Remote interactive pipelines using CASA and Jupyter

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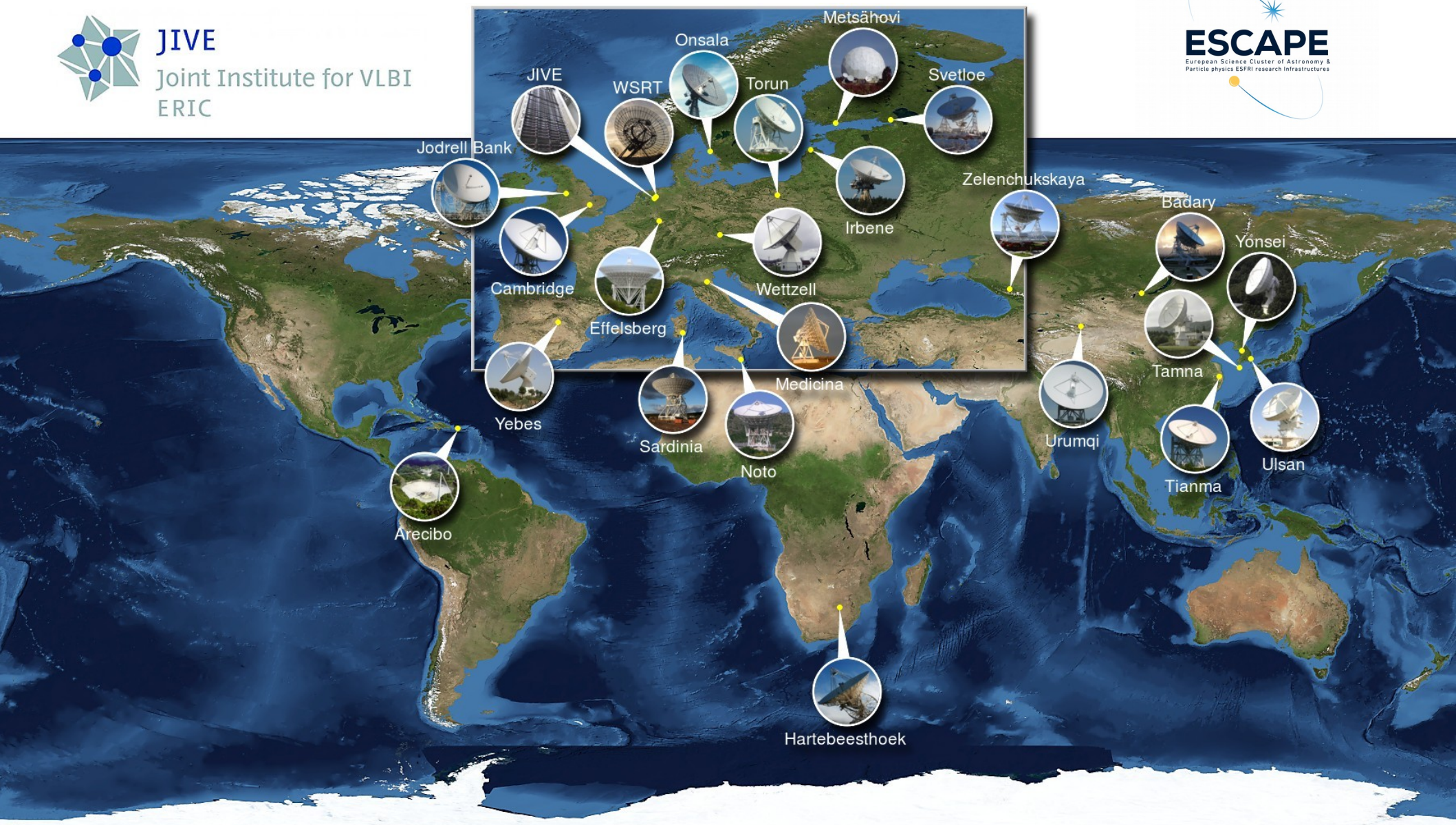
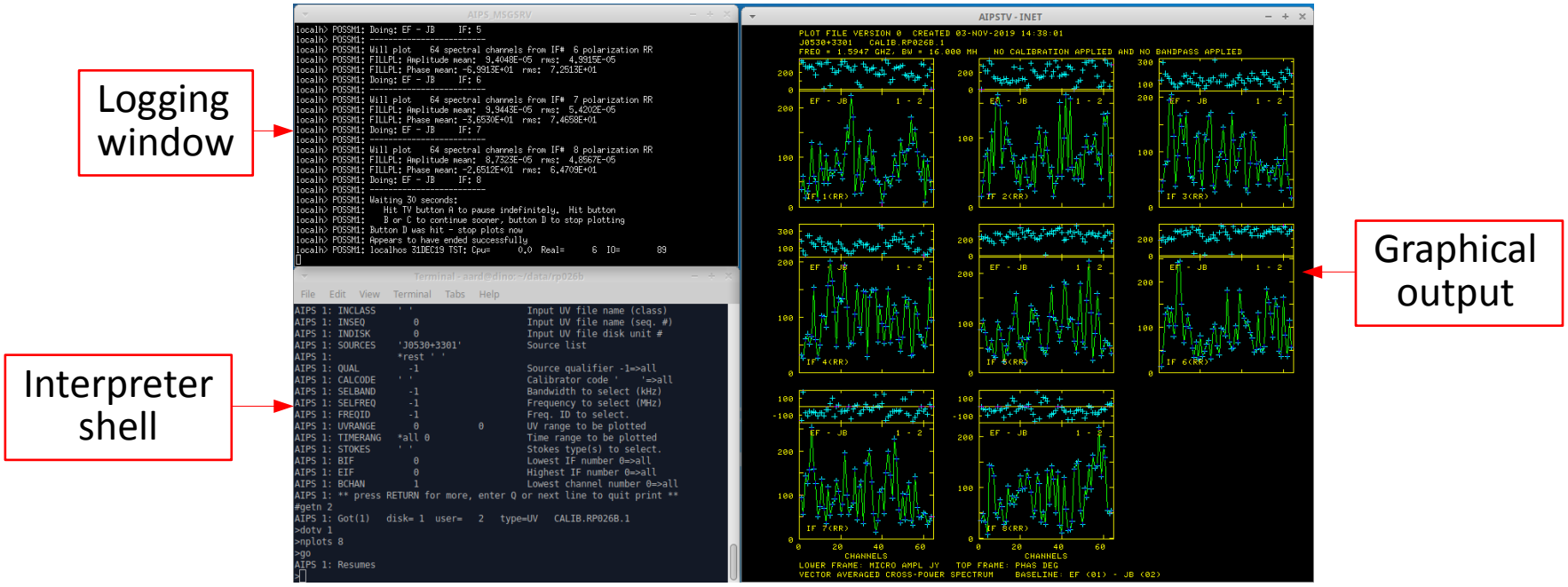
JIVE
Joint Institute for VLBI ERIC

