NSF Midscale RI-1: Status and Earned Value

Presentation to Financial Board call

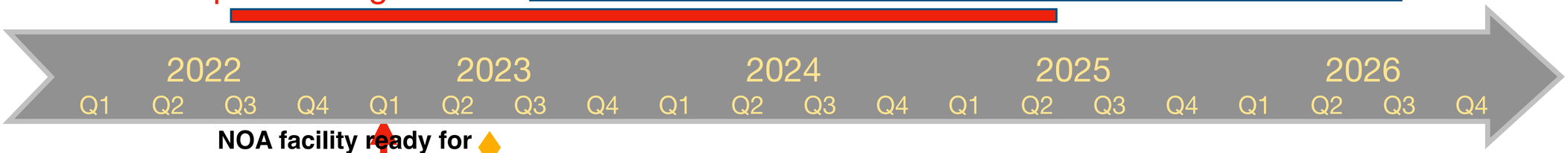
Cristiano Galbiati - May 31, 2023

Schedule

Amherst Augustana Chicago Columbia Hawaii Houston Princeton Temple Davis VT Williams Riverside

DS Midscale RI-1 Cooperative Agreement

This Base Proposal



Baselining date & DS mid-scale RI-1 cooperative agreement funds disbursement date

NOA facility ready for Photodetectors production

Begin Urania site construction

Mock TPC construction and installation complete - ready for testing

Membrane cryostat installed in Hall C and completed Top Cap delivered to LNGS

Aria installation completed

Veto PDM produced, qualified, and delivered to LNGS

AAr cryogenics installed and ready for commissioning

UAr shipping vessels, filling station, and gas sampling system deliv

TPC PDU produced, qualified, ready for installation

Electronics & DAQ components delivered to LNGS

Calibration system delivered to LNGS

DOE support of Urania operations complete

LArTPC detector components, optical planes and installation fixtures delivered to LNGS

UAr cryogenics components delivered to LNGS

Coated TPC acrylic components delivered to LNGS

TPC and optical planes moved into Hall C

Detector installation complete

All UAr delivered from ARIA to LNGS

NSF Key Deliverable

INFN Key Deliverable

STFC Key Deliverable

CFI Key Deliverable

DOE Key Deliverable

Schedule

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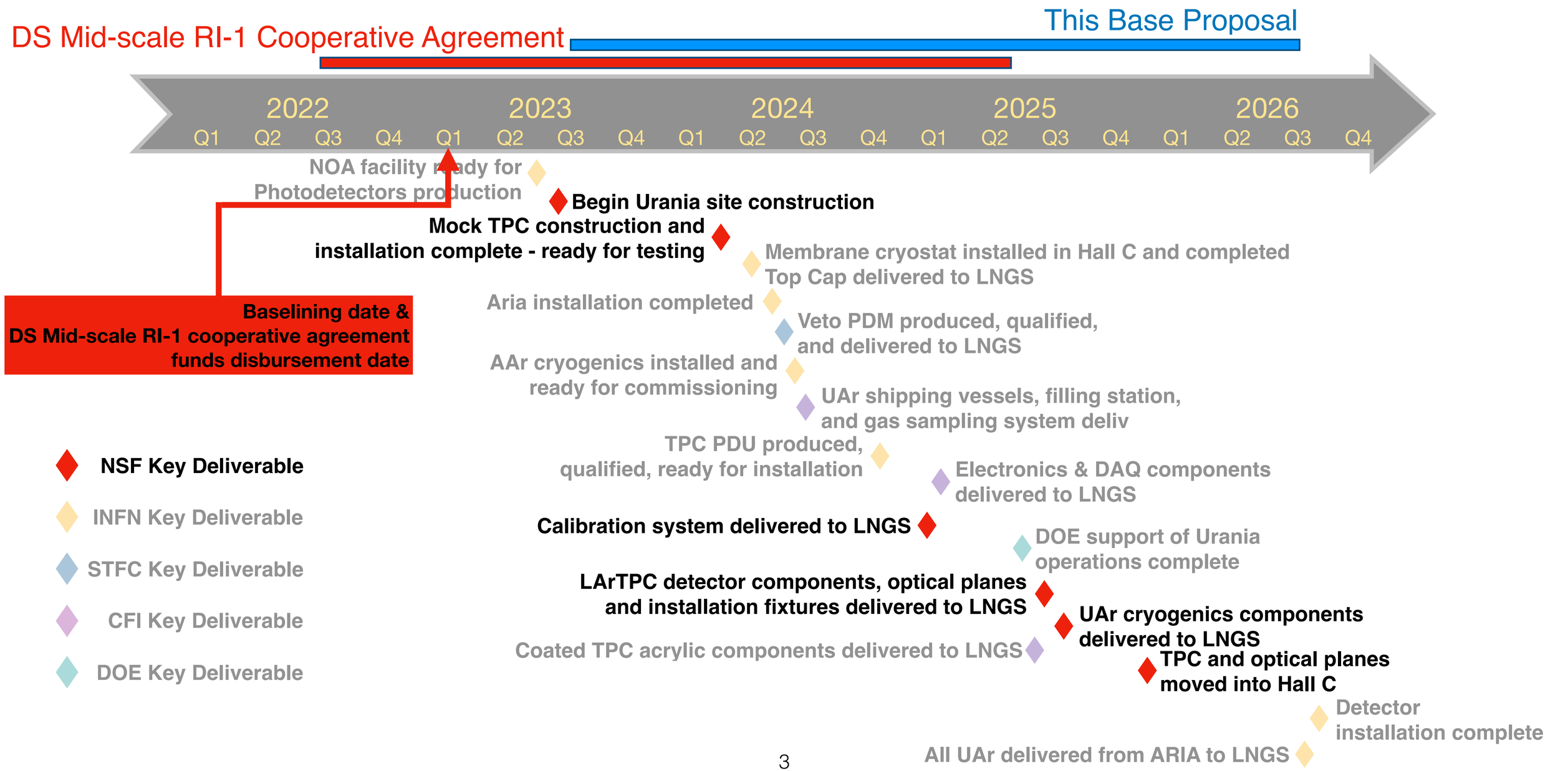

