A closer look at *CASA*

Dirk Petry (ESO), April 2010

Outline

→ **application overview**	- the CASA system of applications
→ **tasks and tools**	- the two-level user interface revisited
→ **global variables**	- Python global variables and the task parameters
→ **non-interactive casapy**	- casapy command line options
→ **Measurement Set, ASDM, uvfits**	- the visibility data formats
→ **calibration tables**	- CASA tables for calibration data
→ ***CASA* images and FITS**	- image storage in tables and FITS files
→ **if you encounter problems**	- how and where to file a helpdesk ticket

CASA application overview

In release 3.0.1:   8 independent applications exposed to the user:

`casapy`	....	**the CASA “shell”**
`casapyinfo`	....	**returns info about how CASA was built**
`casabrowser`	....	**== browsetable() task within casapy**
`casalogger`	....	**the logger started by default with casapy**
`casaplotms`	....	**will be == plotms() task within casapy**
`casaviewer`	....	**== viewer() task within casapy**
`asdm2MS`	....	**the ASDM to MS converter, importasdm in casapy**
`buildmytasks`	....	**integrates user-provided tasks into casapy (see appendix H of the cookbook)**

CASA tasks and tools

Two level user interface: Top level == *Tasks* *(91 in release 3.0.1, see taskhelp)*

accum	**feather**	**importevla**	**plotants**	**sdscale**
applycal	**find**	**importfits**	**plotcal**	**sdsim**
autoclean	**fixvis**	**importgmrt**	**plotms**	**sdsmooth**
bandpass	**flagautocorr**	**importoldasdm**	**plotxy**	**sdstat**
blcal	**flagdata**	**importuvfits**	**polcal**	**sdtpimaging**
boxit	**flagmanager**	**importvla**	**rmtables**	**setjy**
browsetable	**fluxscale**	**imregrid**	**sdaverage**	**simdata**
calstat	**fringecal**	**imsmooth**	**sdbaseline**	**smoothcal**
clean	**ft**	**imstat**	**sdcal**	**specfit**
clearcal	**gaincal**	**imval**	**sdcoadd**	**split**
clearplot	**gencal**	**listcal**	**sdfit**	**uvcontsub**
clearstat	**hanningsmooth**	**listhistory**	**sdflag**	**uvcontsub2**
concat	**imcontsub**	**listobs**	**sdimaging**	**uvmodelfit**
cvel	**imfit**	**listvis**	**sdimprocess**	**uvsub**
deconvolve	**imhead**	**makemask**	**sdlist**	**viewer**
exportasdm	**immath**	**mosaic**	**sdmath**	**viewerconnection**
exportfits	**immoments**	**newflagdata**	**sdplot**	**vishead**
exportuvfits	**importasdm**	**peel**	**sdsave**	**visstat**
				widefield

CASA tasks and tools

Two level user interface: Top level == *Tasks*

documented in

a) built-in documentation

`help` ***<taskname>***

`pdoc` ***<taskname>***

<taskname> `?`

b) task reference web page

http://casa.nrao.edu/docs/taskref/TaskRef.html

c) cookbook

http://casa.nrao.edu/Doc/Cookbook/casa_cookbook.pdf

Note: there is also the CASAGuides wiki

http://casaguides.nrao.edu/

CASA tasks and tools

Two level user interface: Top level == *Tasks*

- provide all basic analysis functionality for inexperienced users (without Python knowledge)

- provide the common analysis functionality for experienced users

- user interface optimised for interactive work with additional helper commands

command	*example*	
default	**`default(clean)`**	**- reset all input parameters**
inp	**`inp`**	**- show parameters of current task**
go	**`go`**	**- start current task**
saveinputs	**`saveinputs(clean, parfile)`**	**- store parameters in file**
tget	**`tget(clean, parfile)`**	**- restore parameters from file**

CASA tasks and tools

Two level user interface: bottom level == *Tools* (*17 of them for release 3.0*)

```
cb (calibrater)          cp (cal plot)    fg (flagger)
ia (image analysis)      im (imager)      me (measures)
mp (MS plot)             ms (MS)          qa (quanta)
sm (simulation)          tb (table)       tp (table plot)
vp (voltage patterns) cs (coord. sys.) at (atmosphere)

pl (pylab functions)
sd (ASAP functions - run asap_init() to import into CASA)
```

CASA tasks and tools

Two level user interface: bottom level == *Tools*

documented in

a) built-in documentation

> **`help`** ***<toolname>***
>
> **`help`** ***<toolname>.<methodname>***

b) toolkit manual web page

> ***http://casa.nrao.edu/docs/casaref/CasaRef.html***

CASA tasks and tools

Two level user interface: bottom level == *Tools*

- contain all the special CASA functionality as Python objects

- not optimised for interactive use, behave just like Python objects

⇒ user calls methods of the tools:

