Target Schedule SpinQuest Collaboration

D. Keller

Target Schedule Overview

- Critical Target Construction
- Major Accomplishments
- Major Hurdles

Cost

- Additional Expenses
- Remaining Costs to SpinQuest (UVA)

Risks

- Additional Modification
- Additional Engineering
- Expense of Documentation

A Look Around

Polarized Target Schedule SpinQuest Polarized Target System

- Magnet and Evaporation Refrigerator
- Supporting cryogenic infrastructure + QT
- Electronics for controls and monitoring
- Commissioning cryogenic systems

•		Expected stars	Expected and	9 10 11 12 1 2 3 4 5 6 7
0 80	▼ E1030-InstallationShort-RJT-20201121	Jan 24, 2019	5/26/21, 15:00	E1039-InstallationShort-RJT-20201121
10	DOE NP Funding Available	Jan 28, 2019	1/28/19, 00:00	DOE NP Funding Available
2 (3)	Rad Safety approval to install complete shielding	Feb 11, 2019	2/11/19, 00:00	Rad Safety approval to install complete shielding
3 0	Accelerator Shutdown starts	7/8/19, 00:00	7/8/19, 00:00	Accelerator Shutdown starts 🔷
4 0	Beam to Switchyard Dump (FY20)	Dec 5, 2019	12/5/19, 00:00	
5 0	Start 2020 shutdown	Apr 12, 2020	4/12/20, 00:00	
6 0	End of COVID-19 restrictions	Jun 29, 2020	6/29/20, 00:00	
7 0	Receive limited funding for remainder of FY2020	July 20, 2020	7/20/20, 00:00	
8 0	Restart installation work	8/2/20,00:00	8/2/20,00:00	
9 0	Beginning of FY2021	Oct 1, 2020	10/1/20, 00:00	
10 (3)	Receive Funds in 2020 Dec Fin Plan	Dec 15, 2020	12/15/20, 00:00	
11 0	Beam to SY dump 2020	Nov 30, 2020	11/30/20, 00:00	
12	Shielding Installation	Jan 29, 2019	5/22/19, 15:00	Shielding Installation PPD Tech SNP; We
27 0	Shielding ready for Lumi monitor installation	Mar 19, 2019	3/19/19, 17:00	Shielding ready for Lumi monitor installation 🔷
28	Target Cave ready for target infrastructure installation	5/9/19, 09:00	5/9/19, 09:00	Target Cave ready for target infrastructure installation 🔷
29	Cryo Platform Installation	Jan 28, 2019	1/4/21, 10:00	Cryo Platform Installation
48 Θ	Parts completed for cryo platform	3/8/19, 15:00	3/8/19, 15:00	Parta completed for cryo platform 🔷
49 (3	Engineering for water cooling complete	7/9/19, 17:00	7/9/19, 17:00	Engineering for water cooling complete
50 O	Electrical engineering for cryo platform/target complete	Apr 15, 2019	4/15/19, 17:00	Electrical engineering for cryo platform/target complete
51 0	Cryo platform frame installed (sans decking)	May 15, 2019	5/15/19, 16:00	Cryo platform frame installed (sans decking)
52 O	Water Cooling Control parts in hand	Sep 25, 2019	9/25/19, 17:00	Water Cooling Co
