

# CALIM and SP(D)O

## the role of the domain experts

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# A slight change of plan

- I was going to repeat a talk I recently gave at Zadar
  - About lowering some threshold
- That talk is attached, for those who are interested
- Here, I will discuss the wider context
  - As a start of our CALIM discussion

# 1990 was a watershed year in radio astronomy

- The SKAI idea was launched
  - Born over lunch in Dwingeloo (Robert Braun)
  - Launched at the 10<sup>th</sup> anniversary of the VLA
- 
- We started the AIPS++ project
  - To bundle the “fruits of the selfcal decade”
  - And to be all things to all men

# We never expected...

- Of course SKAI was a ridiculous idea...
- ...costing at least 200 million dollars
- But if one were to build such a telescope...
- ...how would one go about it?
- We concentrated on station design
  - No thought of data volumes, or DDEs
  - No need for new algorithms
  - No need for a new generation

# Amazingly, the SKA idea caught on

- This might have had a scientific reason
  - But the EoR came much later
  - Inter-wavelength rivalry might have played a role
- In any case, it generated huge activity
  - Precursors
  - Pathfinders
  - Prototypes

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  - Precursors
  - Pathfinders
  - Prototypes
- **In a sense, SKA is already a success**

# In the meantime...

- AIPS++ turned out to be a more complicated proposition than we had bargained for
- But it gave us the Measurement Set
- And the Measurement Equation (!)
- And several widely used modules
  - Measures, fitting, imager, ...
- And we learned to work together (in a way)

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- And several widely used modules
  - Measures, fitting, imager, ...
- And we learned to work together (in a way)
- **AIPS++ was a necessary stage towards SKA**



# CALIM was started in 2003

- I forget why, where and by whom
- It became a yearly meeting for domain experts who are happily developing calibration and imaging for SKA precursors etc
  - It is fiercely independent
  - It never advised anyone
  - It never set any priorities
  - It has a murky “invitation” policy
- But it has been very useful

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# But things are changing

- Big politics
- Big money
- Big energy consumption
- Big egos
- Big contracts (with big penalty clauses)
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**What will be the role of the domain experts?**

# SPDO: “Noone works on SKA!”

- Nonsense: The precursor experience is vital
- Especially since they explore different avenues
  - ASKAP: Staying on top of the data rate
  - LOFAR: Coping with DDEs
  - MWA: Fully filled aperture
- The likely outcome is a trade-off curve
  - Data-volume against wide-field image quality

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- **Could SPDO have issued a contract for all that?**

# Additional “by-products”

- Actual experience with:
  - Aperture arrays
  - Focal plane arrays
  - (A)symmetric dishes
  - RFI mitigation and flagging
  - Data transport infrastructure
  - Correlators and other pre-processors
  - Etc, etc

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# IMHO

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  - To get the necessary answers (quickly)
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  - Eventually, to make the tough decisions
- **In other words: To earn the right to command**

# Many Unanswered Questions

- Answers are needed **before** the tough decisions
- How to speed up the process of getting them?
- The SPO can/must play a role in this:
  - by formulating the questions
  - by creating the conditions for getting answers
- In this way, the SPO becomes a partner
  - And establishes its moral authority

# Creating the Conditions

(to generate answers quickly)

- Award prizes for answers to specific questions
  - About hardware performance (e.g. dishes vs AA)
  - About calibration and imaging algorithms
- Make available smallish “standard” datasets
  - Taken with various existing telescopes
  - Simulations (for new and existing telescopes)
- Make available and promote suitable tools
  - e.g. the use of the PURR log

# Lowering the Threshold

My original talk (attached) dealt with lowering the threshold to participate in the development of 3<sup>rd</sup> Generation Calibration (3GC) (coping with DDEs, really)

Mercifully, I will not bother you with it here

# Byproducts of such a “3GC community”

- It involves (many) more people
  - From many more institutes, around the world
  - Speaking a common language
- It may get better answers more quickly
- It creates the next generation of domain experts
- It creates the next generation of savvy users of the new (and old) telescopes

# Other things the SPO could do

Let's not get ahead of ourselves....

# Not all the questions will be answered in time

- Stations are forever
- Electronics may be upgraded every 5 years
- Software must evolve for years!
- 
- So: find a way to keep the monster **upgradeable**
  - And allowing user-defined customized processing
- By the way: This goes for the precursors too



# The role of CALIM in all this

- Just continue as before?
  - After all, the precursors (and other radio telescopes) will operate alongside SKA
- Being a critical partner of the SPO?
  - This could be very beneficial
  - But what shape should it take?
  - And where would its mandate come from?
- Other?

