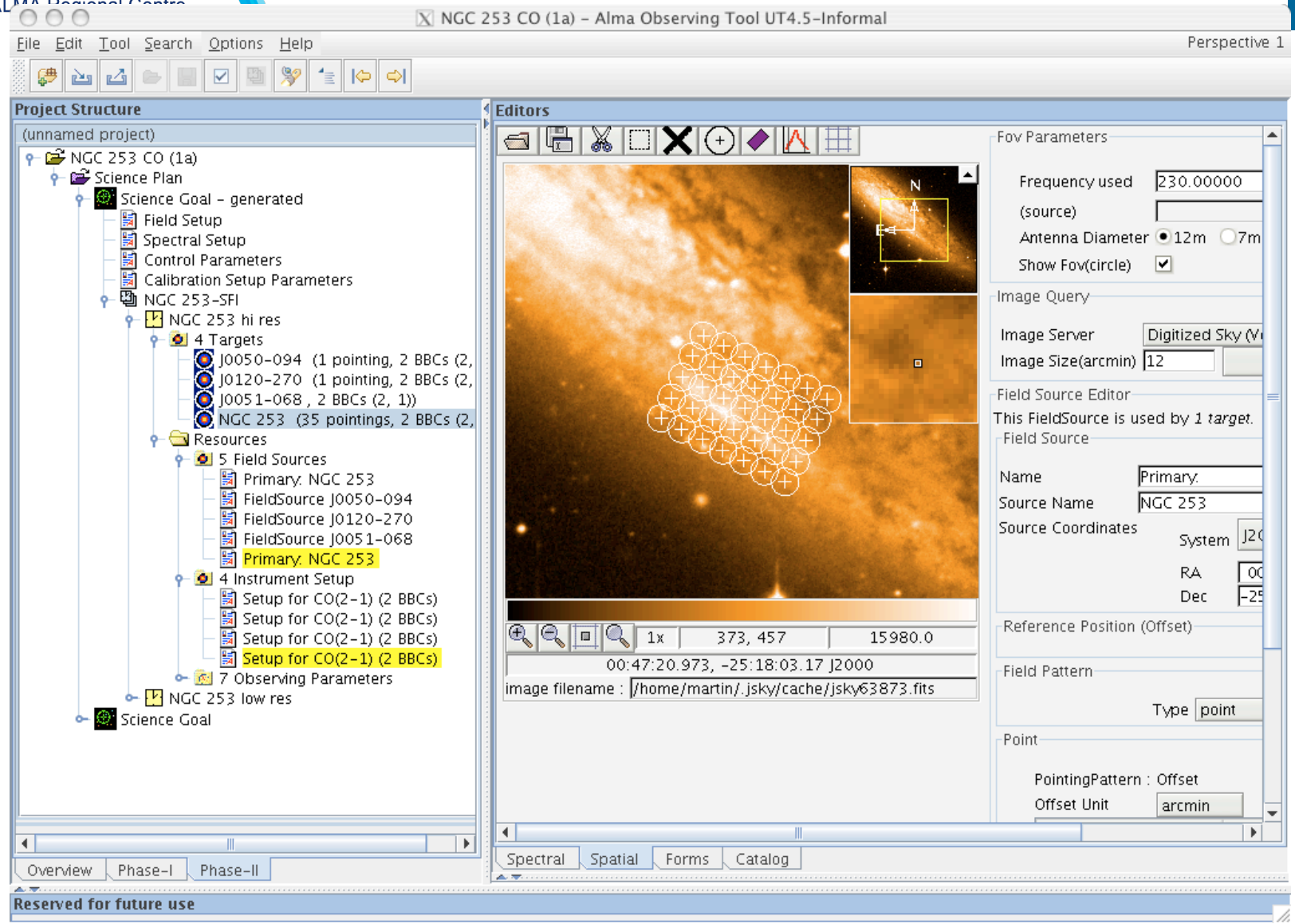
- ❖ **Joint ALMA Observatory issues calls for proposals**
  - Reg
  - Prep
  - user
    - ➢
  - ❖ **A**
    coo
    - ➢ Program Review Comm
- ❖ **Executives approval**

MAKE A PROPOSAL!

Scientific case
Instrument setup: frequency
rms
S/
sc
sp



The ALMA observing tool



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The ALMA Observing tool

- Split Observing Programs in two parts:
- a Phase I Observing Proposal
  - emphasis on the scientific justification of the proposed observations.
- a Phase II Observing Program
  - submitted only if observing time has been granted.
- Set of Scheduling Blocks (SBs)
  - required to drive observing with ALMA.
  - the SB contains a full description of how the science target and the calibration targets are to be observed
- sets of SBs can be combined with a description for the post processing of the data, ultimately resulting in an image.

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Getting ALMA time

Phase II

- Phase I: Proposals are submitted using ALMA Observing Tool
  - **Phase II:** Successful PIs submit observing programme using the Observing Tool
  - Preparation of the scheduling blocks
  - European ARC helps with observation planning and validates observing schedule

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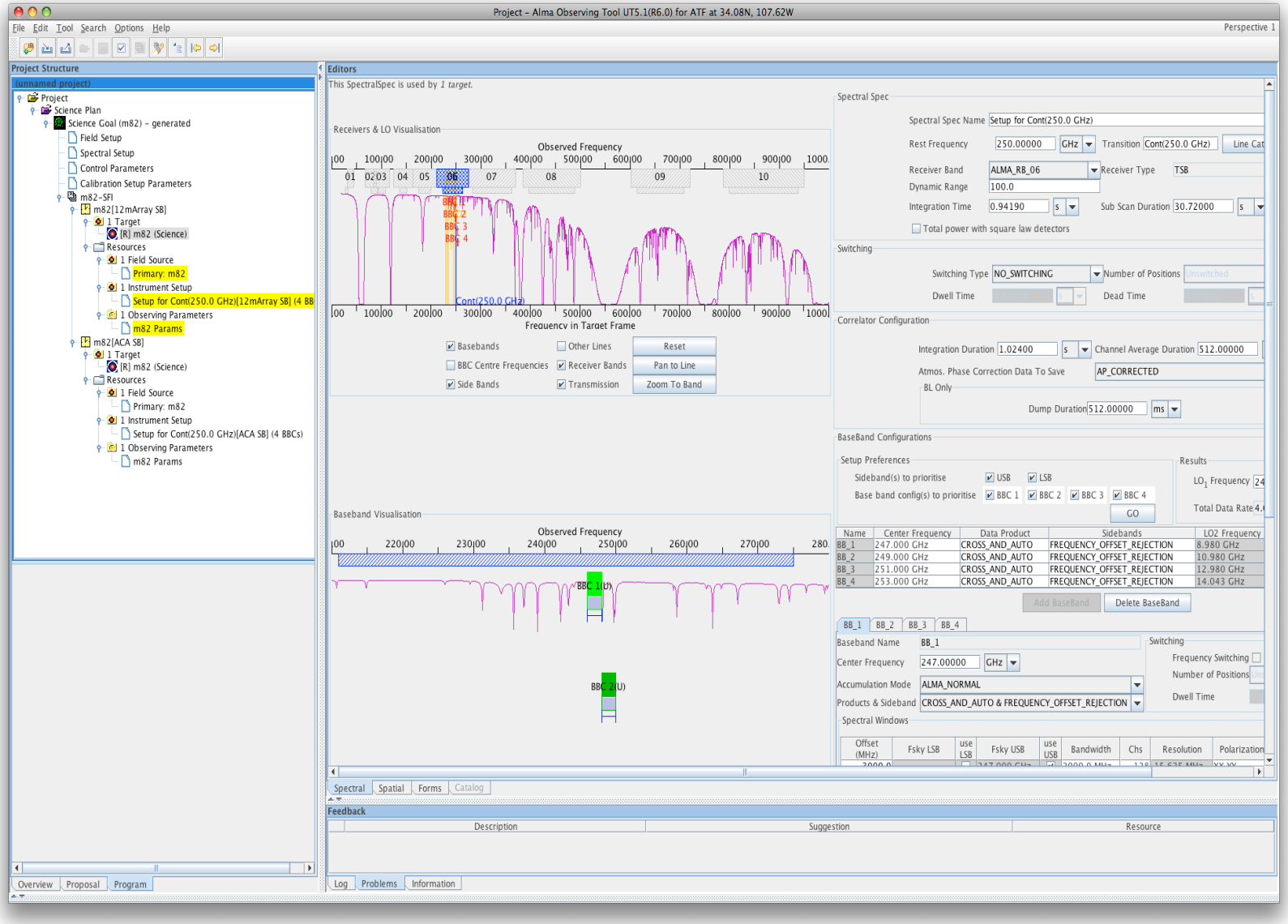
The ALMA observing tool