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



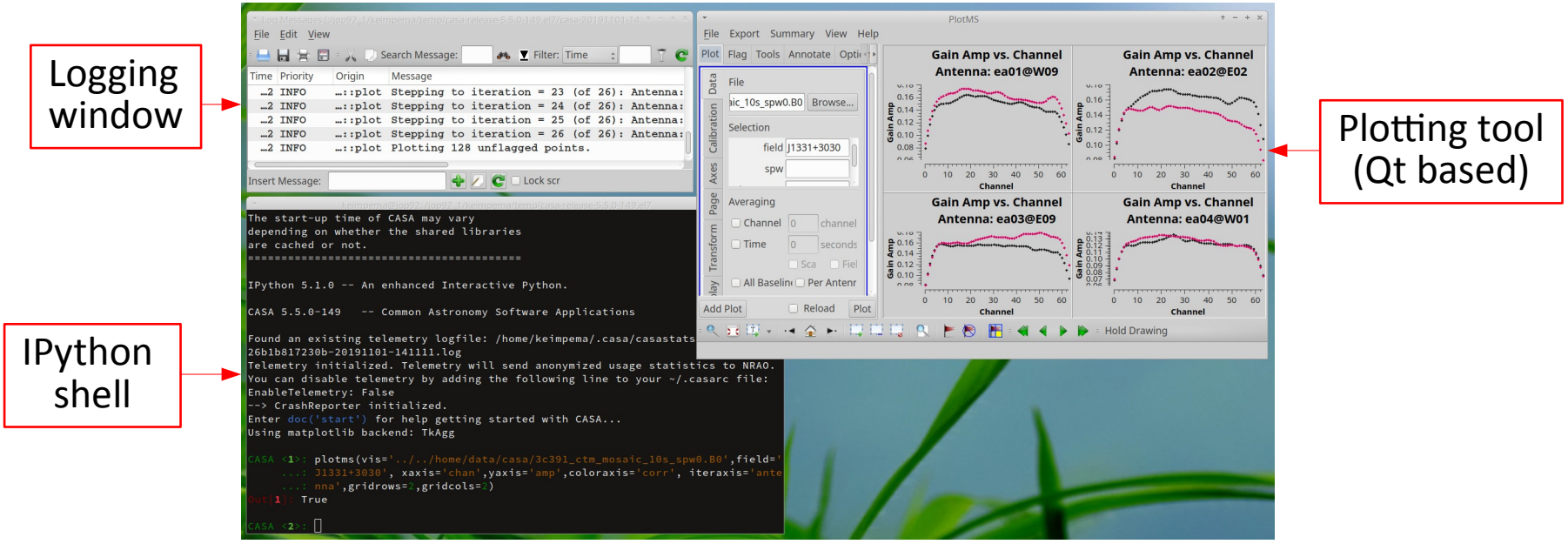
AIPS

- Development started in 1978
- Mainly Fortran 77
- **End of life** but until very recently was the only package with VLBI support.
- Basis for the current EVN pipeline



