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# **SpinQuest Infrastructure Installation: Schedule and Costs**

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E1039/SpinQuest Review

12/1/2020

# Outline

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## Schedule Overview

- What do we have to do
- Completed tasks
- Remaining tasks (infrastructure installation)
- Schedule Drivers

## Costs

- Cost estimates and contingency
- Spending/Resource Plan

## Risks

- Funding
- Resources

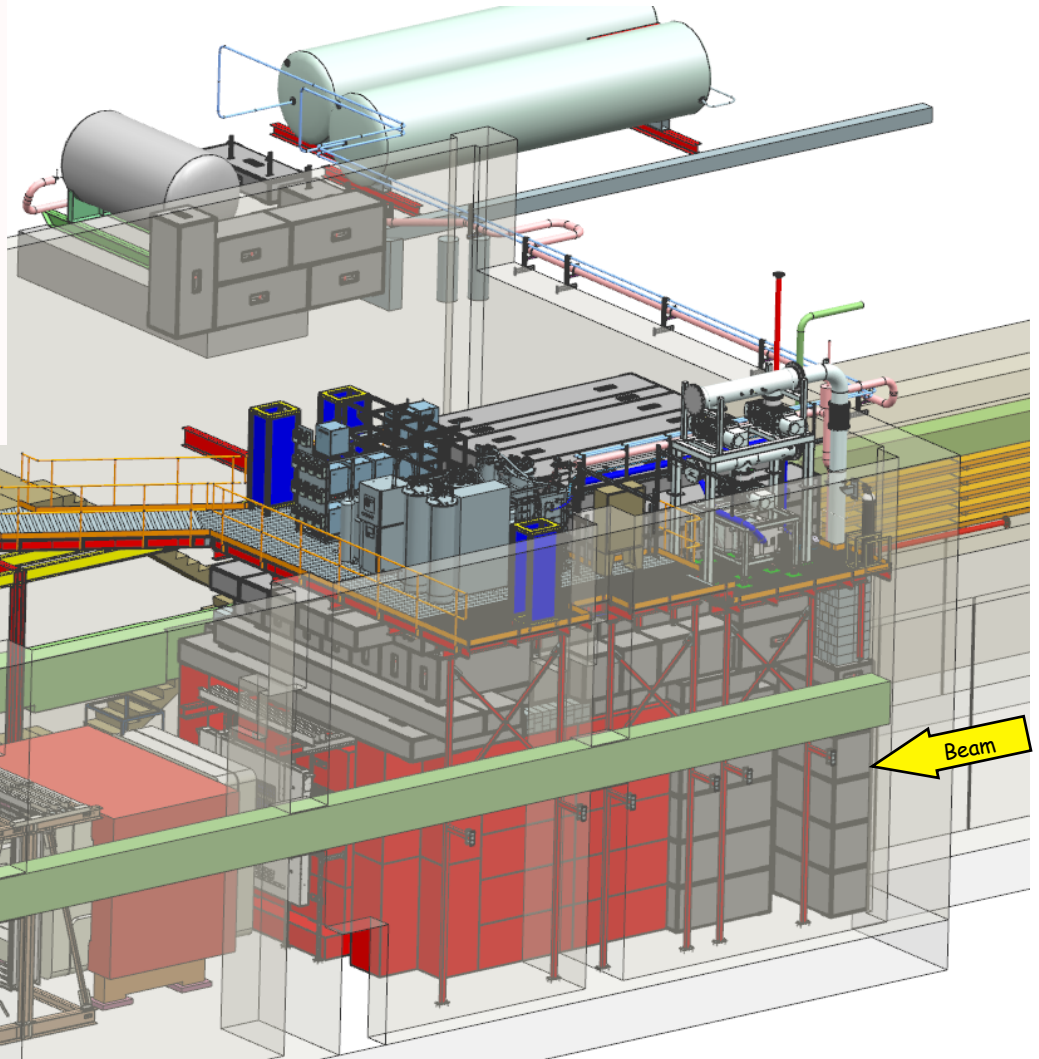
Focus on tasks to complete infrastructure and target installation

# SpinQuest New Target and Infrastructure

Red shielding from E906 (SeaQuest)

## New Items:

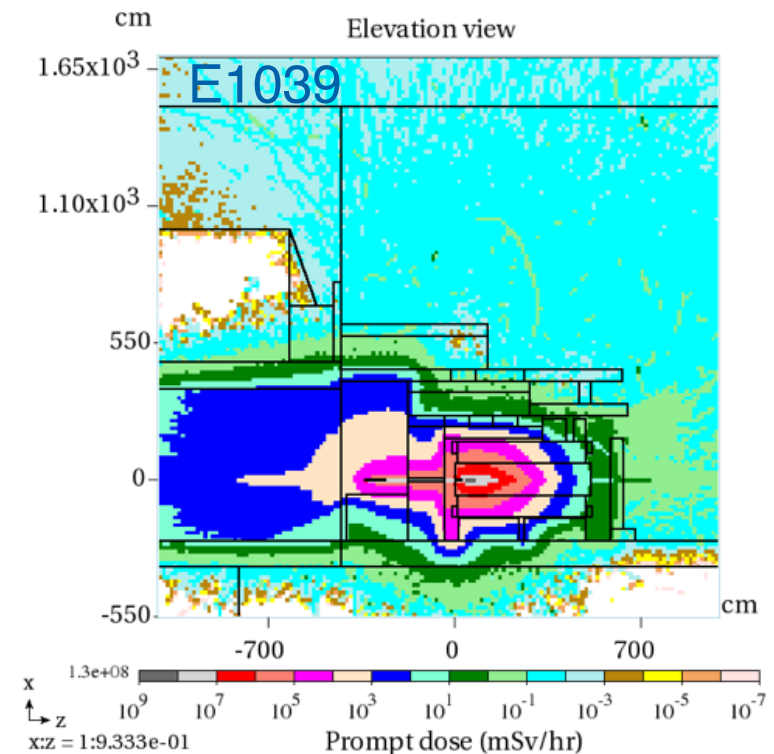
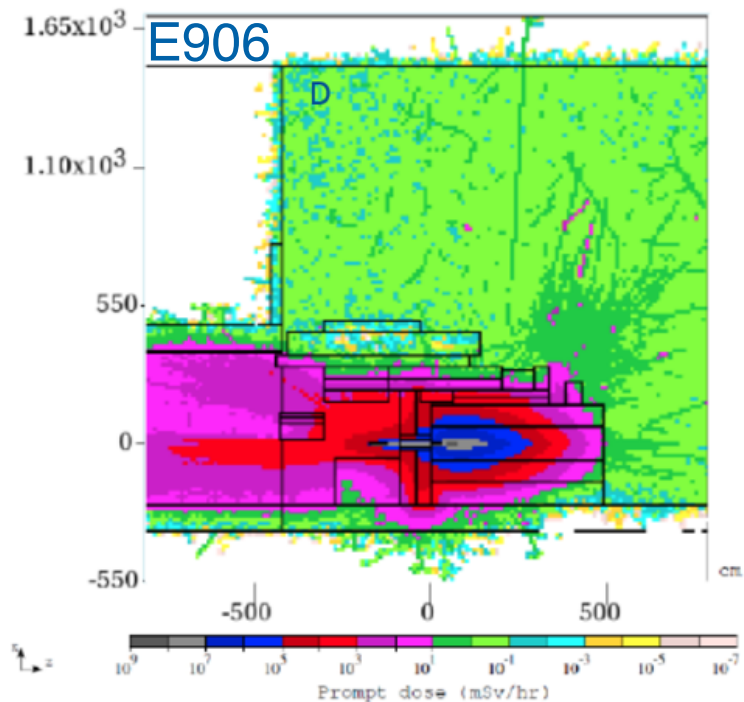
- Shielding re-configuration (FNAL)
- Cryo-platform (FNAL)
- He Liquefaction plant (Quantum Technologies)
- Liquid N<sub>2</sub> Dewar (LANL-reuse)
- Gaseous storage tanks (FNAL-reuse)
- Roots pumps (LANL-New)
- Target (UVa-custom built)
- Attending plumbing for target & cryo-plant (FNAL, LANL, UVa)



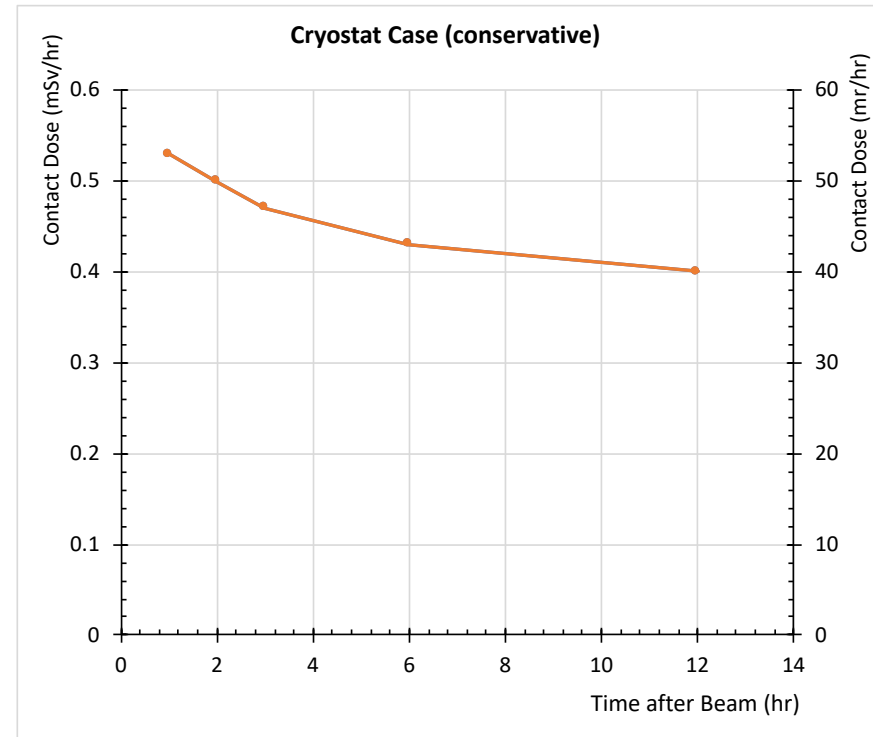
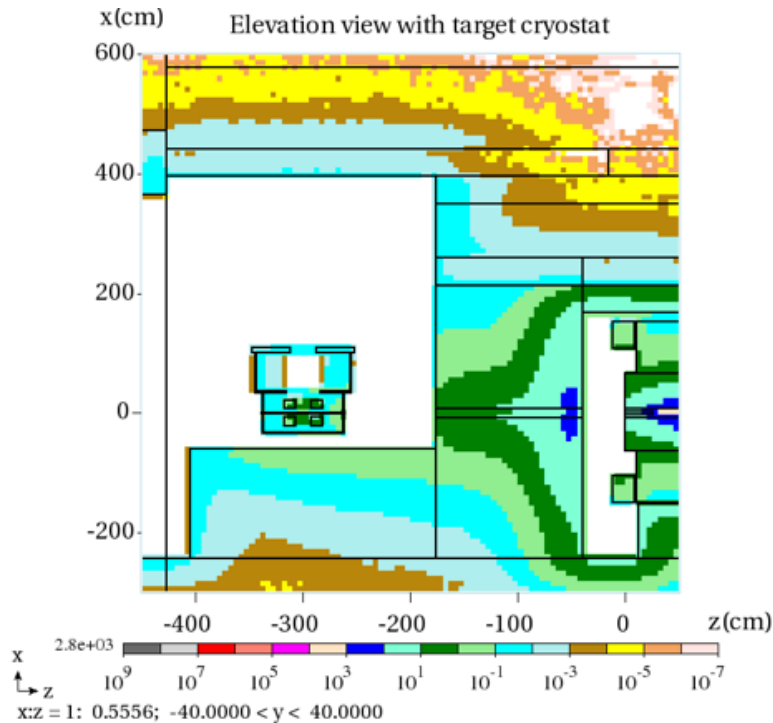
# Shielding Re-Configuration

