

ProtoDUNE-VD plans and schedule

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Initial remarks

- Latest news is that Module-0 installation should be completed by March 7th
 - Must be clarified
- Do we have sufficient time, components and resources to produce 16 modules ?
 - The proposed schedule (next slides) assumes XA installation happens in 3 phases (1. December, 2. January, 3. February)
- Options:
 1. Buy all components assuming this can be done
 2. Go directly to a more conservative scenario with less modules
- Next slides assume 16 modules, but this is something to be discussed

Items on the critical path I

- **SiPMs:** need 2560 for 16 modules
 - We currently have 1452 SiPMs, only 250 from FBK
 - **Plan A:** 750 FBK (5 XA) by mid January . Assembled and tested by mid Feb.
 - **only if installation postponed to end Feb or mounted on bottom membrane XA**
 - **Plan B:** Could have 1200 extra HPK in six weeks —> **Must order next week**
- **Dichroic filters:** need 860 (100x100 equivalent)
 - Order 900 LAr optimised filters: 450 PhotonExport and 450 ZAOT
 - Test production (160 or 300 filters) for mid November. **Must order next week**
 - Mass production for mid December. **Must order mid November**
 - **Plan B:** reuse filters from cold box or spare in labs for December installation

Items on the critical path II

- PCBs take 2 weeks to modify/order, 2 weeks to receive bare boards, and 2 weeks to populate with vendor. For quantity 10 boards, it may take a hand populator 1 week to populate, and we have seen issues with hand population.
- There are 4 flavors of boards to order:
 - 1. DCEM HD style called DMEM
 - 2. DCEM v1.2 for cathode
 - 3. Laser adapter v2.1 for SoF
 - 4. Bias generator (decision?)

Target configuration

- Assuming 16 XA, 8 in membrane and 8 in cathode
- For membrane: 4 behind each short FC wall, half at the top and half at the bottom

	FBK	HPK	TOTAL XAs
Cathode	4	4	8
Membrane	1	5	6
Membrane-SoF	1	1	2
TOTAL SiPMs	960	1600	

Overall ProtoDUNE-VD installation plan

- Presented yesterday by Filippo. **No dates yet —> Need it next week !!!!**

Aim to complete the full assembly in March 2023

November

- Bring in, assemble and lift the field cage support structure
- - Install the vertical cable trays and the PDs supports on the walls
- Re-position the SGFTs (whenever before the first top CRP goes in)

December

Membrane
Cath. Downstream
Cath. Upstream

- - Installation of PD system on the walls
- - Install and cable the CRP+cathode in the upstream position
- - Install and cable the second top CRP and the cathode
- Install (lift) the field cage except the walls to allow bottom CRP installation
- Install the HV extender and the HV feedthrough
- - Install PD and CE penetration
- - Connect the cathode and the fibres of the PDs on the cathode
- Remove and clean part of the false floor
- Install and cable the bottom CRPs
- Remove man lift and remove the TCO beam
- Install the last field cage wall and set field cage in final position
- Install the instrumentation

Which walls ?

Conflict. Can man lift be removed with TCO-side bottom CRP in place ?

Filippo Resnati - LBNC Meeting - 6th October 2022

Conflict with cathode installation in December

- Downstream top CRP is planned to be installed before Christmas
 - CRP and cathode are installed simultaneously. FC behind installed later
- New LAr optimized filters could be at CERN by December 11th
- The cathode might be ready for PD group on the 14th (Philippe)
 - 6 working days until Christmas
 - No time to assemble XA and cabling them before the holidays

Conflict with cathode installation in December

- Five options:

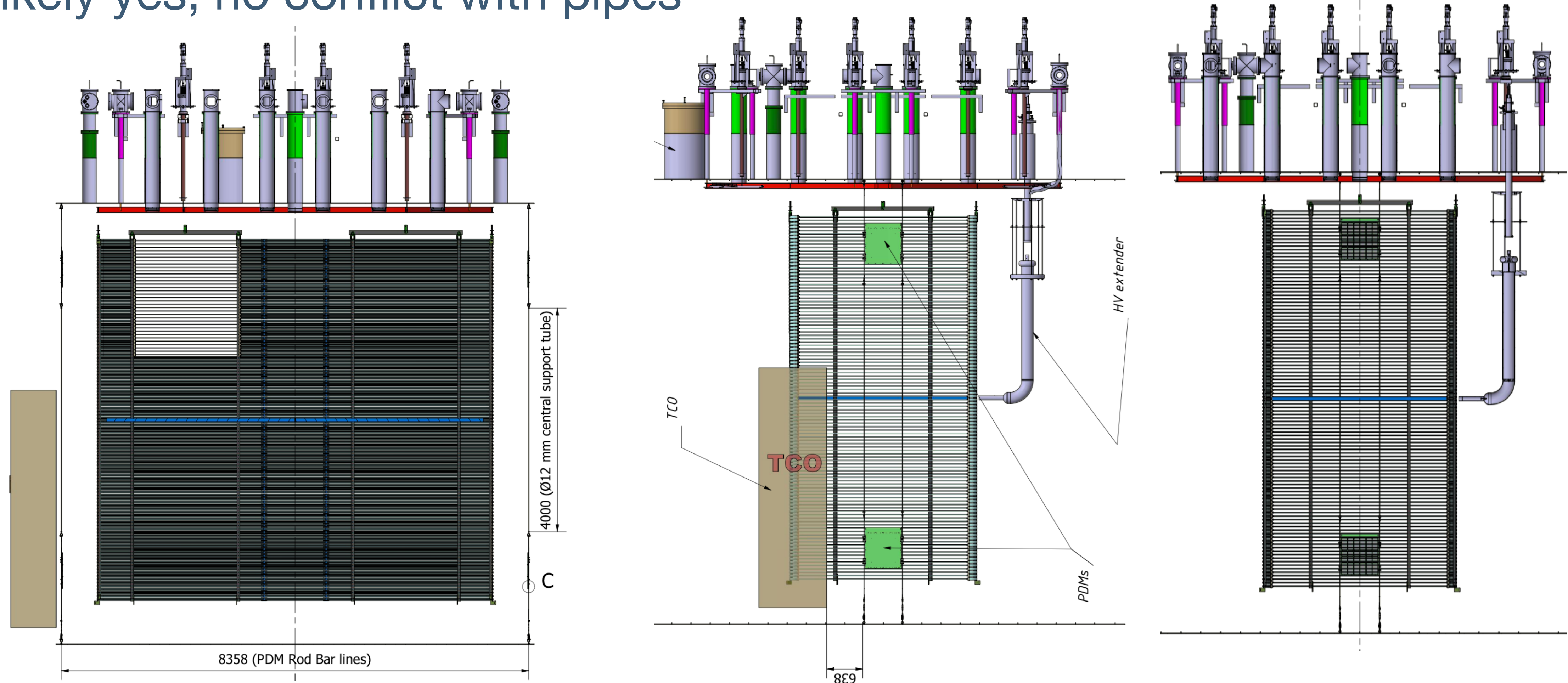
1. Have time to assemble 4 XA and install them in cathode that week: **unlikely**
 - at least 360 filters needed by mid December (2 memb + 4 cath.)
 - Almost impossible even if we get the 360 filters (previous slide)
2. Use existing filters (air optimized) from coldbox + spare at the labs: **not good**
 - Could probably mount XAs but no time to install everything on cathode in Dec.
3. Postpone CRP+cathode installation to January: **best, also for CRP people. Plan A**
4. Install modules later (January) with cathode in place: **to be understood. Plan B**
5. Decouple CRP and cathode (January) installation: **complicated**

Open installation questions I

- Can we install cathode modules with cathode in place ?
- Under investigation
- This would give us more freedom
- Also the possibility of testing modules in place and replacing things in the case of failure

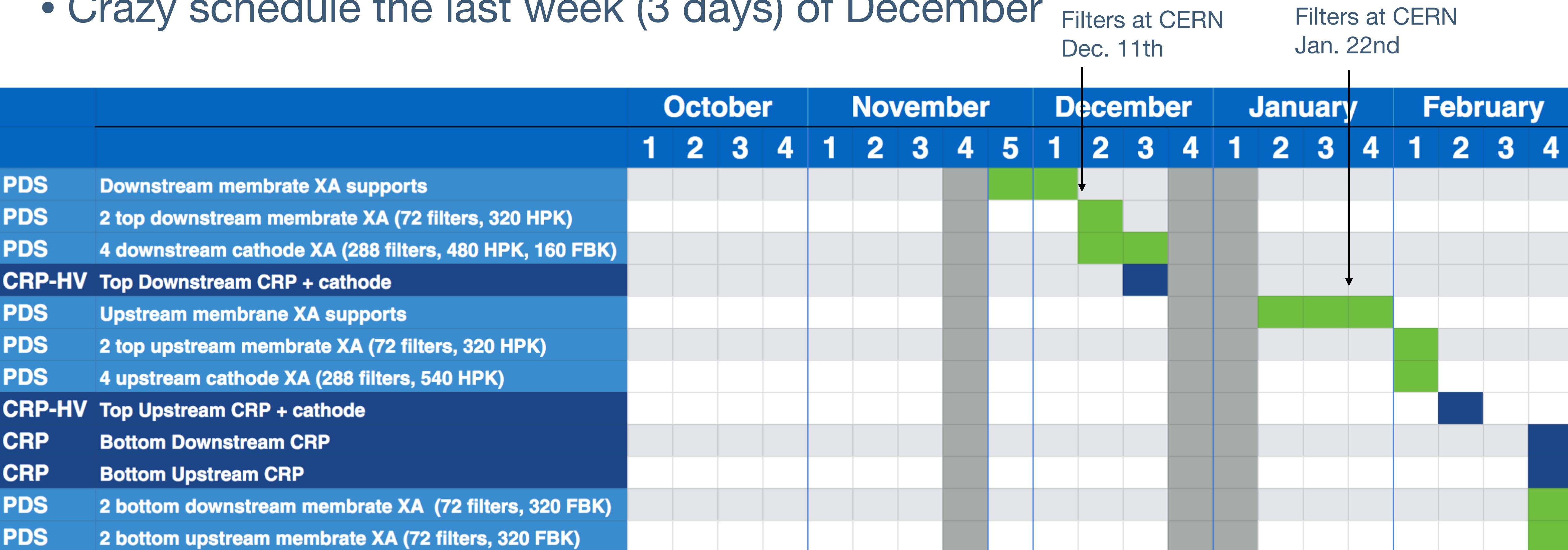
Open installation questions II

- Can we install all bottom membrane modules after FC deployment ?
- Most likely yes, no conflict with pipes