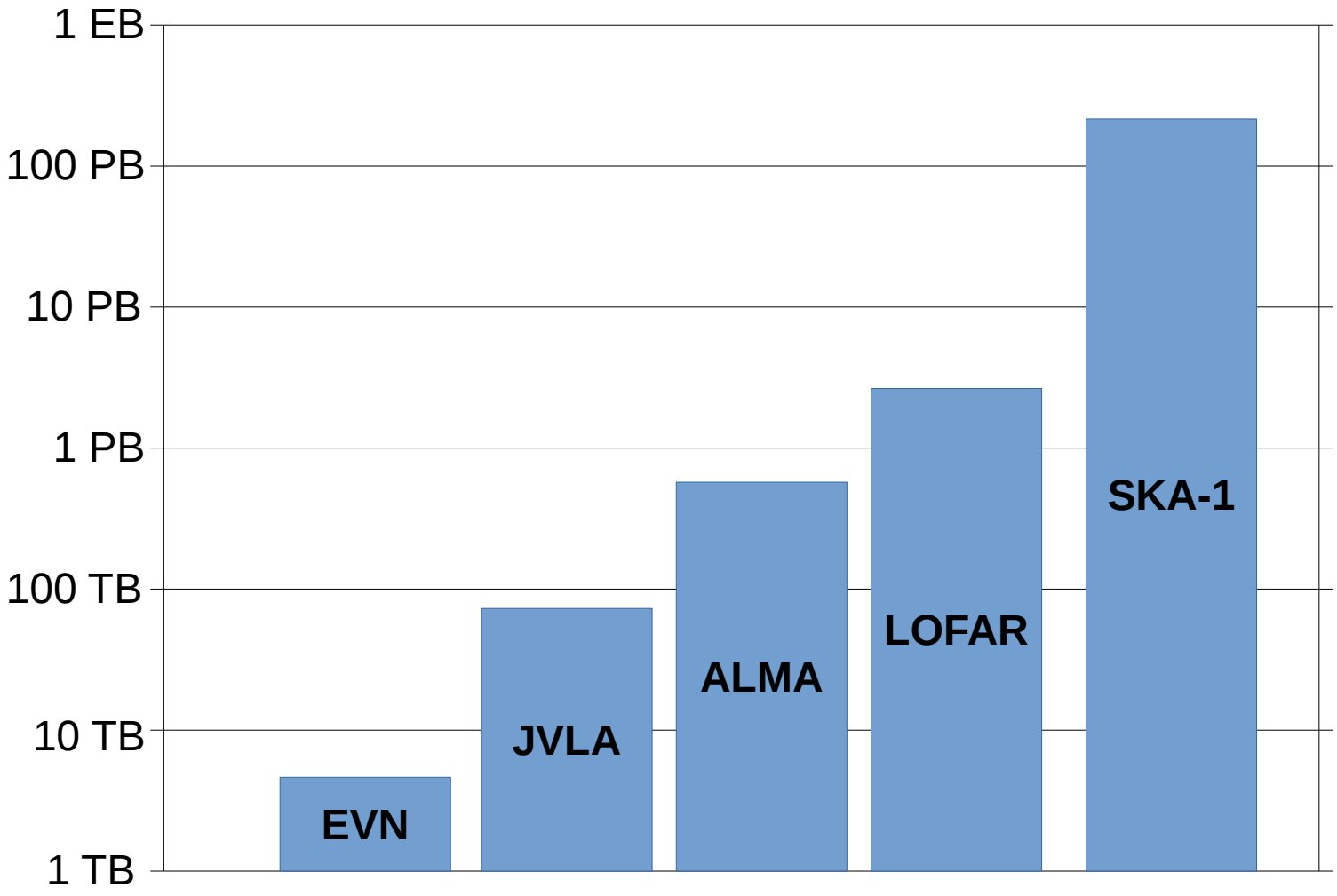
CASA

- De facto standard data reduction package for radio astronomy
- Under active development since 1990s
- Mostly C++, but has python bindings to all tasks
- VLBI support developed at JIVE, basis for next EVN pipeline



