MVTX Basis of Estimate Document (BoE)

04/02/2019 v1

07/26/2019 v4 synced to P6

Introduction

The MVTX upgrade project for sPHENIX relies on the fact that much of the conceptual design, prototype design, and proto-typing has/will be done by the ALICE ITS Upgrade Group at CERN and through a Los Alamos National Laboratory LDRD (Laboratory Directed research and Development) development effort. The cost and schedule of the DOE/BNL support consists of final design efforts, procurement, assembly and installation. Presented here are the effort for the DOE/BNL portion. The complete cost and schedule file including the ALICE/ITS and LDRD effort is found in the MVTX project file (also in P6). The total project cost is $3.7M and after contingency is applied $4.9M. Finish date is in the 1st Qtr of FY2024.

The mechanical design of the MVTX detector will be a "replication" of the ALICE design but since the MVTX detector will sit inside the Intermediate Tracker which is not yet fully designed we have included a 40% contingency to cover a possible modification. Mechanical Integration into sPHENIX requires a clear definition of the surrounding systems. Unfortunately, because the inner volume is still in a state of flux, we have looked at the global support structure for the TPC as an estimate for our needs but with a large contingency. Contingency is risked based and varies between 30% and 40%.

84 Staves and 60 Readout Units (RU) will be procured directly by BNL from CERN through US-ALICE with a fixed cost of $1.36M, and are not included in this document (off-project).

MVTX Project Scope - WBS

WBS Number	WBS Name
3.02	MVTX
3.02.00	External Milestones in WBS 3x from WBS 1x, 2x
3.02.01	MVTX Project Management
3.02.02	MVTX Electronics
3.02.02.01	Readout Unit (RU)
3.02.02.02	FELIX 2.0
3.02.02.03	MAPS Power System
3.02.02.03.01	Power Boards
3.02.02.03.02	Power Supplies
3.02.03	MVTX Mechanics and Detector Assembly
3.02.03.01	Staves
3.02.03.01.01	Production
3.02.03.01.02	Stave Assembly Tooling
3.02.03.01.03	Metrology
3.02.03.01.04	Shipping and Storage Containers
3.02.03.01.05	Shipping the Staves from CERN to LBNL
3.02.03.02	Carbon Structures
3.02.03.02.01	Mechanics Detector Design
3.02.03.02.02	End Wheels
3.02.03.02.03	Mechanics Fabrication
3.02.03.02.03.01	Cylindrical Support Structure (CYSS)
3.02.03.02.03.02	Service Barrel (SB)
3.02.03.02.04	MVTX Final Design Review
3.02.03.03	Barrel Assembly
3.02.03.03.01	Assembly and Testing
3.02.03.03.01.01	Layer Assembly and Test
3.02.03.03.01.02	Half Barrel #1 Assembly and Test
3.02.03.03.01.03	Half Barrel #2 Assembly and Test
3.02.04	MVTX Integration and Infrastructure
3.02.04.01	Cooling System
3.02.04.02	Safety Systems
3.02.04.03	Service Barrel Support Frame & MVTX Interface to sPHENIX
3.02.04.04	Half detector Assembly Readout and Cooling Test at BNL

MVTX upgrade project major cost items

Below we list major cost items and the basis of estimate for the MVTX upgrade project.

WBS Number: 3.02.02.01 Front-end Electronics - RU Services

Technical scope:
This item contains all the services required for the operation of MVTX readout unit.
Work statement:
Produce the identical ALICE/ITS RU cold plates, mezzanine boards and SamTec data cables in the US for 60 RU mother boards to be provided by BNL purchased from ALICE ITS upgrade project.

Assumptions used in developing estimate:
We will use the identical RU service components for the MVTX frontend readout system. All the costs are based on the actual ALICE ITS production cost or quotes from fabrication houses used for the ALICE project. The cost of the MVTX custom SamTec cables are based on the actual cost from LANL R&D purchase of less quantity of 10, scaled up to MVTX quantity of 60.

