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Analysis of the Impact of an Incomplete Simulator on DR Software Development

1 Introduction

This document discusses the DR software requirements and attempts to make assessments of the impact on the project of missing features in the simulator. Only those software requirements which are affected by the simulator are discussed as not all of the requirements depend on the simulator.

2 Role of the simulator in pipeline development

As the SCUBA-2 data reduction (DR) software project has progressed it has become clear that the simulator² is vital to its success. Furthermore the CDR panel identified the simulator to be a very high priority item necessary for successful completion of the project, and that the DR project should ensure that the simulator does not impede future development. Naturally, there must be a way of verifying that the DR software meets the project requirements.³

Currently, however, the simulator does not implement 100% of the features necessary to fully test the pipeline software. Some of these are arguably beyond the scope of the simulator and can be added through automation tasks (scripting). Other features are necessary for the data acquisition (DA) system, and are therefore vital.

Recently it has been agreed that the DR project implements features it deems necessary for fully testing the pipeline, while the DA software team concentrates on developing the routines necessary for writing the data to disk in the ICD-compliant format.¹

3 Impact assessment

The tables in the following sections show that the simulator requirements are split into two categories:

1. Those that absolutely must have specific features in the simulator

2. Those that only require simulated data of some sort

The impact on the pipeline development of each missing feature is rated on a six point scale:

- NONE - no impact
- POTENTIAL - a small impact, unlikely to affect PL testing
- MINOR - small impact, won't affect most aspects of PL testing
- MAJOR - definite impact, will prevent progress in certain areas but does not significantly affect the pipeline as a whole
- SEVERE - serious impact, will significantly delay progress
- FATAL - most serious, PL development unable to progress

A number of items require the full FITS headers and fully-populated RTS/TCS arrays to be present in the data. Although it is possible to work around this lack of header information, the large number of items which depend on the headers means that it is a more important requirement than might be inferred from the MINOR status.

Anything which requires SCAN data for testing the pipeline will need those data to have realistic sky coordinates. All of these items are rated SEVERE or FATAL since without realistic data, we are unable to test the pipeline properly.

In the Notes column, TBA means 'To Be Added'.

3.1 General requirements

Req	Description	Simulator requirement	Notes	Impact on PL
GR11	5/10% relative calibration precision	Realistic atmosphere, SCAN data	Probably OK	MINOR: can be (partially) tested now
GR12	Procedure to correct for calibration drifts	Simulate instrumental drifts	Needs more instrument data	SEVERE: Unable to test PL requirement
GR15	Data format	Data in ICD-compliant format	Need full FITS headers	MINOR: Unable to make full use of PL, time wasted rewriting primitives
GR16	File size <2 GB	Write data before file size exceeds 1 GB		POTENTIAL: could affect scanning strategies
GR19	Rel cal precision again	See GR13	See GR13	MINOR

3.2 Observing mode requirements

Req	Description	Simulator requirement	Notes	Impact on PL
MR2	OFFLINE: re-reduce DREAM/STARE 200 Hz	ICD-compliant data	Need full FITS headers	MINOR: Unable to make full use of ORAC-DR
MR3	Fast, efficient scan reduction method	Easy implementa- tion of scan meth- ods	OK/ongoing	MINOR: mostly met with current simulator
MR4	Not degrade resolution	SCAN data, inc realistic telescope movement	Does not need re- alistic beam	SEVERE: must have full pointing data in SCAN data, but recon- struction with no pointing er- rors will provide some measure of meeting this requirement
MR5	No unrecover- able astrom- etry errors >8"	SCAN data, inc realistic telescope movement		SEVERE: see MR4
MR6	Reproducible results	Obs same source with different obs modes, different atmos conditions		MINOR: for at- mosphere and observing modes are implemented; SEVERE for SKY coordinates not implemented

3.3 Pipeline requirements

Req	Description	Simulator requirement	Notes	Impact on PL
PR3	Engineering recipes	Setup and calibration procedures		MAJOR: Unable to test requirement, however will not impact majority of PL
PR6	Automatic calibration	Data inc realistic atmosphere	SCUBA2 calibration not like SCUBA	MAJOR (possibly)
PR9	Noise estimate from detector variances	ICD-comp 200 Hz data		NONE: already implemented
PR12	Recipes to make basic data quality assessment	Errors in data	Need more instrument info	SEVERE: unable to test PL ability to detect/recognize errors
PR15	Pipeline to reduce combined image	ICD-comp data	Full FITS headers	MINOR: some code to be rewritten
PR16	Observation feedback to observers	ICD-comp data	Full FITS headers	MINOR: some code to be rewritten
PR17	Correct for pointing drifts	Pointing drifts	Can be simulated already	NONE: can be tested now
PR18	Estimate of beam shape	Point-source obs	OK	NONE: can be tested already
PR19	Compare reduced data with catalogues	Data with multiple sources	OK	NONE: no further simulator development needed

3.4 Offline requirements

Req	Description	Simulator requirement	re-	Notes	Impact on PL
OR1	Perform all steps of DA system	200 Hz data		OK	NONE
OR2	Process all 4 subarrays together	ICD-comp data		Full FITS header	MINOR: some code to be rewritten
OR3	Reduce 16h data in 24h	Lots of 200 Hz data, inc pointing/focus/cal obs		Need full FITS headers	MINOR: ??
OR4	Use calibration from multiple nights	Instrument variations		Needs instrument data	MINOR
OR5	Recipes for mosaicking wide fields	SCAN data, sky coords, sky rotation		TBA	FATAL:
OR6	Ability to deal with large maps yet keep file <2 GB	SCAN data, sky coords, sky rotation		TBA	FATAL
OR9	Spectral index plots	Dual-wavelength data		OK	NONE: already implemented
OR10	Source extractor/catalogue creation	Data		OK	NONE
OR11	Report pt-like/extended src	Data		OK	NONE
OR12	Search for variable/moving objects	Data		OK	NONE

