IMCC and MuCol Annual Meeting 2025

Parameter Updates 2025

16th May 2025

R. Taylor

International MUON Collider Collaboration
MuCol
Funded by the European Union
CLUSTER OF EXCELLENCE QUANTUM UNIVERSE
Universität Hamburg DER FORSCHUNG | DER LEHRE | DER BILDUNG
DESY.
CERN

Overview

MuCol Parameter Report 2025

Muon Collider Options

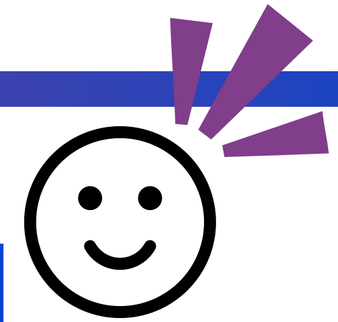
Big Parameters

Trade-Offs and Accelerator Models

Smaller Parameters

MuCol Parameter Report 2024

Thank you for all your contributions!



MuCol

Funded by the European Union

Grant Agreement No: 101094300

MuCoL

A Design Study for a Muon Collider complex at 10 TeV centre of mass

Horizon Europe Framework Programme

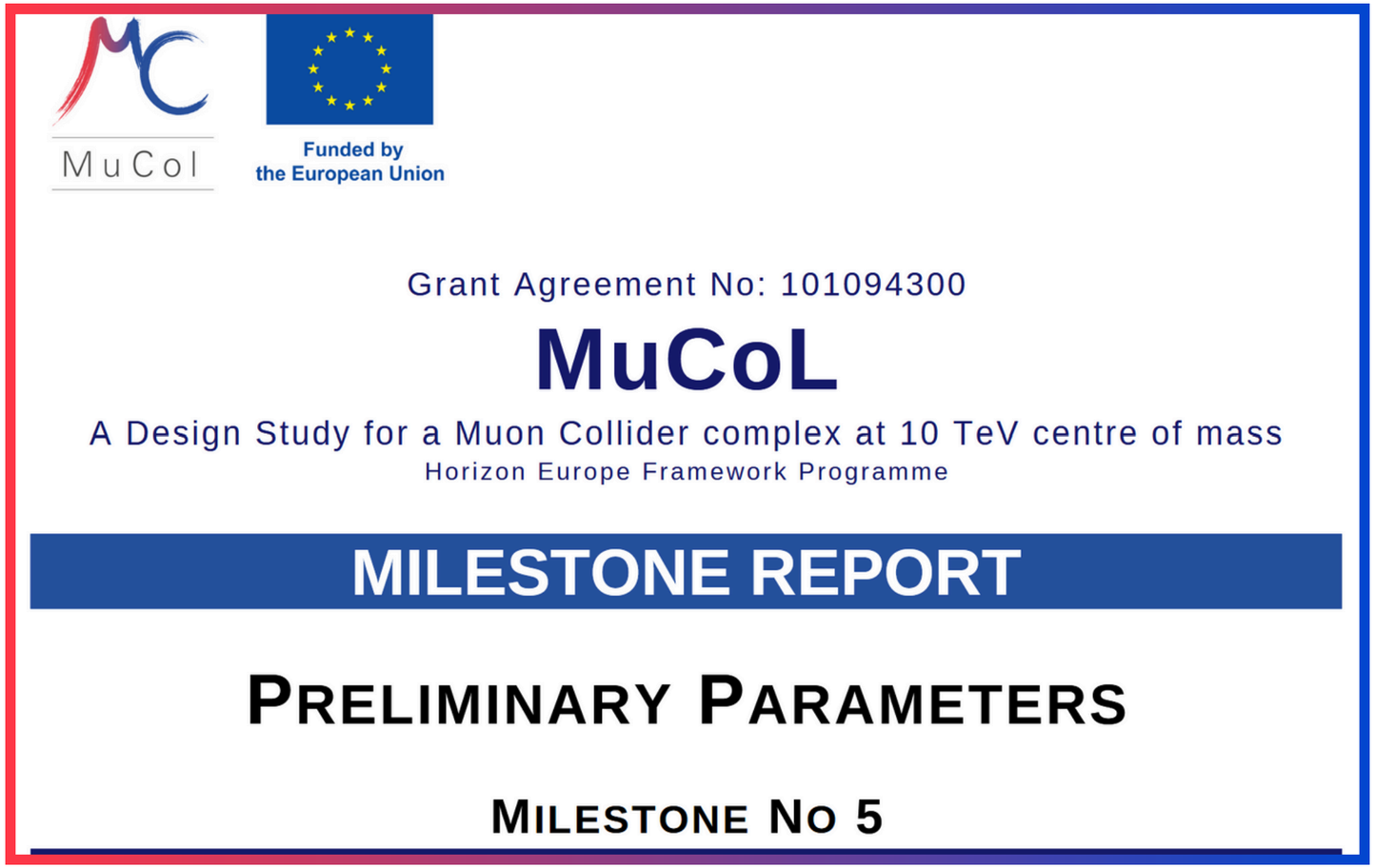
MILESTONE REPORT

PRELIMINARY PARAMETERS

MILESTONE NO 5

