

MVTX Cost & Schedule (WBS 3.2)

Dave Lee/Ming Liu, LANL April 9-11, 2019 BNL

MVTX C & S - Assumptions



- Integrated into the sPHENIX schedule (P6)
- Self contained project, funding from BNL
- Technically driven schedule
- Built-in resource hourly rates, fully burdened with escalation
- Will implement Risk Based Contingency
- Schedule not smoothed, ~6 months contingency in P6 prior to sPHENIX installation
- Electronics ready for production on day-1 due to the successful LDRD effort, cost based on as built experience, FELIX and RU service boards, power system etc.
- Staves and Readout Units (RU) not in P6, separate cost

MVTX in sPHENIX P6 (fully Burd. & Esca.)

BROOKHAVEN NATIONAL LABORATORY				Dat	sPHEN	Buc Buc Buc	T X Project Igeted Cos ct-18 Pub	: Detailed st Include lished: 02	Schedule d -Apr-19 1	2:38	SPHENIX	
ctivity ID Activity Name	CAM	At Compl.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 2018 2019 2020 20 5 FY16 FY17 FY18 FY19 FY20 FY21	21 2022 FY22
POM02B_3.02 POM02 sPHENIX WBS 3.02 Preliminary Basel	ine (MVTX)	1281	01-Feb-17 A	17-Mar-22	0	26695	1266751	\$2,760,452	\$1,569,754	\$4,330,205		
POM02B_3.02.3 Silicon Detectors		1281	01-Feb-17 A	17-Mar-22	0	26695	1266751	\$2,760,452	\$1,569,754	\$4,330,205		
POM02B_3.02.3.00 (Temporary) External Placeholder Mile	stones in WBS 3x	1169	01-Feb-17 A	01-Oct-21	112	0	0	\$0	\$0	\$0		
EXT100090 [External Activity] Initial Project Funding Release	Sourikova, Irina	0	01-Feb-17 A			0	0	\$0	\$0	\$0	01-Feb-17 A, 🔸	
EXT317000 [External Activity] Design/Safety Reviews Complete, Internal Detector Structural Support Released for Production	Pontieri, Chris	0		19-Jul-19*	319	0	0	\$0	\$0	\$0	19-Jul-19* ◆	
EXT101010 [External Activity] FY20 Funding Available	Sourikova, Irina	0	01-Oct-19*		417	0	0	\$0	\$0	\$0	01-Oct-19*, ♦	
EXT147100 [External Activity] Procure TPC DAM Felix 2.0 Boards - Contract Award(s)	Hemmick, Tom	0	06-Nov-19*		392	0	0	\$0	\$0	\$0	06-Nov-19*, ◆	
EXT101015 [External Activity] FY21 Funding Available	Sourikova, Irina	0	01-Oct-20*		362	0	0	\$0	\$0	\$0	01-Oct-20*, ◆	
EXT101016 [External Activity] FY22 Funding Available	Sourikova, Irina	0	01-Oct-21*		112	0	0	\$0	\$0	\$0		*, *
POM02B_3.02.3.02 MVTX		741	01-Apr-19	17-Mar-22	0	26695	1266751	\$2,760,452	\$1,569, 54	\$4,330,205		
POM02B_3.02.3.02.00 Temporary		248	01-Apr-19	26-Mar-20	169	0	0	\$0	\$0	\$0		
POM02B_3.02.3.02.00.01 ALICE ITS Key Tasks		0	01-Apr-19	01-Apr- 19	255	0	0	\$0	\$0	\$0		
S100000 ALICE ITS RU Production Start	Liu, Ming	0	01-Apr-19*		255	0	0	\$0	\$0	\$0	01-Apr-19*, ◆	
POM02B_3.02.3.02.00.02 MVTX Stave Production at CER	N	248	01-Apr-19	26-Mar-20	169	0	0	\$0	\$0	\$0		
S100100 Stave Production - Batch 1	Liu, Ming	62	01-Apr-19	26-Jun-19	169	0	0	\$0	\$0	\$0		
S100200 Stave Production - Batch 2	Liu, Ming	62	27-Jun-19	24-Sep-19	169	0	0	\$0	\$0	\$0		
S100300 Stave Production - Batch 3	Liu, Ming	62	25-Sep-19	26-Dec-19	169	0	0	\$0	\$0	\$0		
S100400 Stave Production - Batch 4	Liu, Ming	62	27-Dec-19	26-Mar-20	169	0	0	\$0	\$0	\$0		
POM02B_3.02.3.02.00.03 sPHENIX Milestones		0			0	0	0	\$0	\$0	\$0		
POM02B_3.02.3.02.01 MVTX Project Management		741	01-Apr-19	17-Mar-22	0	1858	37762	\$592,839	\$48,644	\$641,483		
S100500 Milestone Start MVTX	Liu, Ming	0	01-Apr-19		0	0	0	\$0	\$0	\$0	01-Apr-19, 🔶	
S100600 Project Manager	Liu, Ming	741	01-Apr-19	17-Mar-22	0	1238	0	\$395,226	\$0	\$395,226		
S100700 Mechanical Integration Engineer	Liu, Ming	741	01-Apr-19	17-Mar-22	0	310	0	\$98,806	\$0	\$98,806		
S100800 Electronics Integration Engineer	Liu, Ming	741	01-Apr-19	17-Mar-22	0	310	0	\$98,806	\$0	\$98,806		
S100900 Travel FY19	Liu, Ming	128	01-Apr-19	30-Sep-19	112	0	6250	\$0	\$7,813	\$7,813		
S101000 MVTX Construction Start Approval	Liu, Ming	0	01-Apr-19*		0	0	0	\$0	\$0	\$0	01-Apr-19*, 🔻	
S101100 Travel FY20	Liu, Ming	251	01-Oct-19	30-Sep-20	112	0	12500	\$0	\$15,938	\$15,938		_
S101200 Travel FY21	Liu, Ming	250	01-Oct-20	30-Sep-21	112	0	12500	\$0	\$16,256	\$16,256		
S101300 Iraver FY22 S101400 MVTX Assembly Complete and Ready for Installation	Liu, Ming	112	01-0Ct-21	17-Mar-22	0	0	6512	\$0 \$0	\$8,638	\$8,638 \$0	17	7-Mar-22 🔶
POM02B 3.02.3.02.02 MVTX Electronics		286	01-Apr-19	19-May-20	363	3863	395448	\$195,007	\$469,960	\$664,967		
POM02B_3.02.3.02.02.01 Readout Unit (RU)		193	01-Apr-19	07-Jan-20	453	1137	82428	\$85,282	\$100,435	\$185,717		
Page 1 of 11 Actual W	ork 🗾 C	Critical Rer	n.Work 🔲	Rem	naining V	/ork	Actua	LoE	Remain	ing LoE	♦ Milestone	

MVTX Schedules and Milestones



Today

Milestones



Milestone	Date
Start Construction	3 rd Qtr FY 2019
MVTX Final Design Review	1 st Qtr FY 2021
Half Barrels Assembled	3 rd Qtr FY 2021
Installation Finished	4 th Qtr FY 2022
Ready for Beam	1 st Qtr FY 2023

Schedule Drivers

- Budget availability
 - Final engineering design of the mechanical system
 - Production of support structures
- Mechanical structures
 - Detector and interface system design
 - Carbon structure fabrication
- Detector assembly and test
 - Assembly jigs design and fabrication
 - Detector assembly & QA
 - Metrology
- Final installation in IR
 - Last detector to be installed





Cost Drivers



MVTX Bu	udget by L3 in AYk\$	_	Burdened	Esc.
WBS	Level 2 WBS Description	OPC	TEC	Total
3.2.01	Project Management	\$0	\$642	\$642
3.2.02	Electronics	\$0	\$665	\$665
3.2.03	Mechanics and Assembly	\$0	\$2,001	\$2,001
3.2.04	Integration and Installation	\$0	\$1,023	\$1,023
	Sub-total	\$0	\$4,331	\$4,331
	Contingency	\$0		\$0
	Total Project Cost	\$0	\$4,331	\$4,331

Mechanical design and fabrication

- CYSS
- End wheels
- Service barrel
- Global interface

Basis of Estimate & Resource-Loaded Schedules PHE

Electronics: production

- FELIX: ATLAS/sPHENIX production, LANL/LDRD
- RU services, cables: ALICE/ITS production, LANL/LDRD -
- Power boards: ALICE/ITS production, LANL/LDRD
- CAEN bulk PS: Quotes from CAEN, ALICE/ITS production, LANL/LDRD
- Mechanics & Integration: design and production
 - CYSS, End wheels, Service barrel: ALICE/ITS
 - Integrations: Recent experience at RHIC, HFT/STAR, FVTX/PHENIX

WBS Number: 3.2.2.3 Backend Electronics - FELIX

MVTX BoE Doc

This item contains all the backend readout electronics FELIX boards required for MVTX readout

Work statement:

Technical scope:

Produce 8 FELIX boards to integrate MVTX readout electronics into the sPHENIX DAQ system

Assumptions used in developing estimate:

We will use the ATLAS FELIX v2.0 PCIe board developed by the BNL group for the ATLAS upgrade. The FELIX board production quote for sPHENIX was obtained in 2018. about \$8K per board. A total of 8 FELIX boards (6 + 2 spares) are required for MVTX.

