

(Introduction to)  
The CAOS Problem-Solving  
Environment  
&  
The Software Package CAOS  
+  
AO Simulations...

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# The CAOS “PSE”...

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- It is composed of a global interface (the **CAOS Application Builder**), a library of utility routines (the **CAOS Library**), and some scientific packages (the **Software Packages**).
- a **Software Package** is a set of modules dedicated to a given scientific subject (AO, imaging, whatever).

# CAOS Problem Solving Environment -1

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CAOS  
Application Builder

The diagram consists of a large blue rectangle representing the 'global interface'. Inside this rectangle is a yellow oval containing the text 'CAOS Application Builder'. The text is centered within the oval and the rectangle.

global interface

# CAOS Problem Solving Environment -1

CAOS  
Application Builder

global interface

CAOS Library

ASTROLIB Library

libraries

# CAOS Problem Solving Environment -1

CAOS  
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CAOS  
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# CAOS Problem Solving Environment -1

**CAOS  
Application Builder**

global interface

**CAOS Library**

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# CAOS Problem Solving Environment -1

**CAOS  
Application Builder**

global interface

**CAOS Library**

**ASTROLIB Library**

libraries

**Software Package CAOS**

**Software Package AIRY**

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**Software Package SPHERE**

packages

# CAOS Problem Solving Environment -1

**CAOS  
Application Builder**

global interface

**CAOS Library**

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libraries

**Software Package CAOS**

**Software Package AIRY**

**Software Package PAOLAC**

**Software Package SPHERE**

**Software Package AIRY-LN**

packages

# CAOS Problem Solving Environment -2

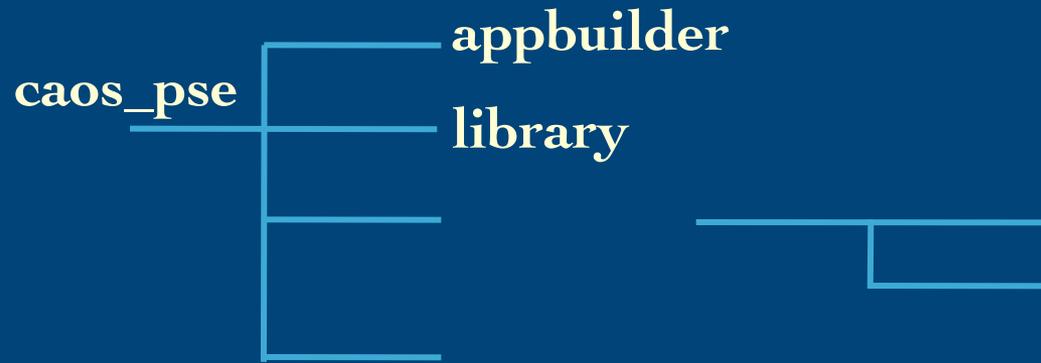


# CAOS Problem Solving Environment -2

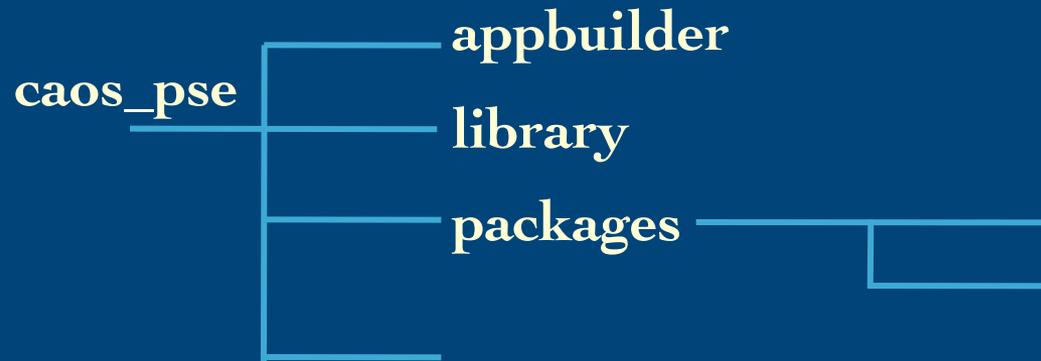




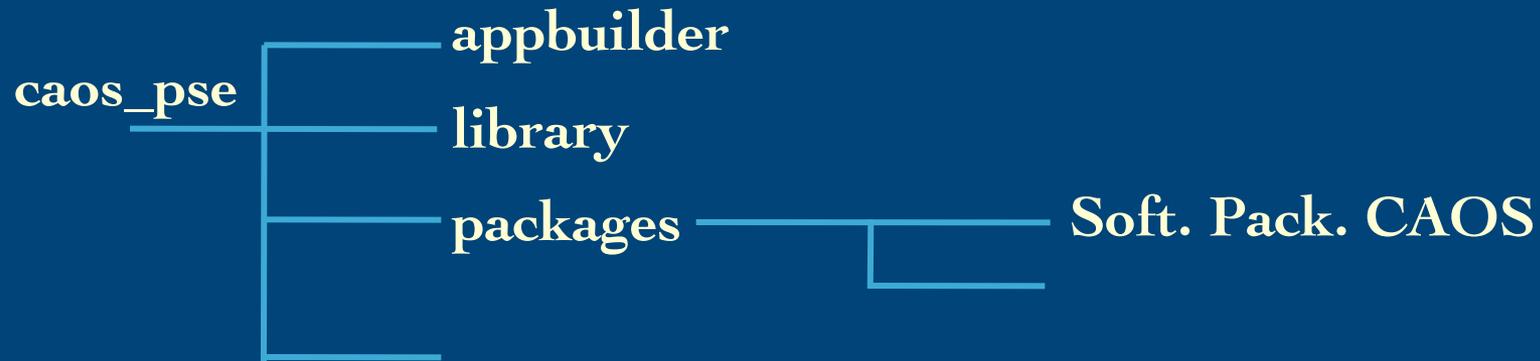
# CAOS Problem Solving Environment -2



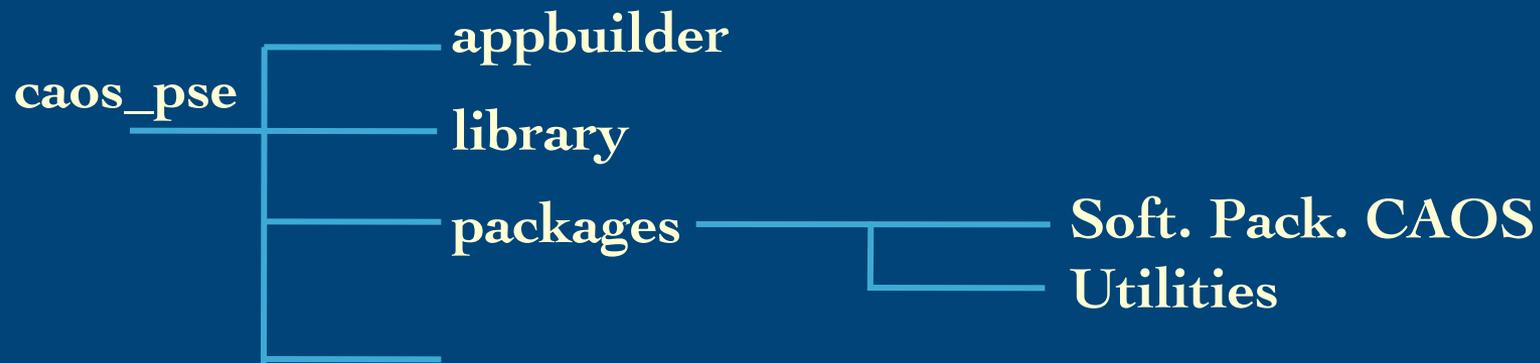
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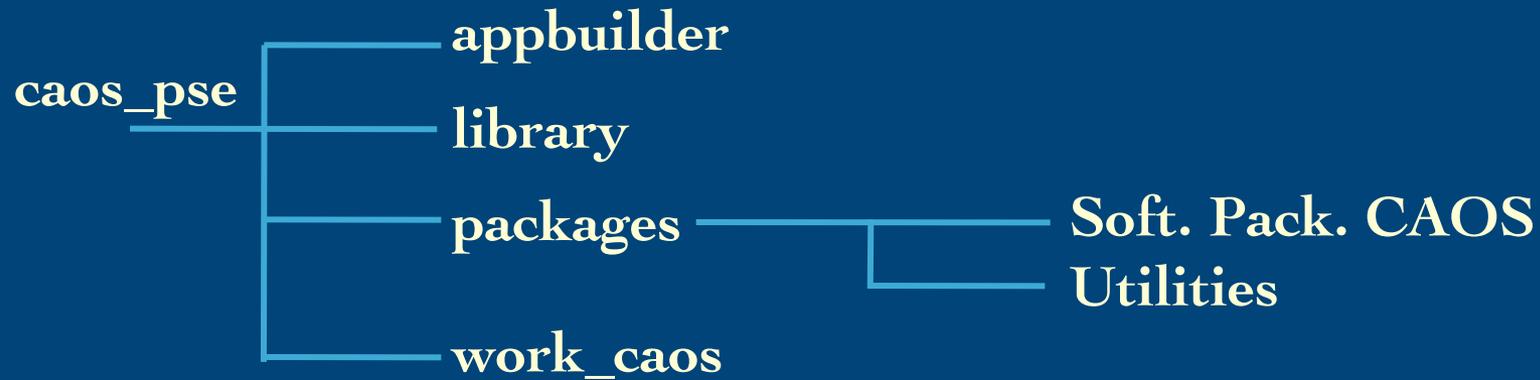
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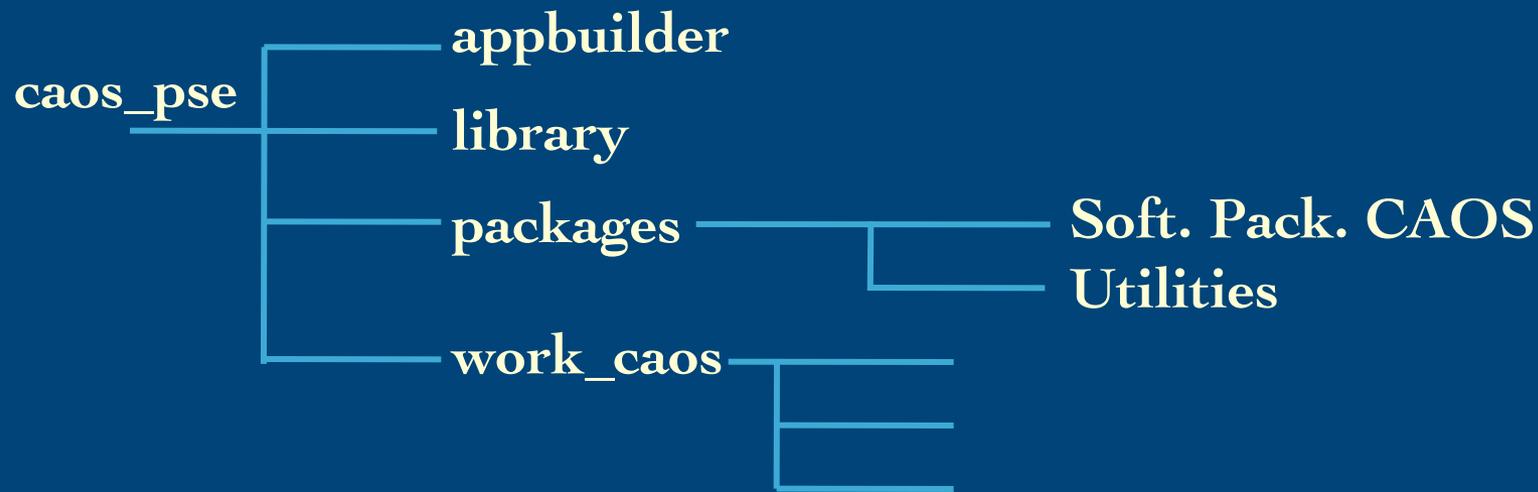
# CAOS Problem Solving Environment -2



