

MONSOON/Torrent Software

Adding automation to detector controller configuration and startup

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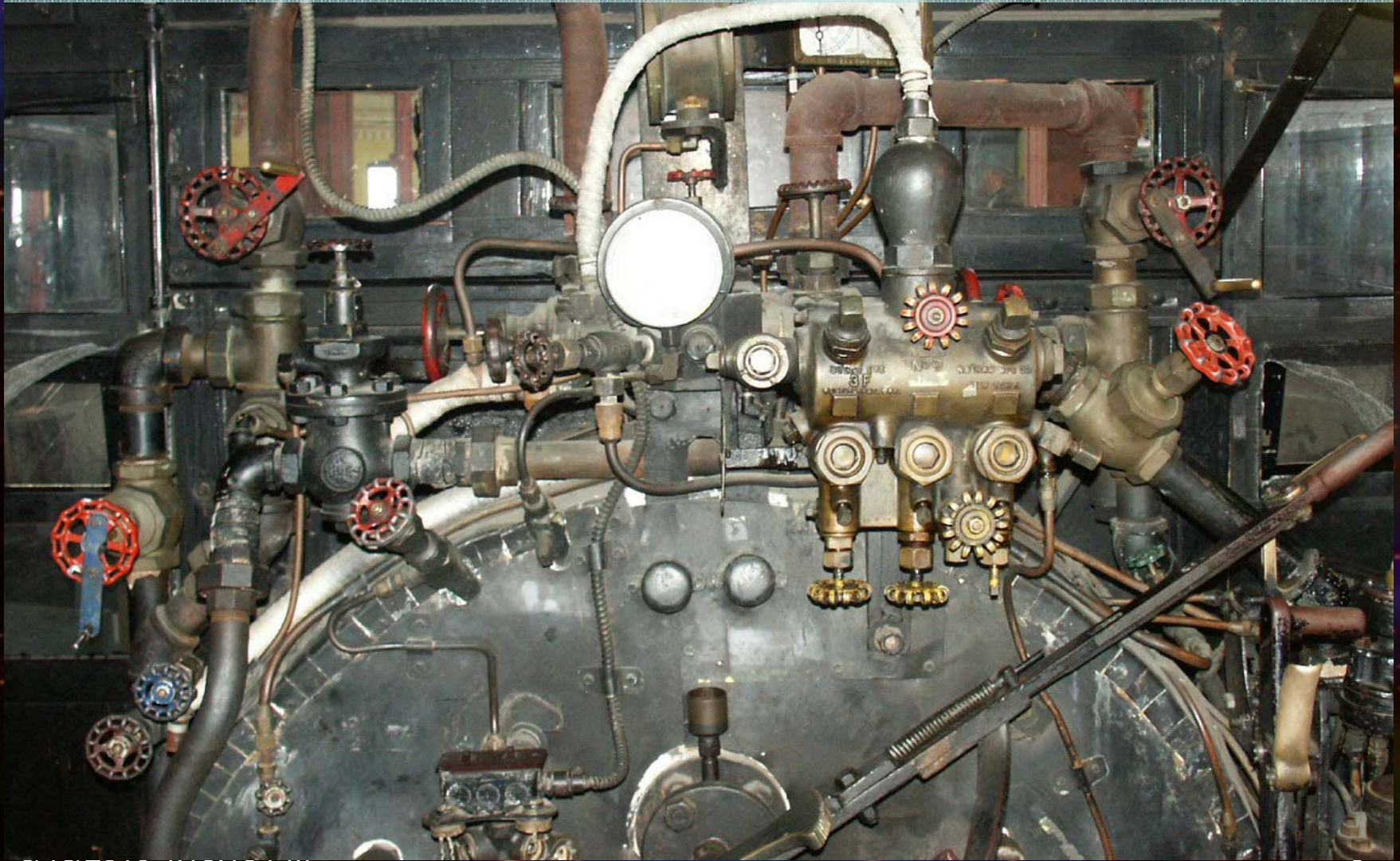
Where are we now

Baseline Information

- Torrent Systems are being run with “orange” software now. We could continue to configure Torrent systems by hand.
- **None** of the software being presented here is **required** to run Torrent hardware.
- This software will make Torrent systems safer, easier to use and simpler to configure, maintain and document.