53 O	Cryo platform/target water cooling installed	1/4/21, 10:00	1/4/21, 10:00	
54 O	Cryo platform electrical services installed (cave ready for tayset)	Oct 24, 2019	10/24/19, 10:30	Cryo platform electrical ser
55 O	Major Cryo Infrastructure	Mar 11, 2019	2/4/21, 17:00	Major Cryp Infrastructure
78 0	Parts available for gaseous He line	Feb 10, 2020	2/10/20, 17:00	
79 (3	Begin LN2 line Fabrication	Sep 10, 2020	9/10/20, 06:00	
80 (9	Begin gaseous He line installation	Sep 24, 2020	9/24/20, 00:00	
81 Θ	Gaseous He line installed	1/7/21, 17:00	1/7/21, 17:00	
82 ()	Gaseous He tanks ready to fill	Dec 8, 2020	12/8/20, 17:00	
83 O	LN2 line installed	Jan 14, 2021	1/14/21, 17:00	
84 Θ	LN2 dewar ready to fill	Jan 14, 2021	1/14/21, 17:00	
			ALC: 12 43	
85 (3	gHe line installed (QT-QT)	2/4/21, 17:00	2/4/21, 17:00	
85 O 86 O	gHe line installed (QT-QT) Target Cave Vacuum & Platforms	2/4/21, 17:00 Jan 24, 2019	2/4/21, 17:00 12/3/20, 17:00	Target Cave Vacuum & Pladorms
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85 0 86 0 97 0 105 0	gHe line installed (QT-QT) Target Cave Vacuum & Platforms BeamLine Beamline pre-beam tumon	2/4/21, 17:00 Jan 24, 2019 Jan 24, 2019 Dec 15, 2020	2/4/21, 17:00 12/3/20, 17:00 5/30/19, 08:00 12/16/20, 10:00	Target Cave Viscuum & Platforms AD Viscuum Tech;
85 0 86 0 97 0 105 0 106 0	gHe line installed (QT-QT) Target Cave Vacuum & Platforms BeamLine Beamline pre-beam tumon Analysis Magnet Water Manifold Refurbishment	2/4/21, 17:00 Jan 24, 2019 Jan 24, 2019 Dec 15, 2020 Feb 20, 2020	2/4/21, 17:00 12/3/20, 17:00 5/30/19, 08:00 12/16/20, 10:00 1/6/21, 15:00	Target Cave Viacuum & Platforms BesmLine AD Viacuum Tech;
85 0 86 0 97 0 105 0 106 0 116 0	gHe line installed (QT-QT) Target Cave Vacuum & Platforms BeamLine BeamLine Beamline pre-beam turnon Analysis Magnet Water Manifold Refurbishment Analysis magnet ready fluid flow tests	2/4/21, 17:00 Jan 24, 2019 Jan 24, 2019 Dec 15, 2020 Feb 20, 2020 1/6/21, 15:00	2/4/21, 17:00 12/3/20, 17:00 5/30/19, 08:00 12/16/20, 10:00 1/6/21, 15:00 1/6/21, 15:00	Target Cave Vacuum & Platforms AD Vacuum Tech;
85 0 97 0 105 0 106 0 116 0 117 0	gHe line installed (QT-QT) Target Cave Vacuum & Platforms BeamLine Beamline pre-beam turnon Analysis Magnet Water Manifold Refurbishment Analysis magnet ready fluid flow tests Liquid He System	2/4/21, 17:00 Jan 24, 2019 Jan 24, 2019 Dec 15, 2020 Feb 20, 2020 1/6/21, 15:00 Dec 13, 2019	2/4/21, 17:00 12/3/20, 17:00 5/30/19, 08:00 12/16/20, 10:00 1/6/21, 15:00 1/6/21, 15:00 2/16/21, 12:00	Image: Cave Viscourn & Platforms BeamLine AD Viscourn Tech; Image: Cave Viscourn & Platforms