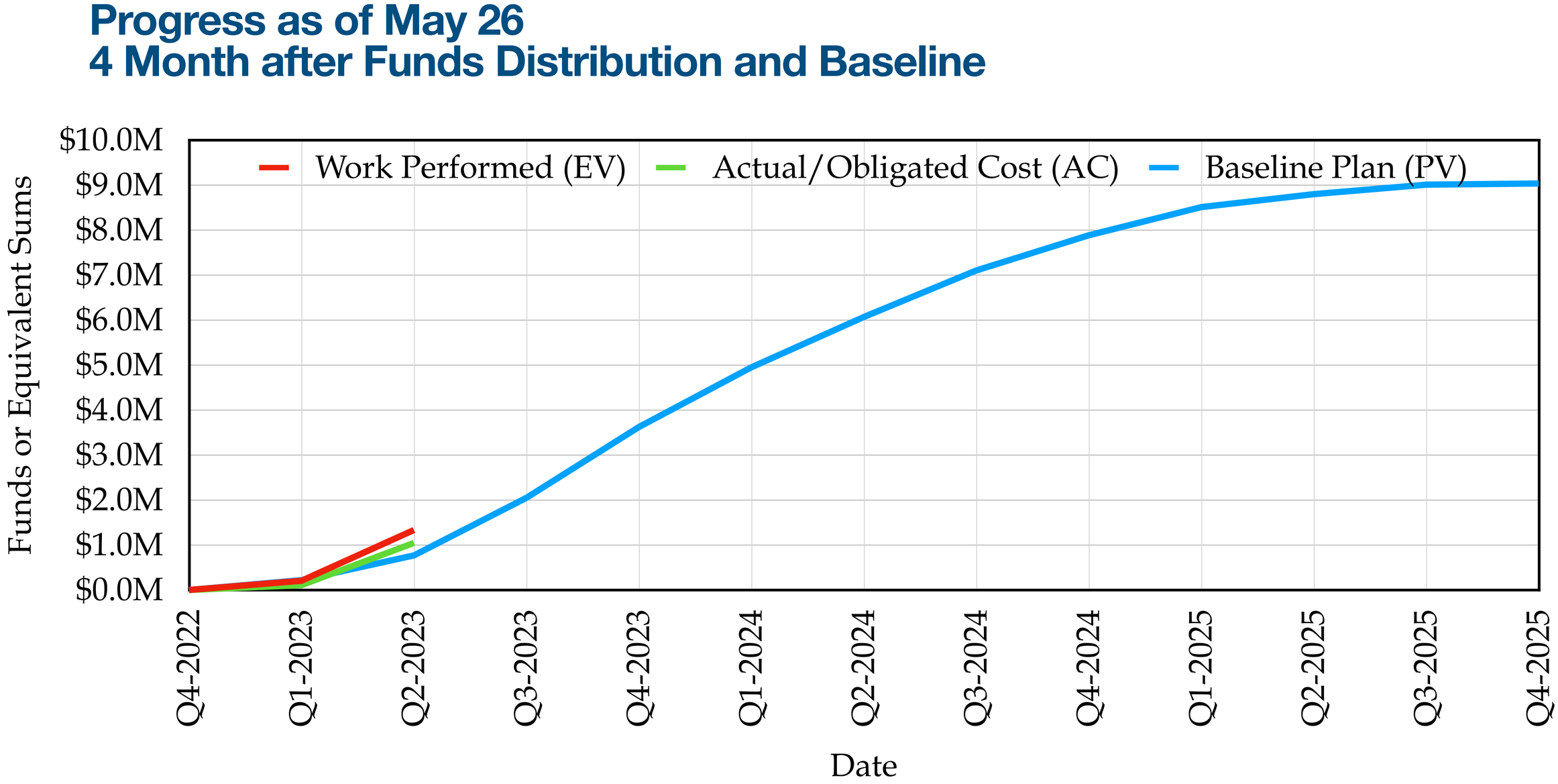

Figure II.C: Work performed (EV), actual/obligated cost (AC), and baseline plan (PV) vs. time.

Table 7-1. Earned Value Calculations Summary Table

Earned Value Analysis					
Abbreviation	**Name**	**Lexicon Definition**	**How Used**	**Equation**	**Interpretation of Result**
PV	Planned Value	The authorized budget assigned to scheduled work.	The value of the work planned to be completed to a point in time, usualy the data date, or project completion.		
EV	Earned Value	The measure of work performed expressed in terms of the budget authorized for that work.	The planned value of all the work completed (earned) to a point in time, usually the data date, without reference to actual costs.	EV = sum of the planned value of completed work	
AC	Actual Cost	The realized cost incurred for the work performed on an activity during a specific time period.	The actual cost of all the work completed to a point in time, usualy the data date.		
BAC	Budget at Completion	The sum of all budgets established for the work to be performed.	The value of total planned work, the project cost baseline.		
CV	Cost Variance	The amount of budget deficit or surplus at a given point in time, expressed as the difference between the earned value and the actual cost.	The difference between the value of work completed to a point in time, usually the data date, and the actual costs to the same point in time.	CV = EV – AC	Positive = Under planned cost Neutral = On planned cost Negative = Over planned cost
SV	Schedule Variance	The amount by which the project is ahead or behind the planned delivery date, at a given point in time, expressed as the difference between the earned value and the planned value.	The difference between the work completed to a point in time, usualy the data date, and the work planned to be completed to the same point in time.	SV = EV – PV	Positive = Ahead of Schedule Neutral = On schedule Negative = Behind Schedule
VAC	Variance at Completion	A projection of the amount of budget deficit or surplus, expressed as the difference between the budget at completion and the estimate at completion.	The estimated difference in cost at the completion of the project.	VAC = BAC – EAC	Positive = Under planned cost Neutral = On planned cost Negative = Over planned cost
