



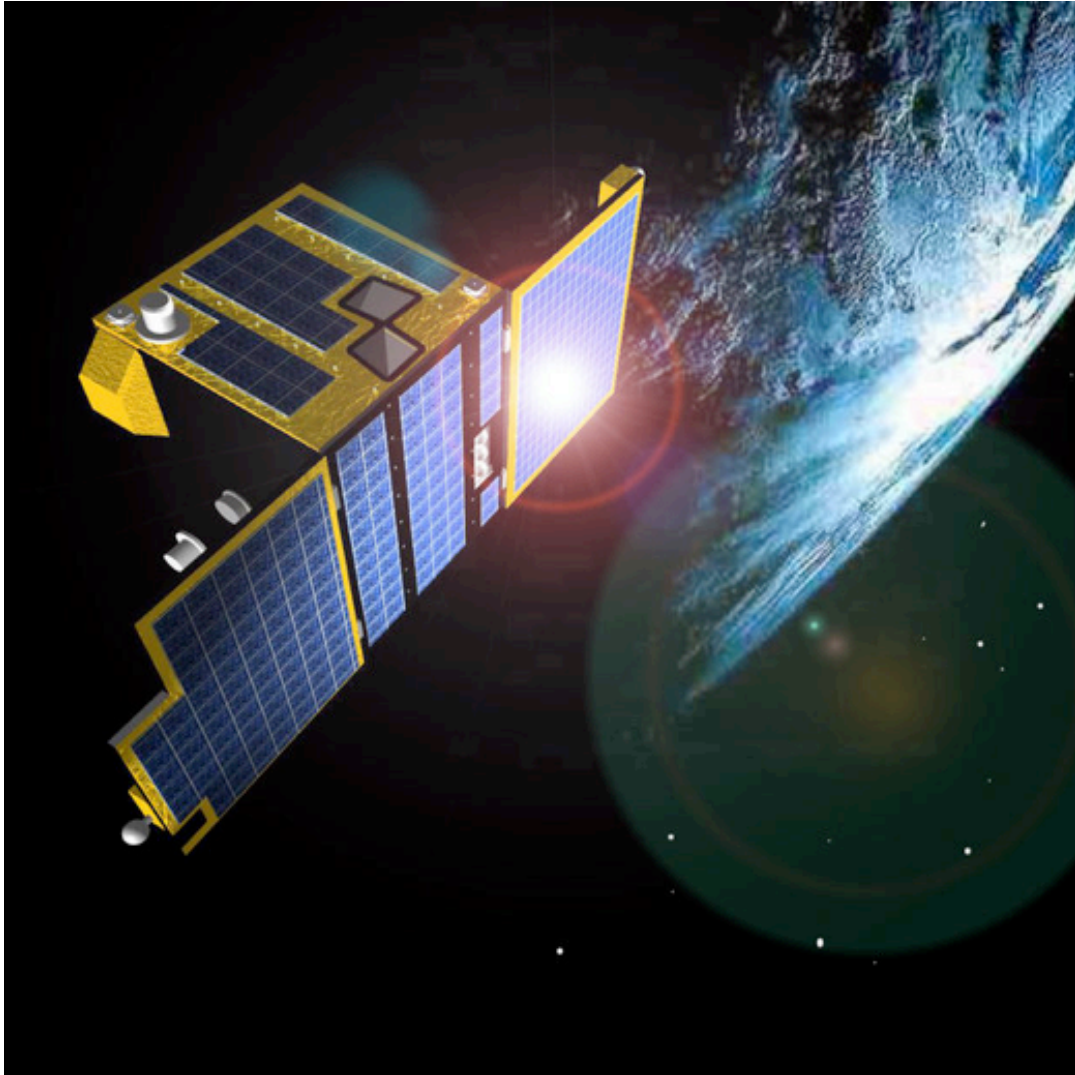
Automation and Flexibility at the PROBA2 Science Centre

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@ ROB, ESA, TCD, KULeuven

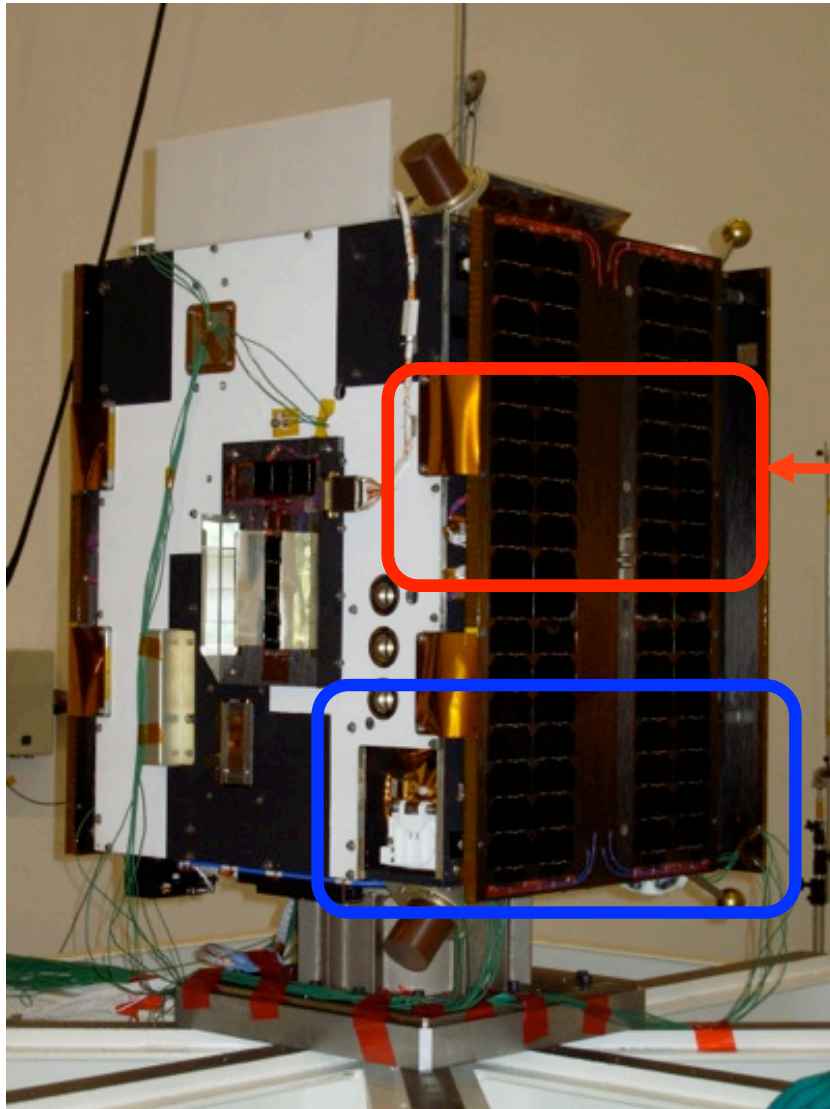
The PROBA2 Science Centre (P2SC) is a small-scale science operations centre supporting the Sun observation instruments onboard PROBA2: the EUV imager SWAP and large-yield radiometer LYRA. PROBA2 is one of ESA's small, low-cost Projects for On-board Autonomy (PROBA) and part of ESA's In-Orbit Technology Demonstration Program. The P2SC is hosted at the Royal Observatory of Belgium, co-located with both Principal Investigator teams. The P2SC tasks cover science planning, instrument commanding, instrument monitoring, data processing, support of outreach activities, and distribution of science data products. **PROBA missions aim for a high degree of autonomy at mission and system level, including the science operations centre. The autonomy and flexibility of the P2SC is reached by a set of web-based interfaces allowing the operators as well as the instrument teams to monitor quasi-continuously the status of the operations, allowing a quick reaction to solar events.** In addition, several new concepts are implemented at instrument, spacecraft, and ground segment level allowing a high-degree of flexibility in the operations of the instruments. We present the key concepts of the P2SC, emphasising the automation and the flexibility achieved in the commanding as well as the data processing chain.