Cost Summary:

Total (K)	M&S	Labor	Contingency (average)
122	103	19	25%

												POM02B_	3.02.3.02.02.02 FELIX 2.0		254 0	1-Apr-19	03-Apr-20	392 1	86 88400	\$18,588	\$103,640	\$122,229
												\$103000	Produce Felix 2.0 first production unit - Labor	Liu, Ming	57 0	1-Apr-19	19-Jun-19	218	16 0	Labor	- M&S	\$3,073
												\$103100	Procure Optical Fiber - Labor	Liu, Ming	121 0	1-Apr-19	19-Sep-19	414	2 0	\$307	\$0	\$307
	4											\$103200	Produce Felix 2.0 first production unit - M&S	Liu, Ming	57 0	1-Apr-19	19-Jun-19	218	0 20000	\$0	\$22,778	\$22,778
	BROOKHAVEN					sPHEN	IIX MVT Bud	X Project	t Detailed st Include	Schedule d	•	\$103300	Procure Optical Fiber - M&S	Liu, Ming	121 0	1-Apr-19	19-Sep-19	414	0 50	\$0	\$63	\$63
	NATIONAL LABORATORY				Da	ta Date	e: 01-Oc	t-18 Pub	lished: 02	-Apr-191	2:38	\$103400	Test/QA 1st Felix Unit and Fibers	Liu, Ming	10 2	0-Sep-19	03-Oct-19	414	40 0	\$0	\$0	\$0
Activity II	D Activity Name	CAM	At Compl. Duration	Start	Finish	Total	Hours	Direct FY19\$ - M&s	Burd AY\$ -	Burd AY\$ - M&S	Burd AY\$ -	\$103500	Procure 7 Felix 2.0 Remaining Units -Provide	Liu, Ming	5 0	6-Nov-19	13-Nov-19	392	6 0	\$1.187	ŚO	\$1.187
S	110400 ship from CERN to LBNL - Batch 1	Liu, Ming	7	27-Jun-19	08-Jul-19	318	0	600	\$0	\$7,500	\$7,500		Requirements to Procurement	, ,								
s	110500 ship from CERN to LBNL - Batch 2	Liu, Ming	7	25-Sep-19	03-Oct-19	268	0	6000	\$0	\$7,564	\$7,564	\$103600	Procure 57 Optical Fiber Sets - Labor	Liu, Ming	20 0	5-Nov-19	06-Dec-19	462	2 0	\$396	\$0	\$396
s	110600 ship from CERN to LBNL - Batch 3	Liu, Ming	7	27-Dec-19	07-Jan-20	219	0	6000	\$0	\$7,650	\$7,650	\$103700	Procure 57 Optical Fiber Sets M&S	Liu, Ming	20 00	6-Nov-19	06-Dec-19	462	0 2850	\$0	\$3,634	\$3,634
C	and on the Struc	turre	es '	27-Mar-20	06-Apr-20	169	0	6000	\$0	\$7,650	\$7,650											
PO	M02B_3.02.3.02.03.02 Carbon Structures		741	01-Apr-19	17-Mar-22	0	5774	368511	\$910,025	\$472,154	\$1,382,179											
PC	0M02B_3.02.3.02.03.02.01 Mechanics Detector Design		80	01-Apr-19	23-Jul-19	0	640	0	327.52		\$167,952											
	110800 Develop MAPS Inner tracker mechanical model	LIU, Ming	80	01-Apr-19	23-JUI-19	0	640	Ů	abor.	M&S	\$107,952											
PC	0M028_3.02.3.02.03.02.02 End Wheels		277	24-Jul-19	28-Aug-20	54	502	72000	\$73,964	\$90,875	\$164,839											
s	110900 Design End-wheels	Liu, Ming	15	24-Jul-19	13-Aug-19	54	120	0	\$36,658	\$0	\$36,658		o									
S	111000 Prototype End-wheels - M&S	Liu, Ming	30	14-Aug-19	25-Sep-19	54	0	10000	\$0	\$12,500	\$12,500											
S	111100 Prototype End-wheels - Labor	Liu. Mine	30	14-Aug-19	25-Sep-19	54	12	0	\$2.305	\$0	\$2,305											

April 9-11, 2019

sPHENIX Director's Review

Resource Distribution





April 9-11, 2019

sPHENIX Director's Review



WBS	Task Name	Cost (K)
3.2.3.2.2	End Wheels (EW)	\$165
3.2.3.2.3.2	Cylindrical Structure(CYSS)	\$465
3.2.3.2.3.3	Service Barrel (SB)	\$428
3.2.2.2	RU Services	\$186
3.2.2.3	FELIX	\$122
3.2.2.4	Power System (PS)	\$357

Electronics



Examples of low contingency

	WBS	Cost (K)	Contingency	Basis
RU Services	3.2.2.2	\$186	25%	As Built*
FELIX	3.2.2.3	\$122	25%	As Built*
Power Board	3.2.2.4.1	\$219	25%	As Built*
Power Supply	3.2.2.4.2	\$138	25%	CAEN

Total Cost = \$665 K

• "As Built" means item is a production unit

Carbon Structures



Examples of high contingency

	WBS	Cost (K)	Contingency	Basis
End Wheels	3.2.3.2.2	\$165	45%	Previous experience
Cylindrical Structure	3.2.3.2.3.2	\$465	45%	Previous experience
Service Barrel	3.2.3.2.3.3	\$428	45%	Previous experience
г	Total Cost -	¢ 1 058 κ		

101d1 COST - 2 T,020 K

Status and Highlights



- MVTX integrated into P6 (2/2019)
 - TPC \$4.3M
- Latest Cost & Schedule update following MVTX workshop at LBNL in 3/2019
 - Carbon structures
 - Design
 - Production
 - Schedule
 - Power system
 - Contingency
 - Electronics
 - Mechanics design
 - Mechanics fabrication
 - Rebalance work load among collaborators
 - LANL, MIT, LBNL, UT-A, BNL et al
- MVTX TPC updated, under review
 - Identified potential cost saving, ~\$600K
 - OPC, TEC assigned



MVTX Workshop @LBNL, 2/28-3/2,2019 Mechanical System Discussion Session:

- Discussed and updated major carbon structures' design & production cost & schedule, risks etc.
- LANL, MIT, BNL and LBNL engineers and physicists

Issues and Concerns



- Budget availability
 - Final mechanical system design work, at MIT, LANL and LBNL
 - Early R&D required to reduce the high production contingency
- Carbon structure production cost & schedule
 - LBNL, other production plan/ATLAS
 - Exploring other companies in Italy, France, Korea ...
 - High contingency in design and production cost ~45%
- Global mechanical system integration
 - Inner volume design is good progress, in ceonuputal
 - High contingency in design and production, ~ 50%

Summary



- TPC in P6, \$4.3M, w/ burden and escalation
- About 6 months contingency in schedule
- Implemented Risk Based Contingency
- Recent scrubbing exercise, possible cost saving ~\$600K
- Plan to update P6 after this review
- Mechanical engineering design in progress
 - Need budget now for the final engineering design work
- Collaboration institutions ready to receive the project fund

backup



MVTX Scope



- Mechanical structure design
 - Design & FEA, LANL/MIT
 - End Wheels
 - Cylindrical structure shells
 - Detector service half barrels
 - Service patch panels
 - Global interface
- Mechanical structure fabrication
 - Composite structures, LBNL
 - Non-composite structures, MIT
 - Installation tooling etc., MIT/LANL/LBNL/BNL
- Ancillary systems "adopt" ALICE/ITS
 - Cooling plant, MIT/BNL
 - Slow control & monitoring etc., MIT/GSU

- MVTX electronics
 - Backend FELIX and cables
 - Integration into sPHENIX DAQ
 - Power system
- Detector assembly & test
 - Stave QA & half detector assembly @LBNL
 - System test & integration @LBNL/BNL
- Installation & commissioning, by all
 - Pre-installation commissioning @BNL
 - Installation @IR

Early generic R&D accomplished through LANL LDRD

- Readout integration
- Detector conceptual design

Carbon Structures – Work in Progress

- Conical sectors are expensive!
- A new design under development to avoid the conical structures, MIT/LANL