Torrent Software Goals

to move from “orange” Configuration Tools like this:



To Torrent Configuration tools more like this:



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TORRENT Production Readiness Review

4

Torrent Software Goals

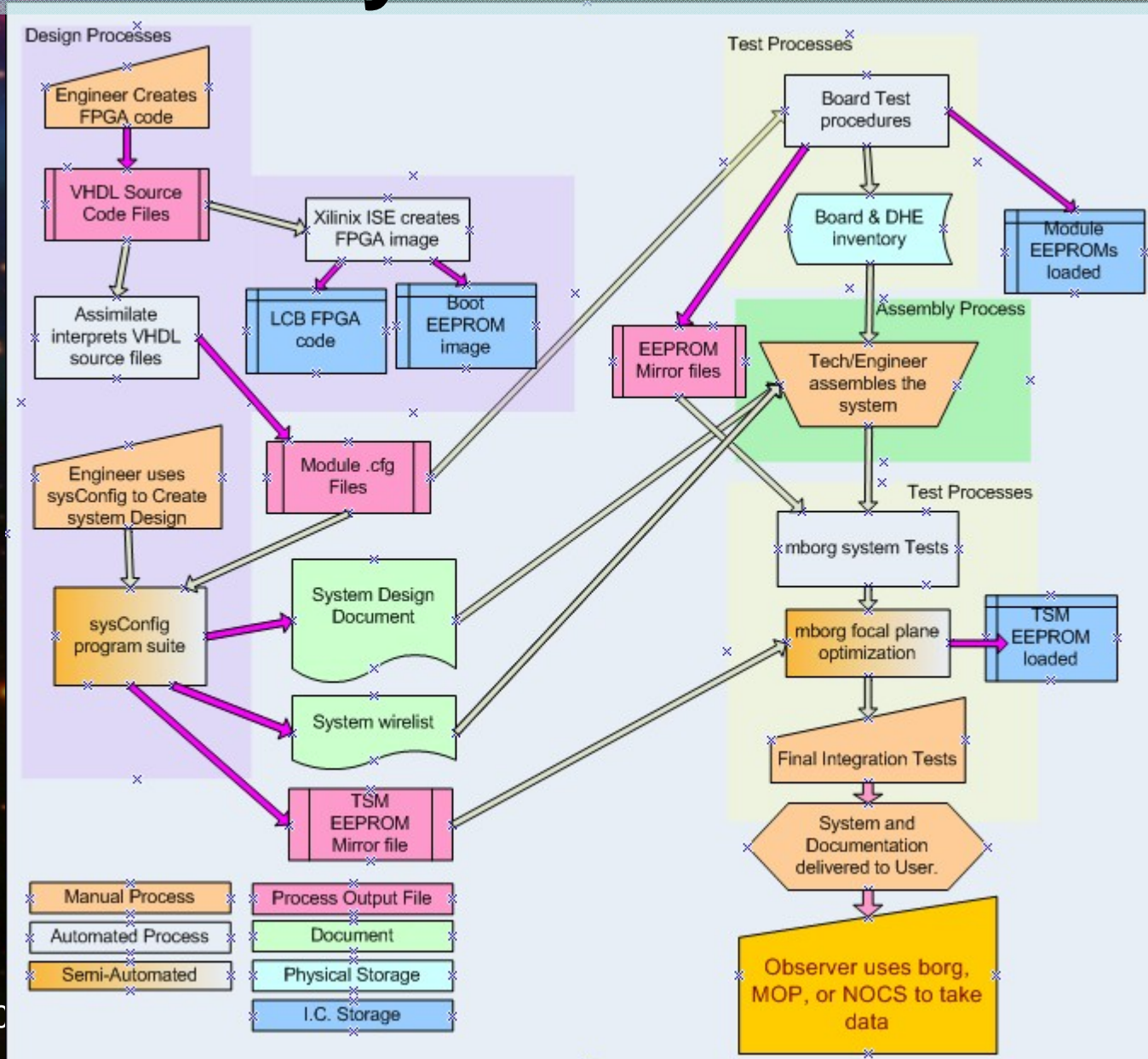
1. Support the hardware in providing detector limited performance for image acquisition.
2. Use the same PAN & User software as MONSOON “orange” systems.
3. Minimize image acquisition process overheads.
4. Store the board calibration values in the DHE not on external media.
5. Store the focal plane attribute default values with the Dewar not on external media.
6. Automate the configuration, testing, calibration & optimization of Torrent focal planes.

Torrent software Goals (cont)

7. To provide tools to:

- Automate the description of the hardware/firmware attributes/registers/functions and the connection of the user attribute-value pairs to the hardware functions.
- Automate the design & specification of Torrent controller configurations and documentation of Torrent controller configurations.
- Automate the startup & initialization of the MONSOON software when used with Torrent systems.

Torrent System Process Flow



Achieving the Goals

1. **Support detector limited observing**
 - Readout speed determined by the science.
 - Detector clock and bias voltage can be changed at readout clock speeds (subject to electrical filter settling).
 - Readout sequences and exposure time can overlap data transfer to DHS.
 - Detector library can be custom designed to support complex operations required by detector or science

Achieving the Goals (cont)

2. Use the same software as the “orange” MONSOON

- Pan processes and libraries used essentially unchanged. Two new gpx/ppx commands added to support hardware EEPROMs in Torrent.
- Currently running (E2V 4482) prototype systems, review CCD and basic CCD systems with the modified “orange” software.