CPI	Cost Performance Index	A measure of the cost efficiency of budgeted resources expressed as the ratio of earned value to actual cost.	A CPI of 1.0 means the project is exactly on budget, that the work actually done so far is exactly the same as the cost so far. Other values show the percentage of how much costs are over or under the budgeted amount for work accomplished.	CPI = EV/AC	Greater than 1.0 = Under planned cost Exactly 1.0 = On planned cost Less than 1.0 = Over planned cost
SPI	Schedule Performance Index	A measure of schedule efficiency expressed as the ratio of earned value to planned value.	An SPI of 1.0 means that the project is exactly on schedule, that the work actually done so far is exactly the same as the work planned to be done so far. Other values show the percentage of how much costs are over or under the budgeted amount for work planned.	SPI = EV/PV	Greater than 1.0 = Ahead of schedule Exactly 1.0 = On schedule Less than 1.0 = Behind schedule
EAC	Estimate At Completion	The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete.	If the CPI is expected to be the same for the remainder of the project, EAC can be calculated using: If future work will be accomplished at the planned rate, use: If the initial plan is no longer valid, use: If both the CPI and SPI influence the remainig work, use:	EAC = BAC/CPI EAC = AC + BAC – EV EAC = AC + Bottom-up ETC EAC = AC + [(BAC – EV)/(CPI x SPI)]	
ETC	Estimate to Complete	The expected cost to finish all the remaining project work.	Assuming work is proceeding on plan, the cost of completing the remainig authorized work can be calculated using: Reestimate the remaining work from the bottom up.	ETC = EAC – AC ETC = Reestimate	
TCPI	To Complete Performance Index	A measure of the cost performance that must be achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the budget available.	The efficiency that must be maintained in order to complete on plan. The efficiency that must be maintained in order to complete the current EAC.	TCPI = (BAC–EV)/(BAC–AC) TCPI = (BAC – EV)/(EAC – AC)	Greater than 1.0 = Harder to complete Exactly 1.0 = Same to complete Less than 1.0 = Easier to complete Greater than 1.0 = Harder to complete Exactly 1.0 = Same to complete Less than 1.0 = Easier to complete