3.5 Display requirements

Req	Description	Simulator requirement	re-	Notes	Impact on PL
DR1	Near-real time display	ICD-comp data		Full FITS headers	MINOR
DR3	Display current map	ICD-comp data		Full FITS headers	MINOR
DR4	Display recent co-add	ICD-comp data		Full FITS headers	MINOR
DR7	Update DREAM as fast as written to disk	Write 1 Hz data		External control	NONE
DR8	DREAM/Stare pipeline not fall behind	Write 1 Hz data		External control	NONE
DR9	Update SCAN image for each completed scan	ICD-comp data			MINOR
DR10	Estimate of noise in co-added map	Data + noise		OK	NONE
DR11	Map of detector noise	200 Hz data + noise		OK	MINOR, maybe NONE?
DR20	Display calibrated images separately	Data		OK	NONE
DR21	Overlay catalogue	Data		OK	NONE

3.6 FTS & Pol requirements

Req	Description	Simulator requirement	re-	Notes	Impact on PL
XR2	Pol mag and orientation overlay total flux image	Pol data		OK	MAJOR: unable to test polarimetry reduction
XR3	Pol histograms etc	Pol data		OK	MAJOR: unable to test polarimetry reduction
XR5	Means of viewing FTS data products	FTS data		FTS group responsible?	MAJOR: unable to test FTS processing

3.7 Simulation & Testing requirements

Req	Description	Simulator requirement	Notes	Impact on PL
TR2	Test obs modes	Simulate all observing modes	DREAM/STARE available now, SCAN available but ongoing	FATAL
TR3/4	Scanning strategies	Ability to implement PONG et al	Available now	NONE
TR5	Testing of SCAN data to be used as input for improving the simulator	Ability to add new algorithms easily	Available now	NONE

3.8 External requirements

Req	Description	Simulator requirement	Notes	Impact on PL
ER3	200 Hz simulations available for testing pipeline	200 Hz data + errors + real sky + realistic coords	TBA: errors, sky coords, rotation	MINOR to FATAL depending on which part of the PL is tested
ER5	Simulated sky to include pt/extended sources	Produce images of pt/ext sources	Available now for pt sources	MAJOR: currently possible to use 'real' data for ext sources, but will need alternative once realistic sky coords implemented
ER6	Test viability of STARE mode	Generate STARE mode data	Available now	NONE
ER7	Test viability of DREAM mode	Generate DREAM mode data	Available now	NONE

Note all of these external requirements are a 'Requirement on ATC'

3.9 Simulator requirements listed in order of impact

In the following table, the simulator requirements are listed in order of decreasing impact on the DR project. Those requirements which are listed as having no impact (NONE above) are omitted.

Rating	Impact description	Simulator Requirement	DR requirement	Notes
FATAL	Unable to test pipeline SCAN reduction	SCAN data	GR11, GR19, MR3, MR4	TBA
	Unable to test reproducibility	SKY coordinates, rotation	MR6	TBA
	Unable to deal with realistic (large) maps	SKY coordinates, rotation	OR5, OR6	
SEVERE	Unable to test correction for calibration drifts	Instrumental drifts	GR12, OR3	
	Unable to test pipeline error detection	Errors in data	PR12	Needs more instrumental data
	Unable to quantify astrometry/resolution losses	SCAN data + Realistic telescope motion	MR4, MR5	SCAN reconstruction with no pointing errors provides basic test
MAJOR	Unable to test setup and calibration methods	Setup and calibration procedures	PR3, OR3	Requires external input
	Unable to test automated calibration	Data + realistic atmosphere	PR6	
	Unable to test imaging of extended sources	Produce images of extended sources	ER5	
	Unable to test polarimetry reduction	Polarimetry data	XR2, XR3	
	Unable to test FTS reduction	FTS data	XR5	Responsibility of FTS group?
MINOR	Unable to validate calibration accuracy	Realistic atmosphere	GR11, GR19	
	Time wasted rewriting code	ICD compliant data	GR15, PR15, PR16, OR2, OR3, DR1, DR3, DR4	Full FITS headers, populated RTS/TCS structures
	Unable to make full use of ORAC-DR	ICD compliant data	MR2	Full FITS headers, populated RTS/TCS structures
POTENTIAL	Unable to implement different scan methods	Easy implementation of scan methods	MR3	OK
	Could affect scanning strategies	Write data before file size > 1 GB	GR16	

4 Conclusions

Most of the impact on the DR project as a result of an incomplete simulator is from two sources:

- No realistic Sky coordinates (sky rotation)
- Missing header (FITS, RTS, TCS) information

Clearly the emphasis on further simulator development lies with these items. However, in practice, the header information will be written by the DA system and is thus most reasonably implemented by ATC, while the former is better-implemented by the DR project itself.

References

- [1] Tim Jenness. SCUBA-2 DA/DR Interface Control Document. SCUBA-2 Project SC2/SOF/IC210/01, 2003.
- [2] B. D. Kelly. SCUBA-2 Simulator Manual. SCUBA-2 Project SC2/SOF/S200/021, 2004.
- [3] Douglas Scott. SCUBA-2 Data Reduction Software Requirements. SCUBA-2 Project SC2/SRE/S210/001, 2004.