Move target location ~ 1m upstream from dump

- Improve dump/target vertex separation
- Reduce prompt dose to experiment/counting room
- Reduce exposure to personnel working on target maintenance
- E1039 Approved for  $1E13$  protons/4.4sec spill (shielding assessment addendum)



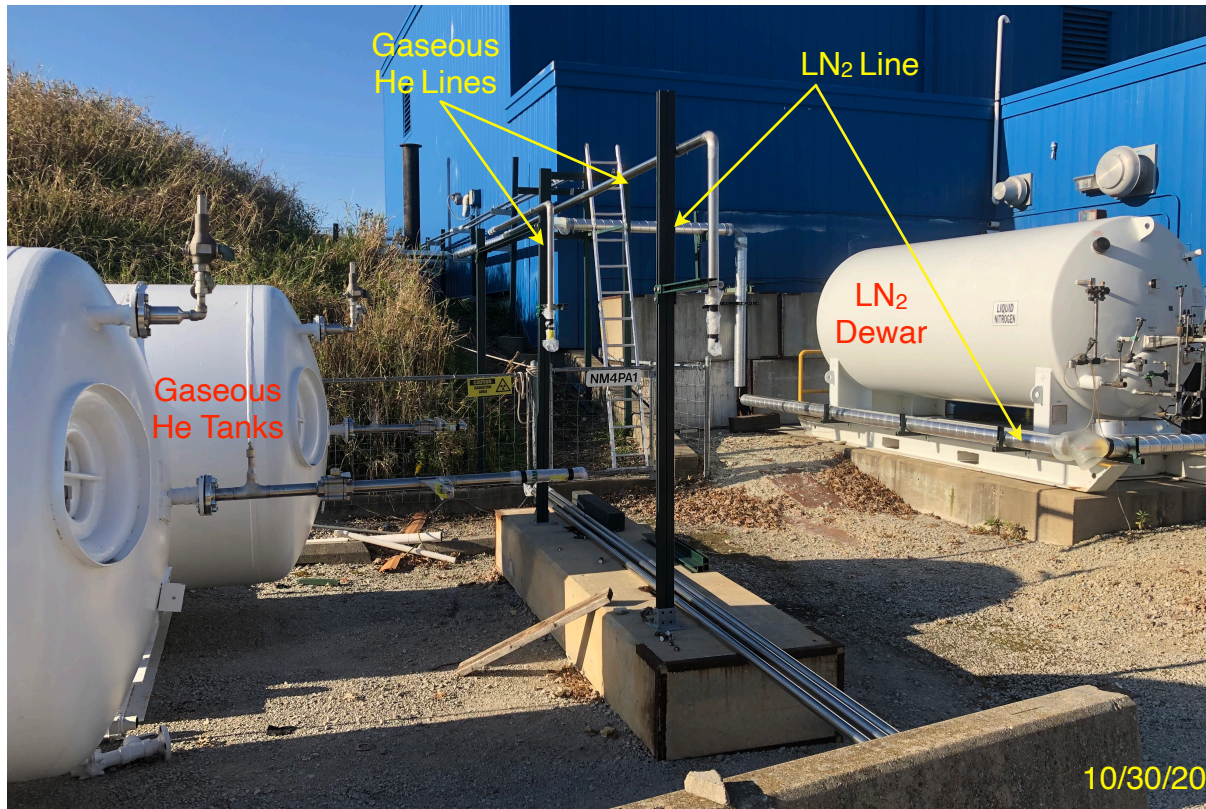
# Shielding Re-Configuration



Residual dose in target cave after 6 months irradiation at 1E13 protons/spill

- Elevation: after 3 hr, of no beam for a cool down
- Cryostat case residual dose vs time after beam exposure.
- Details in shielding assessment

# Cryo-Plumbing Installation



## Outdoor LN<sub>2</sub> transfer line

- Connect LN<sub>2</sub> dewar to cryo-system
- Brazing nearly complete outdoors
- Goal: complete outdoor plumbing before bad weather sets in.

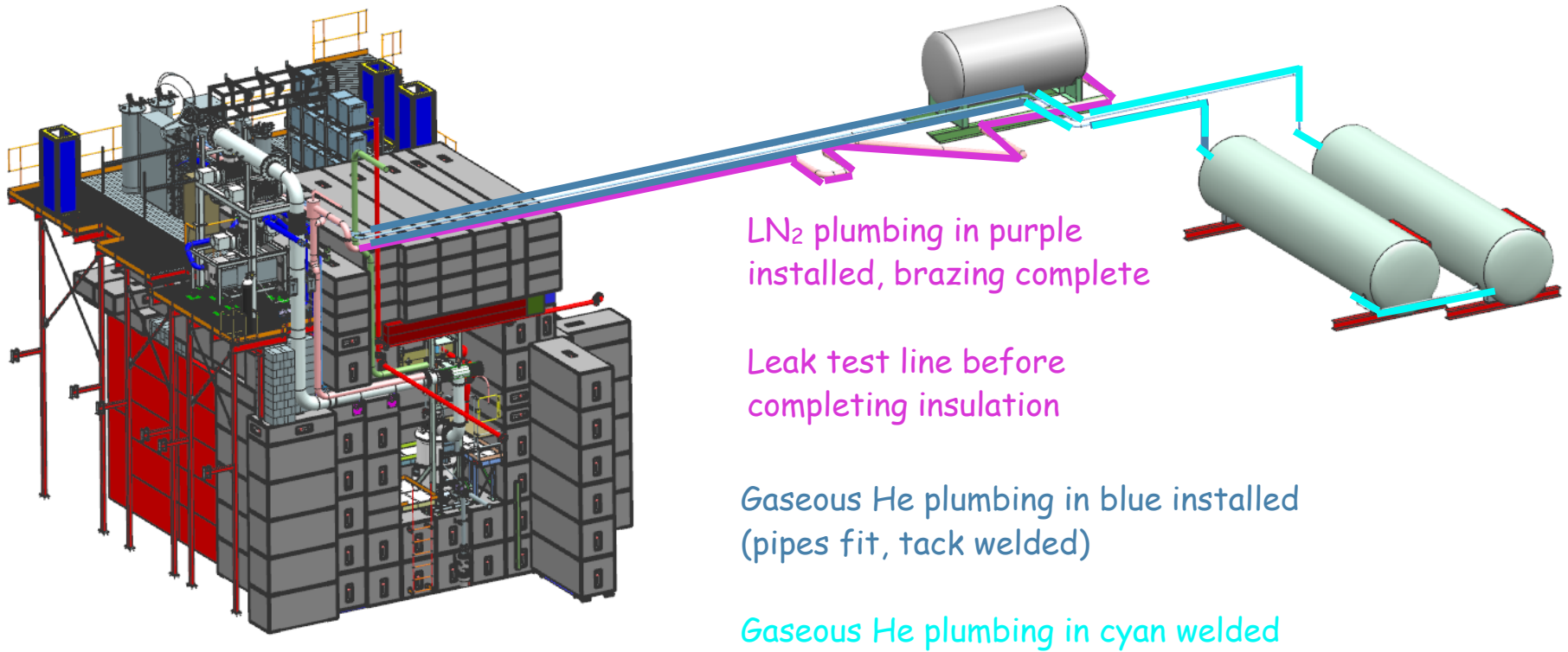
➔ Funding induced work stoppage

## Pressure test LCW to cryo platform

### Upcoming tasks (dates TBD)

- Gaseous He line installation (2x) underway
- He tank material certification (Dec 9)
- Pressure tests for LN<sub>2</sub> dewar, He tanks

