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Progression of Power Parameters During a Concurrent Engineering Study

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05-07/10/2022



- Motivation
- Analysis of legacy CE study data models
- Progression of Power Parameters
- Implications for the design study

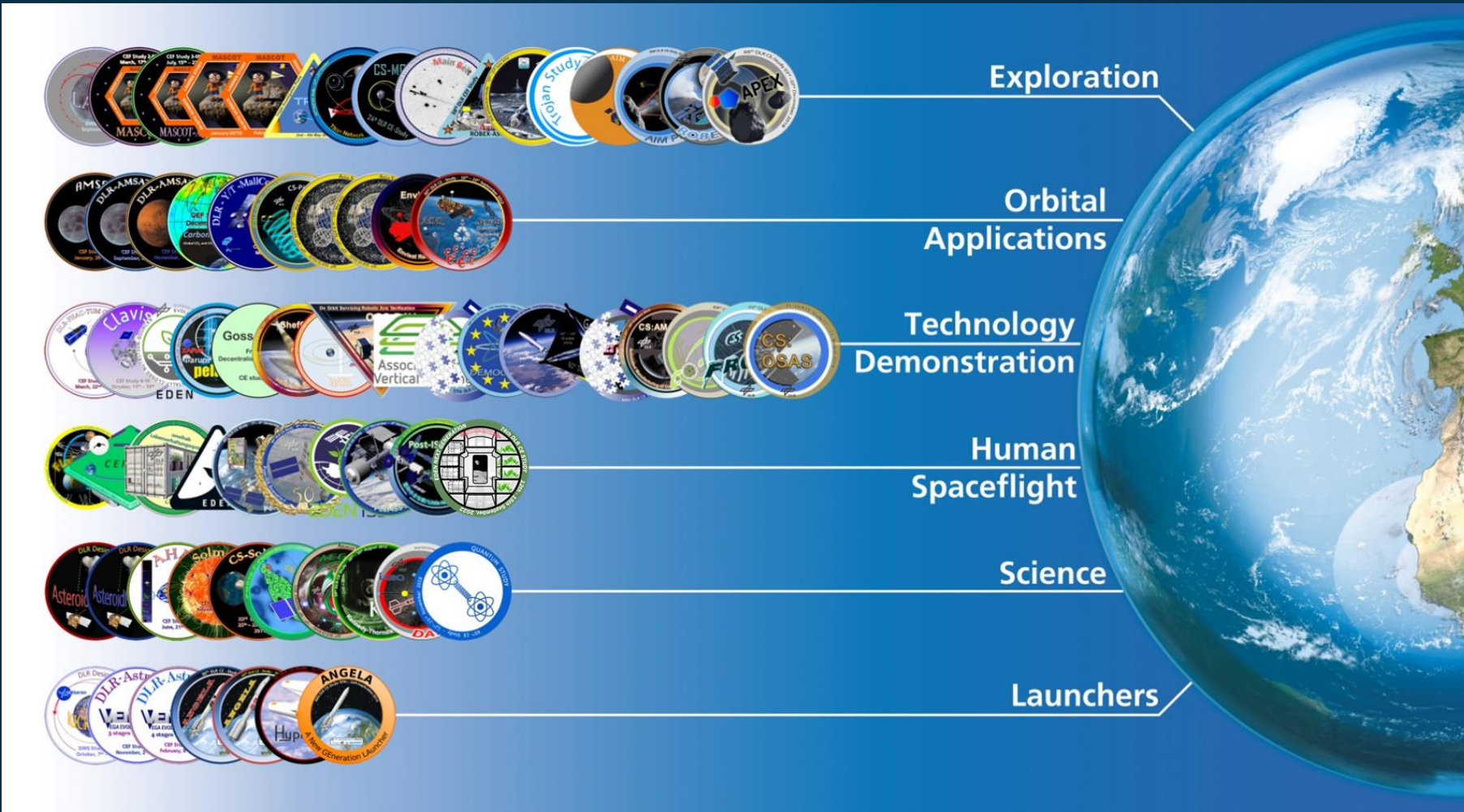


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Motivation



Archive of
74 CE studies

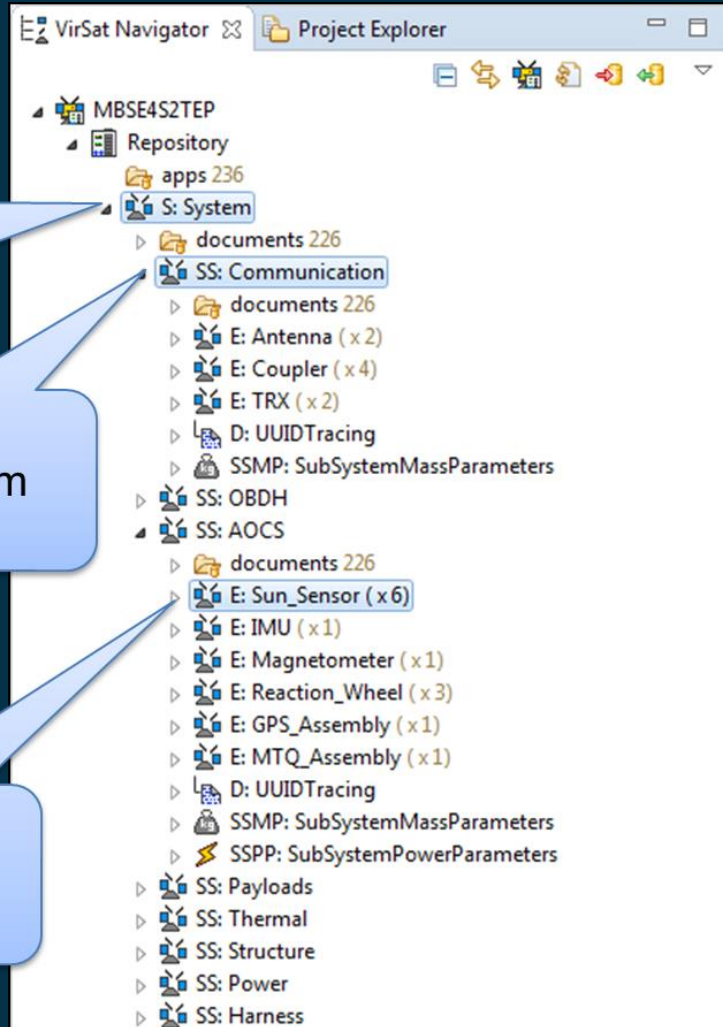
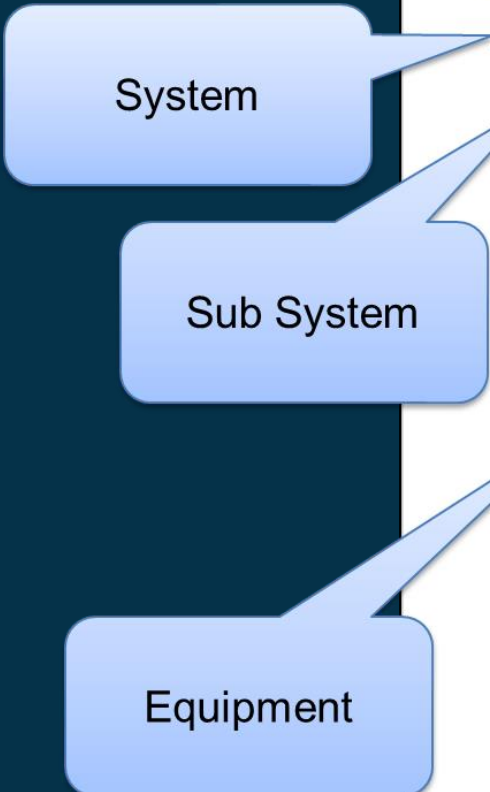


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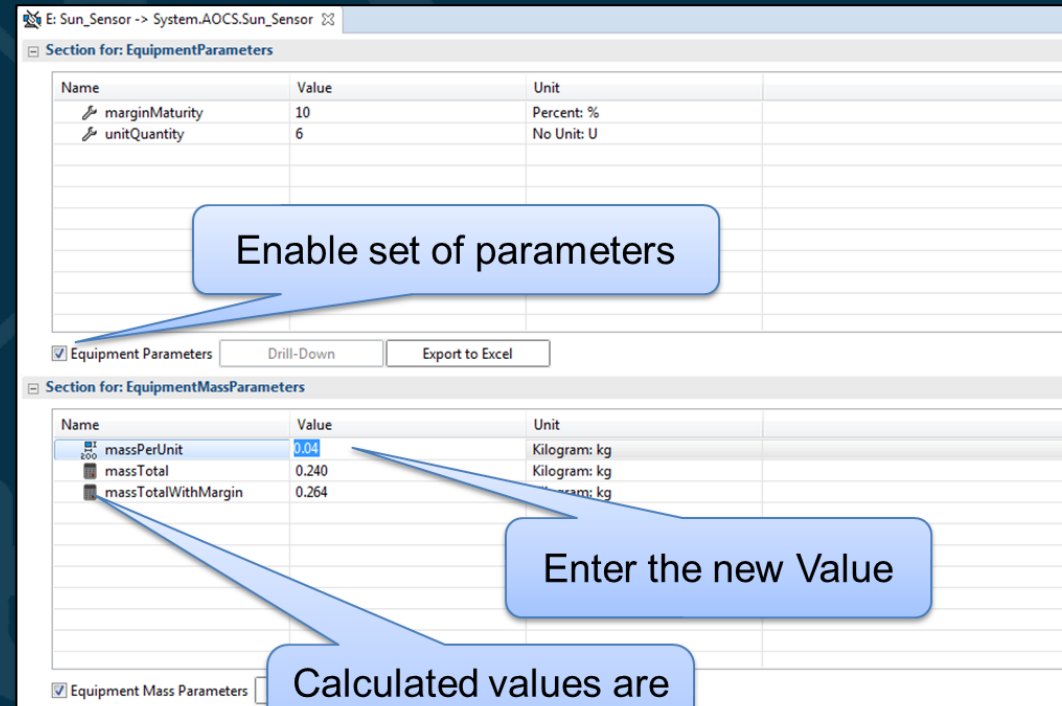