Ross' talk

SPHEN

Half Barrel





MVTX Detector in sPHENIX





April 9-11, 2019

MVTX in P6: 1/11



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POM02B_3.0	2 POM02 sPHENIX WBS 3.02 Preliminary Baselir	ne [MVTX]	1281	01-Feb-17 A	17-Mar-22	0	26695	1266751	\$2,760,452	\$1,569,754	\$4,330,205		
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POM02B_3	.02.3.00 (Temporary) External Placeholder Miles	tones in WBS 3x	1169	01-Feb-17 A	01-Oct-21	112	0	0	\$0	\$0	\$0		
EXT100090	[External Activity] Initial Project Funding Release	Sourikova, Irina	0	01-Feb-17 A			0	0	\$0	\$0	\$0	01-Feb-17 A, 🔸	
EXT317000	[External Activity] Design/Safety Reviews Complete, Internal Detector Structural Support Released for Production	Pontieri, Chris	0		19-Jul-19*	319	0	0	\$0	\$0	\$0		19-Jul-19* 🕈
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POM02B_	3.02.3.02.00 Temporary		248	01-Apr-19	26-Mar-20	169	0	0	\$0	\$0	\$0		
POM02B	3.02.3.02.00.01 ALICE ITS Key Tasks		0	01-Apr-19	01-Apr-19	255	0	0	\$0	\$0	\$0		
S100000	ALICE ITS RU Production Start	Liu, Ming	0	01-Apr-19*		255	0	0	\$0	\$0	\$0	01-A	pr-19*, ◆
POM02B_	3.02.3.02.00.02 MVTX Stave Production at CERN		248	01-Apr-19	26-Mar-20	169	0	0	\$0	\$0	\$0		
S100100	Stave Production - Batch 1	Liu, Ming	62	01-Apr-19	26-Jun-19	169	0	0	\$0	\$0	\$0		
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S100300	Stave Production - Batch 3	Liu, Ming	62	25-Sep-19	26-Dec-19	169	0	0	\$0	\$0	\$0		
\$100400	Stave Production - Batch 4	Liu, Ming	62	27-Dec-19	26-Mar-20	169	0	0	\$0	\$0	\$0		
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S100500	Milestone Start MVTX	Liu, Ming	0	01-Apr-19		0	0	0	\$0	\$0	\$0	01-	Apr-19, •
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\$101300 \$101400	NVTX Assembly Complete and Ready for Installation	Liu, Ming	112	01-001-21	17-Mar-22	0	0	6512	\$0 \$0	\$8,638	\$8,638 \$0		17-Mar-22 🔶
DOM02B	3.02.3.02.02 MVTX Electronics		286	01-Apr-19	19-May-20	363	3863	395448	\$195.007	\$469,960	\$664.967		
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MVTX in P6: 2/11

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Nz	BROOKHAVEN				Dat	ta Date	Buc e: 01-0	dgeted Cos ct-18 Publ		SPHENIX			
ty ID	Activity Name	CAM	At Compl.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 2 FY16 FY17 FY18	018 2019 2020 2021 2 FY19 FY20 FY21 FY
S101500	Produce RU Cold Plate - Labor	Liu, Ming	20	01-Apr-19	26-Apr-19	255	60	0	\$5,400	\$0	\$5,400	1120 1120 1120	0
S101600	Procure Transition Board for RU	Liu, Ming	10	01-Apr-19	12-Apr- 19	463	0	8716	\$0	\$10,895	\$10,895		0
S101700	Produce RU Cold Plate - M&S	Liu, Ming	20	01-Apr-19	26-Apr-19	255	0	12104	\$0	\$15,130	\$15,130		
\$101800	Procure Power Mezzanine for RU	Liu, Ming	10	01-Apr-19	12-Apr-19	463	0	22108	\$0	\$27,635	\$27,635		0
\$101900	Test/QA RU - Labor	Liu, Ming	18	29-Apr-19	22-May-19	453	112	0	\$3,600	\$0	\$3,600		•
\$102000	Test/QA RU - M&S	Liu, Ming	18	29-Apr-19	22-May-19	453	0	7500	\$0	\$9,375	\$9,375		•
S102100	Procure 60 SamTec Cables -Provide Bequirements to Procurement	Liu, Ming	5	23-May-19	30-May-19	453	5	0	\$922	\$0	\$922		I.
S102200	Procure 60 SamTec Cables -Prepare & Send Solicitation	Liu, Ming	20	31-May-19	27-Jun-19	453	0	0	\$0	\$0	\$0		
\$102300	Procure 60 SamTec Cables -Vendor Responses	Liu, Ming	10	28-Jun-19	12-Jul-19	453	0	0	\$0	\$0	\$0		0
S102400	Procure 60 SamTec Cables -Vendor Selection	Liu, Ming	10	15-Jul-19	26-Jul-19	453	0	0	\$0	\$0	\$0		0
\$102500	Procure 60 SamTec Cables -Contract Awards	Liu, Ming	0	29-Jul-19		453	0	0	\$0	\$0	\$0		29-Jul-19, 🔸
S102600	Procure 60 SamTec Cables -Contract/PO - Leadtime	Liu, Ming	60	29-Jul-19	22-Oct-19	453	0	0	\$0	\$0	\$0		
\$102700	Procure 60 SamTec Cables - Delivery Acceptance	Liu, Ming	5	23-Oct-19	29-Oct-19	453	0	30000	\$0	\$34,850	\$34,850		1
S102800	Test/QA SamTec Cables	Liu, Ming	40	30-Oct-19	30-Dec-19	453	960	0	\$75,360	\$0	\$75,360		•
\$102900	Ship RU & SamTec Cables to UT Austin	Liu, Ming	5	31-Dec-19	07-Jan-20	453	0	2000	\$0	\$2,550	\$2,550		1
POM02B	3.02.3.02.02.02 FELIX 2.0		254	01-Apr-19	03-Apr-20	392	186	88400	\$18,588	\$103,640	\$122,229		
\$103000	Produce Felix 2.0 first production unit - Labor	Liu, Ming	57	01-Apr-19	19-Jun-19	218	16	0	\$3,073	\$0	\$3,073		
\$103100	Procure Optical Fiber - Labor	Liu, Ming	121	01-Apr-19	19-Sep-19	414	2	0	\$307	\$0	\$307		
S103200	Produce Felix 2.0 first production unit - M&S	Liu, Ming	57	01-Apr-19	19-Jun-19	218	0	20000	\$0	\$22,778	\$22,778		
\$103300	Procure Optical Fiber - M&S	Liu, Ming	121	01-Apr-19	19-Sep-19	414	0	50	\$0	\$63	\$63		
S103400	Test/QA 1st Felix Unit and Fibers	Liu, Ming	10	20-Sep-19	03-Oct-19	414	40	0	\$0	\$0	\$0		D
\$103500	Procure 7 Felix 2.0 Remaining Units -Provide Requirements to Procurement	Liu, Ming	5	06-Nov-19	13-Nov-19	392	6	0	\$1,187	\$0	\$1,187		I
S103600	Procure 57 Optical Fiber Sets - Labor	Liu, Ming	20	06-Nov-19	06-Dec-19	462	2	0	\$396	\$0	\$396		
		Lin Ming	20	05-Nov+19	06-Dec-19	462	0	2850	\$0	\$3.634	\$3,634		8

