Building a Simple Instrument Utility using ginga and astropy

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MOSFIRE

- One of Keck's most used instruments
- Uses a novel "configurable slit mask unit" (CSU)



CSU Fatal Error

- A rare but costly failure is the CSU Fatal Error
- Recovery requires reinitializing individual bars, often all 92 of them which is time consuming (up to 1.5 hours).
- Bar initialization is serial.
- Bar moves are parallel.



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Θ2

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CSU Fatal Error

- Recovery can be much faster if the SA can optimize the procedure. Move each bar to near its home switch using a fast move, then perform a slow init for that bar.
- This requires going through a decision tree for each of the 92 bars, but that is time consuming and prone to error.
- Python to the rescue!

Solution

- Need image analysis software —> python
- Need user to confirm moves are safe —> GUI
 - Inspired by "Kassis Init" software (IDL + shell scripts), but need higher reliability on image analysis and better UI for user.

Image Analysis

- Image the mask and measure the bar locations.
 - Know the relationship between pixels and bar coordinates (also a python solution)
 - Divide image up by bar. Median filter vertically.
 - Take horizontal gradient of pixel values.
 - Fit gradient to a model to determine slit edges

CSU Long Slit



CSU MOS Mask



CSU Fatal Error



Ginga



Ginga Plugin



	Dialogs	Thumbs	Contents	Errors)
		IMAGE: CSL	J_initializer		
		Image the	CSU Mask		
Acquire Mask Ir	mage				
		Analyze CSU	Mask Image		
Analyze Mask Ir	mage		Overlay Ana	lysis Resu	ults
		Edit Analys	is Results		
Set Bar Number	1				
Set Position	+137.0				
Edit Bar # 1	1			to +137.0	mm Edit Bar
		Bar Positio	ns Overlay		
From csu_bar_s	tate		From FITS	6 Header	
Clear Overlays					
	I	ndividual Bar	Initialization		
Set Bar Number	1				
Initialize Bar # 1	1		Initializ	e Bar	Open Before Init
		Individual B	ar Control		
Set Bar Number	1				
Set Destination	+0.0				
Move Bar # 1	1			to +0.0 n	nm Move Bar
Close					

• Acquire Mask Image

	Dialogs	Thumbs	Contents	Errors)
		IMAGE: CSL	J_initializer		
		Image the	CSU Mask		
Acquire Mask Ir	mage				
		Analyze CSU	Mask Image	1	
Analyze Mask Ir	mage		Overlay An	alvsis Resi	ilts
rindig 20 maoit in	linge		in Desults		
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		Bar Position	ns Overlay		
From csu_bar_s	state		From FIT	S Header	
Clear Overlays					
		Individual Bar	Initialization	1	
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Initialize Bar # 1	1		Initializ	ze Bar	Open Before Init
		Individual B	ar Control	1	
Set Bar Number	1]	
Move Bar # 1	1			to +0.0 r	mm Movo Bar
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- Acquire Mask Image
- Analyze Mask Image

Image the CSU Mask Acquire Mask Image Analyze CSU Mask Image Analyze Mask Image Overlay Analysis Results Edit Analysis Results Set Bar Number 1 Set Position +137.0 Edit Bar # 1 to +137.0 mm Edit Bar # 1 Bar Positions Overlay From csu_bar_state From csu_bar_state From csu_bar_state Individual Bar Initialization Set Bar Number 1 Initialize Bar # 1 Individual Bar Control Set Bar Number 1 Set Destination +0.0 Move Bar # 1 to +0.0 mm Move Bar # 1	Image the CSU Mask Acquire Mask Image Analyze CSU Mask Image Analyze Mask Image Overlay Analysis Results Set Bar Number 1 Set Position +137.0 Edit Analysis Results Set Position +137.0 Edit Bar # 1 to +137.0 mm Edit Bar # 1 Individual Bar Initialization Set Bar Number 1 Initialize Bar # 1 Individual Bar Control Set Bar Number 1 Set Destination +0.0 Move Bar # 1 to +0.0 mm	Dial	logs Thumbs Contents Errors
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- Acquire Mask Image
- Analyze Mask Image
- Overlay Results