Cost Summary: (Burd. AY$)

Total (K)	M&S	Labor	Contingency (average)
213	84	129	25%

Quotes of M&S items

Major Items	**Cost (Quote), $K**
Cold Plates	**15.4**
RU Transition Boards	**7.9**
RU Power Mezzanine Cards	**4.7**
Samtec Cables	**30**

Cold plates, Transition boards and Power Mezzanine are based on quotes from UT-A in 2019;

Samtec cables are based on the actual cost of LANL R&D 8m long cables, $1k/per-pair for quantity of 10 readout cables. Scaled up to 60 cables (30 pairs of readout cables), total of $30K.

	Part Number	Description	Company	Unit Price	# / board	Total #	Total Price	Link
		TOTAL # of RU Boards				70		
		RU Cooling & Mechanical						
1	RS Pro 707-4657	Thermal Interface Sheet; 150 x 150 mm2; 1mm	Allied	$ 16.55	1	70	$ 1,159	https://www.alliedelec.com/rs-pro-7074657/70647790/
2	RS Pro 707-4663	Thermal Interface Sheet; 150 x 150 mm2; 2mm	Allied	$ 17.49	1	70	$ 1,224	https://www.alliedelec.com/rs-pro-7074663/70647792/
3	RS Pro 707-4676	Thermal Interface Sheet; 150 x 150 mm2; 3mm	Allied	$ 36.29	0.5	35	$ 1,270	https://www.alliedelec.com/rs-pro-7074676/70647795/
4		Shipping		$ 100.00		1	$ 100	
5		Misc. Mechanical Components (nuts, bolts, washers, latches, front-panel, standoffs,…)		$ 85.00	1	70	$ 5,950	
6		Cold Plate Material		$ 44.00	1	100	$ 4,400	
7		Material Shipping		$ 200.00		1	$ 200	
8		Cold Plate Labor & Glue	UT Machine Shop	$ 20.00	3.5	350	$ 7,000	
		Power Mezzanine for RU						
9		Power Mezz Assembly	Silicon Hills	$ 2,400.00		1	$ 2,400	
10		Power Mezz PCB Fab	APCT	$ 1,600.00		1	$ 1,600	
11	ERM8-030-02.0-L-DV-TR	Samtec Connector	Samtec	$ 4.53	1	70	$ 317	https://wwws.samtec.com/my-samtec/pricing.aspx
12	ESHF-110-01-L-D-RA	Samtec Connector	Samtec	$ 2.43	2	140	$ 340	https://wwws.samtec.com/my-samtec/pricing.aspx
13		Shipping		$ 100.00		1	$ 100	
		Transition Board for RU						
14	UT Engineer	Transition Board Design	UT	$ 85.00		10	$ 850	
15		Transition Board Assembly	Silicon Hills	$ 3,800.00		1	$ 3,800	
16		Transition Board PCB Fab	APCT	$ 1,900.00		1	$ 1,900	
17	ERF8-020-01-L-D-RA-TR	Samtec Connector	Samtec	$ 6.25	3	216	$ 1,350	https://wwws.samtec.com/my-samtec/pricing.aspx
18	ERM8-050-02.0-L-DV-TR	Samtec Connector	Samtec	$ 5.45	2	144	$ 785	https://wwws.samtec.com/my-samtec/pricing.aspx
19		Shipping	UT	$ 100.00		1	$ 100	
		RU Testing Salaries						
20	Technician	Monthly Base Salary		$ 8,000.00		2	$ 16,000	~1.5 month testing + 0.5 month training
21		Fringe Benefits				30%	$ 4,800	
22		Overhead				56.5%	$ 11,752	
		RU Testing Equipment						
23		Scope, supplies, probes, cables		$ 7,500.00		1	$ 7,500	
		Shipping						
24		Ship RU from CERN to Austin		$ 2,000.00		1	$ 2,000	
25		RU Boards shipped to BNL		$ 500.00		1	$ 500	
		Overhead				56.50%	$ 283	
		TRAVEL						
26		Travel to BNL & LANL (1 - 2 weeks each)		$ 3,000.00		4	$ 12,000	
27		Overhead				56.5%	$ 6,780	
		TOTAL					**$ 96,460**	
	Last Update:							
	5/31/19							

Figure 1 Quote from UT-A on RU Cold plates, and transition and power mezz. boards.