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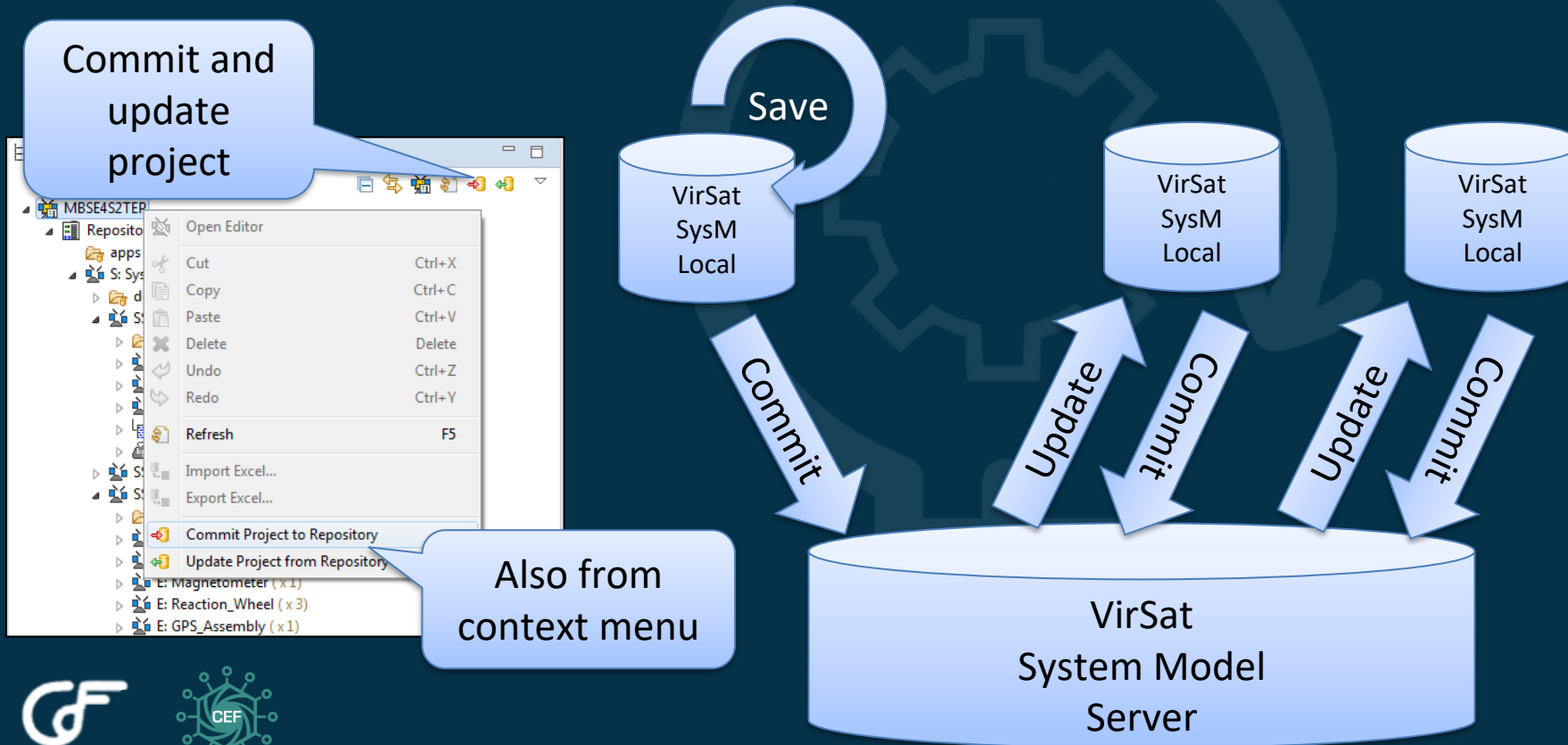


For many of them a data model in Virtual Satellite format



Motivation

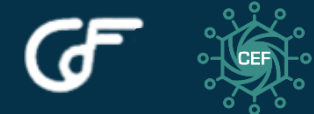
<https://github.com/virtualsatellite>



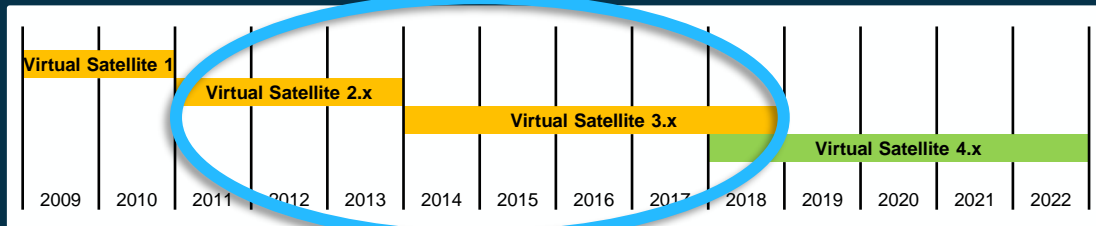
Due to commit/update procedure:
Logs of the time-based evolution of study models on a change-by-change basis



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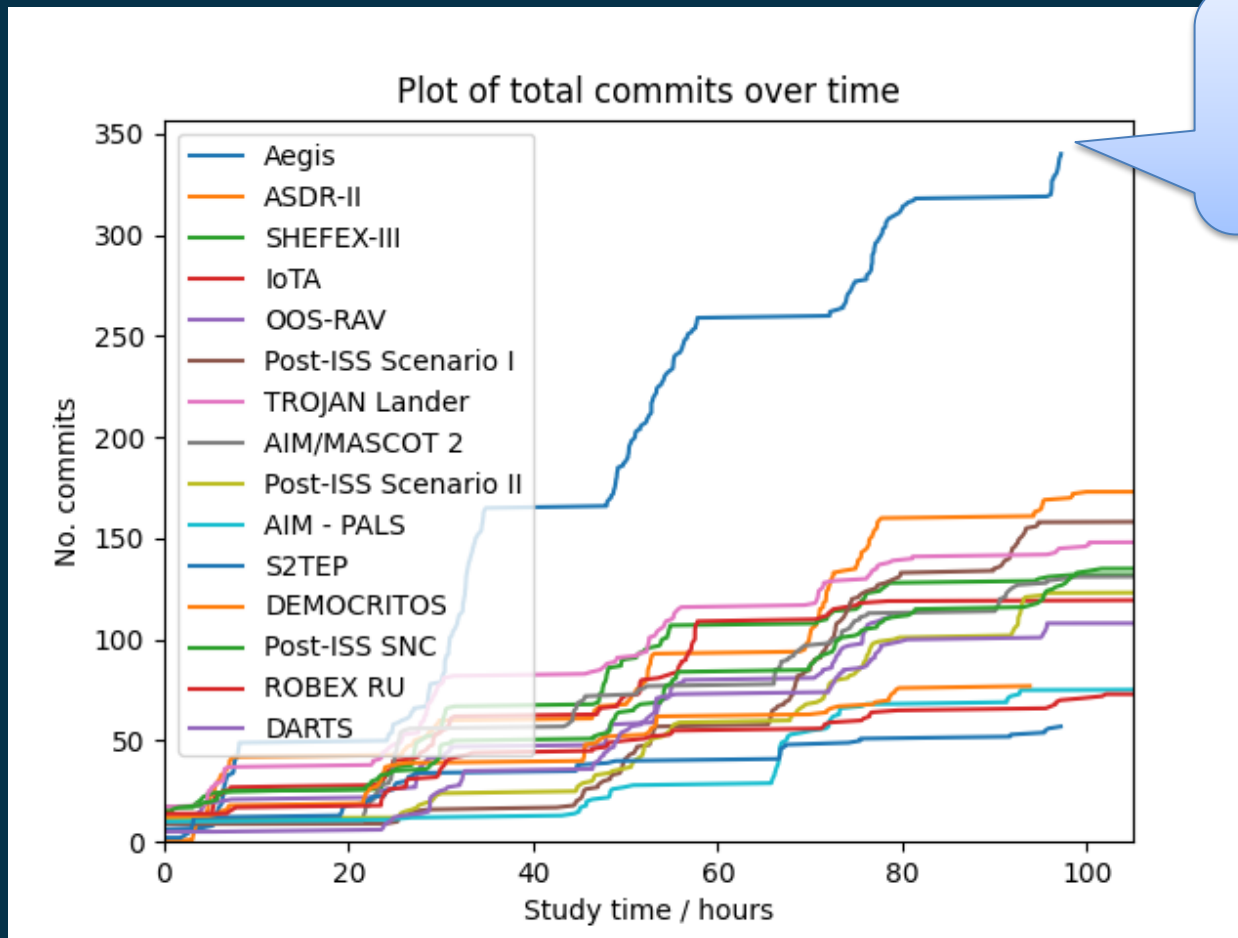
Develop a basis for semi-automated analysis of legacy CE study data models by investigating a subset of studies