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ity ID \$103800 \$103900 \$104000 \$104100	Activity Name Procure 7 Felix 2.0 Remaining Units -Prepare & Send Solicitation	CAM	At Compl				5. 01-OC	t-18 Publ	lished: 02	-Apr-19 1	2:38		- UP
\$103800 \$103900 \$104000 \$104100	Procure 7 Felix 2.0 Remaining Units -Prepare & Send Solicitation		At compi.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 2018	2019 2020 2021 202 FY19 FY20 FY21 FY22
\$103900 \$104000 \$104100		Liu, Ming	20	14-Nov-19	13-Dec-19	392	0	0	\$0	\$0	\$0		
\$104000 \$104100	Procure 7 Felix 2.0 Remaining Units -Vendor Responses	Liu, Ming	10	16-Dec-19	30-Dec-19	392	0	0	\$0	\$0	\$0		0
S104100	Procure 7 Felix 2.0 Remaining Units -Vendor Selection	Liu, Ming	10	31-Dec-19	14-Jan-20	392	0	0	\$0	\$0	\$0		a a a a a a a a a a a a a a a a a a a
	Procure 7 Felix 2.0 Remaining Units -Contract Awards	Liu, Ming	0	15-Jan-20		392	0	0	\$0	\$0	\$0		15-Jan-20, 🔶
\$104200	Procure 7 Felix 2.0 Remaining Units -Contract/PO - Leadtime	Liu, Ming	40	15-Jan-20	12-Mar-20	392	0	0	\$0	\$0	\$0		
\$104300	Procure 7 Felix 2.0 Remaining Units - Delivery Acceptance	Liu, Ming	5	13-Mar-20	19-Mar-20	392	0	56000	\$0	\$65,054	\$65,054		1
\$104400	Test/QA 7 Felix Units and Fibers - Labor	Liu, Ming	6	20-Mar-20	27-Mar-20	392	120	0	\$13,625	\$0	\$13,625		8
\$104500	Test/QA 7 Felix Units and Fibers - M&S	Liu, Ming	0	20-Mar-20	20-Mar-20	398	0	7500	\$0	\$9,563	\$9,563		1
\$104600	Ship Felix Units and Fibers to BNL	Liu, Ming	5	30-Mar-20	03-Apr-20	392	0	2000	\$0	\$2,550	\$2,550		I.
POM02B_3	3.02.3.02.02.03 MAPS Power System		286	01-Apr-19	19-May-20	363	2541	224620	\$91,137	\$265,885	\$357,022		
POM028_3/	02.3.02.02.03.01 Power Boards		225	01-Apr-19	24-Feb-20	413	2236	117320	\$79.666	\$139.821	\$219.487		
S104700	Review ALICE PB Design - Labor	Liu, Ming	30	01-Apr-19	10-May-19	140	588	0	\$19,050	\$0	\$19,050		
S104800	Fabricate PB Prototype - Labor	Liu, Ming	40	13-May-19	09-Jul-19	140	226	0	\$12,138	\$0	\$12,138		
\$104900	Fabricate PB Prototype - M&S	Liu, Ming	40	13-May-19	09-Jul-19	140	0	5750	\$0	\$7,188	\$7,188		
S105000	Procure Power Distribution (Cables plus Connectors) - Labor	Liu, Ming	20	10-Jul-19	06-Aug-19	140	320	0	\$0	\$0	\$0		0
S105100	Procure Power Distribution (Cables plus Connectors) - M&S	Liu, Ming	20	10-Jul-19	06-Aug-19	140	0	1000	\$0	\$1,250	\$1,250		0
\$105200	Test PB Prototype and Distribution - Labor	Liu, Ming	20	07-Aug-19	04-Sep-19	140	480	0	\$11,950	\$0	\$11,950		
\$105300	Test PB Prototype and Distribution - M&S	Liu, Ming	20	07-Aug-19	04-Sep-19	140	0	1150	\$0	\$1,438	\$1,438		
S105400	Design Production Power Board - M&S	Liu, Ming	20	05-Sep-19	02-Oct-19	140	0	2000	\$0	\$2,505	\$2,505		0
S105500	Design Production Power Board - Labor	Liu, Ming	20	05-Sep-19	02-Oct-19	140	400	0	\$19,241	\$0	\$19,241		0
S105600	Hold Power system Review	Liu, Ming	5	03-Oct-19	09-Oct-19	140	96	0	\$2,980	\$0	\$2,980		0
\$105700	Fabricate Break Out Boards (qty?) - M&S	Liu, Ming	20	10-Oct-19	07-Nov-19	483	0	15000	\$0	\$19,125	\$19,125		
S105800	Fabricate PB to Stave Cables (qty?) - M&S	Liu, Ming	20	10-Oct-19	07-Nov-19	483	0	5000	\$0	\$6,375	\$6,375		
S105900	Procure Production PB -Provide Requirements to Procurement	Liu, Ming	5	10-Oct-19	17-Oct-19	413	86	0	\$8,871	\$0	\$8,871		I
S106000	Fabricate Cold (Cooling) Plates - M&S	Liu, Ming	10	10-Oct-19	24-Oct-19	493	0	3420	\$0	\$4,361	\$4,361		0

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	NZ	BROOKHAVEN ATIONAL LABORATORY		SPHENIX										
Acti	rity ID	Activity Name	CAM	At Compl.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 2018 5 FY16 FY17 FY18	2019 2020 2021 2022 FY19 FY20 FY21 FY22
	\$106100	Fabricate Cold (Cooling) Plates - Labor	Liu, Ming	10	10-Oct-19	24-Oct-19	493	40	0	\$5,436	\$0	\$5,436		
	\$106200	Procure Production PB -Prepare & Send	Liu, Ming	20	18-Oct-19	15-Nov-19	413	0	0	\$0	\$0	\$0		0
	\$106300	Procure Production PB -Vendor Responses	Liu, Ming	10	18-Nov-19	03-Dec-19	413	0	0	\$0	\$0	\$0		D
	\$106400	Procure Production PB -Vendor Selection	Liu, Ming	10	04-Dec-19	17-Dec-19	413	0	0	\$0	\$0	\$0		0
	\$106500	Procure Production PB -Contract Award	Liu, Ming	0	18-Dec-19	18-Dec-19	413	0	0	\$0	\$0	\$0		
	\$106600	Procure Production PB -Contract/PO - Leadtime	Liu, Ming	40	18-Dec-19	14-Feb-20	413	0	0	\$0	\$0	\$0		
	\$106700	Procure Production PB - Delivery Acceptance (qty?)	Liu, Ming	5	18-Feb-20	24-Feb-20	413	0	84000	\$0	\$97,580	\$97,580		1
	POM02B_S	3.02.3.02.02.03.02 Power Supplies		151	10-Oct-19	19-May-20	363	305	107300	\$11,471	\$126,064	\$137,535		
	S106800	Procure and terminate PS-to-PB (cabling?) - M&S	Liu, Ming	30	10-Oct-19	22-Nov-19	473	0	10500	\$0	\$13,388	\$13,388		
	S106900	Procure and Integrate Power -Provide Requirements to Procurement	Liu, Ming	5	10-Oct-19	17-Oct-19	363	209	0	\$4,024	\$0	\$4,024		0
	S107000	Procure and terminate PS-to-PB (cabling?) - Labor	Liu, Ming	30	10-Oct-19	22-Nov-19	473	40	0	\$1,943	\$0	\$1,943		
	\$107100	Procure and Integrate Power -Prepare & Send Solicitation	Liu, Ming	20	18-Oct-19	15-Nov-19	363	0	0	\$0	\$0	\$0		D
	\$107200	Procure and Integrate Power -Vendor Responses	Liu, Ming	10	18-Nov-19	03-Dec-19	363	0	0	\$0	\$0	\$0		Ū.
	\$107300	Procure and Integrate Power -Vendor Selection	Liu, Ming	10	04-Dec-19	17-Dec-19	363	0	0	\$0	\$0	\$0		٥
	\$107400	Procure and Integrate Power -Contract Award	Liu, Ming	0	18-Dec-19		363	0	0	\$0	\$0	\$0		18-Dec-19, ♦
	\$107500	Procure and Integrate Power -Contract/PO - Leadtime	Liu, Ming	90	18-Dec-19	27-Apr-20	363	0	0	\$0	\$0	\$0		
	S107600	Procure and Integrate Power - Delivery Acceptance (power supplies?, qty?)	Liu, Ming	5	28-Apr-20	04-May-20	363	0	94800	\$0	\$110,126	\$110,126		1
	\$107700	test PB with power supplies	Liu, Ming	5	05-May-20	11-May-20	363	40	0	\$4,857	\$0	\$4,857		
	\$107800	Document Power System	Liu, Ming	1	12-May-20	12-May-20	363	16	0	\$647	\$0	\$647		1
	\$107900	Ship Power System to BNL - M&S	Liu, Ming	5	12-May-20	19-May-20	363	0	2000	\$0	\$2,550	\$2,550		I
	POM02B_	3.02.3.02.03 MVTX Mechanics and Detector Asser	mbly	741	01-Apr-19	17-Mar-22	0	16520	564177	\$1,279,337	\$721,361	\$2,000,698		
	POM02B	3.02.3.02.03.01 Staves		411	01-Apr-19	17-Nov-20	225	2671	166852	\$160,245	\$211,462	\$371,707		
	POM02B_	8.02.3.02.03.01.01 Production		248	01-Apr-19	26-Mar-20	169	1447	57360	\$181	\$72,305	\$72,486		
	S108000	Test/QA Staves at CERN	Liu, Ming	248	01-Apr-19	26-Mar-20	169	1440	0	\$0	\$0	\$0		
	\$108100	CERN Test System - M&S	Liu, Ming	20	01-Apr-19	26-Apr- 19	367	0	7360	\$0	\$9,200	\$9,200		
	Pa	age 4 of 11 Actual Wor	rk	Critical Rei	n.Work 🔲	Ren	naining V	Vork 💻	Actua	LoE	Remain	ing LoE	♦ Milestone	