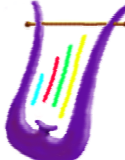
What is PROBA2?

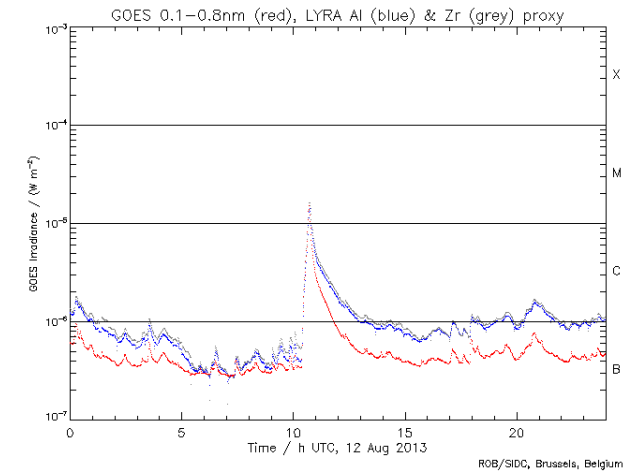
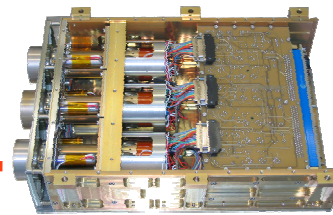


- Project for Onboard Autonomy (PROBA) spacecraft, part of ESA's in-orbit Technology Demonstration Program.
- micro-sat launched in 2009, LEO sun-synchronous
- 4 scientific instruments