Screenshot of CASA 5.5.0

Yearly archivable data



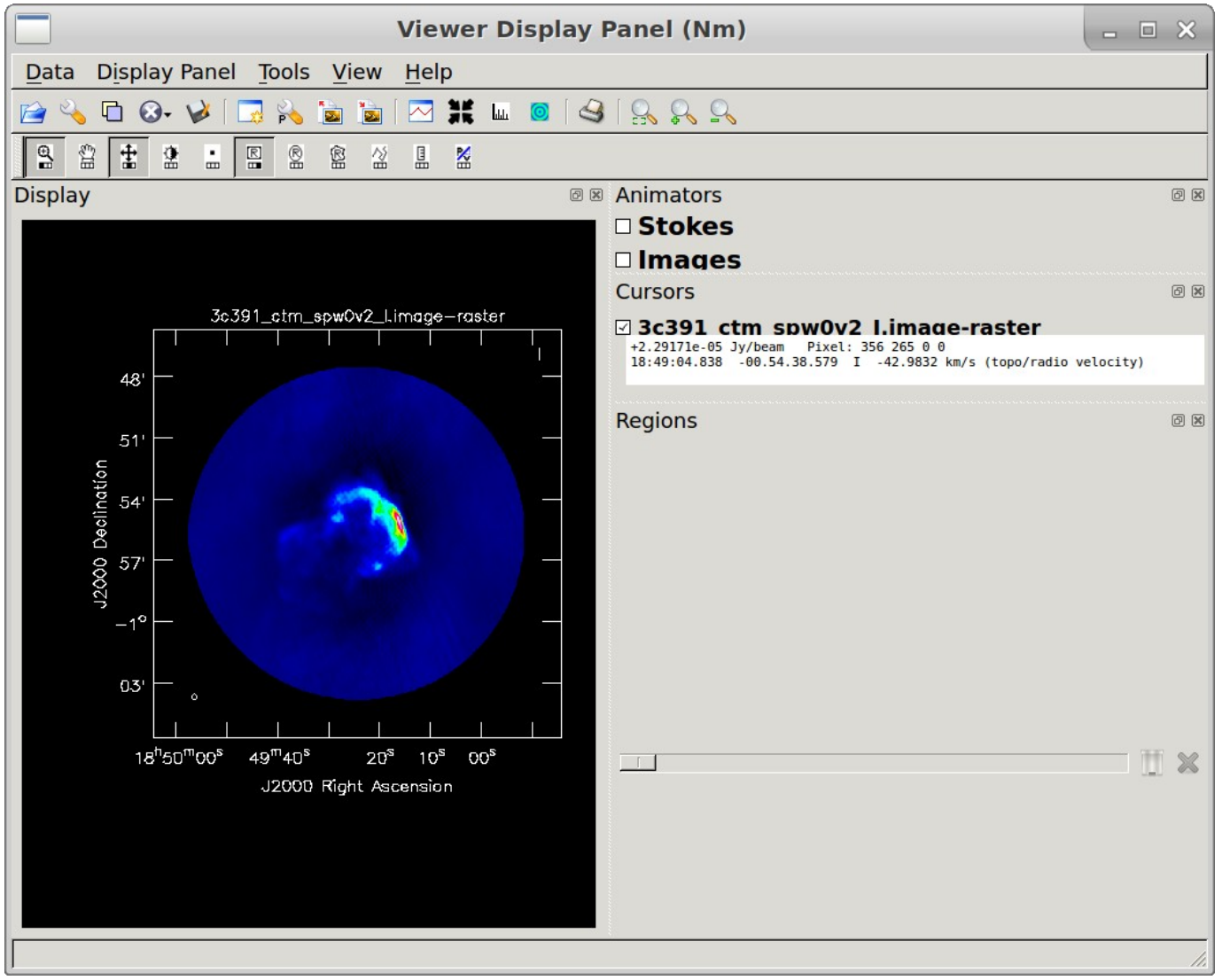
Interactive Jupyter pipelines

- Data reduction should be done where the data is stored
- Existing non-interactive CASA pipelines: ALMA / JVLA, LOFAR, MEERKATHI
- Jupyter offers many advantages
  - User friendly: Notebooks are easy and intuitive to use; all results are embedded in a single document
  - Easy to deploy: Off-the-shelf solutions to deploy multi-user services, e.g. Jupyter hub + Kubernetis
  - Accountability: Data reduction process is self-documenting and fully repeatable

CASA Jupyter kernel

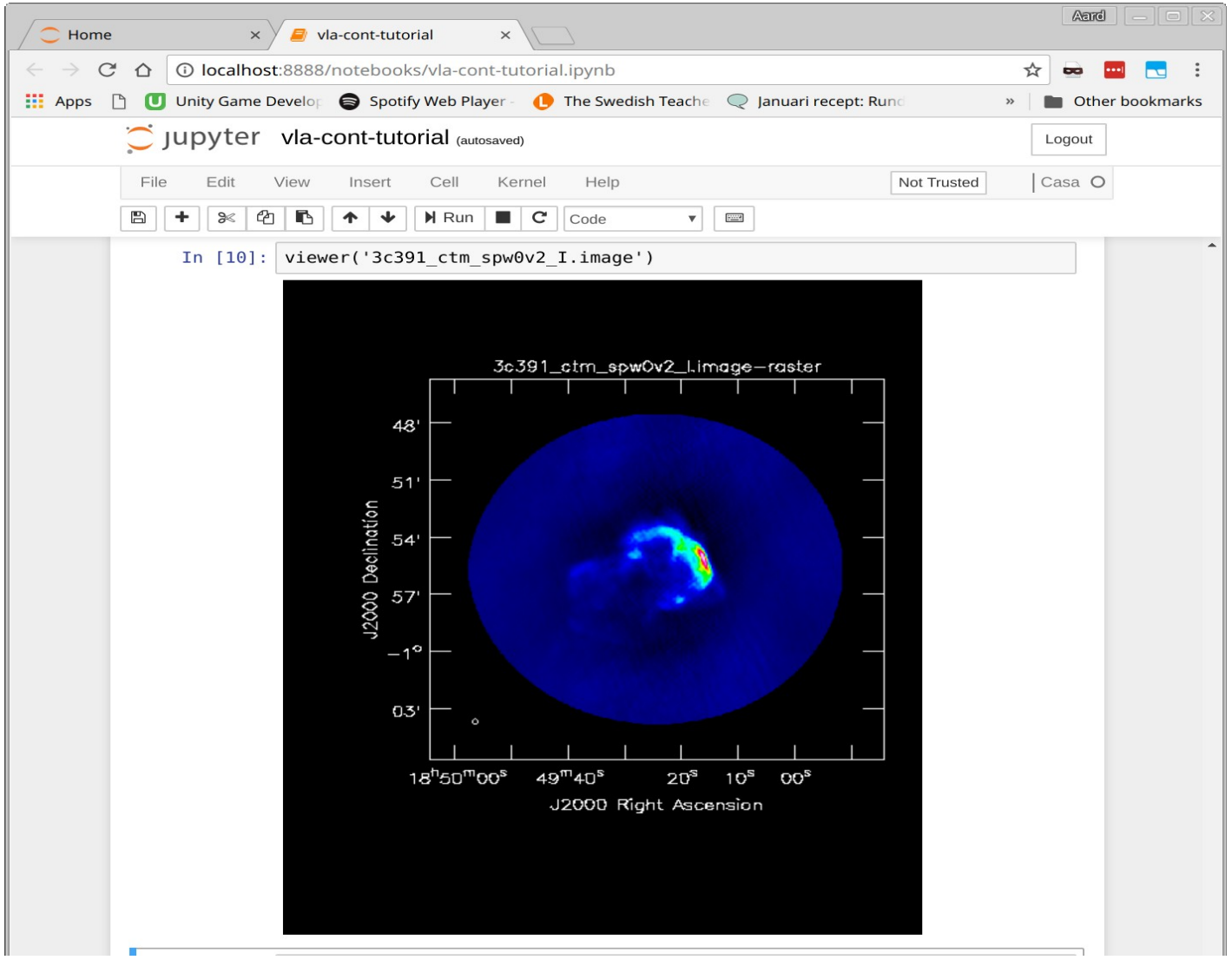
- Based on the generic python wrapper kernel
- Initialization:
  - Load needed python packages: casacore, casa tasks, matplotlib, ….
  - Setup environment: Config, logging, dbus, etc..
- CASA has python bindings for all tasks
- Many tasks open a C++ coded GUI, these are wrapped so that output goes to notebook.
- Distributed both as **Docker** and **Singularity** images
- *https://github.com/aardk/jupyter-casa*