# Cryo-Infrastructure Installation

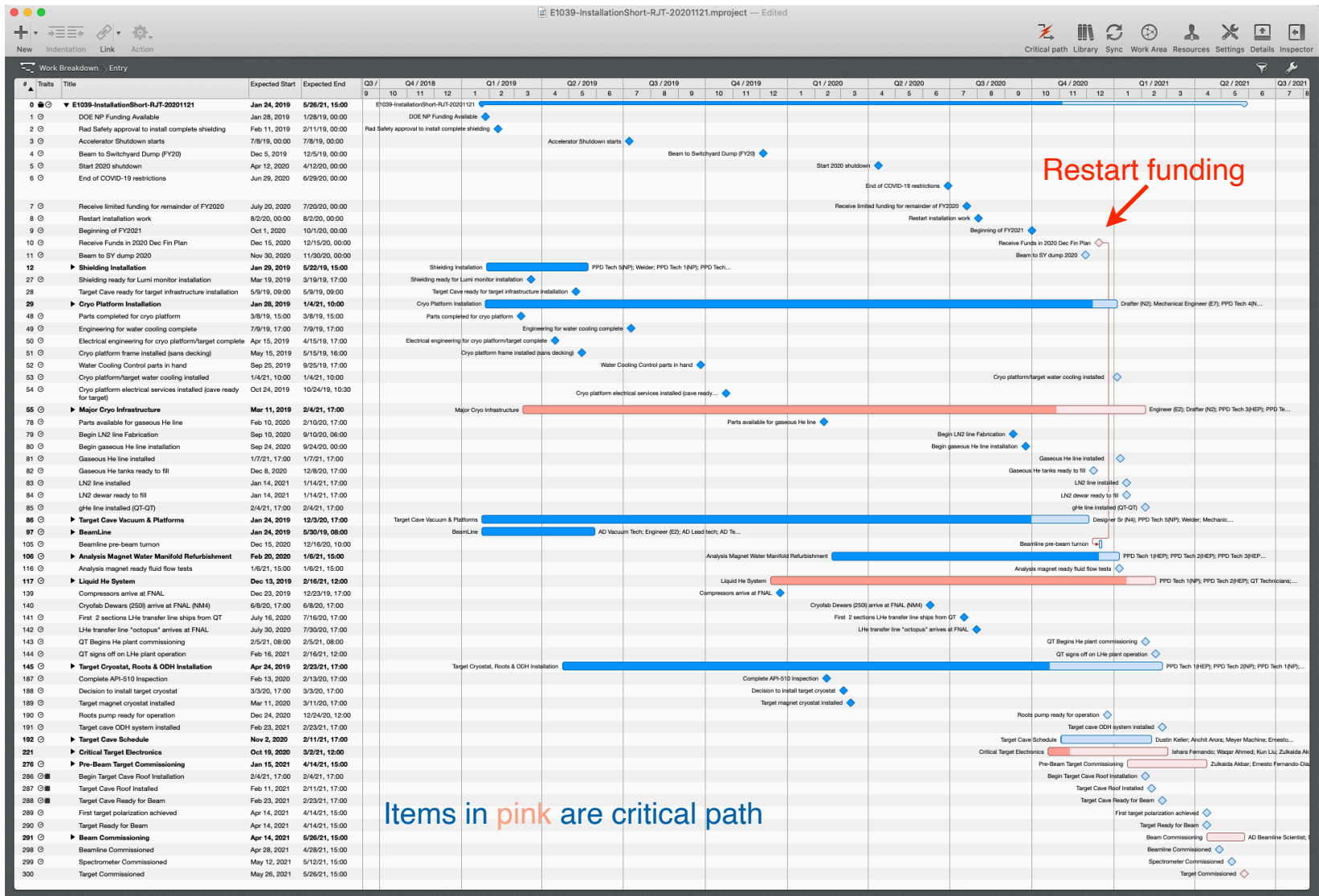


# Cryo-Infrastructure Installation





# Schedule Overview

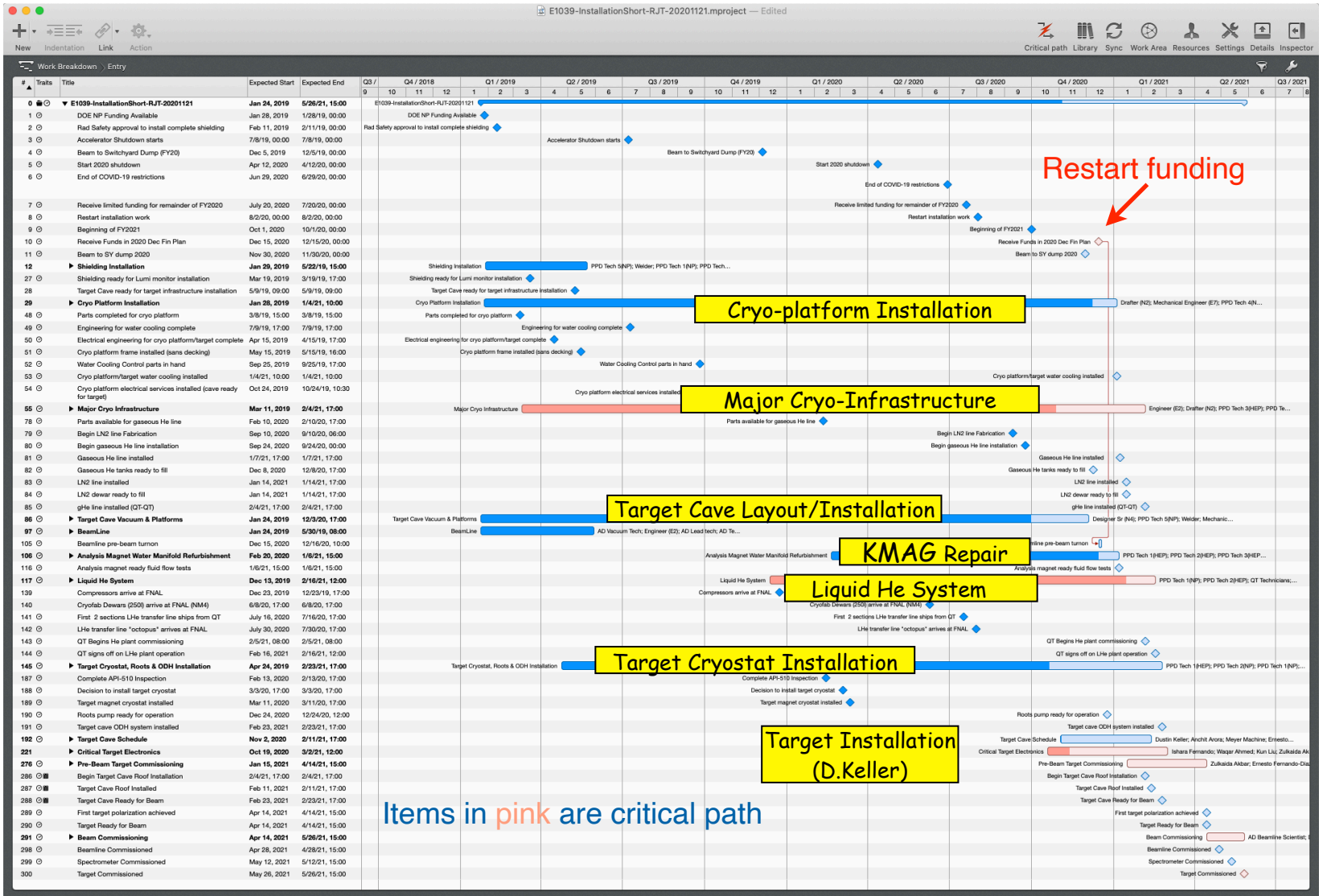


Items in pink are critical path

Technically driven schedule



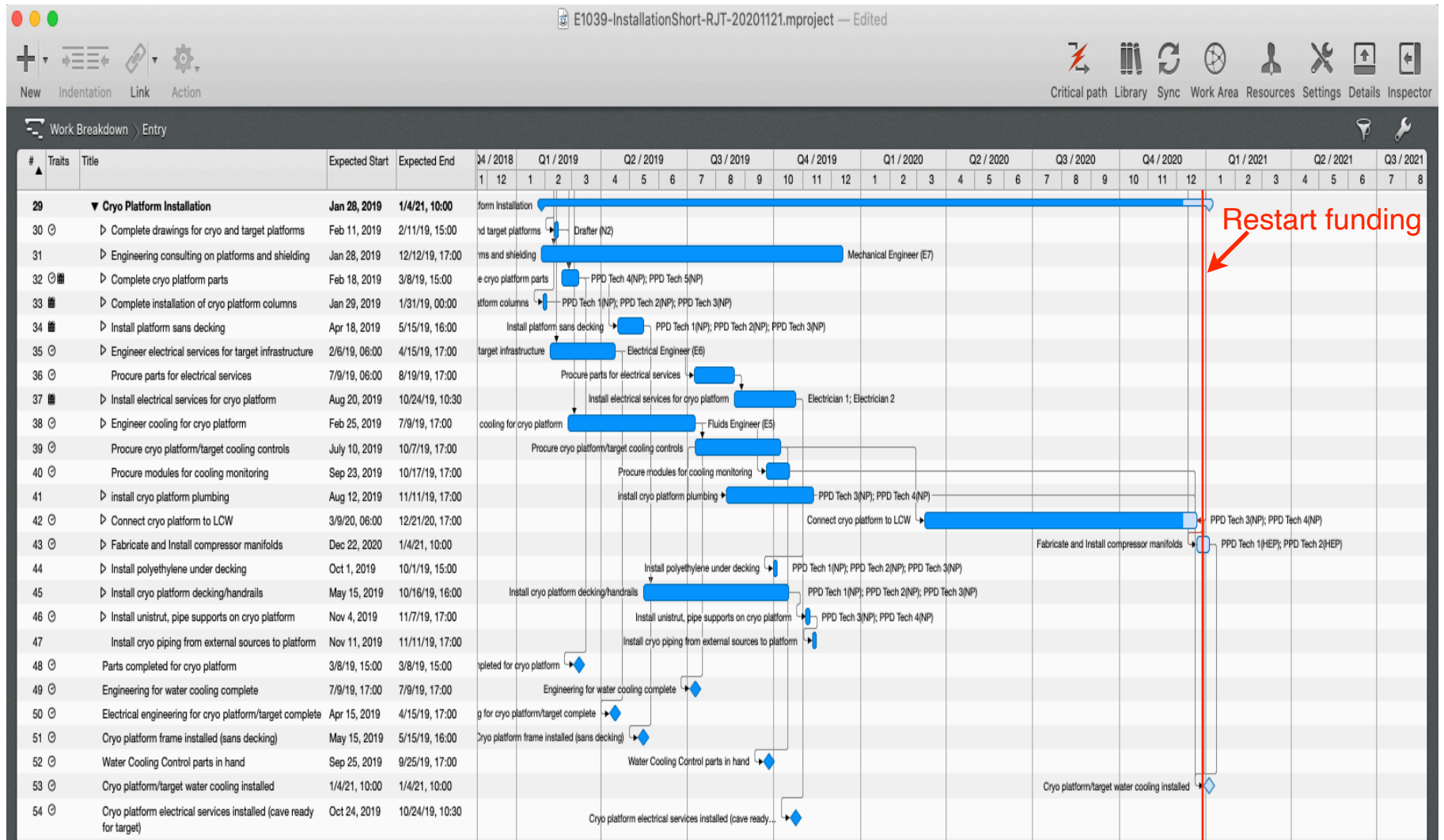
# Schedule Overview



Technically driven schedule



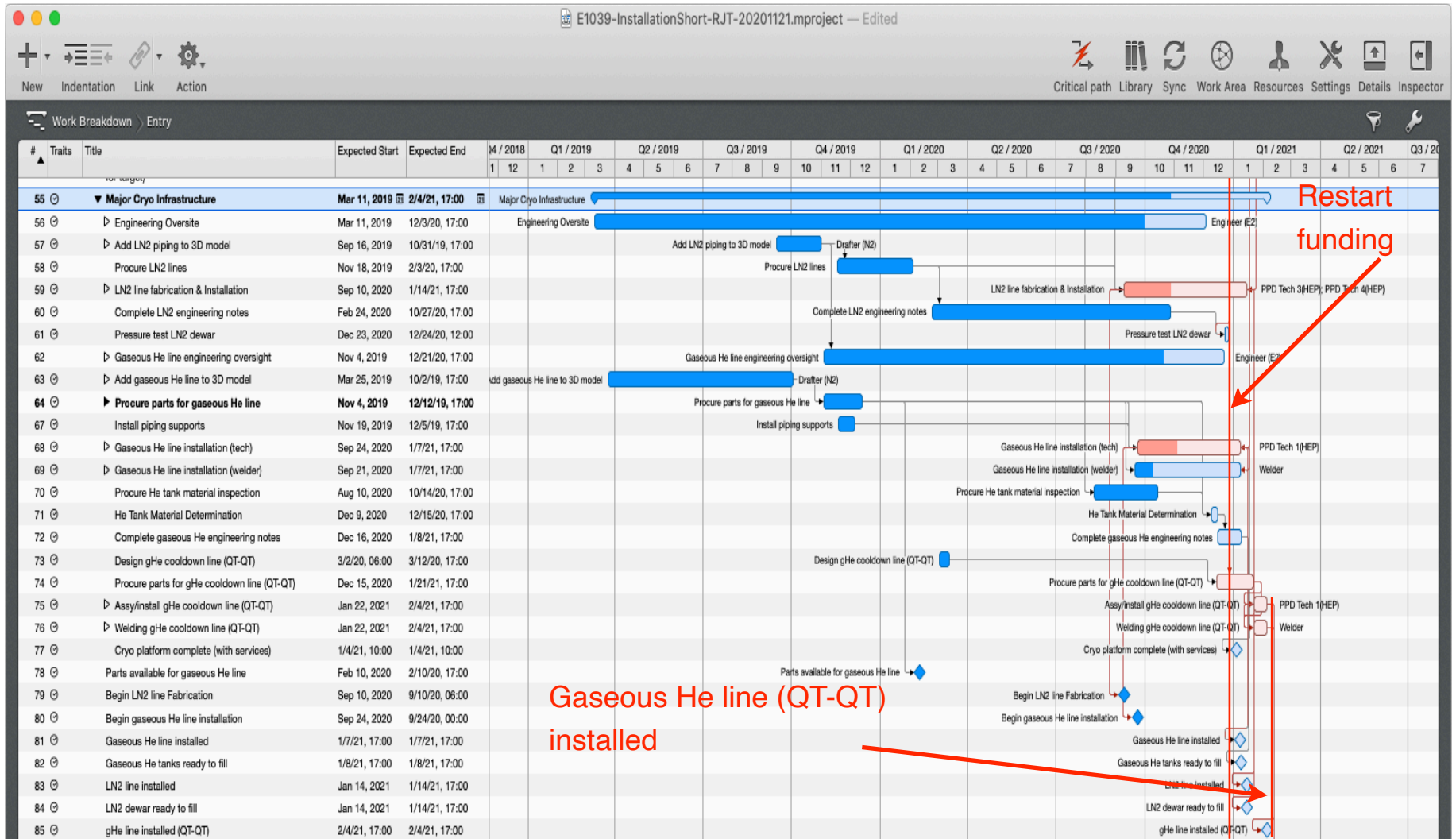