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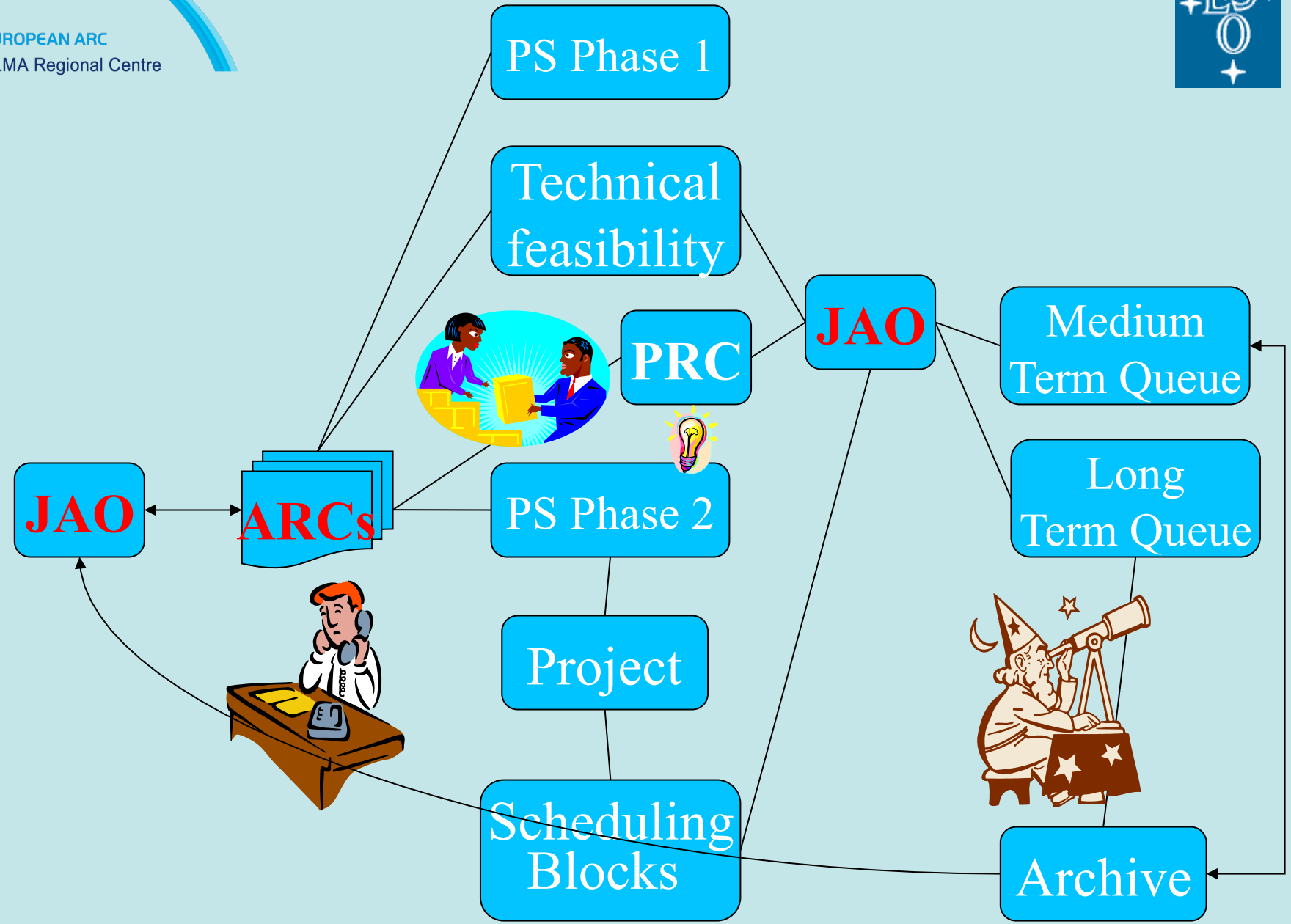
ALMA DATA FLOW