<toolname>.<methodname>(<parameters>)

e.g., `ms.open('mydata.ms')` - open an MS read-only with the MS tool

- anything possible with tasks is also possible using tools alone

- tasks are Python scripts using the tools + xml interface definition

CASA tasks and tools

Example: the task *flagautocorr(vis)* - *flag the rows with autocorrelation data in an MS*

```
import os
from taskinit import *
def flagautocorr(vis=None):
        casalog.origin('flagautocorr')
        try:
                fg.clearflagselection(0)
                if ((type(vis)==str) & (os.path.exists(vis))):
                        fg.open(vis)
                else:
                        raise Exception, 'Visibility data set not found'
                fg.setdata()
                fg.setmanualflags(autocorrelation=True)
                fg.run()
                fg.done()
                ms.open(vis,nomodify=False)
                ms.writehistory(message='flagautocorr',origin='flagautocorr')
                ms.close()
        except Exception, instance:
                fg.done()
                print '*** Error ***',instance
```

CASA tasks and tools

Example: the task *flagautocorr(vis)* - *flag the rows with autocorrelation data in an MS*

one input parameter

```
import os
from taskinit import *
def flagautocorr(vis=None):
        casalog.origin('flagautocorr')
        try:
                fg.clearflagselection(0)
                if ((type(vis)==str) & (os.path.exists(vis))):
                        fg.open(vis)
                else:
                        raise Exception, 'Visibility data set not found'
                fg.setdata()
                fg.setmanualflags(autocorrelation=True)
                fg.run()
                fg.done()
                ms.open(vis,nomodify=False)
                ms.writehistory(message='flagautocorr',origin='flagautocorr')
                ms.close()
        except Exception, instance:
                fg.done()
                print '*** Error ***',instance
```

CASA tasks and tools

Example: the task *flagautocorr(vis)* - *flag the rows with autocorrelation data in an MS*

autoflag tool

```
import os
from taskinit import *
def flagautocorr(vis=None):
        casalog.origin('flagautocorr')
        try:
                fg.clearflagselection(0)
                if ((type(vis)==str) & (os.path.exists(vis))):
                        fg.open(vis)
                else:
                        raise Exception, 'Visibility data set not found'
                fg.setdata()
                fg.setmanualflags(autocorrelation=True)
                fg.run()
                fg.done()
                ms.open(vis,nomodify=False)
                ms.writehistory(message='flagautocorr',origin='flagautocorr')
                ms.close()
        except Exception, instance:
                fg.done()
                print '*** Error ***',instance
```

CASA tasks and tools

Example: the task *flagautocorr(vis)* - *flag the rows with autocorrelation data in an MS*

MS tool

```
import os
from taskinit import *
def flagautocorr(vis=None):
        casalog.origin('flagautocorr')
        try:
                fg.clearflagselection(0)
                if ((type(vis)==str) & (os.path.exists(vis))):
                        fg.open(vis)
                else:
                        raise Exception, 'Visibility data set not found'
                fg.setdata()
                fg.setmanualflags(autocorrelation=True)
                fg.run()
                fg.done()
                ms.open(vis,nomodify=False)
                ms.writehistory(message='flagautocorr',origin='flagautocorr')
                ms.close()
        except Exception, instance:
                fg.done()
                print '*** Error ***',instance
```

CASA global variables and task parameters

- casapy == Python shell with CASA extensions

- in casapy variables defined on the command line are global, i.e. scripts started with

  ```
  execfile('scriptfilename')
  ```

  have access to the variable values

Example:

script “myscript.py”:

```
# test global variables
print “value of a is “, a
```

command line:

```
CASA <2>: a = 10
CASA <3>: execfile('myscript.py')
```

output:

```
 value of a is  10
```

CASA global variables and task parameters

- **`taskname`**

  = name of the current task which will be executed by *`go`*

- **every task parameter name behaves like a global variable**

  ⇒ e.g., if you specify the input parameter `field` in a command line

```
field = 'NGC4826'
```

  then `field` will keep this value until you change it, for all tasks!

- **the parameters of all tasks are coherently named so they can be shared:**

`vis`	**- the input MS**
`outputvis`	**- the output MS**
`field`	**- the selection condition on the field table in an MS**
`spw`	**- the selection condition on the spectral window table in an MS**
...	