Achieving the Goals (cont)

3. Minimize image acquisition overheads.

- Can allow overlap of instrument configuration and Integration time with the data transfer to DHS.
- Setup times for complete change in observation parameters less than 2 secs. startExp command to integration start on order .25 secs.
- Data transfer DHE to PAN 1.25 secs for 4kx4k detector (32bit Pixels @ 50MBytes/sec) with no allowance for ADC and clocking delays. Total readout time for 4 output 4kx4k detector @ 150 kPix/sec <25 secs.

Achieving the Goals (cont)

4. Store the board calibration values in the DHE not on external media. !

- EEPROMs on AFE, LCB and PSM boards are loaded with calibration values during board testing.
- Torrent program “*collector*” reads configuration files and EEPROMs and constructs the system ‘.csv’ file from this data.
- Faulty EEPROM values caught through CRC check on entire EEPROM. Additional error checking/correction could be added if deemed necessary.
- Allows swapping out a failed DHE controller and achieving identical performance from the new DHE controller.

Achieving the Goals (cont)

5. Store the attribute default values with the Dewar not on external media. !

- EEPROM on Transition module utility board is loaded with operating values during detector optimization
- “*collector*” reads TSM configuration file and EEPROM and constructs a DefaultSetup.mod file and a system SetVoltages.mod file
- Faulty EEPROM values caught through CRC check on entire EEPROM. Correct values can be obtained from a database if EEPROM not available.

Achieving the Goals (cont)

6. Automate the configuration, testing, calibration and optimization of Torrent systems. !

- Provide “`sysConfig`” tools to the system or detector engineer/scientist.
- Provide `mborg` test and focal plane optimization routines to do testing and calibration of boards and detector optimization.
- Keep track of , document configuration decisions and test & optimization results automatically.

7. Providing Automation Tools

- Automate the description of the hardware & firmware attributes, registers, functions.
 - “*assimilate*” an OO python program to read the VHDL source code files and produce system configuration files.
 - Assigns attributes to locations in module EEPROM memory space as needed.
 - Produces a template Config.csv file for testing.
 - Needs to be run once for each version of the FPGA firmware.

Torrent Automated Configuration Processes

assimilate

ISE .prj Proj
(list of source
used in FPG

Torrent_SFTW.vhd

to
tor
to
tor
to
tor
tor
tor
tor
tor

The .cfg re
the DHE a
DHE EEPROM
all systems

Reading .vhd files form Version 1.00.

```

r100.vhd
Reading vhd1 File /MNSN/engr_Development/Torrent/Xilinx/SystemBuilds/TorrentFpga_Ver118/DebugMux_Ve
r114.vhd
Error: could not open VHDL file Torrent_SFTW.vhd in Dir /MNSN/engr_Development/Torrent/Xilinx/SystemBuilds/ for reading ! Co
ntinuing
Reading software vhd1 comment File Torrent_SFTW.vhd
    
```

Status:

Step 1. Select project root directory name. /MNSN/engr_Development/Torrent/Xilinx/SystemBuilds/TorrentFpga_Ver118