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y ID	Activity Name	CAM	At Compl.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 2 5 FY16 FY17 FY18	018 2019 2020 2021
S108200	Travel and Per Diem at CERN - M&S	Liu, Ming	248	01-Apr-19	26-Mar-20	169	0	50000	\$0	\$63,105	\$63,105		
\$108300	CERN Test System - Labor	Liu, Ming	20	01-Apr-19	26-Apr- 19	367	7	0	\$181	\$0	\$181		D
POM02B_3	.02.3.02.03.01.02 Stave Assembly Tooling		120	28-May-20	17-Nov-20	0	264	45000	\$59,738	\$57,715	\$117,453		
\$108400	Stave Assembly Tooling - Design	Liu, Ming	10	28-May-20	10-Jun-20	0	80	0	\$18,076	\$0	\$18,076		•
S108500	Stave Assembly Tooling - Prototype - M&S	Liu, Ming	30	11-Jun-20	23-Jul-20	0	0	20000	\$0	\$25,500	\$25,500		•
\$108600	Stave Assembly Tooling - Prototype - Labor	Liu, Ming	30	11-Jun-20	23-Jul-20	0	120	0	\$27,114	\$0	\$27,114		-
S108700	Stave Assembly Tooling - Final Jig Design	Liu, Ming	20	24-Jul-20	20-Aug-20	0	40	0	\$9,038	\$0	\$9,038		
\$108800	Stave Assembly Tooling - Procure Assembly Fixtures and Tooling - M&S	Liu, Ming	60	21-Aug-20	17-Nov-20	0	0	25000	\$0	\$32,215	\$32,215		-
S108900	Stave Assembly Tooling - Procure Assembly Fixtures and Tooling - Labor	Liu, Ming	60	21-Aug-20	17-Nov-20	0	24	0	\$5,510	\$0	\$5,510		-
POM02B_3	.02.3.02.03.01.03 Metrology		65	28-May-20	27-Aug-20	55	363	7000	\$78,445	\$8,925	\$87,370		
S109000	Metrology design	Liu, Ming	20	28-May-20	24-Jun-20	55	160	0	\$36,152	\$0	\$36,152		
\$109100	Design jigs	Liu, Ming	20	25-Jun-20	23-Jul-20	55	160	0	\$36,152	\$0	\$36,152		
\$109200	Procure jigs - M&S	Liu, Ming	20	24-Jul-20	20-Aug-20	55	0	5000	\$0	\$6,375	\$6,375		
\$109300	Procure jigs - Labor	Liu, Ming	20	24-Jul-20	20-Aug-20	55	3	0	\$428	\$0	\$428		•
S109400	ship to LBNL - Labor	Liu, Ming	5	21-Aug-20	27-Aug-20	55	40	0	\$5,712	\$0	\$5,712		1
\$109500	ship to LBNL - M&S	Liu, Ming	5	21-Aug-20	27-Aug-20	55	0	2000	\$0	\$2,550	\$2,550		8
POM02B_3	.02.3.02.03.01.04 Shipping and Storage Containers		341	01-Apr-19	06-Aug-20	295	597	33492	\$21,882	\$42,153	\$64.034		
\$109600	Design & Fabricate Storage Cabinets for Staves - M&S	Liu, Ming	39	01-Apr-19	23-May-19	341	0	6992	\$0	\$8,740	\$8,740		
\$109700	Design shipping container for 21 staves	Liu, Ming	5	01-Apr-19	05-Apr-19	360	40	0	\$9,485	\$0	\$9,485		I
S109800	Design & Fabricate Storage Cabinets for Staves	Liu, Ming	39	01-Apr-19	23-May-19	341	275	0	\$5,353	\$0	\$5,353		
\$109900	Procure Stave Shipping Plate (84) - Labor	Liu, Ming	5	08-Apr-19	12-Apr-19	360	10	0	\$1,608	\$0	\$1,608		1
\$110000	Procure Stave Shipping Plate (84) - M&S	Liu, Ming	5	08-Apr-19	12-Apr- 19	360	0	10000	\$0	\$12,500	\$12,500		1
S110100	Ship Stave Shipping Devices to CERN	Liu, Ming	10	15-Apr-19	26-Apr- 19	360	0	5000	\$0	\$6,250	\$6,250		I
\$110200	Design & Fabricate Shipping and Storage Containers (Half-Barrels) - M&S	Liu, Ming	50	28-May-20	06-Aug-20	295	0	11500	\$0	\$14,663	\$14,663		
S110300	Design & Fabricate Shipping and Storage Containers (Half-Barrels) - Labor	Liu, Ming	50	28-May-20	06-Aug-20	295	272	0	\$5,436	\$0	\$5,436		
POM02B_3	.02.3.02.03.01.05 Shipping the Staves from CERN to LBNL		193	27-Jun-19	06-Apr-20	169	0	24000	\$0	\$30,364	\$30,364		

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ctivity ID	Activity Name	CAM	At Compl.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 2018 5 FY16 FY17 FY18	2019 2020 2021 2022 FY19 FY20 FY21 FY22
\$11040	ship from CERN to LBNL - Batch 1	Liu, Ming	7	27-Jun-19	08-Jul-19	318	0	6000	\$0	\$7,500	\$7,500		0
\$11050	ship from CERN to LBNL - Batch 2	Liu, Ming	7	25-Sep-19	03-Oct-19	268	0	6000	\$0	\$7,564	\$7,564		0
\$11060) ship from CERN to LBNL - Batch 3	Liu, Ming	7	27-Dec-19	07-Jan-20	219	0	6000	\$0	\$7,650	\$7,650		1
\$11070	ship from CERN to LBNL - Batch 4	Liu, Ming	7	27-Mar-20	06-Apr-20	169	0	6000	\$0	\$7,650	\$7,650		I
POM02B	3.02.3.02.03.02 Carbon Structures		741	01-Apr-19	17-Mar-22	0	5774	368511	\$910,025	\$472,154	\$1,382,179		
POM02B_	3.02.3.02.03.02.01 Mechanics Detector Design		80	01-Apr-19	23-Jul-19	0	640	0	\$167,952	\$0	\$167,952		
\$11080	Develop MAPS inner tracker mechanical model	Liu, Ming	80	01-Apr-19	23-Jul-19	0	640	0	\$167,952	\$0	\$167,952		-
POM02B_	3.02.3.02.03.02.02 End Wheels		277	24-Jul-19	28-Aug-20	54	502	72000	\$73,964	\$90,875	\$164,839		
\$11090	Design End-wheels	Liu, Ming	15	24-Jul-19	13-Aug-19	54	120	0	\$36,658	ŞO	\$36,658		
\$11100	Prototype End-wheels - M&S	Liu, Ming	30	14-Aug-19	25-Sep-19	54	0	10000	\$0	\$12,500	\$12,500		
\$11110	Prototype End-wheels - Labor	Liu, Ming	30	14-Aug-19	25-Sep-19	54	12	0	\$2,305	\$0	\$2,305		
S11120	Procure Al Half Disks - Labor	Liu, Ming	5	14-Aug-19	20-Aug-19	311	4	0	\$555	\$0	\$555		1
S11130	Procure Al Half Disks - M&S	Liu, Ming	5	14-Aug-19	20-Aug-19	311	0	1000	\$0	\$1,250	\$1,250		1
S11140	Procure Half Rings - Labor	Liu, Ming	5	14-Aug-19	20-Aug-19	311	4	0	\$555	\$0	\$555		1
\$11150	Procure Half Rings - M&S	Liu, Ming	5	14-Aug-19	20-Aug-19	311	0	1000	\$0	\$1,250	\$1,250		1
S11160	Experimental Tooling for Carbon Structure - Labor	Liu, Ming	80	26-Sep-19	24-Jan-20	54	186	0	\$28,859	\$0	\$28,859		
S11170	Experimental Tooling for Carbon Structure - M&S	Liu, Ming	0	26-Sep-19	26-Sep-19	134	0	25000	\$0	\$31,250	\$31,250		1
S11180	Review End-wheels	Liu, Ming	2	27-Jan-20	28-Jan-20	54	16	0	\$5,034	\$0	\$5,034		1
\$11190	Procure End-wheels -Provide Requirements to Procurement	Liu, Ming	5	29-Jan-20	04-Feb-20	54	160	0	\$0	\$0	\$0		
\$11200	Procure End-wheels -Prepare & Send Solicitation	Liu, Ming	20	05-Feb-20	04-Mar-20	54	0	0	\$0	\$0	\$0		
\$11210	Procure End-wheels -Vendor Responses	Liu, Ming	10	05-Mar-20	18-Mar-20	54	0	0	\$0	\$0	\$0		0
S11220	Procure End-wheels -Vendor Selection	Liu, Ming	10	19-Mar-20	01-Apr-20	54	0	0	\$0	\$0	\$0		0
S11230	Procure End-wheels -Contract Award	Liu, Ming	0	02-Apr-20		54	0	0	\$0	\$0	\$0		02-Apr-20, ♦
S11240	Procure End-wheels -Contract/PO - Leadtime	Liu, Ming	100	02-Apr-20	21-Aug-20	54	0	0	\$0	\$0	\$0		
\$11250	Procure End-wheels - Delivery Acceptance	Liu, Ming	5	24-Aug-20	28-Aug-20	54	0	35000	\$0	\$44,625	\$44,625		I
POM028_	3.02.3.02.03.02.03 Mechanics Fabrication		741	01-Apr-19	17-Mar-22	0	4408	286511	\$614,456	\$368,529	\$982,985		
Pa	age 6 of 11 Actual Wor	k	Critical Ren	n.Work 🔲	Rem	aining V	Vork	Actual	LoE	Remaini	ng LoE	♦ Milestone	