- **get help on a parameter by typing `help par.`<parametername>**

casapy command line options

Useful casapy command line options:

`--logfile` ***filename***	**............ use this filename instead of "casapy.log"**
`--nologger`	**............ don't start a logger**
`--log2term`	**............ print the log messages in the terminal**
`--nogui`	**............ don't permit any GUIs (implies --nologger)**
`-c` ***filename***	**............ execute the Python script *filename*, then exit**

Example: run a pipeline script non-interactively

```
casapy --nologger -c mypipeline.py
```

CASA Measurement Sets, ASDMs, and uvfits

- Internal CASA visibility data format is the Measurement Set (MS)

- Presently supported input formats:

ALMA: ALMA Science Data Model (ASDM)

EVLA: Science Data Model (SDM, same as the ASDM)

VLA: VLA archive format

FITS IDI: planned for later this year

and the transport format uvfits

CASA Measurement Sets, ASDMs, and uvfits

The MS

- relational database system with fixed structure made from *CASA Tables*

- consists of a main *table* with 15 required *sub-tables* + several optional ones

- uses OS directory structure (need to copy with *`cp -R`*, remove with *`rm -r`*)

- visibilities stored in the MAIN table

- no compression

- manipulate an MS with the *`ms`* and the *`tb`* tool or with *`browsetable()`*

- during processing, CASA may add “scratch columns” to the MS main table

CASA Measurement Sets, ASDMs, and uvfits

The ASDM

- relational database system with fixed structure

- consists of set of up to 56 tables (also observatory setup information!)

- uses OS directory structure (need to copy with *`cp -R`*, remove with *`rm -r`*)

- visibilities stored in the MAIN table

- no compression

- on disk, table descriptions in XML files, table data in binary MIME format files

- import into CASA using the task *`importasdm`* (for v1) or *`importoldasdm`* (for v0.9)

- in release 3.0.1 there is a beta-version of *`exportasdm`* (MS to ASDM)

CASA calibration tables

Calibration tables for visibility data

- CASA tables with defined columns and subtables

- contain calibration solutions and/or parametrisations

- serve communication between calibration tasks and storage of final result

CASA images and fits

Two formats for images in CASA:

a) CASA images

- **based on CASA Tables**
- **proper name in casacore: PagedImage**
- **approach: make the image accessible as a multi-dimensional lattice**
- **arbitrary size on disk, paged into memory**

b) FITS

- **translation to/from CASA images by `importfits` and `exportfits` tasks**
- **follows the IAU FITS standard v3.0 (2008)**
- **special additions for compatibility with AIPS for spectral image cube axes**

History

- All CASA data formats contain history or log sub-tables

- Access via browsetable() or special tasks/tool methods:

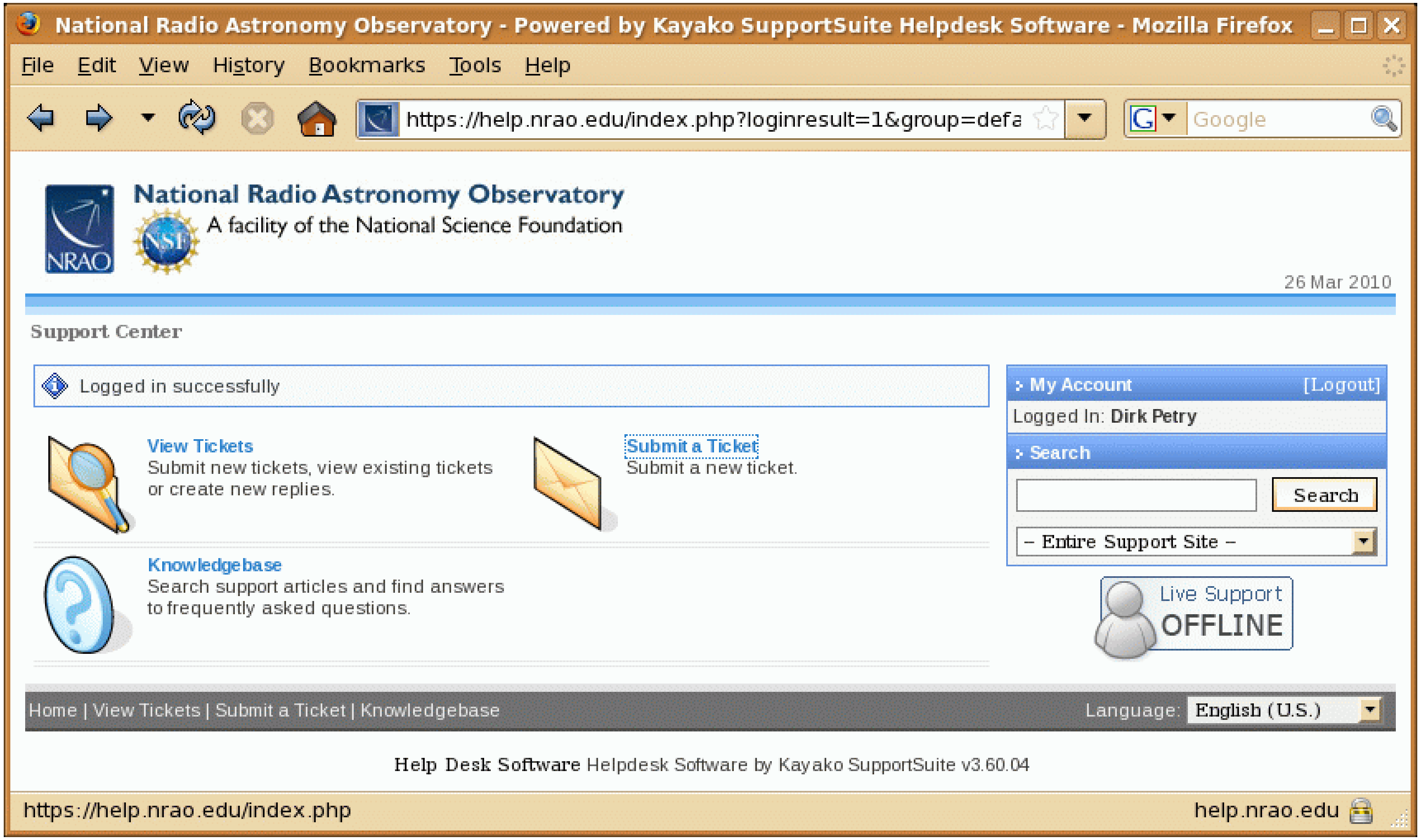
MS: listhistory() or ms.listhistory()
Image: ia.history()