CE Study No.	Study code name	Target	Type
26	Aegis	SSO; 700 km	Science / Astronomy
31	ASDR-II	LEO (Debris)	Orbit Applications / On Orbit Serv.
41	SMETEX-III	N/A	Technology Demonstration
47	IoTA	N/A	Technology Demonstration
49	OOS-RAV	LEO	Technology Demonstration
50	Post-ISS Scenario I	LEO	Human Spaceflight
51	TROJAN Lander	Trojan Asteroid	Exploration / Lander
53	AIM/MASCOT 2	N/A	Exploration / Lander
55	Post-ISS Scenario II	LEO	Human Spaceflight
56	AIM-PALS	65803 Didymos	Exploration
57	S2TEP	LEO	Technology Demonstration
58	DEMOCRITOS	Mars / Europa	Technology Demonstration
61	Post-ISS SNC	LEO	Human Spaceflight
62	ROBEX RU	Moon	Exploration
63	DARTS	Earth-Sun L2	Science



Usually between 50 and 150 commits



Outlier “Aegis” was students only study (might have been more enthusiastic about committing changes to Virtual Satellite)

Sources:

Wessel, H.: Comparative Data Analysis of Legacy Concurrent Engineering Studies, Diploma Thesis. TU Dresden, Germany (2022)

Quantius, D., Wessel, H., Fischer, P., Peters, D. (2022). Progression Visualisation of Mass Parameters During a Concurrent Engineering Study. In: Luo, Y. (eds) Cooperative Design, Visualization, and Engineering. CDVE 2022. Lecture Notes in Computer Science, vol 13492. Springer, Cham. https://doi.org/10.1007/978-3-031-16538-2_2



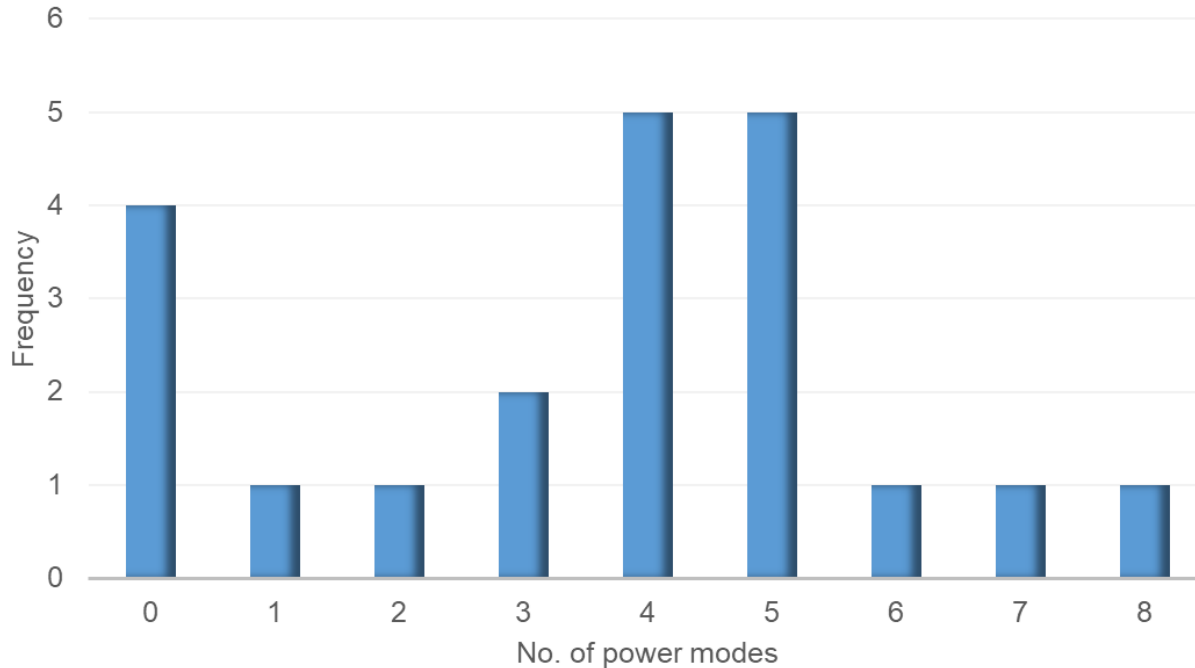
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Analysis of legacy CE study data models

Mostly 4 or 5 power modes used

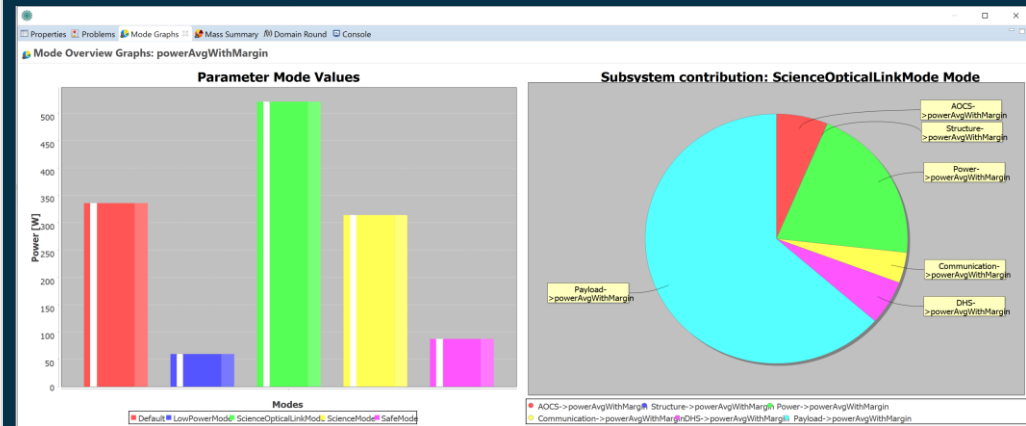
Usage of power modes within a subset of 21 CE studies



Section for: SystemMode

Name	note	Mode Duration
LowPowerMode	stowed solar panels, no defined attitude, once sufficient power is in the batterie...	90.0
SafeMode	identical to LEOP	90.0
ScienceMode	no description	90.0
ScienceOpticalLinkMode	to MEO reference duration is 30 min, to ground 10 min	10.0

Buttons: Add SystemMode, Remove SystemMode, Drill-Down, Export to Excel

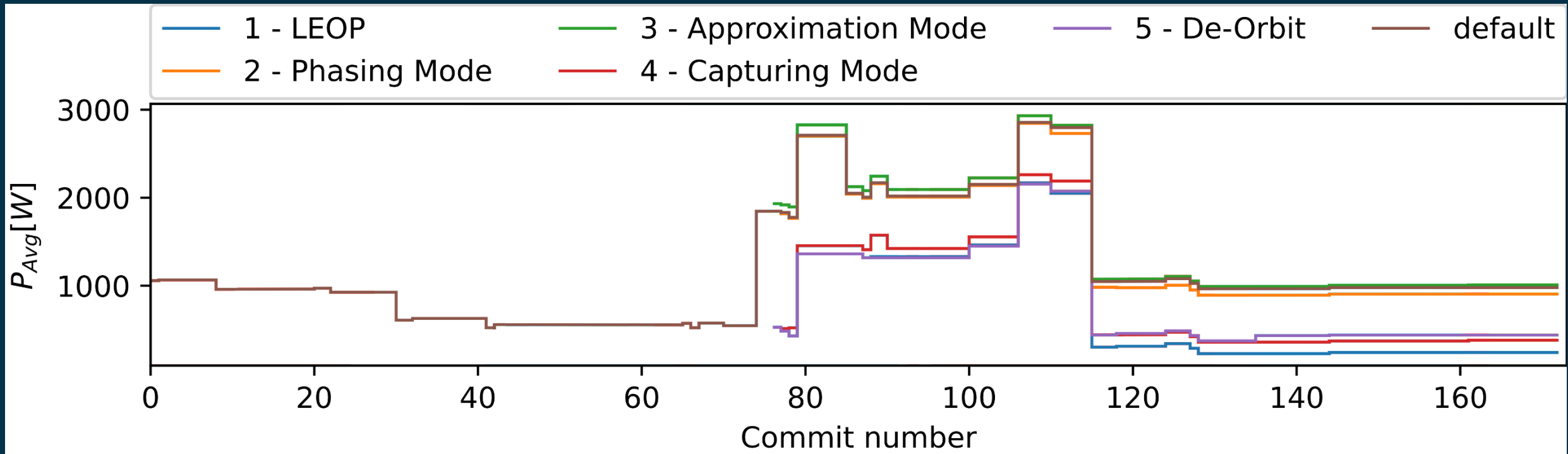


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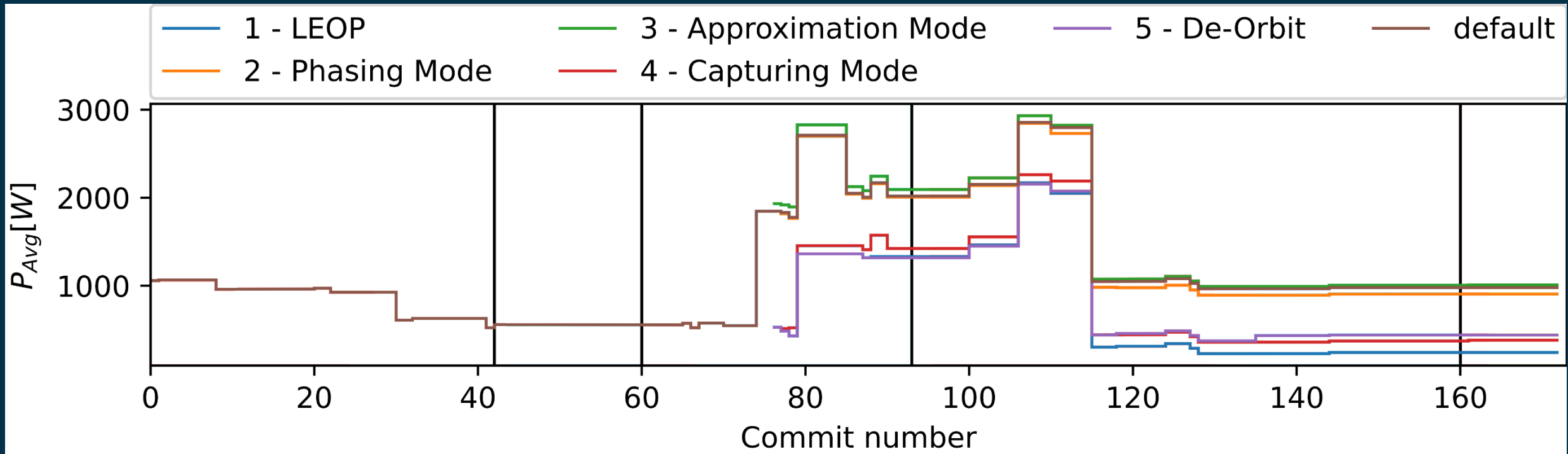
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Plot of total average power progression per mode