MuCol Parameter Report 2024

Thank you for all your contributions!



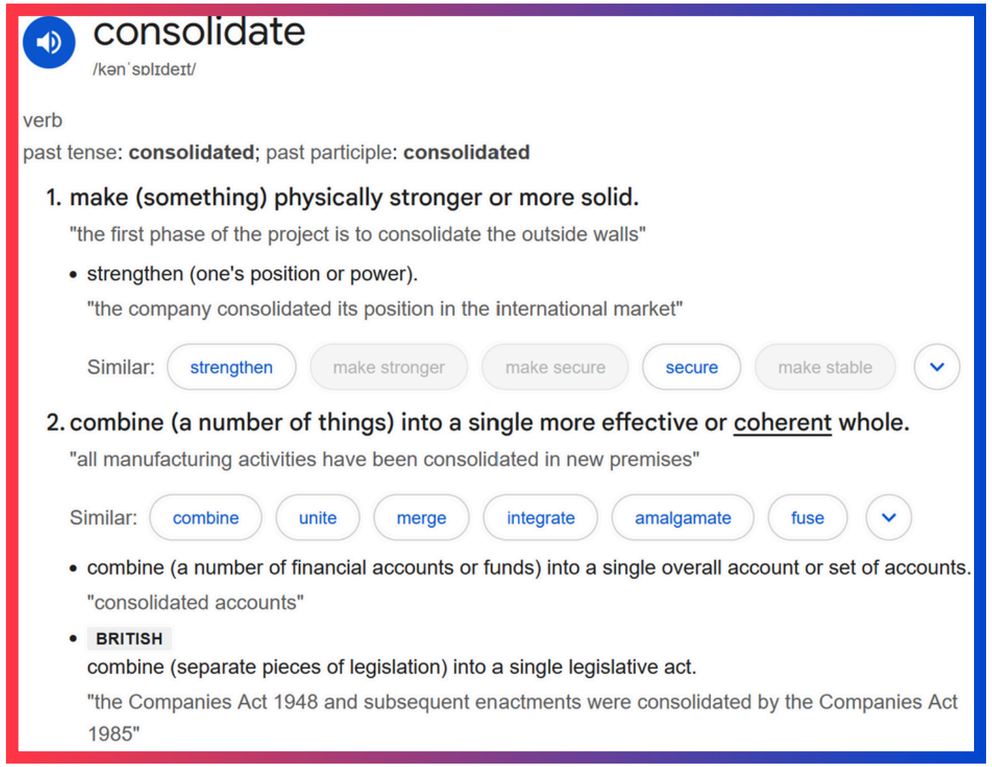
...now lets do it again!

MuCol Parameter Report 2025

Title: **Consolidated parameters**
Deadline: **31st October 2025**

Useful not just as paperwork, but as a reference to check other systems.

I will re-open the spreadsheet for smaller iterative changes, taking 2024 report & ESPPU as baseline.


consolidate
/kənˈsɒlɪdeɪt/

verb
past tense: **consolidated**; past participle: **consolidated**

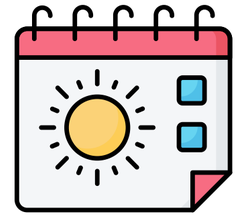
1. **make (something) physically stronger or more solid.**
   "the first phase of the project is to consolidate the outside walls"
   - strengthen (one's position or power).
     "the company consolidated its position in the international market"