In case of problems ...

What to do if you encounter a problem with *CASA*:

If the cookbook and the release notes don't help, go to http://help.nrao.edu/

Don't have an account? Register at http://my.nrao.edu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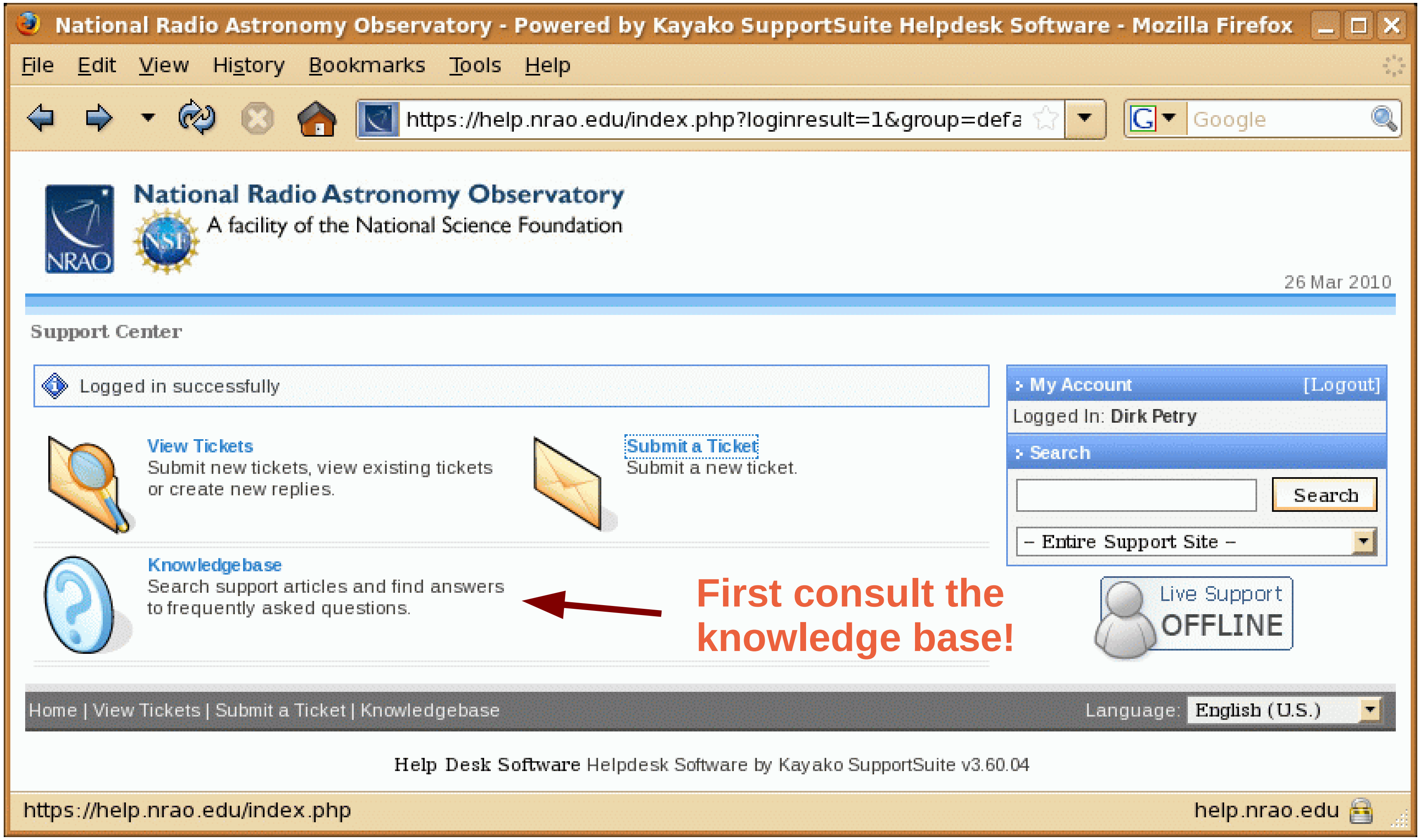

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https://help.nrao.edu/index.php

First consult the knowledge base!