# Schedule: Cryo-Platform



Previously challenged by AD fluids tech availability

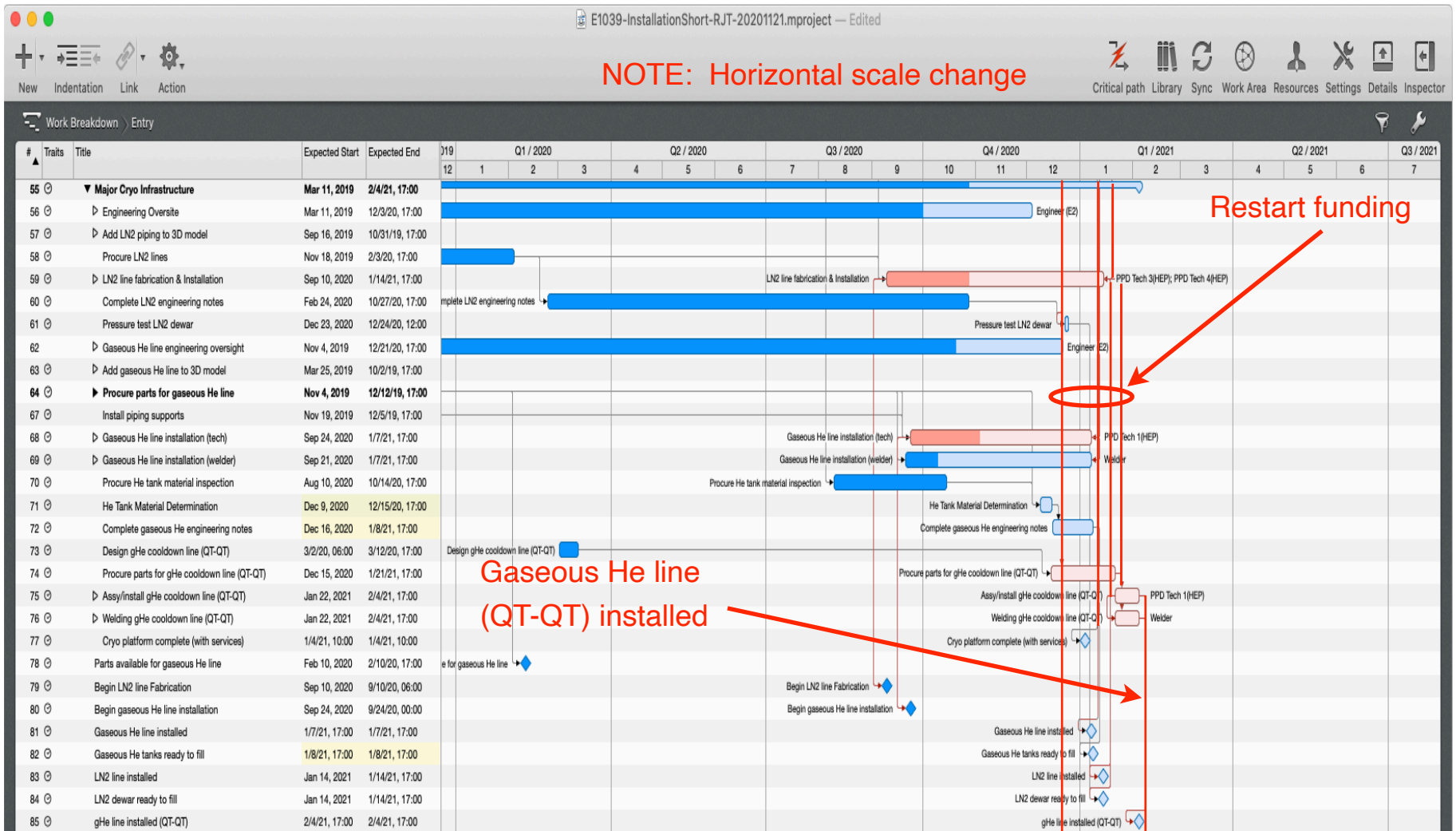


# Schedule: Major Cryo-Infrastructure



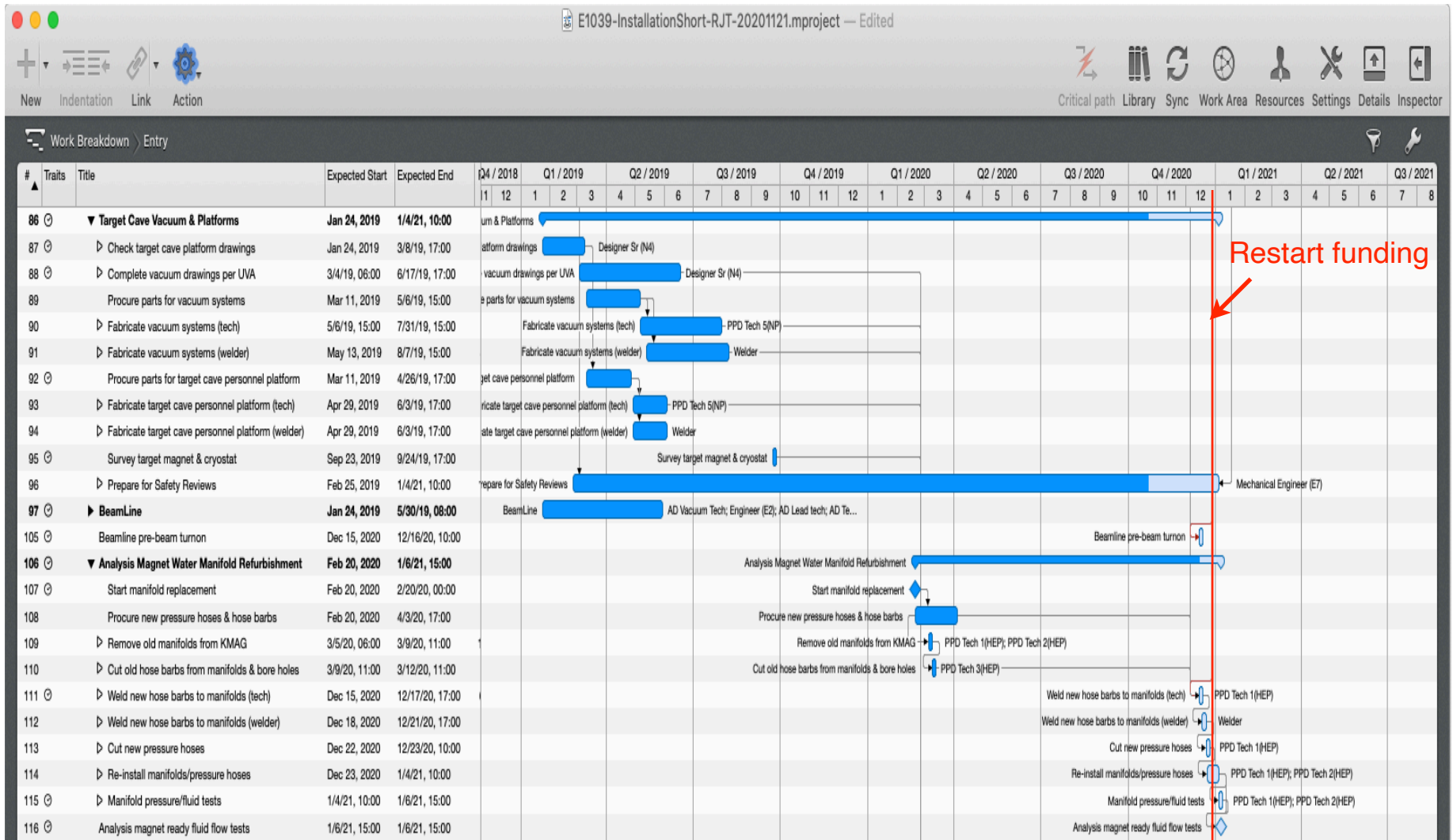
Outdoor plumbing installation started to "beat weather"

# Schedule: Major Cryo-Infrastructure



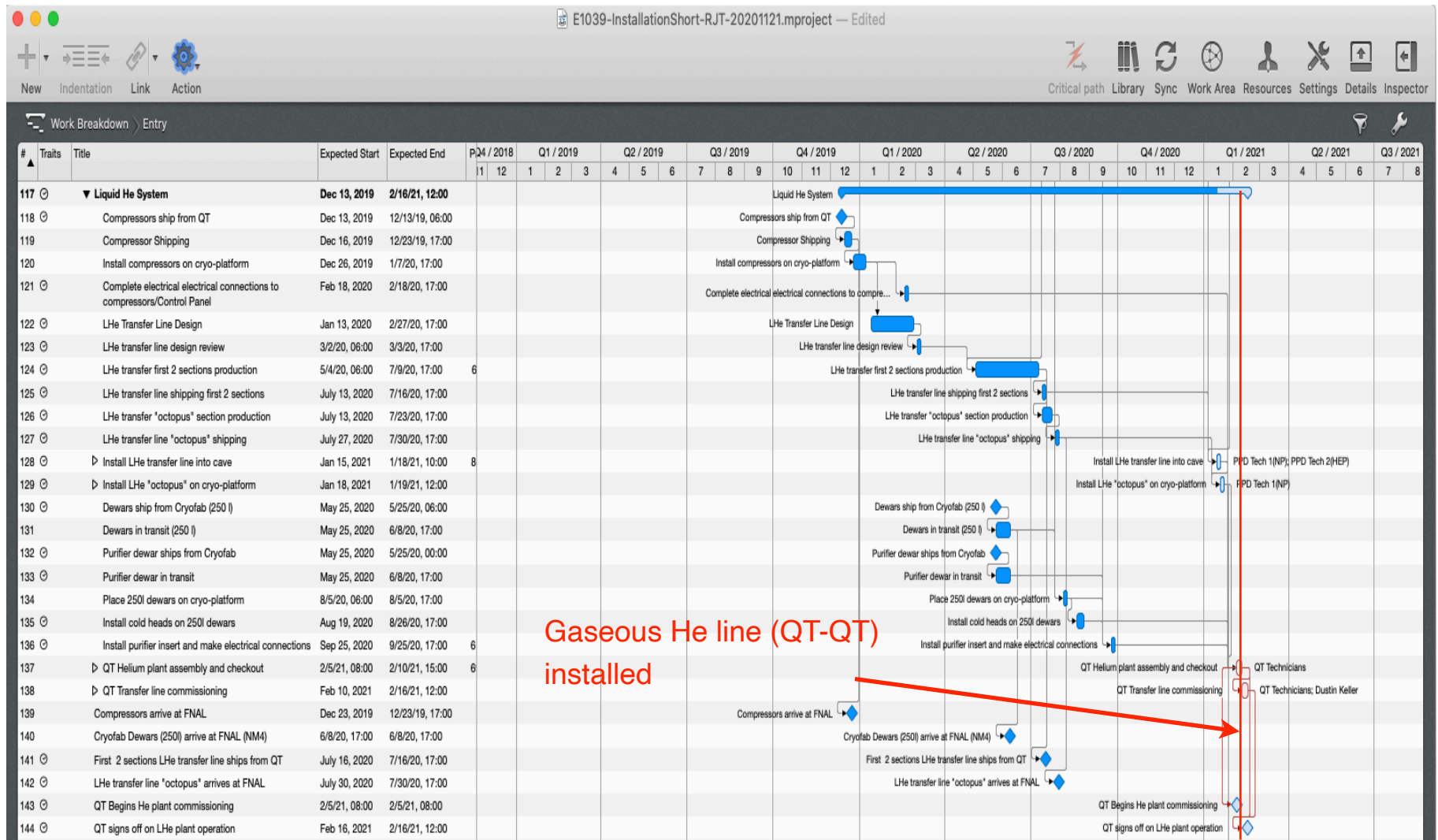
Outdoor plumbing installation started to “beat weather”