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Getting ALMA data

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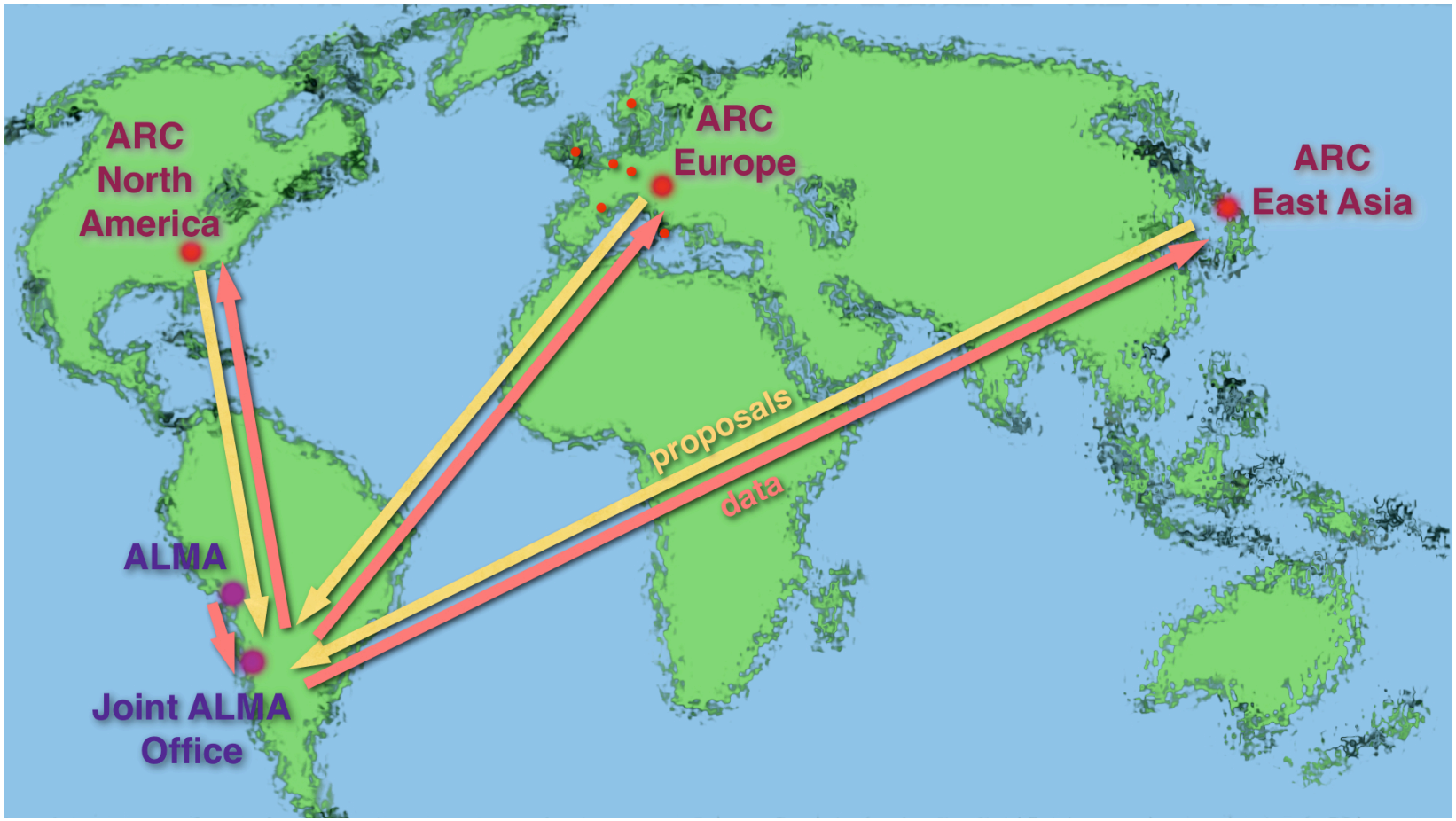
The ARCs and their relation to the JAO



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Data reduction

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The ALMA offline reduction package (CASA)

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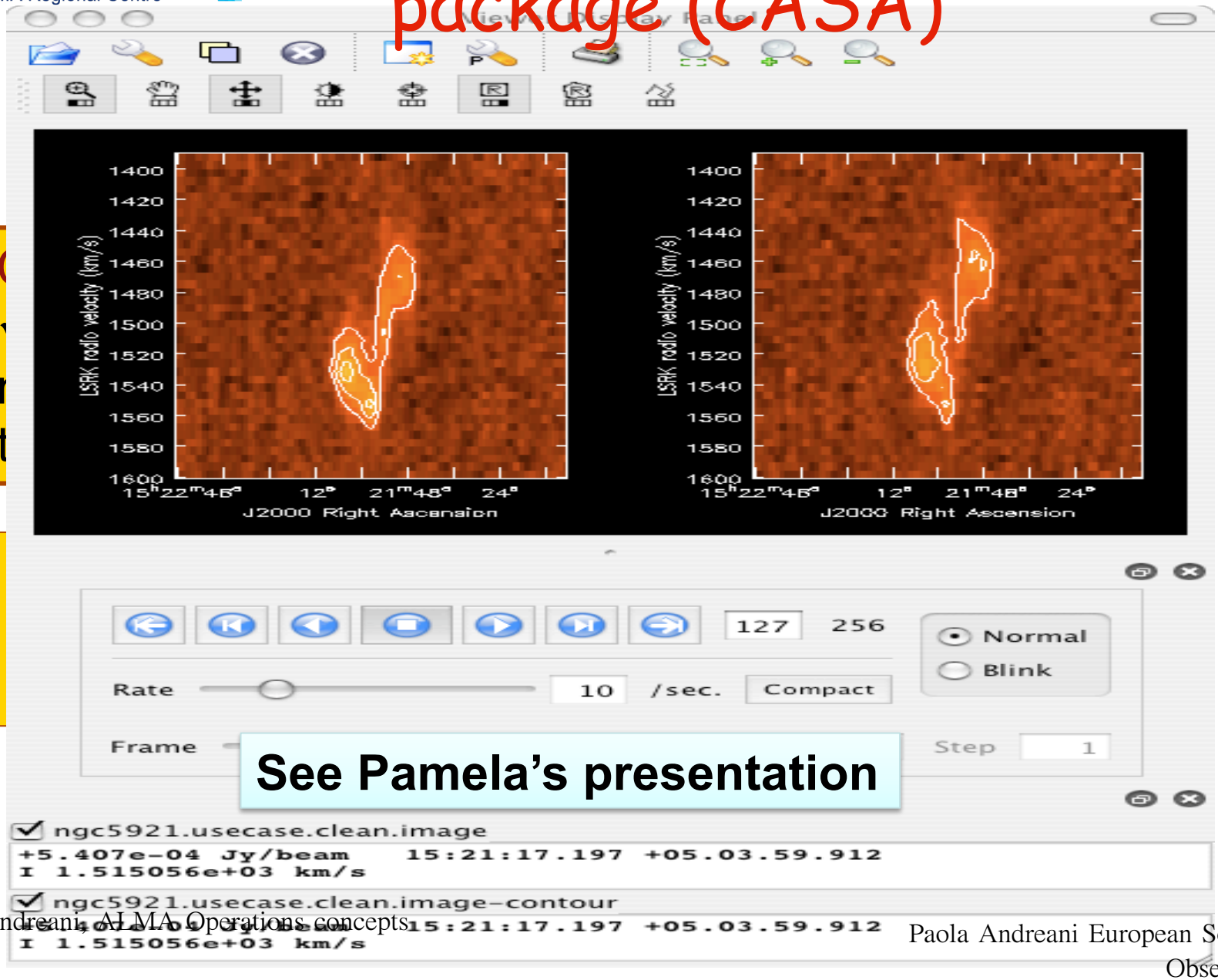

See Pamela's presentation

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Simulating the data

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ALMA simulator

It is possible to simulate with the CASA package (see Pamela's talk) observations with ALMA.

The ALMA simulator is a task (in CASA), which produces

- synthetic visibilities
- a synthesized deconvolved image
- some analysis tools (image fidelity etc.)