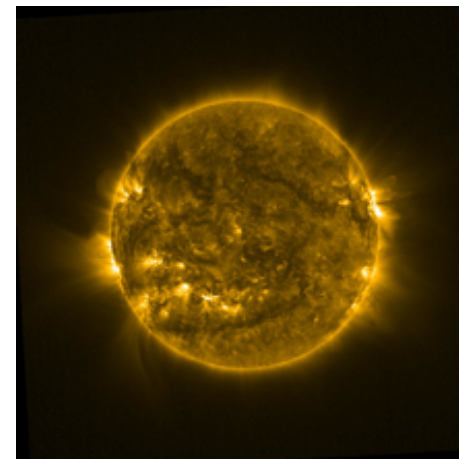
Solar Payload of PROBA2



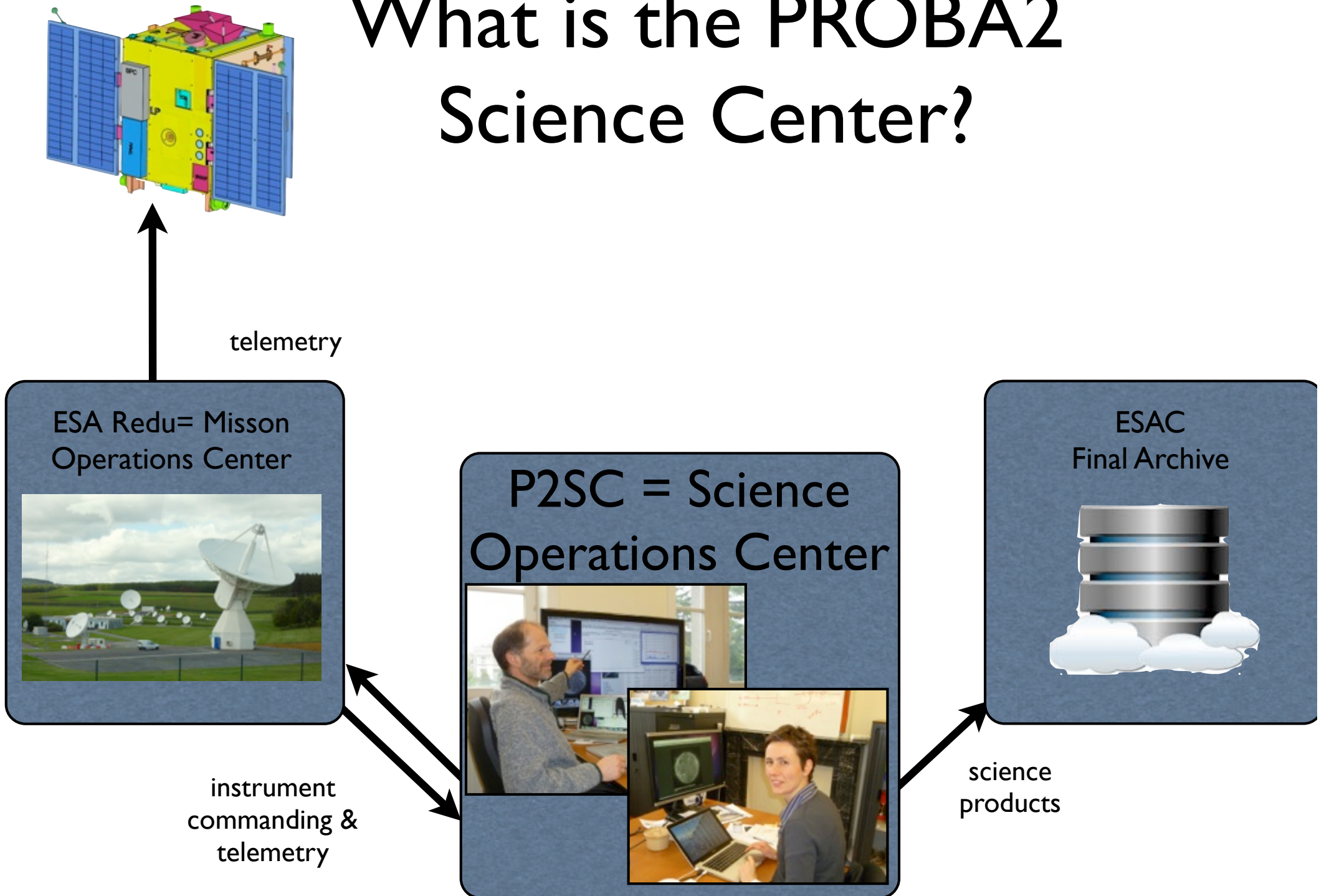
LYRA  EUV radiometer



coronal EUV imager

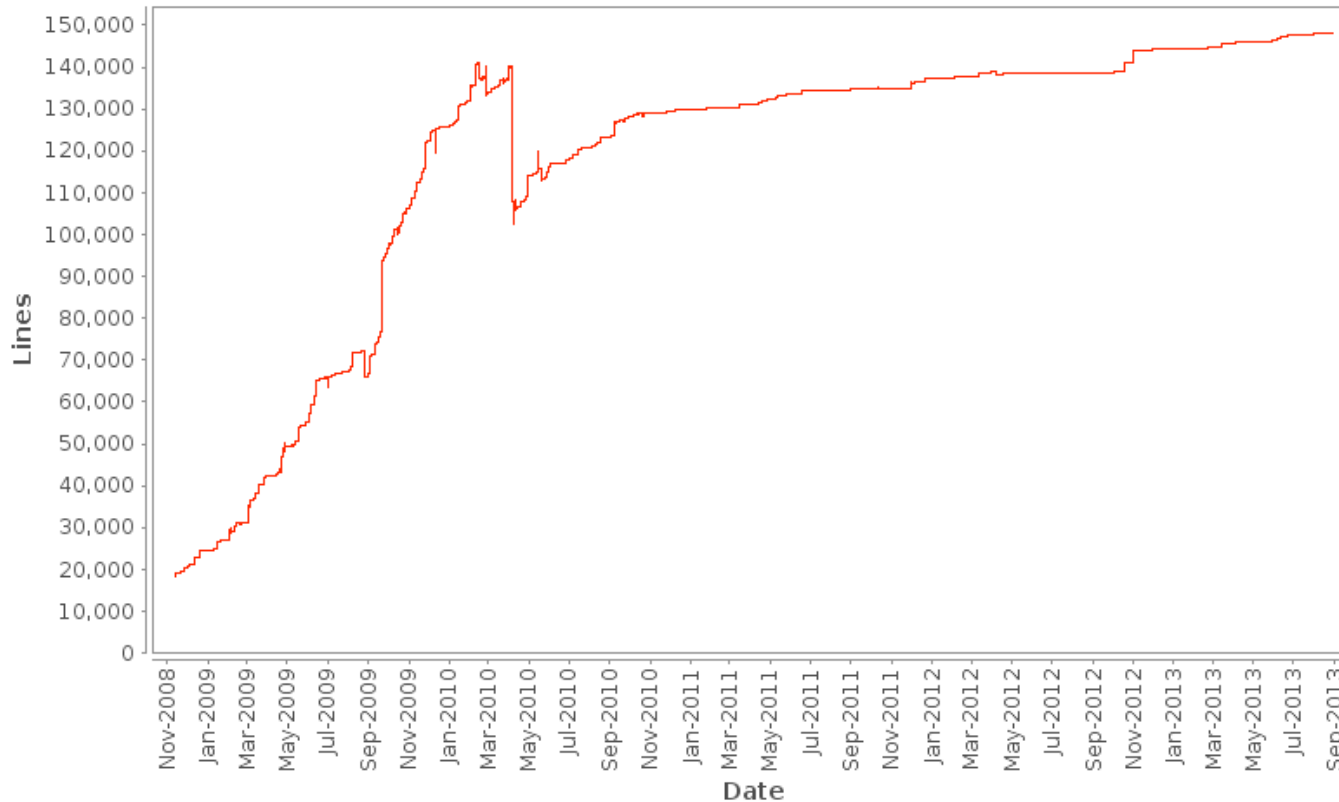


What is the PROBA2 Science Center?



