sPHENIX MVTX Cost & Schedule Review
MVTX Cost and Schedule

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July 29-30, 2019

BNL

Scope of the MVTX Project – WBS 3.02

- Mechanical system (3.02.03, 3.02.04)
  - **MVTX detector mechanical structures**
    - **Design & simulations, MIT/LANL**
    - **End Wheels**
    - **Cylindrical support structure**
    - **Service barrels**
  - **Mechanical system integration**
    - **Service barrel support & interface to sPHENIX**
    - **Installation tooling etc., BNL/LANL/MIT/LBNL**
    - **Adopt ALICE cooling plant design**
  - **Detector assembly**
    - **Stave QA & detector assembly @LBNL**

Walt's talk

Camelia's talk

Yuan's talk

- Electronics (3.02.02)
  - **Readout Integration**
    - **RU QA & assembly @UT-A**
    - **Backend: ATLAS FELIX**
    - **FELIX boards @LANL/BNL**
    - **Frontend RU services: daughter cards, transition boards, cables etc.**
  - **Ancillary systems - "adopt" ALICE ITS system**
    - **Power, slow control & monitoring etc.**

Jo's talk

BNL provides Staves & RUs, w/o cost to MVTX project:
- 84 ALICE/ITS-IB (modified) staves from CERN; 48+spares(2-inner layers+10%)
- 60 ALICE/ITS-RU from CERN 48+spares(12, 25%)

Early R&D by LANL LDRD $5M, FY17-19

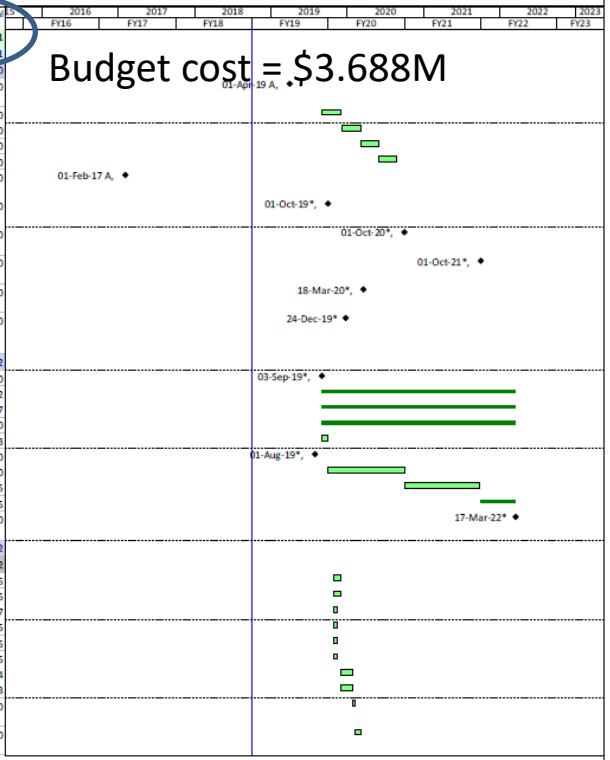
MVTX C & S - Assumptions

- Fully Integrated into the sPHENIX schedule (P6)
- Self contained project, funding from BNL
- Up-to-date Institutional resource hourly rates, fully burdened
- Implement Risk Based Contingency
- Schedule smoothed, ~6 months float in P6 prior to sPHENIX installation
- Electronics ready for production on start of project to the successful LDRD effort, cost based on as built experience, FELIX and RU service boards, power system etc.
- Linkages to Stave and RU in the schedule