Example: casaviewer



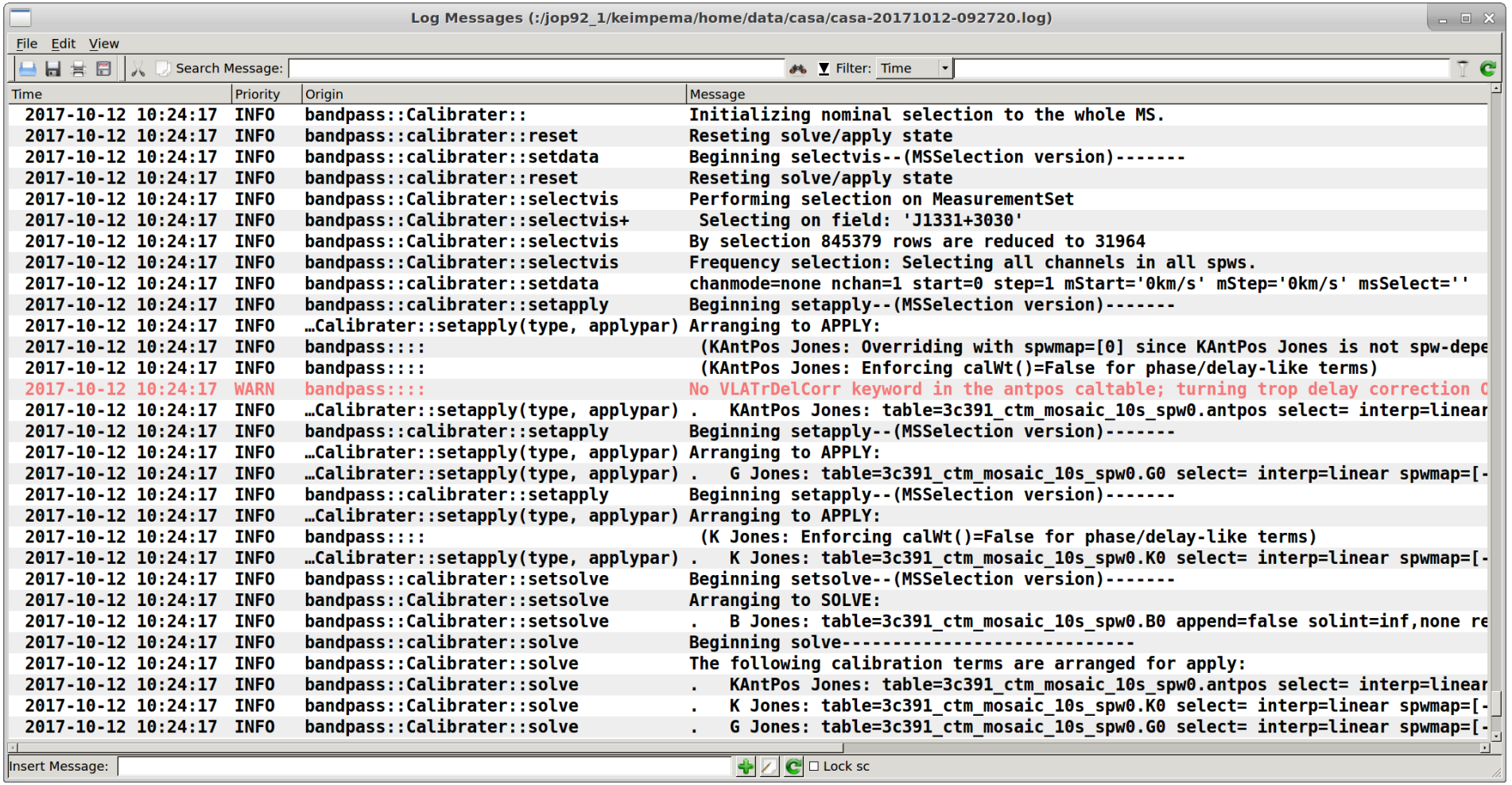
viewer('3c391_ctm_spw0v2_I.image')

Example: casaviewer



viewer('3c391_ctm_spw0v2_I.image', **gui = False,**
outformat = 'png', outfile = viewer_temp.png)

Logging



CASA displays logging information inside *casalogger* task.