P2SC development

/trunk/p2sc/bin: Lines of Code



ROB, Brussels (B)

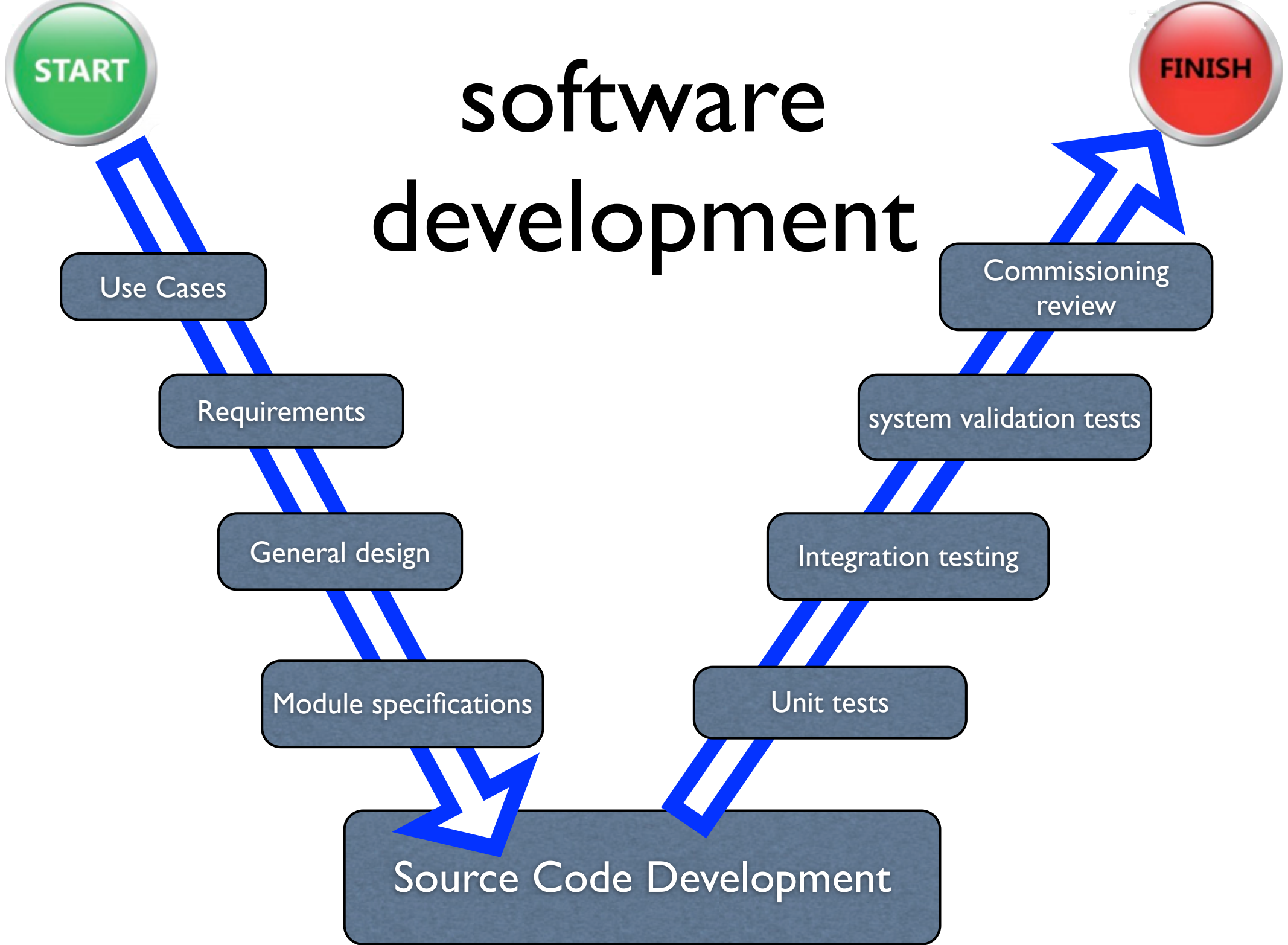
TCD, Dublin (I)

KULeuven, Leuven (B)

ESTEC, Noordwijk (NL)

on average, 18 *scientists* from 4 institutes programmed 200 lines of code in 650 files in about 2 years (excluding external libraries, configuration files, duplications)

software development



START

FINISH

Use Cases

Requirements

General design

Module specifications

Source Code Development

Unit tests

Integration testing

system validation tests

Commissioning review



@ a research environment

Use Cases

Commissioning review

Requirements

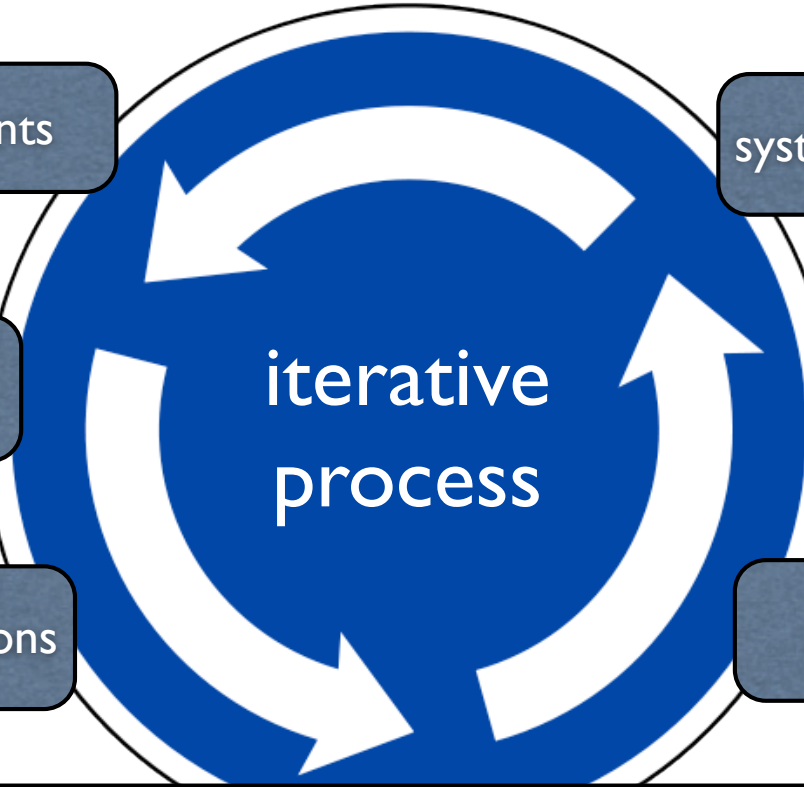
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Source Code Development