In case of problems ...

What to do if you encounter a problem with *CASA*
***and you can't find the solution in the documentation or the knowledge base*:**

A) *You think you might have found a bug in CASA*

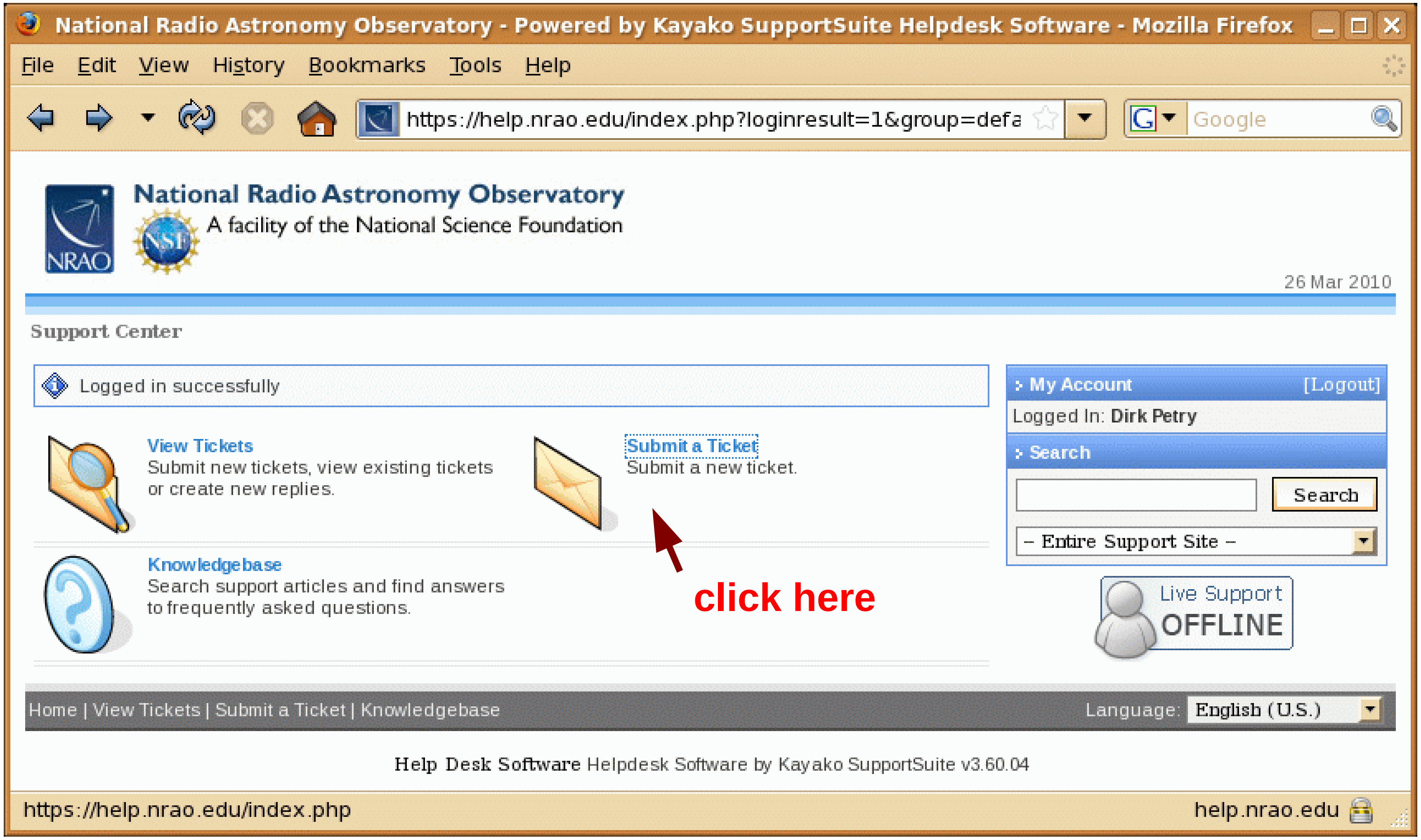
- **Try to reproduce your problem, ideally by writing a Python *script* which will demonstrate the problem.**
- **Put your *test data (if needed)* on some web or ftp server where it can remain for at least several months.**
- **File a helpdesk ticket including the script, a short description of the problem, and the URL of the data.**
- **Need to mention *CASA version* and your *operating system (32 bit or 64 bit?)***

B) *You don't know how to perform a certain analysis task in CASA*

- **If you can't make progress, then, as in (A) try to prepare a *script* for your analysis up to the point where you don't know how to go further.**
- **File a helpdesk ticket including the script and a description of what you would like to achieve.**

In case of problems ...