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

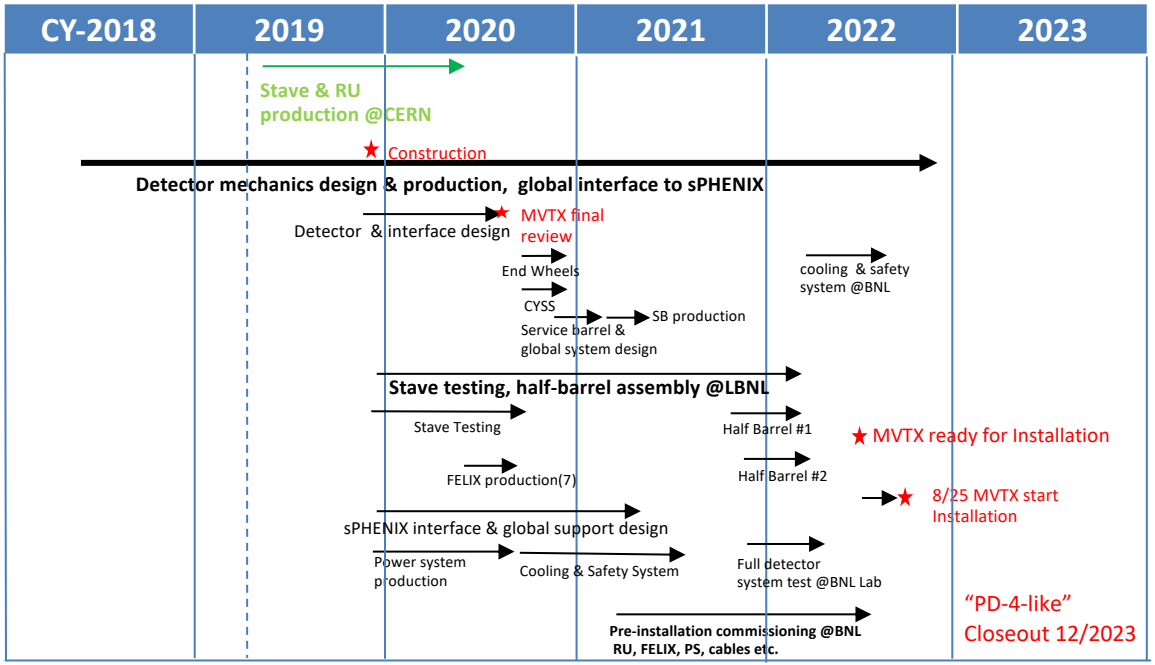
MVTX Project Detailed Schedule
Data Date: 01-Oct-18 Published: 25-Jul-19 16:48