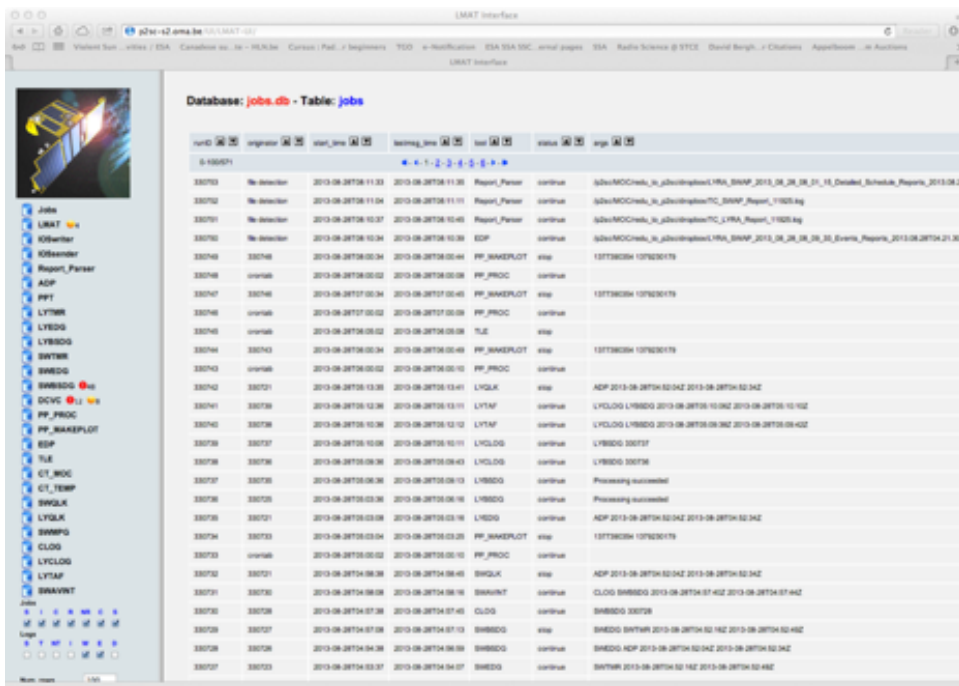
Examples of automation and flexibility

- work flow management tool
- Automated rule-based cross-validation of operational data
- fully automatic FITS generating pipelines & catalogs
- flexible commanding of instruments at SOC through meta-language

All processes report to a Workflow manager

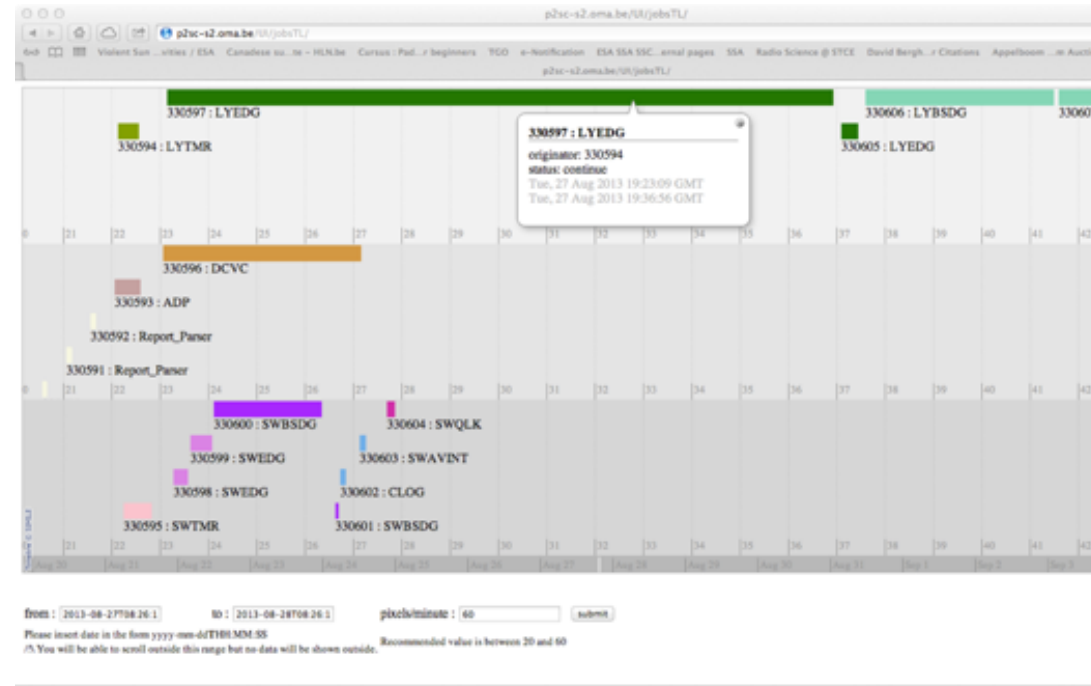
- triggers each module when needed
- collects errors, warnings, progress messages
- shows overviews of what is going on