Step 2. Select project system file name. TorrentFpga_Ver118.prj

Step 3. Select focal plane config directory name. /MNSN/soft_dev/cfg/_testhdwr

Step 4. Select sftwr attribute file name. /MNSN/soft_dev/cfg/Torrent_SFTW.vhd

Step 4. Done Read .prj or vhd1 File

Step 6. Done Build Hdw Desc

Step 7. Done Process Software file

Step 8. Write Cfg Files

Turn off display

VHDL File Name	lLine #l	Text of the comment line in the file
PSM_RegisterControl_V104.vhd	490	#MD:PSM:0x02: --This is the Wishbone module select address of the PSM Control Module.
PSM_RegisterControl_V104.vhd	492	PsmCodeId: NONE: 1: 1: A: PSM:0xFFFF: 0: 16: NONE: SMPL:CNST:16:1.04:Version:Firm
PSM_RegisterControl_V104.vhd	495	PsmModuleId: NONE: 1: 1: A: PSM:0xFFFFE: 0: 16: NONE: SMPL:CNST:16:202.0:Ident:Firm
PSM_RegisterControl_V104.vhd	496	PsmResetCnd: NONE: 1: 1: A: PSM:0xFFFFE: 0: 0: SMPL: NONE:CHND:16::ResetCnd:Trigge
PSM_RegisterControl_V104.vhd	499	PsmModInStatus: NONE: 1: 1: A: PSM:0xFFFFD: 0: 32: NONE: SMPL:NONE:16:0:Boolean:Status
PSM_RegisterControl_V104.vhd	502	PsmModOutStatus: NONE: 1: 1: A: PSM:0xFFFFC: 0: 8: NONE: SMPL:NONE:16:0:Boolean:Status
PSM_RegisterControl_V104.vhd	506	FpgaTemp: NONE: 1: 1: A: PSM:0x0000: 0: 10: NONE: SMPL:NONE:21:0:Deg C:Current c
PSM_RegisterControl_V104.vhd	509	FpgaVccInt: NONE: 1: 1: A: PSM:0x0001: 0: 10: NONE: SMPL:NONE:21:0:Volts:Current c
PSM_RegisterControl_V104.vhd	512	FpgaVccAux: NONE: 1: 1: A: PSM:0x0002: 0: 10: NONE: SMPL:NONE:21:0:Volts:Current a
PSM_RegisterControl_V104.vhd	515	FpgaVRefP: NONE: 1: 1: A: PSM:0x0003: 0: 10: NONE: SMPL:NONE:21:0:Volts:Telenetr
PSM_RegisterControl_V104.vhd	518	FpgaVRefN: NONE: 1: 1: A: PSM:0x0004: 0: 10: NONE: SMPL:NONE:21:0:Volts:Telenetr
PSM_RegisterControl_V104.vhd	521	FpgaTempMax: NONE: 1: 1: A: PSM:0x0005: 0: 10: NONE: SMPL:NONE:21:0:Deg C:Maximum c
PSM_RegisterControl_V104.vhd	524	FpgaVccIntMax: NONE: 1: 1: A: PSM:0x0006: 0: 10: NONE: SMPL:NONE:21:0:Volts:Maximum c
PSM_RegisterControl_V104.vhd	527	FpgaVccAuxMax: NONE: 1: 1: A: PSM:0x0007: 0: 10: NONE: SMPL:NONE:21:0:Volts:Maximum c

Step 8. Select csvFile Directory Name /MNSN/soft_dev/cfg/_testhdwr

Step 9. Select csv File Name testhdwr_ConfigInplt.csv

Write csv File

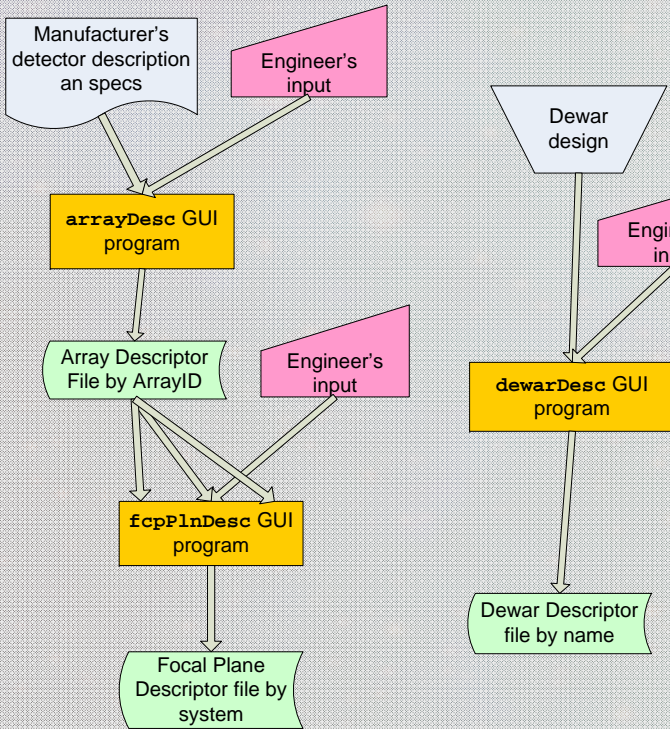
Write csv File and Exit

Exit (No Save)

7. Providing Automation Tools

- Automate the design & specification of Torrent controller configurations.
 - “*sysConfig*” tools – *arrayDesc*, *fclPlnDesc*, *dewarDesc*, *dheDesc* and *sysConfig*
 - Run once while designing a focal plane system. Produces “System Configuration Document”.
 - Run again if something is changed, i.e. a new array is installed, a new firmware version is released.
 - Can be used to track and document changes to default value settings.
 - Can create modified GUI display for borg & mborg.

Torrent System Design and Configuration sysConfig and its anc



Describing the generic Array --- (using Pmw 1.3)

Status: Starting logging: Wednesday 20100707.1422:18 -

Default Directory /MNSN/soft_dev/cfg/_detectors

Array Description file name

Read Description File

Write Array Description file

Desg	Signal Name
A1	SUB
A8	SUB
C1	SUB
C8	SUB
F2	SUB
F7	SUB
D8	P1
E8	P2
F8	P3
D4	S1_L
E4	S2_L
D5	S1_R
E5	S2_R
F6	S3
E2	SW_L
E7	SW_R
E3	RG_L
E6	RG_R

Edit Pin Values

Save & Exit

Describing the RSpecDwr Dewar --- (using Pmw 1.3)

Status: Error: dewar couldn't read file >/MNSN/soft_dev/cfg/_dewars/RSpecDwr_Dewar.dsc< No Name??