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85 0 97 0 105 0 105 0 105 0 105 0 105 0 105 0 105 0 117 0 140 142 0 142 0 142 0 143 0 143 0 145 0 187 0 187 0 188 0 189 0 190 0 191 0 191 0 191 0 191 0 192 0	 gHe line installed (QT-QT) Target Cave Vacuum & Platforms BeamLine Beamline pre-beam tumon Analysis Magnet Water Manifold Refurbishment Analysis magnet ready fuid flow tests Liquid He System Compressors arrive at FNAL Oryofab Dewars (250) arrive at FNAL (NM4) First 2 sections LHe transfer line ships from QT LHe transfer line 'octopus' arrives at FNAL QT Begins He plant commissioning QT signs off on LHe plant operation Target Cryostat, Roots & ODH Installation Complete API-510 Inspection Decision to install target cryostat Target magnet oryostat installed Roots pump ready for operation Target cave ODH system installed Target Cave Schedule Critical Target Electronics Pre-Beam Target Commissioning 	2/4/21, 17:00 Jan 24, 2019 Jan 24, 2019 Dec 15, 2020 Feb 20, 2020 1/6/21, 15:00 Dec 13, 2019 Dec 23, 2019 6/6/20, 17:00 July 16, 2020 July 30, 2020 July 30, 2020 July 30, 2020 Feb 16, 2021 Feb 13, 2020 Feb 13, 2020 Mar 11, 2020 Dec 24, 2020 Feb 23, 2021 Nov 2, 2020 Oct 19, 2020 Jan 15, 2021	2/4/21, 17:00 12/3/20, 17:00 5/30/19, 08:00 12/16/20, 10:00 1/6/21, 15:00 1/6/21, 15:00 2/16/21, 12:00 6/8/20, 17:00 7/16/20, 17:00 2/16/21, 12:00 2/16/21, 12:00 2/13/20, 17:00 3/3/20, 17:00 3/3/20, 17:00 3/3/20, 17:00 3/11/20, 17:00 3/11/20, 17:00 2/23/21, 17:00 2/23/21, 17:00 3/2/21, 12:00 4/14/21, 15:00	Image: Cave Viscourn & Platforms BeemLire AD Viscourn Tech; Image: Cave Viscourn & Platforms BeemLire AD Viscourn Tech; Image: Cave Viscourn & Platforms Image: Cave Viscourn & Platforms <t< td=""></t<>
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85 0 97 0 105 0 106 0 116 0 117 0 140 0 141 0 142 0 143 0 144 0 145 0 188 0 189 0 190 0 191 0 192 0 296 0 298 0 299 0 298 0 298 0 298 0 299 0	gHe line installed (QT-QT) Target Cave Vacuum & Platforms Beamline pre-beam tumon Analysis Magnet Water Manifold Refurbishment Analysis magnet ready fluid flow tests Liquid He System Compressons arrive at FNAL Cryotab Dewars (250) arrive at FNAL (NM4) First 2 sections LHe transfer line ships from QT LHe transfer line 'octopus' arrives at FNAL QT Begins He plant commissioning QT signs off on LHe plant operation Target Cryostat, Roots & OCH installation Complete API-610 Inspection Decision to install target cryostat Target magnet oryostat installed Roots pump ready for operation Target Cave Schedule Critical Target