   Similar: strengthen | make stronger | make secure | secure | make stable

2. **combine (a number of things) into a single more effective or coherent whole.**
   "all manufacturing activities have been consolidated in new premises"

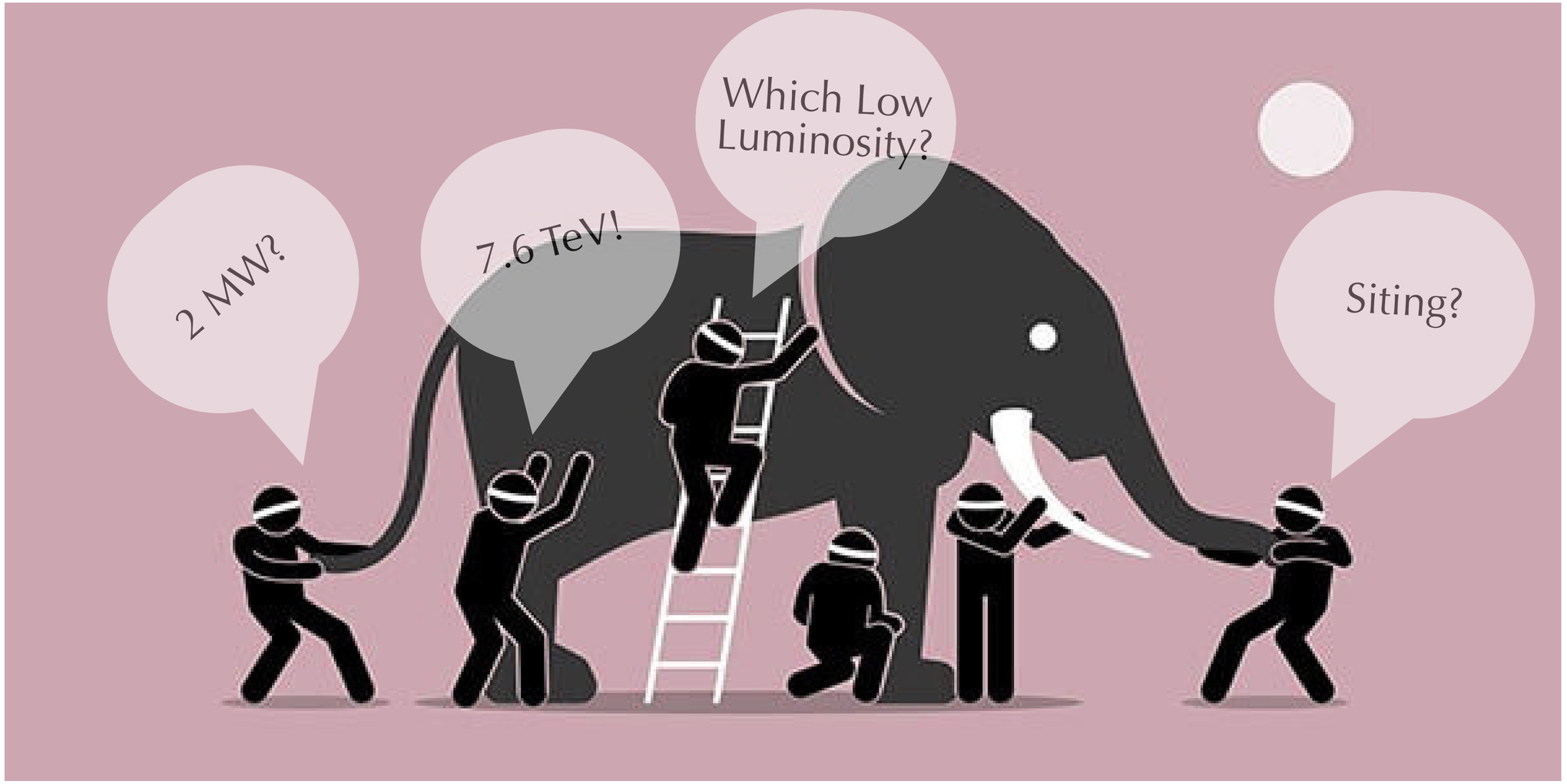
   Similar: combine | unite | merge | integrate | amalgamate | fuse
   - combine (a number of financial accounts or funds) into a single overall account or set of accounts.
     "consolidated accounts"
   - BRITISH
     combine (separate pieces of legislation) into a single legislative act.
     "the Companies Act 1948 and subsequent enactments were consolidated by the Companies Act 1985"

Initiating now, in case there are any parameters which require more preparation, and any inter-group deadlines.