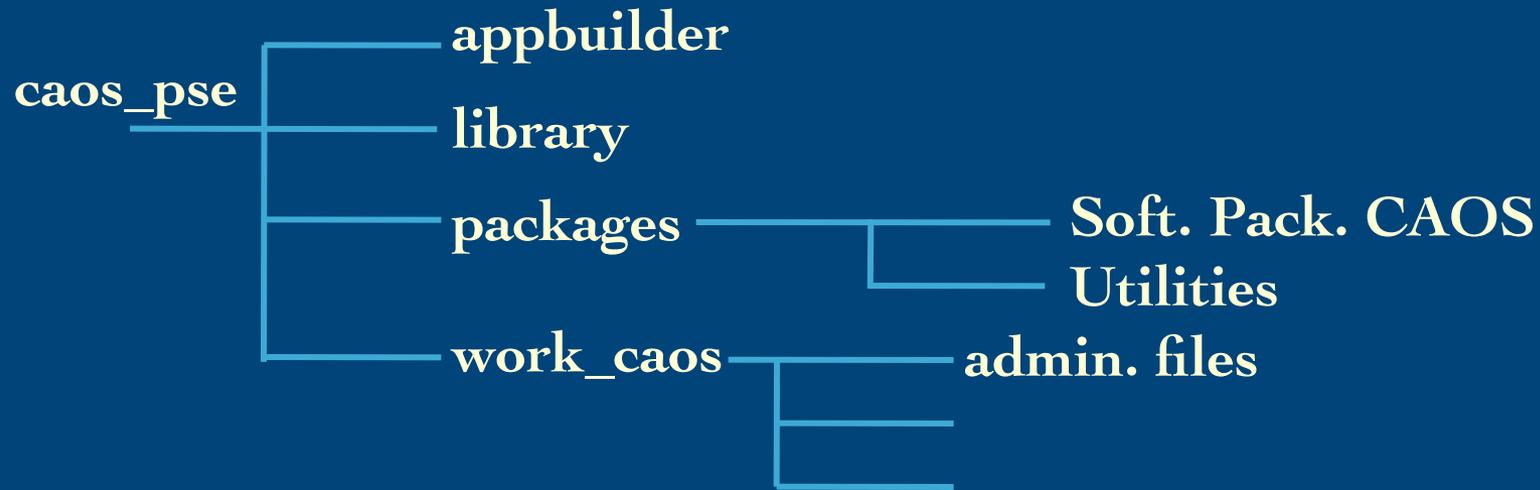
# CAOS Problem Solving Environment -2



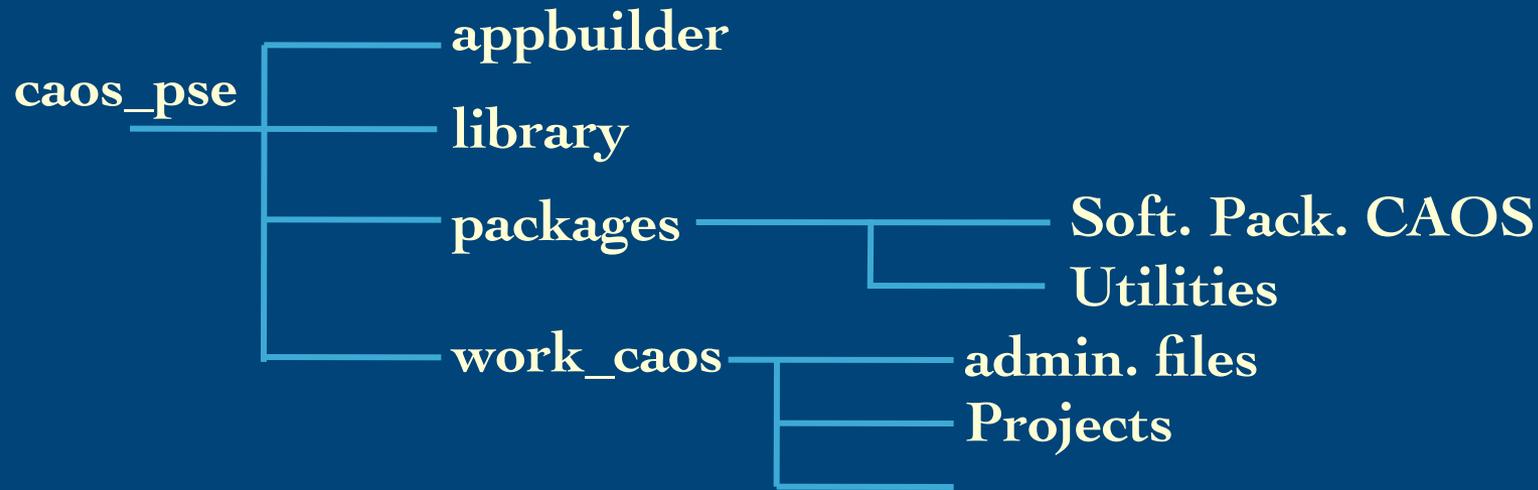
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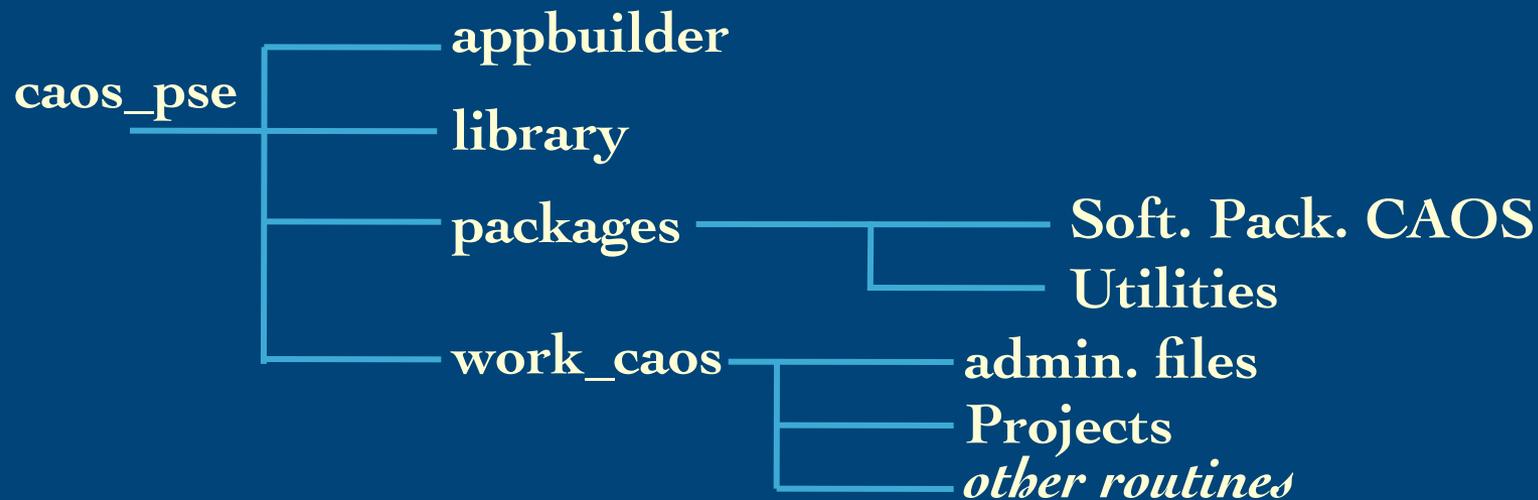
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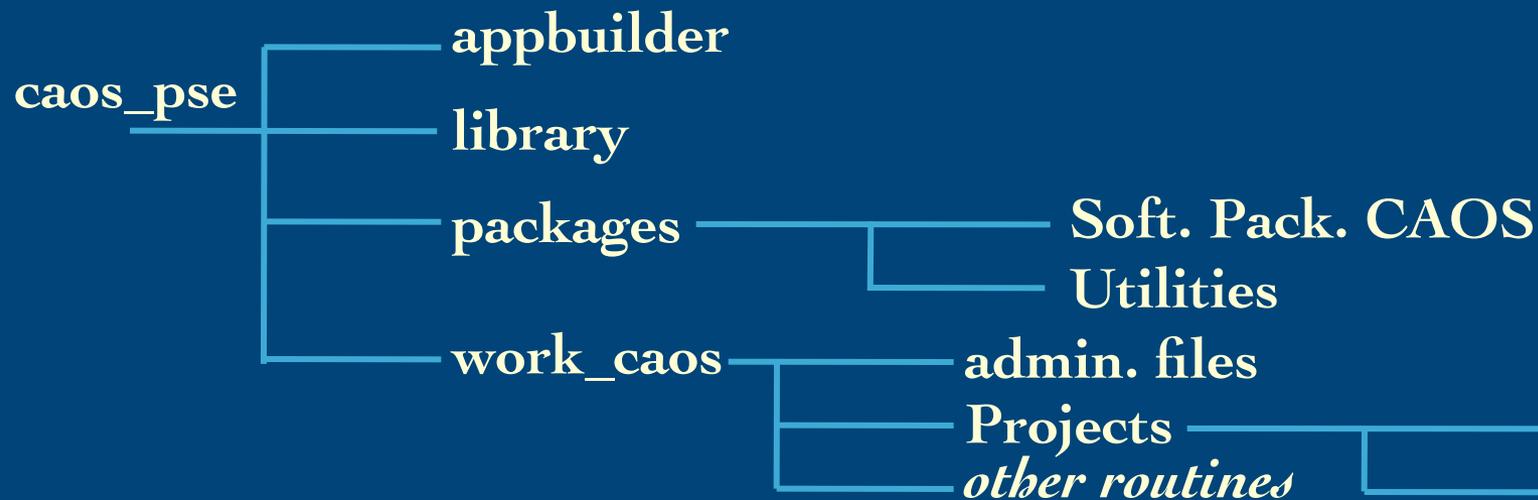
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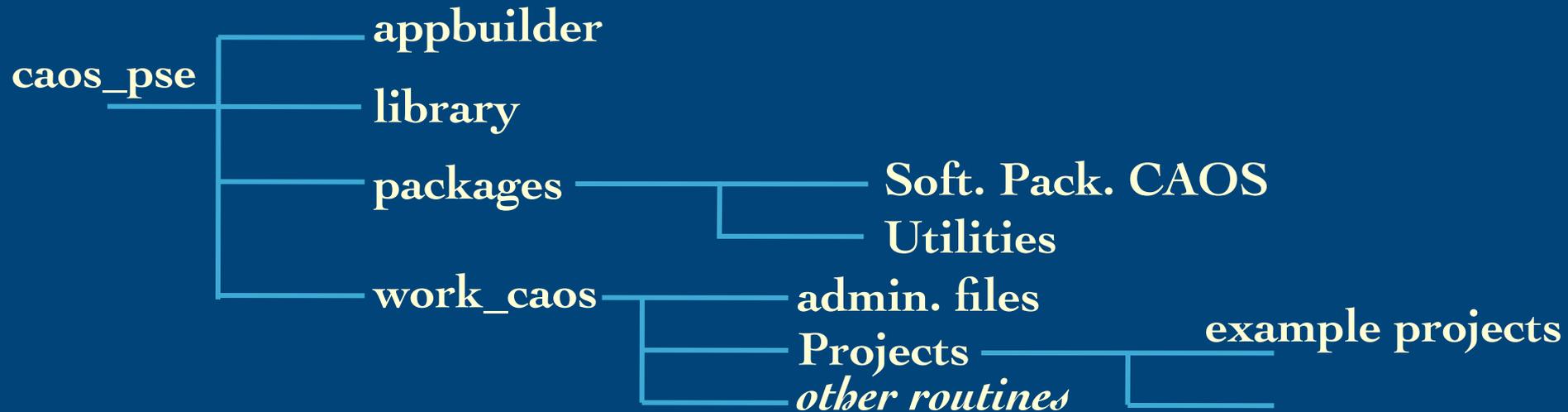
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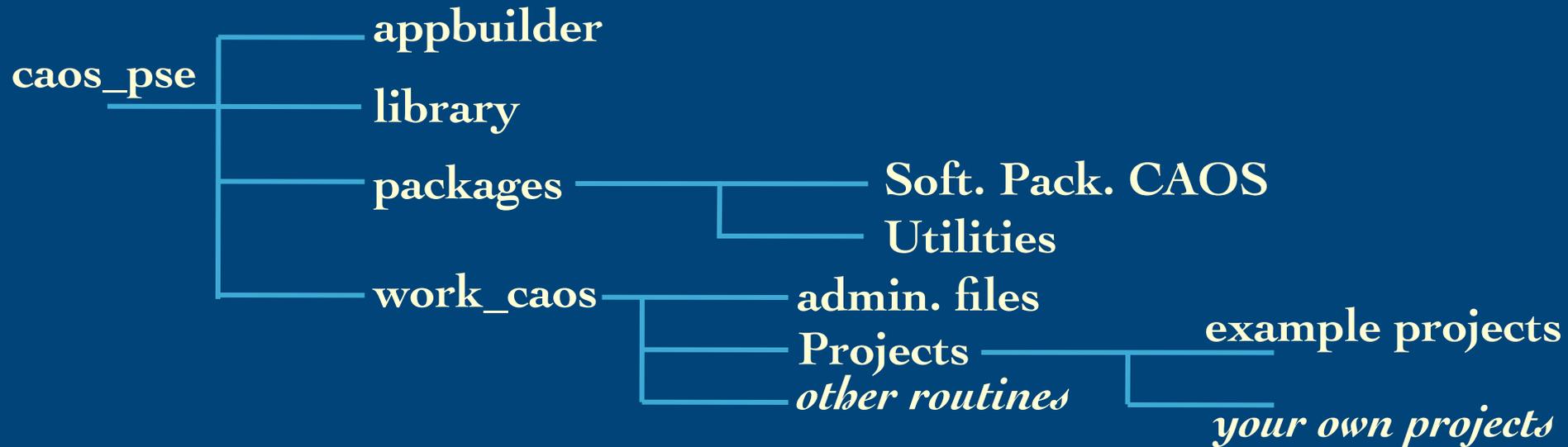
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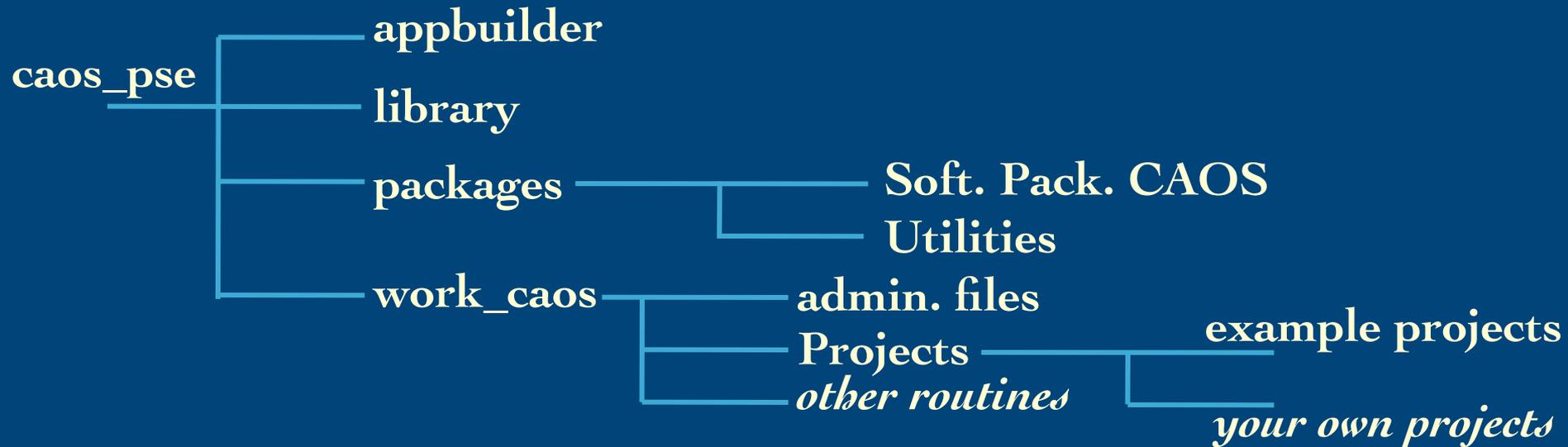
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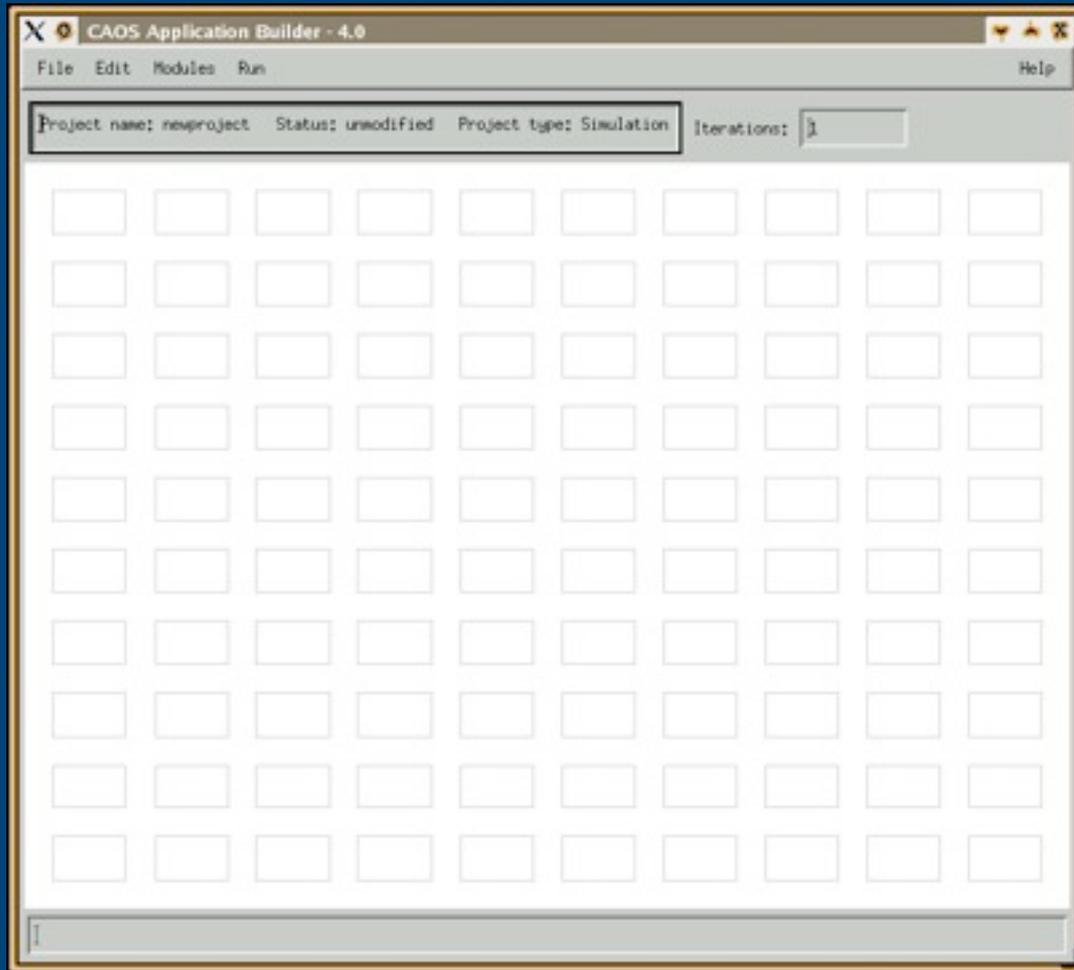