Electronics Pre-Beam Target Commissioning Begin Target Cave Roof Installation Target Cave Roof Installed Target Cave Roof	2/4/21, 17:00 Jan 24, 2019 Jan 24, 2019 Dec 15, 2020 Feb 20, 2020 1/6/21, 15:00 Dec 13, 2019 Dec 23, 2019 6/8/20, 17:00 July 16, 2020 July 30, 2020 2/5/21, 08:00 Feb 16, 2021 Apr 24, 2019 Feb 13, 2020 Mar 11, 2020 Dec 24, 2020 Dec 24, 2020 Dec 24, 2020 Dec 24, 2020 Feb 23, 2021 Nov 2, 2020 Dec 19, 2020 Jan 15, 2021 Feb 11, 2021 Feb 11, 2021 Feb 11, 2021 Apr 14, 2021 Apr 14, 2021 Apr 14, 2021 Apr 28, 2021 May 12, 2021	2/4/21, 17:00 12/3/20, 17:00 5/30/19, 08:00 12/16/20, 10:00 1/6/21, 15:00 1/6/21, 15:00 1/6/21, 15:00 2/16/21, 12:00 2/16/21, 12:00 2/16/21, 12:00 2/16/21, 12:00 2/13/20, 17:00 2/11/21, 17:00 2/11/21, 17:00 2/11/21, 15:00 4/14/21, 15:00 4/14/21, 15:00 5/26/21, 15:00 5/12/21, 15:00 5/12/21, 15:00	
85 0 97 0 105 0 106 0 116 0 117 0 140 1 141 0 142 0 143 0 144 0 145 0 187 0 188 0 190 0 191 0 192 0 296 0 298 0 299 0 299 0 299 0 299 0 299 0 299 0 299 0 299 0 299 0	gHe line installed (QT-QT) Target Cave Vacuum & Platforms Beamline pre-beam turnon Analysis Magnet Water Manifold Refurbishment Analysis magnet ready fluid flow tests Liquid He System Compressors arrive at FNAL Cryotab Dewars (250) arrive at FNAL (NM4) First 2 sections LHe transfer line ships from QT LHe transfer line 'octopus' arrives at FNAL QT Begins He plant commissioning QT signs off on LHe plant operation Complete API-510 Inspection Decision to install target oryostat Target magnet oryostat installed Roots pump ready for operation Target cave QDH system installed Kortisol Target Ceve Schedule Critical Target Electronics Pre-Beam Target Commissioning Begin Target Cave Roof Installation Target Cave Roof Installed Target Cave Roof Ins	2/4/21, 17:00 Jan 24, 2019 Jan 24, 2019 Dec 15, 2020 Feb 20, 2020 1/6/21, 15:00 Dec 13, 2019 Dec 23, 2019 6/6/20, 17:00 July 16, 2020 July 30, 2020 July 30, 2020 2/5/21, 08:00 Feb 16, 2021 Apr 24, 2019 Feb 13, 2020 Jan 15, 2021 Nov 2, 2020 Oet 19, 2020 Dec 24, 2020 Dec 24, 2020 Feb 23, 2021 Nov 2, 2020 Oet 19, 2020 Jan 15, 2021 Apr 14, 2021 Apr 14, 2021 Apr 14, 2021 Apr 14, 2021 Apr 28, 2021 May 12, 2021 May 12, 2021	2/4/21, 17:00 12/3/20, 17:00 5/30/19, 08:00 12/16/20, 10:00 1/6/21, 15:00 1/6/21, 15:00 2/16/21, 12:00 2/16/21, 12:00 2/16/21, 12:00 2/16/21, 12:00 2/16/21, 12:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/13/20, 17:00 2/23/21, 17:00 2/23/21, 17:00 2/11/21, 17:00 2/11/21, 17:00 2/11/21, 17:00 2/11/21, 15:00 4/14/21, 15:00 4/14/21, 15:00 5/26/21, 15:00 5/12/21,	