Activity ID	Activity Name	At Compl. Duration	Start	Finish	Total Float	Hours	Direct FY19$ - M&S	Burd AY$ - Labor	Burd AY$ - M&S	Burd AY$ - Total
POM02	sPHENIX WBS 3.02 Preliminary Baseline [MVTX]	1281.00	01-Feb-17 A	17-Mar-22	0.00	21937	1189882	2,187,836	1,500,665	3,688,501
MVTX		1281.00	01-Feb-17 A	17-Mar-22	0.00	21937	1189882	2,187,836	1,500,665	3,688,501
	External Milestones in WBS 3x from WBS 1x, 2x	1169.00	01-Feb-17 A	01-Oct-21	112.00	0	0	0	0	0
S100000	RU Production Start	0.00	01-Apr-19 A			0	0	0	0	0
S100100	Stave Production - Batch 1	62.00	03-Sep-19*	03-Dec-19	101.00	0	0	0	0	0
S100200	Stave Production - Batch 2	62.00	04-Dec-19	04-Mar-20	101.00	0	0	0	0	0
S100300	Stave Production - Batch 3	62.00	05-Mar-20	01-Jun-20	101.00	0	0	0	0	0
S100400	Stave Production - Batch 4	62.00	02-Jun-20	27-Aug-20	101.00	0	0	0	0	0
EXT100090	[External Activity] Initial Project Funding Release	0.00	01-Feb-17 A			0	0	0	0	0
EXT101010	[External Activity] FY20 Funding Available	0.00	01-Oct-19*		465.00	0	0	0	0	0
EXT101015	[External Activity] FY21 Funding Available	0.00	01-Oct-20*		202.00	0	0	0	0	0
EXT101016	[External Activity] FY22 Funding Available	0.00	01-Oct-21*		112.00	0	0	0	0	0
EXT147100	[External Activity] Procure TPC DAM Felix 2.0 Boards - Contract Award(s)	0.00	18-Mar-20*		352.00	0	0	0	0	0
EXT317000	[External Activity] Design/Safety Reviews Complete, Internal Detector Structural Support Released for Production	0.00		24-Dec-19*	287.00	0	0	0	0	0
	MVTX Project Management	655.00	01-Aug-19	17-Mar-22	0.00	1548	36250	497,769	46,833	544,602
S100500	Milestone Start MVTX	0.00	03-Sep-19*		0.00	0	0	0	0	0
S100600	Project Manager	633.00	03-Sep-19	17-Mar-22	0.00	1238	0	398,112	0	398,112
S100700	Mechanical Integration Engineer	633.00	03-Sep-19	17-Mar-22	0.00	310	0	99,657	0	99,657
S100800	Electronics Integration Engineer	633.00	03-Sep-19	17-Mar-22	0.00	0	0	0	0	0
S100900	Travel FY19	20.00	03-Sep-19	30-Sep-19	112.00	0	6250	0	7,813	7,813
S101000	MVTX Construction Start Approval	0.00	01-Aug-19*		22.00	0	0	0	0	0
S101100	Travel FY20	251.00	01-Oct-19	30-Sep-20	112.00	0	10000	0	12,750	12,750
S101200	Travel FY21	250.00	01-Oct-20	30-Sep-21	112.00	0	10000	0	13,005	13,005
S101300	Travel FY22	112.00	01-Oct-21	17-Mar-22	0.00	0	10000	0	13,265	13,265
S101400	[EXTERNAL] MVTX Assembly Complete and Ready for Installation	0.00		17-Mar-22*	0.00	0	0	0	0	0
	MVTX Electronics	260.00	03-Sep-19	15-Sep-20	293.00	2407	301084	211,165	358,417	569,582
	Readout Unit (RU)	220.00	30-Oct-19	15-Sep-20	293.00	1465	68545	129,007	83,995	213,002
S101500	Produce RU Cold Plate - Labor	20.00	30-Oct-19	27-Nov-19	145.00	60	0	6,335	0	6,335
S101700	Produce RU Cold Plate - M&S	20.00	30-Oct-19	27-Nov-19	145.00	0	15353	0	19,575	19,575
S101600	Procure Transition Board for RU M&S	10.00	30-Oct-19	13-Nov-19	303.00	0	7935	0	10,117	10,117
S101601	Procure Transition Board for RU Labor	10.00	30-Oct-19	13-Nov-19	303.00	8	0	845	0	845
S101800	Procure Power Mezzanine for RU M&S	10.00	30-Oct-19	13-Nov-19	303.00	0	4757	0	6,065	6,065
S101801	Procure Power Mezzanine for RU Labor	10.00	30-Oct-19	13-Nov-19	303.00	8	0	845	0	845
S101900	Test/QA RU - Labor	40.00	02-Dec-19	29-Jan-20	293.00	420	0	33,784	0	33,784
S102000	Test/QA RU - M&S	40.00	02-Dec-19	29-Jan-20	293.00	0	7500	0	9,563	9,563
S102100	Procure 60 SamTec Cables -Provide Requirements to Procurement	5.00	30-Jan-20	05-Feb-20	293.00	5	0	950	0	950
S102200	Procure 60 SamTec Cables -Prepare & Send Solicitation	20.00	06-Feb-20	05-Mar-20	293.00	0	0	0	0	0



Page 1 of 8 — Actual Work | Critical Rem. Work | Remaining Work | Actual LoE | Remaining LoE | Milestone

Simplified MVTX Schedule



Milestones

Milestone	Date
Start Construction	4th Qtr FY 2019
MVTX Final Design Review	3rd Qtr FY 2020
Half Barrels Assembled	1st Qtr FY 2022
Installation Finished	4th Qtr FY 2022
Ready for Beam	1st Qtr FY 2023

Lower Level Milestones

Management		
	Project Start	Sept 3, 2019
Electronics		
	Procure Samtec Cables	Feb 5, 2020
	Procure Transition Board	Nov 13, 2019
	Procure Power Mezzanine for RU	Nov 13, 2019
	Procure FELIX units(7)	Apr 14,2020
	Procure Power Boards	Feb 12, 2020
	Fab Cooling plates	Sep 16, 2019
	Fab breakout boards	Sep 30,2019
	Procure Power Distributioin	Sep 30, 2019
	Ship Power System to BNL	Apr 23, 2020
	Procure CAEN Power Supplies	April 20 2020