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N.	BROOKHAVEN ATIONAL LABORATORY				Dat	sPHEN	NIX MV Buo e: 01-O	FX Project dgeted Cos ct-18 Publ	Detailed at Include ished: 02	l Schedule ed 2-Apr-19 1	2:38		SPHENIX
ctivity ID	Activity Name	CAM	At Compl.	Start	Finish	Total Eloat	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 2018 5 FY16 FY17 FY18	2019 2020 2021 2022 FY19 FY20 FY21 FY22
\$11260	D Travel LBNL - FY19	Liu, Ming	128	01-Apr-19	30-Sep-19	0	0	17500	\$0	\$21,875	\$21,875		
\$11270	0 Travel LBNL - FY20	Liu, Ming	251	01-Oct-19	30-Sep-20	0	0	17500	\$0	\$22,313	\$22,313		
\$11280	0 Travel LBNL - FY21	Liu, Ming	250	01-Oct-20	30-Sep-21	0	0	17500	\$0	\$22,759	\$22,759		
S11290	0 Travel LBNL - FY22	Liu, Ming	112	01-Oct-21	17-Mar-22	0	0	17500	\$0	\$23,214	\$23,214		
POM028	3.02.3.02.03.02.03.01 Cylindrical Support Structure (CYSS)		291	24-Jul-19	21-Sep-20	180	2409	102871	\$333,977	\$131,161	\$465,137		
\$11300	CReview CYSS Design-Fabrication Compatibility	Liu, Ming	40	24-Jul-19	18-Sep-19	0	371	0	\$12,141	\$0	\$12,141		-
\$11310	00 Modify CYSS Design	Liu, Ming	40	19-Sep-19	15-Nov-19	0	320	0	\$85,991	\$0	\$85,991		-
\$11320	C Review CYSS Design for Fabrication (PRR)	Liu, Ming	15	18-Nov-19	10-Dec-19	0	118	0	\$13,884	\$0	\$13,884		•
\$11330	0 Detail Design CYSS	Liu, Ming	15	11-Dec-19	02-Jan-20	0	120	0	\$27,114	\$0	\$27,114		•
\$11340	0 Procure CYSS Material - M&S	Liu, Ming	5	03-Jan-20	09-Jan-20	251	0	15640	\$0	\$19,941	\$19,941		1
\$11350	C Procure CYSS Material - Labor	Liu, Ming	5	03-Jan-20	09-Jan-20	251	8	0	\$0	\$0	\$0		8
\$11360	0 Production & Test CYSS - M&S	Liu, Ming	80	28-May-20	18-Sep-20	155	0	87231	\$0	\$111,220	\$111,220		
\$11370	C Production & Test CYSS - Labor	Liu, Ming	80	28-May-20	18-Sep-20	155	1472	0	\$194,846	\$0	\$194,846		
\$11380	C Milestone: Complete CYSS	Liu, Ming	0	21-Sep-20	21-Sep-20	180	0	0	\$0	\$0	\$0		I
POM02B	_3.02.3.02.03.02.03.02 Service Barrel (SB)		291	03-Jan-20	04-Mar-21	155	2000	113640	\$280,479	\$147.208	\$427.688		
\$11390	CReview SB Design-Fabrication Compatibility	Liu, Ming	40	03-Jan-20	02-Mar-20	0	91	0	\$12,505	\$0	\$12,505		-
\$11400	0 Modify SB Design	Liu, Ming	30	03-Mar-20	13-Apr-20	0	240	0	\$54,228	\$0	\$54,228		-
\$11410	0 Review SB Design for Fabrication (PRR)	Liu, Ming	15	14-Apr-20	04-May-20	0	112	0	\$14,809	\$0	\$14,809		
\$11420	0 Procure SB Material - M&S	Liu, Ming	5	05-May-20	11-May-20	246	0	15640	\$0	\$19,941	\$19,941		1
\$11430	00 Procure SB Material - Labor	Liu, Ming	5	05-May-20	11-May-20	246	8	0	\$0	\$0	\$0		1
\$11440	00 Production & Test SB - M&S	Liu, Ming	110	21-Sep-20	03-Mar-21	155	0	98000	\$0	\$127,267	\$127,267		
\$11450	C Production & Test SB - Labor	Liu, Ming	110	21-Sep-20	03-Mar-21	155	1549	0	\$198,937	\$0	\$198,937		
S11460	0 Milestone: Complete SB	Liu, Ming	0	04-Mar-21	04-Mar-21	155	0	0	\$0	\$0	\$0		· · · · · ·
POM02B_	3.02.3.02.03.02.04 MVTX Final Design Review		16	05-May-20	27-May-20	0	224	10000	\$53,652	\$12,750	\$66,402		
\$11470	0 MVTX Design Review - M&S	Liu, Ming	5	05-May-20	11-May-20	0	0	10000	\$0	\$12,750	\$12,750		1
S11480	0 MVTX Design Review - Labor	Liu, Ming	5	05-May-20	11-May-20	0	64	0	\$8,942	\$0	\$8,942		1
P	age 7 of 11 Actual Wor	rk 🗾	Critical Rer	n.Work	Rem	naining V	Vork 💻	Actual	LoE	Remaini	ng LoE	♦ Milestone	

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	Activity Name	CAM	At Compl.	Start	Finish	Total Float	Hours	Direct FY19\$ - M&S	Burd AY\$ -	Burd AY\$ - M&S	Burd AY\$ - Total	2015 2016 2 5 FY16 FY17	2017 2018 FY18	2019 202 FY19 FY20	0 2021 20 FY21 FY2
14900	Incorporate MVTX Design Review Comments	Liu, Ming	10	12-May-20	26-May-20	0	144	0	\$40,239	\$0	\$40,239				
15000	Complete Final MVTX Design Review	Liu, Ming	1	27-May-20	27-May-20	0	16	0	\$4,471	\$0	\$4,471			T	
/02B_	3.02.3.02.03.03 Barrel Assembly		556	05-Sep-19	29-Nov-21	75	8075	28814	\$209,067	\$37,745	\$246,812				
VI02B_3	02.3.02.03.03.01 Assembly and Testing		556	05-Sep-19	29-Nov-21	75	8075	28814	\$209,067	\$37,745	\$246,812				
15100	Test and Rework Staves - Batch 1	Liu, Ming	12	05-Sep-19	20-Sep-19	277	276	0	\$5,234	\$0	\$5,234			0	
15200	Test and Rework Staves - Batch 2	Liu, Ming	12	04-Oct-19	22-Oct-19	268	276	0	\$5,391	\$0	\$5,391			D	
15300	Test and Rework Staves - Batch 3	Liu, Ming	12	08-Jan-20	24-Jan-20	219	276	0	\$5,391	\$0	\$5,391			0	
15400	Milestone: Complete Reception of 84 Staves from CERN	Liu, Ming	0		06-Apr-20	169	0	0	\$0	\$0	\$0			06-Apr-20 🔶	
15500	Test and Rework Staves - Batch 4	Liu, Ming	12	07-Apr-20	22-Apr-20	169	276	0	\$5,391	\$0	\$5,391			0	
M028_	02.3.02.03.03.01.01 Layer Assembly and Test		140	18-Nov-20	11-Jun-21	0	2884	5336	\$69,916	\$6,939	\$76,856				_
115600	Test Installation of Staves onto Layer End-Wheels	Liu, Ming	20	18-Nov-20	17-Dec-20	0	368	0	\$7,208	\$0	\$7,208				•
115700	Hold Half-Detector Assembly Review (PRR)	Liu, Ming	5	18-Dec-20	24-Dec-20	0	96	0	\$2,729	\$0	\$2,729				1
115800	Install Staves Onto Layer End-Wheels To Form Layers - M&S	Liu, Ming	70	28-Dec-20	07-Apr-21	0	0	2760	\$0	\$3,589	\$3,589				
115900	Install Staves Onto Layer End-Wheels To Form Layers - Labor	Liu, Ming	70	28-Dec-20	07-Apr-21	0	1484	0	\$34,303	\$0	\$34,303				_
16000	Test and Rework Layers After Assembly - M&S	Liu, Ming	30	08-Apr-21	19-May-21	0	0	2576	\$0	\$3,350	\$3,350				
1610	Test and Rework Layers After Assembly - Labor	Liu, Ming	30	08-Apr-21	19-May-21	0	647	0	\$14,442	\$0	\$14,442				-
16200	Perform Half-Detector Metrology On Layers	Liu, Ming	15	20-May-21	10-Jun-21	0	289	0	\$11,234	\$0	\$11,234				•
16300	Milestone: Complete Layers	Liu, Ming	0	11-Jun-21	11-Jun-21	0	0	0	\$0	\$0	\$0				I
M028_	0.02.3.02.03.03.01.02 Half Barrel #1 Assembly and Test		95	11-Jun-21	26-Oct-21	5	2038	11739	\$57,980	\$15,373	\$73,353				_
16400	Assemble Layers and CYSS into Half Barrel #1 - M&S	Liu, Ming	20	11-Jun-21	09-Jul-21	0	0	2760	\$0	\$3,589	\$3,589				•
116500	Assemble Layers and CYSS into Half Barrel #1 - Labor	Liu, Ming	20	11-Jun-21	09-Jul-21	0	400	0	\$12,530	\$0	\$12,530				•
116600	Test and Rework Half Barrel #1 - M&S	Liu, Ming	30	12-Jul-21	20-Aug-21	15	0	2576	\$0	\$3,350	\$3,350				
116700	Test and Rework Half Barrel #1 - Labor	Liu, Ming	30	12-Jul-21	20-Aug-21	5	679	0	\$18,794	\$0	\$18,794				
116800	Perform Half Barrel #1 Metrology On Final Assembly - Labor	Liu, Ming	10	23-Aug-21	03-Sep-21	5	216	0	\$7,943	\$0	\$7,943				0
16900	Validation Of Final Assembly - M&S	Liu, Ming	20	07-Sep-21	04-Oct-21	5	0	2576	\$0	\$3,357	\$3,357				
117000	Validation Of Final Assembly - Labor	Liu, Ming	20	07-Sep-21	04-Oct-21	5	568	0	\$13,723	\$0	\$13,723				