Time information added (day lines)



Progression of Power Parameters

CE study schedule – activity blocks

Presentations (all)

Non-Moderated Time (in groups)

Breaks (individually)

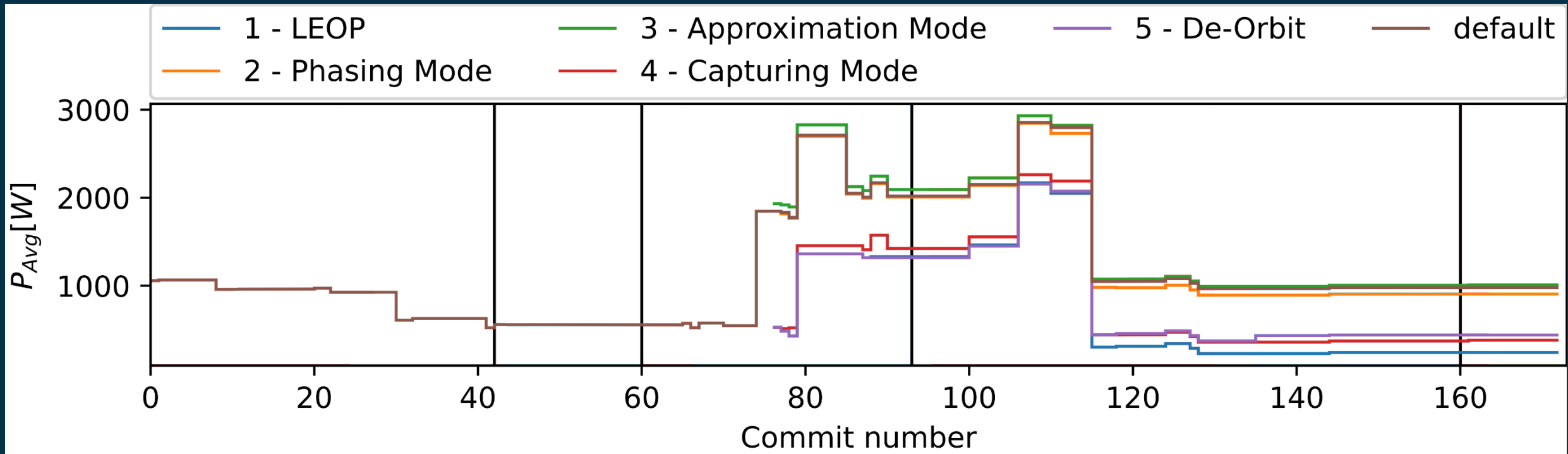
Sessions (all together)

Private Time (individually)

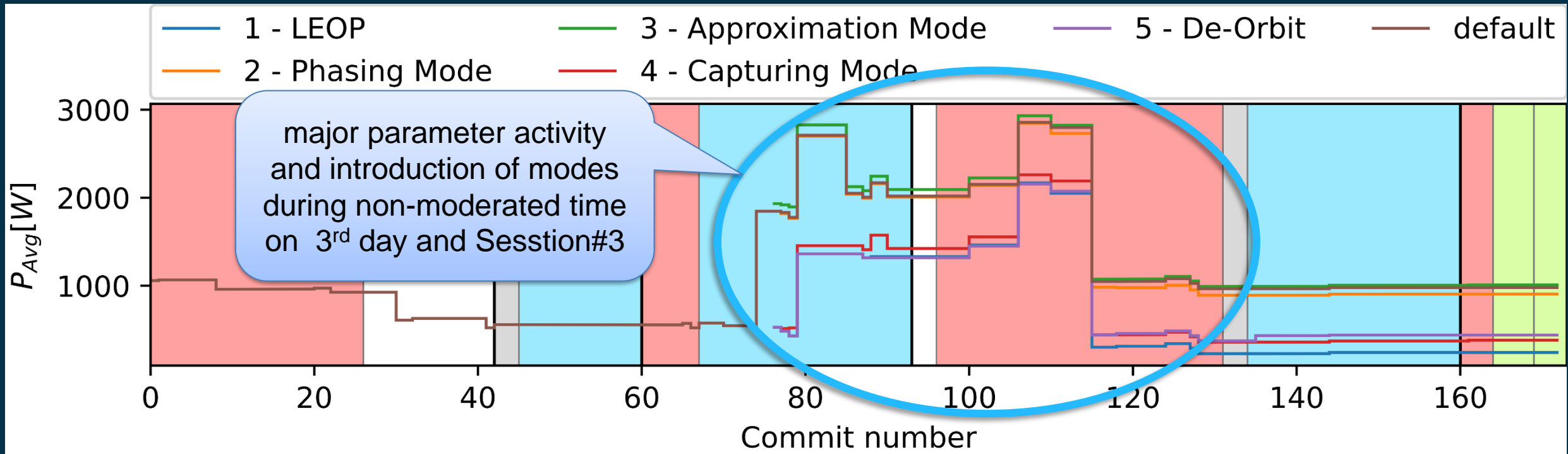
	Mo	Tue	Wed	Thur	Fri
09:30		Short Status Report	Session #2	Session #3	Session #4
10:30		Non-Moderated Time	- Modes of Operation - Configuration - Input into VirSat (mass, dimensions, temperatures, power) - Domain Round	- Domain Round - Open Issues - Latest S/S decisions - Configuration session - Input into VirSat - Domain Round	- Configuration - Domain Round
11:00	Kick-Off Presentations				Final Presentations
11:30	- Introduction - Study Background - Systems - Mission Analysis				- CaptureSystem - Mission Analysis - AOCS / GNC - Structure - Configuration
12:00					
13:30	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
	- Lunch in Uni-canteen - Short rest period	- Lunch in Uni-canteen - Short rest period	- Lunch in Uni-canteen - Short rest period	- Lunch in Uni-canteen - Short rest period	- Lunch in Uni-canteen - Short rest period
14:00	Session #1	Non-Moderated Time	Non-Moderated Time	Non-Moderated Time	Final Presentations
14:30	- Responsibility Allocation - VirSat Introduction - Input into VirSat (mass, dimensions, temperatures) - Domain Round	- Action Items - Splinter Meetings - Preparation of next Session	- Action Items - Splinter Meetings - Preparation of next Session	- Action Items - Splinter Meetings - Preparation of next Session - Preparation of Final Presentations	- Power - Data Handling - Communication - Thermal - Systems - Conclusion
16:00		Private Time (individually)			
16:30					
17:00					
17:30					



Time information added (day lines)

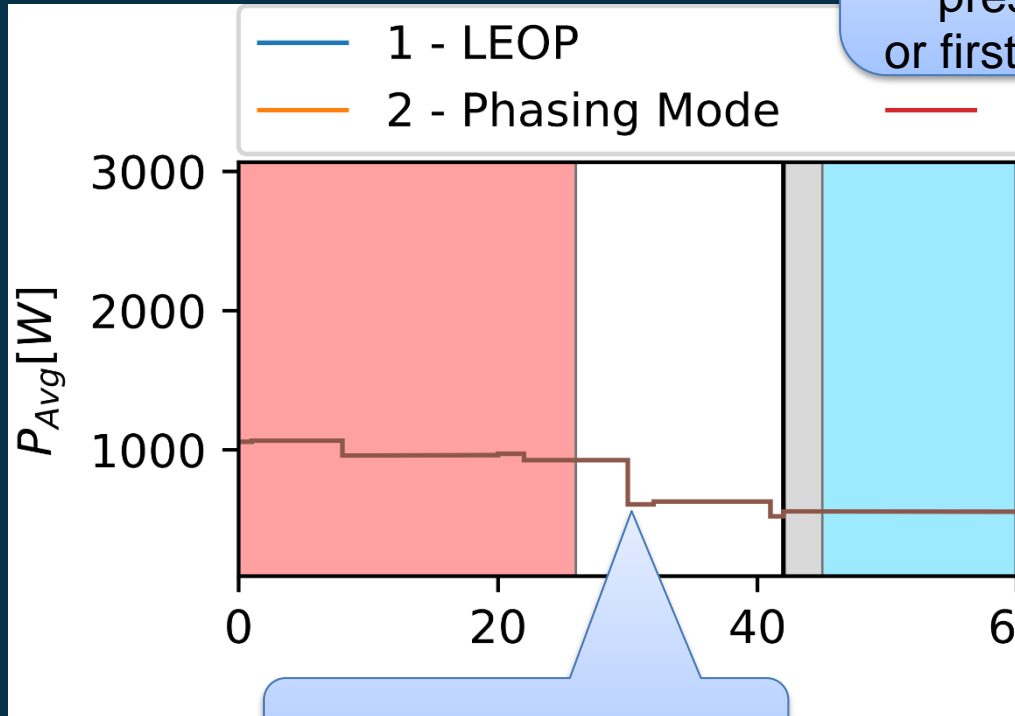


„Activity block“ information added



Progression of Power Parameters

First two days



no work on the data model during kick-off presentations or first lunch break

Time	Mo	Tue
0900		Short Status Report
0930		Non-Moderated Time
1000		Splitter Meetings
1100	Kick-Off Presentations	Preparation of next Session
1130	Introduction	
1140	Study Background	
1200	System	
1210	Mission Analysis	
1230	Lunch Break	Lunch Break
1300	Lunch in DLR canteen	Lunch in DLR canteen
1330	Short rest period	Short rest period
1400	Session #1	Non-Moderated Time
1430	Responsibility Allocation	Action Items
1500	ViS&I introduction	Splitter Meetings
1530	Input into ViS&I (mass, dimensions, temperatures)	Preparation of next Session
1550	Domain Round	
1600		
1630		
1700		
1730		
1800		
1830		

no commits

no commits

...but after work

Default mode only!