LOS ALAMOS NATIONAL LABS

Quote: 201811-17285

Date: November 28, 2018

LOS ALAMOS NATIONAL LABS
SM 30 BIKINI ATOLL RD
LOS ALAMOS NM 87545
Attn: ANITA ARCHULETA
Phone/Email: (505) 667-4478 / aka@lanl.gov

Currency: US DOLLARS (USD)
Selling Term: NET THIRTY
Freight Term: Ex-works/Samtec Factory

Samtec Part	Quantity	MOQ	Unit Price (OEM)	Expiration Date
HDR-208970-01 Like Part: ERCD-020--TED-TEU-2-1 **Notes:** - J1 END: ERM8-040-01-S-D-EM2-B ON CUSTOM TRANSITION PCB, ERH-40-03-T EXTENDED HOUSING WITH SQUEEZE LATCHES J2 and J3 ENDS: ERM8-020-01-S-D-EM2-B ON CUSTOM TRANSITION PCB, ERH-20-03-T EXTENDED HOUSING WITH SQUEEZE LATCHES CABLE: 24 PAIRS OF 30AWG TWINAX, (4EA. TF-30100C-06-S-T-TB-0780) LENGTH: 5300mm	40	3 10 40	$833.340 $669.726 $535.785	Feb 28, 2019
HDR-208971-01 Like Part: ERCD-040 **Notes:** - J1 END: ERF8-040-01-S-D-RA-L ON CUSTOM PCB, WITH HARDWARE FOR PANEL MOUNT J2 and J3 ENDS: CUSTOM ECUE TRANSITION PCB (REF: PCB LIKE ONE USED IN HDR-185770-XX-ECUE) EPOXY ON CABLE TERMINATIONS ONLY CABLE: 24 PAIRS OF 30AWG TWINAX, SHINGLED (4EA. TF-30100C-06-S-T-TB-0780) LENGTH: 2650mm	40	5 10 40	$500.000 $377.663 $308.300	Feb 9, 2019

Figure 2 Actual custom SamTec cables paied for LANL R&D project.

WBS Number: 3.02.02.02 Back-end Electronics - FELIX 2.0

Technical scope:

This item contains all the backend readout electronics FELIX boards and associated optical fiber and patch panel systems required for MVTX readout.

Work statement:

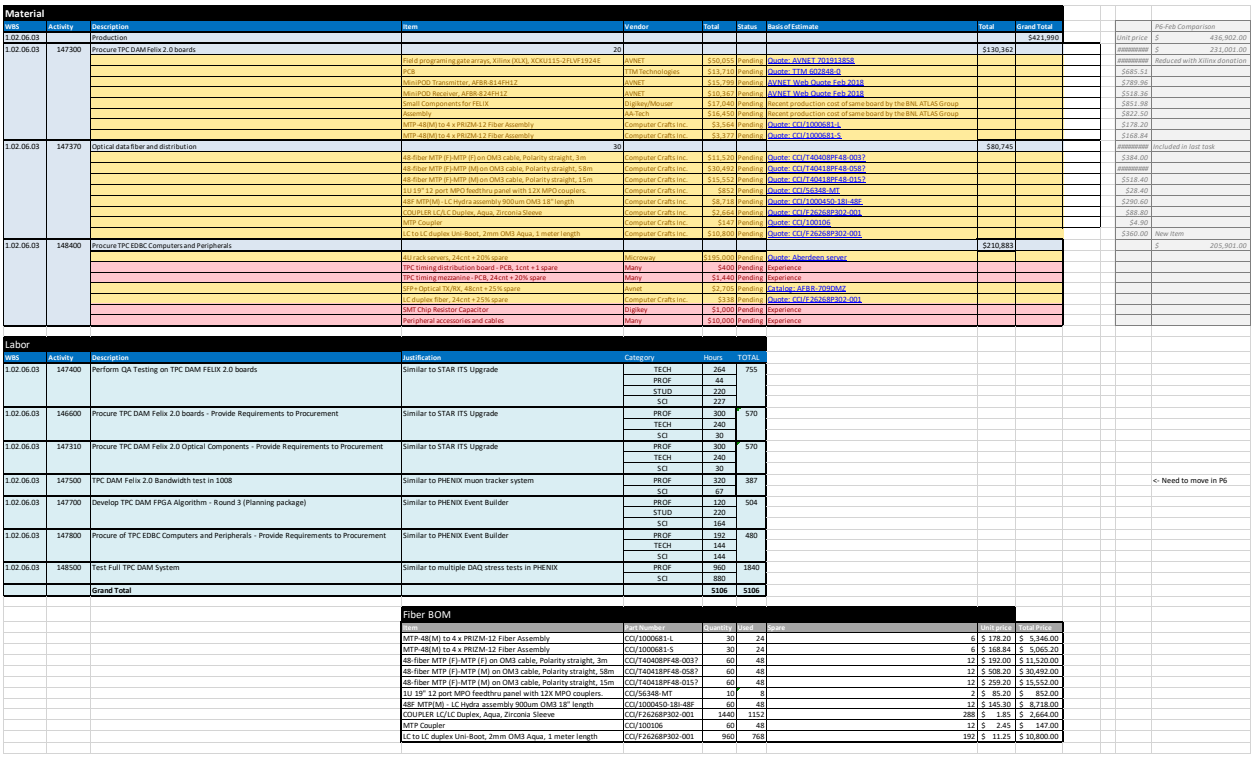
Produce 8 FELIX boards to integrate MVTX readout electronics into the sPHENIX DAQ system. And procure optical fibers and patch panel boxes for 8 FELIX units.

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, under $8K per board for sPHENIX TPC production. A total of 8 FELIX boards (6 + 2 spares) are required for MVTX. Cos of the optical fibers and patch panel boxes are based on the actual cost occurred to LANL MVTX readout R&D project.

Cost Summary: (Burden AY$)