Muon Collider Options

There are many muon colliders. (48 combinations - not inc. site)



Muon Collider Options

There are many muon colliders. (48 combinations - not inc. site)

	Driver	Impact	Technology Difference
2 MW p^+ **4 MW p^+**	Transmission	Intensity in the front-ends	Proton Driver 5 GeV / 10 GeV Target graphite / Lq Pb / Fl W
Rectilinear B8 **Rectilinear B10**	Longitudinal emittance	RF cavities downstream, luminosity	Rectilinear magnet stress and integration
Collider 11 T **Collider 14 T**	Luminosity	Circumference, β*	HTS vs NbSn3
3 TeV **7.6 TeV** **10 TeV**	Energy	Number of RCS, circumference, luminosity, neutrino radiation	RCS magnets, collider optics
Achieved Intensity **Target Intensity**	Decay, optics design	Luminosity, collective effects	Aperture, gradients, optics

Muon Collider Options

There are many muon colliders. (48 combinations - not inc. site)

	Driver	Impact	Technology Difference
2 MW p^+ **4 MW p^+**	Transmission	Intensity in the front-ends	Proton Driver 5 GeV / 10 GeV Target graphite / Lq Pb / Fl W
Rectilinear B8 **Rectilinear B10**	Longitudinal emittance	RF cavities downstream, luminosity	Rectilinear magnet stress and integration
Collider 11 T **Collider 14 T**	Luminosity	Circumference, β*	HTS vs NbSn3
3 TeV **7.6 TeV** **10 TeV**	Energy	Number of RCS, circumference, luminosity, neutrino radiation	RCS magnets, collider optics
Achieved Intensity **Target Intensity**	Decay, optics design	Luminosity, collective effects	Aperture, gradients, optics

Baseline is: 2 MW, RectB8, Collider 14 T, 10 TeV, target intensity

Muon Collider Options

There are many muon colliders. (48 combinations)

	Driver	Impact	Tech	erence
2 MW p^+ **4 MW p^+**	Transmission	Intensity in the front		V / 10 GeV id Pb
Rectilinear B8 **Rectilinear B10**	Longitudinal emittance	RF cavit l		agnet stress and ation
Collider 11 T **Collider 14 T**	Lumin		HTS vs NbSn3	
3 TeV **7.6 TeV** **10 TeV**		of RCS, ircumference, luminosity, neutrino radiation	RCS magnets, collider optics	
Achieved Intensity **Target Intensity**	eay, optics design	Luminosity, collective effects	Aperture, gradients, optics	

Goal of parameters is not to collapse down to one collider (yet). Instead is to make sure we are all on the same page...

Baseline is: 2 MW, RectB8, Collider 14 T, 10 TeV, target intensity?

Incremental Updates

- **Intensity** has impacts across complex
  - Especially collective effects efforts
  - Want latest transmission from systems
- **Other examples non-system dependent?**

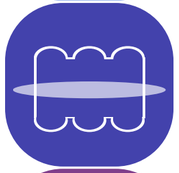
Subsystem	Energy	Length	Achieved Transm.	Achieved μ^-/bunch	Target μ^-/bunch
	GeV	m	%	10^{12}	10^{12}
Proton Driver	5 (p^+)	1500	–	500 (p^+)	
Front End	0.17	150	9	45.0	
Charge Sep.	0.17	12	95	42.8	
Rectilinear A	0.14	363	50	21.4	
Bunch Merge	0.12	134	78	16.7	
Rectilinear B	0.14	424	32	5.3	
Final Cooling	0.005	100	60	3.2	
Pre-Acc.	0.25	140	86	2.8	4.0
Low-Energy Acc.	5	–	*90**	2.5	
RLA2	62.5	○2430	90	2.3	
RCS1	314	○5990	90	2.1	
RCS2	750	○5990	90	1.9	
RCS3	1500	○10700	90	1.7	
3 TeV Collider	1500	○4500	–	1.7	2.2
RCS4	5000	○35000	90	1.5	
10 TeV Collider	5000	○10000	–	1.5	1.8

Key	
	Not yet updated from Oct24
	Same value as Oct24
	Different to Oct24
	Parameter unknown/needs work
	Parameter is Frozen
IR	Interrim Report 2023
ES	ESPPU 2025
UP	Updated Parameters 2024

- Everything else will use traffic-light system on CERNBox Spreadsheet
  - (Link by the end of month)

New Parameters compared to last year


Civil Engineering Parameters?