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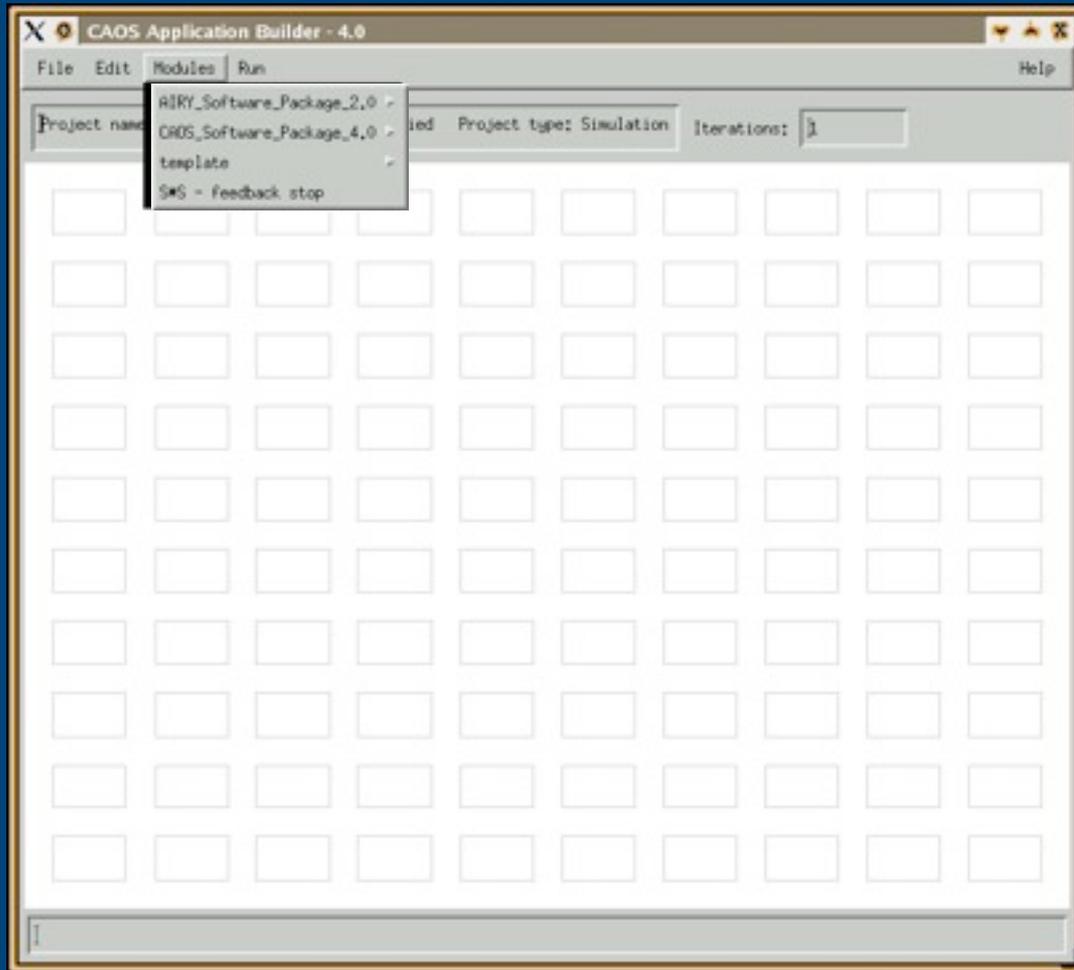
somewhere else: astrolib, *some other library*

# CAOS Application Builder



It is essentially a **worksheet** where the user can place small blocks, the modules, and connect them with data paths to form a **project**.