Figure I.A: Earned value calculations summary table (from PMBOK [*A Guide to the Project Management Body of Knowledge*, Project Management Institute, Inc., Fifth Edition (2013)]).

Progress as of March 31
1 Month after Funds Distribution and Baseline

Award	**Award Start**	**Award End**	**Total Project Cost (TPC)** PMB + contingency
	09/01/2022	08/31/2025	$11.711M
Project Budget	**PMB** Performance Mgmt Budget	**ETC** Estimate-to-Complete	**Remaining Funds**
	$9.035M	$8.830M	$8.928M
Budget Contingency	**Awarded**	**Remaining**	
	$2.675M	$2.675M	
Performance Indicators	**WC** Work Completed	**CPI** Cost Perf. Index	**SPI** Schedule Perf. Index
	2.4%	1.91	0.94

Progress as of May 26
4 Month after Funds Distribution and Baseline

Award	**Award Start** (mm/dd/yyyy)	**Award End** (mm/dd/yyyy)	**Total Project Cost (TPC)** BAC + Contingency
	09/01/2022	08/31/2025	$11.711M
Project Budget	**BAC** Budget At Completion	**ETC** Estimate To Complete	**Remaining Funds**
	$9.035M	$7.703M	$7.988M
Budget Contingency	**Awarded**	**Remaining**	
	$2.675M	$2.675M	
Performance Indicators	**WC** Work Completed	**CPI** Cost Perf. Index	**SPI** Schedule Perf. Index
	15.1%	1.27	1.73

Table II.A: Award summary information.

Progress as of May 26
4 Month after Funds Distribution and Baseline

Earned Value Metrics Q2-2023		
BAC	$9,034,819	
PV	$768,350	
EV	$1,332,164	
AC	$1,046,563	
SPI	173%	EV / PV
CPI	127%	EV / AC
EAC	$8,749,218	EAC = AC + (BAC — EV)
EAC-C-PI	$7,097,855	BAC / CPI
EAC-C/S-PI	$4,536,757	AC + [(BAC — EV) / (CPI × SPI)]
ETC-Simple	$7,702,655	EAC - AC
ETC-Trend	$6,051,292	(EAC - AC) / CPI
SV	$563,814	EV - PV
CV	$285,601	EV - AC
VAC	$285,601	BAC - EAC
WC	15.1%	$\sum_i (WC_i \times BAC_i) / BAC$
Remaining Funds	$7,988,256	BAC - AC

Table II.B: Earned value metrics for partial Q2-2023 (through May 2023).