The simulator models:

- thermal noise
- atmospheric phase delay (using a mock phase screen)
- cross-polarization leakage, gain drift

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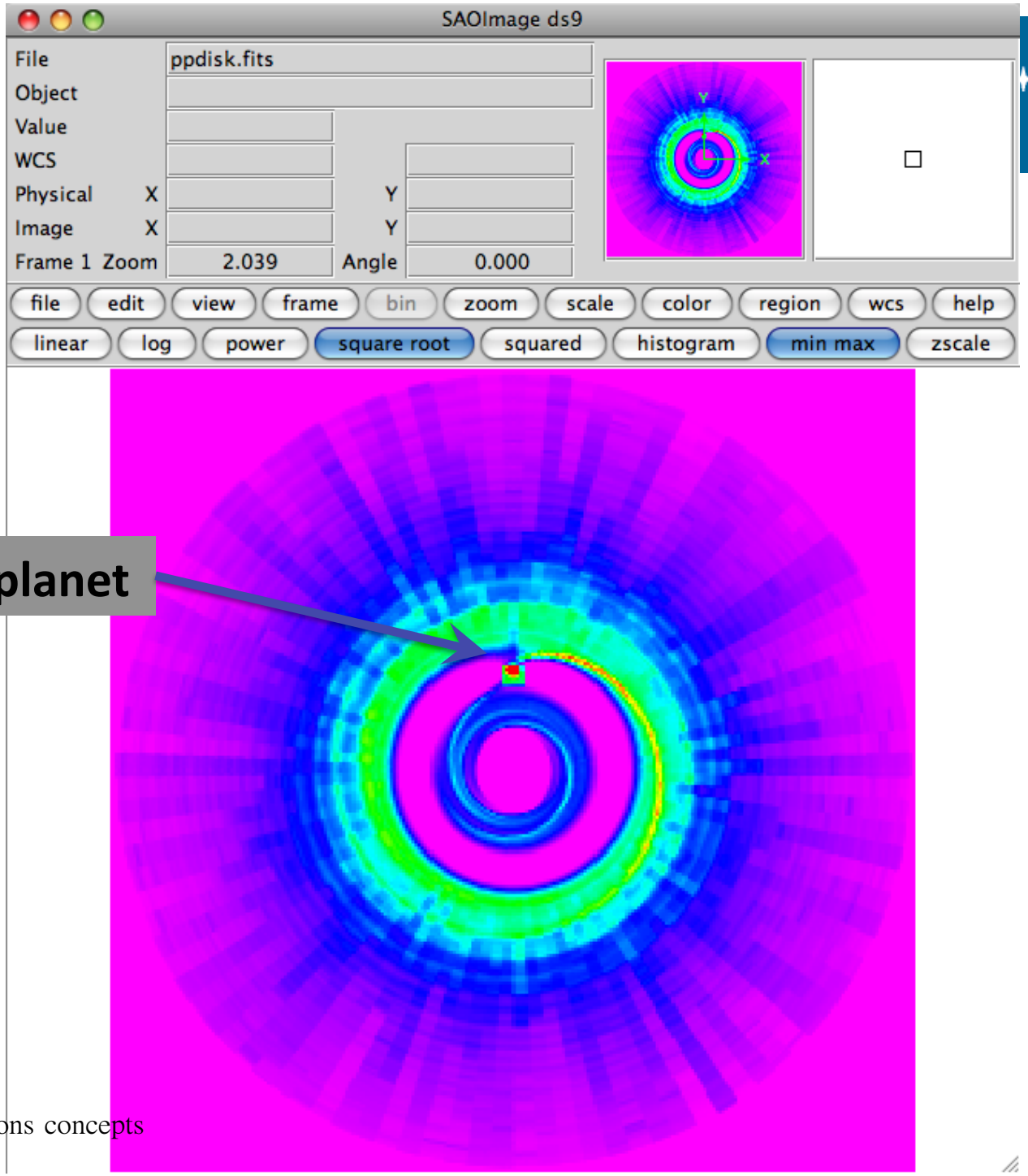

IPy testing

IPy testing | Default

```
CASA <51>: inp
---------> inp()
#  almasimmos :: ALMA mosaic simulation task (prot
modelimage          = 'ppdisk.im'       #  input
incell              = '8.63888953e-7deg' #  input
inbright            =   0.067459        #  input
                                        #   (Jy/sq arcsec)
complist            =          ''       #  componentlist table to observe
antennalist         = 'almaconfig.out22' #  antenna position file
project             =      'sim'        #  root for output files
refdate             = '2012/05/21/22:05:00' #  center time/date of observation
totaltime           =    '7200s'        #  total time of observation
integration         =      '10s'        #  integration (sampling) time
startfreq           = '668.0GHz'        #  frequency of first channel
chanwidth           =   '8.0GHz'        #  channel width
nchan               =          1        #  number of channels
direction           = ['J2000 19h00m00 -40d00m00'] #  mosaic center, or list of
                                        #   pointings
pointingspacing     = '0.1arcsec'       #  spacing in between beams in mosaic
relmargin           =        1.0        #  space btw. pointings and edge,
                                        #   relative to pointingspacing
cell                = '0.004arcsec'     #  output cell/pixel size
imsize              = [192, 192]        #  output image size in pixels (x,y)
niter               =        200        #  Maximum number of iterations
threshold           =    '0.0mJy'       #  Flux level (+units) to stop cleaning
psfmode             =     'clark'       #  method of PSF calculation to use
                                        #   during minor cycles
weighting           =  'natural'        #  Weighting to apply to visibilities
uvtaper             =      False        #  Apply additional uv tapering of
                                        #   visibilities.
stokes              =        'I'        #  Stokes params to image
noise_thermal       =      False        #  Add thermal noise
fidelity            =       True        #  Calculate fidelity images
display             =       True        #  Plot simulation result images,figures
async               =      False        #  If true the taskname must be started
                                        #   using almasimmos(...)

CASA <52>:
```

Your desired observation (array, time) is easily entered at the CASA user interface

IPy testing

IPy testing | Default

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psfmode             =    'clark'        #  method
                                        #   during
weighting           =  'natural'        #  Weight
uvtaper             =      False        #  Apply
                                        #   visib
stokes              =        'I'        #  Stokes
noise_thermal       =      False        #  Add th
fidelity            =       True        #  Calcul
display             =       True        #  Plot simulation result images,figures
async               =      False        #  If true the taskname must be started
                                        #   using almasimmos(...)