How to file a helpdesk ticket at help.nrao.edu:



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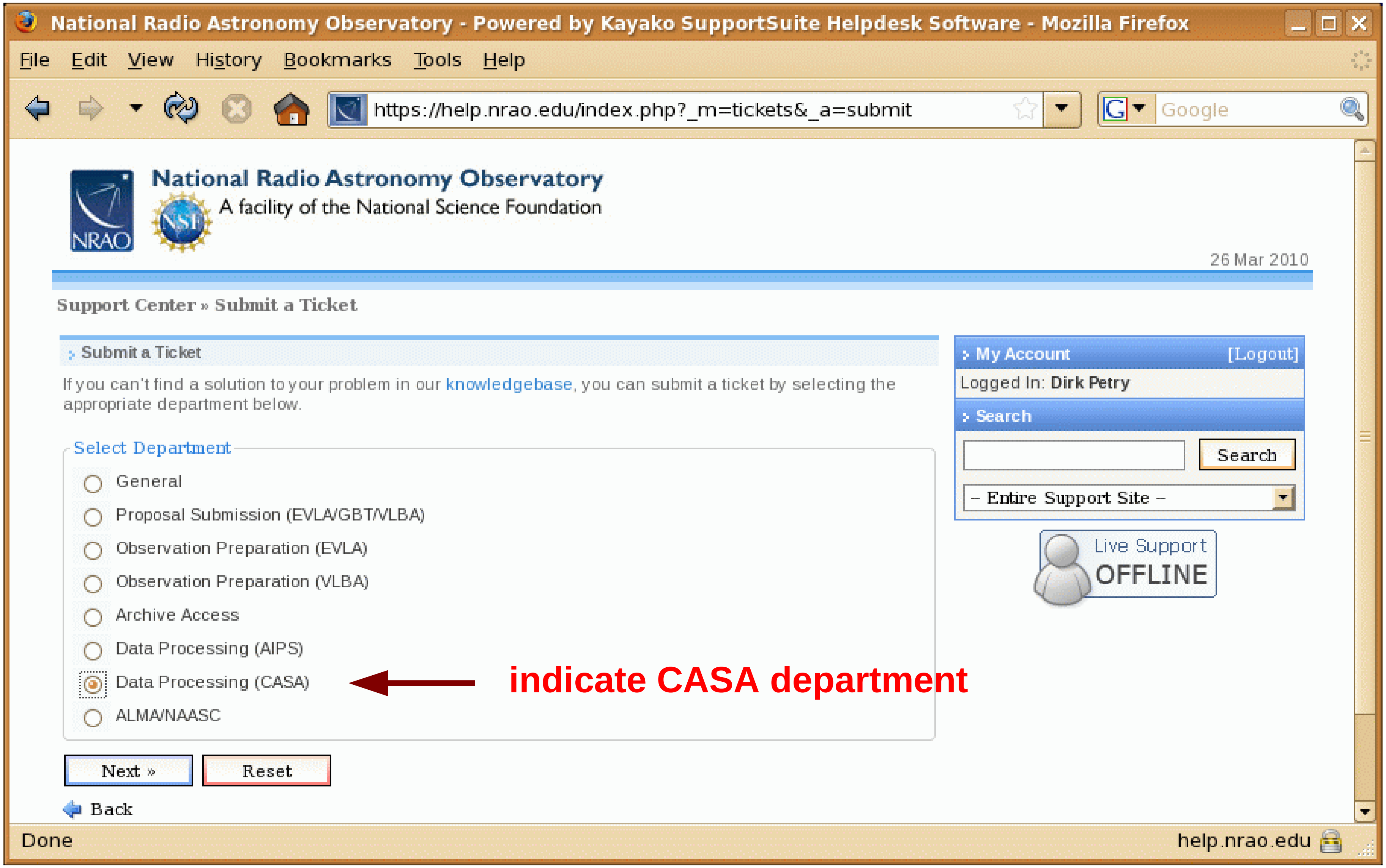
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If you can't find a solution to your problem in our knowledgebase, you can submit a ticket by selecting the appropriate department below.