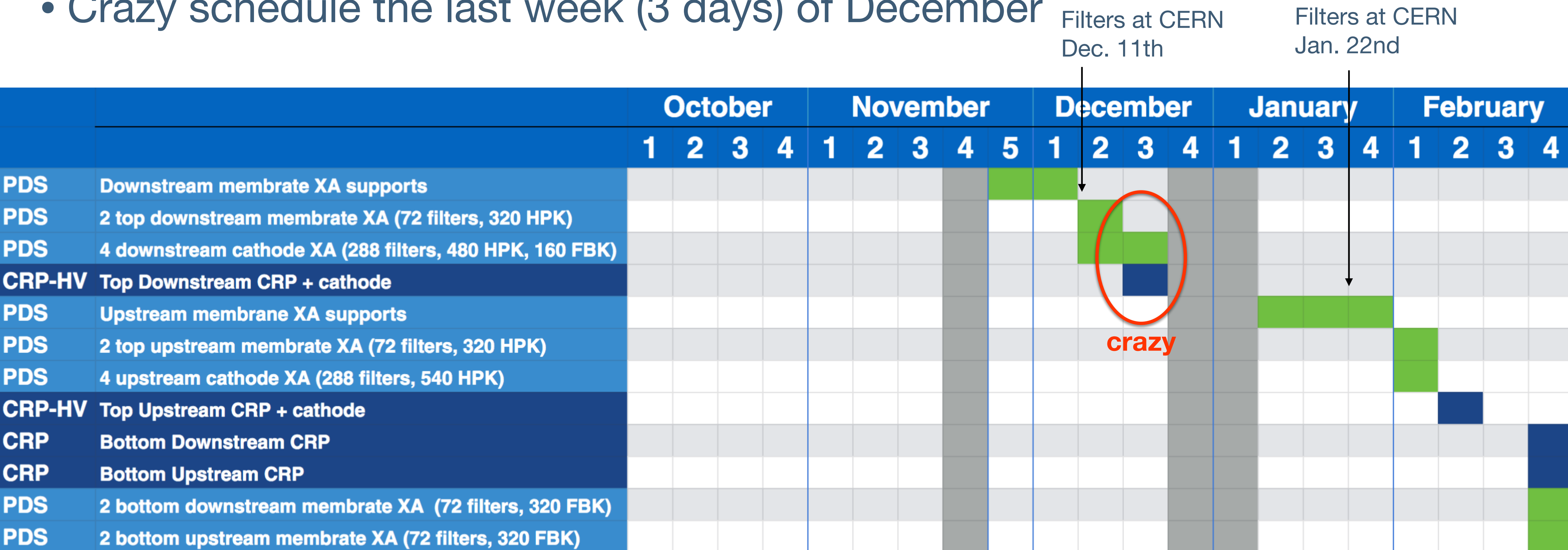
Proposed overall installation sequence I

- With first CRP+cathode installed in December
- Would need 360 filters from test production (risky)
- Crazy schedule the last week (3 days) of December



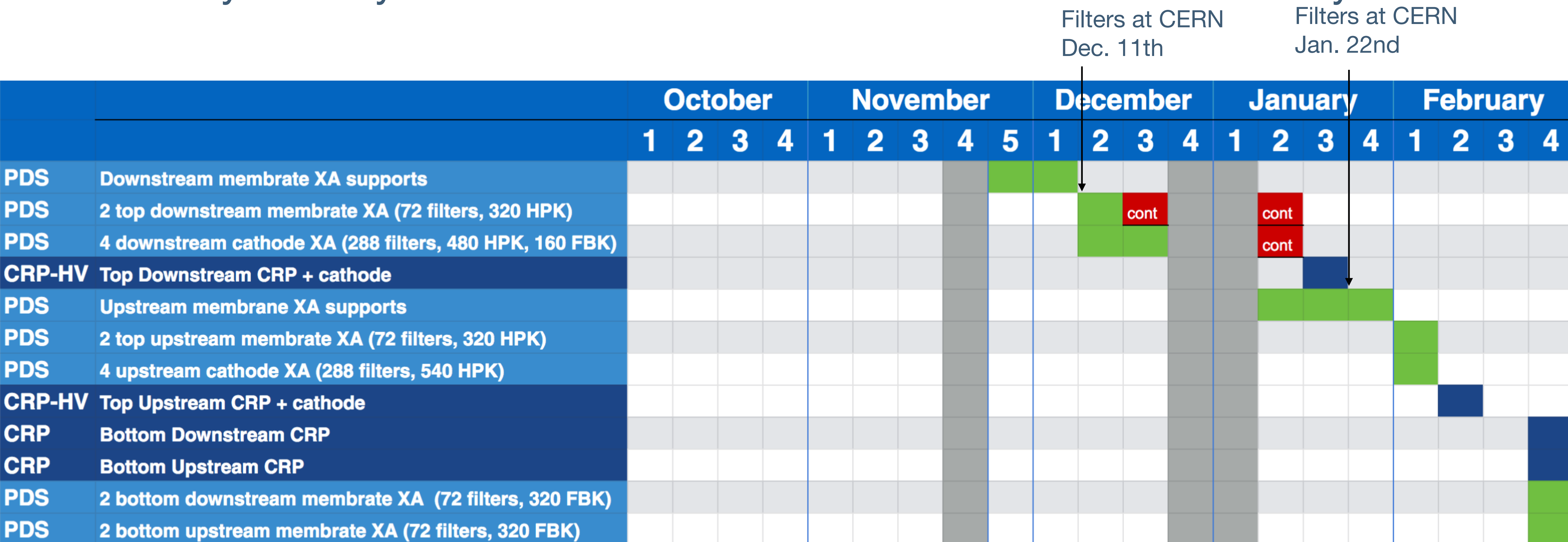
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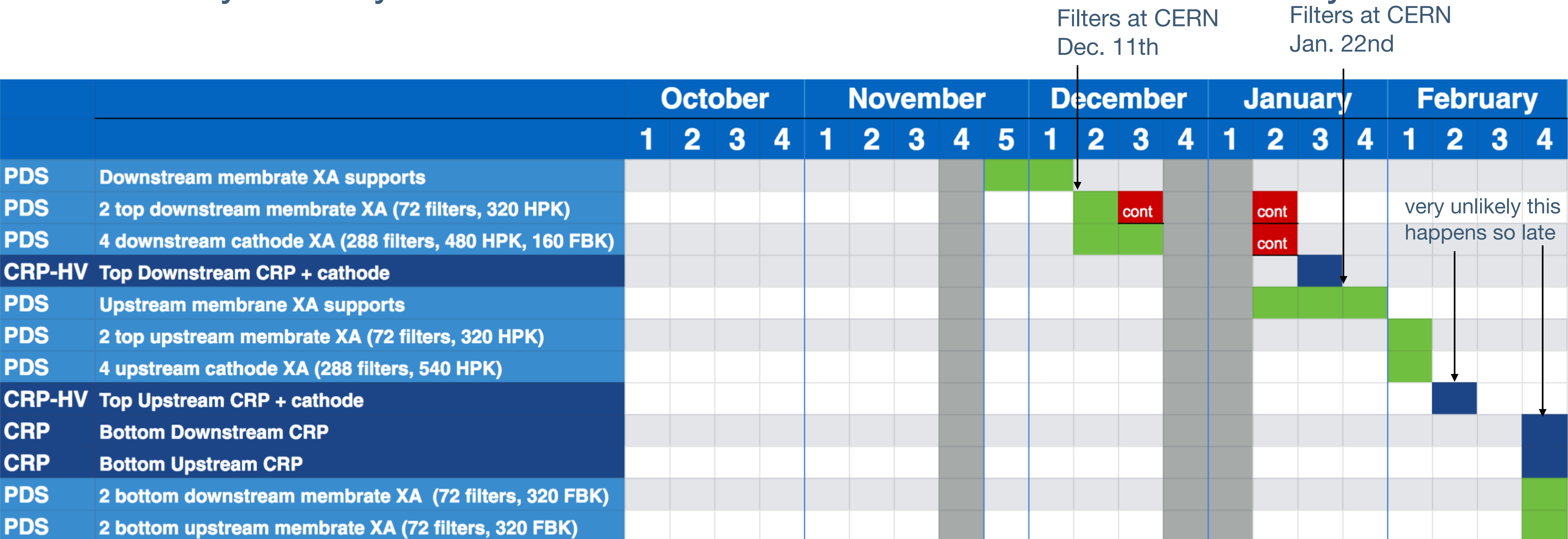
Proposed overall installation sequence II

- If we can postpone first CRP+cathode to January
- Very unlikely if management wants installation completed by March 7th
- Also very unlikely that second CRP+cathode is installed in February