# Discussion

- We are a gathering of domain experts, happily engaged in developing calibration and imaging for SKA precursors
- ...SKA will be different, we are told...
- How is the SPO going to approach the calim problem, and what is the role of the domain experts?
- Fact: The precursor experience is absolutely essential
  - The SPO needs its own domain expertise to absorb it
- Fact: Many urgent questions are still unanswered
  - The SPO can help to get answers more quickly
- What should the role of CALIM be in all this?

What follows is my original Zadar talk

# Lowering the Threshold

for joining  
the 3GC Community

by

Jan Noordam

*noordam@astron.nl*



# Prometheus



He brought  
you the fire of  
the Gods

(even though  
nobody asked  
him to)

# You may have heard of MeqTrees

- It is the only package that offers the full Measurement Equation
- It holds the Blue Ribbon of Dynamic Range (Oleg Smirnov, using WSRT data)
- It has made the most impressive LOFAR maps (Sarod Yatawatta)
- It can handle large problems (Panos Labropoulis)
- It is unrivalled for simulation (Tony Willis)

# The Order of Things (I)

- MeqTrees is about 3GC, i.e. calibration of Direction-Dependent Effects (DDE)
  - Subtraction of compact foreground sources, while estimating instrumental parameters
- 3GC sets the stage for 4GC
  - All the clever techniques discussed at this conference
  - How well do they work if 3GC fails (more or less)?

# The Order of Things (II)

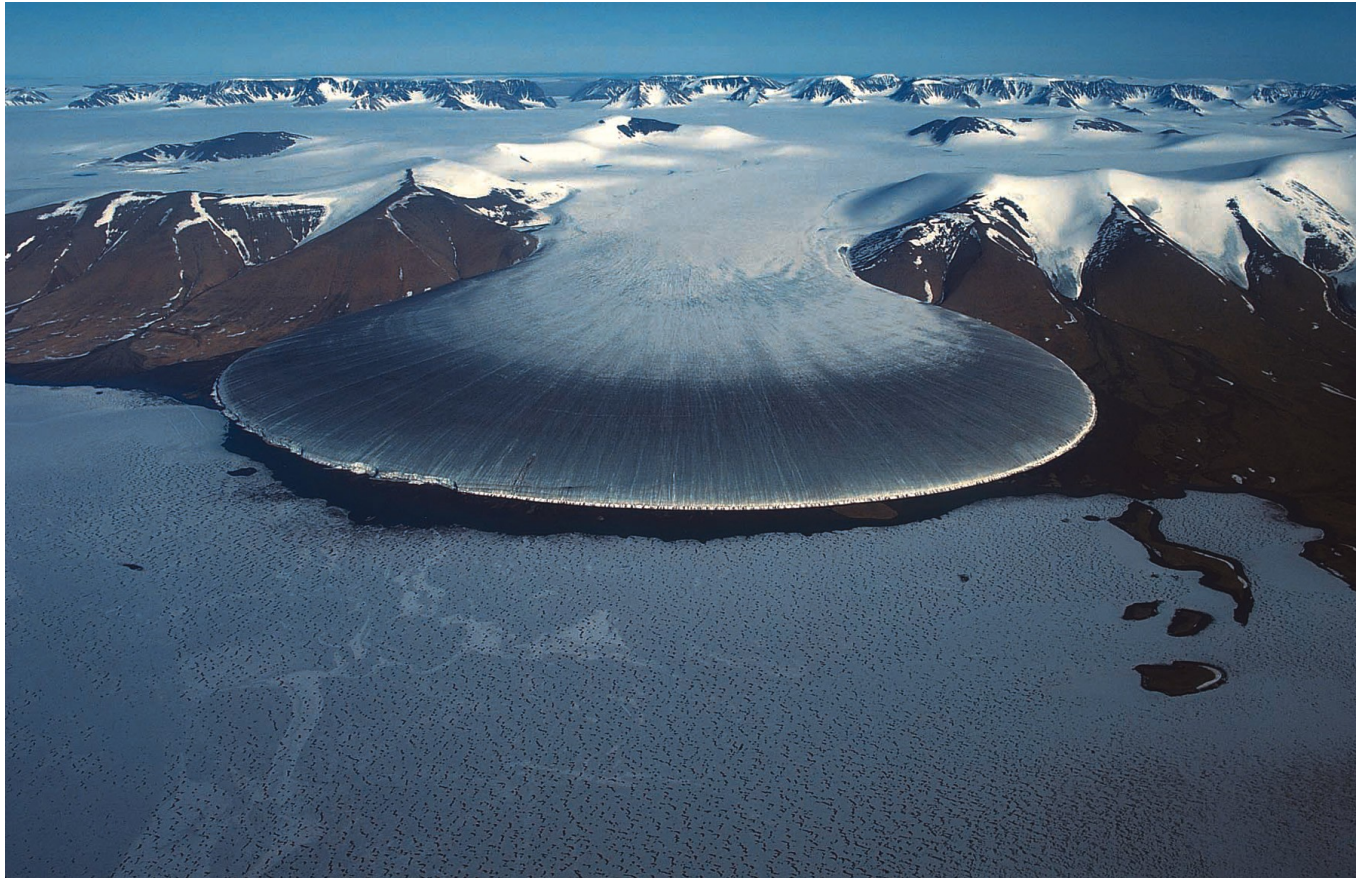
- Far-sighted ASTRON policy: A split between development (MeqTrees) and production (BBS)
- This works rather well...
  - E.g. Sarod's early LOFAR images acted like a beacon for the BBS developers
- But things would go even better (faster) if more people were involved in the process.
- This is the real subject of this talk....