# Schedule: Target Cave & KMAG Repair



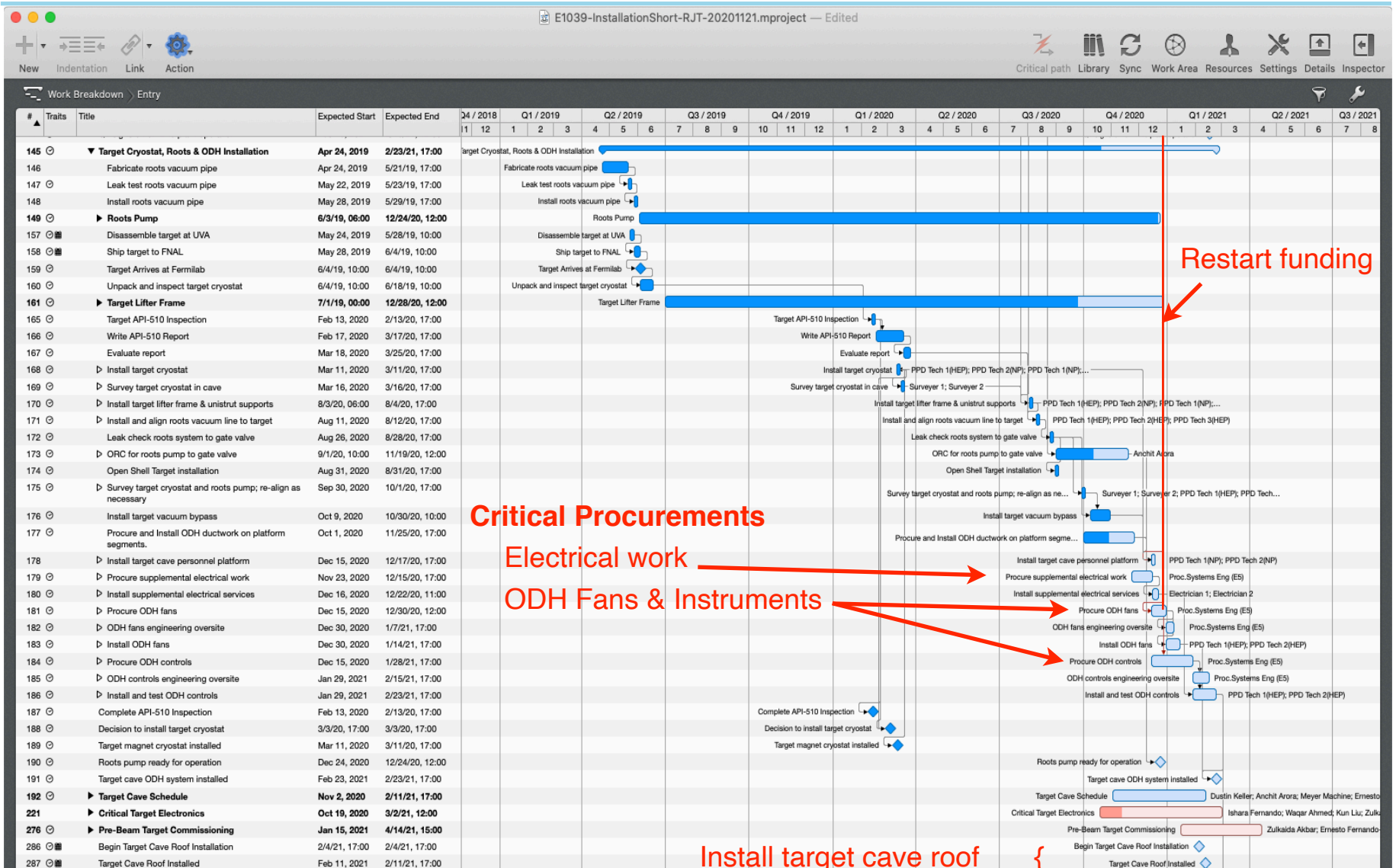
NOTE: Platform installed in another schedule section  
Engineering note needed for lifter

# Schedule: Liquid Helium System



Gaseous He line (QT-QT)  
installed

# Schedule: Target Cryostat



Restart funding

Critical Procurements  
Electrical work  
ODH Fans & Instruments

Install target cave roof





# Roll-Up of Expected Costs to Complete

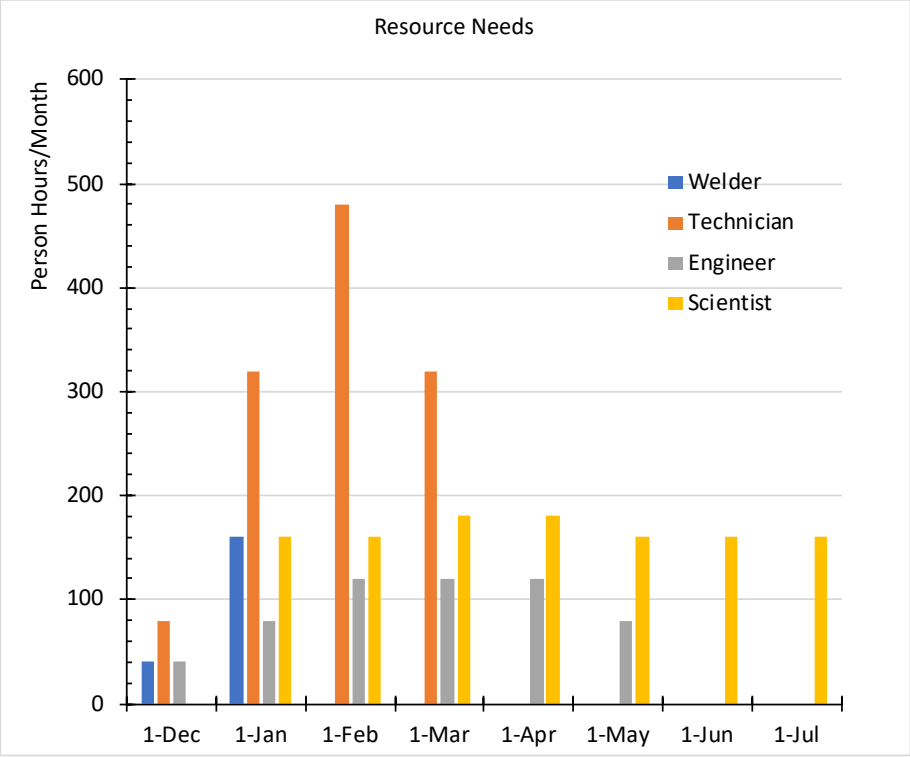
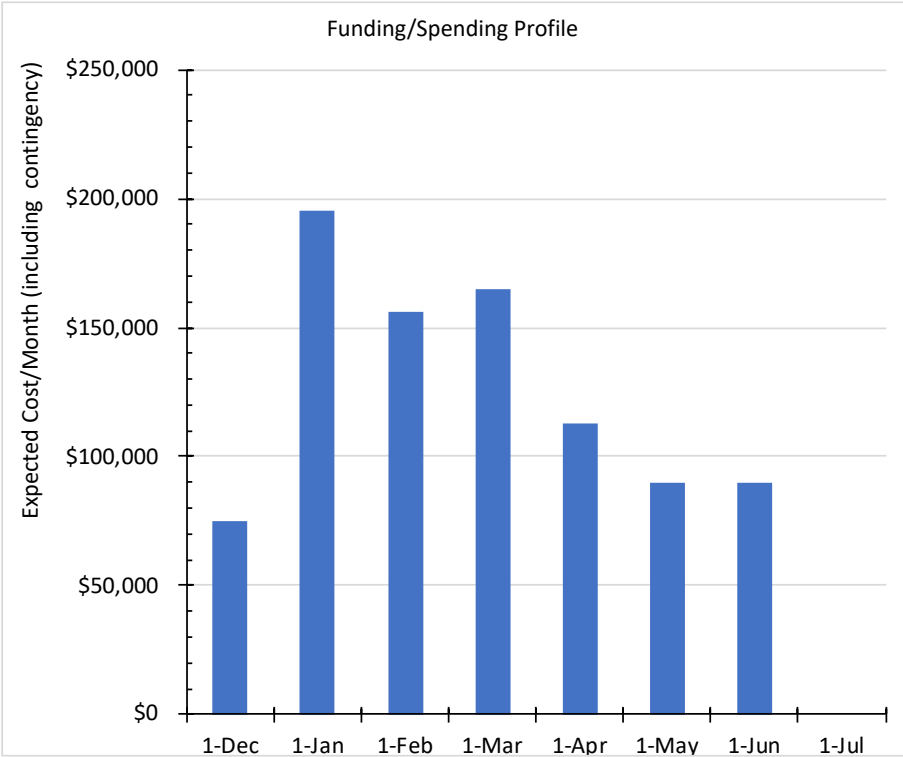
		Estimated Cost to Complete (as of 11/20/20)						
System	Item	M&S	M&S + Cont.	Labor	Labor + Cont.	Total (no Cont.)	Total + Cont.	Notes
<b>Target</b>	Install gaseous He transfer lines	\$0	\$0	\$30,892	\$46,337	\$30,892	\$46,337	11/20/20 materials purchased, ~1/3 complete
	Install LN2 transfer Line	\$0	\$0	\$44,074	\$66,111	\$44,074	\$66,111	11/01/20 All materials purchased, ~1/3 complete
	Complete H2O syst. Install & commish	\$0	\$0	\$22,142	\$30,879	\$22,142	\$30,879	5/3/20 Labor cost overrun of original estimate (Eng. Est.)
	gHe x-fer line (QT-QT)	\$3,700	\$4,710	\$14,515	\$21,773	\$18,215	\$26,483	11/5/19 (RJT est based on J.Kintner)
	Design and install target cave ODH	\$37,525	\$45,030	\$85,163	\$127,745	\$122,688	\$172,775	6/8/20(D.Allspach est.) 50% cont.
	Target & Cryo Review Prep	\$0	\$0	\$95,531	\$143,296	\$95,531	\$143,296	Includes QT, roots and target (FNAL) 50% cont.
	Alignment	\$0	\$0	\$3,602	\$4,682	\$3,602	\$4,682	10/1/20 Need 2nd alignment of cryostat 30% cont (experience)
	Target Installation	\$0	\$0	\$22,496	\$36,660	\$22,496	\$36,660	Target, roots vacuum line & lifter frame in cave
	SubTotal	\$41,225	\$49,740	\$318,414	\$477,484	\$359,639	\$527,224	
<b>Spectrometer</b>	Alignment	\$0	\$0	\$7,249	\$10,874	\$7,249	\$10,874	spectrometer alignment 50% contingency
	Electrical	\$9,500	\$11,400	\$0	\$0	\$9,500	\$11,400	ODH + supplemental electrical service (D.Featherston)
	KMAG repair	\$1,467	\$1,761	\$17,342	\$26,012	\$18,809	\$27,773	Work 40% complete
	SubTotal	\$10,967	\$13,161	\$24,591	\$36,886	\$35,558	\$50,047	
<b>Beamline</b>	Checkout	\$6,000	\$12,000	\$24,228	\$36,342	\$30,228	\$48,342	
		SubTotal	\$6,000	\$12,000	\$24,228	\$36,342	\$30,228	\$48,342
<b>Management</b>	Installation+commissioning	\$5,000	\$10,000	\$241,249	\$241,249	\$246,249	\$251,249	RJT( salary Jan-Jun)
		SubTotal	\$5,000	\$10,000	\$241,249	\$241,249	\$246,249	\$251,249
	<b>Total</b>	<b>\$63,192</b>	<b>\$84,901</b>	<b>\$608,482</b>	<b>\$791,961</b>	<b>\$671,674</b>	<b>\$876,862</b>	