IMAGE: CSU_initializer Image the CSU Mask Acquire Mask Image Analyze CSU Mask Image Analyze Mask Image Overlay Analysis Results Edit Analysis Results Edit Analysis Results Set Bar Number 1 Set Position +137.0 Edit Bar # 1 to +137.0 mm Edit Bar # 1 Individual Bar Initialization Set Bar Number 1 Individual Bar Control Set Bar Number Set Destination +0.0 Move Bar # 1 to +0.0 mm	Image the CSU Mask Acquire Mask Image Analyze CSU Mask Image Analyze Mask Image Overlay Analysis Results Edit Analysis Results Set Bar Number 1 Set Position +137.0 Edit Bar # 1 to +137.0 mm Edit Bar # 1 Bar Positions Overlay From csu_bar_state From FITS Header Clear Overlays Individual Bar Initialization Set Bar Number 1 Initialize Bar # 1 Individual Bar Control Set Bar Number 1 Set Destination +0.0 Move Bar # 1 to +0.0 mm Move Bar # 1	IMAGE: CSU_initializer Image the CSU Mask Acquire Mask Image Analyze CSU Mask Image Analyze Mask Image Overlay Analysis Results Edit Analysis Results Edit Analysis Results Set Bar Number 1 Set Position +137.0 Edit Bar # 1 to +137.0 mm Edit Bar # 1 to +137.0 mm Edit Bar # 1 To +137.0 mm Edit Bar # 1 Individual Bar Positions Overlay From csu_bar_state From FITS Header Clear Overlays Individual Bar Initialization Set Bar Number 1 Initialize Bar # 1 Initialize Bar Open Before Individual Bar Control Set Bar Number 1 Set Destination +0.0 Move Bar # 1 to +0.0 mm	Image the CSU Mask Acquire Mask Image Analyze CSU Mask Image Analyze Mask Image Analyze Mask Image Analyze CSU Mask Image Analyze Mask Image Overlay Analysis Results Edit Analysis Results Set Bar Number 1 Set Position +137.0 Edit Bar # 1 to +137.0 mm Edit Bar # 1 Bar Positions Overlay From csu_bar_state From csu_bar_state Individual Bar Initialization Set Bar Number 1 Initialize Bar Open Before Individual Bar Control Set Bar Number Set Destination +0.0 Move Bar # 1 to +0.0 mm Move Bar # 1	Dialogs	Thumbs Cor	tents Errors	
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Vorkspace Tabs 📀 MDI 🔺 븆 🔶 🔶 🕂 —		Dialogs Thumbs Contents Errors
	mage	IMAGE: CSU_initializer
2		Image the CSU Mask
	3	Acquire Mask Image
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10		Analyze CSO Mask Image
12	11	Analyze Mask Image Overlay Analysis Results
16		Edit Analysis Results
18	19 19	Set Bar Number 1
22	. 21	Set Position +137.0
24	23	Edit Bar # 1 to +137.0 mm Edit Bar
28	27	Bar Positions Overlay
30	29	From csu bar state From FITS Header
34	33	
36	35	Clear Overlays
40	39	Individual Bar Initialization
42	41	Set Bar Number 1
45	A5	Initialize Bar # 1 Initialize Bar Open Before Init
48	47	Individual Bar Control
50 52	51	Set Bar Number 1
54	53	Set Destination +0.0
28 58	57	Move Bar # 1 to +0.0 mm Move Bar
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66	65	
68 70	69 69	
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Ginga

Ginga	Dialogo Thumbo Contento Erroro
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	Image the CSU Mask
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	Analyze Mask Image Overlay Analysis Results
16 18	Edit Analysis Results
20	Set Bar Number 1
21	Set Position +137.0
26	Edit Bar # 1 to +137.0 mm Edit Bar
78	Bar Positions Overlay
30 12	From csu_bar_state From FITS Header
36 38	
	Individual Bar Initialization
42	Set Bar Number 1
46	Initialize Bar # 1 Initialize Bar Open Before Init
	Individual Bar Control
52	Set Bar Number 1
53	Set Destination +0.0
57	Move Bar # 1 to +0.0 mm Move Bar
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Image Operation CSU_initializer	Close



Ginga

Workspace Tabs

Determine pixel position of slit edges

Transform those in to physical coordinates of the CSU

Compare to controller positions

Color code based on "safety"

- Acquire Mask Image
- Analyze Mask Image
- Overlay Results

IMAGE: CSU_initializer Image the CSU Mask Acquire Mask Image Analyze CSU Mask Image Analyze Mask Image Overlay Analysis Results Edit Analysis Results Set Bar Number 1 Set Position +137.0 Edit Bar # 1 to +137.0 mm Edit Bar # 1 Bar Positions Overlay From csu_bar_state From FITS Header Clear Overlays Individual Bar Initialization Set Bar Number 1 Individual Bar Control Set Bar Number Individual Bar Control Set Bar Number 1 Set Destination +0.0 Move Bar # 1 to +0.0 mm Move Bar # 1	Dialogs	Thumbs	Contents	Errors)
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	Move Bar # 1			to +0.0 r	mm Move Ba

- Acquire Mask Image
- Analyze Mask Image
- Overlay Results
- User can edit results

IMAGE: CSU_Initializer Image the CSU Mask Acquire Mask Image Analyze CSU Mask Image Analyze Mask Image Overlay Analysis Results Edit Analysis Results Set Bar Number 1 Set Position +137.0 Edit Bar # 1 to +137.0 mm Edit Bar # 1 Bar Positions Overlay From csu_bar_state From FITS Header Clear Overlays Individual Bar Initialization Set Bar Number 1 Initialize Bar # 1 Individual Bar Control Set Bar Number 1 Set Destination +0.0 Move Bar # 1 to +0.0 mm Move Bar # 1	ts Errors
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	to +0.0 mm Move Bar