web-based
workflow manager
allows to run the
P2SC from
anywhere, anytime



Database: jobs.db - Table: jobs

jobID	originator	start_time	ending_time	job	status	msg
330703	No detector	2013-08-28T08:11:32	2013-08-28T08:11:32	Report_Parser	continue	sdhwMOCweb_in_gdhwinsploit/PRA_SWAP_2013_08_28_01_14_Detailed_Schedule_Report_2013-08-28
330702	No detector	2013-08-28T08:11:04	2013-08-28T08:11:01	Report_Parser	continue	sdhwMOCweb_in_gdhwinsploit/PRA_SWAP_Report_11003.log
330701	No detector	2013-08-28T08:10:37	2013-08-28T08:10:40	Report_Parser	continue	sdhwMOCweb_in_gdhwinsploit/PRA_Report_11003.log
330700	No detector	2013-08-28T08:10:34	2013-08-28T08:10:38	ESP	continue	sdhwMOCweb_in_gdhwinsploit/PRA_SWAP_2013_08_28_01_14_Events_Report_2013-08-28T04:21:30:00
330740	unavail	2013-08-28T08:00:04	2013-08-28T08:00:04	PP_WAKEPLOT	exit	137786084 107620179
330746	unavail	2013-08-28T08:00:02	2013-08-28T08:00:04	PP_PROC	continue	
330747	unavail	2013-08-28T07:00:34	2013-08-28T07:00:40	PP_WAKEPLOT	exit	137786084 107620179
330748	unavail	2013-08-28T07:00:02	2013-08-28T07:00:08	PP_PROC	continue	
330749	unavail	2013-08-28T08:00:02	2013-08-28T08:00:08	TLK	exit	
330744	unavail	2013-08-28T08:00:34	2013-08-28T08:00:40	PP_WAKEPLOT	exit	137786084 107620179
330742	unavail	2013-08-28T08:00:04	2013-08-28T08:00:08	PP_PROC	continue	
330740	unavail	2013-08-28T08:00:02	2013-08-28T08:00:10	PP_PROC	continue	
330743	unavail	2013-08-28T08:00:34	2013-08-28T08:00:40	PP_WAKEPLOT	exit	137786084 107620179
330740	unavail	2013-08-28T08:00:02	2013-08-28T08:00:10	PP_PROC	continue	
330701	unavail	2013-08-28T08:13:30	2013-08-28T08:13:41	LYQLK	exit	ADP 2013-08-28T04:52:04Z 2013-08-28T04:52:04Z
330741	unavail	2013-08-28T08:12:36	2013-08-28T08:13:11	LYTAF	continue	LYCLOG LYBDDG 2013-08-28T08:10:34Z 2013-08-28T08:10:42Z
330740	unavail	2013-08-28T08:10:38	2013-08-28T08:12:12	LYTAF	continue	LYCLOG LYBDDG 2013-08-28T08:09:34Z 2013-08-28T08:09:42Z
330738	unavail	2013-08-28T08:10:08	2013-08-28T08:10:11	LYCLOG	continue	LYBDDG 330737
330738	unavail	2013-08-28T08:08:36	2013-08-28T08:08:43	LYCLOG	continue	LYBDDG 330736
330737	unavail	2013-08-28T08:08:36	2013-08-28T08:08:13	LYBDDG	continue	Processing successful
330736	unavail	2013-08-28T08:03:36	2013-08-28T08:03:16	LYBDDG	continue	Processing successful
330735	unavail	2013-08-28T08:03:08	2013-08-28T08:03:16	LYBDDG	continue	ADP 2013-08-28T04:52:04Z 2013-08-28T04:52:04Z
330734	unavail	2013-08-28T08:03:04	2013-08-28T08:03:08	PP_WAKEPLOT	exit	137786084 107620179
330733	unavail	2013-08-28T08:00:02	2013-08-28T08:00:10	PP_PROC	continue	
330732	unavail	2013-08-28T04:58:36	2013-08-28T04:58:45	SWQLK	exit	ADP 2013-08-28T04:52:04Z 2013-08-28T04:52:04Z
330731	unavail	2013-08-28T04:58:08	2013-08-28T04:58:16	SWAVINT	continue	CLOG SWBDDG 2013-08-28T04:57:42Z 2013-08-28T04:57:42Z
330730	unavail	2013-08-28T04:57:38	2013-08-28T04:57:45	CLOG	continue	SWBDDG 330728
330728	unavail	2013-08-28T04:57:08	2013-08-28T04:57:13	SWBDDG	exit	SWBDDG SWTMR 2013-08-28T04:51:12Z 2013-08-28T04:51:48Z
330728	unavail	2013-08-28T04:56:38	2013-08-28T04:56:39	SWBDDG	continue	SWBDDG NDP 2013-08-28T04:52:04Z 2013-08-28T04:52:04Z
330727	unavail	2013-08-28T04:53:37	2013-08-28T04:54:07	SWBDDG	continue	SWTMR 2013-08-28T04:52:14Z 2013-08-28T04:52:48Z