Default Directory /MNSN/soft_dev/cfg/_dewars

Dewar Description file name RSpecDwr_Dewar.dsc

Read Dewar Description File

Write Dewar Description file

Dewar Name RSpecDwr # of Cnctrs 4

Cnctr1 JP1 Cnctr2 JP2 Cnctr3 JP3 Cnctr4 JP4

Describing the generic2AFE Dhe --- (using Pmw 1.3)

Status: OK: Done with detHdElctn AFE2Video
OK: Done with detHdElctn Utility
OK: Done with detHdElctn J1Util

Default Directory /MNSN/soft_dev/cfg/_common

DHE Description file name generic2AFE_trntDHE.dsc

Read DHE Description File

Write DHE Description file

System Name generic2AFE

Voltagess Boards

Cnctr1 AFE1Biases Cnctr2 AFE1Clks Cnctr3 AFE1Video Cnctr4 AFE2Biases
Cnctr5 AFE2Clks Cnctr6 AFE2Video Cnctr7 Utility Cnctr8 J1Util

AFE1Biases AFE1Clks AFE1Video AFE2Biases AFE2Clks AFE2Video Utility J1Util

Cnctr Type Misc # of Pins 20

Pin Descriptions

Desg	Signal Name	Sgnl Type	Minimum	Maximum	Nominal	Warning	Alarm	F
HVR0	HVBiasRtn0	AGND	0.0	0.0	0.0	0.08	0.16	
HVB0	HVBias00	BIAS	-5.0	30.0	0.0	0.08	0.16	
HVB1	HVBias01	BIAS	-5.0	30.0	0.0	0.08	0.16	
HVB2	HVBias02	BIAS	-5.0	30.0	0.0	0.08	0.16	
HVB3	HVBias03	BIAS	-5.0	30.0	0.0	0.08	0.16	
HVB4	HVBias04	BIAS	-5.0	30.0	0.0	0.08	0.16	
HVB5	HVBias05	BIAS	-5.0	30.0	0.0	0.08	0.16	
HVB6	HVBias06	BIAS	-5.0	30.0	0.0	0.08	0.16	
HVB7	HVBias07	BIAS	-5.0	30.0	0.0	0.08	0.16	
HR10	HVBiasRtn1	AGND	0.0	0.0	0.0	0.08	0.16	
LVR0	LVBiasRtn0	AGND	0.0	0.0	0.0	0.08	0.16	
LVB0	LVBias00	BIAS	-18.0	18.0	0.0	0.08	0.16	
LVB1	LVBias01	BIAS	-18.0	18.0	0.0	0.08	0.16	
LVB2	LVBias02	BIAS	-18.0	18.0	0.0	0.08	0.16	
LVB3	LVBias03	BIAS	-18.0	18.0	0.0	0.08	0.16	
LVB4	LVBias04	BIAS	-18.0	18.0	0.0	0.08	0.16	

Edit Pin Values Copy Pin Paste Pin Copy Connector Paste Connector

Save & Exit Exit (No save)

sysConfig Tools

These tools are used to define, document and track:

- arrayDesc – Gui based tool to describe an detector.
Signal Names and Signal types for pins by designation. Signal nominal, min and max safe values.
- fcIPInDesc - Gui based tool to describe a focal plane.
Number, type, unique Identifier and position in focal plane for each detector in focal plane. Connection points for focal plane functions, temperature Sensors, heaters, etc.
- dewarDesc – Gui tool to describe a Dewar.
Number and type of Connectors. Number of Pins in each connector. Name of each connector and pin.
- dheDesc - Gui tool to describe a DHE.
Number, type and serial number of boards. Voltage settings for vHv+, vHv-, vCb+,vCb-, vAna+, vAna-, vBb for system. Names of connections for AFE signals and TSM utility board signals.

Torrent System

Configuring the reviewCCD System (using Pmw 1.3)

Status: OK: Done with detHdElctn Utility
OK: Done with detHdElctn J1Util

Default configuration Directory: /MNSN/soft_dev/cfg/_reviewCCD

Config Description file name: reviewCCD_System.dsc

Edit System Info **Read system config File** **Write system config file**

Focalplane Name: review2CCD Dewar Name: mosTest Torrent DHE Name: generic2AF1

Array Type	Mosaic Cols	Mosaic Rows	# of Arrays
e2vEng	2	1	2

Dewar Name: mosTest # of Cnctrs: 4

J1	J2	J3	J4
Cnctr Type: MilCirc			
# of Pins: 10			

Voltages **Boards**

FE1Bias FE1Clk FE1Vide FE2Bias FE2Clk FE2Vide J1Util J1Util

Cnctr Type: Misc # of Pins: 20

Pin Descriptions

Desg	Signal Name	Sgnl Type	Minimum	Maximum	D
HVR0	afe1HVBiasRtnC	AGND	0.0	0.0	
HVB0	afe1HVBias00	BIAS	-5.0	30.0	
HVB1	afe1HVBias01	BIAS	-5.0	30.0	
HVB2	afe1HVBias02	BIAS	-5.0	30.0	
HVB3	afe1HVBias03	BIAS	-5.0	30.0	
HVB4	afe1HVBias04	BIAS	-5.0	30.0	
HVB5	afe1HVBias05	BIAS	-5.0	30.0	
HVB6	afe1HVBias06	BIAS	-5.0	30.0	
HVB7	afe1HVBias07	BIAS	-5.0	30.0	