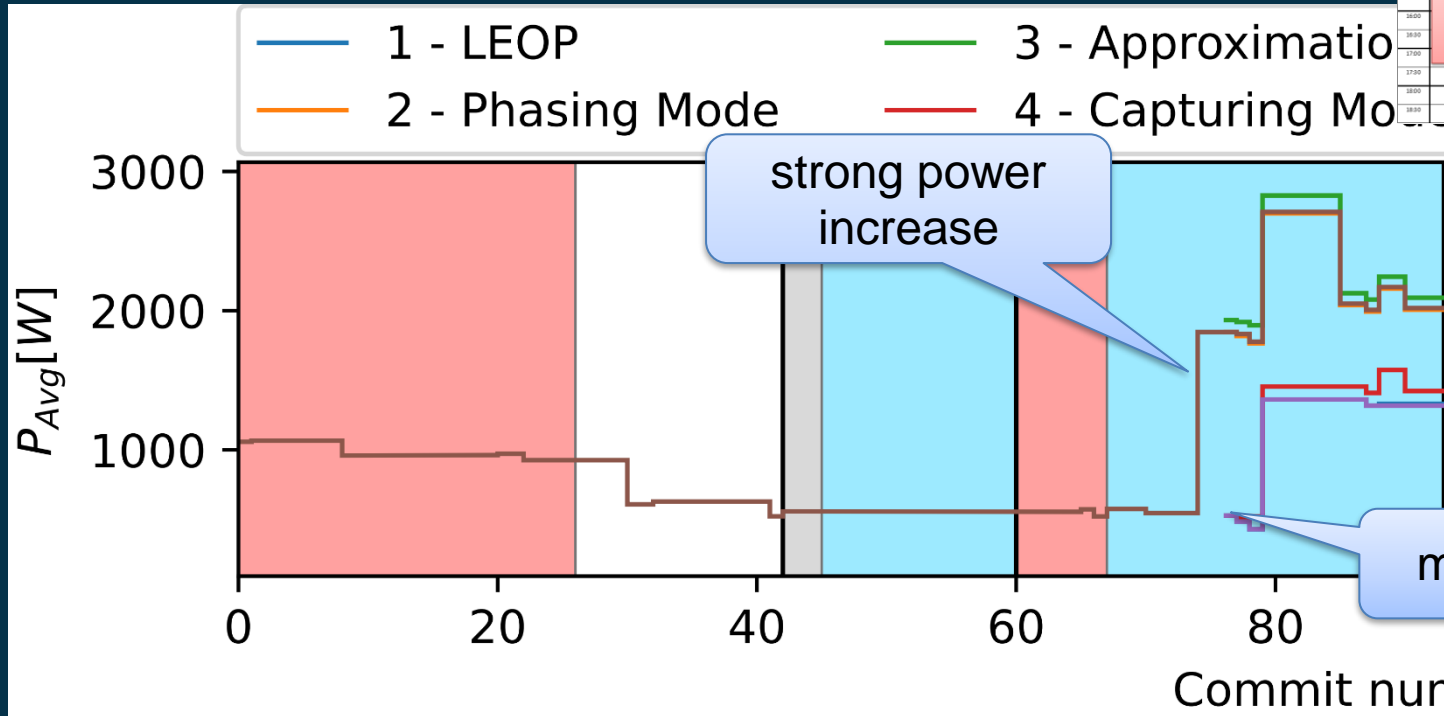


Progression of Power Parameters

Until 3rd day

Time	Mo	Tue	Wed
0900			
0930		Short Status Report	Session #2
1000		Non-Moderated Time	Modes of Operation
1030		Action Items	Configuration
1100	Kick-Off Presentations	Splinter Meetings	Input into V&Sat (mass, dimensions, temperatures, power)
1130	Introduction	Preparation of next Session	Domain Round
1145	Study Background		
1200	Systems		
1215	Mission Analysis		
1230	Lunch Break	Lunch Break	Lunch Break
1300	Lunch in Uni-canteen	Lunch in Uni-canteen	Lunch in Uni-canteen
1330	Short rest period	Short rest period	Short rest period
1400	Session #1	Non-Moderated Time	Non-Moderated Time
1430	Responsibility Allocation	Action Items	Action Items
1500	V&Sat introduction	Splinter Meetings	Splinter Meetings
1530	Input into V&Sat (mass, dimensions, temperatures)	Preparation of next Session	Preparation of next Session
1550	Domain Round		
1600			
1630			
1700			
1800			

no commits

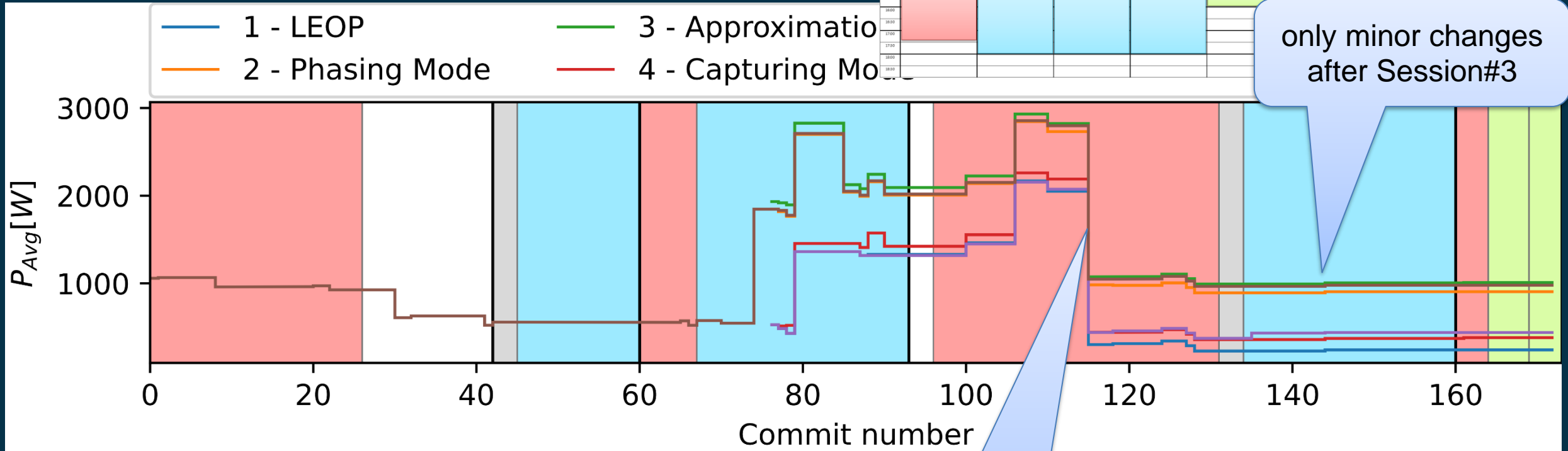


Progression of Power Parameters



Complete study week

Time	Mo	Tue	Wed	Thur	Fr
0900		Short Status Report	Session #2	Session #3	Session #4
1000		Non-Moderated Time	Modes of Operation - Configuration - Input into ViSat (mass, dimensions, temperatures, power)	Domain Round - Open Issues - Latest S/C Decisions	Configuration - Domain Round
1030		Action Items - Splitter Meetings - Preparation of next Session	Domain Round	Configuration session - Input into ViSat - Domain Round	Final Presentations
1100	Kick-Off Presentations				Introduction - Mission Overview - Mission Analysis
1130					Configuration - Mission Analysis - S/C Dec - Structure - Configuration
1200					
1230	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
1300	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period
1330					
1400	Session #1	Non-Moderated Time	Non-Moderated Time	Non-Moderated Time	Final Presentations
1430	Responsibility Allocation - ViSat introduction - Input into ViSat (mass, dimensions, temperatures) - Domain Round	Action Items - Splitter Meetings - Preparation of next Session	Action Items - Splitter Meetings - Preparation of next Session	Action Items - Splitter Meetings - Preparation of next Session - Preparation of Final Presentations	Final Presentations
1500					Final Presentations
1530					Final Presentations
1600					Final Presentations
1630					Final Presentations
1700					Final Presentations
1800					Final Presentations



relevant power design decision during Session#3



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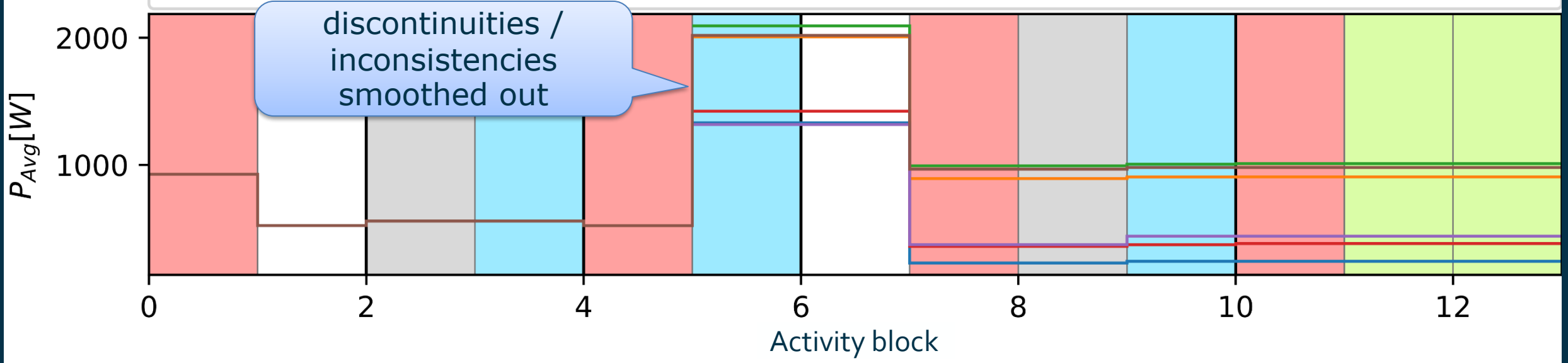