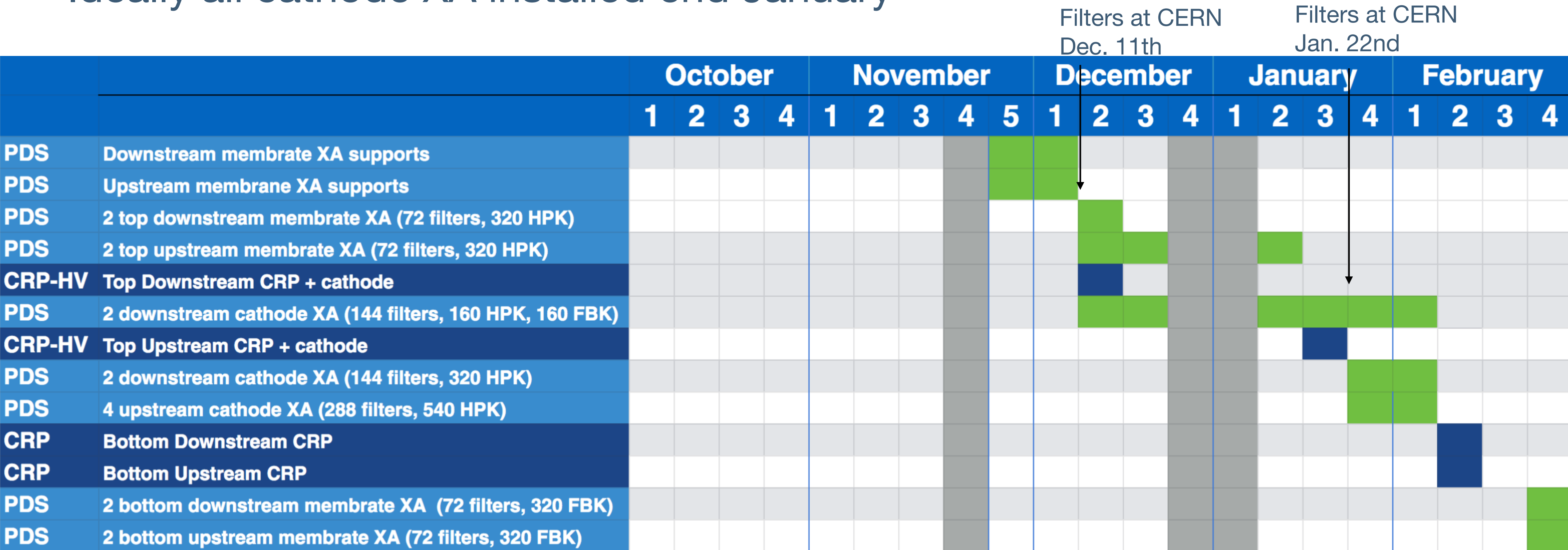
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- Also very unlikely that second CRP+cathode is installed in February



Proposed overall installation sequence III

- Most probable installation scenario, with early CRP-Cathode installation
- Forces us to install XA with cathode in place or reuse existing filters in Dec.
- Ideally all cathode XA installed end January



Filters at CERN
Dec. 11th

Filters at CERN
Jan. 22nd

Summary

- We need dates on the overall Module-0 installation schedule. Next week !!!!
- Several electronic components on the critical path but will most likely not impact the overall schedule (see dedicated talks)
- Fiber installation needs to be included in the schedule, most likely happening in January/February (talks by David and Zelimir)
- XA module availability mainly driven by filters
- If first CRP-Cathode installed in December:
 1. Reuse filters. Not good, this is the cathode that will see most of the beam
 2. Find a way of **installing XA with cathode in place** in January
- Having sufficient XA (6) with FBK SiPMs most likely requires **bottom membrane XA installation with FC in place** (end February)

backup

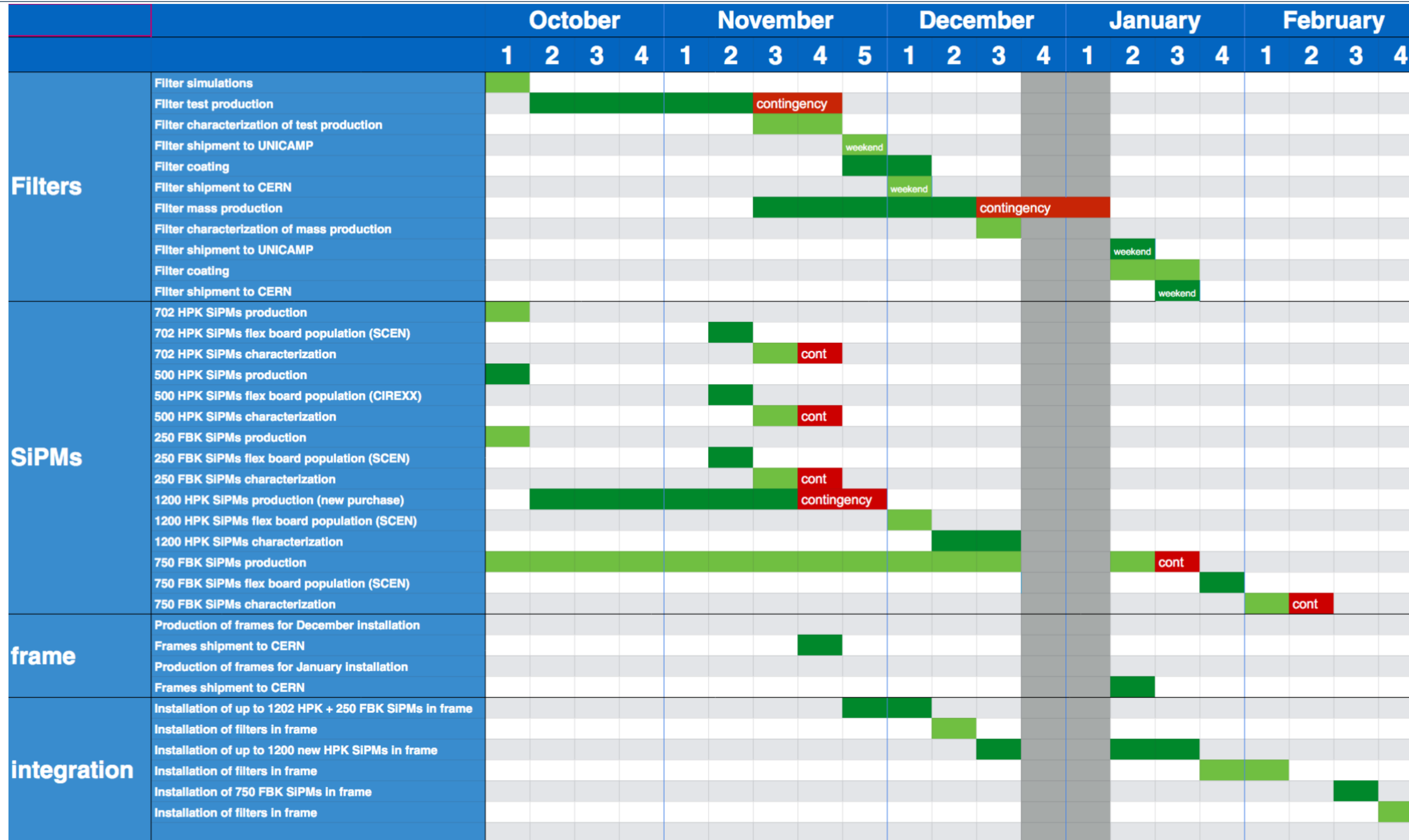
ProtoDUNE-VD PDS goals

- Demonstrate that the system can be built
- Mechanical integration of all components
- Demonstrate new concepts as PoF and SoF under HV conditions
- Test installation procedures

ProtoDUNE-VD PDS performance goals

- Focus on goals that cannot be accomplished in Cold Box or test benches
- Measure overall detected light yield versus position, and compare with ProtoDUNE-VD simulations
 - LY is global measure on how well we understand light production, propagation, detection
 - If data/MC discrepancies exist, try to identify where (eg, LAr absorption length, reflectivity of detector materials, etc.)
 - A realistic MC is necessary for trustable extrapolations to FD2 light yield. Insufficient LY is number 1 risk in VD-TDR.
- Measure PDS-based energy resolution
 - For example “à la LArIAT”, using Michel electrons from cosmic ray stopping muons
- Measure efficiency in matching TPC and PDS flash information
- Measure PDS time resolution
 - Compare timing of different channels in same event. Useful to tune flash finding parameters

X-Arapucas



Response and monitoring system

		October				November					December				January				February			
		1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4
Top fibers	Fibers and diffusers fabrication										contingency											
	Optical feedthrough fabrication and testing										contingency											
	Design of fiber holders			cont																		
	Fabrication of fiber holders					cont																
	Fibers and diffusers shipment to CERN																					
	Optical feedthrough shipment to CERN																					
	Fiber holders shipment to CERN																					
Bottom fibers	Dismantling ProtoDUNE-DP LRM																					
	Fabrication of fiber holders										contingency											
	Shipment to CERN																					
Integration	Top fibers installation																					
	Bottom fibers installation																					

Scenarios for December installation

- Only membrane arapucas
- All with HPK SiPMs

	full test production ready by mid November	reduced test production ready by mid November	test production delayed by more than 2 weeks
bottom membrane arapucas after FC (144 filters)	Scenario D.1.1 all 4 top membrane arapucas with new filters		Scenario D.1.3 reuse existing filters for 4 top membrane arapucas
all membrane arapucas in december (288 filters)	Scenario D.2.1 all 8 membrane arapucas with new filters	Scenario D.2.2 <ul style="list-style-type: none"> • 4 membrane arapucas with new filters • 4 membrane arapucas with existing filters 	Scenario D.2.3 only 4 arapucas can be instrumented with existing filters