Dewar Functions **Array1** **Array2**

Cnctr Type: Misc # of Pins: 20

Pin Descriptions

Desg	Signal Name	Sgnl Type	Nominal	...
1	TS1_i+	TEMP	0.0	
2	TS1_v+	TEMP	0.0	
3	TS1_i-	TEMP	0.0	
4	TS1_v-	TEMP	0.0	
5	None	NDNE	0.0	
6	TS2_i+	TEMP	0.0	
7	TS2_v+	TEMP	0.0	
8	TS2_i-	TEMP	0.0	
9	TS2_v-	TEMP	0.0	

Pin Designation

Pin Designation
A
B
C
D
E
F
G
H
J

Current Pin List:

ArrayName*PinDesg, ... DewarConnector*PinDesg, ... DHEConnector*PinDesg, ...

```

ccd1:A1=>J3:H=>AFE1Video:VID2
ccd1:A2=>J3:J=>AFE1Video:VID1
ccd1:A7=>J3:K=>AFE1Video:VID3
ccd1:A8=>J3:L=>AFE1Video:VID4
ccd1:B1=>J3:M=>AFE1Biases:HVB0
ccd1:B2=>J3:h=>AFE1Biases:HVB3
ccd1:B7=>J3:e=>AFE1Biases:HVB3
    
```

Clear Selection

Do Connect **Delete Connect**

Sort by Array Pin Sort by Dewar Pin Sort by DHE Pin

Set Default Values

Write Files **Print Reports**

Load TSM EEPROM **Save & Exit** **Exit (No save)**

- System Description File
- Torrent_TSM.cfg file
- System_SFT file
- User Def

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Pulling it all together

- “*sysConfig*” – a GUI engineer’s assistant. !
The engineer:
 - Selects the Focal plane, Dewar and DHE for system.
 - Connects the focal plane signals to Dewar connectors and then to DHE signals.
 - Selects default settings for focal plane attributes.
 - Prints a wire list for the ‘tech’ assembling the system.
 - Prints and stores the System documentation records.
 - Prints and stores a attribute default values Document.
 - Stores an TSM EEPROM mirror file
 - Creates a ucode sequencer source code template.
 - Can creates a GUI display file for borg or mborg

7. Providing Automation Tools

- Automate the connection of the user attribute-value pairs to the hardware descriptions.
 - “*sysConfig*” creates a system software.cfg file that is used by *collector* to assign user names to the hardware attributes.
 - “*sysConfig*” creates a system ucode Template to connect the signals to bits in the ucode.
 - “*sysConfig*” creates a system defaults file relating user attribute names to default values.
 - “*sysConfig*” creates a system “.ini” file to handle startup issues
- At this point there is sufficient information to start a system for checkout.