Logging

PythonDataScienceHan | vla-cont-tutorial

localhost:8888/notebooks/vla-cont-tutorial.ipynb

Apps | Unity Game Develop | Spotify Web Player | The Swedish Teache | Januari recept: Runc | South Indian-Style V | Bookmarks | Other bookmarks

jupyter vla-cont-tutorial Last Checkpoint: 38 minutes ago (autosaved) Logout

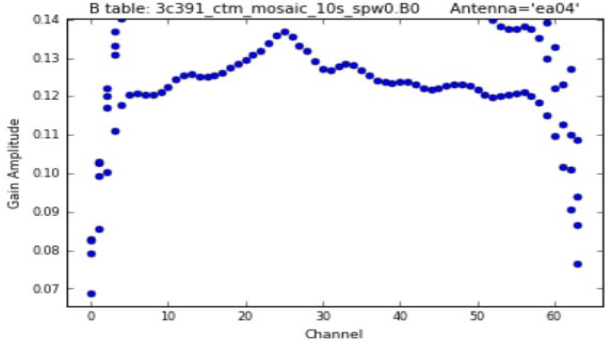
File Edit View Insert Cell Kernel Help Not Trusted Casa

Run Code

In [27]:
```
bandpass(vis='3c391_ctm_mosaic_10s_spw0.ms',caltable='3c391_ctm_mosaic_10s_spw0.B0',
         field='J1331+3030',spw='',refant='ea21',combine='scan',
         solint='inf',bandtype='B',
         gaintable=['3c391_ctm_mosaic_10s_spw0.antpos',
                    '3c391_ctm_mosaic_10s_spw0.G0',
                    '3c391_ctm_mosaic_10s_spw0.K0'])
```

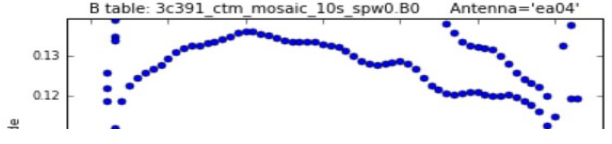
Show log

In [28]:
```
plotcal(caltable= '3c391_ctm_mosaic_10s_spw0.B0',poln='R',
        xaxis='chan',yaxis='amp',field= 'J1331+3030',subplot=221,
        iteration='antenna',figfile='plotcal_3c391-3C286-B0-R-amp.png')
```