CASA <52>:
```

Your desired observation (array, time) is easily entered at the CASA user interface

As well as details of the input model, if you wish e.g. to change size or frequency, and details of how to image the data.

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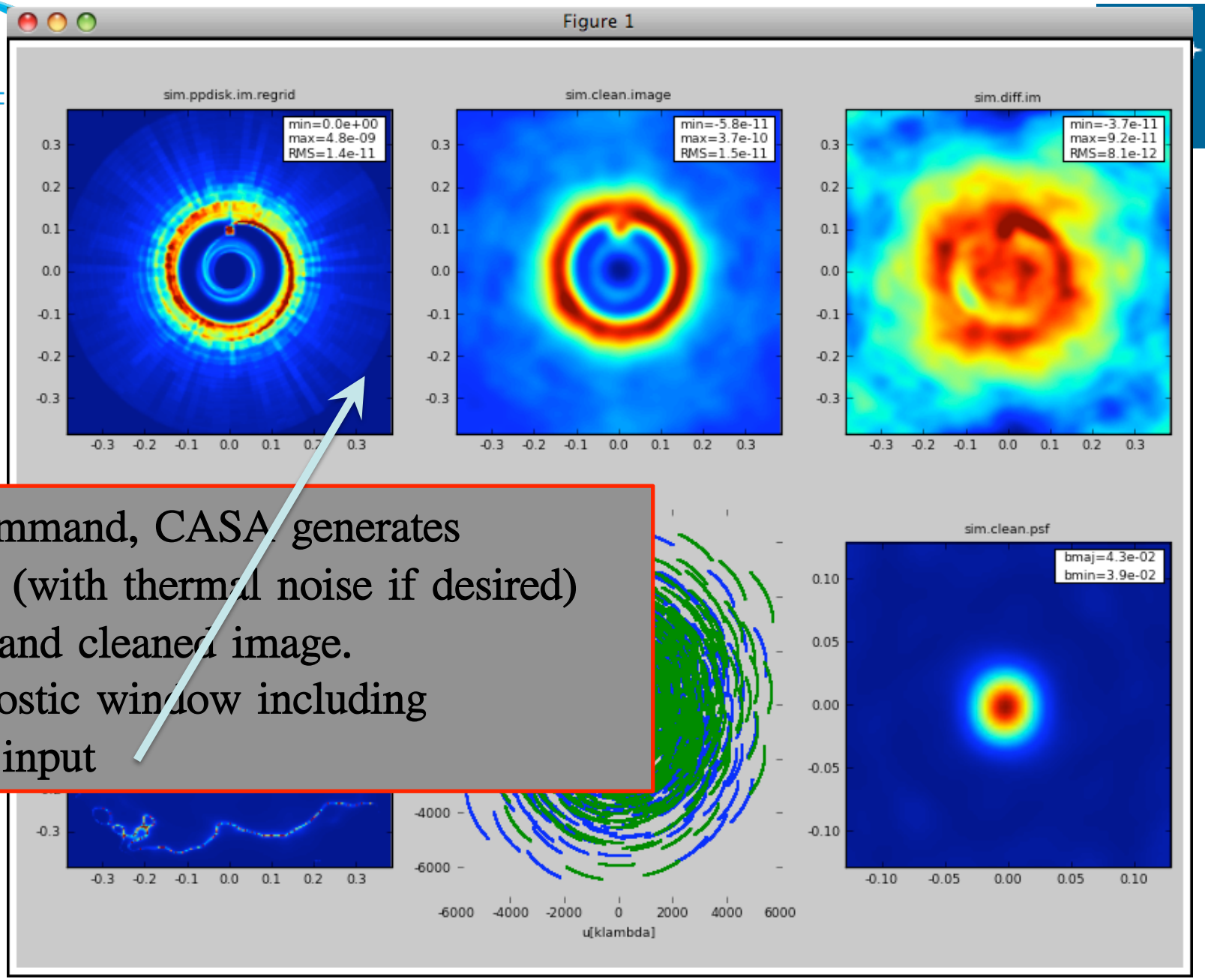

In one command, CASA generates

- uv data (with thermal noise if desired)
- a dirty and cleaned image.
- a diagnostic window including
  - your input

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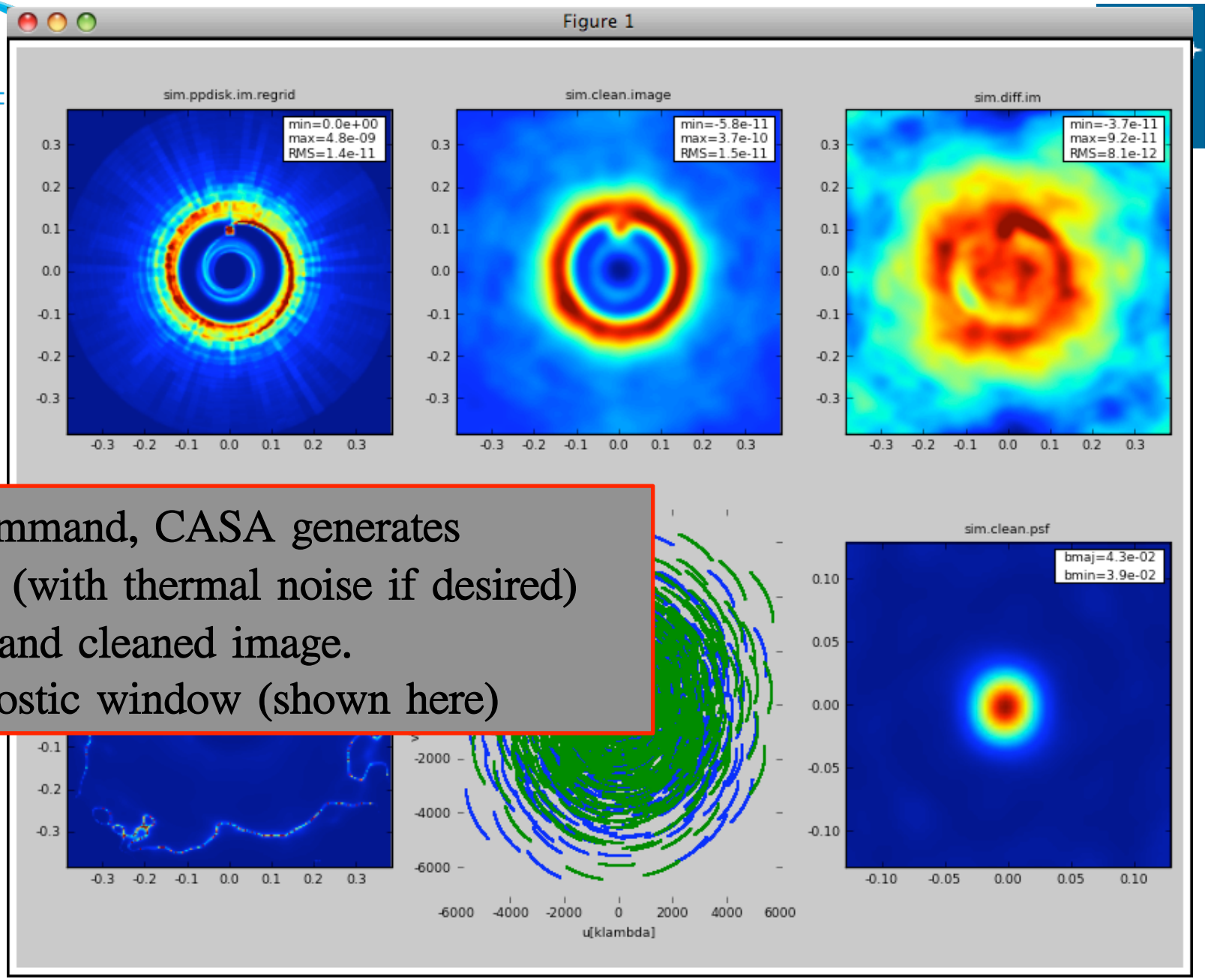

In one command, CASA generates

- uv data (with thermal noise if desired)
- a dirty and cleaned image.
- a diagnostic window (shown here)

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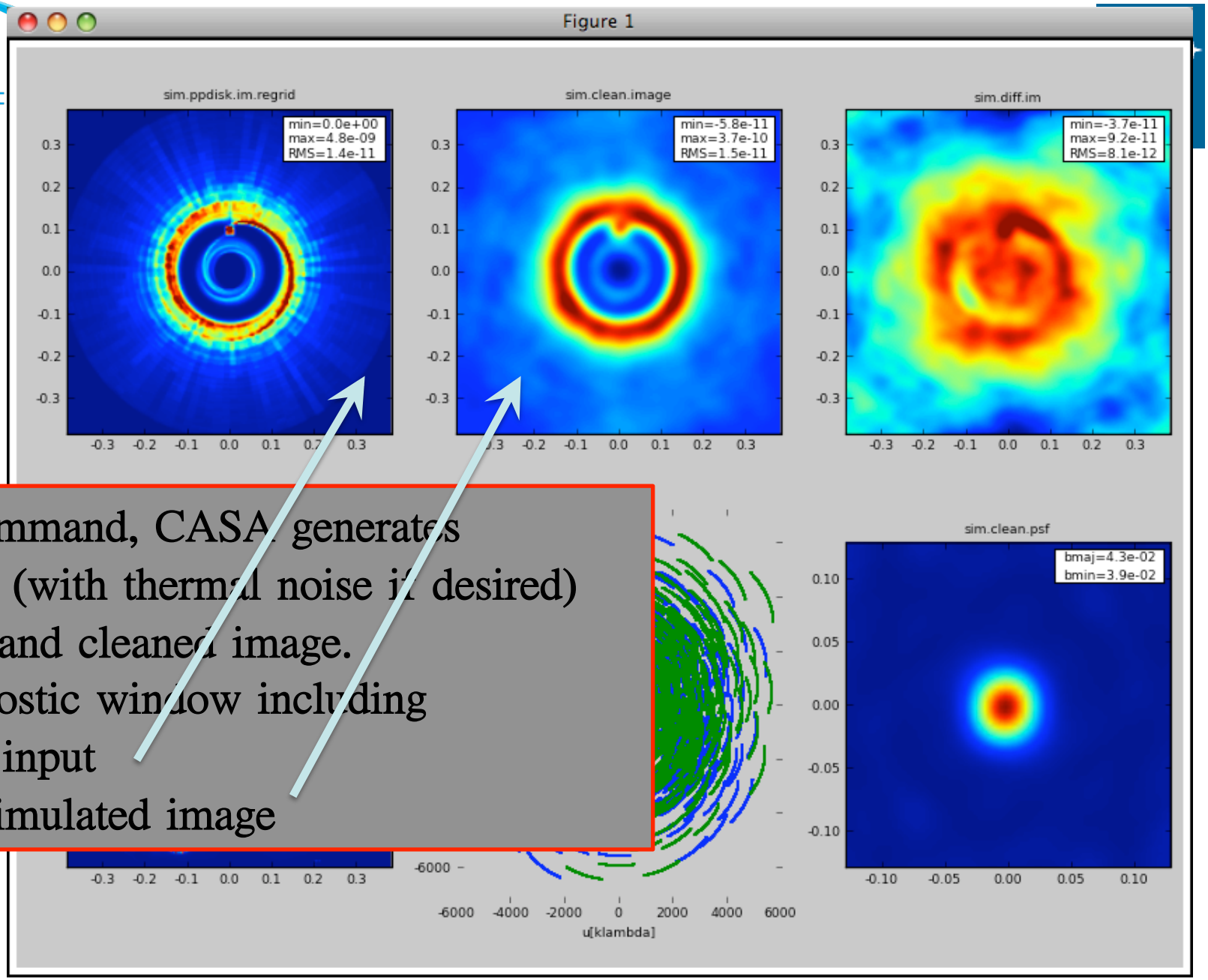
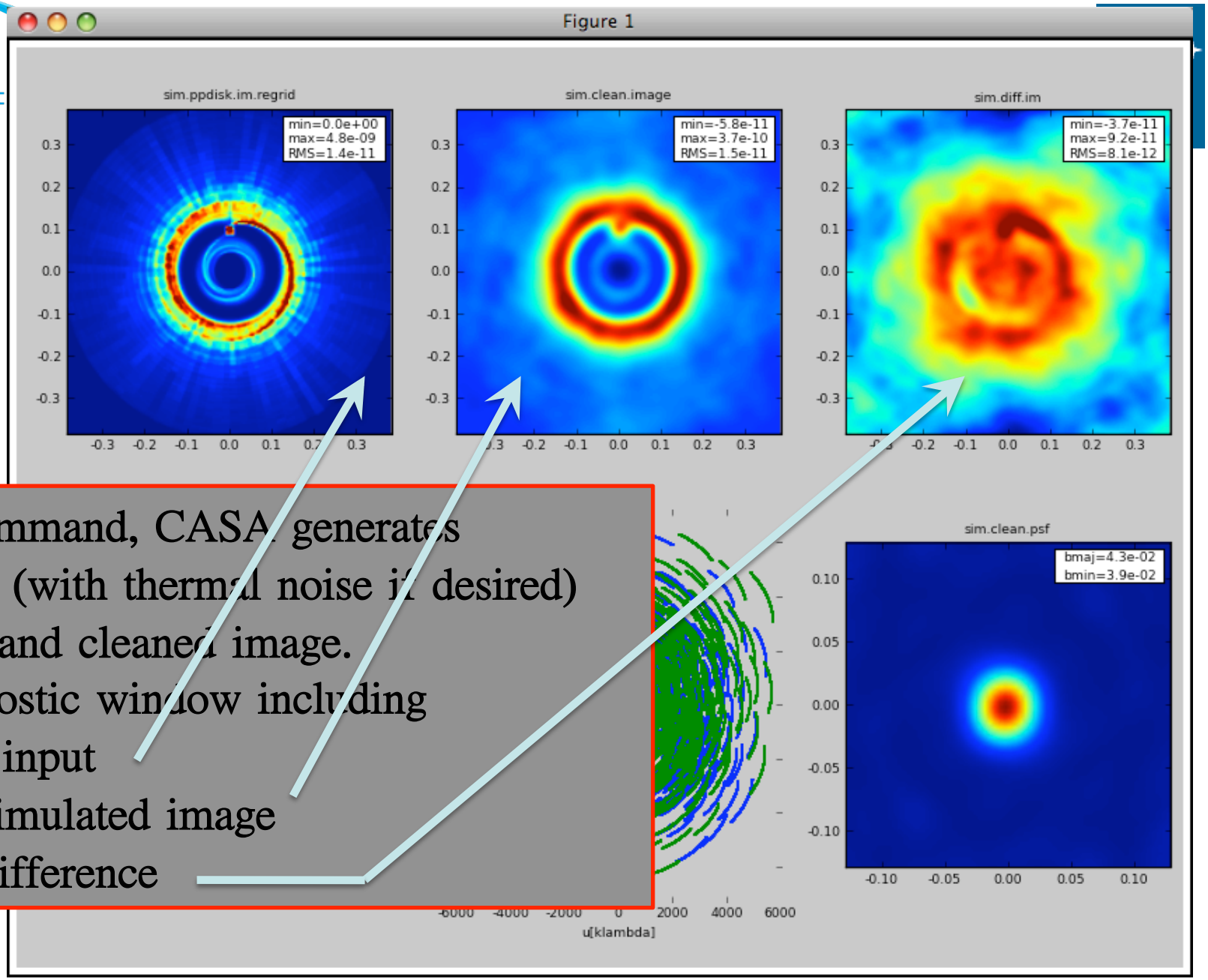


In one command, CASA generates

- uv data (with thermal noise if desired)
- a dirty and cleaned image.
- a diagnostic window including