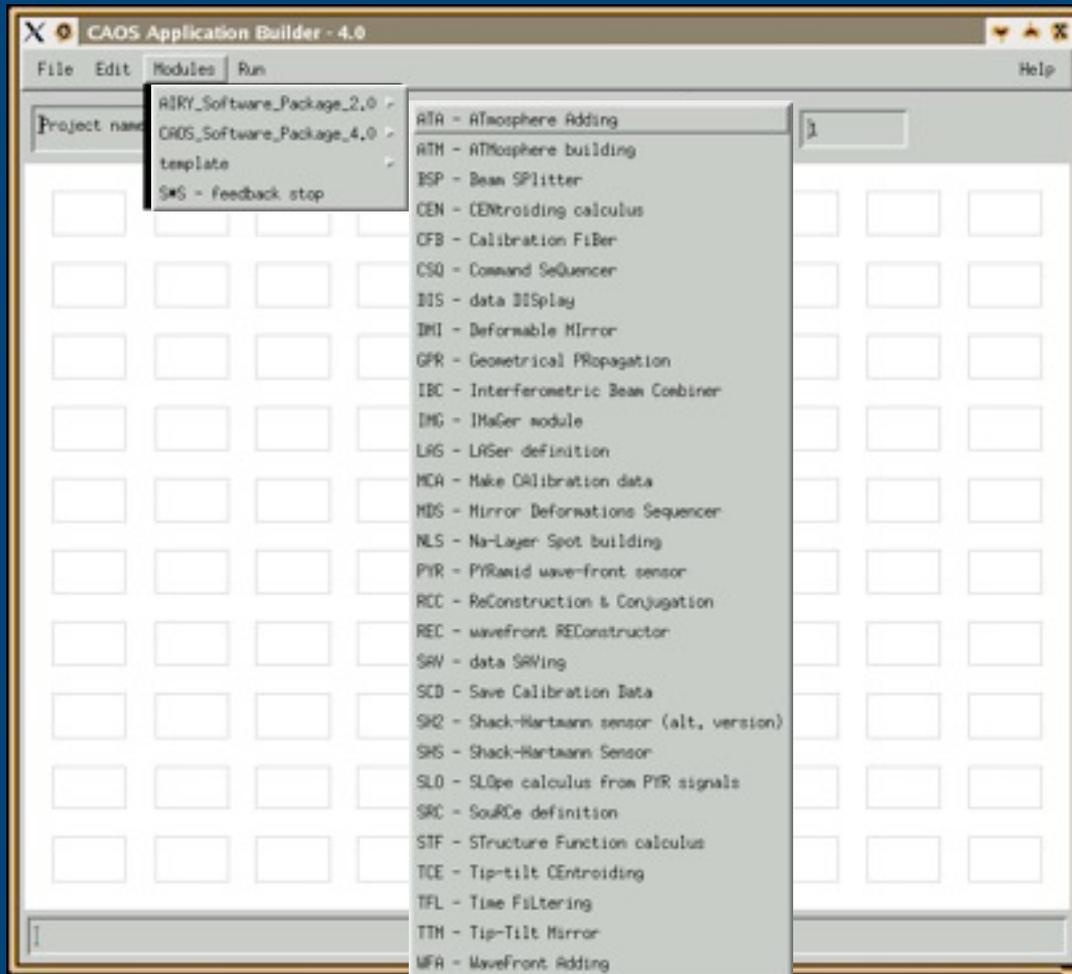
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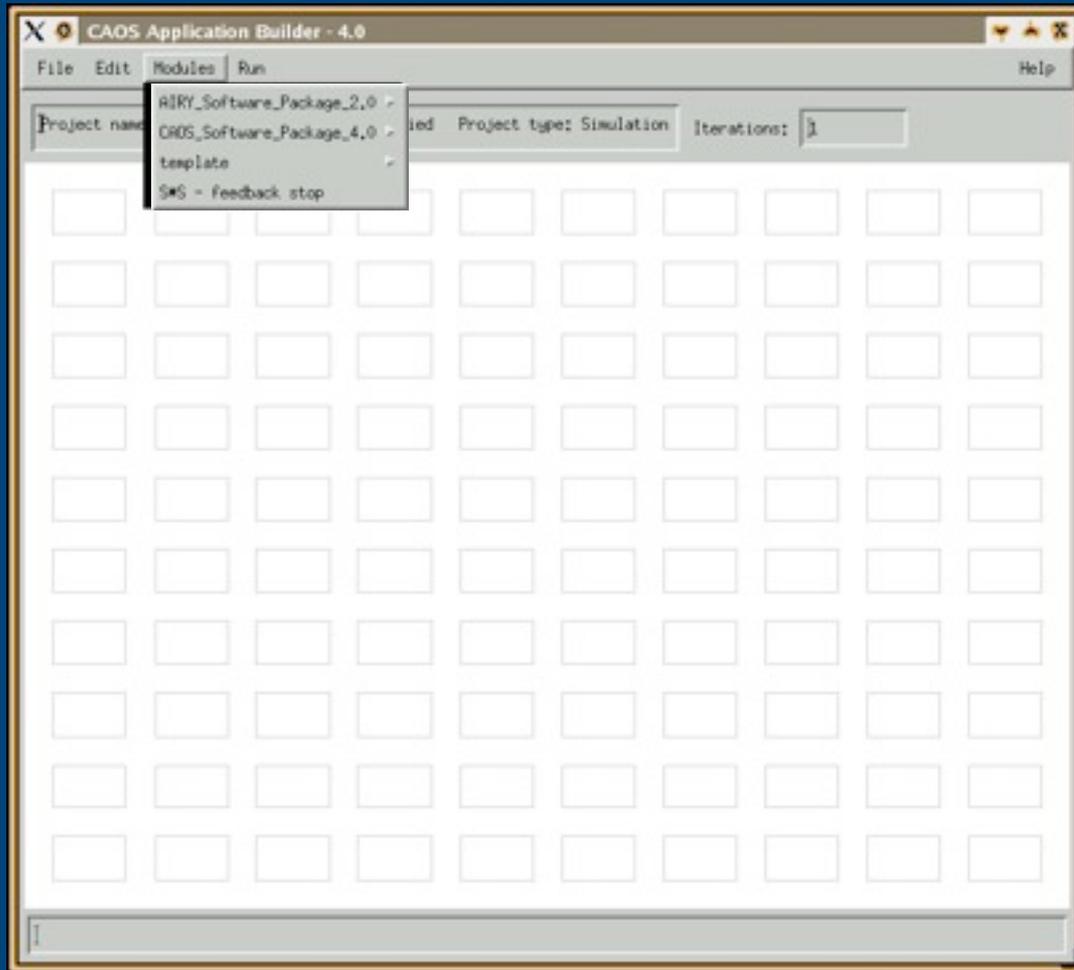
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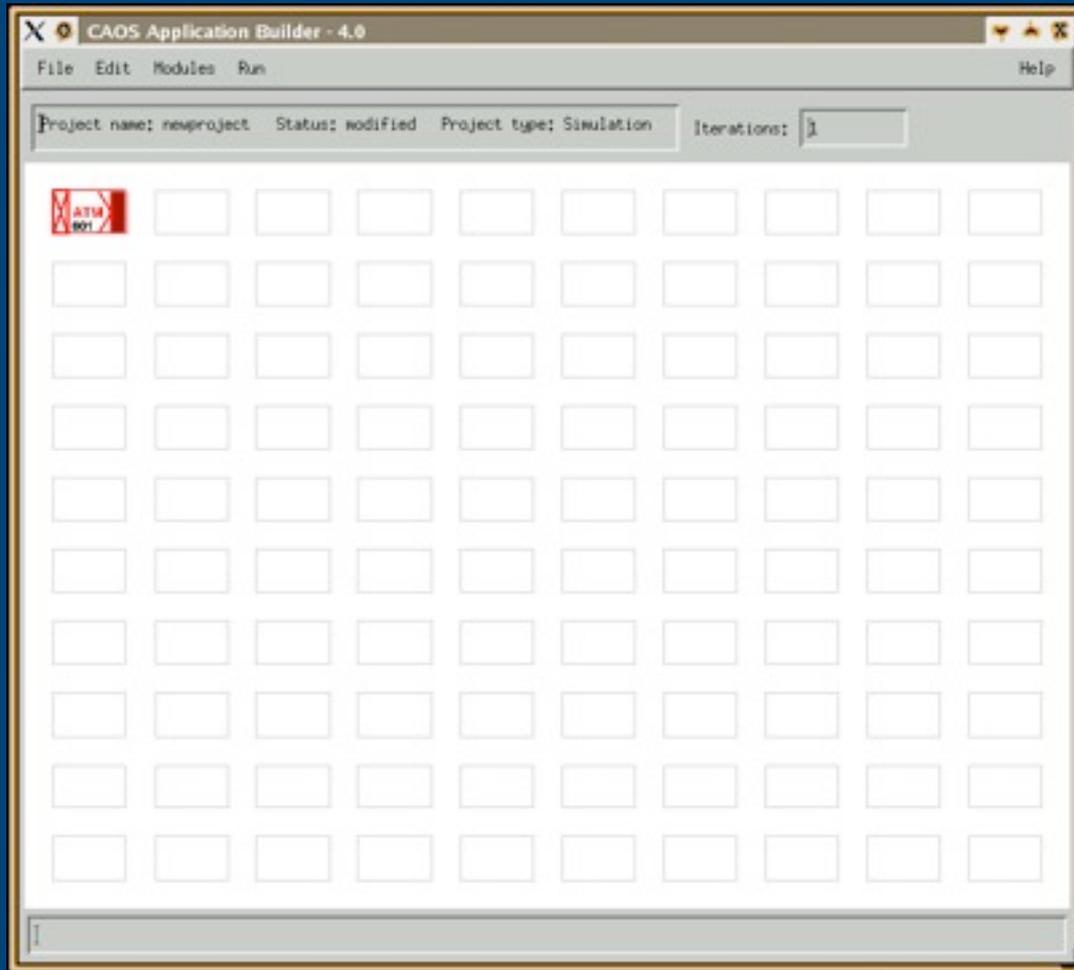