CTF3 Demonstrator Option?


Parameters driving cost and power?


4 MW target design?

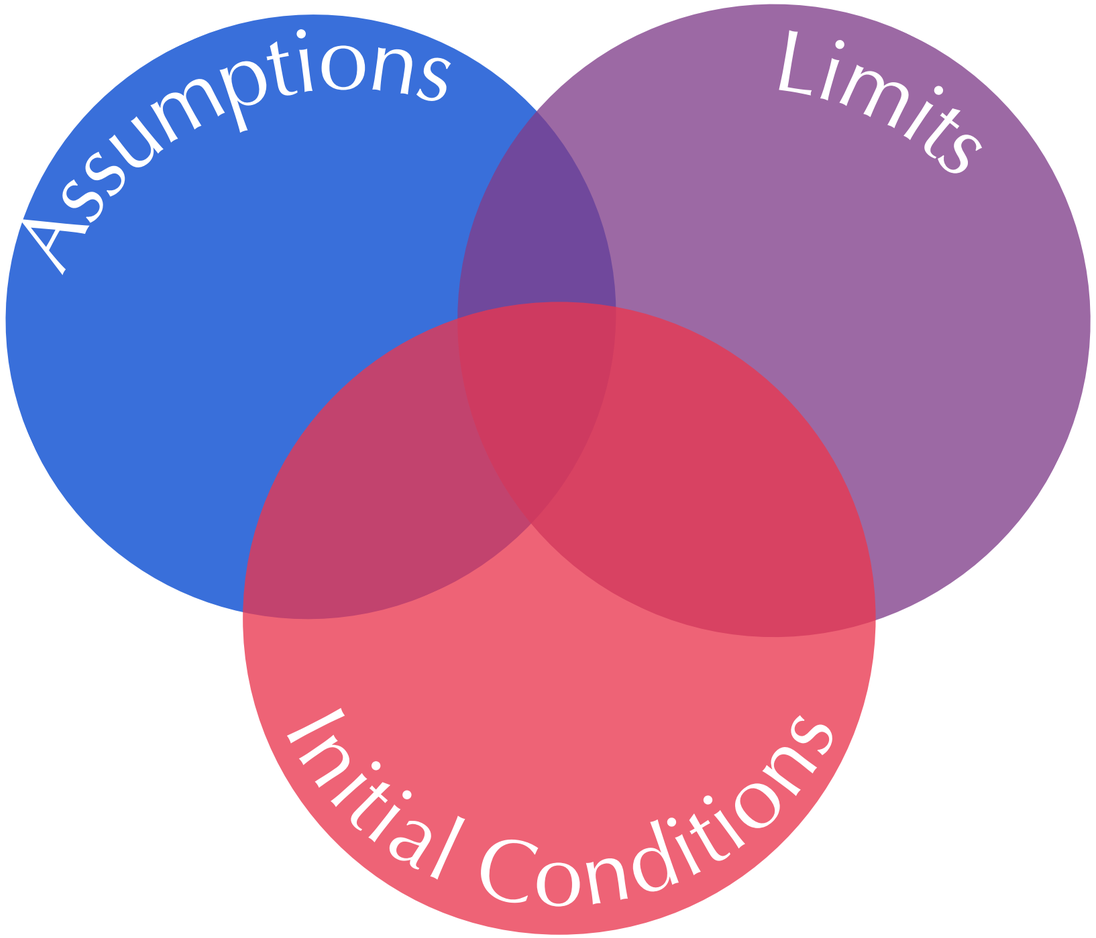

Fixed Field Accelerator parameters?