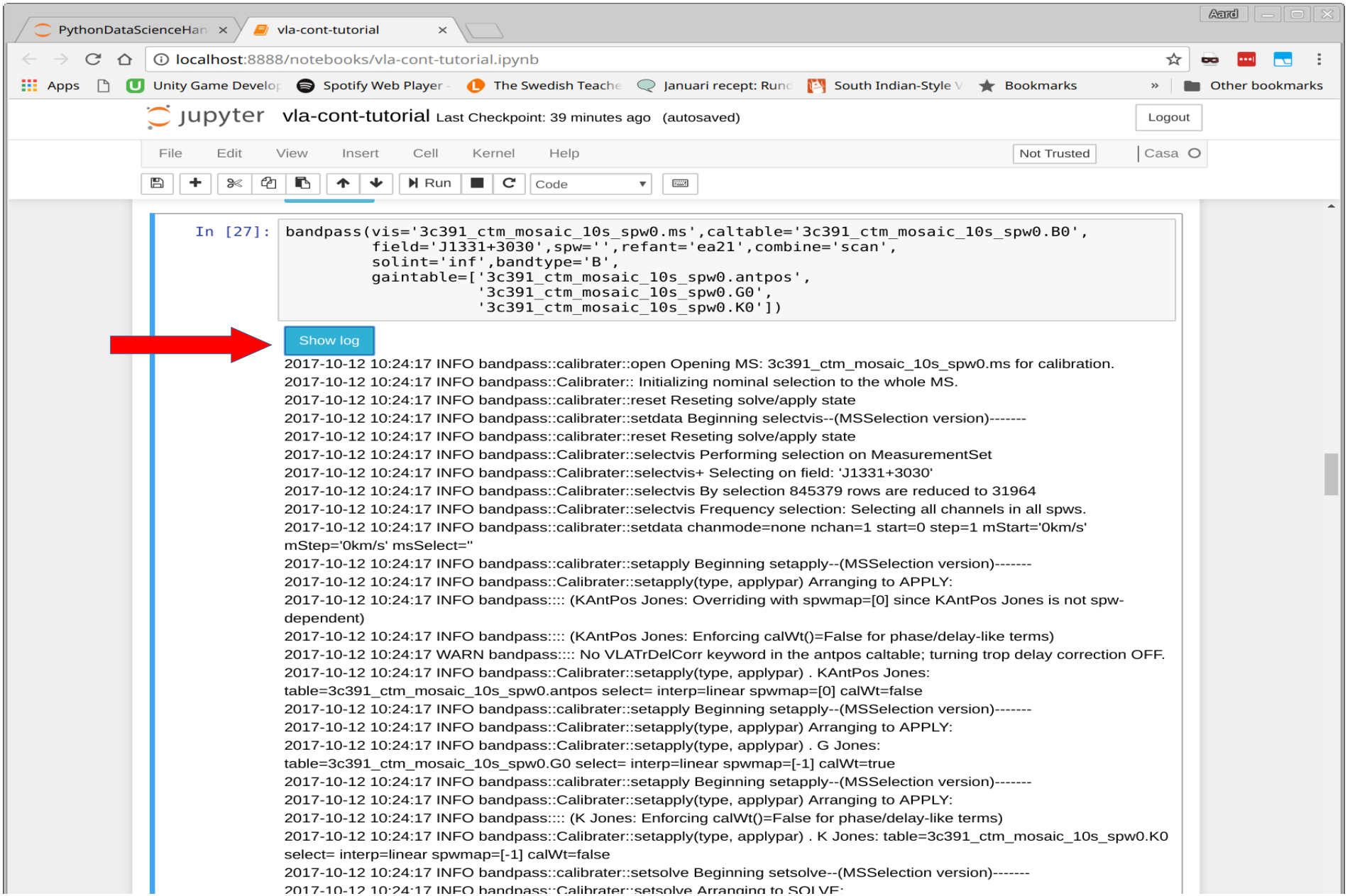


Show log

In [29]:
```
plotcal(caltable= '3c391_ctm_mosaic_10s_spw0.B0',poln='L',
        xaxis='chan',yaxis='amp',field= 'J1331+3030',subplot=221,
        iteration='antenna',figfile='plotcal_3c391-3C286-B0-L-amp.png')
```



Logging


PythonDataScienceHan
vla-cont-tutorial
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Logout
File Edit View Insert Cell Kernel Help
Not Trusted
Casa
Run
Code
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bandpass(vis='3c391_ctm_mosaic_10s_spw0.ms',caltable='3c391_ctm_mosaic_10s_spw0.B0',
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'3c391_ctm_mosaic_10s_spw0.G0',
'3c391_ctm_mosaic_10s_spw0.K0'])
Show log
2017-10-12 10:24:17 INFO bandpass::calibrater::open Opening MS: 3c391_ctm_mosaic_10s_spw0.ms for calibration.
2017-10-12 10:24:17 INFO bandpass::Calibrater:: Initializing nominal selection to the whole MS.
2017-10-12 10:24:17 INFO bandpass::calibrater::reset Reseting solve/apply state
2017-10-12 10:24:17 INFO bandpass::calibrater::setdata Beginning selectvis--(MSSelection version)-------
2017-10-12 10:24:17 INFO bandpass::calibrater::reset Reseting solve/apply state
2017-10-12 10:24:17 INFO bandpass::Calibrater::selectvis Performing selection on MeasurementSet
2017-10-12 10:24:17 INFO bandpass::Calibrater::selectvis+ Selecting on field: 'J1331+3030'
2017-10-12 10:24:17 INFO bandpass::Calibrater::selectvis By selection 845379 rows are reduced to 31964
2017-10-12 10:24:17 INFO bandpass::Calibrater::selectvis Frequency selection: Selecting all channels in all spws.
2017-10-12 10:24:17 INFO bandpass::calibrater::setdata chanmode=none nchan=1 start=0 step=1 mStart='0km/s'
mStep='0km/s' msSelect=''
2017-10-12 10:24:17 INFO bandpass::calibrater::setapply Beginning setapply--(MSSelection version)-------
2017-10-12 10:24:17 INFO bandpass::Calibrater::setapply(type, applypar) Arranging to APPLY:
2017-10-12 10:24:17 INFO bandpass:::: (KAntPos Jones: Overriding with spwmap=[0] since KAntPos Jones is not spw-
dependent)
2017-10-12 10:24:17 INFO bandpass:::: (KAntPos Jones: Enforcing calWt()=False for phase/delay-like terms)
2017-10-12 10:24:17 WARN bandpass:::: No VLATrDelCorr keyword in the antpos caltable; turning trop delay correction OFF.
2017-10-12 10:24:17 INFO bandpass::Calibrater::setapply(type, applypar) . KAntPos Jones:
table=3c391_ctm_mosaic_10s_spw0.antpos select= interp=linear spwmap=[0] calWt=false
2017-10-12 10:24:17 INFO bandpass::calibrater::setapply Beginning setapply--(MSSelection version)-------
2017-10-12 10:24:17 INFO bandpass::Calibrater::setapply(type, applypar) Arranging to APPLY:
2017-10-12 10:24:17 INFO bandpass::Calibrater::setapply(type, applypar) . G Jones:
table=3c391_ctm_mosaic_10s_spw0.G0 select= interp=linear spwmap=[-1] calWt=true
2017-10-12 10:24:17 INFO bandpass::calibrater::setapply Beginning setapply--(MSSelection version)-------
2017-10-12 10:24:17 INFO bandpass::Calibrater::setapply(type, applypar) Arranging to APPLY:
2017-10-12 10:24:17 INFO bandpass:::: (K Jones: Enforcing calWt()=False for phase/delay-like terms)
2017-10-12 10:24:17 INFO bandpass::Calibrater::setapply(type, applypar) . K Jones: table=3c391_ctm_mosaic_10s_spw0.K0
select= interp=linear spwmap=[-1] calWt=false
2017-10-12 10:24:17 INFO bandpass::calibrater::setsolve Beginning setsolve--(MSSelection version)-------