7. Providing Automation Tools

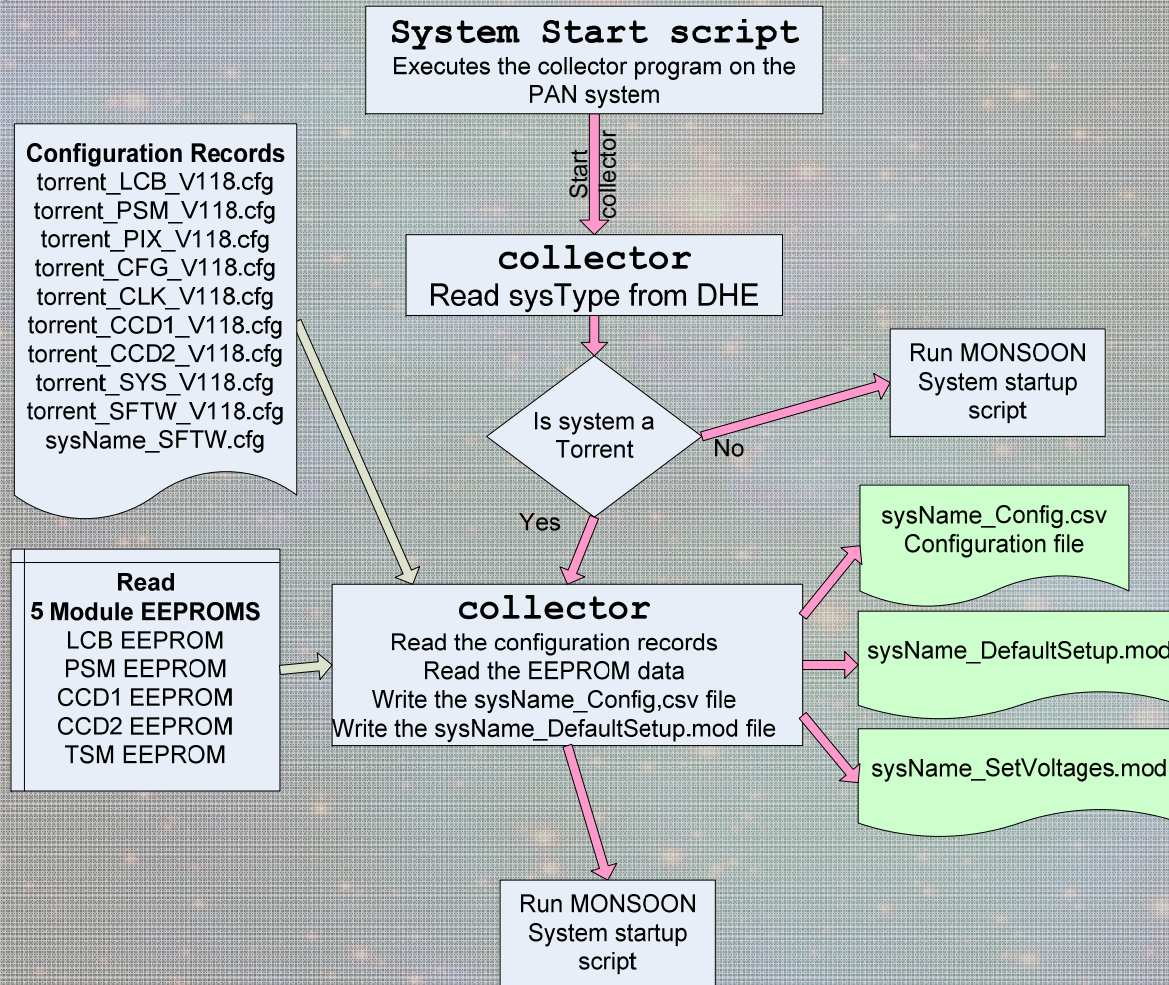
- Automate the documentation of Torrent controller configurations.
 - “*sysConfig*” tracks and stores the system configuration document.
 - “*sysConfig*” allows printing a formatted document for the system documentation package.
 - “*sysConfig*” allows the user to modify the configuration if a detector or board is changed out.

7. Providing Automation Tools

- Automate the startup & initialization of the PAN software when used with Torrent systems. !
 - “*collector*” – run before the standard MONSOON startup script for the system.
 - Reads the FPGA .cfg files,
 - Reads the EEPROMs in the DHE
 - And Creates
 - a sysName_Config.csv file,
 - a sysName_DefaultSetup.mod and
 - a sysName_SetVoltages.mod file from the EEPROM data.
 - Starts the Execution of the standard MONSOON startup script for the system.

Torrent Automated Configuration Processes

collector - System Startup



borg and mborg GUI

The BORG is running an OUV system (testhdwr) on fire-a using localFITS DHS

Buttons: Stop Logging, Display Log, Exit System, About

```

OK: ppxAsyncResp: Success. \
OK: ppxSetAVP: Success. \ modeFdir set to >/Monsoon/cfg/
OK: ppxSetAVP: Success. \ modeFname set to >testhdwr.ini
OK: ppxSetMode: Success. \ File /Monsoon/cfg/_testhdwr/te
OK: ppxSetMode: Success. \ File /usr/Monsoon/cfg/_testhdw
OK: ppxSetMemCfg: Success \ Downloaded File /usr/Monsoo
OK: ppxSetAVP: Success. \ mcbSeqEnable set to 0.000<0>
OK: ppxSetAVP: Success. \ intTime set to 0.000<0>
asyncMsg: OK: Board ID check Passed. \ @ 20100623:0906
    
```

Help:

Control Panels: DHE Control, Focalplane Ctrl, Sequencer Dis

Buttons: Connect & Initialize, Conn

Exposure Parameters

Image Directory:

Image File:

Image Count:

Integration Time:

Exposure Type: ZERO, DARK, OBJECT, FLAT, FOCUS

Number of exposures:

Exposure Sequence Control: Start, Pause, Resume

Disconnect from Pan and Exit Borg

Exposure Variables Attribute Display

intTime (Secs)	0.000	actIntTime (mSec)	100,000
rowBin (Rows)	1,000	colBin (Pixels)	1,000
imageDir (Directory)	/data		
imageFile (Filename)	testHsim		
imageCount (Count)	0,000	expID (FloatID)	0
numOutputs (count)	4,000	outputCfg (ConfigID)	0,000
expVector (INT)	1,000	1 is Normal Exposure; 8/16 is Focus Sequence	
shutterEnable (BOOL)	0x00000001	shutterOpenCmd (BOOL)	0x00000000
shutterStatus (BOOL)	0x00000002		