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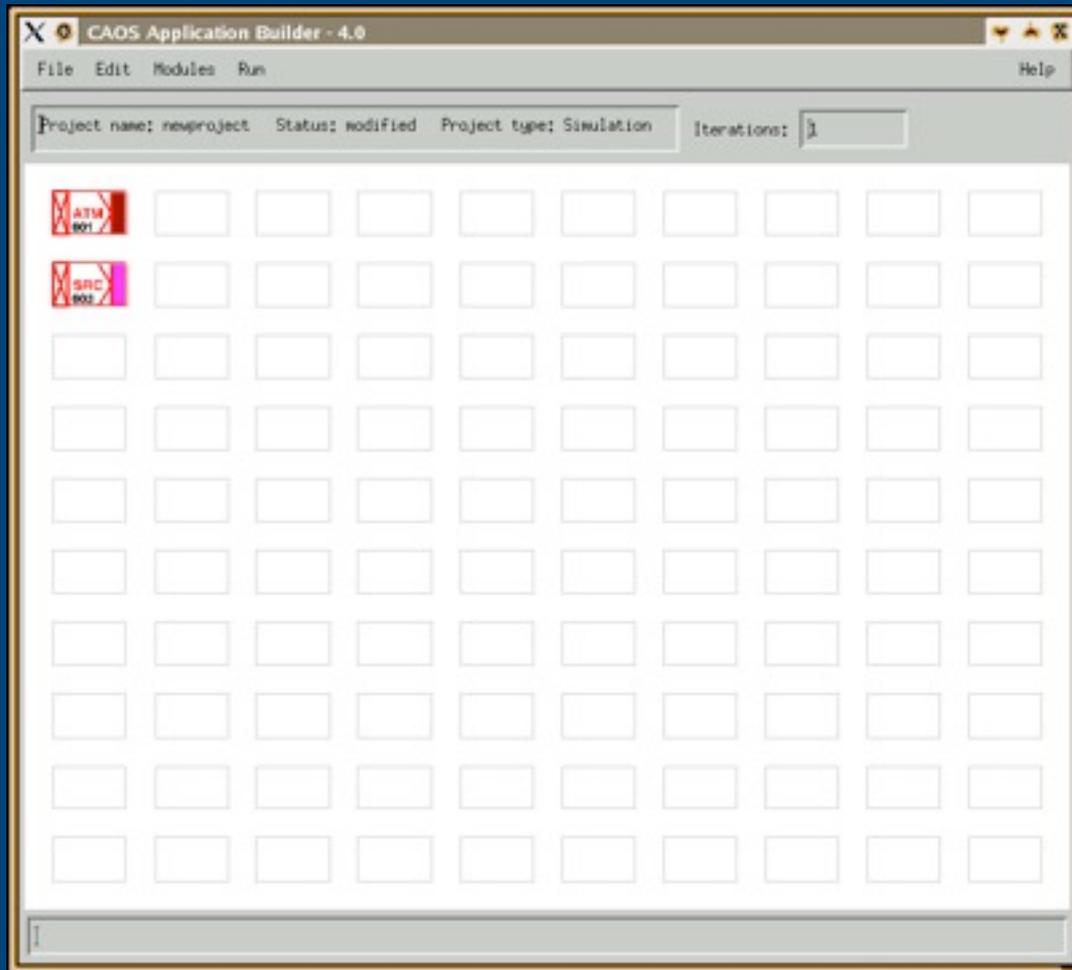
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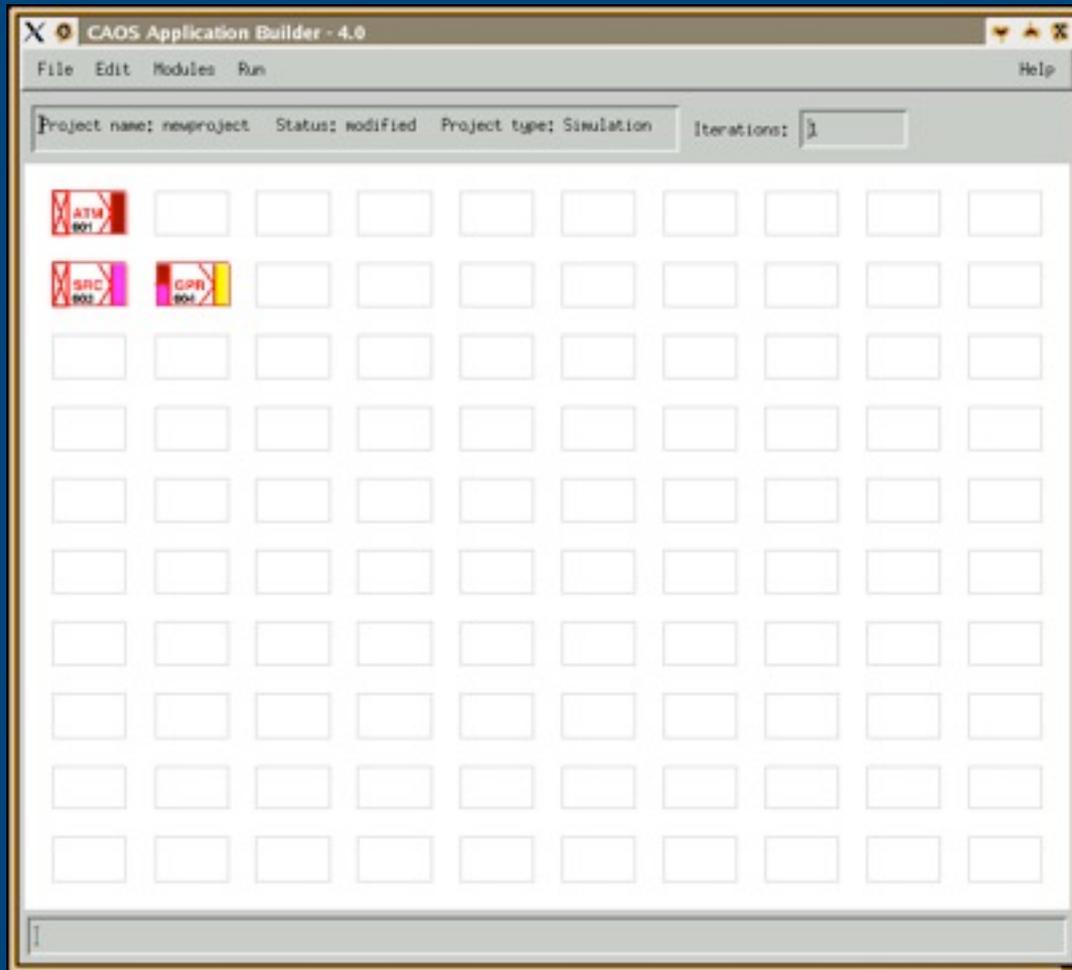
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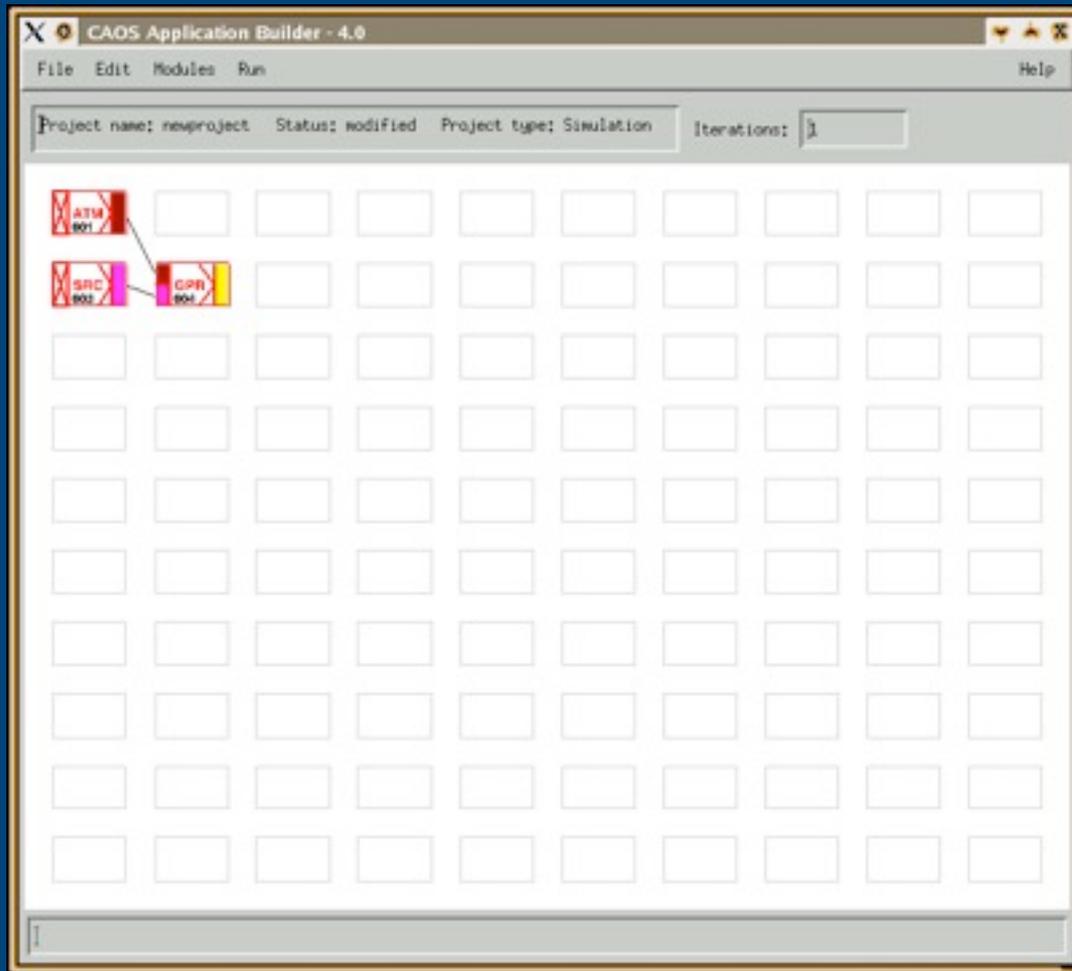