Select Department

- General
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- Observation Preparation (EVLA)
- Observation Preparation (VLBA)
- Archive Access
- Data Processing (AIPS)
- [✓ Data Processing (CASA)] ← **indicate CASA department**
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In case of problems

How to file a helpdesk ticket:

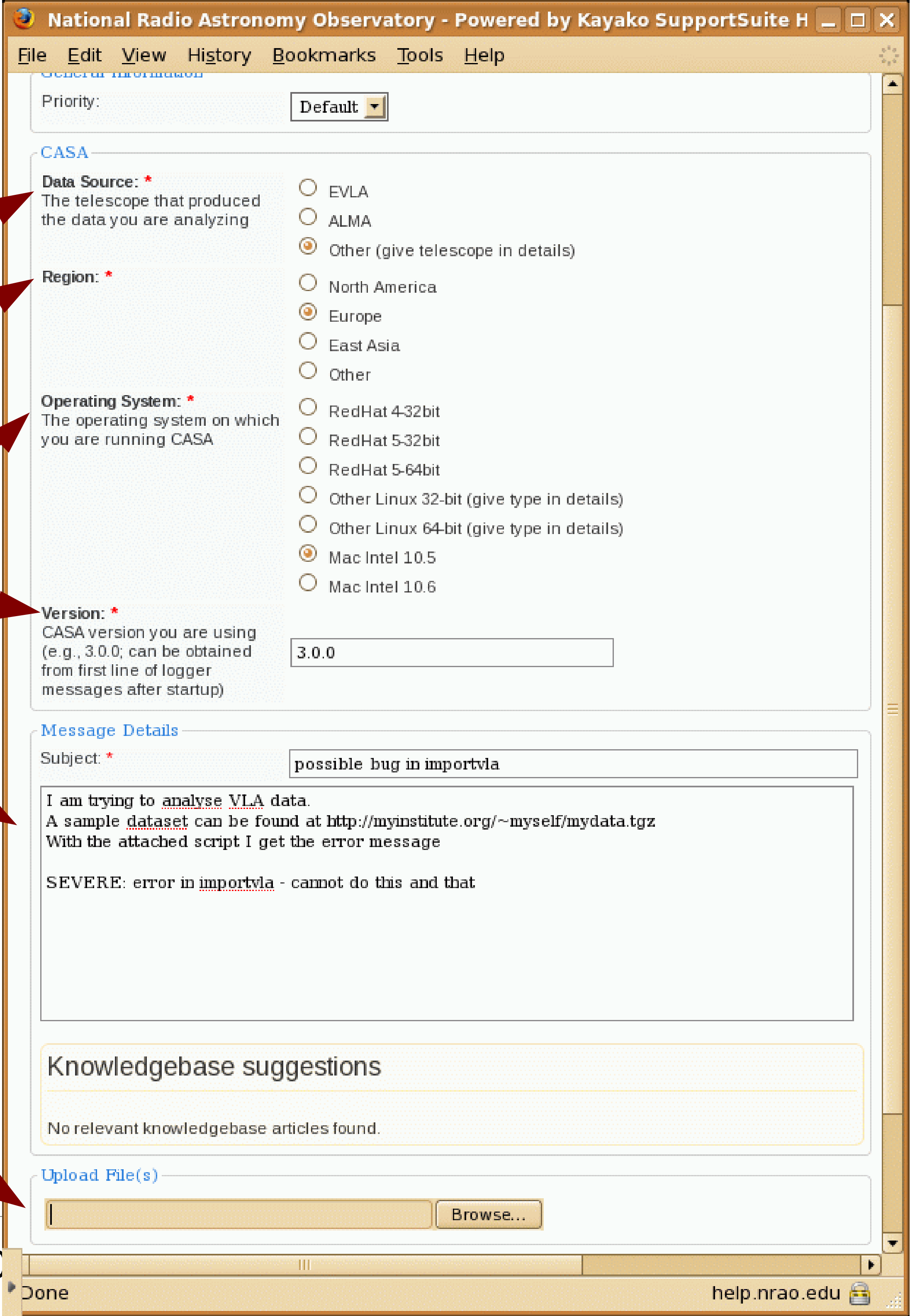
Where does your data come from?
(identify necessary expertise)

Where do you come from?
(who is responsible?)

What OS and CASA version are you using?
(for reproducing your problem)

Give at least a description of what you are trying to do and the URL of your test data if needed to reproduce your problem.
Also quote error messages.

Upload a Python script which demonstrates your problem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Priority: Default

CASA

Data Source: *
The telescope that produced the data you are analyzing

EVLA / ALMA / [✓ Other (give telescope in details)]

Region: *

North America / [✓ Europe] / East Asia / Other

Operating System: *
The operating system on which you are running CASA

RedHat 4-32bit / RedHat 5-32bit / RedHat 5-64bit / Other Linux 32-bit (give type in details) / Other Linux 64-bit (give type in details) / [✓ Mac Intel 10.5] / Mac Intel 10.6

Version: *
CASA version you are using (e.g., 3.0.0; can be obtained from first line of logger messages after startup)