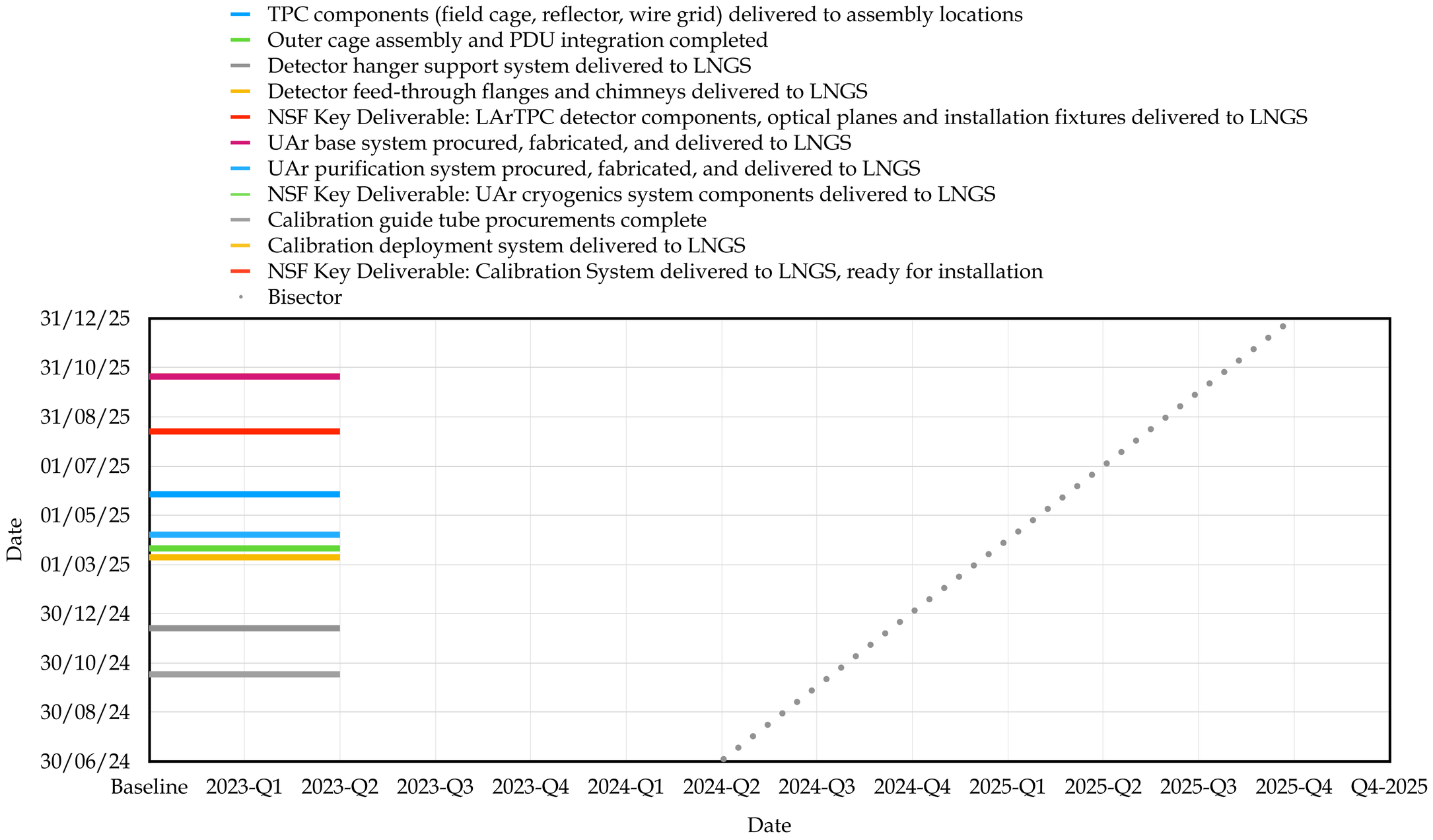

Figure III.B: Forecast (and accomplished) date as function of time for the Key Deliverables (a.k.a. KPP, Key Performance Parameters) owned by the U.S. Institutions and within the scope of the NSF Midscale RI-1 DarkSide cooperative agreement.