- **Any other big updates?**

Assumptions, limits and initial conditions

Encourage contributors to consider their design assumptions

- What format is best? List/table/written text?
- Also includes relation between parameters

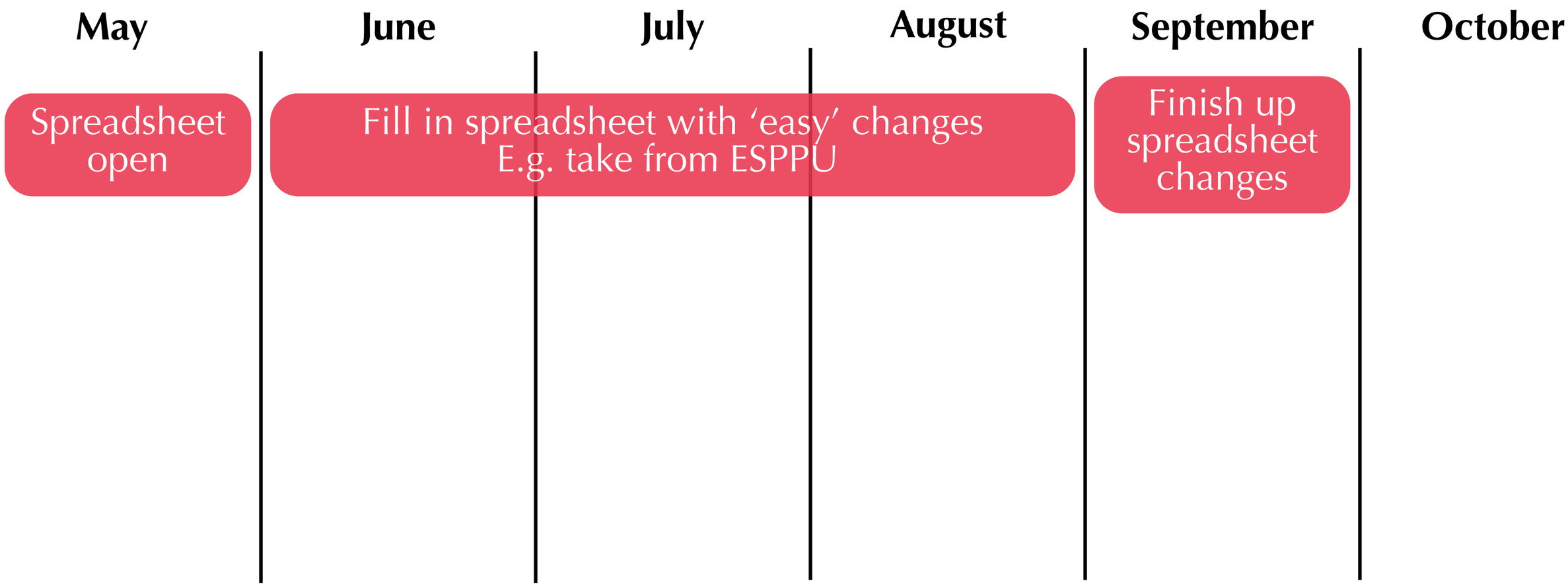


At this stage, constraints are just as important as values

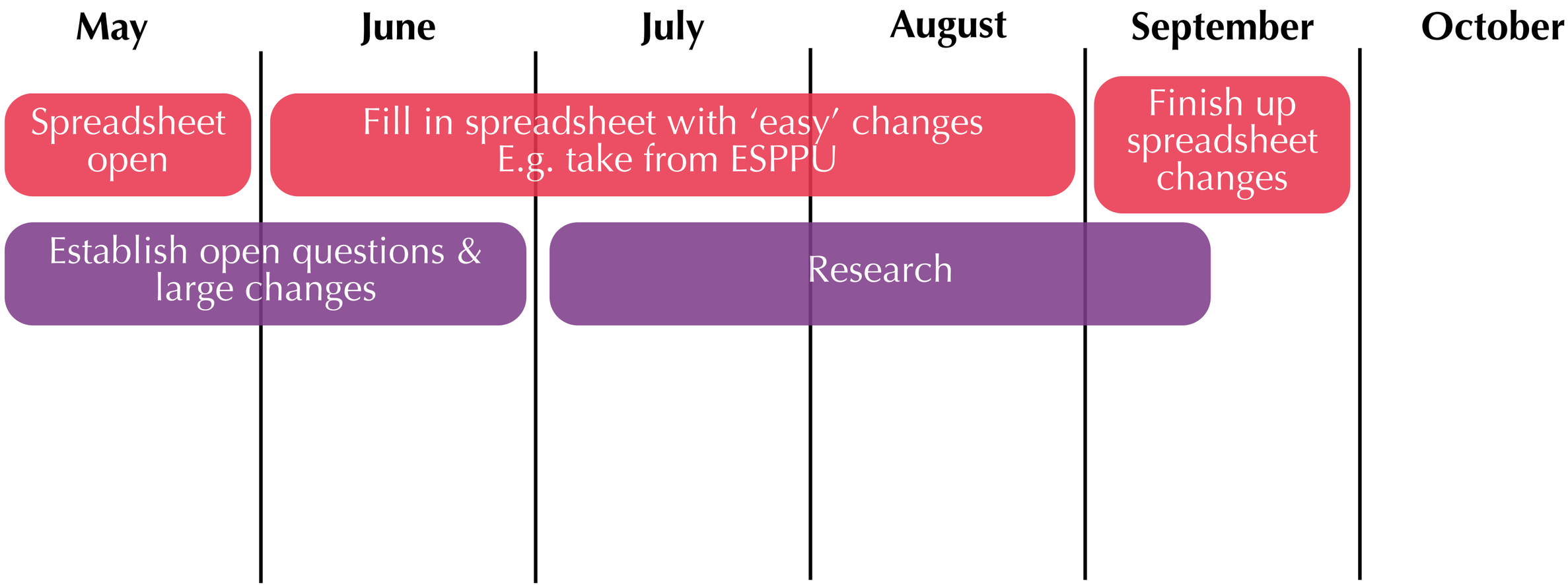
- Would encourage technologies to define major constraints.