3.0.0

Message Details

Subject: * possible bug in importvla

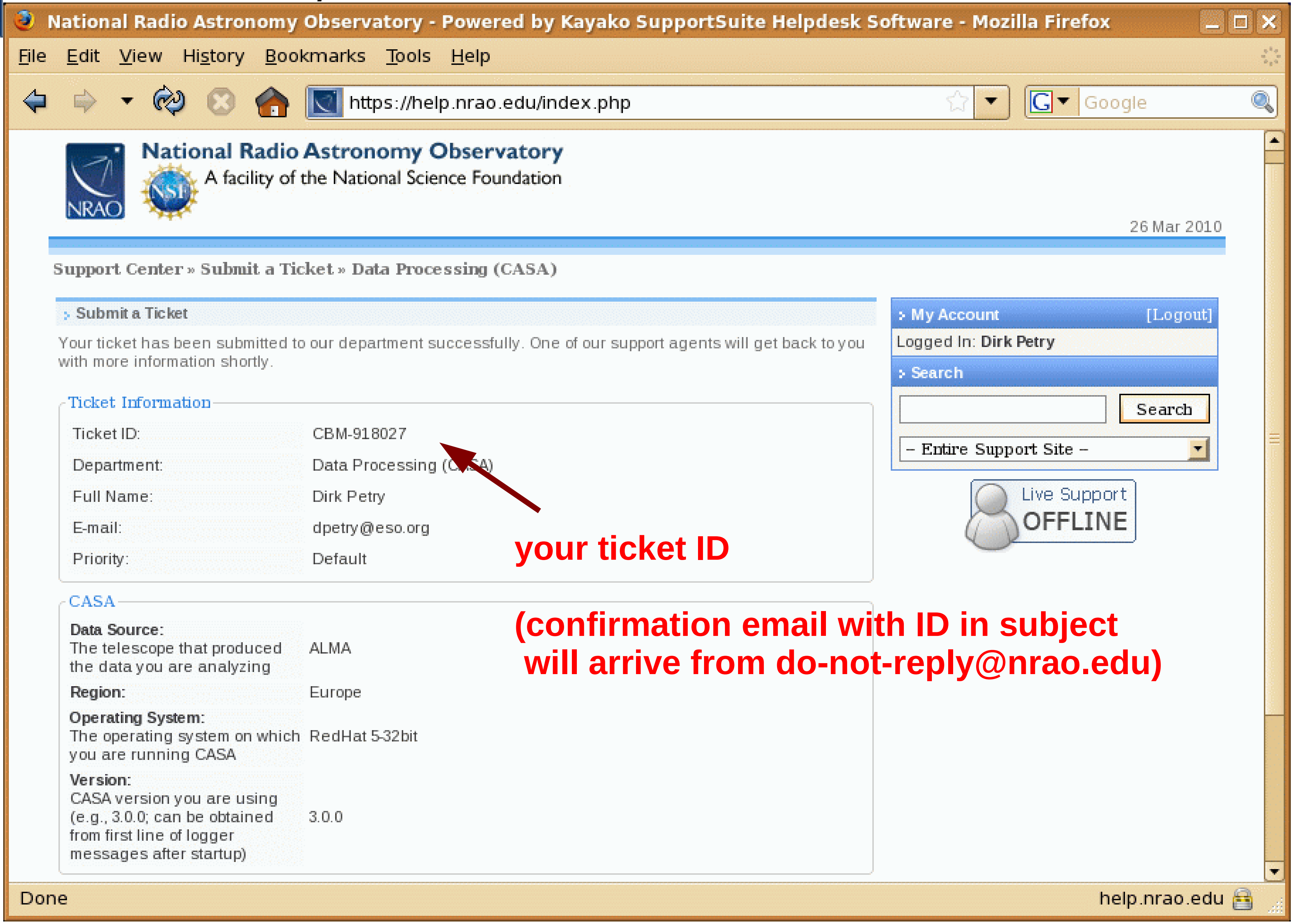
```
I am trying to analyse VLA data.
A sample dataset can be found at http://myinstitute.org/~myself/mydata.tgz
With the attached script I get the error message

SEVERE: error in importvla - cannot do this and that
```

Knowledgebase suggestions

No relevant knowledgebase articles found.

Upload File(s)

In case of problems ...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Support Center » Submit a Ticket » Data Processing (CASA)

Submit a Ticket

Your ticket has been submitted to our department successfully. One of our support agents will get back to you with more information shortly.

Ticket Information

Ticket ID:	CBM-918027
Department:	Data Processing (CASA)
Full Name:	Dirk Petry
E-mail:	dpetry@eso.org
Priority:	Default

CASA

Data Source: The telescope that produced the data you are analyzing	ALMA
Region:	Europe
Operating System: The operating system on which you are running CASA	RedHat 5-32bit
Version: CASA version you are using (e.g., 3.0.0; can be obtained from first line of logger messages after startup)	3.0.0

your ticket ID

(confirmation email with ID in subject will arrive from do-not-reply@nrao.edu)