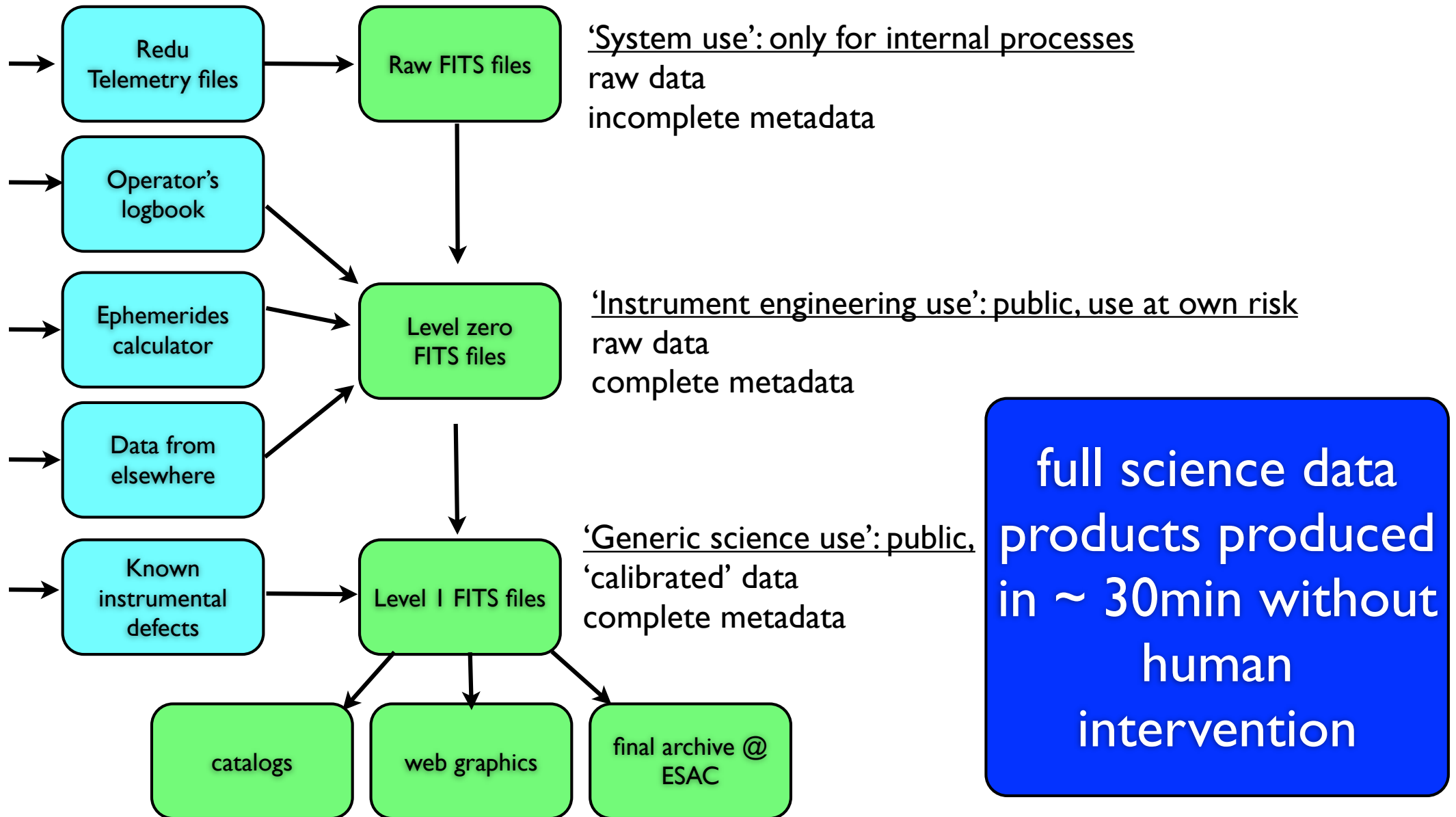


Automated rule based cross validation of operational data

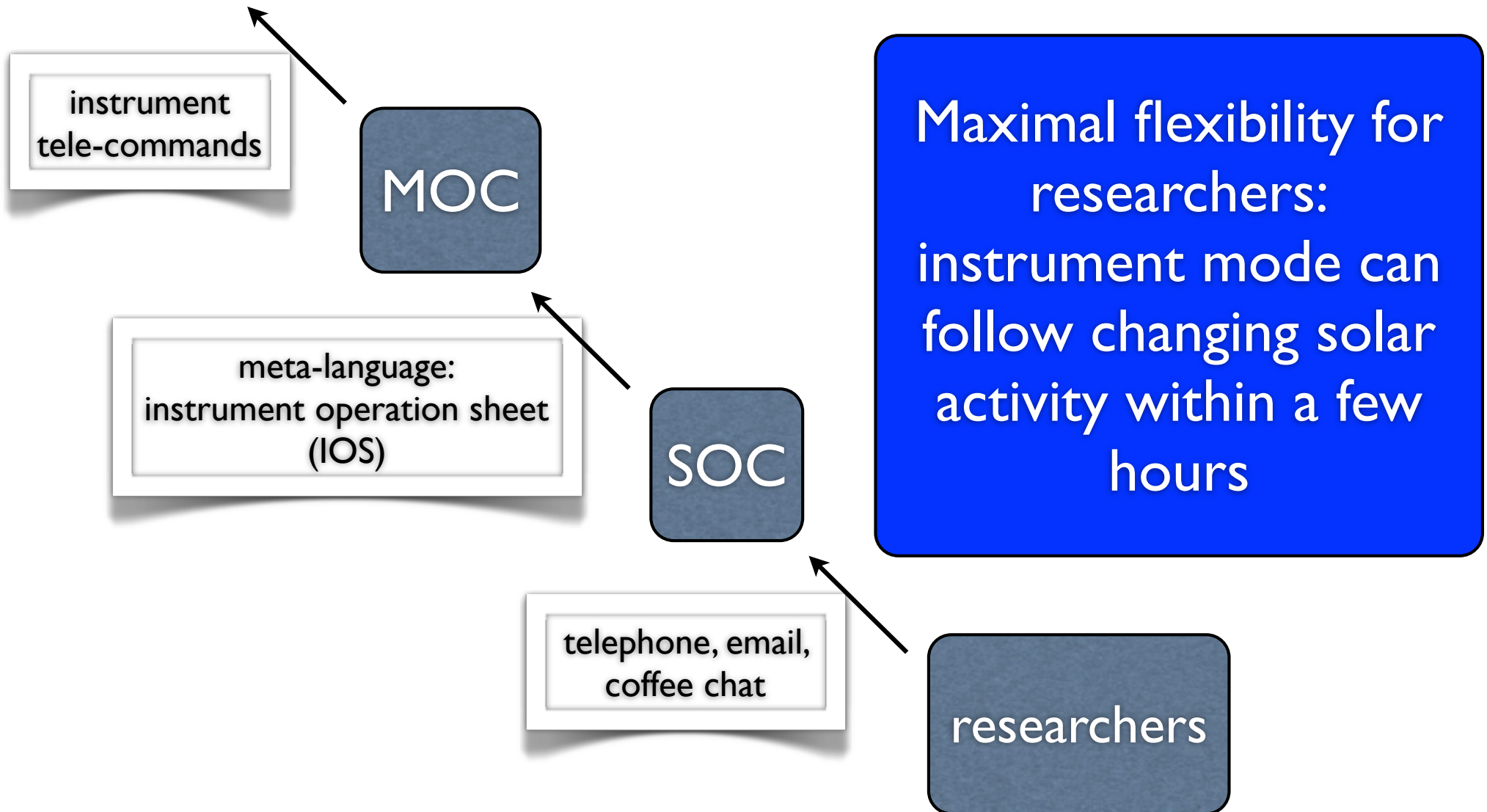
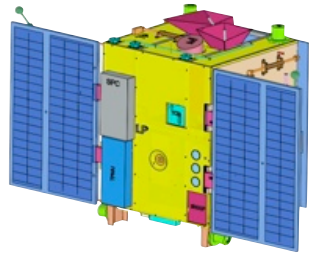
- checks if incoming housekeeping data are within limits
- checks if incoming housekeeping data are consistent with commanding
- checks if incoming observations are consistent with commanding
- checks if statistics of processes are 'normal'

A 'virtual operator' does all the routine work, only noteworthy events are presented to the human operator