Total (K)	M&S	Labor	Contingency (average)
110.6	90.0	20.5	25%



Material

WBS	Activity	Description	Item	Vendor	Total	Status	Basis of Estimate	Total	Grand Total		P6-Feb Comparison
1.02.06.03		Production							$421,990	Unit price	$ 436,902.00
1.02.06.03	147300	Procure TPC DAM Felix 2.0 boards	20					$130,362		##########	$ 231,001.00
			Field programing gate arrays, Xilinx (XLX), XCKU115-2FLVF1924E	AVNET	$50,055	Pending	Quote: AVNET 70191385R			##########	Reduced with Xilinx donation
			PCB	TTM Technologies	$13,710	Pending	Quote: TTM 602848-0			$685.51	
			MiniPOD Transmitter, AFBR-814FH1Z	AVNET	$15,799	Pending	AVNET Web Quote Feb 2018			$789.96	
			MiniPOD Receiver, AFBR-824FH1Z	AVNET	$10,367	Pending	AVNET Web Quote Feb 2018			$518.36	
			Small Components for FELIX	Digikey/Mouser	$17,040	Pending	Recent production cost of same board by the BNL ATLAS Group			$851.98	
			Assembly	AA-Tech	$16,450	Pending	Recent production cost of same board by the BNL ATLAS Group			$822.50	
			MTP-48(M) to 4 x PRIZM-12 Fiber Assembly	Computer Crafts Inc.	$3,564	Pending	Quote: CCI/1000681-L			$178.20	
			MTP-48(M) to 4 x PRIZM-12 Fiber Assembly	Computer Crafts Inc.	$3,377	Pending	Quote: CCI/1000681-S			$168.84	
1.02.06.03	147370	Optical data fiber and distribution	30					$80,745		##########	Included in last task
			48-fiber MTP (F)-MTP (F) on OM3 cable, Polarity straight, 3m	Computer Crafts Inc.	$11,520	Pending	Quote: CCI/T40408PF48-003?			$384.00	
			48-fiber MTP (F)-MTP (M) on OM3 cable, Polarity straight, 58m	Computer Crafts Inc.	$30,492	Pending	Quote: CCI/T40418PF48-058?			##########	
			48-fiber MTP (F)-MTP (M) on OM3 cable, Polarity straight, 15m	Computer Crafts Inc.	$15,552	Pending	Quote: CCI/T40418PF48-015?			$518.40	
			1U 19" 12 port MPO feedthru panel with 12X MPO couplers.	Computer Crafts Inc.	$852	Pending	Quote: CCI/56348-MT			$28.40	
			48F MTP(M) - LC Hydra assembly 900um OM3 18" length	Computer Crafts Inc.	$8,718	Pending	Quote: CCI/1000450-18I-48F			$290.60	
			COUPLER LC/LC Duplex, Aqua, Zirconia Sleeve	Computer Crafts Inc.	$2,664	Pending	Quote: CCI/F26268P302-001			$88.80	
			MTP Coupler	Computer Crafts Inc.	$147	Pending	Quote: CCI/100106			$4.90	
			LC to LC duplex Uni-Boot, 2mm OM3 Aqua, 1 meter length	Computer Crafts Inc.	$10,800	Pending	Quote: CCI/F26268P302-001			$360.00	New Item
1.02.06.03	148400	Procure TPC EDBC Computers and Peripherals						$210,883			$ 205,901.00
			4U rack servers, 24cnt +20% spare	Microway	$195,000	Pending	Quote: Aberdeen server				
			TPC timing distribution board - PCB, 1cnt +1 spare	Many	$400	Pending	Experience				
			TPC timing mezzanine - PCB, 24cnt + 20% spare	Many	$1,440	Pending	Experience				
			SFP+ Optical TX/RX, 48cnt + 25% spare	Avnet	$2,705	Pending	Catalog: AFBR-709DMZ				
			LC duplex fiber, 24cnt +25% spare	Computer Crafts Inc.	$338	Pending	Quote: CCI/F26268P302-001				
			SMT Chip Resistor Capacitor	Digikey	$1,000	Pending	Experience				
			Peripheral accessories and cables	Many	$10,000	Pending	Experience				

Labor

WBS	Activity	Description	Justification	Category	Hours	TOTAL	
1.02.06.03	147400	Perform QA Testing on TPC DAM FELIX 2.0 boards	Similar to STAR ITS Upgrade	TECH	264	755	
				PROF	44		
				STUD	220		
				SCI	227		
1.02.06.03	146600	Procure TPC DAM Felix 2.0 boards - Provide Requirements to Procurement	Similar to STAR ITS Upgrade	PROF	300	570	
				TECH	240		
				SCI	30		
1.02.06.03	147310	Procure TPC DAM Felix 2.0 Optical Components - Provide Requirements to Procurement	Similar to STAR ITS Upgrade	PROF	300	570	
				TECH	240		
				SCI	30		
1.02.06.03	147500	TPC DAM Felix 2.0 Bandwidth test in 1008	Similar to PHENIX muon tracker system	PROF	320	387	<- Need to move in P6
				SCI	67		
1.02.06.03	147700	Develop TPC DAM FPGA Algorithm - Round 3 (Planning package)	Similar to PHENIX Event Builder	PROF	120	504	
				STUD	220		
				SCI	164		
1.02.06.03	147800	Procure of TPC EDBC Computers and Peripherals - Provide Requirements to Procurement	Similar to PHENIX Event Builder	PROF	192	480	
				TECH	144		
				SCI	144		
1.02.06.03	148500	Test Full TPC DAM System	Similar to multiple DAQ stress tests in PHENIX	PROF	960	1840	
				SCI	880		
		Grand Total			**5106**	**5106**	