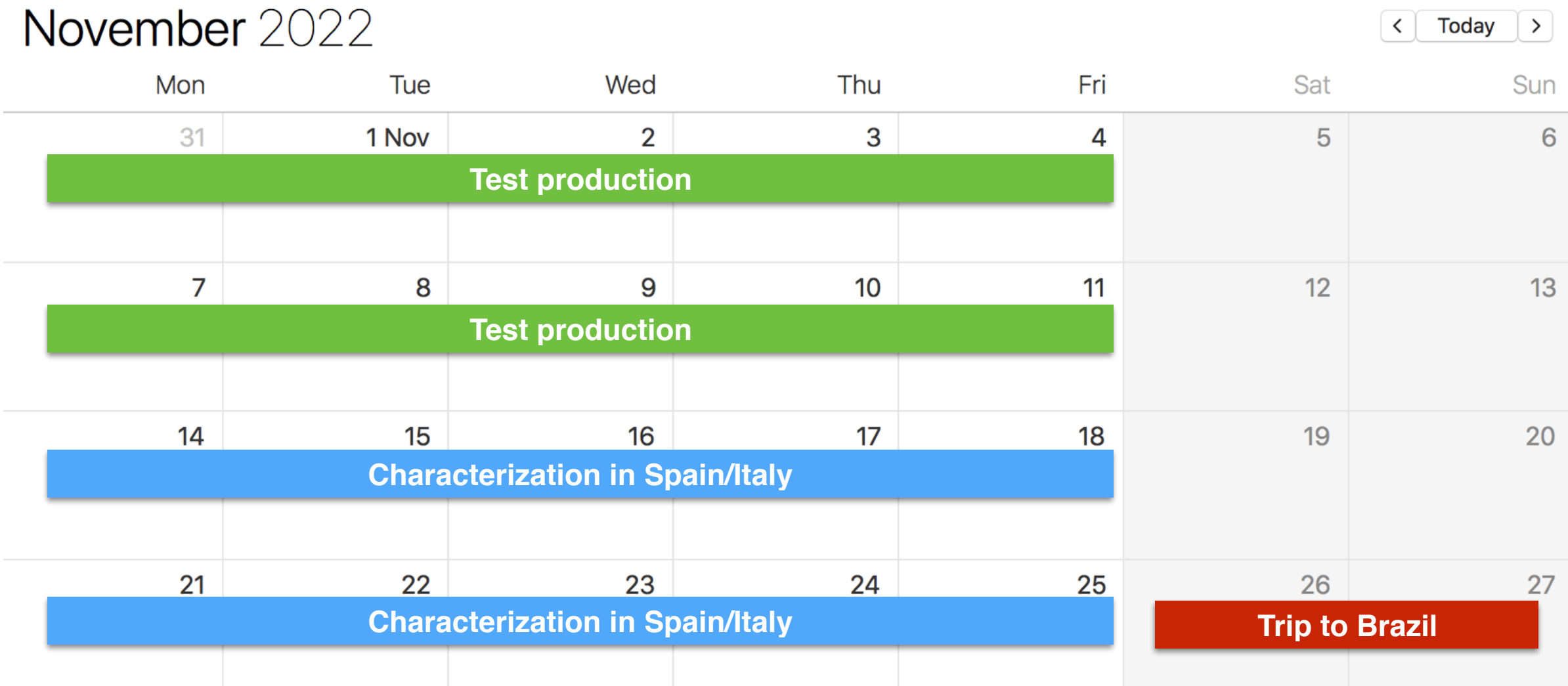
Scenarios for end January installation

- 720 or 576 filters depending on scenarios for December
- Assuming 1200 new HPK SiPMs are ordered

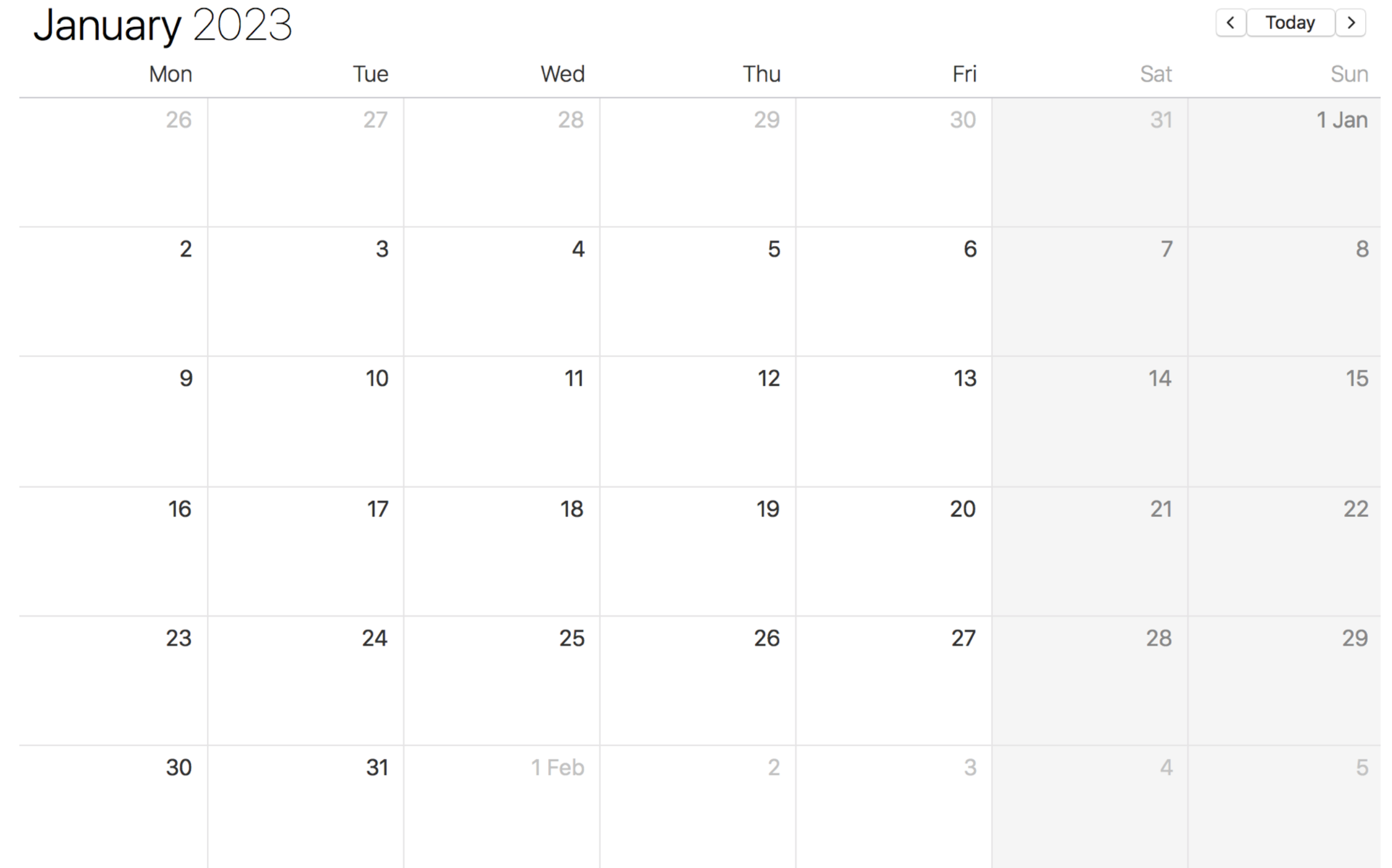
	installation can be postponed to mid February	full mass production ready by mid December & installation cannot be postponed	full mass production delayed by a month & installation cannot be postponed
750 FBK SiPMs by end January	Scenario J.1.1 <ul style="list-style-type: none"> •Coating bef./after January CM •4 cathode modules with FBK •4 cathode modules with HPK 	Scenario J.1.2 <ul style="list-style-type: none"> •Coating before January CM •1 cathode module with FBK •7 cathode modules with HPK 	Scenario J.1.3 <ul style="list-style-type: none"> •Unmount 4 membrane modules and convert to cathode modules •1 cathode module with FBK •3 cathode modules with HPK
750 FBK SiPMs delayed	Scenario J.2.1 <ul style="list-style-type: none"> •Coating bef./after January CM •1 cathode module with FBK •7 cathode modules with HPK 	Scenario J.2.2 <ul style="list-style-type: none"> •Same as above 	Scenario J.2.3 <ul style="list-style-type: none"> •Same as above