# The Order of Things (III)

All this not only applies to LOFAR  
but also to all the other  
new and existing  
radio telescopes  
up to SKA

# Glacial Rate of Evolution of data reduction software in the last 2 decades or so



We cannot afford such a low rate  
(the new telescopes are upon us!)



**x23203775 fotosearch.com**

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- **3<sup>rd</sup> Generation Calibration (3GC) Community**
  - **Many people, sharing scripts and results**

# The Dream:

## Blazing the trail together

- Explore new algorithms before cutting corners
- Full support for the Measurement Equation
  - The new Lingua Franca of radio interferometry
- 3<sup>rd</sup> Generation Calibration (3GC) community
  - Many people, sharing scripts and results
- **Rapid experimentation**
  - **Idea → implementation → execution → result**
  - **Measured in Tree Time Units (TTU = ~45 minutes)**

Unfortunately....

It ain't as easy  
as we thought it would be



# The Heavy Lifters

Oleg



# The Heavy Lifters

Oleg



Sarod

# The Heavy Lifters

Oleg



Sarod



Panos



CALI

# The Heavy Lifters

Oleg



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Panos



Tony



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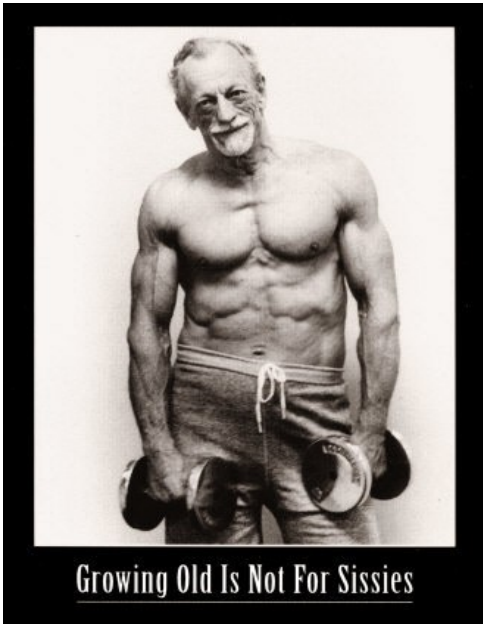
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Tony