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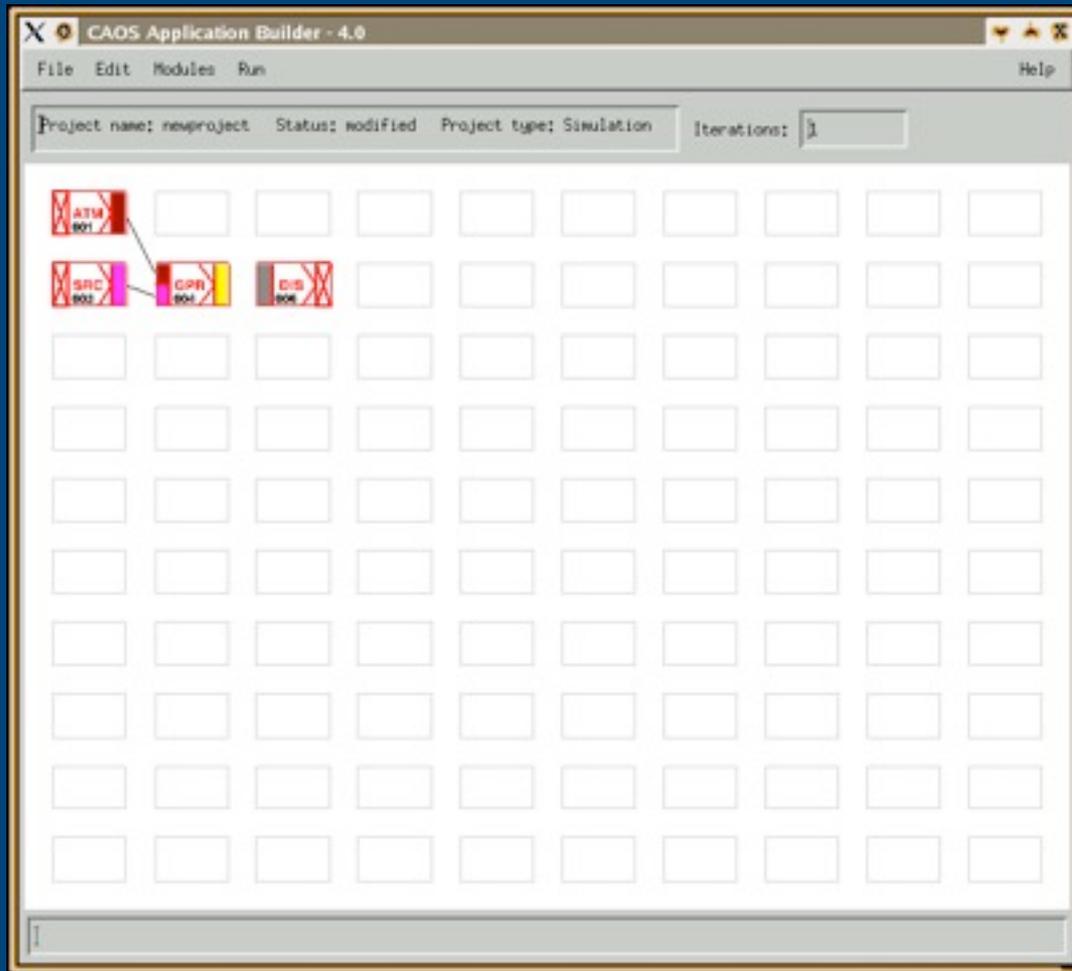
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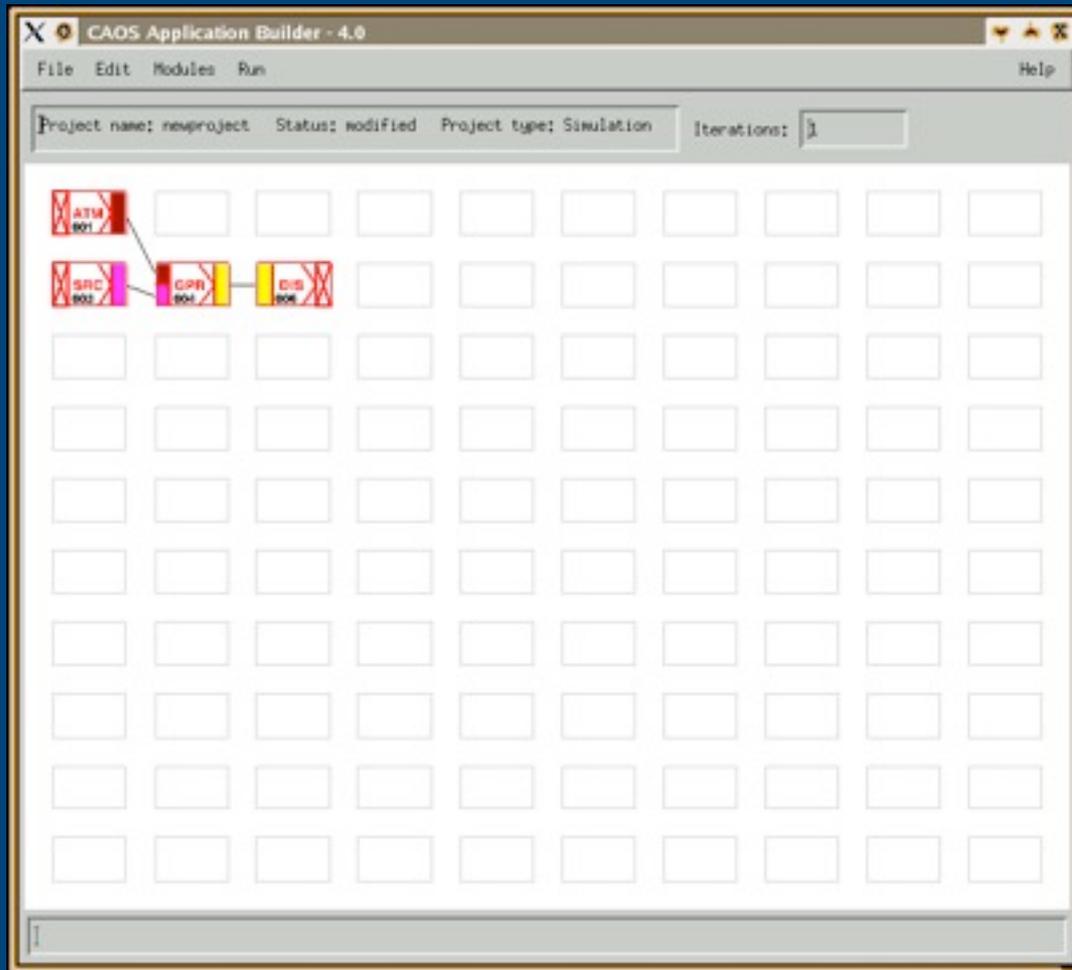
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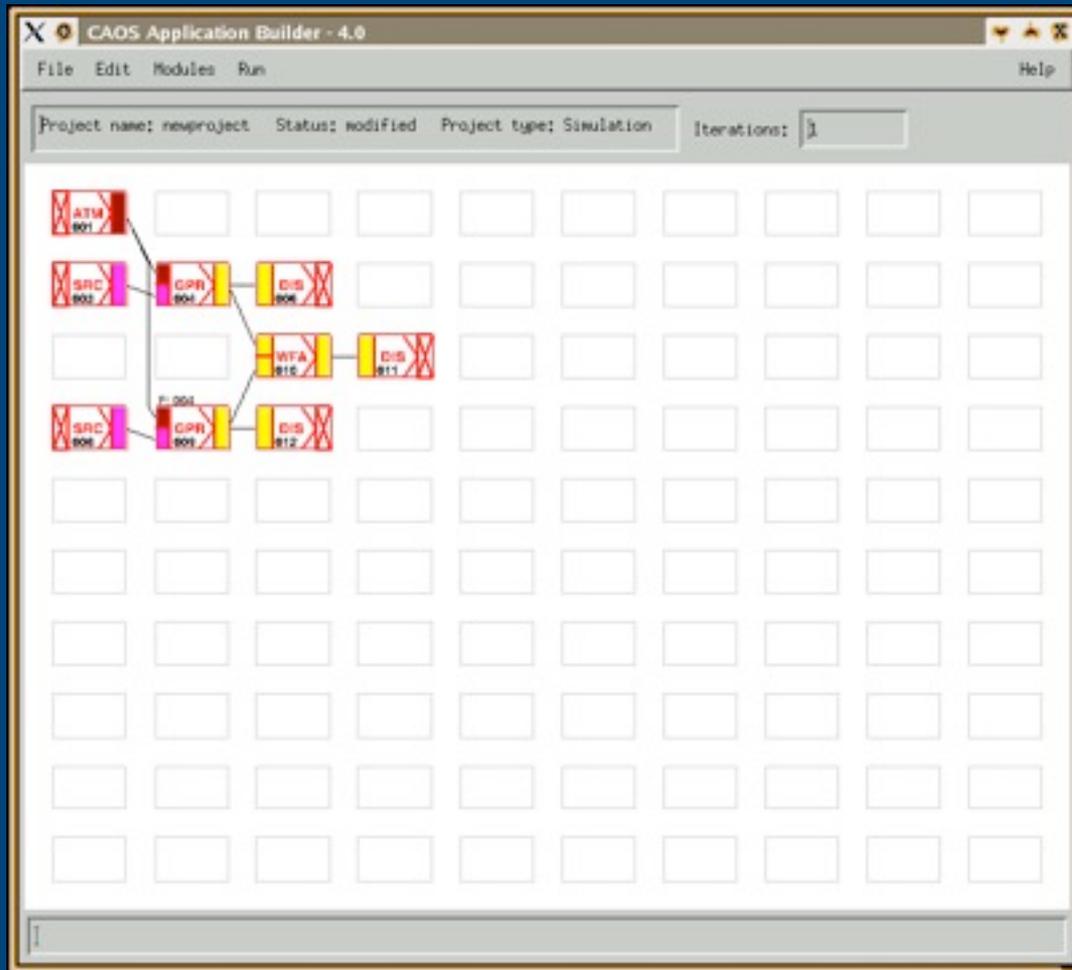
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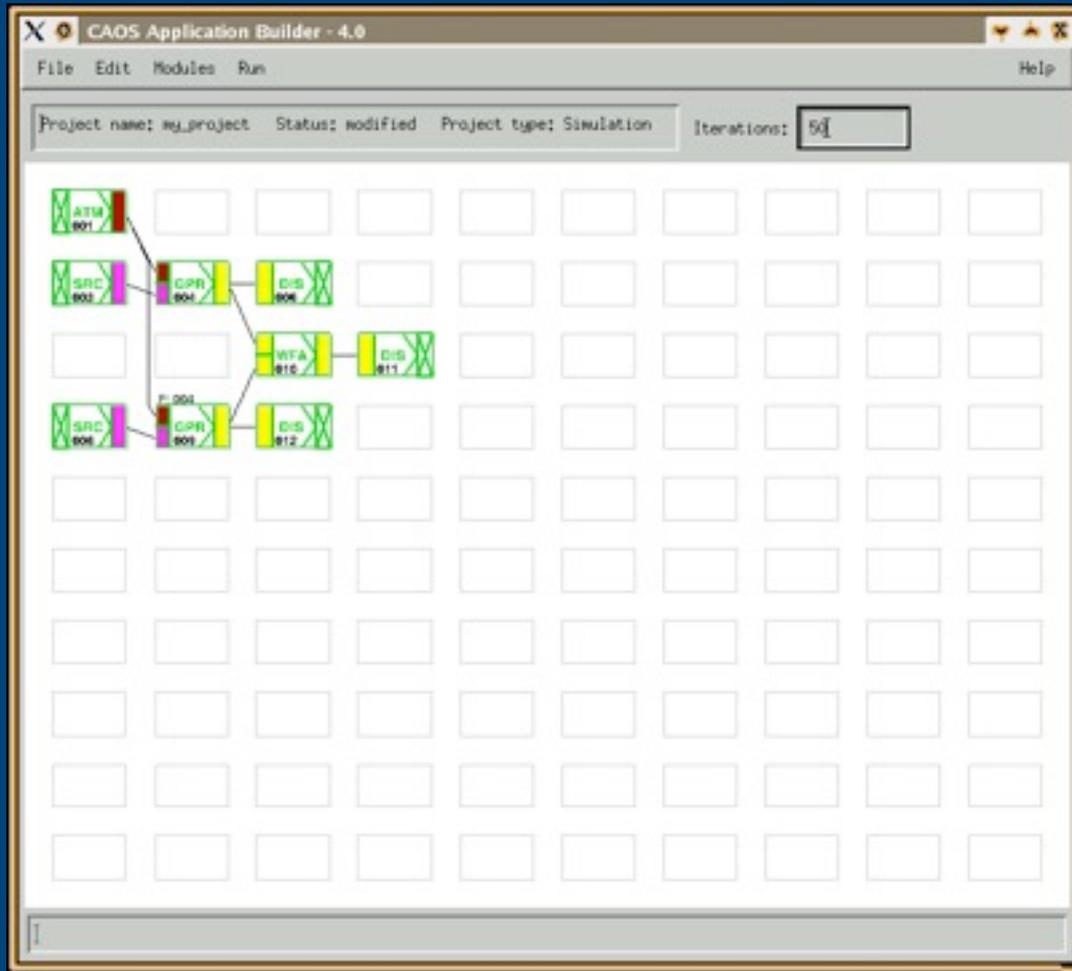
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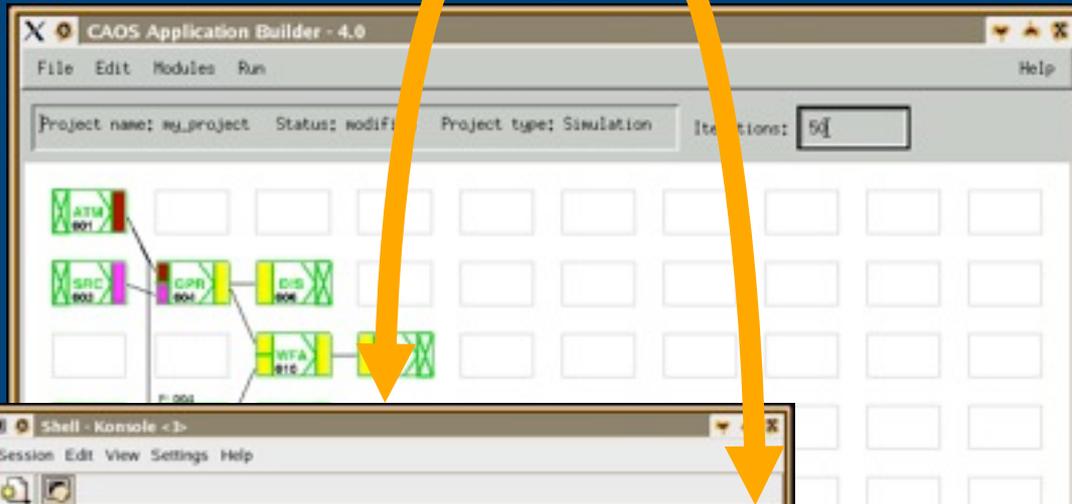
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```
Shell - Konsole <->
Session Edit View Settings Help