Scenario D.1.1

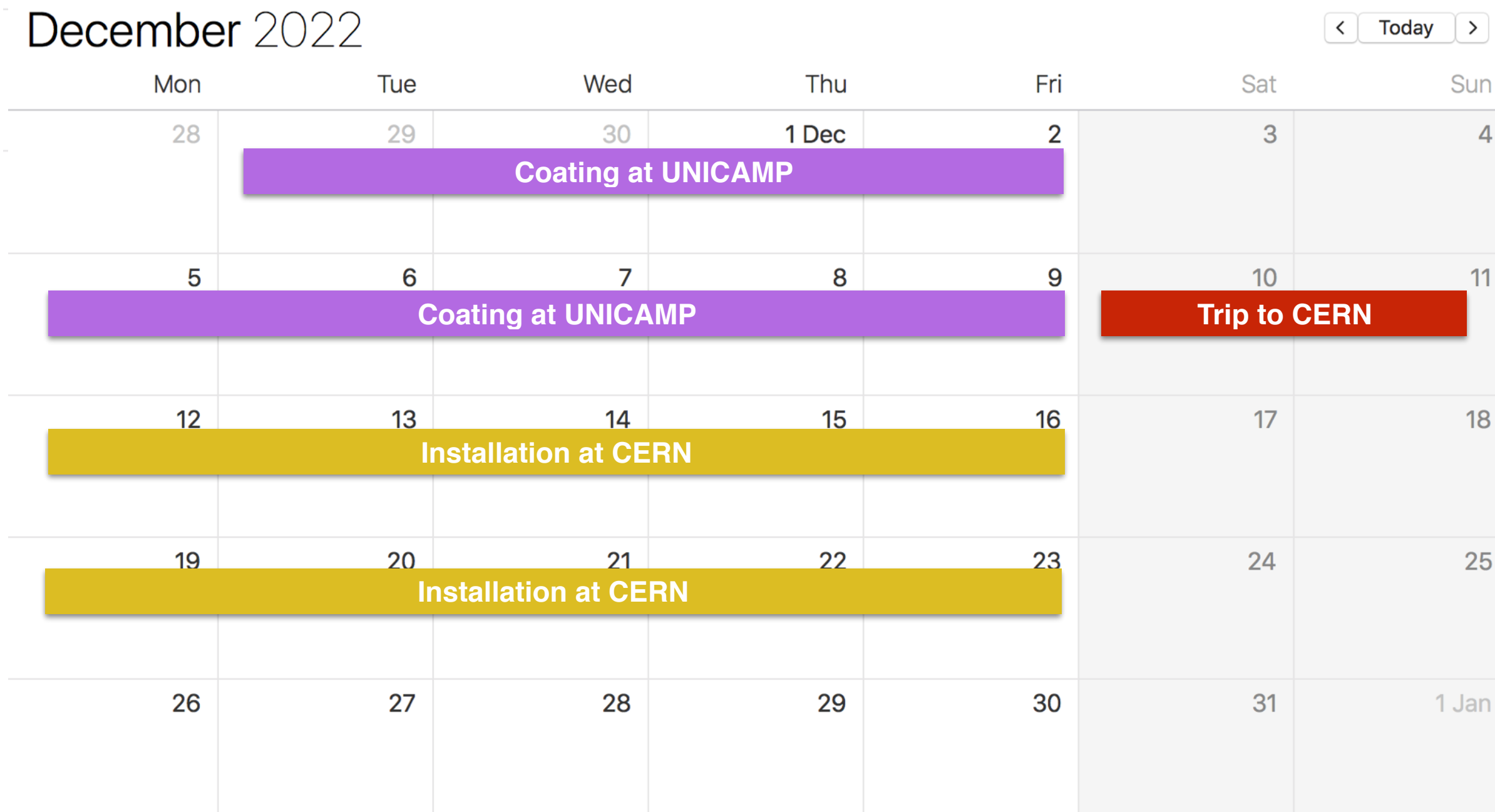
November 2022



January 2023



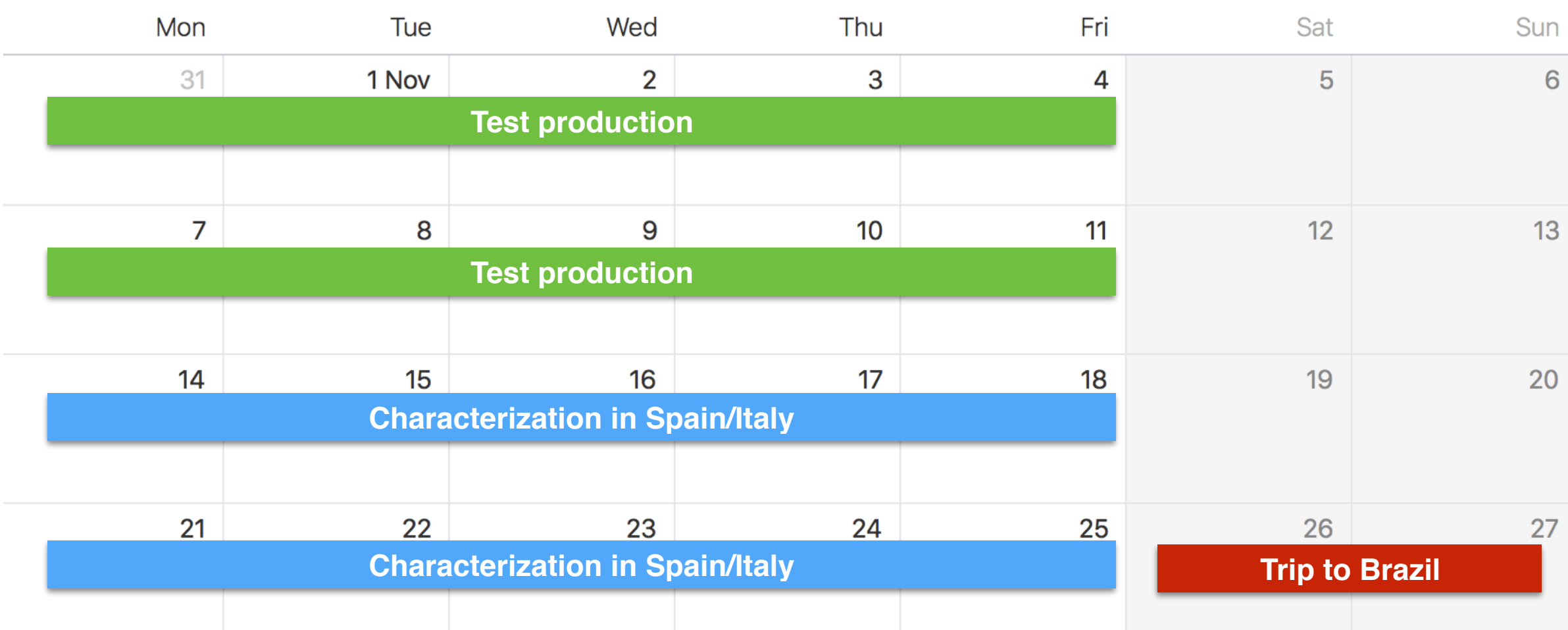
December 2022



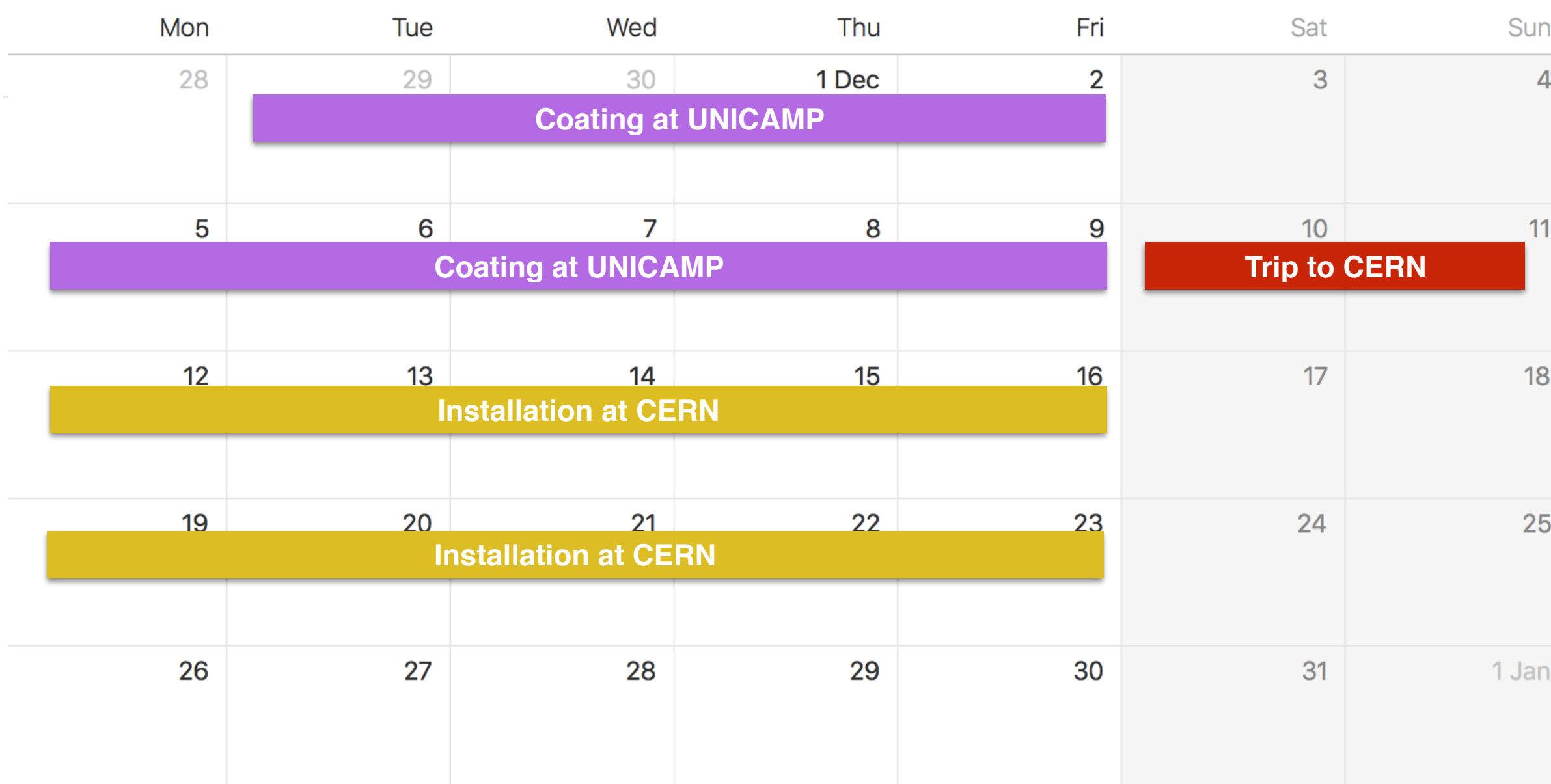
- PE and ZAOT test production ready by November 14th: 160 filters
- 4 top membrane arapucas installed in December