Growing Old Is Not For Sissies

CALI

# The Heavy Lifters

Oleg

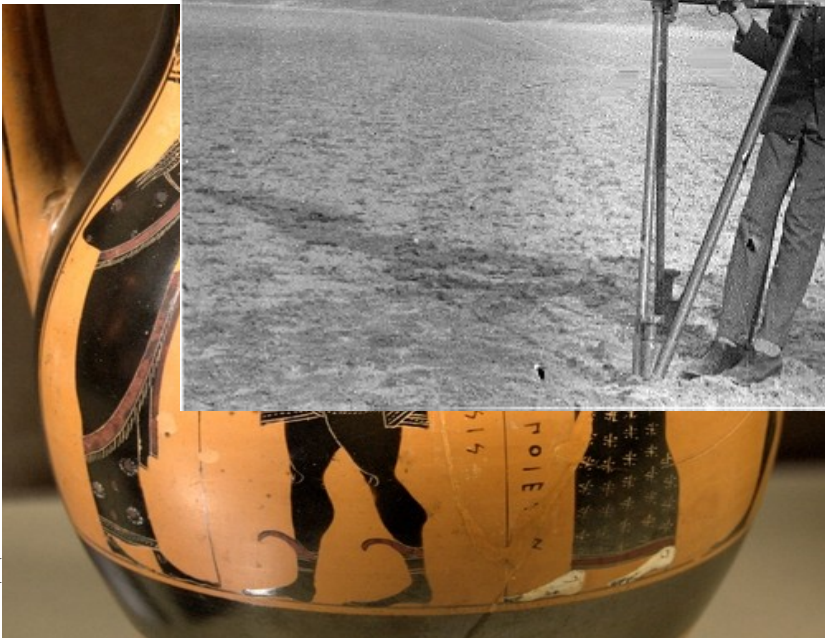
Panos

CALIF

Sarod

lan

Tony



Growing Old Is Not For Sissies

For everybody else  
the threshold seems a little high



CALIM 2011, Manchester (UK)



How can we lower  
the threshold?

# The key to MeqTrees: the TDL Script

- It is just python text!
  - With a few Tree Definition Language extensions
- It has two main parts:
  - Function(s) for tree definition
  - Functions for tree execution (and other jobs)
- It is executed
  - interactively in the MeqBrowser
  - or in batch mode.