Largest cost contributions circled in red

Contingency reduced for tasks partially complete

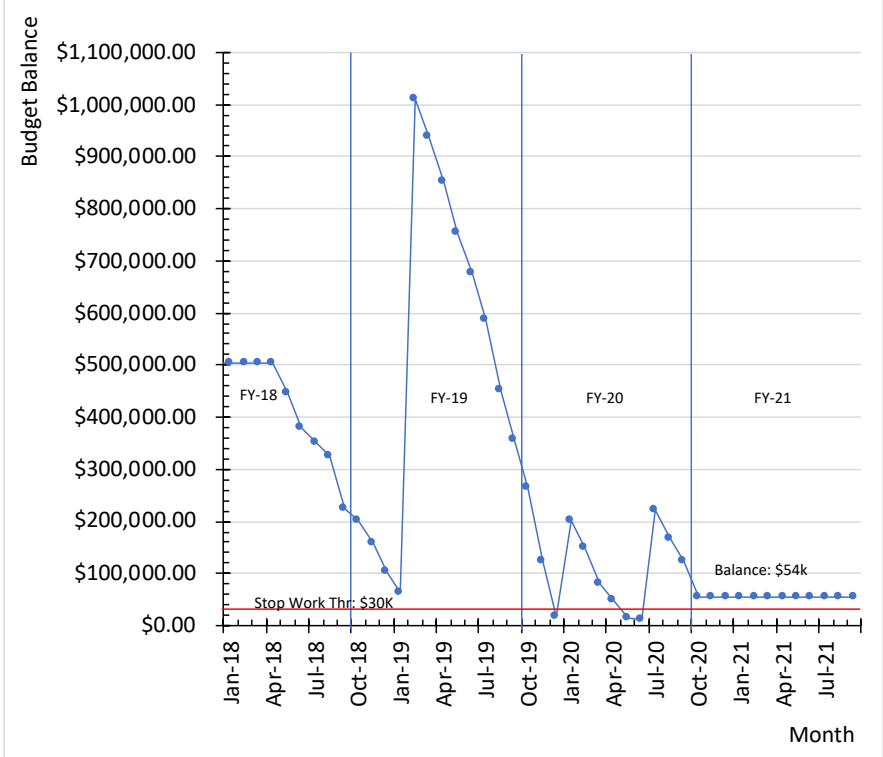
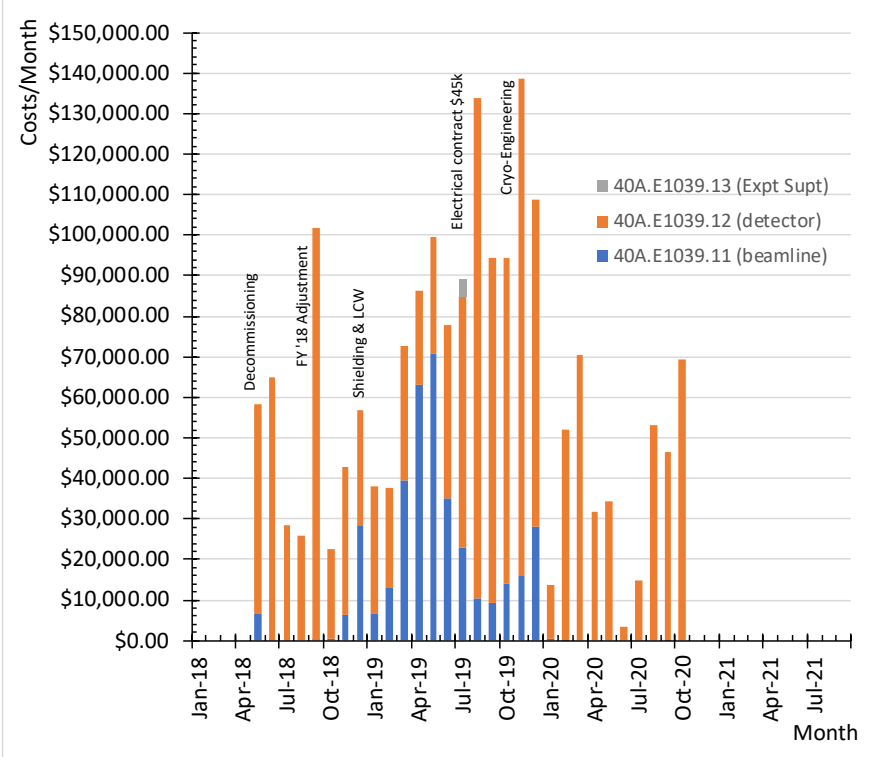
Details in backup slides

# Ideal Funding/Spending Profile



Funding/Spending profile assumes that all resources available as needed.

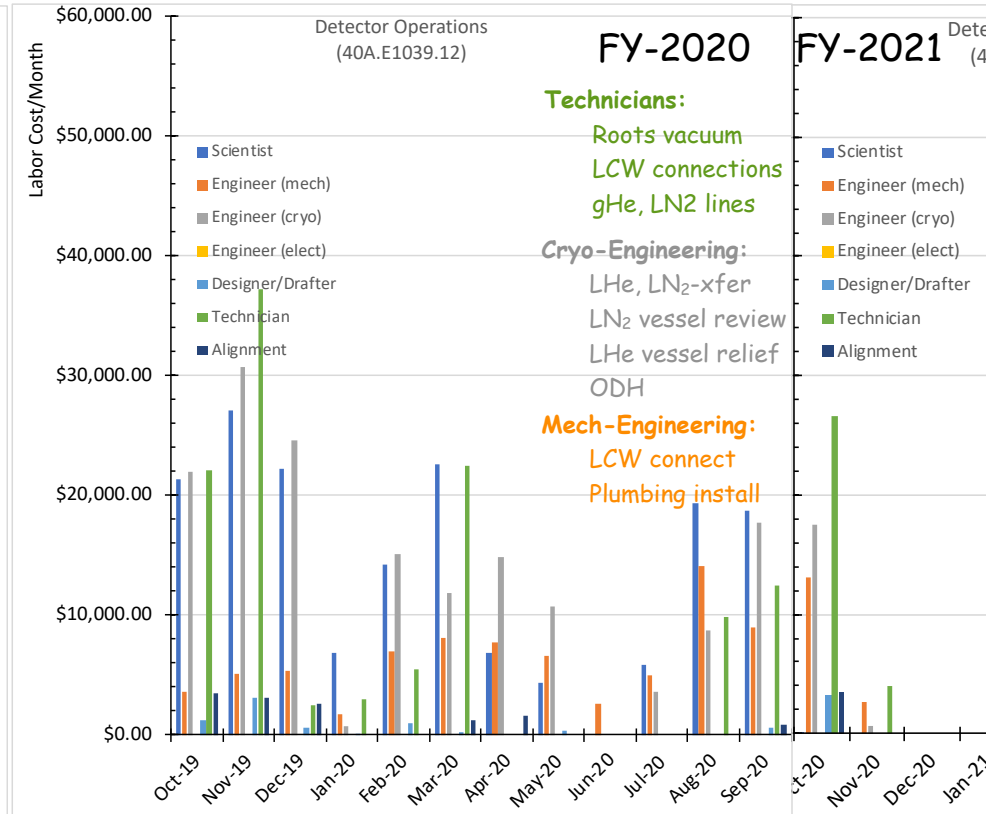
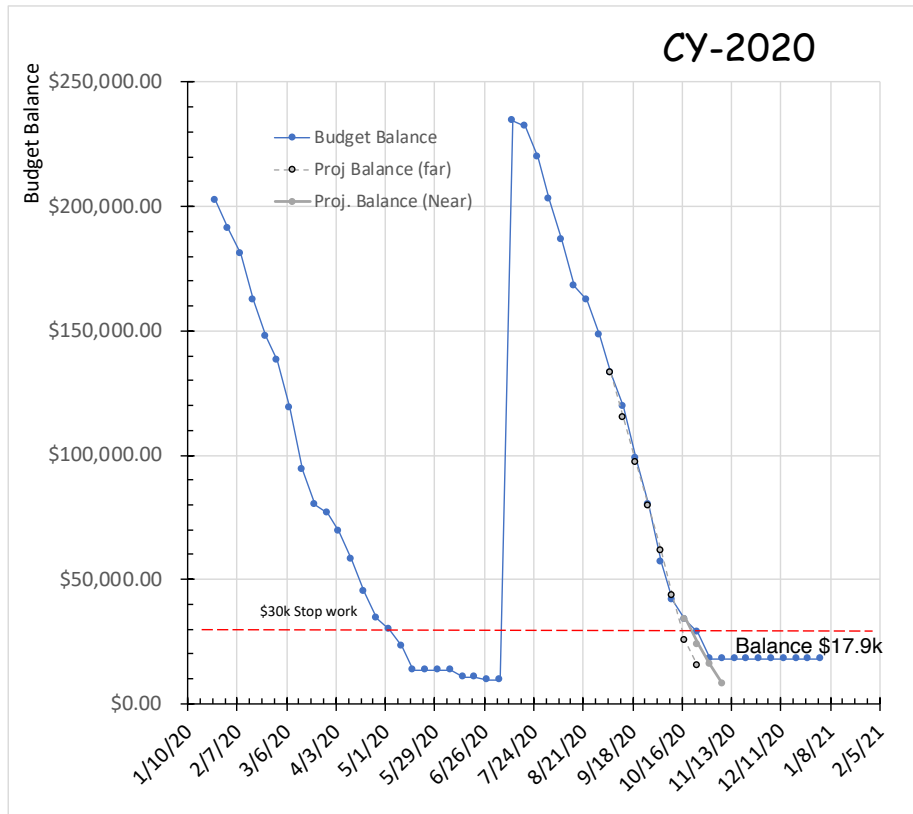
# Costs DOE-HEP Funds Through October Status



## Costs through October 2020 Status

- Beamline costs from collimator construction and beamline checkout (2019)
  - Balance \$54k at end of Oct.
- ➔ Stop work order 11/2

# Costs DOE-HEP through October Status



## Budget and Labor through 11/8/20

- Stop work order issued 11/2/20
- Current balance \$17k
- He tank material identification obligated, will execute contract week of 12/9

# Risks

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## Funding:

- Reliable source of funds to complete
- Reliable source of funds to remain on schedule

## Resources:

- Project low priority at the lab (resource availability)
- Critical resources moving ahead
  - Welding & brazing for infrastructure
  - Rigging shielding blocks
  - Crane assistance for infrastructure installation
  - Engineers for engineering note review
- Infrastructure largely complete early March 2021 (pending funding/resources)