  - your input
  - the simulated image



In one command, CASA generates

- uv data (with thermal noise if desired)
- a dirty and cleaned image.
- a diagnostic window including
  - your input
  - the simulated image
  - the difference

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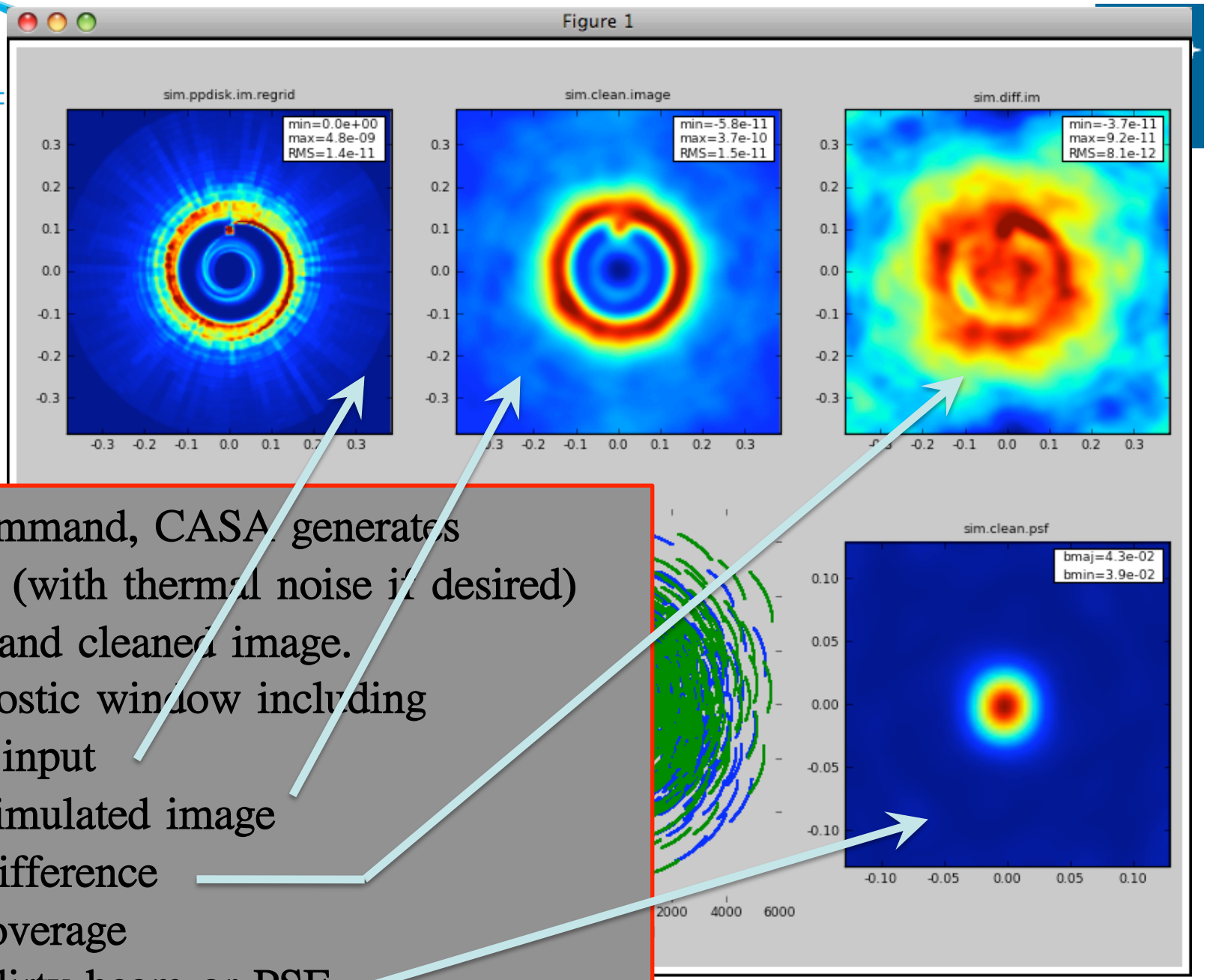

In one command, CASA generates

- uv data (with thermal noise if desired)
- a dirty and cleaned image.
- a diagnostic window including
  - your input
  - the simulated image
  - the difference
  - uv coverage
  - and dirty beam or PSF

The European ARC

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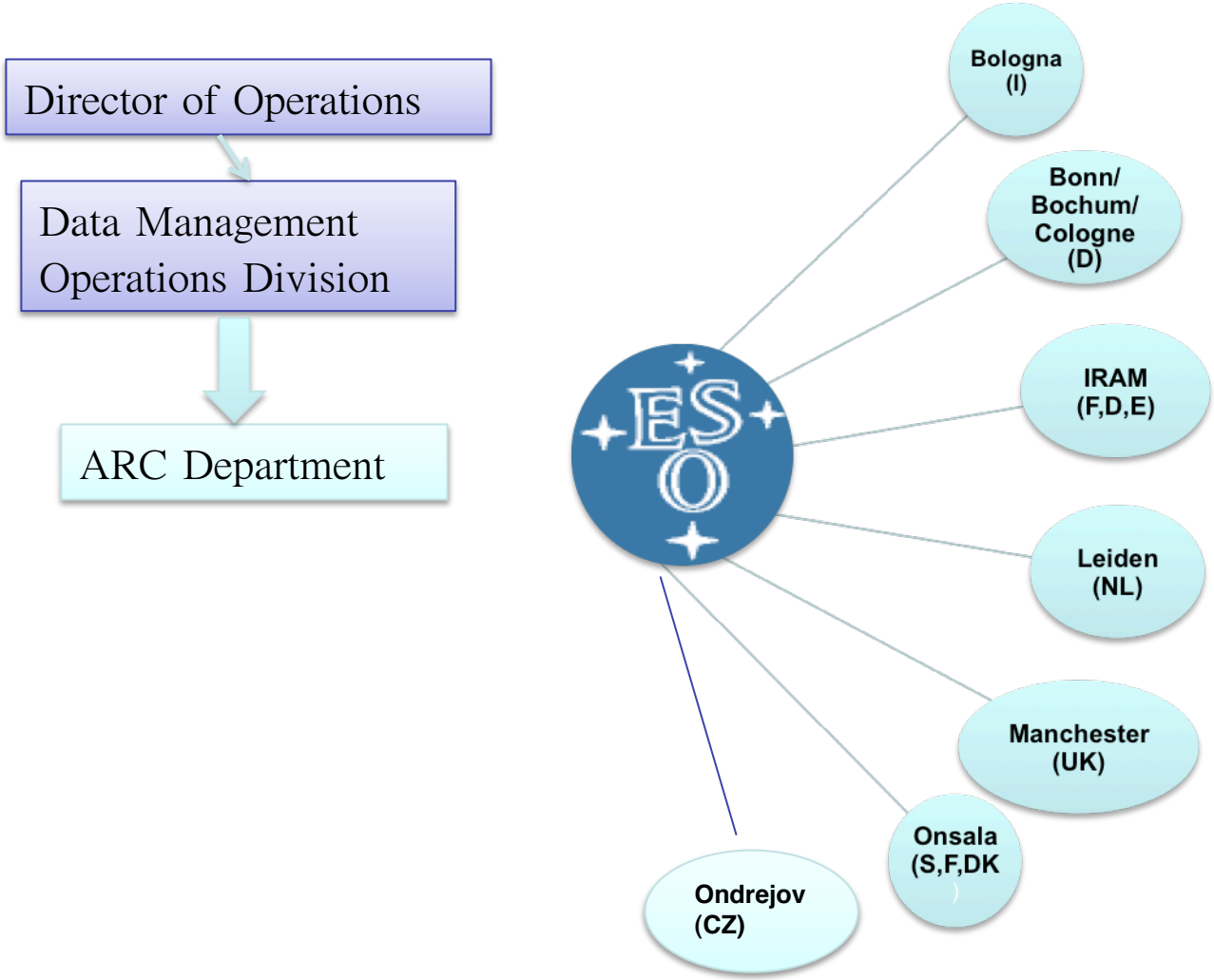
The European ARC



The European ARC network

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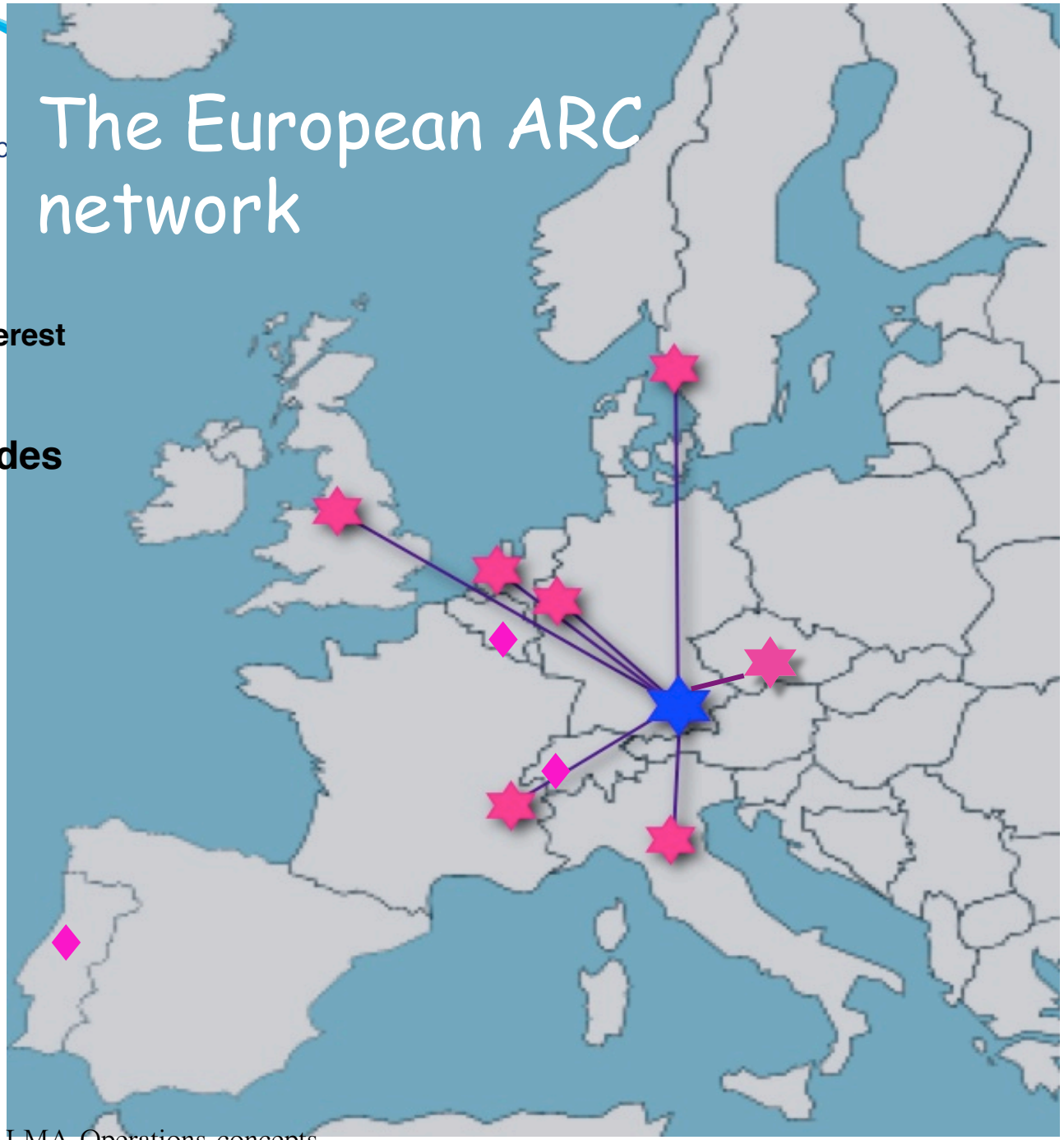
The European ARC network

♦: **express interest**

☆: **ARC nodes**



The European ARC

- Core functions
  - Scientific support:
  - Proposal & observation preparation
  - user support
  - Archive Operations:
  - host a copy, data delivery
  - Astronomer on duty at OSF
  - Science community activity
  - User support:
  - f2f help

ESO: ARC Department

ARC nodes

- Non-core functions
  - Data reduction
  - Advanced pipeline
  - Extended archive support
  - Support for special projects
  - Science community activity:
  - training, schools, workshops

ARC nodes

ESO ARC + nodes

ALMA simulators

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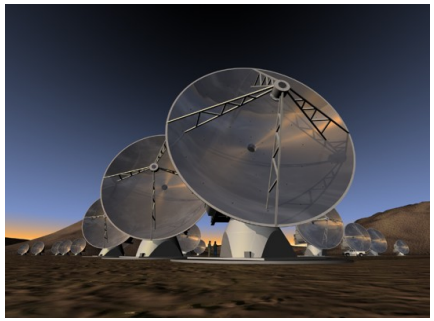
Current Timeline

- **Start of CSV (Commissioning and Science Verification): Jan 2010** (3 antennas at the AOS)
- **ESDP (Early Science Decision Point): End 2010 (call for proposals)**
  - Mirror Archives in place
  - ALMA User Portal activated
  - ALMA Helpdesk activated

- Deadline for proposals (Early 2011)
  - PRC review procedure initiated
- Deadline for PRC final ranking (Mid 2011)
  - Preparation of SBs
- **Start Early Science: Autumn 2011**
  - Take and deliver data



- **Inauguration: September 2012**
  - More than 50 fully equipped antennas
- **Baseline ALMA Construction Complete 2013**

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Early Science Operations

- Start Science Operations before the ALMA construction finishes
- Conditions for Early Science Operations:
  - 16 antennas with at least 4 receiver bands
  - Single field interferometry and pointed mosaics
  - Baselines out to 1 km
  - Basic set of spectral line modes
  - Single dish mapping (zero baseline observations) of extended objects in continuum and spectral line mode
  - Calibration better or comparable with existing mm-arrays
- Early Science Operations
  - One year scheduling period
  - Time shared with commissioning. At least 33% of available time will be used for observations

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Questions ?

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