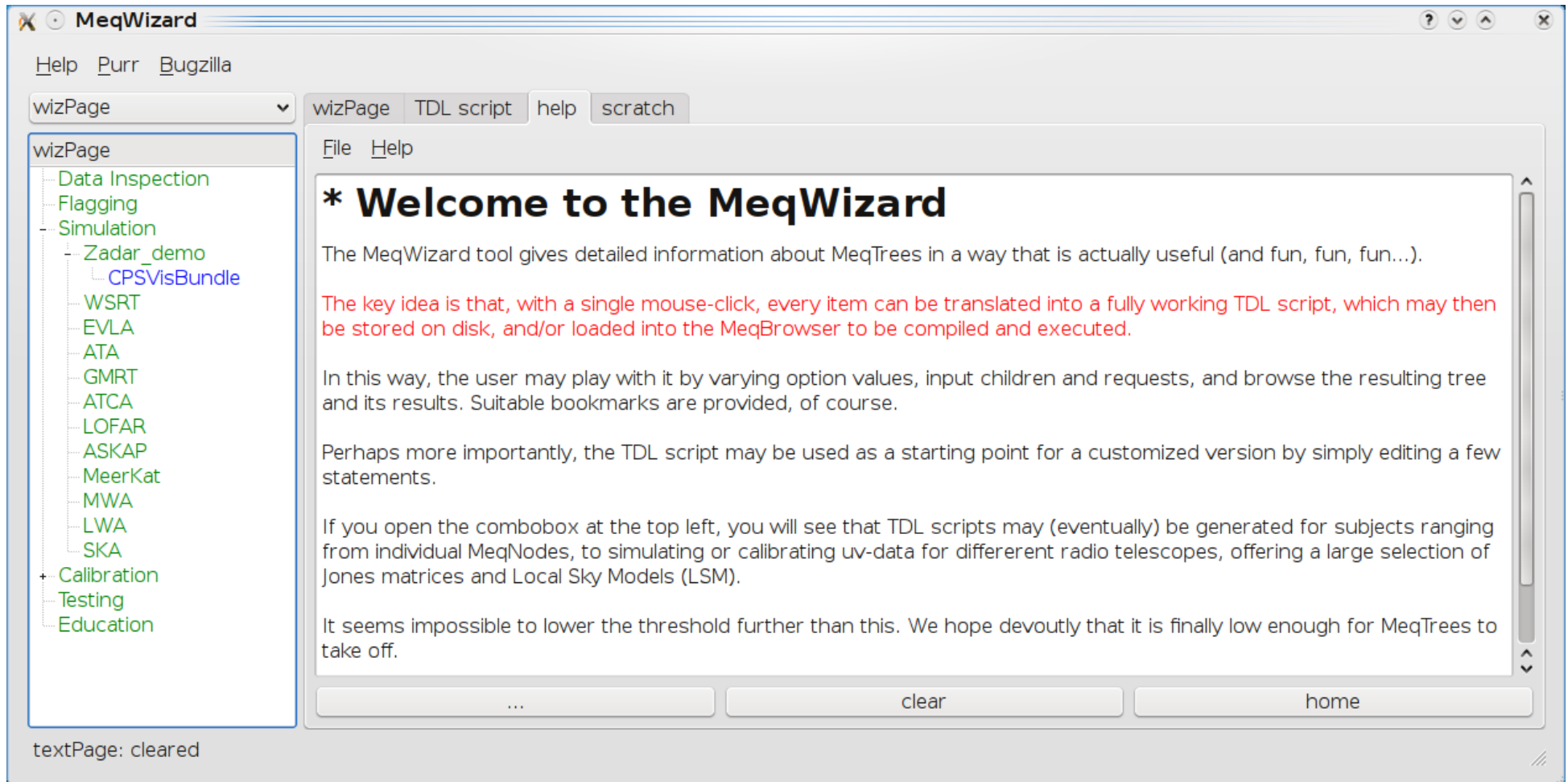
# The MeqWizard TDL Script

- Is generated by the MeqWizard GUI
- It is **complete**, and “guaranteed” to work
- It has lots of **built-in help and visualization**
- Its trees are optimized in size and speed
- It contains the latest TDL features
- It allows detailed inspection (html version)
- It allows tweaking of parameters (and even editing)
- **It encourages sharing**

# Generating a MeqWizard TDL Script takes just 3 mouse-clicks!

- Start the MeqWizard GUI
- **Click 1:** Select an application
  - Optionally: Tweak its parameters
- **Click 2:** Generate the TDL script
  - Optionally: Share it with someone by email
- **Click 3:** Execute the TDL script
  - Interactively with the MeqBrowser
  - In batch mode

# Start up the MeqWizard GUI



# Click 1: Select an application



# Optional: Tweak the Application

The screenshot displays the MeqWizard application interface. On the left, a tree view shows the project structure under 'wizPage', with 'CPSVisBundle' selected. The main window shows the 'App: CPSVisBundle' configuration, including a list of sub-items like 'MeqWizardApplication' and 'CPSVisBundle'. A dialog box titled 'CPSVisBundle' is open, showing the function signature and parameters for the 'CPSVisBundle' function. The dialog includes a 'copt' button and 'OK', 'Cancel', and 'Help' buttons. The background shows the application's code editor with the function definition for 'CPSVisBundle'.

```
def CPSVisBundle (ns, stub,
compose=True, bookmark=True,
folder = None (default) (<type 'NoneType'>))
.....
# Generate a VisBundle for a
# specified (polrep) polarization
#
# ** Explanation of function arguments
# -- ns: The nodescope, which
# -- stub: The nodestub from which the nodes are derived
# -- quals: a list of station names (used as nodename qualifiers)
# -- polrep: the required polarization representation
# -- compose: If True, compose the result into a single tensor node
# -- bookmark: If True, make a MeqBrowser bookmark page for the result
# -- folder: Optional folder for the MeqBrowser bookmark page
#
```

# Click 2: Generate the TDL script

The screenshot displays the MeqWizard application window. On the left, a tree view under 'wizPage' shows 'CPSVisBundle' selected. The main window is titled 'App: CPSVisBundle' and shows a tree view with 'CPSVisBundle' selected. Below this, there are buttons for 'expand', 'hide', 'shortcut', 'copt', and 'help (above)'. At the bottom, there are dropdown menus for 'request=2D' and 'sequence=None', and a 'test' button. A dialog box titled 'CPSVisBundle' is open, showing a configuration window with the following options:

- \*\* Call to TDLHF: CPSVisBundle(...)
- ns = ns (python variable)
- stub = stub('1') (python variable)
- %range(3) (dropdown) quals
- polrep = "linear"
- True (dropdown) compose
- True (dropdown) bookmark
- folder = None (default) (<type 'NoneType'>)
- copt (button)
- OK (button)
- Cancel (button)
- Help (button)

The dialog box also contains a text area with the following code:

```
def CPSVisBundle (ns, stub,
compose=True, bookmark=True,
.....
# Generate a VisBundle for a
# specified (polrep) polarization
#
# ** Expl...
# -- ns: The node...
# -- stub: The nodes...
# -- quals: a list of station...
# -- polrep: the required polarization...
# -- compose: If True, compose the re...
# -- bookmark: If True, make a MeqBro...
# -- folder: Optional folder for the MeqBrowser bookmark...
#
```

A blue arrow points from the 'CPSVisBundle' dialog box to the 'CPSVisBundle' entry in the tree view. A blue circle highlights the '--> TDL Script' button at the bottom right of the dialog box.