Progression of Power Parameters



Filtered by state at end of activity block

Time	Mo	Tue	Wed	Thur	Fr
0900					
0930		Short Status Report	Session #2	Session #3	Session #4
1000		Non-Moderated Time	Modes of Operation - Configuration - Input into ViSat (mass, dimensions, temperatures, jwells) - Domain Round	Domain Round - Open Issues - Latest S/C Decisions - Configuration session - Input into ViSat - Domain Round	Configuration - Domain Round
1030		Action Items - Splitter Meetings - Preparation of next Session			
1100	Kick-Off Presentations				Final Presentations
1130	Introduction - Study Background - Systems - Mission Analysis				Configuration - Mission Analysis - ACS/IBC - Structure - Configuration
1200					
1230	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
1300	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period
1330					
1400	Session #1	Non-Moderated Time	Non-Moderated Time	Non-Moderated Time	Final Presentations
1430	Responsibility Allocation - ViSat introduction - Input into ViSat (mass, dimensions, temperatures) - Domain Round	Action Items - Splitter Meetings - Preparation of next Session	Action Items - Splitter Meetings - Preparation of next Session	Action Items - Splitter Meetings - Preparation of next Session - Preparation of Final Presentations	Final Presentations
1500					
1530					
1600					
1630					
1700					
1800					

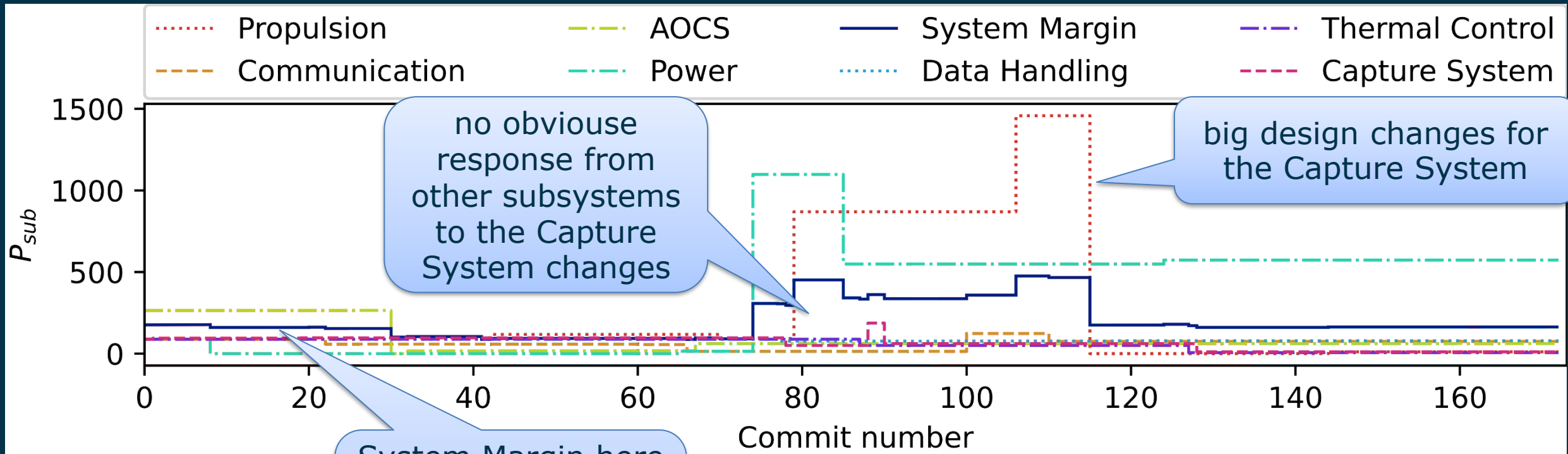


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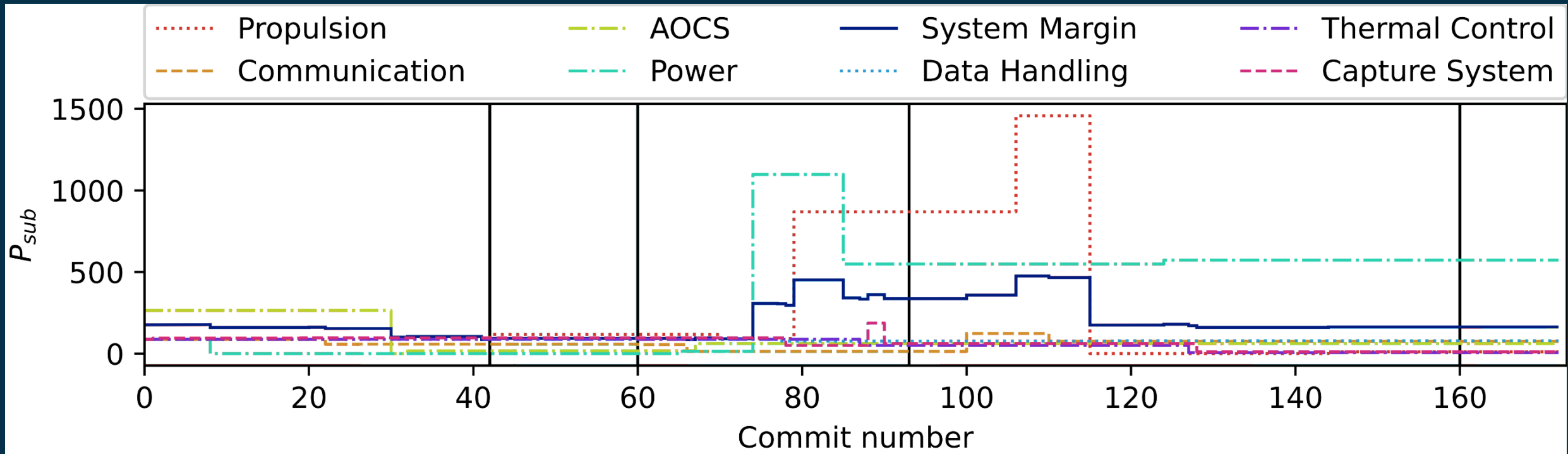


Progression of Power Parameters

Plot of power progression per subsystem for default mode

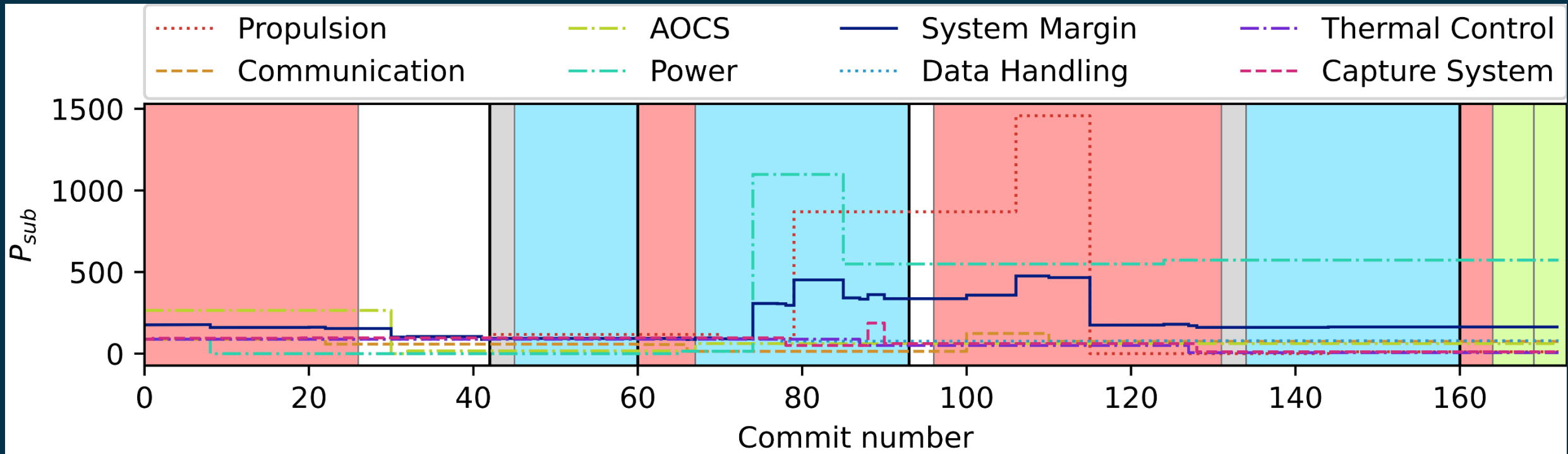


Time information added (day lines)