COMMON caos_block, tot_iter, this_iter
ret = mds(0.001_00,
         mds_00001_p,
         INIT=mds_00001_c)
IF ret NE 0 THEN ProjectMsg, "mds"

ret = src(0.002_00,
         src_00002_p,
         INIT=src_00002_c)
IF ret NE 0 THEN ProjectMsg, "src"

ret = gpr(0.002_00,
         0.001_00,
         0.003_00,
         gpr_00003_p,
         INIT=gpr_00003_c)
IF ret NE 0 THEN ProjectMsg, "gpr"

ret = dis(0.003_00,
         dis_00010_p,
         INIT=dis_00010_c)
IF ret NE 0 THEN ProjectMsg, "dis"
```

```
Shell - Konsole <->
Session Edit View Settings Help

: Initialization:
:
print, "=== INITIALIZATION... ==="
@Projects/pyr_calib/mod_calls.pro

: Loop Control :
:
print, "=== RUNNING... ==="
FOR this_iter=1, tot_iter DO BEGIN           ; Begin Main Loop
  print, "=== ITER. #" + strtrim(this_iter) + "/" + strtrim(tot_iter) + "..."
  @Projects/pyr_calib/mod_calls.pro
ENDFOR                                     ; End Main Loop

: End Main :
:
END
```

When the project is designed, it can be saved on disk, **generating the IDL code** which implements the simulation program.

# CAOS Application Builder



The “virtual machine” feature of IDL permits in addition to have an IDL-licence-free version of a given project... What you will use later on.

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Session Edit View Sett...
COMMON caos_block, t...
ret = mds(0.001_00,
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IF ret NE 0 THEN Proj...
ret = src(0.002_00,
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      INIT=src_00002_c)
IF ret NE 0 THEN Proj...
ret = gpr(0.002_00,
      0.001_00,
      0.003_00,
      gpr_00003_p,
      INIT=gpr_00003_c)
IF ret NE 0 THEN Proj...
ret = dis(0.003_00,
      dis_00010_p,
      INIT=dis_00010_c)
IF ret NE 0 THEN Proj...
```