# Optional: Inspect the TDL script

The screenshot shows the MeqWizard application window. The title bar reads "MeqWizard". The menu bar includes "Help", "Purr", and "Bugzilla". Below the menu bar is a dropdown menu currently set to "wizPage", and a tabbed interface with tabs for "wizPage", "TDL script", "help", and "scratch". The "TDL script" tab is active, displaying a window with a menu bar "File", "Inspect", and "Help". The main content area of this window shows the title "MeqWizard TDL Script: MeqWizardApplication CPSVisBundle". Below the title is a red note: "NB: For the moment, the html links in this TDL script do not work in the MeqWizard GUI for some reason. So, if you are looking at the GUI now, save this script with the button marked '->HTML' below, and load the resulting html file 'MeqWizard\_save\_HTML.html' into a web browser for easy navigation. It is worth it." This is followed by a green paragraph: "Automatically generated TDL scripts may be dauntingly large, especially if they contain an extensive hierarchy of 'atomic' helper functions. For ease of navigation, here is a list of html links to the main elements of the script. The hierarchy of helper functions may be navigated from its top link(s) in the mandatory function \_define\_forest(). In addition, a complete list of html links is given at the bottom." Below this text are three blue hyperlinks: "Executive Summary", "TDL preamble", and "Other (specific) imports". At the bottom of the window are five buttons: "back", "tree", "test", "save", and "-> HTML", followed by a "Load into MeqBrowser" button. A status bar at the bottom of the application window contains the text: "The TDL script is displayed on the TDL page. (press \"back\" to return to the wizPage page)&&&".

MeqWizard TDL Script: MeqWizardApplication  
CPSVisBundle

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[Executive Summary](#)

[TDL preamble](#)

[Other \(specific\) imports](#)

back tree test save -> HTML Load into MeqBrowser

The TDL script is displayed on the TDL page. (press "back" to return to the wizPage page)&&&

# Click 3: Execute the TDL script

The screenshot shows the MeqWizard application window. On the left is a tree view with 'CPSVisBundle' selected. The main area displays the TDL script content, including a title, a note about broken links, and a list of links. A blue arrow points from the text to the 'Load into MeqBrows' button, which is circled in blue. The bottom of the window contains a status bar with instructions.

MeqWizard

Help Purr Bugzilla

wizPage

wizPage TDL script help scratch

File Inspect Help

## MeqWizard TDL Script: MeqWizardApplication CPSVisBundle

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[TDL preamble](#)

[Other \(specific\) imports](#)

back tree test save -> HTML Load into MeqBrows

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# The script may be shared

- **It is just python text, and self-contained!**
  - It may be sent by email
  - It may be inspected (html version)
  - Its parameters may be tweaked
  - It may even be edited (by the brave)
- 
- Preferably: Accompanied by a PURR log
  - A detailed report on a data reduction project

# The parameters of the script may be tweaked at two levels

- Either frozen into the TDL script itself
  - For sharing sophisticated ideas...
  - ...with un-sophisticated users
- Or interactively by the end-user
  - Using TDLOptions in the MeqBrowser
  - For sharing between sophisticated users
- Usually: a mixture of both

# Another Dream:

## Customizing the Production System

- With the obscene data volumes...
- ...you will get only one shot at data reduction
- ...on a machine that is not your own
- ...done by somebody else, in service mode
- ...which will give you a “standard product”

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- With the expected data volumes...
- ...you will get only one shot at data reduction
- ...on a machine that is not your own
- ...done by somebody else in service mode
- ...which will give you a “standard product”
- **What if the data reduction could be customized with your own TDL script?**

# So, don't be intimidated by the Heavy Lifters



CALIM 2011, Manchester (UK)

# With the MeqWizard exo-skeleton...



you can be part of the 3GC Community also