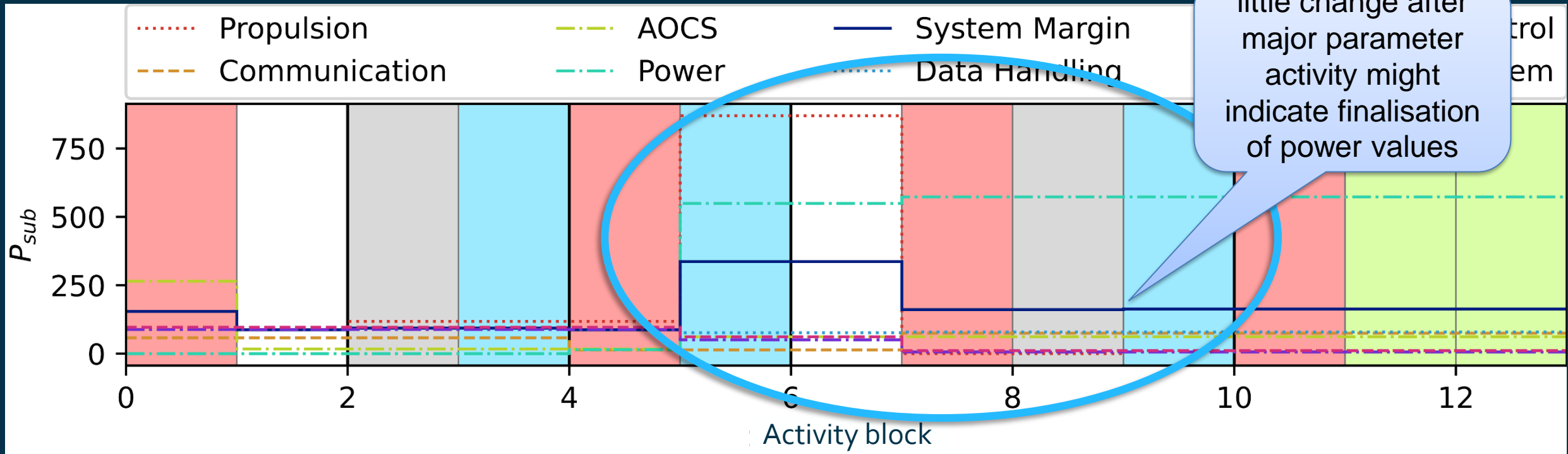
Progression of Power Parameters

„Activity block“ information added



Progression of Power Parameters

Filtered by state at end of activity block

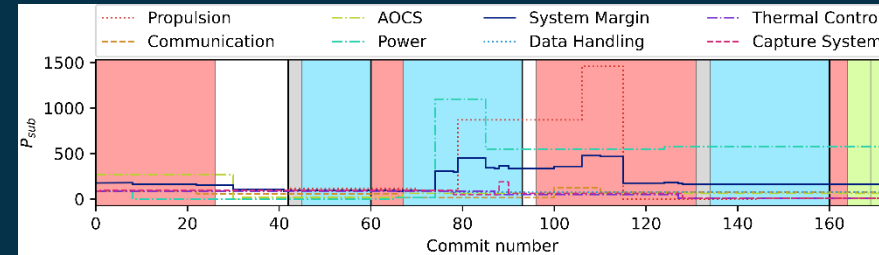
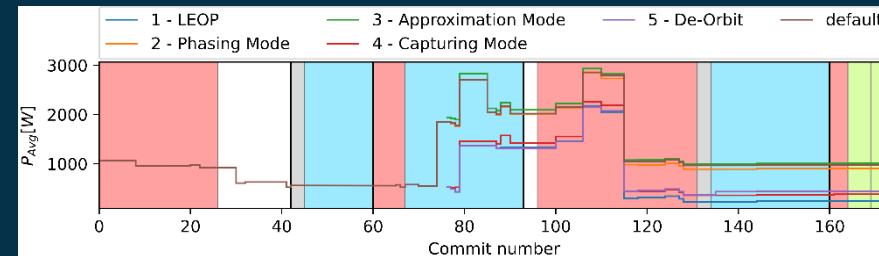


Implications for the design study

Combination of a parameter value progression with study schedule activity blocks was not found in literature and is one key innovation of the presented work:

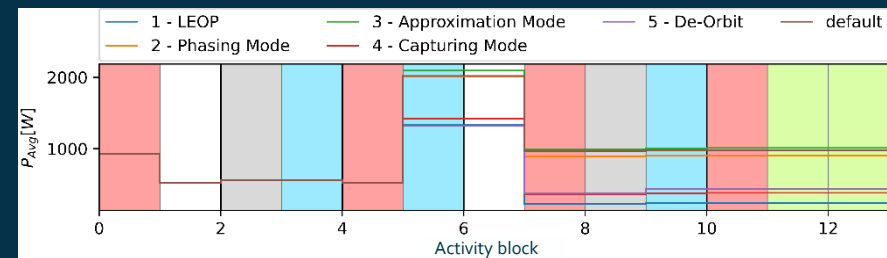
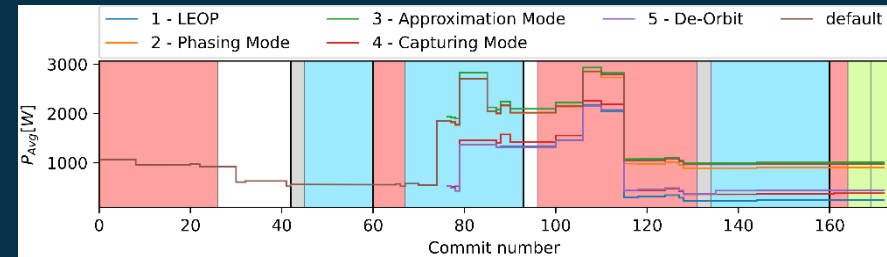
Knowing the CE process applied, it allows for a deeper interpretation of the model behaviour and thus the design progress!

Time	Mo	Tue	Wed	Thur	Fr
0900					
0930		Short Status Report	Session #2	Session #3	Session #4
1000		Non-Moderated Time	Modes of Operation - Configuration - Input into VirSat (mass, dimensions, temperatures, power) - Domain Round	Domain Round - Open Issues - Latest S/S decisions - Configuration session - Input into VirSat - Domain Round	Configuration - Domain Round
1030		Action Items - Splinter Meetings - Preparation of next Session			
1100	Kick-Off Presentations				Final Presentations
1130	Introduction - Study Background - Systems - Mission Analysis				CaptureSystem - Mission Analysis - ACS/ GNC - Structure - Configuration
1200					
1230	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
1300	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period	Lunch in Uni-canteen - Short rest period
1330					
1400	Session #1	Non-Moderated Time	Non-Moderated Time	Non-Moderated Time	Final Presentations
1430	Responsibility Allocation - VirSat Introduction - Input into VirSat (mass, dimensions, temperatures) - Domain Round	Action Items - Splinter Meetings - Preparation of next Session	Action Items - Splinter Meetings - Preparation of next Session	Action Items - Splinter Meetings - Preparation of next Session - Preparation of Final Presentations	Power - Data Handling - Communication - Thermal - Systems - Conclusion
1500					
1530					
1600					
1630					
1700					
1730					
1800					
1830					



Implications for the design study

Viewing the values at the end of each activity block serves to filter out outliers and thus leads to an easier to read course of the curves



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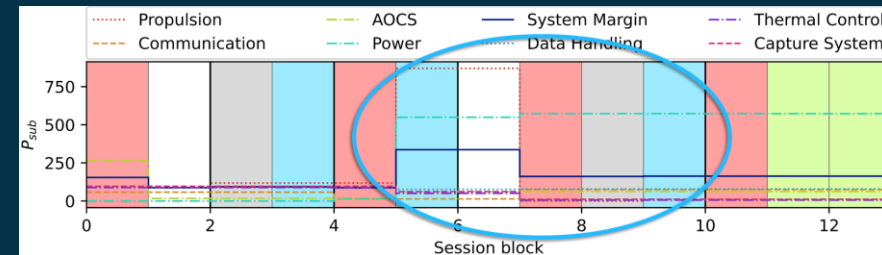
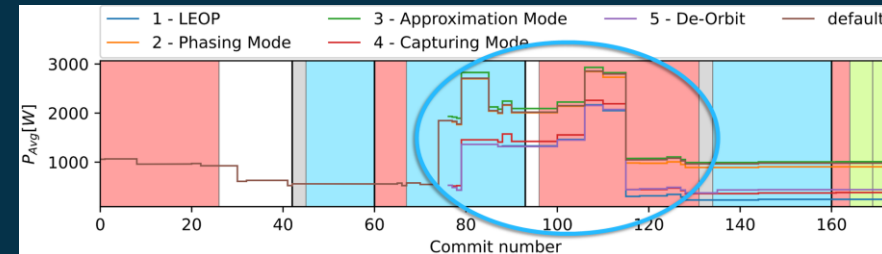
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Implications for the design study

If **alternating behavior** (little changes after major parameter activity) is pattern that can be applied to other studies as well, it could help the team leader of a CE study to **make pre-emptive estimations** during the course of the study:

Preliminary study **schedule** and planned number of sessions will be **appropriate to achieve a consistent design at the end**



Thank you for your attention!