Fully automated production of science data products



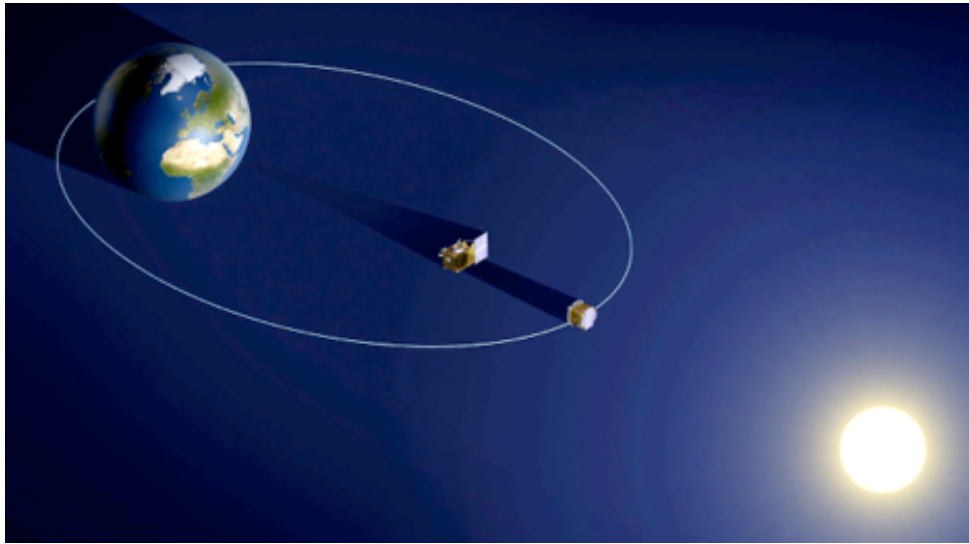
Instrument Operation Sheets are a metalanguage of instrument commands, produced at the SOC, and at MOC automatically parsed and uploaded to the spacecraft at next pass



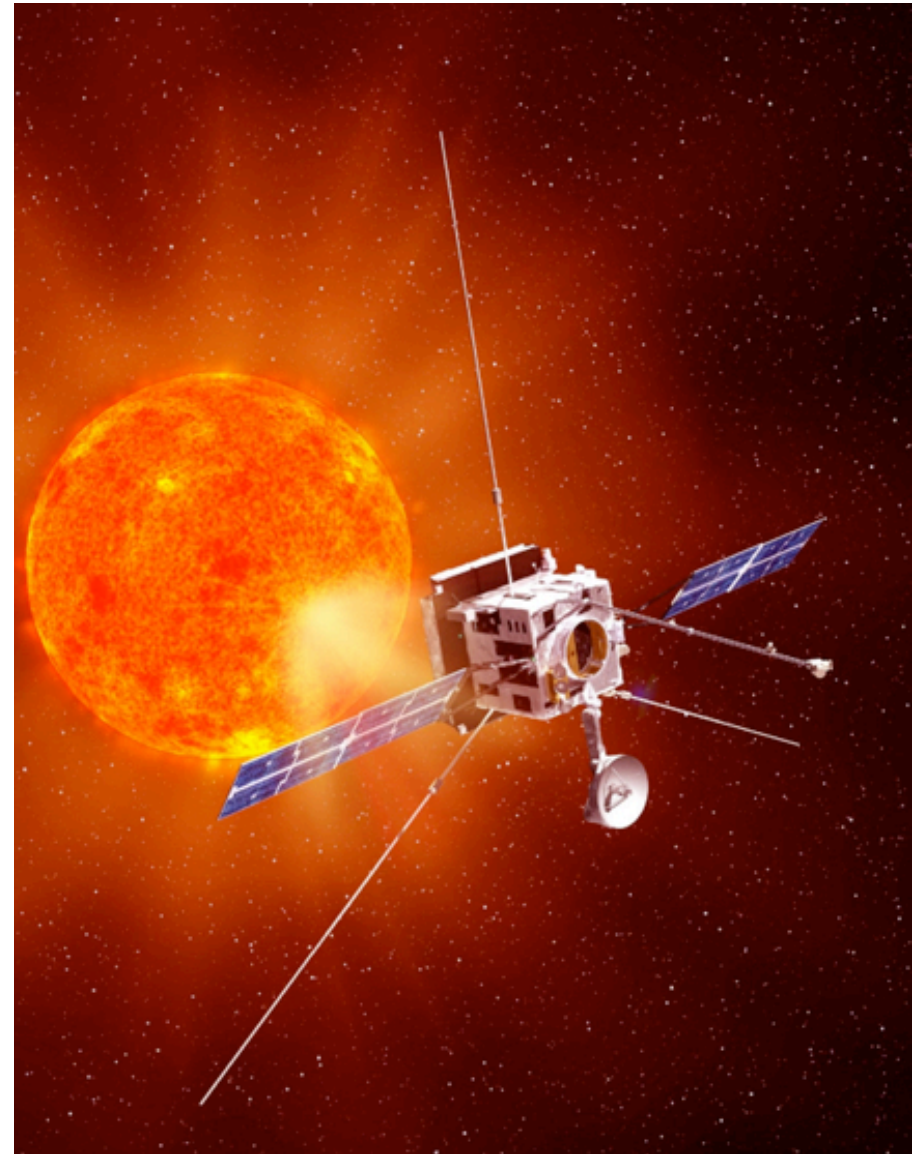
Some lessons learned

- direct instrument commanding has been very useful, the use of a meta-language has complications
- virtualization of P2SC servers has been useful for having test & development copies but an optimized design of the lay-out of the virtual servers was non-trivial
- software development by scientists resulted in the use of many different programming languages. Well defined interfaces to the workflow manager were important.

To do: Science centers for PROBA3 and for the EUI instrument onboard Solar Orbiter



Talk at this conference:
“Design exercise: the EUI
data center at the Royal
Observatory of Belgium”
by Cis Verbeeck



Want to know more?

- read the paper: [Zender 2013, Solar Physics](#)
- visit us at: <http://proba2.oma.be> or <http://sci.esa.int/proba2>
- email us: swap_lyra@oma.be
- talk to us at this conference

David Berghmans



Joe Zender



Cis Verbeeck