Scenario D.1.1

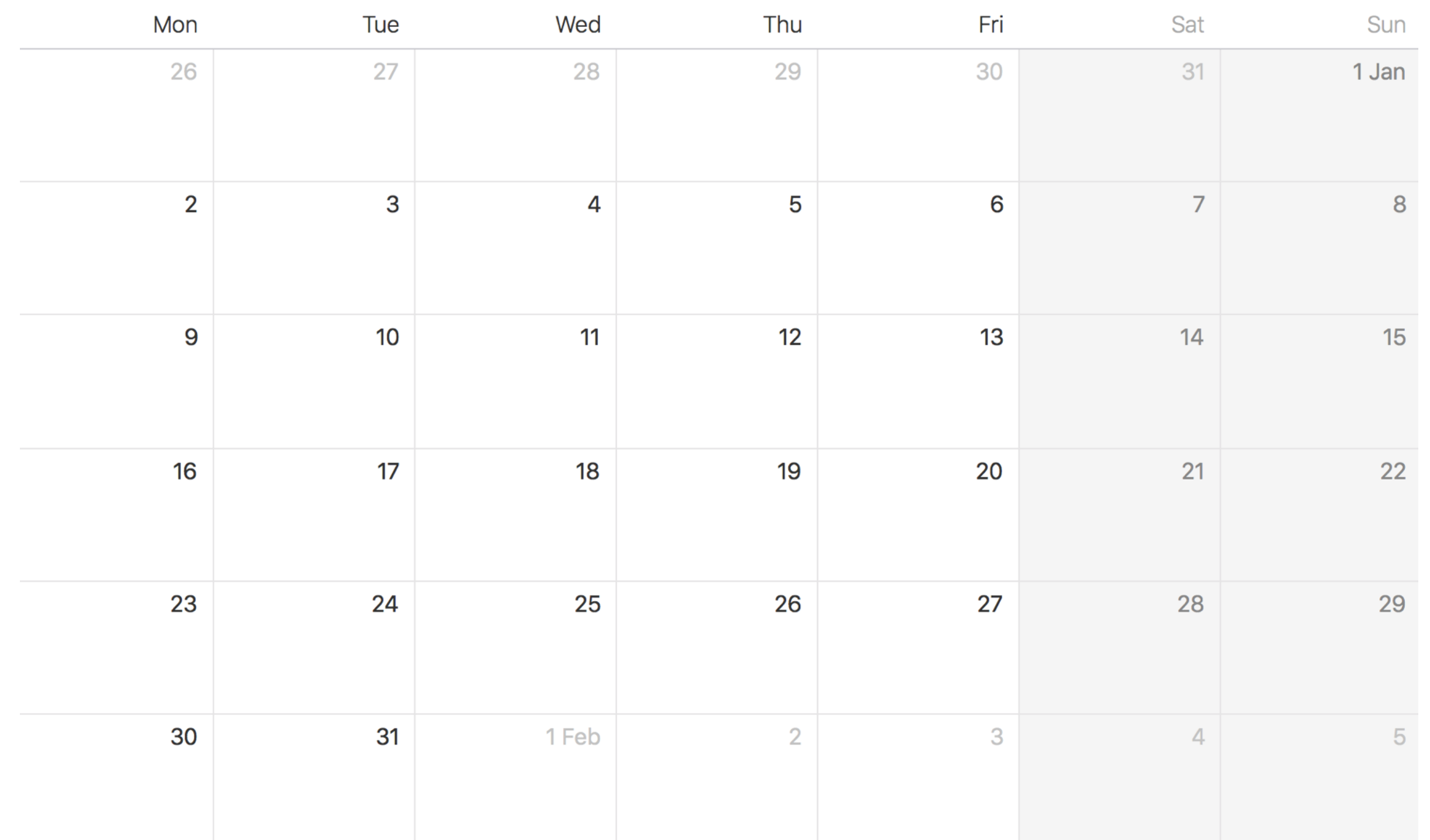
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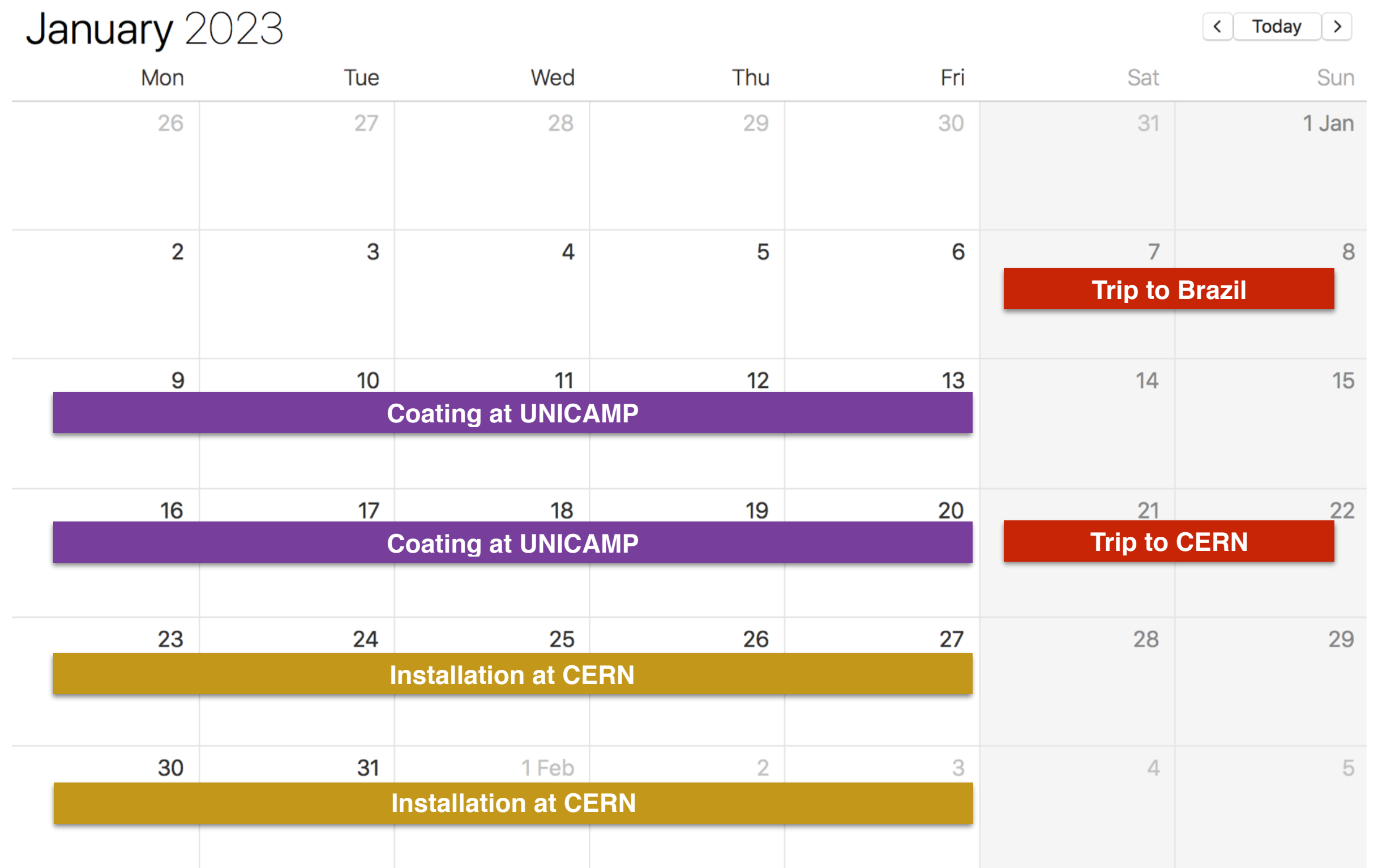
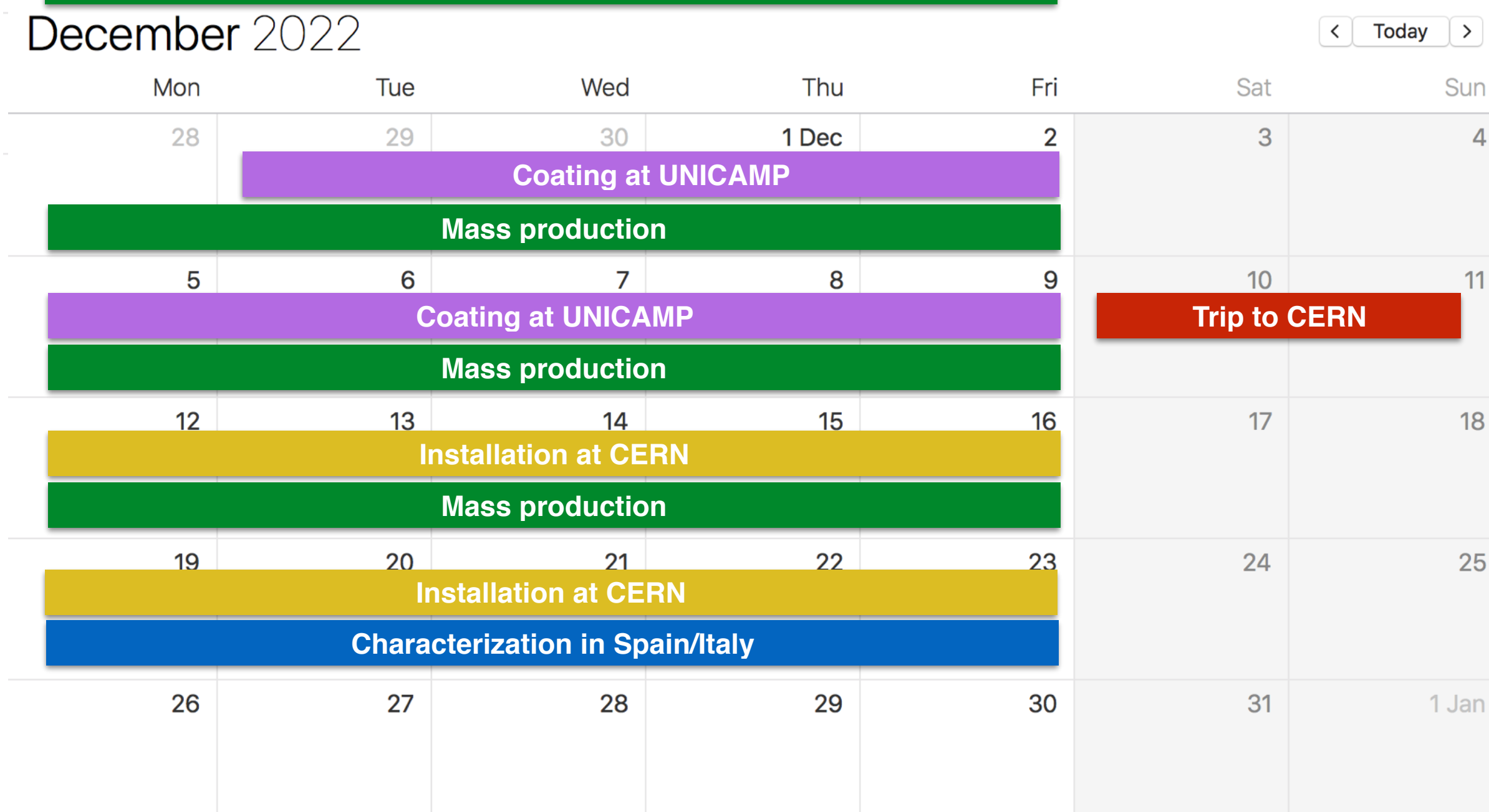
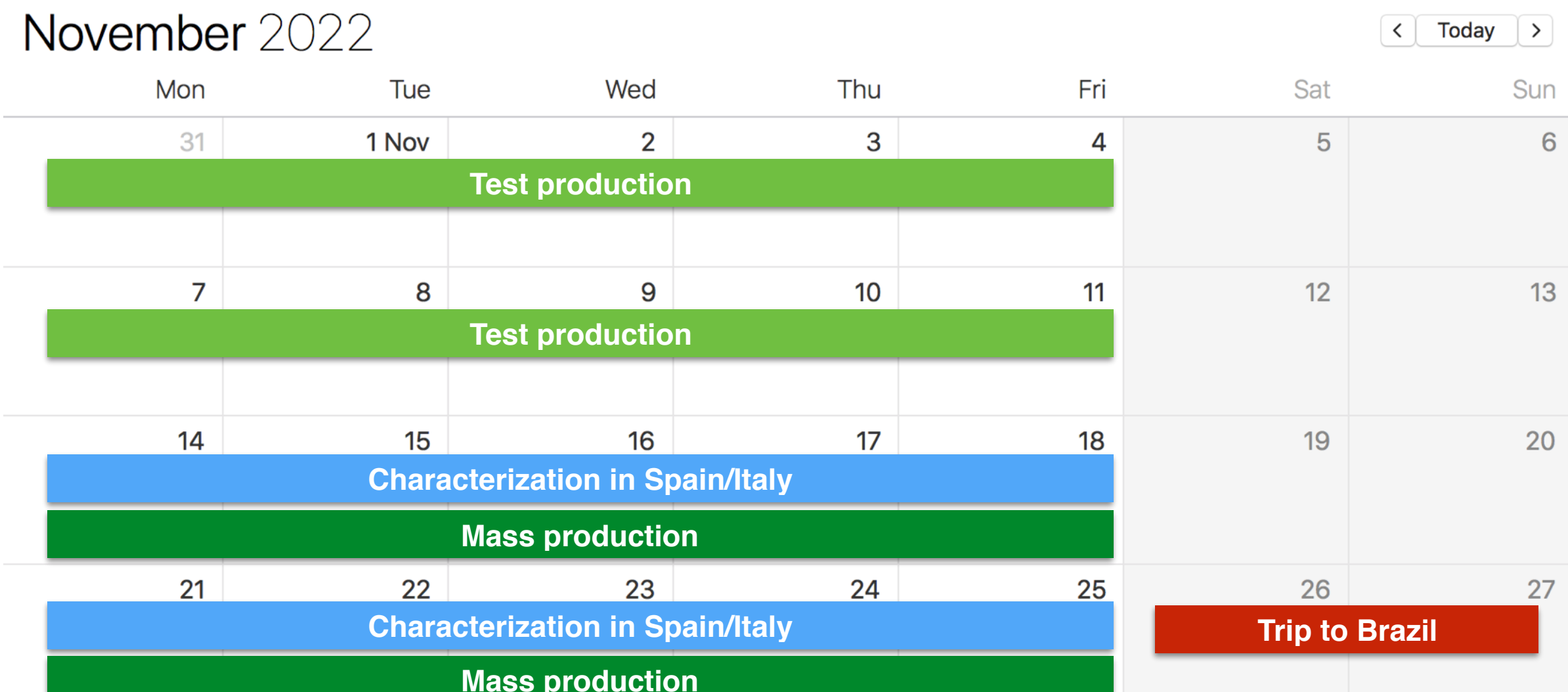