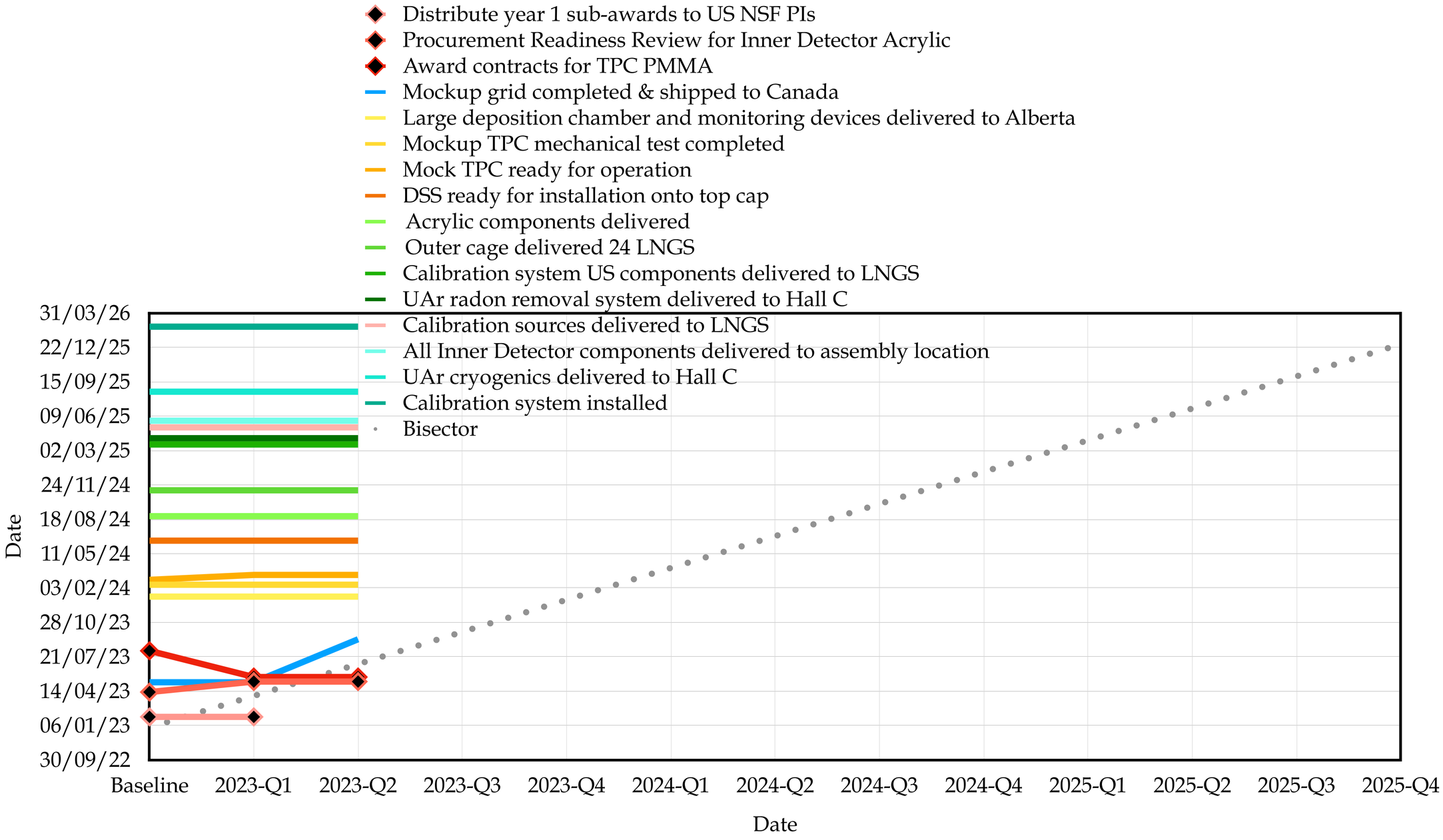

Figure III.D: Forecast (and accomplished) date as function of time for the Tier 1 milestones owned by the U.S. Institutions and within the scope of the NSF Midscale RI-1 DarkSide cooperative agreement. Legenda: solid lines with black-filled romboids identify Tier 1 milestones already completed; dashed line identify Tier 1 milestones not yet completed, whose monitoring will continue in the next editions of this document.