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Activity ID	Activity Name	CAM	At Compl.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 2 5 FY16 FY17 FY18	018 2019 2020 2021 2022 FY19 FY20 FY21 FY22
\$11	710C Pack/Ship Final Assemblies of Half Barrel #1 To BNL - M&S	Liu, Ming	15	05-Oct-21	26-Oct-21	5	0	3827	\$0	\$5,077	\$5,077		
\$11	720C Pack/Ship Final Assemblies of Half Barrel #1 To BNL - Labor	Liu, Ming	15	05-Oct-21	26-Oct-21	5	175	0	\$4,990	\$0	\$4,990		
POM	028_3.02.3.02.03.03.01.03 Half Barrel #2 Assembly and Test		95	12-Jul-21	29-Nov-21	75	2046	11739	\$59,762	\$15,433	\$75,195		
\$11	730C Assemble Layers and CYSS Into Half Barrel #2 - M&S	Liu, Ming	20	12-Jul-21	06-Aug-21	0	0	2760	\$0	\$3,589	\$3,589		•
\$11	740C Assemble Layers and CYSS Into Half Barrel #2 - Labor	Liu, Ming	20	12-Jul-21	06-Aug-21	0	408	0	\$13,894	\$0	\$13,894		•
S11	7500 Test and Rework Half Barrel #2 - M&S	Liu, Ming	30	09-Aug-21	20-Sep-21	0	0	2576	\$0	\$3,350	\$3,350		-
\$11	760C Test and Rework Half Barrel #2 - Labor	Liu, Ming	30	09-Aug-21	20-Sep-21	0	679	0	\$18,794	\$0	\$18,794		-
\$11	770C Perform Half Barrel #2 Metrology On Final Assembly	Liu, Ming	10	21-Sep-21	04-Oct-21	0	216	0	\$7,991	\$0	\$7,991		0
\$11	7800 Validation Of Final Assembly - M&S	Liu, Ming	20	05-Oct-21	02-Nov-21	0	0	2576	\$0	\$3,417	\$3,417		•
\$11	7900 Validation Of Final Assembly - Labor	Liu, Ming	20	05-Oct-21	02-Nov-21	0	568	0	\$14,093	\$0	\$14,093		•
S11	800C Pack/Ship Final Assemblies of Half Barrel #2 to BNL - M&S	Liu, Ming	15	03-Nov-21	24-Nov-21	0	0	3827	\$0	\$5,077	\$5,077		
\$11	810C Pack/Ship Final Assemblies of Half Barrel #2 to BNL - Labor	Liu, Ming	15	03-Nov-21	24-Nov-21	0	175	0	\$4,990	\$0	\$4,990		•
\$11	8200 Milestone: Complete Barrel (RR)	Liu, Ming	0	29-Nov-21	29-Nov-21	75	0	0	\$0	\$0	\$0		1
POMO	2B 3.02.3.02.04 MVTX Integration and Infrastructure		741	01-Apr-19	17-Mar-22	0	4454	269365	\$693,269	\$329,789	\$1,023,058		
\$1183	00 Clean Tent/Room -Provide Requirements to Procurement	Liu, Ming	5	01-Apr-19	05-Apr-19	643	0	0	\$0	\$0	\$0		1
\$1184	00 Clean Tent/Room -Prepare & Send Solicitation	Liu, Ming	20	08-Apr-19	03-May-19	643	0	0	\$0	\$0	\$0		
S1185	00 Clean Tent/Room -Vendor Responses	Liu, Ming	10	06-May-19	17-May-19	643	0	0	\$0	\$0	\$0		0
\$1186	00 Clean Tent/Room -Vendor Selection	Liu, Ming	10	20-May-19	03-Jun-19	643	0	0	\$0	\$0	\$0		0
S1187	00 Clean Tent/Room -Contract Award	Liu, Ming	0	04-Jun-19		643	0	0	\$0	\$0	\$0		04-Jun-19, 🔶
\$1188	00 Clean Tent/Room -Contract/PO - Leadtime	Liu, Ming	48	04-Jun-19	09-Aug-19	643	0	0	\$0	\$0	\$0		
S1189	00 Clean Tent/Room - Delivery Acceptance	Liu, Ming	5	12-Aug-19	16-Aug-19	643	0	50000	\$0	\$56,945	\$56,945		1
POM	02B_3.02.3.02.04.01 Cooling System		120	28-May-20	17-Nov-20	250	152	87000	\$26,091	\$111,421	\$137,513		
\$119	000 Cooling System - MIT Travel	Liu, Ming	120	28-May-20	17-Nov-20	250	0	25000	\$0	\$32,045	\$32,045		
\$119	100 Design Cooling (Modify ALICE Design)	Liu, Ming	5	28-May-20	03-Jun-20	205	40	0	\$9,038	\$0	\$9,038		1
\$119	200 Mock up Testing - M&S	Liu, Ming	5	04-Jun-20	10-Jun-20	205	0	20000	\$0	\$25,500	\$25,500		8
\$119	300 Mock up Testing - Labor	Liu, Ming	5	04-Jun-20	10-Jun-20	205	40	0	\$5,712	\$0	\$5,712		0
\$119	400 Final Design of Cooling System	Liu, Ming	5	11-Jun-20	17-Jun-20	205	40	0	\$9,038	\$0	\$9,038		1
			0.17.1.0										
	Page 9 of 11 Actual Wo	гк	Critical Rei	n. Work 🔲	Ren	haining V	vork	Actua	LOE	Remain	ing LoE	 Milestone 	