January 2023



- Mass production of remaining 740 filters by December 19th
- 4 bottom membrane and 8 cathode arapucas installed end January

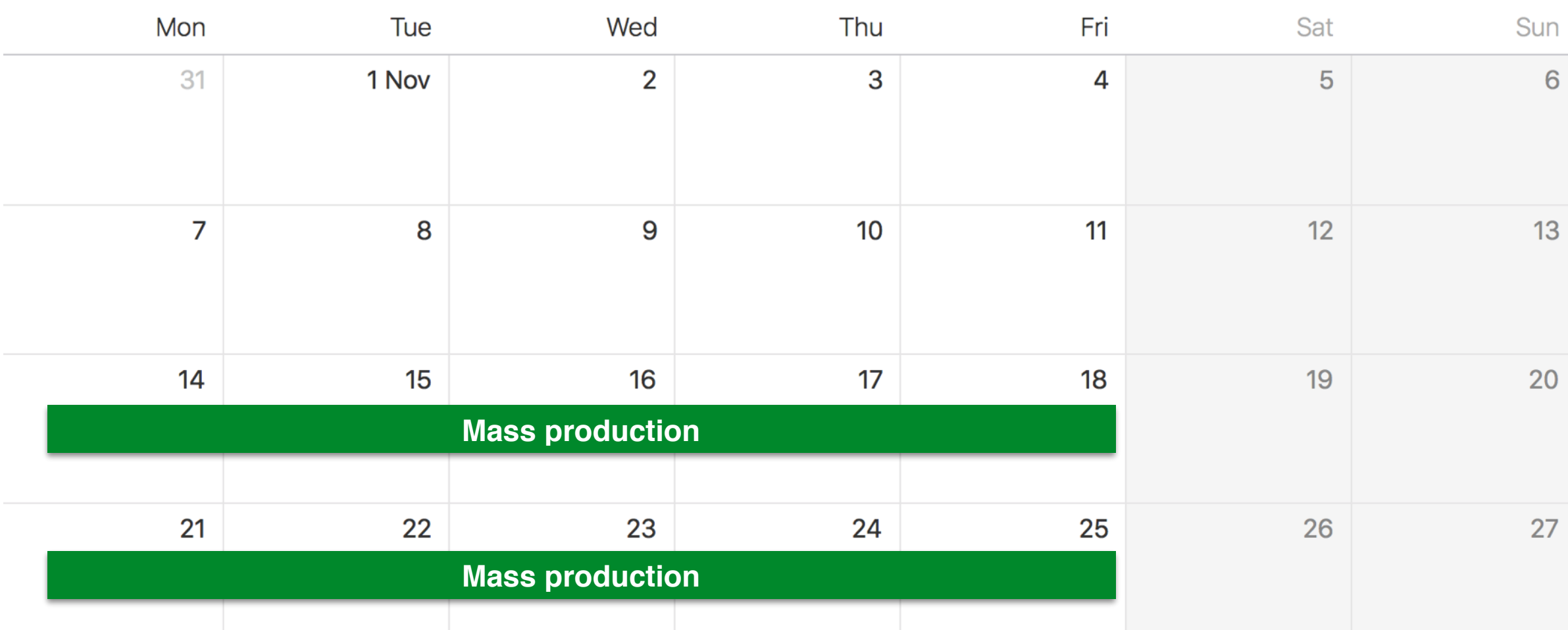
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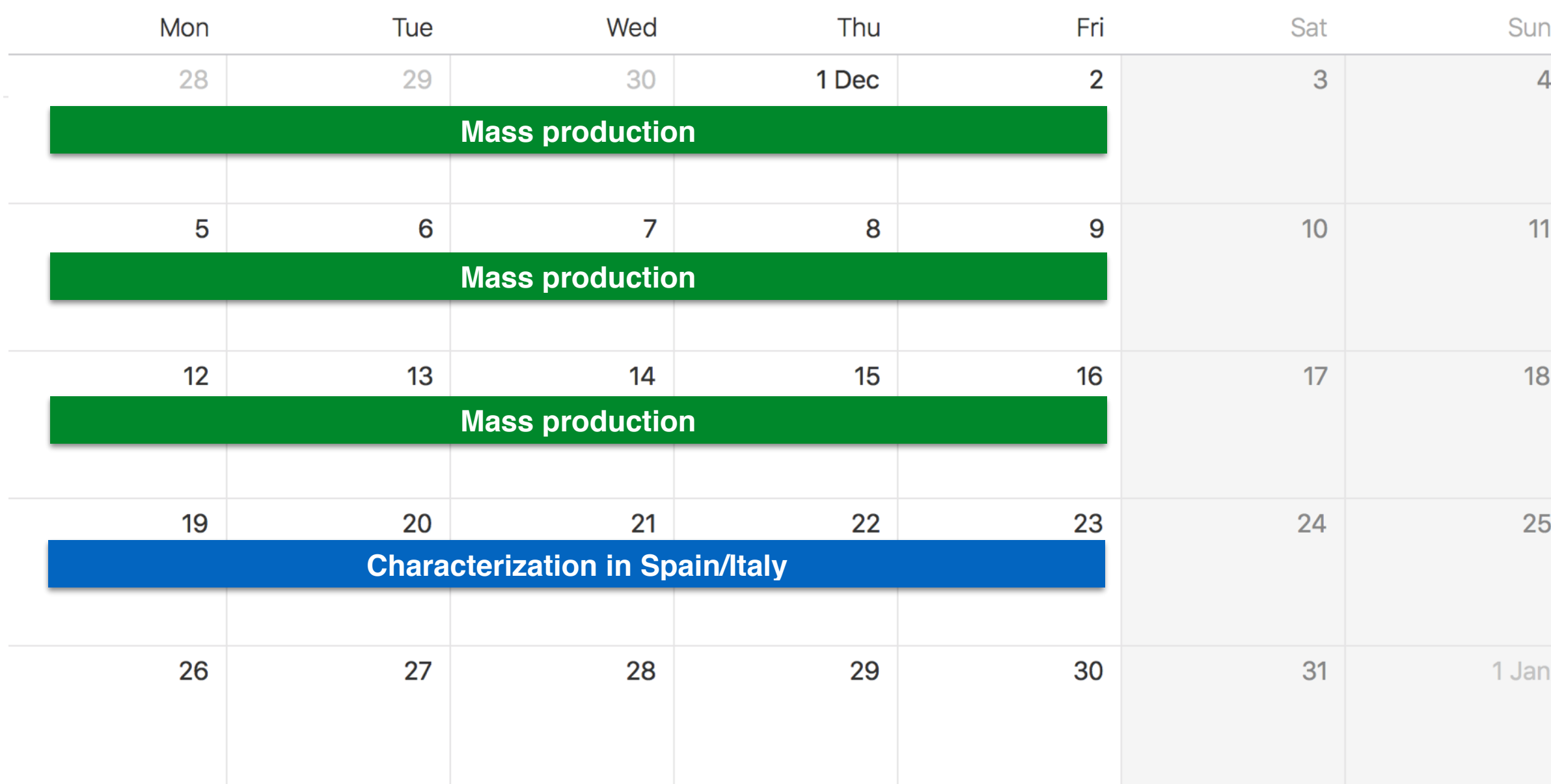
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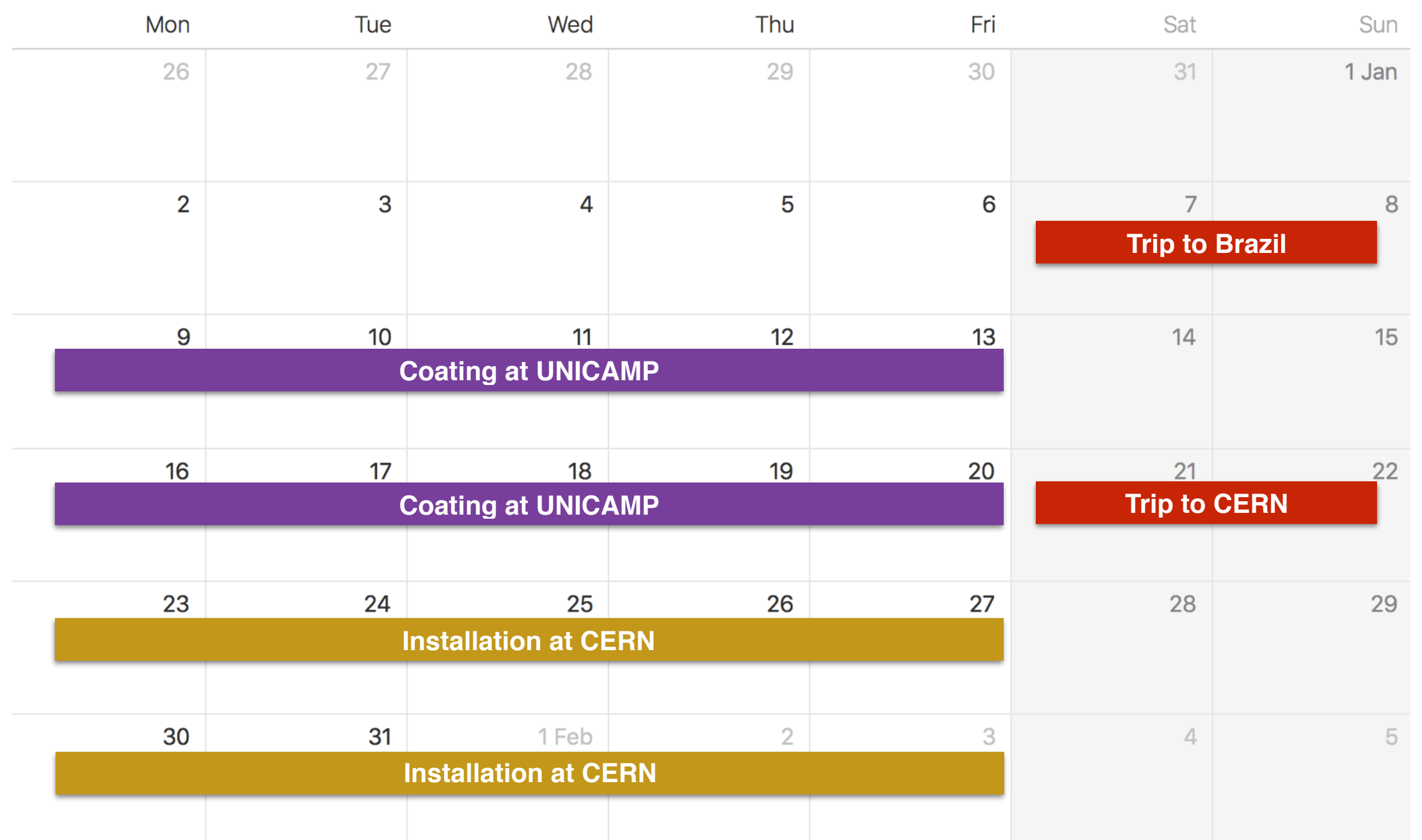
November 2022