PSM_Control Attribute Display

psmResetCmd (ResetCmd)	----		
psmCodeId (Version)	1,060	psmModuleID (Ident)	202,000
psmModInStatus (BOOL)	0x06000100	psmModOutStatus (BOOL)	0x00000000
PwrSupplyStatus (BOOL)	0x00000000	pwrUpPrimarySupplies (BOOL)	0x00000000
vanaPowerEnable (BOOL)	0x00000001	vcbPowerEnable (BOOL)	0x00000000
psmTemperature1 (Deg C)	0,000	psmTemperature2 (Deg C)	0,000
PowerSyncEnable (BOOL)	0x00000001	PowerSyncRate (Value)	207,000
vana+ServoEnable (BOOL)	0x00000001	vana+SetPoint (Volts)	128,000
vana-ServoEnable (BOOL)	0x00000001	vana-ServoPwmValue (%)	50,394
vcb+ServoEnable (BOOL)	0x00000001	vcb+SetPoint (Volts)	288,000
vcb-ServoEnable (BOOL)	0x00000001	vcb-ServoPwmValue (%)	50,394

Buttons: Close, Update, Apply Changes, Save Changes, Save All

Mborg Optimization Tools

- pteTest – a test to determine the serial and parallel photon transfer efficiency for a CCD. !
- noiseTest - a test to determine the system noise for a CCD or IR system. !
- features - a test to determine the location and extent of “hot” and “bad” pixels, rows, columns. !
- optimize – a series of sequences to ease the task of optimizing a focal plane or detector TBD !
- eepEdit –this tool allows the engineer to write the optimization voltage values to the TSM EEPROM and/or edit the EEPROM values by hand !
 - Done after engineer is satisfied with optimization results
 - Hand editing is “possible but not recommended.”

Mborg Diagnostic tools

- Provide software to automate the diagnostic testing of Torrent Boards at the Telescope.
 - *lcbTest* – tests the functionality of an LCB board !
 - *afeTest* – tests the functionality of each AFE !
 - *recalibrate* will run a calibration test on the clock rails, high and low voltage biases
 - *preAmpTest* – tests the functionality of a transition module preAmp board. !
 - *utilTest* - tests the functionality of a transition module utility board !
 - *psmTest* – tests the functionality of the PSM !

Runtime Failure Mode Analysis

- “*collector*” cannot connect to DHE !
 - System in [SIM] mode.
 - Informs user and suggests corrective actions.
 - Sends report to responsible maintenance tech/engineer.
- “*collector*” detects a “not Torrent” DHE !
 - Executes the normal MONSOON startup script for the system and exits.
- “*collector*” detects a “bad” EEPROM on LCB, PSM or AFE !
 - Collector checks that power supply voltages are in range.
 - Checks for an existing set of “.ini”, “.csv” and “.mod” files.
 - Request that the user contact maintenance.
 - Asks maintenance for permission to use the existing files.
 - If answer is “YES” execute the normal startup script and exit.
 - If answer is “NO” exit.
 - Sends report to responsible maintenance tech/engineer.

Runtime Failure Mode Analysis (cont)

- “*collector*” detects a “bad” EEPROM on TSM !
 - Request user to contact maintenance.
 - Asks maintenance if correct system is connected.
 - If a previous sysName_setVoltages.mod file exist.
 - Yes; Asks for maintenance permission to startup using previous file.
 - If No exits without starting system
 - Sends report to responsible maintenance tech/engineer.
- PAN processes fail to connect to DHE
 - PAN goes into [SIM] mode
 - “client’ software informs user of problem and suggests corrective action.
 - Suggest user contact maintenance.
- PAN processes connect & get errors during operations
 - “client’ software informs user of problem and suggests corrective action.
 - Suggest user contact maintenance.

Runtime Failure Mode Analysis (cont)

- ❖ A “client” system (borg, NOCS, MOP) finds voltages have been incorrectly set before detector powerOn sequence.
 - During Initialization “client” Informs user of failure.
 - Requests that the user contact maintenance.
 - Sends report to responsible maintenance tech/engineer
- ❖ A “client” system finds some voltages have been incorrectly set after detector powerOn sequence. !
 - During Initialization “client”
 - executes detector powerOff sequence.
 - Informs user of failure.
 - Requests that the user contact maintenance.
 - During normal operations “client”.
 - Postpones start Exposure command
 - Informs user of failure. Asks if user wishes to continue.
 - In user “client” programs that can use it the ‘alarm’ level will execute a detector powerOff sequence
 - Requests that user contact maintenance.
 - Sends report to responsible maintenance tech/engineer.

Conclusion

- Questions?
- Answers!
 - 42
 - NCC-1701-E
 - The Dumbbell Nebula
 - It's a hardware problem