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ctivity ID	Activity Name	CAM	At Compl.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017 5 FY16 FY17 FY1	2018 2019 2020 2021 2022 18 FY19 FY20 FY21 FY22
\$119500	Procure Cooling Plant - M&S	Liu, Ming	100	18-Jun-20	09-Nov-20	250	0	40000	\$0	\$51,275	\$51,275		
\$119600	Procure Cooling Plant - Labor	Liu, Ming	100	18-Jun-20	09-Nov-20	250	32	0	\$2,303	\$0	\$2,303		—
\$119700	Ship Cooling Plant to BNL	Liu, Ming	5	10-Nov-20	17-Nov-20	250	0	2000	\$0	\$2,601	\$2,601		•
POM02B	3.02.3.02.04.02 Safety Systems		140	18-Jun-20	11-Jan-21	205	986	35200	\$141,112	\$45,426	\$186,538		
\$119800	Safety Systems - MIT Travel	Liu, Ming	140	18-Jun-20	11-Jan-21	205	0	25000	\$0	\$32,180	\$32,180		
\$119900	Define MVTX Safety and Interlock requirements	Liu, Ming	10	18-Jun-20	01-Jul-20	205	120	0	\$9,038	\$0	\$9,038		0
\$120000	Review Sensors & Interlocks with BNL ES&H	Liu, Ming	10	02-Jul-20	16-Jul-20	205	80	0	\$9,038	\$0	\$9,038		٥
\$120100	Design Electronics Safety System	Liu, Ming	20	17-Jul-20	13-Aug-20	205	288	0	\$26,383	\$0	\$26,383		
S120200	Design Cooling Interlocks	Liu, Ming	30	14-Aug-20	25-Sep-20	205	120	0	\$27,114	\$0	\$27,114		
\$120300	Procure Safety Systems - M&S	Liu, Ming	40	28-Sep-20	24-Nov-20	205	0	10000	\$0	\$12,986	\$12,986		
\$120400	Procure Safety Systems - Labor	Liu, Ming	40	28-Sep-20	24-Nov-20	205	58	0	\$12,009	\$0	\$12,009		
\$120500	Test Safety Systems	Liu, Ming	15	25-Nov-20	17-Dec-20	205	161	0	\$27,145	\$0	\$27,145		8
\$120600	Ship Safety Systems to BNL	Liu, Ming	5	18-Dec-20	24-Dec-20	205	0	200	\$0	\$260	\$260		U U
\$120700	Test Safety Systems at BNL	Liu, Ming	10	28-Dec-20	11-Jan-21	205	160	0	\$30,385	\$0	\$30,385		0
POM02B	3.02.3.02.04.03 Stave Support Frame & MVTX Int	erface to sPHEN	741	01-Apr-19	17-Mar-22	0	2020	97165	\$455,487	\$115.997	\$571.483		
\$120800	Travel FY19	Liu, Ming	128	01-Apr-19	30-Sep-19	112	0	2560	\$0	\$3,200	\$3,200		
\$120900	Design Interface to sPHENIX	Liu, Ming	100	19-Jul-19	12-Dec-19	319	800	0	\$178,076	\$0	\$178,076		
\$121000	Travel FY20	Liu, Ming	251	01-Oct-19	30-Sep-20	112	0	5000	\$0	\$6,375	\$6,375		
\$121100	Procure Support Structure -Provide Requirements to Procurement	Liu, Ming	5	13-Dec-19	19-Dec-19	469	8	0	\$1,142	\$0	\$1,142		I
\$121200	Procure Support Structure -Prepare & Send Solicitation	Liu, Ming	20	20-Dec-19	21-Jan-20	469	0	0	\$0	\$0	\$0		
\$121300	Procure Support Structure -Vendor Responses	Liu, Ming	10	22-Jan-20	04-Feb-20	469	0	0	\$0	\$0	\$0		0
\$121400	Procure Support Structure -Vendor Selection	Liu, Ming	10	05-Feb-20	19-Feb-20	469	0	0	\$0	\$0	\$0		0
\$121500	Procure Support Structure -Contract Award	Liu, Ming	0	20-Feb-20		469	0	0	\$0	\$0	\$0		20-Feb-20, 🔶
\$121600	Procure Support Structure -Contract/PO - Leadtime	Liu, Ming	40	20-Feb-20	15-Apr-20	469	0	0	\$0	\$0	\$0		
S121700	Procure Support Structure - Delivery Acceptance	Liu, Ming	5	16-Apr-20	22-Apr-20	469	0	40000	\$0	\$46,467	\$46,467		1
Pa	ge 10 of 11 Actual Wo	rk 🗖	Critical Ren	n.Work 🔲	Ren	naining V	/ork	Actual	LoE	Remaini	ng LoE	♦ Milestone	

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Activity ID Add S121800 Pet S121900 FE S122000 Tra S122100 Pr S122100 Pr S122100 Pr S122200 Pr S122300 Pr S122400 Pr S122500 Pr S122600 Pr S122500 Pr S122600 Pr S122800 S1 S122800 S1 S122800 S1	SPHENIX MVTX Project Detailed Schedule BROOKHAVEN Budgeted Cost Included NATIONAL LABORATORY Data Date: 01-Oct-18 Published: 02-Apr-19 12:38 wity ID Activity Name CAM Actompl Start Finish Total Hours Burd Arts- Burd Arts- Burd Arts- Z016 Z017 Z018														
S121800 De S121900 FE S122000 Tra S122100 Pra S122100 Pra S122200 Pra S122200 Pra S122200 Pra S122400 Pra S122400 Pra S122400 Pra S122500 Pra S122600 Pra S122800 shi S122800 shi S122800 shi S122800 shi	ctivity Name	CAM /	At Compl.	Start	Finish	Total	Hours	Direct FY19\$ -	Burd AY\$ -	Burd AY\$ -	Burd AY\$ -	2015 2016 2017	2018 2019 2020 2021 2022 2018 519 570 5711 5732		
S121900 FE. S122000 Tra S122100 Pre S122200 Pre S122200 Pre S122200 Pre S122200 Pre S122200 Pre S122400 Pre S122400 Pre S122500 Pre S122600 Pre S122800 shi S122800 shi S122800 shi S122800 shi	esign Interface to rail system	Liu, Ming	50	28-May-20	06-Aug-20	205	400	0	\$90,380	\$0	\$90,380				
S122000 Tra S122100 Prr Prr S12200 S12200 Prr S122400 Prr S122400 Prr S122200 Prr S122200 Prr S122400 Prr S122600 Prr S122800 Prr S122800 Shi S122800 Shi S122800 Shi S122800 Shi S122800 Shi	EA,Thermal,stress analysis	Liu, Ming	100	07-Aug-20	04-Jan-21	205	800	0	\$184,123	\$0	\$184,123				
S122100 Pr S122200 Pr Sol Sol S12200 Pr S12200 Pr S122400 Pr S122500 Pr S122600 Pr S122600 Pr S122700 Pr S122800 shi S122800 shi S122800 shi S122800 shi	ravel FY21	Liu, Ming	250	01-Oct-20	30-Sep-21	112	0	5000	\$0	\$6,503	\$6,503				
\$122200 Pressol \$000000000000000000000000000000000000	rocure Rail Interface -Provide Requirements to rocurement	Liu, Ming	5	05-Jan-21	11-Jan-21	205	8	0	\$1,177	\$0	\$1,177		0		
S122300 Pre S122400 Pre S122500 Pre S122600 Pre S122700 Pre S122800 shi S122900 shi S122900 shi S122900 shi	rocure Rail Interface -Prepare & Send olicitation	Liu, Ming	20	12-Jan-21	09-Feb-21	205	0	0	\$0	\$0	\$0				
S122400 Pro S122500 Pro S122600 Pro S122700 Pro S122800 shi S122800 shi S122900 shi S122000 Tra	rocure Rail Interface -Vendor Responses	Liu, Ming	10	10-Feb-21	24-Feb-21	205	0	0	\$0	\$0	\$0		0		
S122500 Pro S122600 Pro S122700 Pro S122800 shi S122900 shi S122900 shi	rocure Rail Interface -Vendor Selection	Liu, Ming	10	25-Feb-21	10-Mar-21	205	0	0	\$0	\$0	\$0		a a a a a a a a a a a a a a a a a a a		
S122600 Pro S122700 Pro S122800 shi S122900 shi S122900 shi	rocure Rail Interface -Contract Award	Liu, Ming	0	11-Mar-21		205	0	0	\$0	\$0	\$0		11-Mar-21, 🔶		
S122700 Pro S122800 shi S122900 shi S122900 shi	rocure Rail Interface -Contract/PO - Leadtime	Liu, Ming	40	11-Mar-21	05-May-21	205	0	0	\$0	\$0	\$0				
\$122800 shi \$122900 shi \$123000 Tra	rocure Rail Interface - Delivery Acceptance	Liu, Ming	5	06-May-21	12-May-21	205	0	40000	\$0	\$47,396	\$47,396		I		
S122900 shi	hip to BNL - M&S	Liu, Ming	5	13-May-21	19-May-21	205	0	2000	\$0	\$2,601	\$2,601		0		
\$123000 Tra	hip to BNL - Labor	Liu, Ming	5	13-May-21	19-May-21	205	4	0	\$588	\$0	\$588		0		
	ravel FY22	Liu, Ming	112	01-Oct-21	17-Mar-22	0	0	2605	\$0	\$3,455	\$3,455				
POM02B_3.0	02.3.02.04.04 Half detector Assembly Readout a	nd Cooling Test	548	08-Jan-20	17-Mar-22	0	1296	0	\$70,579	\$0	\$70,579				
\$123100 Te	est RU at BNL	Liu, Ming	5	08-Jan-20	14-Jan-20	453	100	0	\$15,442	\$0	\$15,442		I		
\$123200 Te	est FELIX at BNL	Liu, Ming	5	06-Apr-20	10-Apr-20	392	100	0	\$15,442	\$0	\$15,442		1		
S123300 PS	S tests at BNL	Liu, Ming	3	19-May-20	22-May-20	363	40	0	\$3,726	\$0	\$3,726		I		
\$123400 As	ssemble & Test Cooling System at BNL	Liu, Ming	20	18-Nov-20	17-Dec-20	250	240	0	\$23,533	\$0	\$23,533				
\$123500 Te	est Half Barrel #1	Liu, Ming	15	27-Oct-21	17-Nov-21	5	168	0	\$6,219	\$0	\$6,219				
\$123600 Te	est Half Barrel #2	Liu, Ming	15	29-Nov-21	17-Dec-21	0	168	0	\$6,219	\$0	\$6,219		•		
\$123700 Sys	ystem Test at BNL	Liu, Ming	60	20-Dec-21	17-Mar-22	0	480	0	\$0	\$0	\$0		-		
S123800 Co	ompleted: System Test at BNL	Liu, Ming	0		17-Mar-22	0	0	0	\$0	\$0	\$0		17-Mar-22 🔶		
Dago	a 11 of 11 Actual Work		tical Ren	n Work	Rom	naining M	/ork	Actual		Remain	ing LoE	♦ Milestone			