- Acquire Mask Image
- Analyze Mask Image
- Overlay Results
- User can edit results
- Or compare to others

Acquire Mask Image Analyze Mask Image Set Bar Number 1 Set Position +137.0 Edit Bar # 1	IMAGE: CSU_initializer Image the CSU Mask Analyze CSU Mask Image Overlay Analy Edit Analysis Results to	sis Results +137.0 mm Edit Bar
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	Individual Bar Initialization	
Set Bar Number 1		
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	Individual Bar Control	
Set Bar Number 1		
Set Destination +0.0		
Move Bar # 1	to	o +0.0 mm Move Ba

- Acquire Mask Image
- Analyze Mask Image
- Overlay Results
- User can edit results
- Or compare to others
- Init an individual bar

Dialogs	Thumbs	Contents	Errors
	IMAGE: CSU_	initializer	
	Image the C	SU Mask	
Acquire Mask Image			
	Analyze CSU N	lask Image	
Analyze Mask Image		Overlay An	alysis Results
	Edit Analysis	Results	
Set Bar Number 1			
Set Position +137.0			
Edit Bar # 1			to +137.0 mm Edit Bar
	Bar Positions	overlay	
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Clear Overlays			
	ndividual Bar lı	nitializatior	1
Set Bar Number 1			
Initialize Bar # 1		Initiali	ze Bar 🗌 Open Before Init
	Individual Ba	r Control	
Set Bar Number 1			
Set Destination +0.0			
Move Bar # 1			to +0.0 mm Move Bar
Close			

- Acquire Mask Image
- Analyze Mask Image
- Overlay Results
- User can edit results
- Or compare to others
- Init an individual bar
- Move an individual bar

Dialogs	Thumbs	Contents	Errors
	MAGE: CSU	initializer	
	Image the C	SU Mask	
Acquire Mask Image			
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Analyze Mask Image		Overlay Ana	alysis Results
	Edit Analysi	s Results	
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Set Position +137.0			
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Inc	dividual Bar I	nitialization	
Set Bar Number 1			
Initialize Bar # 1		Initializ	ze Bar Open Before Init
	Individual Ba	ar Control	
Set Bar Number 1			
Set Destination +0.0			
Move Bar # 1			to +0.0 mm Move Bar

- Acquire Mask Image
- Analyze Mask Image
- Overlay Results
- User can edit results
- Or compare to others
- Init an individual bar
- Move an individual bar

As final step, software will generate and run a sequence of parallel move and serial init commands for each bar which are both safe and optimized to recover in the minimum time.

	Dialogs	Thumbs	Contents	Errors)
	- (IMAGE: CSU	J_initializer		
		Image the	CSU Mask		
Acquire Mask In	nage				
	ł	Analyze CSU	Mask Image		
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From csu_bar_s	tate		From FIT	S Header	
Clear Overlays					
	li	ndividual Bar	Initialization	1	
Set Bar Number	1				
Initialize Bar # 1			Initializ	ze Bar	Open Before Init
		Individual E	Bar Control		
Set Bar Number 1	I]	
Set Destination +	0.0				
Move Bar # 1				to +0.0 r	mm Move Ber

```
141 🔻
               ##
               ## Analyze Image¬
142
              ## _____
143 -
              fr = Widgets.Frame("Analyze CSU Mask Image") -
144
               vbox.add_widget(fr, stretch=0)-
145
146
147
               btns2 = Widgets.HBox()-
               btns2.set_spacing(3)¬
148
149
       -
150
               btn_analyze = Widgets.Button("Analyze Mask Image") -
               btn_analyze.add_callback('activated', -
151
                                       lambda w: self.analyze_mask_image())¬
152
               btns2.add_widget(btn_analyze, stretch=0) ¬
153
               btns2.add_widget(Widgets.Label(''), stretch=1)-
154
155
               btn_overlay = Widgets.Button("Overlay Analysis Results")-
156
               btn_overlay.add_callback('activated', --
157
                                       lambda w: self.overlay_analysis_results())¬
158
               btns2.add_widget(btn_overlay, stretch=0)¬
159
               btns2.add_widget(Widgets.Label(''), stretch=1)-
160
161
               vbox.add_widget(btns2, stretch=0)-
162
```

The Power of Python

- We will control the instrument using a python interface to Keck KTL keywords (see Kyle Lanclos' talk tomorrow) or by calling existing instrument scripts via subprocess module.
- While also getting powerful analysis tools:
 - numpy (dot, linalg.lstsq, gradient)
 - astropy.modeling

The Power of Python

- Two non-programmers (SA and OA) made GUI with no previous GUI programming experience.
 - Eric's ginga-plugins template was very useful. Lots of copy and pasting of code!
- As a plugin, we get all ginga features for free: image display, stretch, cut, zoom, WCS, etc.
- This is a work in progress.