Progress as of May 26
4 Month after Funds Distribution and Baseline

Detailed EVM Data			Cumulative [k$]				Cumulative []		
WBS	**Description**	**Institution**	**BAC**	**PV**	**EV**	**AC**	**WC**	**CPI**	**SPI**
0.01.02	Mgmt. Support NSF	Princeton	$555.1	$229.2	$158.4	$158.4	29%	1.00	0.69
1.01.02.01	UAr Base System	UCLA	$353.6	$0.0	$0.0	$0.0			
1.01.02.02	UAr Purification System	Columbia	$1,228.0	$162.8	$87.7	$21.9	6%	4.00	0.54
1.01.02.03	UAr Getter	Princeton	$487.3	$0.0	$0.0	$0.0			
1.02.02.02	ID Assembly Tools US	VTech & Will.	$1,401.9	$133.5	$585.0	$548.0	36%	1.07	4.38
1.02.04.01	ID Acrylic US	VTech & Will.	$621.2	$0.0	$368.3	$189.0	90%	1.95	N/A
1.02.04.02	S2 System	UCLA	$92.9	$0.0	$0.0	$0.0			
1.02.04.03	Outer Cage	Chicago	$717.0	$62.6	$35.8	$34.6	5.0%	1.03	0.57
1.02.04.04	HV System	UC Davis	$457.6	$3.2	$22.2	$19.6	5%	1.13	6.94
1.02.04.05	Reflectors	UC Davis	$132.2	$0.0	$0.0	$0.0			
1.02.04.06	Wire Grid	Houston	$630.5	$31.4	$0.0	$0.0	0%	N/A	0.00
1.02.05.01	ID Flanges & Chimneys	UCLA	$512.5	$0.0	$0.0	$0.0			
1.02.05.02	ID Adjustable Hangers	UCLA	$200.0	$0.0	$0.0	$0.0			
1.02.05.03	ID Integration Support	Princeton	$1,050.5	$119.6	$74.7	$75.0	8%	1.00	0.62
1.04.01.01	Calib. Deployment US	Hawaii	$384.4	$0.0	$0.0	$0.0			
1.04.02.01	Calib. Sources US	Hawaii	$137.4	$1.1	$0.0	$0.0	0%	N/A	0.00
1.09	Outreach US	Fort Lewis & PU	$210.2	$25.0	$0.0	$0.0	0%	N/A	0.00
All Sub-Systems			**$9,034.8**	**$768.4**	**$1,332.1**	**$1,046.5**	**15.1%**	**1.27**	**1.73**

Table VI.A: Detailed cost and performance data.

CR: Advance Purchase of SS Material

[Already submitted to NSF PO for revision, waiting for clearance for official submission]

- **Rationale:** Change from titanium to stainless steel forced by Ukraine war. The NSF-supported groups are responsible for the optical planes structure.

- **Change Request:** shift the existing Optical Plane budget from year 2 to year 1. The low-radioactivity steel has a longer delivery time than anticipated at the time of Mid-scale request submission and was planned to begin in year 2. To maintain the current delivery date of the sub-system the procurement needs to advance into year 1 and begin by summer 2023. Advancing the procurement to this time also allows the opportunity of consolidating the procurement of similar material by our INFN Collaborators for the inner detector vessel.

- **Additional Note:** an additional impact of the change of material from titanium to stainless steel is the cost to machine the outer cage components prior to their assembly as optical planes. Machining of the titanium was an in-kind contribution by CIEMAT however their shop is not equipped to handle the alternative in stainless steel. Cost being estimated, near $300k. Future change request for funding this activity should be expected when cost is finalized.

Advance purchase of UAr getter

[Already submitted to NSF PO for revision, waiting for clearance for official submission]

- **Rationale:** we are 100% ready to place the purchase order for the UAr getters. Funds are planned for year 2 and 3 fo the program. Cost of this specific item has increasing at more than >10% per year in the last two years. It would make sense to anticipate the purchase to year 1.

- **Change Request:** shift the existing Getter budget from year 2 and 3 to year 1. The pricing history of the getter material shows higher-than-typical escalation. Advancing the purchase mitigates future potential cost increases.

CR: Replanning – redistribution of Virginia Tech budget

[In preparation]

- **Rationale:** VTech and Williams College realized significant savings thanks to value engineering of the annealing and coating vessel. Additional savings from Configuration Change that led to substitution of PMMA into Gd-PMMA for TPC vessel barrel, which decreased the amount of PMMA to be procured by US NSF groups. Combined savings anticipated at $400k level.

- **Change Request:** We would like to apply savings in the above mentioned amount to support Gd-PMMA for TPC vessel barrel. Other international groups are applying savings from their value engineering ito help solve this issue

UCLA (I)

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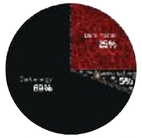
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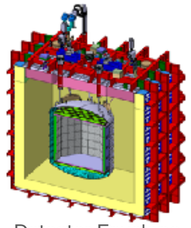
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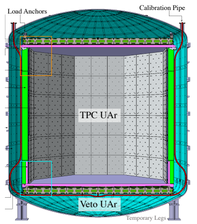
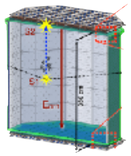
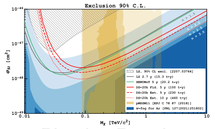
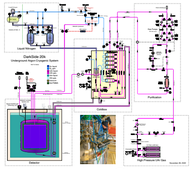