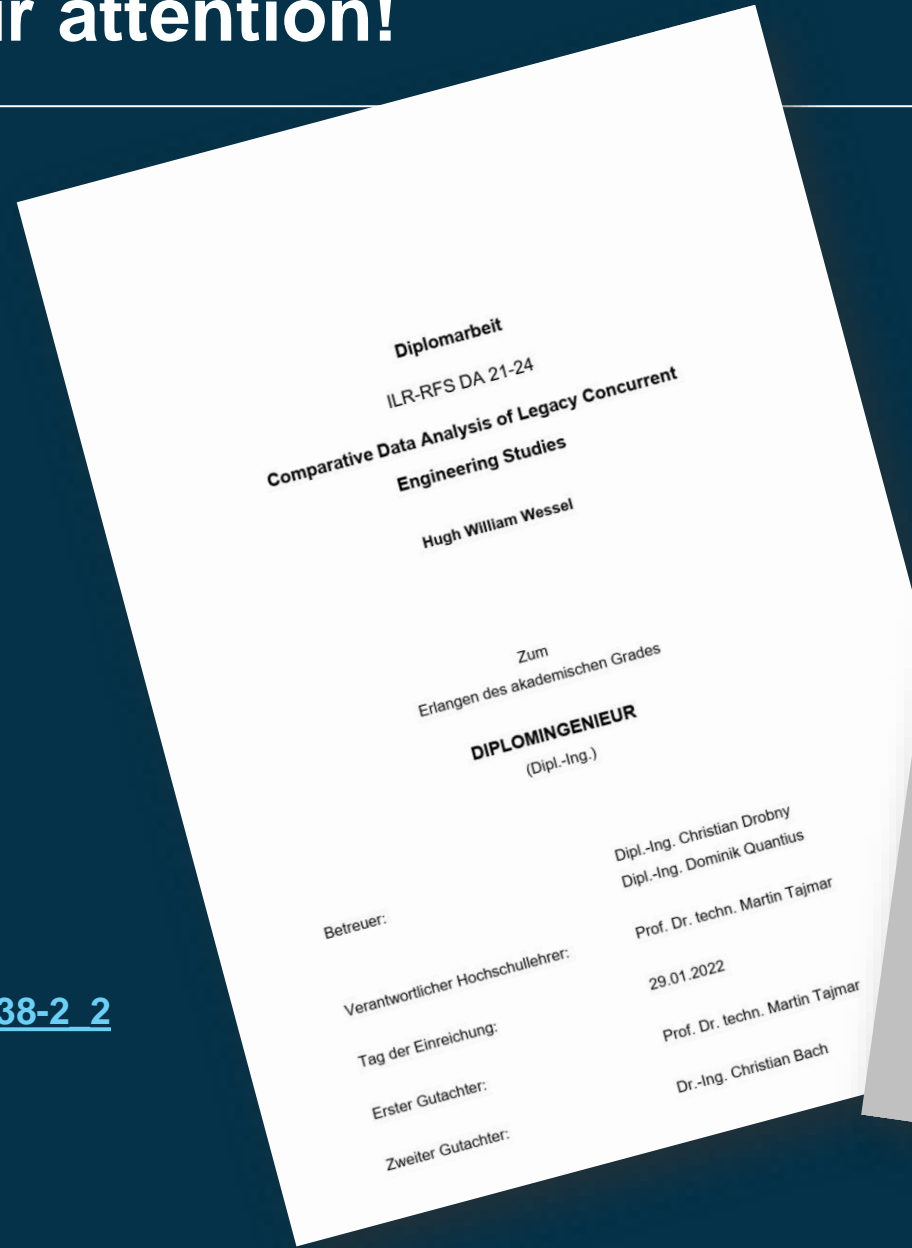


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<https://elib.dlr.de/187059/>

https://doi.org/10.1007/978-3-031-16538-2_2

<https://github.com/virtualsatellite>

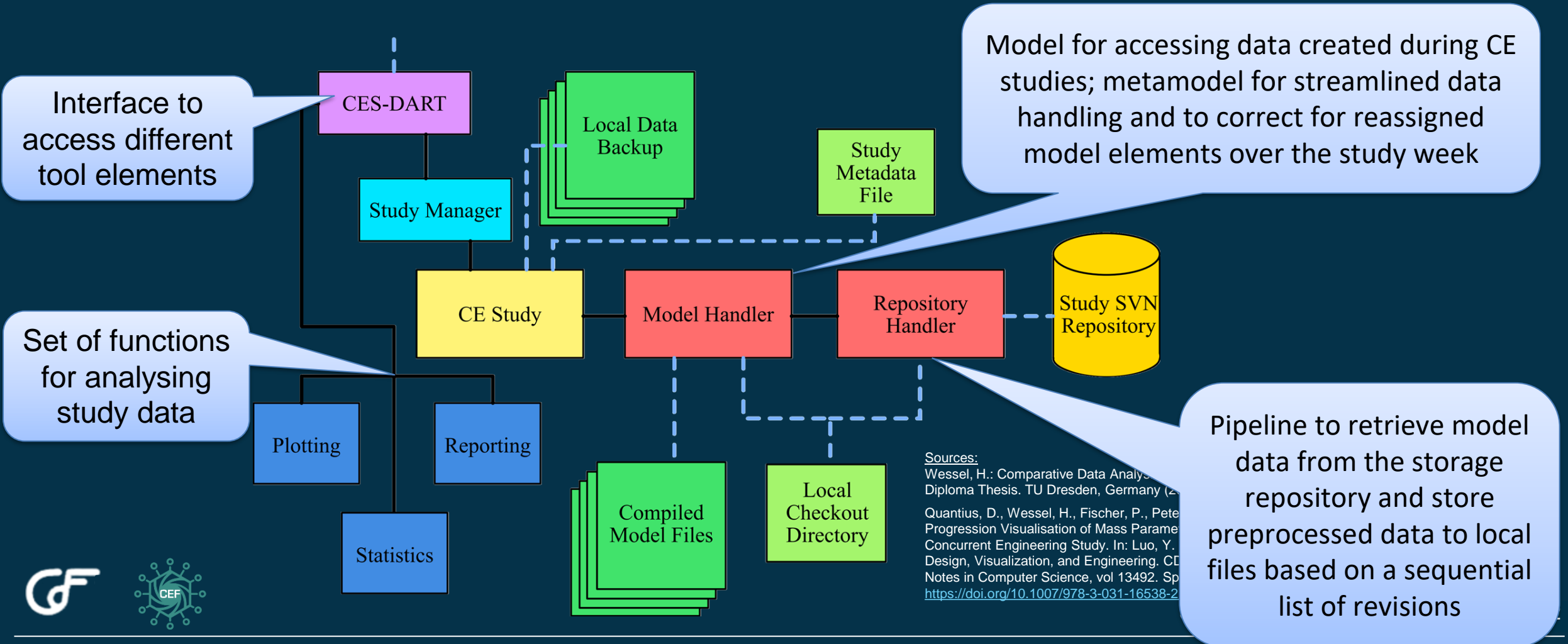


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→ THE EUROPEAN SPACE AGENCY

High-level diagram of code hierarchy



Sources:
 Wessel, H.: Comparative Data Analysis. Diploma Thesis. TU Dresden, Germany (2008).
 Quantius, D., Wessel, H., Fischer, P., Petermann, M.: Progression Visualisation of Mass Parameter Evolution in a Concurrent Engineering Study. In: Luo, Y. (Ed.) Design, Visualization, and Engineering. CE Notes in Computer Science, vol 13492. Springer, 2011. <https://doi.org/10.1007/978-3-031-16538-2>








Ask the SECESA 2022 Audience



In order to engage the audience, please you are asked to define up to 3 **agree/disagree questions** to trigger their reaction and feedback vis è vis your work.

Please note that the agree/disagree scale shall be as follows:

-  Strongly agree
-  Somewhat agree
-  Neither agree nor disagree
-  Somewhat disagree
-  Strongly disagree

The organisers will inject your **agree/disagree questions** into an interactive tool that will be used at the end of your presentation.



Please Remove this page from your final set of slides



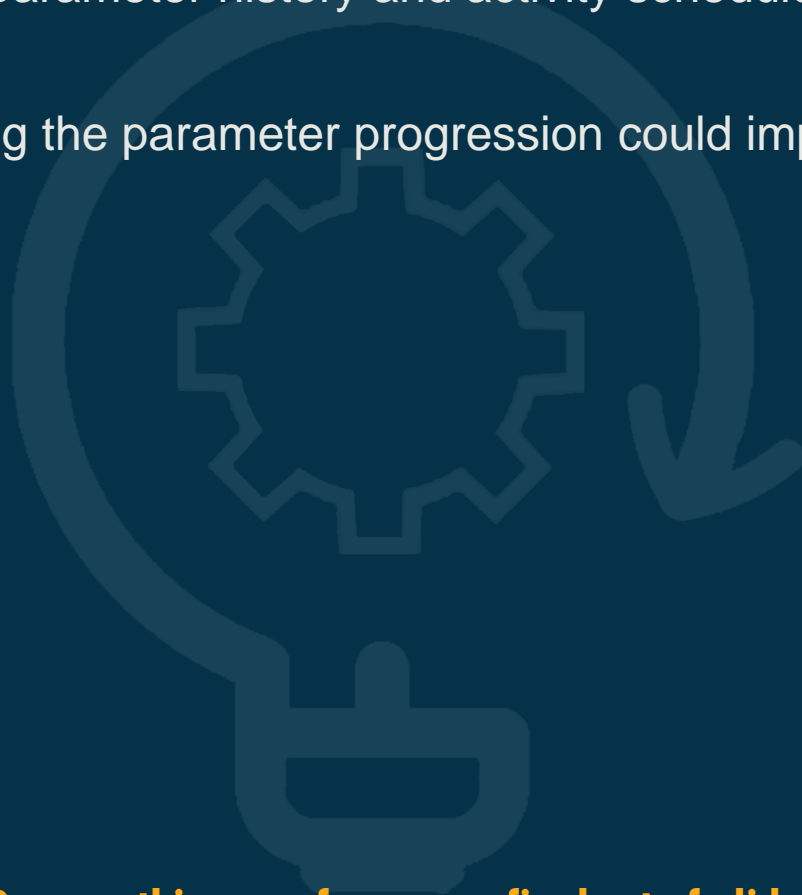
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Agree/Disagree Questions

1. Do you already work with parameter progression visualisations during CE studies or systems engineering?
2. Have you seen the combination of parameter history and activity schedule for visualisation already somewhere else?
3. Do you think a dashboard visualising the parameter progression could improve CE / SE?



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