Should state explicitly where converging designs have different starting points.

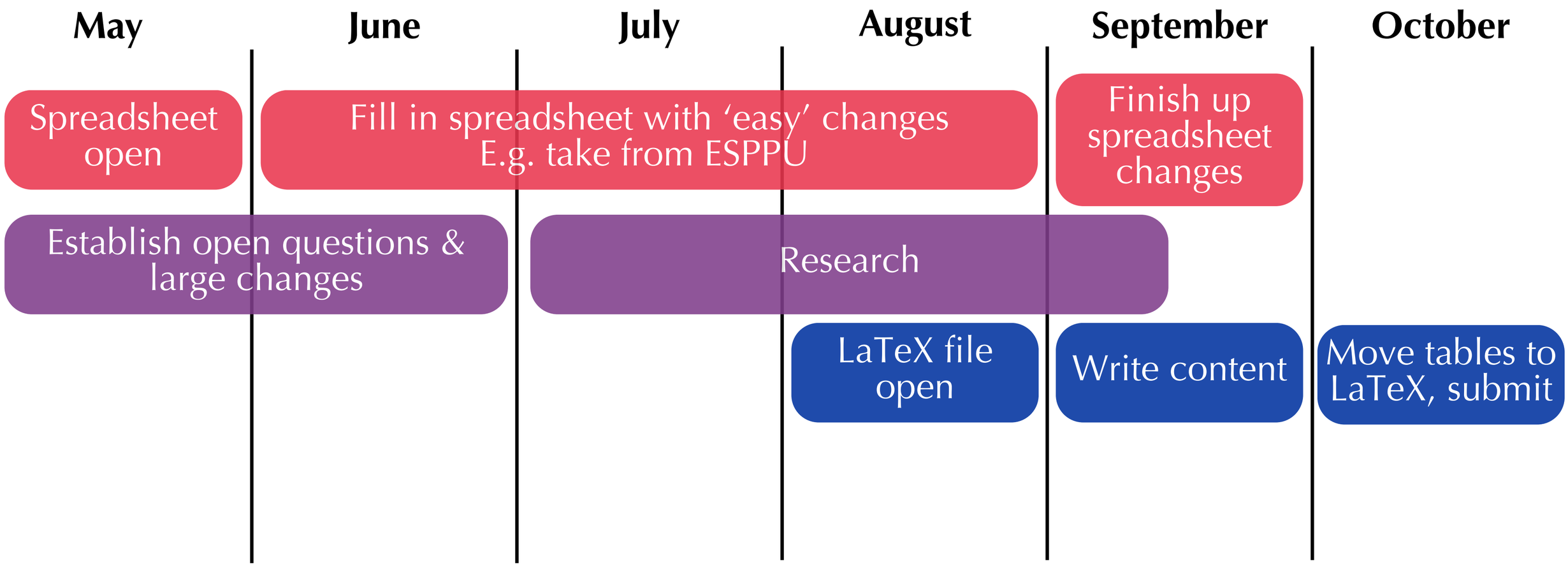
Parameter Timeline 2025



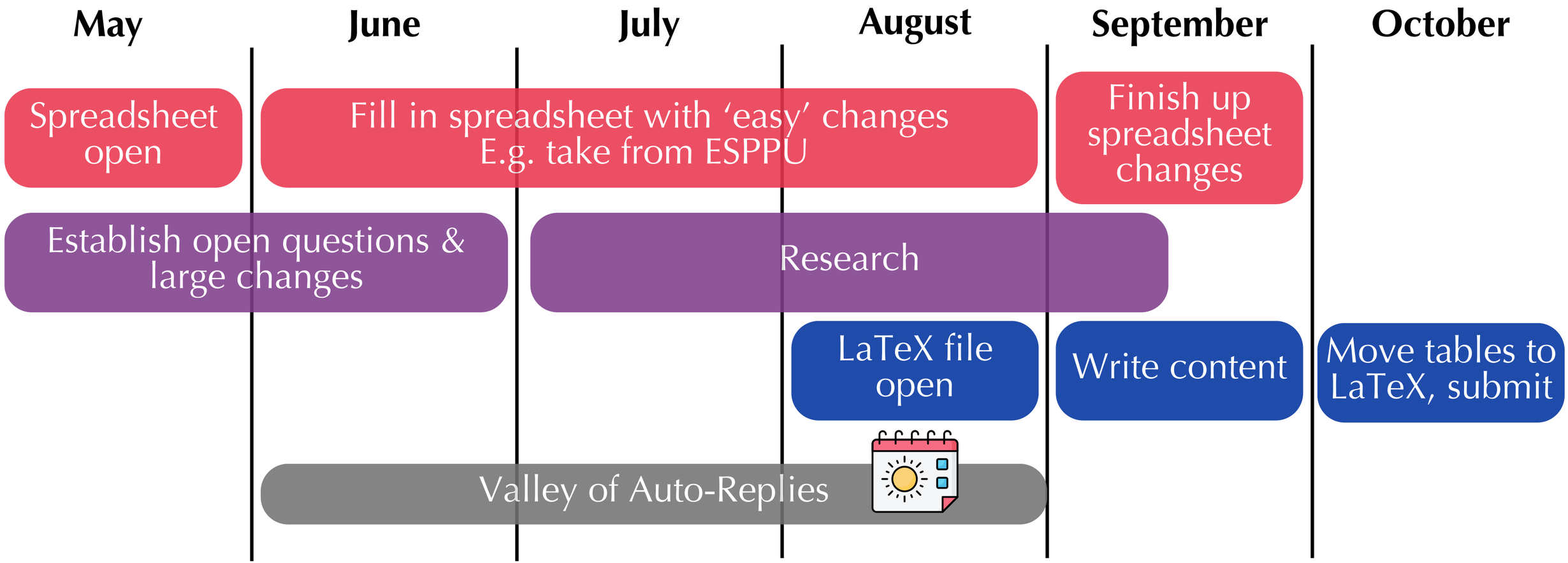
Parameter Timeline 2025



Parameter Timeline 2025



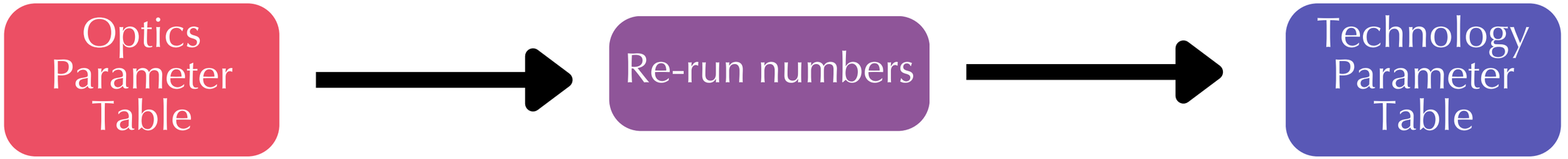
Parameter Timeline 2025



Parameter Timeline 2025

Last year all contributors had the **same timeline**.

- Did not consider interconnected parameters.



Propose main optics tables have deadlines 2 weeks prior to technology tables.

To keep track: **For what parameters would this benefit?**
E.g. *RCS RF*

Summary

Thank you to the community for your hard work, and for a fantastic Muon Collider Week!