Lower Level Milestones

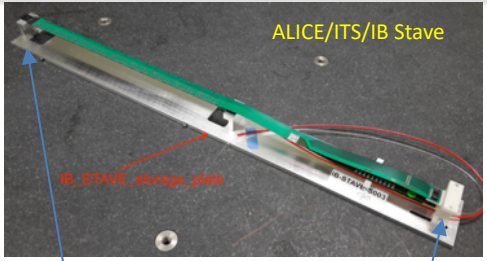
MVTX Mechanics and Detector Assembly		
	Stave Assembly Tooling	Jan 22, 2020
	Metrology design and produce	Dec 30, 2020
	Ship stave container to CERN	Sep 30, 2019
	Ship first batch staves to LBNL	Dec 12, 2019
	Ship last batch staves to LBNL	Sep 3, 2020
	End Wheels production and test	Aug 17, 2020
	CYSS Production and test	Sep 1, 2020
	Production and test SB	Oct 7, 2020
	Test and rework staves batch 1	Apr 9, 2020
	Test and rework staves batch 4	Sep 29, 2020
	Hold half detector Assembly review	Mar 1, 2021
	Perform half detector metrology on layers	Jul 30, 2021
	Install staves onto end wheels	Jun 8, 2021
	Assemble layers and CYSS into half barrel 1,2	Aug 27, 2021 , Sep 23, 2021
	Perform half barrel 1,2 metrology	Oct 5 , 2021 , Nov 3, 2021

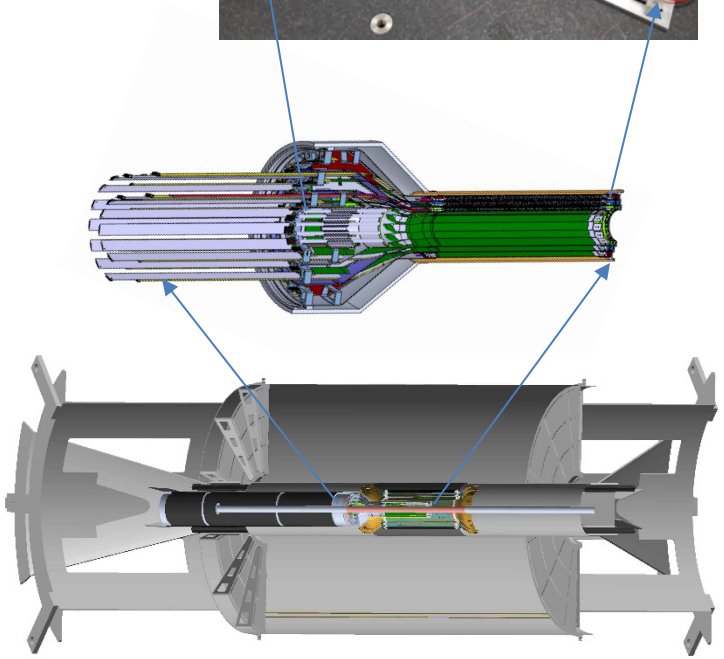
Lower Level Milestones

MVTX Integration and Infrastructure		
	Design cooling system	Aug 25,2020
	Procure cooling system	Mar 1, 2021
	Ship to BNL	Mar 8, 2021
	Review Sensors and Interlocks with BNL ES&H	Oct 15, 2020
	Design Electronics Safety System	Nov 13, 2020
	Tet safety system at BNL	Apr 12, 2021
	Design interface to sPHENIX	June 22, 2020
	Design insertion system	Oct 7, 2020
	Test half barrel 1 at BNL	Dec 27, 2021
	Test half barrel 2 at BNL	Jan 19, 2022
	MVTX Full system test at BNL	Mar 29, 2022

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
  - Currently, last detector to be installed





High Level Costs

WBS	Level 2 WBS Description	Burdened AY$ labor	Burdened AY$ M&S	Burdened AY$ Total
3.02.01	MVTX Project Management	$498.8k	$46.8k	$544.6k
3.02.02	MVTX Electronics	$211.2k	$358.4k	$569.6k
3.02.03	MVTX Mechanics and Detector Assembly	$1241.6k	$667.0k	$1908.6k
3.02.04	MVTX Integration and Installation	$456.8k	$416.5k	$873.3k
	Total	$2187.8k	$1500.6k	$3688.5k