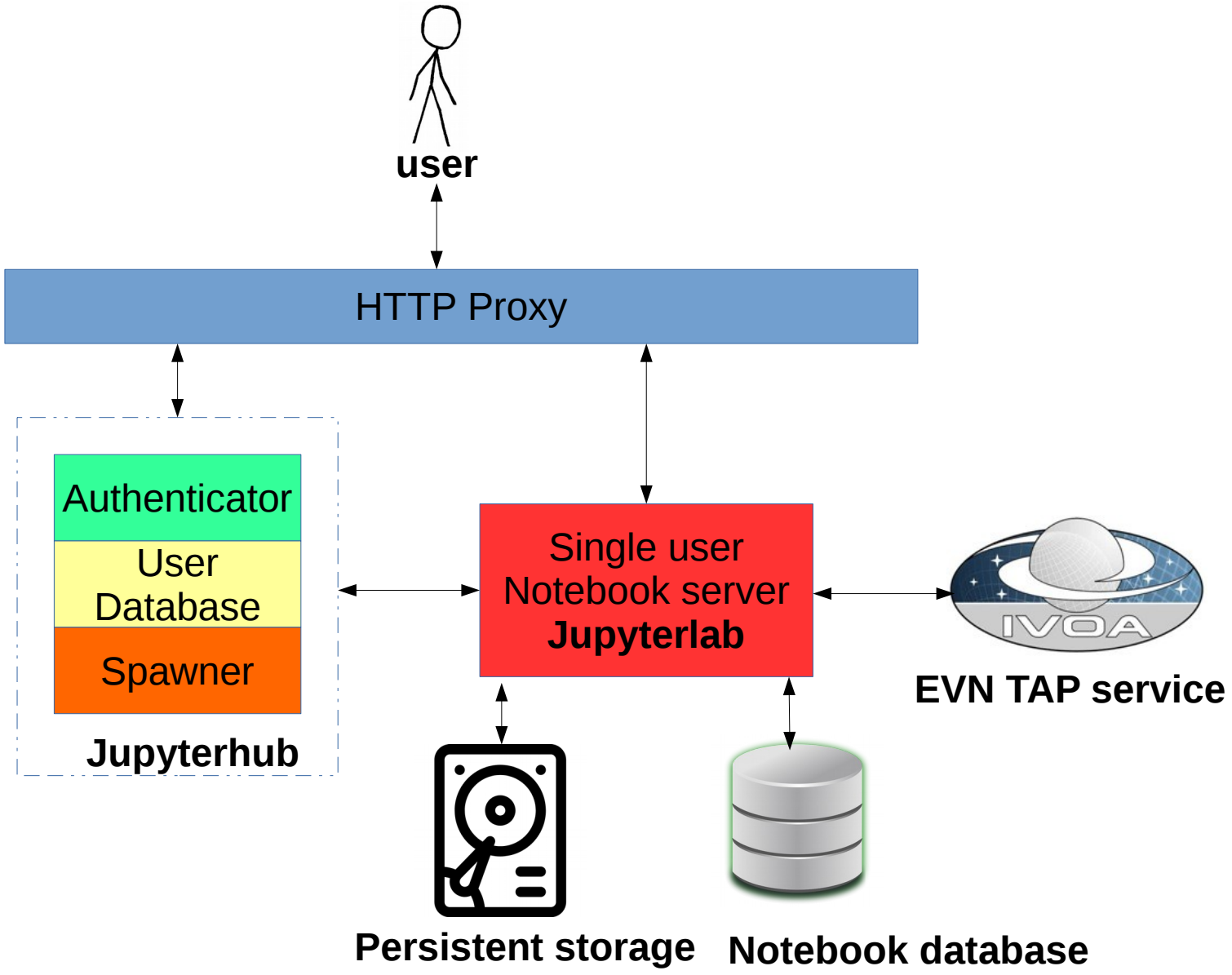
CASA 6

- **The good**
  - Code base moved to Python3
  - Older CASA releases were distributed as tarball that included all dependencies (incl. Python, matplotlib)
  - CASA 6 also distributed as PIP wheel
- **The bad**
  - Not all tasks are ported: These are included as AppImage (https://appimage.org)
  - Running AppImage containers in Docker / Singularity requires elevated privileges
  - Matplotlib based calibration plotting tool is replaced by C++ program
  - Can only produce a single plot per run (without GUI)

EVN Archive Portal

- Provide access to EVN Archive through Jupyterhub
- Users can pipeline any experiment and results are stored in persistent storage
- Users can submit improved pipeline results back into the archive
- Archive will accessed through VO queries using a JupyterLab plugin
- EVN TAP service is being developed in WP4
- All experiments older than 1yr are public
- Will be made available in the ESAP

EVN Archive Portal



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