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# Back Up Slides

# Remaining Costs: LN2 Transfer Line

Liquid N2 Transfer Lines										
M&S	Item	Cost	Cont. Rate (%)	Contingency	Cost + Cont.	Notes	Planned Costs	Actual Cost	CPI	
	Foam Jacketed Cu	\$7,487.58	0	\$0.00	\$7,487.58	Firm Quote \$7987.56 + 10% cont	\$7,987.56	\$7,487.58	1.07	
	Valves & Instrum	\$0.00	0	\$0.00	\$0.00	Off the shelf items, LANL contribution				
	SubTotal	\$7,487.58		\$0.00	\$7,487.58		SubTotal			
Less comp. Purchases		\$7,487.58		\$0.00	\$7,487.58					
Remaining M&S		\$0.00		\$0.00	\$0.00					
Labor	Item	Hrs	Cost			Notes	Planned Costs	Actual Cost	CPI	
	Technician	240	\$31,293.60	50	\$15,646.80	\$46,940.40	\$31,293.60	\$7,509.49	4.17	
	Welder	85	\$14,463.60	50	\$7,231.80	\$21,695.40	\$14,463.60	\$1,250.82	11.56	
	Engineering	80	\$12,730.40	50	\$6,365.20	\$19,095.60	\$12,730.40	\$13,897.97	0.92	
	Engineering Oversight	50	\$5,554.50	50	\$2,777.25	\$8,331.75	\$5,554.50	\$3,970.02	1.40	
	SubTotal	455	\$64,042.10		\$32,021.05	\$96,063.15	SubTotal	\$64,042.10	\$22,658.28	2.83
Less completed tasks			\$22,658.28							
Remaining labor costs			\$41,383.82	50	\$20,691.91	\$62,075.73				
Include 6.5% increase			\$44,073.77		\$22,036.88	\$66,110.65				
	<b>Total (M&amp;S + Labor)</b>		<b>\$71,529.68</b>		<b>\$32,021.05</b>	<b>\$103,550.73</b>				
<b>Cost to Complete</b>			<b>\$44,073.77</b>			<b>\$66,110.65</b>				
Notes										
Date	Notes									
11/4/19	Email from Jake Kintner. His email separates out: a)dewar into building, b)inside building to quantum, c) inside building to target cave.									
11/18/19	Initial purchases approved (e-commerce only) for \$4507.74. Total purchases at this time are \$16,848.32 (balance ~\$12k not committed).									
11/25/19	Add contingency. Need to check whether all materials were included in price quotes.									
12/1/19	Reduce total costs for Misc. M&S to \$9k; the original \$26k included \$14k for the foam jacketed Cu (now \$8k\$) (per J.Kintner discussion)									
2/10/20	The PR cost for the Rovanco foam jacket copper pipe is \$7487.58. Set contingency for items purchase (LANL) from 10% to 0 (\$4353).									
4/27/20	Labor for J.Kintner 65.81 h + 1/2 D.Mitchell thru 3/27/20.									
10/19/20	All materials purchased. Approximately 1/3 tech labor 1/4 welder labor complete									
11/1/20	Add engineering oversite 10 hrs/week, 5 wks									

# Remaining Costs: NM4 Water (LCW)

NM4 Water											
M&S	Item		Cost	Cont Rate(%)	Contingency	Cost + Cont.	Notes	Planned Costs	Actual Cost	CPI	
	Flex hose		\$3,780.84	0	\$0.00	\$3,780.84	Purchase order for \$3780.84 + 10% cont	\$3,780.84	\$3,780.84	1.000	
	Misc.		\$500.00	0	\$0.00	\$500.00	Estimate cost \$500 + 50% contingency	\$500.00	\$489.63	1.021	
	SubTotal		\$4,280.84		\$0.00	\$4,280.84		SubTotal	\$4,280.84	\$4,270.47	1.002
	Less completed purch.		\$4,280.84		\$0.00	\$4,280.84					
	Remaining M&S		\$0.00		\$0.00	\$0.00					
<b>Labor</b>											
Labor	Item	Hrs	Cost	Cont. Rate(%)			Notes	Planned Costs	Actual Cost	CPI	
	Installation: 2 tech 2 wk	160	\$20,862.40	50	\$10,431.20	\$31,293.60	Original estimate \$20,862.40+ 50% cont.	\$20,862.40	\$11,063.98	1.886	
	Engineering Oversight	8	\$1,495.20	50	\$747.60	\$2,242.80	Orig. est. \$1495.20+50% cont, new Jr. Eng.(J.Chikelu)	\$1,495.20	\$7,274.18	0.206	
						\$0.00					
	SubTotal	0	\$22,357.60		\$11,178.80	\$33,536.40		SubTotal	\$22,357.60	\$15,373.68	1.454
	Less completed tasks		\$15,373.68		\$0.00	\$15,373.68					
	Remaining Labor costs		\$6,983.92			\$18,162.72	Remaining labor costs from original estimate				
	Est. remaining Labor		\$29,125.60	30	\$8,737.68	\$37,863.28	Remaining labor costs from 11/20/20 estimate				
	Est. additional costs		\$22,141.68		\$8,737.68	\$30,879.36	(carry over contingency from above estimate)				
	<b>Total (M&amp;S + Labor)</b>		<b>\$26,638.44</b>		<b>\$11,178.80</b>	<b>\$37,817.24</b>		<b>Total</b>	<b>\$19,644.15</b>		
<b>Cost to Complete</b>			<b>\$22,141.68</b>			<b>\$30,879.36</b>					
<b>Notes</b>											
Date	Notes										
11/20/19	Replace \$3500 estimate for quote of \$3780.84 for the hoses.										
5/13/20	based on labor to-date obtain new est. to complete (F.Rios email) \$39,958 includes H2O connections and manifolds										
10/1/20	Connection made to platform, remaining work: manifold fabrication & installation, pressure test (approximately 2/3 of remaining labor from 5/13)										



# Remaining Costs: Gaseous He Line (QT-QT)

Gaseous He Transfer Line										
M&S	Item		Cost	Cont. Rate (%)	Contingency	Cost + Cont	Notes	Planned Costs	Actual Cost	CPI
	Pipe		\$3,600.00	30	\$1,080.00	\$4,680.00	See notes below	\$3,600.00		#DIV/0!
	Fittings		\$100.00	30	\$30.00	\$30.00		\$100.00		#DIV/0!
	SubTotal		\$3,700.00		\$1,110.00	\$4,710.00		SubTotal	\$3,700.00	\$0.00 #DIV/0!
	Less completed purch.		\$0.00		\$0.00	\$0.00				
	Remaining M&S		\$3,700.00		\$1,110.00	\$4,710.00		Subtotal		
Labor	Item	Hrs	Cost					Planned Costs	Actual Cost	CPI
	Tech	80	\$10,431.20	50	\$5,215.60	\$15,646.80	Init Est. \$10,431.20 + 50% cont.	\$10,431.20		#DIV/0!
	Welder	24	\$4,083.84	50	\$2,041.92	\$6,125.76	Init. Est. \$4,083.84 + 50% cont .	\$4,083.84		#DIV/0!
	SubTotal	104	\$14,515.04		\$7,257.52	\$21,772.56	Notes	SubTotal	\$14,515.04	\$0.00 #DIV/0!
	Less completed tasks		\$0.00			\$0.00				
	Remaining Labor costs		\$14,515.04		\$7,257.52	\$21,772.56				
	<b>Total (M&amp;S+Labor)</b>		<b>\$18,215.04</b>		<b>\$8,367.52</b>	<b>\$26,482.56</b>		<b>Total</b>	<b>\$18,215.04</b>	<b>\$0.00</b>
<b>Total Cost To Complete</b>			<b>\$18,215.04</b>		<b>\$8,367.52</b>	<b>\$26,482.56</b>				
Notes										
Date	Notes									
11/5/19	Use 3/4" foam insulated Cu as standard 100 ft (J.Kintner) [ $\$14,000 \times (100/396) = \$3,535$ ]									
4/27/20	Engineering labor on gHe transfer (J.Kintner)									

# Remaining Costs: ODH Installation

ODH Design & Install										
M&S	Item		Cost	Cont. Rate	Contingency	Cost+cont.	Notes	Planned Cost	Actual Cost	CPI
	Controls		\$23,625.00	20	\$4,725.00	\$28,350.00	Del Allspach email 6/4/20	\$23,625.00		#DIV/0!
	Fans		\$4,400.00	20	\$880.00	\$5,280.00	Fans commercially available	\$4,400.00		#DIV/0!
	Electrical		\$9,500.00	20	\$1,900.00	\$11,400.00	Includes supl. electrical for platform	\$9,500.00		#DIV/0!
	SubTotal		\$37,525.00		\$7,505.00	\$45,030.00		SubTotal	\$37,525.00	\$0.00 #DIV/0!
Less completed purch.			\$0.00		\$0.00	\$0.00				
Remaining M&S			\$37,525.00		\$7,505.00	\$45,030.00				
Labor	Item	Hrs	Cost				Notes	Planned Cost	Actual Cost	CPI
Controls	Engineering	40	\$5,215.60	50	\$2,607.80	\$7,823.40	Init. Est. \$5,215.60+50%cont. 5 FTE days	\$5,215.60		#DIV/0!
	Technician	160	\$20,862.40	50	\$10,431.20	\$31,293.60	Init. Est. \$20,862.40+50% cont. 20 FTE days	\$20,862.40		#DIV/0!
Fans, ESH	Engineering	96	\$16,335.36	50	\$8,167.68	\$24,503.04	Init. Est. \$16,335.36 + 50% cont. 12 FTE days	\$16,335.36		#DIV/0!
	Technician	288	\$37,552.32	50	\$18,776.16	\$56,328.48	Init. Est. \$37552.32 + 50% cont. 36 FTE days	\$37,552.32		#DIV/0!
	SubTotal	584	\$79,965.68		\$39,982.84	\$119,948.52		SubTotal	\$79,965.68	\$0.00 #DIV/0!
Less completed tasks			\$0.00		\$0.00	\$0.00				
Remaining Labor costs			\$79,965.68		\$39,982.84	\$119,948.52				
Include 6.5% addition			\$85,163.45		\$42,581.72	\$127,745.17				
	<b>Total (M&amp;S+Labor)</b>		<b>\$117,490.68</b>		<b>\$47,487.84</b>	<b>\$164,978.52</b>		<b>Total</b>		
<b>Cost to Complete</b>			<b>\$122,688.45</b>		<b>\$50,086.72</b>	<b>\$172,775.17</b>				
Notes										
Date	Notes									
6/4/20	Use Del's estimates									
10/1/20	U.Virginia fabricates ductwork (not included above)									

# Remaining Costs: Target Safety Prep

Target Safety Prep											
M&S	Item		Cost	Cont Rate (%)	Contingency	Cost + Cont	Notes		Planned Costs	Actual Costs	CPI
	SubTotal		\$0.00		\$0.00	\$0.00		SubTotal			
Less completed purch.			\$0.00		\$0.00	\$0.00					
Remaining M&S			\$0.00		\$0.00	\$0.00					
Labor	Item	Hrs	Cost	Cont Rate (%)	Contingency	Cost + Cont	Notes		Planned Costs	Actual Costs	CPI
	Target Safety doc review	832	\$132,396.16	50	\$37,236.42	\$169,632.58	Init. Est. \$132,396.16		\$132,396.16		
	QT Doc Review	624	\$99,297.12	50	\$42,328.58	\$141,625.70	15% complete: 50% cont on remainder		\$99,297.12		
	Roots Vacuum System	52	\$8,274.76	50	\$4,137.38	\$12,412.14			\$8,274.76		
	SubTotal	1508	\$239,968.04		\$83,702.38	\$323,670.42		SubTotal	\$239,968.04		
Less completed tasks			\$150,267.60								
Remaining labor costs			\$89,700.44	50	\$44,850.22	\$134,550.66					
Include 6.5% increase			\$95,530.97		\$47,765.48	\$143,296.45					
	<b>Total</b>		<b>\$239,968.04</b>		<b>\$83,702.38</b>	<b>\$323,670.42</b>		<b>Total</b>			
<b>Cost to complete</b>			<b>\$95,530.97</b>		<b>\$47,765.48</b>	<b>\$143,296.45</b>					

Notes											
Date	Notes										
10/15/19	Estimate for QT review and roots only. FNAL transfer lines covered by other estimates. Based on earlier document detailing safety										
5/11/20	320 hrs (\$50,921.60) completed on Target safety doc review										
5/11/20	92 hrs (\$14,639.96) completed on QT doc Review										
5/11/20	0 hrs on roots										
11/20/20	484 hrs (\$90,459.60) completed on Target safety doc review										
11/20/20	320 hrs (\$59,808.00) completed on QT doc review										