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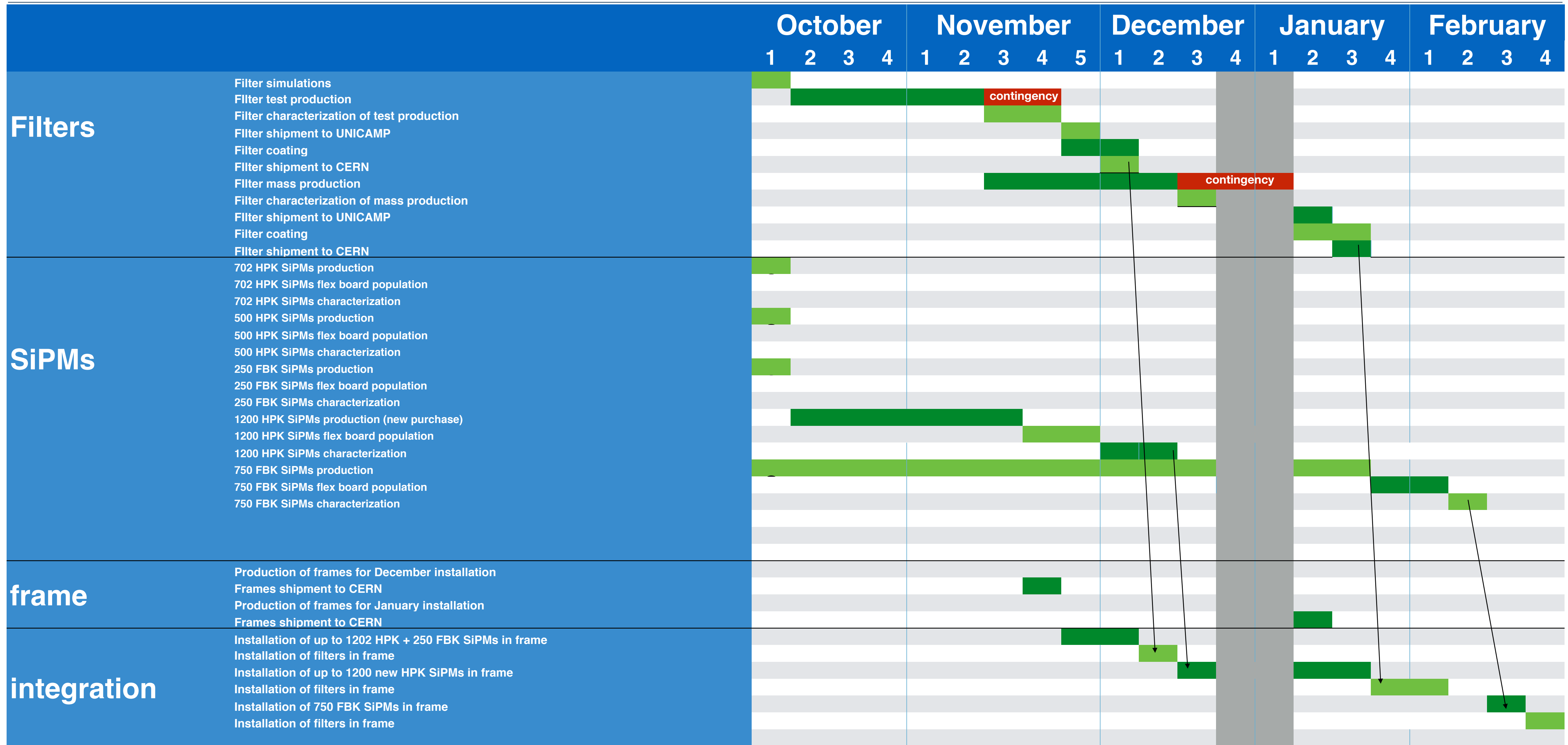


January 2023



- Mass production of remaining 740 filters by December 19th
- 4 bottom membrane and 8 cathode arapucas installed end January

X-Arapuca module fabrication



Contingency for filters

- Two weeks for test production: November 10th —> November 23rd
 - time for characterisation will be reduced from 10 to 2 days
 - We should be travelling on November 26th
- If test production is delayed by more than two weeks existing filters should be reused
- Two weeks for mass production: December 16th —> January 4th
 - time for characterisation reduced from 5 to 2 days (during Christmas !!!)
 - We should be traveling on January 7th
- If mass production is delayed by more than two weeks and installation cannot be postponed there is no contingency

Open installation questions II

- Can we install top upstream membrane modules with scissor lift after upstream FC deployment ?
- Filippo mentioned that it could be possible if they are moved towards the borders
- Needs further investigation
- Not assumed in schedule