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; Loop Control ;
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print, "=== RUNNING... ==="
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  @Projects/pyr_calib/mod_calls.pro
ENDFOR                                       ; End Main Loop
.....
; End Main ;
.....
END
```

# CAOS PSE: availability

All (*public!*) parts of the CAOS PSE are available for download:

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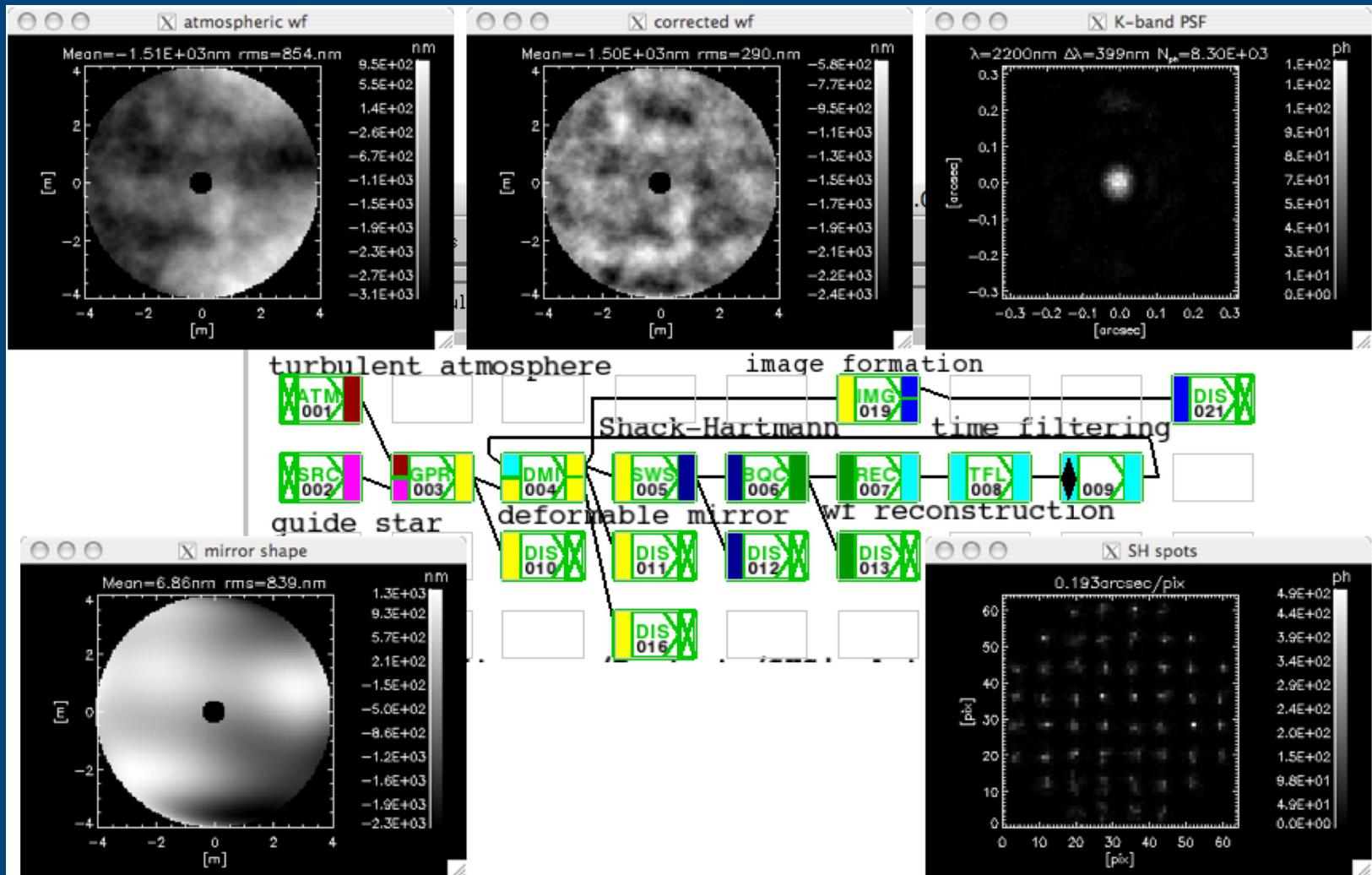
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Current status of the dedicated mailing-lists  
(as on september 2016):

- Soft. Pack. CAOS: 117 subscribers,
- Soft. Pack. AIRY: 30 subscribers,
- *Soft. Pack. SPHERE: 23 subscribers,*
- *Soft. Pack. PAOLAC: 3 subscribers.*

# End-to-end AO modeling with the Software Package CAOS -1

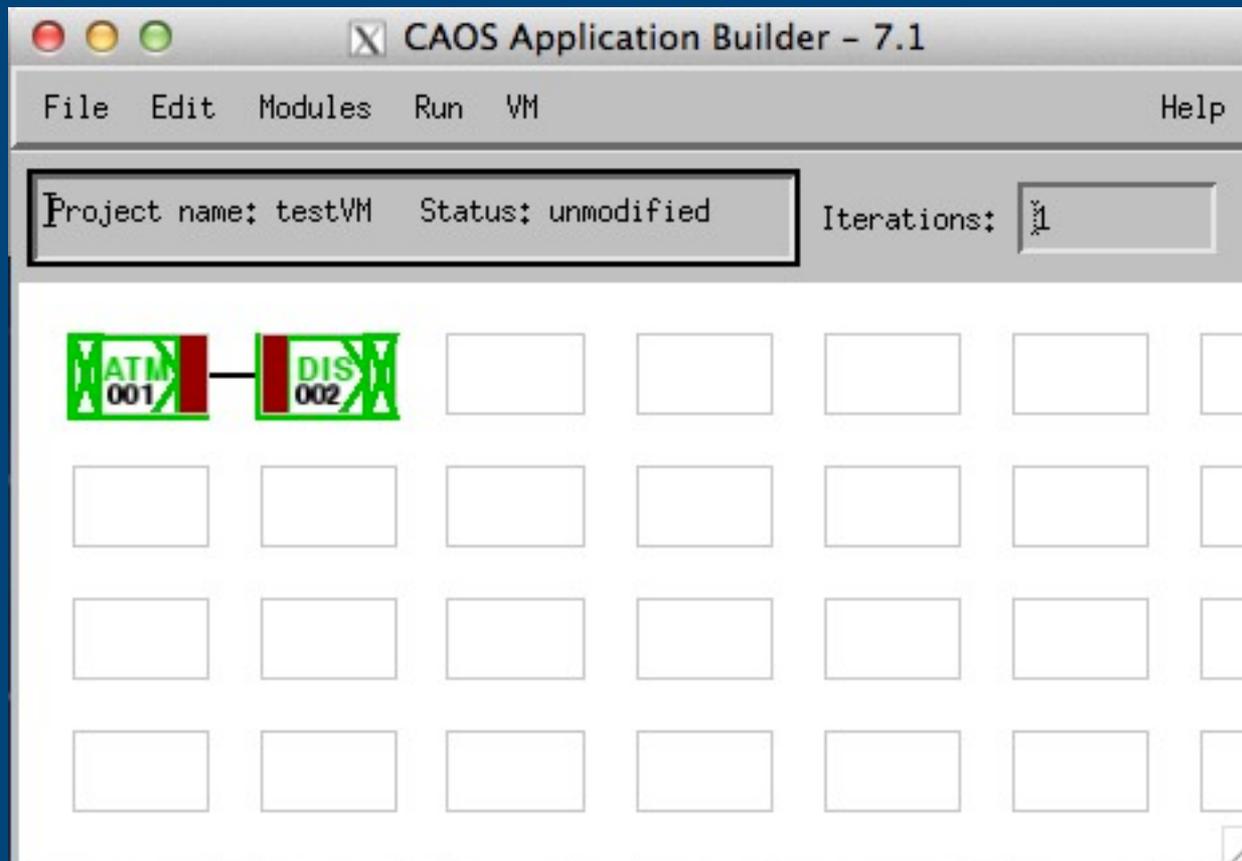


# End-to-end AO modeling with the Software Package CAOS -2

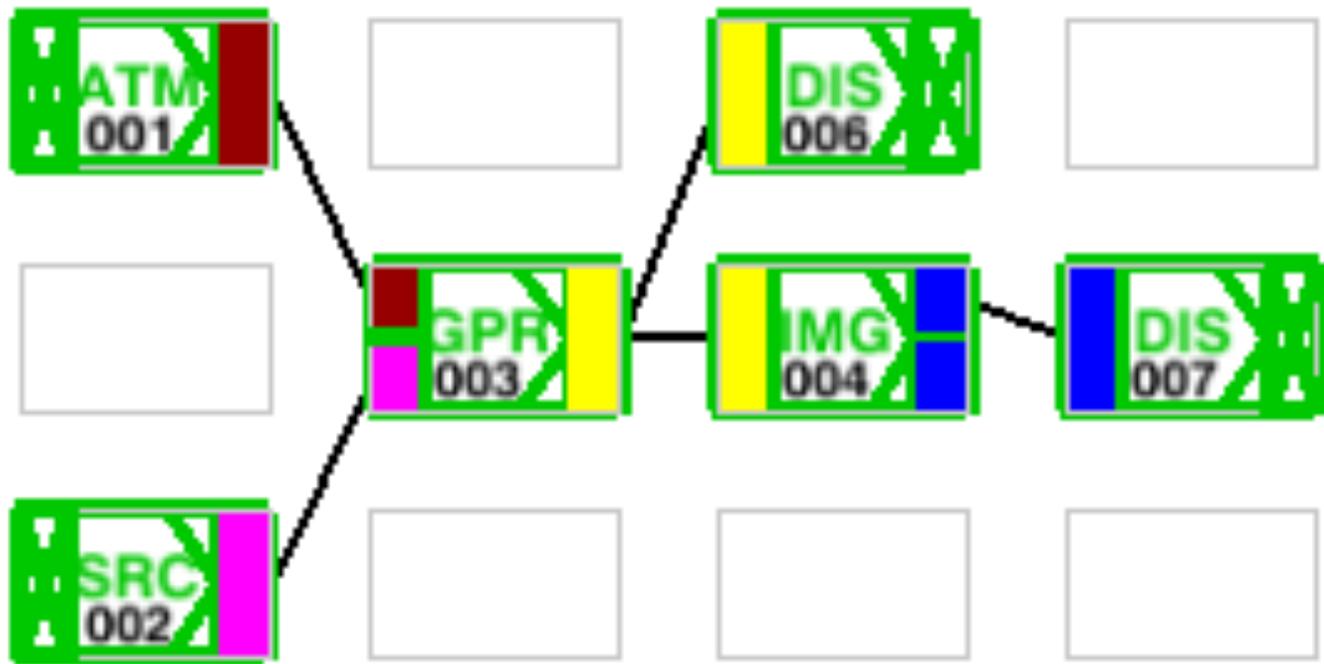
Table 1. The 31 modules of the Software Package CAOS, version 7.0.

Module	Purpose
<b>Optical turbulence &amp; image formation</b>	
ATM - ATMosphere building	-builds the turbulent atmosphere (FFT+subharmonics, Zernike) (see also utility PSG - Phase Screen Generation)
SRC - SouRCe definition	-characterizes the guide star/observed object
GPR - Geometrical PRopagator	-propagates light from source to telescope through atmosphere
IMG - IMAging device	-forms an image of the observed object (+detector noises)
<b>Wavefront sensing</b>	
PYR - PYRamid wavefront sensor	-simulates the pyramid wavefront sensor
SLO - SLOpe computation	-computes the slopes from the pyramid signals
SWS - Shack-Hartman Wavefront Sensor	-simulates the Shack-Hartmann (SH) wavefront sensor
BQC - Barycentre/Quad-cell Centroiding	-compute the signals from the SH spots centroiding calculus
IWS - Ideal Wavefront Sensing	-applies "ideal" wavefront sensing (see text)
TCE - Tip-tilt CEntroiding	-computes and reconstructs tip-tilt
<b>Wavefront reconstruction, control &amp; correction</b>	
REC - wavefront REConstruction	-reconstructs the wavefront
TFL - Time-FiLtering	-applies time-filtering after wavefront reconstruction
SSC - State-Space Control	-applies state-space control
DMI - Deformable MIRROR	-simulates the behavior of a deformable mirror (DM)
TTM - Tip-Tilt MIRROR	-simulates the behavior of a tip-tilt mirror
<b>Calibration</b>	
CFB - Calibration FiBER characterization	-defines a fiber to be used for calibration purpose
MDS - Mirror Deformation Sequencer	-generates a sequence of DM modes or influence functions
SCD - Save Calibration Data	-saves the calibration data (interaction matrix+set of deformates)
<b>Wide-field AO</b>	
AVE - signals AVEraging	-averages measurements from various wavefront sensors
COM - COMbine measurements	-combines measurements from various wavefront sensors
DMC - Deformable Mirror Conjugated	-corrects at different conjugated altitudes
<b>Other modelling modules</b>	
LAS - LASer characterization	-defines laser projector characteristics
NLS - Na-Layer Spot definition	-characterizes the Sodium-layer behavior
IBC - Interferometric Beam Combiner	-combines the light from two apertures
COR - CORonagraphic module	-simulates various coronagraphs (Lyot, Roddier&Roddier, FQPM)
AIC - Achromatic Interfero-Coronagraph	-simulates the Achromatic Interfero-Coronagraph
BSP - Beam SPplitter	-splits the light beam
<b>Other utility modules</b>	
WFA - WaveFRont Adding	-adds or combines together wavefronts
ATA - ATMosphere Adding	-adds or combines together atmospheres
IMA - IMAge Adding	-adds or combines together images
STF - STructure Function	-calculates the structure function and compares to theory

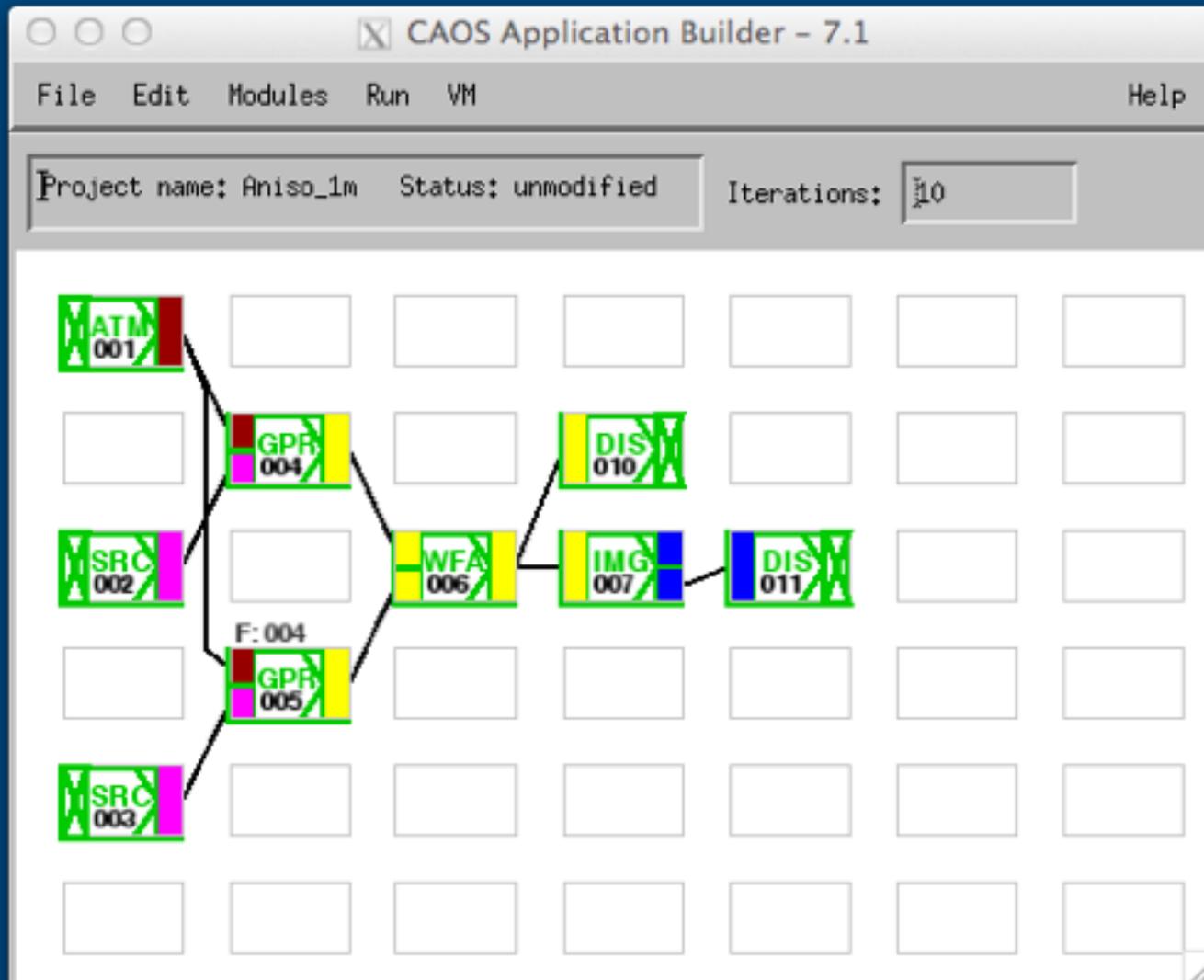
# Imaging through the turbulent atmosphere: loss of resolution !



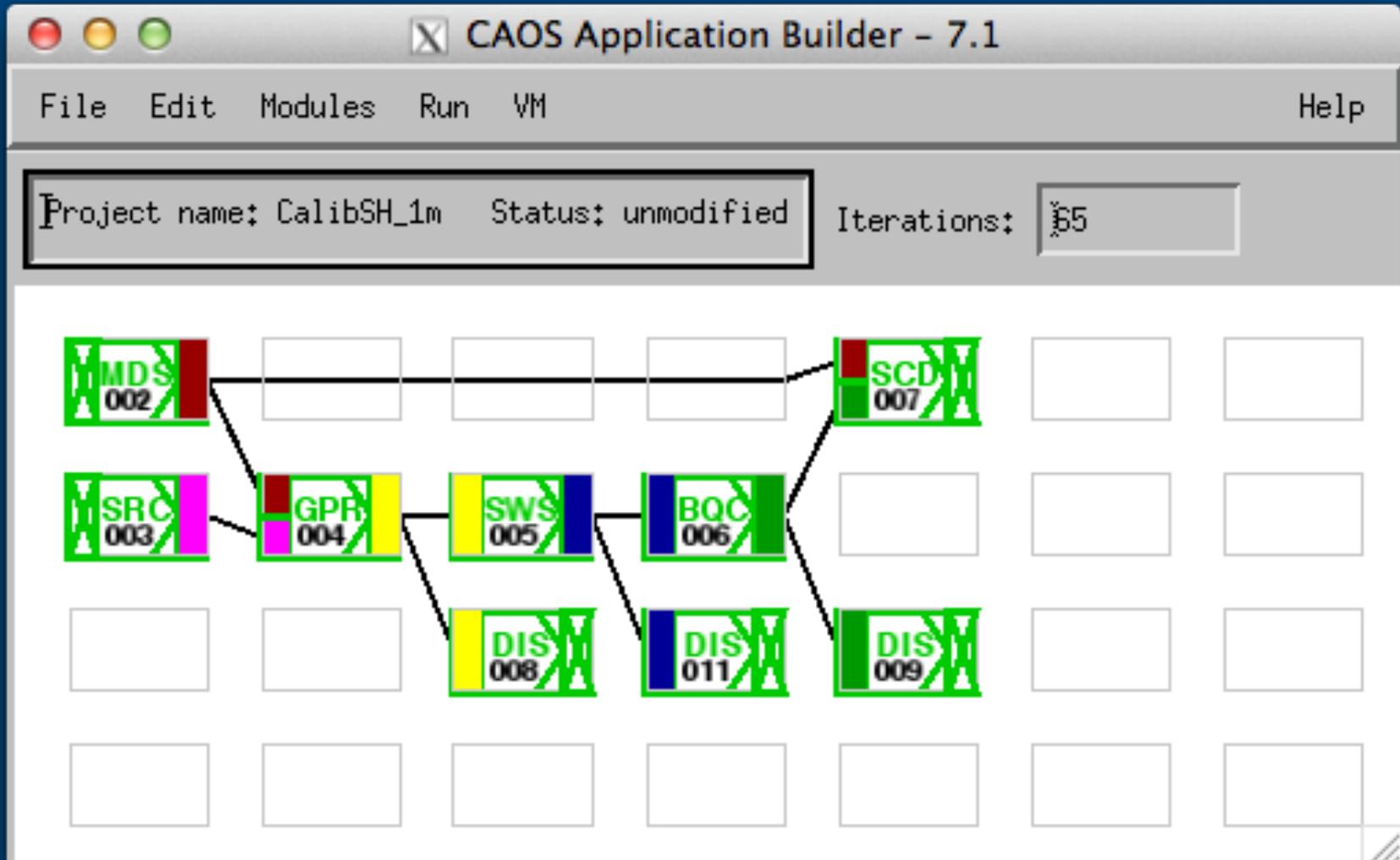
# Imaging through the turbulent atmosphere: loss of resolution !



# Imaging through the turbulent atmosphere: anisoplanatism !



# End-to-end simulation of a complete AO system: calibration



# End-to-end simulation of a complete AO system: running...