Mechanical design and fabrication

- CYSS
- End wheels
- Service barrel
- Global interface

Electronics

- Readout Unit
- Felix
- Maps Power System

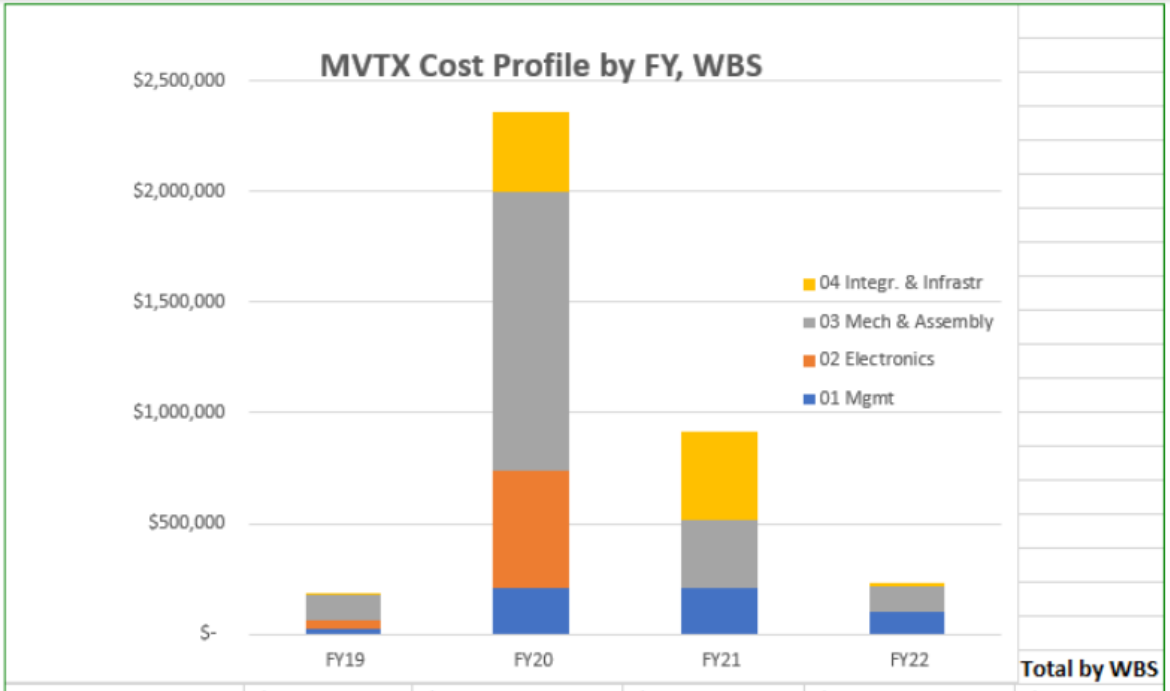
Integration and Infrastructure

- Cooling System
- Safety System
- Service Barrel Support
- Assembly and cooling tests