Inner Elements





Physics Reach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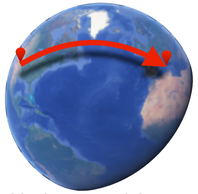
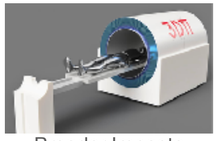

Underground Argon


Detector Control

QA/QC


Mock-up


Broader Impacts

- Hanguo Wang, in his capacity as UCLA PI, during the last funding cycles received year-round support from NSF under a special arrangement, which advanced the design at CERN and LNGS of the core elements of the TPC and of the UAr cryogenics.
- As year-round support level could not be maintained moving forward, Hanguo elected to retire as of May 1, 2023.
- UCLA will withdraw its application for this base grant.
- The Princeton and UCLA administrations are working to terminate the Mid-scale subaward to UCLA. Specific tasks and deliverables previously assigned to UCLA are being returned under Princeton purview.

UCLA (II)

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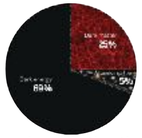
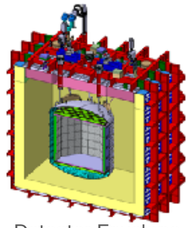

Physics Motivation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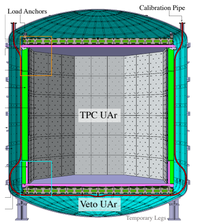
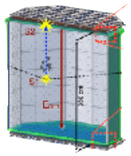
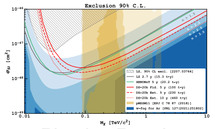
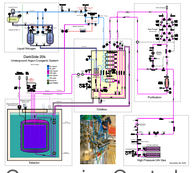


Inner Elements





Physics Reach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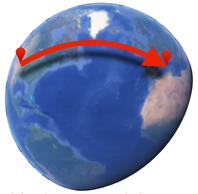
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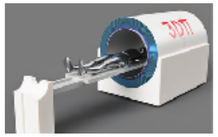
Broader Impacts

- While the loss of UCLA group's intellectual contributions and on-site presence is significant, expertise is available within the NSF-supported US groups, which will mitigate the impact of the loss by redeploying their deep pool of talents, developed thanks to the NSF long-standing support of the XENON and DarkSide programs.
- Guillaume Plante of Columbia has assumed the role of L1 manager for the UAr cryogenics (previously covered by Hanguo Wang).
- Luca Grandi of Chicago has assumed the role of L1 manager for the inner detector (previously covered by Hanguo Wang).
- Princeton postdocs Bianca Bottino, Ako Jamil, and Giacomo Gallina have recently moved permanently to LNGS, joining Andrea Ianni and Paolo Organtini, to compensate the loss of expert personnel on site.

UCLA (III)

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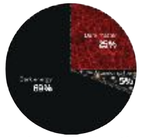
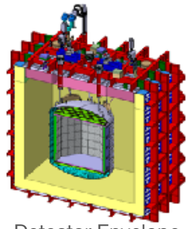

Physics Motivation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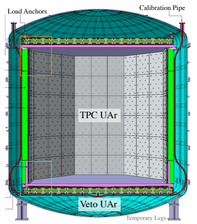

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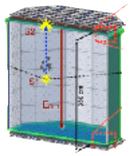
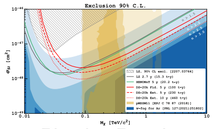
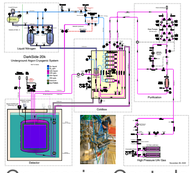




Physics Reach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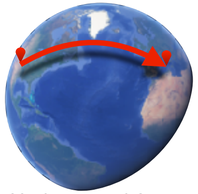
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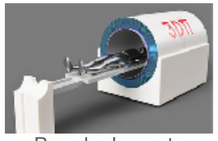
QA/QC


Mock-up


Broader Impacts

- The withdrawal of the UCLA proposal will decrease the overall budget by $2.4M, equivalent to 22% of the total grant request.
- A few participating Institutions may need additional resources to enable their expanded roles and responsibilities and to cover the scope of work previously assigned to the UCLA group.
- We look forward to cooperate with the NSF PO to monitor the situation and to frame as needed future supplemental requests to front this unexpected situation.
- Within this framework, we look forward to the opportunity of retaining the participation of Hanguo Wang as a consultant with a support level of a few months per year.

The End