Final Milestones Assume no additional delays



Target Schedule (Milestones)

		WK 1			
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	25	5 26	6 2	27	
Target Cave Schedule					
Critical Target Electronics					
Pre-Beam Target Commissioning Zulkaida Akbar; Ernesto Fernando-Diaz; Anchit Arora;					
Begin Target Cave Roof Installation <<					
Target Cave Roof Installed <<					
Target Cave Ready for Beam <<					
First target polarization achieved					
Target Ready for Beam					
Beam Commissioning	_				
Beamline Commissioned Be	mline	Com	missi	one	
Spectrometer Commissioned					
Target Commissioned					



Target Schedule (Primary Infrastructure)

Title	WK	WK 3, January 10 WK 4, January 17									WK 5, January 24						WK 6, January 31							WK 7, February 7 WK									
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14
▼ Target Cave Schedule													-														-				7		
Evaporation Fridge			(Dustin	Keller;	; Anchi	t Aror	ra																									
Fridge Separator Pump and Line													_		Anchi	t Arora;	Meye	er Mac	hine; l	Ernest	o Ferr	ando-	Diaz										
Fabricate Quench Line	~	<																															
Design 2nd half of quench line	~	<																															
Fabircate 2nd half of quench line	~	<																															
Transport Quench Line to FNAL	~	<																															
Finalize Recovery Manifold Prints	~	:																															
Fabricate Manifold Parts	~	<																															
Transport Manifold to FNAL	~	:																															
Install Target Cave Roof																			Ins	tall Ta	rget C	ave Ro	oof ⊢									D Tecl	h 1(HE
 Target Services Installation 	-												-										\pm										
Install He Backfill Line	~	<																															
Install cables in west penetration	~	:																															
Install Quench Line supports	~	<																															
Install Helium Quench Line		_																															
Install N2 vent line	~	:											-										+										
Install Manifold in NM4		:											_																				
He cooldown line installed (QT-QT)																	He c	cooldo	wn lin	e insta	alled (C	at-Qt)	-	>									
Install He safety relief vent line	fver	nt line	\bigcirc	PPD T	ech 1((HEP);	PPD	Tech 2	(HEP)) ——													\square										

Target Schedule (Critical Electronics)

Title		1	WK 8							
	7	8	9	10	11	12	13	14	15	16
Target Cave Schedule						Dus	tin Kel	ler; Ar	nchit A	vrora;
Critical Target Electronics										
▶ NMR	~									
Microwave	~									
Magnet Power Supply Rack	~									
Helium Vapor Pressure	~									
Separator Flow Control	~									
Pfieffer Vacuum Sensors	~									
Main Flow Monitor	~									
Fridge Sensors										
Control Room Integration	~									
Modified Fridge back af FNAL	~									
Pre-Beam Target Commissioning	_									
Begin Target Cave Roof Installation	~									
Target Cave Roof Installed	Targe	t Cave	e Roof	Instal	led <	>				
Target Cave Ready for Beam										

, Febr	uary	14			W	/K 9,	Febru	uary 2	21			WK								
17	18	19	20	21	22	23	24	25	26	27	28	1	2	3	4	5	6	7	8	
Meyer	Mach	nine; E	rnesto																	
							+						\neg							
														Ernee	o Ferr	nando	Diaz: \	Nagar	Ahm	
														LIIIea	to ren	ando	Diaz,	vaqa	Ann	
							_													
	Targ	et Cav	/e Rea	dy for	Beam		>													



Target Schedule (Pre-beam Commissioning)

Fitle .	WK	(11,	Marcl	h 7	WK 12, March 14									
	10	11	12	13	14	15	16	17	18	19	20	21		
Pre-Beam Target Commissioning													_	
Connect target to infrastructure(?)	~													
Connect target electronics(?)	~													
Fully sealed circulation of QT system	~												_	
 Polarized Target Magnet Commissioning 	-													
Fill magnet from QT transfer line						\Box_{1}	Zulka	ida Ak	bar; E	rnesto	Ferna	ando-	C	
Energize Magnet			Ene	rgize M	Magne	t 📺			Zul	kaida	Akbar	; Erne	35	
Fill Fridge							Fill Fri	dge 🌔						
Measure boiloff rates									Me	easure	boilo	ff rate	s	
Polarize Target														
Begin Target Cave Roof Installation	~													
Target Cave Roof Installed	~													
Target Cave Ready for Beam	~													
First target polarization achieved														
Target Ready for Beam														

١	VK 13	B, Ma	rch 2	1			٧	VK 14	4, Ma	rch 2	28											
22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	Γ
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Diaz; /	Anchit	Arora;																				
sto Fe	rnand	o-Diaz	; Anc	hit Arc	ora;																	
	Zulkai	da Ak	bar; E	rnesto	Ferna	ando-l	Diaz; A	Anchit	Arora	;												
s 📥																	ך zu	ılkaida	Akbar	Erne	sto Fe	ər
														Polar	ize Ta	rget	Ċ					
																	Fin	st targ	et pola	rizatio	n ach	ie
																			Target	Read	y for	B



Pre-beam Commissioning Major cryogenic commissioning

Sealed QT Commissioning:

QT has its own commissioning procedure for the liquefier which will take a dedicated two weeks. This can be done with everything closed/ sealed from the QT system except the main helium gas intake manifold for the first part as needed. The second part should include a full circulation test over the entire system also allowing efficiency studies of the QT transfer line for another two weeks.