Basis of Estimate & Resource-Loaded Schedules

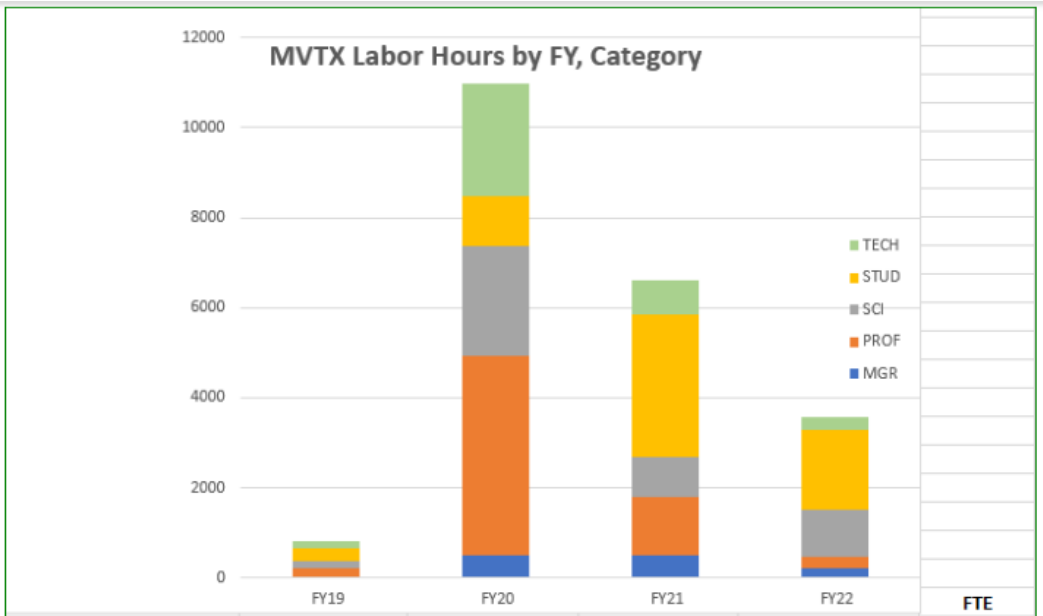
- Electronics: production
  - FELIX: ATLAS/sPHENIX production, LANL/LDRD
  - RU services, cables: ALICE/ITS production, LANL/LDRD
  - Power boards: ALICE/ITS production , LANL/LDRD
  - CAEN bulk PS: Quotes from CAEN, ALICE/ITS production, LANL/LDRD
- Mechanics & Integration: design and production
  -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

Cost Profile



	FY19	FY20	FY21	FY22	Total by WBS
01 Mgmt	$ 23,540	$ 210,128	$ 209,596	$ 101,338	$ 544,602
02 Electronics	$ 41,687	$ 527,895			$ 569,582
03 Mech & Assembly	$ 112,831	$ 1,257,896	$ 307,183	$ 113,468	$ 1,791,378
04 Integr. & Infrastr	$ 3,200	$ 364,985	$ 399,262	$ 15,491	$ 782,939
Grand Total	$ 181,258	$ 2,360,904	$ 916,041	$ 230,297	$ 3,688,501

Resource Hours



					FTE
MGR	39	491	489	219	**0.70**
PROF	186	4450	1300	259	**3.52**
SCI	141	2434	911	1041	**2.57**
STUD	291	1103	3138	1758	**3.57**
TECH	164	2515	772	296	**2.13**
Grand Total	821	10993	6610	3573	
Total FTE	0.47	6.25	3.76	2.03	**12.50**

Major Cost Items

WBS	Task Name	Cost (K)
03.02.02	End Wheels (EW)	$311
03.02.03.01	Cylindrical Structure(CYSS)	$201
03.02.03.02	Service Barrel (SB)	$266
02.01	RU Services	$213
02.02	FELIX	$111
02.03	Power System (PS)	$246

Carbon Structures

Example of low contingency items

	WBS	Cost (K)	Contingency	Basis
RU Services	03.02.01 Line 31	$213	25%	As Built*
FELIX	03.02.02 Line 51	$111	25%	As Built*
Power Board	03.02.03.01 Line 70	$144	25%	As Built*
Power Supply	03.02.03.02 Line 90	$102	25%	CAEN quote

- “As Built” means item is a vendor quote for production unit

Carbon Structures

Examples of high contingency

	WBS	Cost (K)	Contingency	Basis
End Wheels	03.02.02 Line 143	$311	40%	Previous experience
Cylindrical Structure	03.02.03.01 Line 158	$201	40%	Previous experience
Service Barrel	03.02.03.02 Line 169	$266	40%	Previous experience

Status and Highlights

- MVTX integrated into P6 (2/2019)
  - **TPC $4.6 M**
- 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

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 busy schedule for carbon lab
  - Exploring other companies in Italy, France, Other USA vendors …
  - High contingency in design and production cost ~40%
- Global mechanical system integration
  - MVTX design has good progress but not final
  - High contingency in design and production, ~ 40%

Summary

- TPC in P6, $4.6 M, w/ burden and escalation and contingency
- About 6 months float in schedule
- Implemented Risk Based Contingency
- 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