# Remaining Costs: K MAG Repair

K MAG Repair											
M&S	Item		Cost	Cont. Rate(%)	Contingency	Cost + cont.	Notes		Planned Costs	Actual Costs	CPI
	Hose barbs		\$3,750.24	0	\$0.00	\$3,750.24	D.Mitchell email estimate \$3750.24 + 20% cont		\$3,750.24	\$2,056.32	1.82
	Pressure Hose		\$1,459.20	0	\$0.00	\$1,459.20	Original Estimate \$1459.20+ 20% cont		\$1,459.20	\$1,975.18	0.74
	SS pipe for manifold		\$1,467.40	20	\$293.48	\$1,760.88					
	SubTotal		\$6,676.84		\$293.48	\$6,970.32	Estimate \$5209.44 + 20% cont	SubTotal	\$5,209.44	\$4,031.50	1.29
Less completed purch.			\$5,209.44			\$5,209.44					
Remaining M&S			\$1,467.40		\$293.48	\$1,760.88					
Labor	Item	hrs	Cost	Cont. Rate(%)	Contingency	Cost + cont.	Notes		Planned Costs	Actual Costs	CPI
Remove old fittings	Technician	45	\$15,549.01	0	\$0.00	\$15,549.01	D.Mitchell init. estimates \$5867.55 + 50% cont		\$5,867.55	\$15,549.01	0.38
Manifold prep	Technician	24	\$3,129.36	50	\$1,564.68	\$4,694.04	New: Init cost \$3,129.36+50% cont.		\$3,129.36		
Weld manifolds	Welder	16	\$2,722.56	50	\$1,361.28	\$4,083.84	New: Init cost \$2,752.56+50% cont.		\$2,722.56		
Install new fittings	Technician	80	\$10,431.20	50	\$5,215.60	\$15,646.80	New: Init cost \$10431.20+50% cont.		\$10,431.20		
	SubTotal		\$31,832.13		\$8,141.56	\$39,973.69		SubTotal	\$22,150.67	\$15,549.01	
Less completed tasks			\$15,549.01			\$15,549.01					
Remaining labor costs			\$16,283.12		\$8,141.56	\$24,424.68					
Include 6.5% increase			\$17,341.52		\$8,670.76	\$26,012.28	FY20 FY21 increase in labor rates				
	<b>Total M&amp;S +Labor</b>		<b>\$38,508.97</b>		<b>\$8,435.04</b>	<b>\$46,944.01</b>		<b>Total</b>		<b>\$19,580.51</b>	
<b>Cost to Complete</b>			<b>\$18,808.92</b>		<b>\$8,964.24</b>	<b>\$27,773.16</b>					
Notes											
Date	Notes										
4/19/20	Budgetary costs for hose barbs vendor assumed embargo of Chinese products. Actual costs of parts much lower.										
4/19/20	Technician time for removing old manifolds/hoses underestimated										
10/6/20	New estimates for re-installation (technician estimates) Add 3 tasks (manifold prep, welding and installation)										

Costs for removing manifolds exceed initial engineering estimate for entire task RED circle.

- Include cost estimates for remaining tasks from technicians performing the job.
- Include 50% contingency.

# Remaining Costs: Alignment

Alignment												
Labor	Item	Crew	Geodecist	Cost	Cont. Rate (%)	Contingency	Cost + Cont	Notes	Planned Costs	Actual Costs	CPI	
	Target Cryostat Positioning	15	3	\$2,830.01	0	\$0.00	\$2,830.01	J.Kyle estimate \$2433.24 + 50% cont	\$2,433.24	\$2,830.01	0.86	
	Target Cryostat confirmation	5	2	\$3,381.80	0	\$0.00	\$3,381.80	J.Kyle estimate \$970.21 + 50% cont	\$970.21	\$3,381.80	0.29	
	Target stick	10	10	\$3,485.56	0	\$0.00	\$3,485.56	J.Kyle estimate \$2895.20 + 50% cont	\$2,895.20	\$3,485.56	0.83	
	Control Network	65	18	\$13,200.80	0	\$0.00	\$13,200.80	J.Kyle estimate \$10,210.35	\$10,210.85	\$13,200.80	0.77	
	Target Cryostat confirmation 2	5	2	\$3,381.80	30	\$1,014.54	\$4,396.34	New: Based on previous confirmation	\$3,381.80			
	SubTotal	100	35	\$26,279.97		\$1,014.54	\$27,294.51		SubTotal	\$19,891.30	\$22,898.17	0.87
Less complete tasks				\$22,898.17			\$22,898.17					
Remaining Labor Costs	SubTotal			\$3,381.80		\$1,014.54	\$4,396.34					
Include 6.5% increase				\$3,601.62		\$1,080.49	\$4,682.10					
<b>Total Cost To Complete (Target)</b>				<b>\$3,601.62</b>		<b>\$1,080.49</b>	<b>\$4,682.10</b>					
Labor	Item	Crew	Geodecist	Cost				Notes	Planned Costs	Actual Costs	CPI	
	Spectrometer alignment	40	10	\$6,806.90	50	\$3,403.45	\$10,210.35	Init estimate \$6,806.90 + 50% cont.	\$6,806.90		#DIV/0!	
	SubTotal	40	10	\$6,806.90		\$3,403.45	\$10,210.35		SubTotal	\$6,806.90	\$0.00	#DIV/0!
Less complete tasks				\$0.00			\$0.00					
Remaining Labor Costs				\$6,806.90		\$3,403.45	\$10,210.35					
Include 6.5% increase				\$7,249.35		\$3,624.67	\$10,874.02					
	<b>Total</b>			<b>\$33,086.87</b>		<b>\$4,417.99</b>	<b>\$37,504.86</b>		<b>Total</b>		<b>\$22,898.17</b>	
<b>Total Cost To Complete (spectrometer)</b>				<b>\$7,249.35</b>		<b>\$3,624.67</b>	<b>\$10,874.02</b>					
Notes												
Date	Notes											
10/14/19	email from J.Kyle detailing alignment estimates (rough only)											
2/11/20	Control network surveyed. Labor was \$13,200.80 (init est was \$10,210.35)											
	65hrs for surveyers, 18 hrs geodecist (original estimate 40,10)											
11/10/20	Need second alignment of target cryostat after nosepiece install											

# Remaining Costs: Beamline

Beamline											
M&S	Item		Cost	Cont. Rate (%)	Contingency	Cost + Cont.	Notes		Planned Cost	Actual Costs	CPI
Commissioning	Misc. Supplies		\$6,000.00	100	\$6,000.00	\$12,000.00	RJT guess		\$6,000.00		#DIV/0!
	SubTotal		\$6,000.00		\$6,000.00	\$12,000.00		SubTotal			
	Less comp. purchases		\$0.00		\$0.00	\$0.00					
	Remaining M&S		\$6,000.00		\$6,000.00	\$12,000.00					
Labor	Item	Hrs	Cost						Planned Cost	Actual Costs	CPI
Checkout	C. Johnstone	80	\$17,533.60	50	\$8,766.80	\$26,300.40	One time cost (startup)				#DIV/0!
	Tech	40	\$5,215.60	50	\$2,607.80	\$7,823.40	One time cost (startup)				#DIV/0!
Shielding	C.Johnstone	35	\$7,670.95	0	\$0.00	\$7,670.95	Task Complete (1/31/2020)			\$7,670.95	0.00
	SubTotal	155	\$30,420.15		\$11,374.60	\$41,794.75		SubTotal	\$0.00	\$7,670.95	0.00
	Less Completed Tasks		\$7,670.95		\$0.00	\$7,670.95					
	Remaining Labor		\$22,749.20		\$11,374.60	\$34,123.80					
	Include 6.5% increase		\$24,227.90		\$12,113.95	\$36,341.85					
	<b>Total M&amp;S+Labor</b>		<b>\$36,420.15</b>		<b>\$17,374.60</b>	<b>\$53,794.75</b>					
<b>Cost to Complete</b>			<b>\$30,227.90</b>		<b>\$18,113.95</b>	<b>\$48,341.85</b>					
Notes											
Date	Notes										
11/2/19	Email from C.Johnstone (Guesses at labor).										
2/5/20	Correct estimates for C.Johnstone (shielding) use her actual labor rate rather than technician (reduce hrs for completed task).										

# Remaining Costs: Gaseous He Transfer Line

Gaseous He Transfer Line											
M&S	Item		Cost	Cont. Rate(%)	Contingency	Cost + cont.	Notes		Planned Costs	Actual Costs	CPI
	V&I		\$3,522.40	0	\$0.00	\$3,522.40	Init. Est. 3521.76 + 20%			\$3,521.76	0.00
	Fittings		\$2,599.20	0	\$0.00	\$2,599.20	Init est. \$1409.14 + 20%			\$3,020.90	0.00
	Piping		\$3,068.50	0	\$0.00	\$3,068.50	Pipe procured (\$3068.50 accrued)				0.46
	Unistrut supports		\$1,276.78	0	\$0.00	\$1,276.78	Init est. \$1978.43+20%			\$1,276.78	0.00
	Tank Certification		\$5,000.00	0	\$0.00	\$5,000.00	(tank materials certification)		\$5,000.00	\$6,142.00	0.81
	SubTotal		\$15,466.88		\$0.00	\$15,466.88		SubTotal	\$5,000.00	\$13,961.44	0.36
Less comp. purchases			\$15,466.88		\$0.00	\$15,466.88					
Remaining M&S			\$0.00		\$0.00	\$0.00					
Labor	Item	Hrs	Cost				Notes		Planned Costs	Actual Costs	CPI
	Technician	228	\$29,728.92	50	\$14,864.46	\$44,593.38	Init. Est. \$29,728.92+50% cont.		\$29,728.92	\$19,735.20	1.51
	Welder	54	\$9,188.64	50	\$4,594.32	\$13,782.96	Init. Est. \$9188.64+50% cont		\$9,188.64	\$3,405.87	2.70
	Engineering	120	\$13,330.80	50	\$6,665.40	\$19,996.20	Init. Est. \$13,330.80+50% cont.		\$13,330.80	\$9,244.62	1.44
	Engineering Oversight	50	\$5,554.50	50	\$2,777.25	\$8,331.75	New: Init. Est \$5,554.50 +50% cont		\$5,554.50	\$5,655.63	0.98
	SubTotal	452	\$57,802.86		\$28,901.43	\$86,704.29		SubTotal	\$52,248.36	\$32,385.69	1.61
Less comp. tasks			\$28,796.70								
Remaining labor costs			\$29,006.16	50	\$14,503.08	\$43,509.24					
Add 6.5% increase			\$30,891.56		\$15,445.78	\$46,337.34					
	<b>Total (M&amp;S + Labor)</b>		<b>\$73,269.74</b>		<b>\$28,901.43</b>	<b>\$102,171.17</b>		<b>Total</b>		<b>\$46,347.13</b>	
<b>Cost to Complete</b>			<b>\$30,891.56</b>		<b>\$15,445.78</b>	<b>\$46,337.34</b>					
Notes											
Date	Notes										
10/24/19	email update from G.Horton-Smith. Appears to be missing support structure materials..										
10/21/19	email update from G.Horton-Smith. For support structure materials.										
11/19/19	Update tank materials inspection with quote from vendor. Supplemental information is from actual purchases.										
11/25/19	Add contingency columns										
2/10/20	McMaster, Janco, Columbia, Chicago orders accrued, zero contingency for these										
4/27/20	Take engineering labor to be all G.Horton-Smith + 1/2 D.Mitchell + D.Allspach+ 2h G.Tatkowski										
5/11/20											
9/23/20	Procurement SNAFU, team charges additional \$1200 for Free online training on their own equipment										
10/6/20	All materials in hand										