PT Magnet Commissioning:

The first step here is to do a cooldown of the magnet and ramp it up to make sure all is well and to measure the boil-off rate we are getting with the recent safety modifications and vacuum setup. This would normally take about two weeks of dedicated time and can be coupled to the refrigerator and/or fully sealed QT commissioning. This assumes no un-intended quenches or vacuum issues which can added much more time for this commissioning.

Beam-target Commissioning:

The next step is to see at what intensity we can actually run without quenching. The focus is on finding the intensity threshold and would require completion of the critical path electronics for monitoring purposes. There would be a set of intended quenches done to understand and reproduce thresholds and study optimization of the magnet pumping cycle and present coil temperature regulation system. Geometry and materials of the target insert may need to be modified to get the lowest background rates. This may end up being different for NH3 and ND3. This part of the commissioning is expected to take about three weeks.





Pre-beam Commissioning Major cryogenic commissioning

- Sealed QT Commissioning: 4 weeks
- Polarized Target Commissioning: 2 weeks
- Beam-target Commissioning: 3 weeks

Point of No Return SpinQuest Ramp before summer shutdown

- Push towards full target assembly as soon as we can
- Cave will be closed up no later than 1st week of May
- FNAL AD needs 2 weeks dedicated to beam tuning
- We can then initiate non-target beam commissioning before 2021 SS (July 5)
- Complete target/cryo-connections and safety review over SS (Sep 20)
- Target-beam commissioning after SS
- Production data taking 2 months after SS

Major Accomplishments Target System Status

- Cryo-engineer details for magnet vessel complete and considered safe
- Magnet in place and roots piping connected and able to run
- LCW source installation near complete
- Roots piping leak checked (all clear)
- Actuator (target position device) ready (need install/ORC)
- Microwaves (safety + interlocks) ready (need install/ORC)
- LANL NMR system complete final boards being setup, UVA backup system ready (need ORC)
- Full in cave magnet survey complete
- Beam-line piping and magnet/fridge vacuum
- All major QT infrastructure is in place

Major Hurdles (before target com) **Target System Status**

- Fridge modifications
- Complete cave piping/venting system
- Fabrication of ASME certified piping + documentation
- Seal up system and leak check fully
- Put cave together
- Critical path electronics
- Beam window fabrication
- Cryogenic Safety Review

Cost to SpinQuest (UVA) No Further Modifications?

- Further analysis and engineering (CDF) time (~5 K)
- Fabrication of piping System (~25 K)
- Fabrication of the in cave connection and manifold (~15 K)
- Refrigerator Modification (~25 K)
- Second modification to the target magnet piping (~5 K)

Running Costs Commissioning and first year of operations

- Chamber gas (based on E906) \$27K per year
- LHe for first cooldown at least 2000 LHe to prime system (\$30K)
- LHe for quench commissioning (\$45)
- Target LHe cost about 500 LHe/month (\$10K)

Have secured funding for running costs for the first year

Risks **No Further Modifications?**

- Remaining Modification
- Remaining Engineering
- Remaining Documentation and Analysis
- FNAL resource availability
- Priority level of project (especially with no FNAL funding)
- Cryogenic Safety Review (no guarantees)

Risks FNAL is not (yet) a polarized target facility

- Very little reservoir or help or knowledge
- This is a low budget project (and low priority)
- FNAL-FESHM cryo-sections updated 2014 (but not for PT)
- Still figuring out how to apply the code
- No full time cry-engineer on this project
- Piece wise safety/code protocol

Where are we now How much left to do

- Construction and major equipment ~85%
- Documentation and prep work ~50%
- Supporting infrastructure ~65%

Where are we now How much left to do

A Look Around

Full Cave View















Target Venting System

- All evaporation/boil-off helium vapor captured
- All relief ported out of the building
- All piping to code + docs





Separator relief line (0.375" ID to KF-16)

























Thank You