Fiber BOM

Name	Part Number	Quantity	Used	Spare	Unit Price	Total Price
MTP-48(M) to 4 x PRIZM-12 Fiber Assembly	CCI/1000681-L	30	24	6	$ 178.20	$ 5,346.00
MTP-48(M) to 4 x PRIZM-12 Fiber Assembly	CCI/1000681-S	30	24	6	$ 168.84	$ 5,065.20
48-fiber MTP (F)-MTP (F) on OM3 cable, Polarity straight, 3m	CCI/T40408PF48-003?	60	48	12	$ 192.00	$ 11,520.00
48-fiber MTP (F)-MTP (M) on OM3 cable, Polarity straight, 58m	CCI/T40418PF48-058?	60	48	12	$ 508.20	$ 30,492.00
48-fiber MTP (F)-MTP (M) on OM3 cable, Polarity straight, 15m	CCI/T40418PF48-015?	60	48	12	$ 259.20	$ 15,552.00
1U 19" 12 port MPO feedthru panel with 12X MPO couplers.	CCI/56348-MT	10	8	2	$ 85.20	$ 852.00
48F MTP(M) - LC Hydra assembly 900um OM3 18" length	CCI/1000450-18I-48F	60	48	12	$ 145.30	$ 8,718.00
COUPLER LC/LC Duplex, Aqua, Zirconia Sleeve	CCI/F26268P302-001	1440	1152	288	$ 1.85	$ 2,664.00
MTP Coupler	CCI/100106	60	48	12	$ 2.45	$ 147.00
LC to LC duplex Uni-Boot, 2mm OM3 Aqua, 1 meter length	CCI/F26268P302-001	960	768	192	$ 11.25	$ 10,800.00

Figure 3. FELIX v2.0 production cost shown in the sPHENIX PD2/3 for TPC DAM production, as well as optical fibers, patch panels. For 20 FELIX v2.0, total direct cost is $130K, or $6.5K per FELIX board.

WBS Number: 3.02.02.03.01 MVTX Power Unit Boards

Technical scope:

This item contains all power control and modules required for MVTX staves and electronics.

Work statement:

Produce 30 ALICE/ITS power distribution units (24 + 6 spares) for staves.

Assumptions used in developing estimate:

We will use the identical ALICE/ITS power distribution units (PU) for MVTX operation. The production cost is estimated (from ALICE production) $2500 per board for a production of 30 boards in US; and also the cooling plates for each PU board.

Cost Summary: (Burden AY$)

Total (K)	M&S	Labor	Contingency (average)
246.0	184.4	61.6	25%

WBS Number: 3.02.02.03.02 MVTX CAEN Power System

Technical scope:

This item contains all power control and modules required for MVTX staves and electronics.

Work statement:

Produce CAEN power supply modules.

Assumptions used in developing estimate:

For the CAEN off the shelf power supply controller and modules, we have obtained a very similar/identical modules (less quantities) and controllers from CAEN for LANL R&D in 2018. LBNL received very similar quotes from CAEN this year.

Cost Summary: (Burden AY$)

Total (K)	M&S	Labor	Contingency (average)
315	90.7	11	25%

Identical/similar CAEN powered system and modules purchased by LANL for R&D. The MVTX PS system cost is based on the scaled-up numbers.

CAEN Tools for discovery

CAEN Technologies, Inc.

QUOTATION

Our Reference: QU / 7118 / 2017 **Date of Quotation:** 5/4/2017

From: Southwest Area Sales Office
Address: 112 Tyra Lane
Townville, SC 29689
Phone: +1 864 356-2606
Email: greg@setechsales.com

To: Los Alamos National Laboratory
Address: PO Box 1663
87545 Los Alamos - NM
USA
Attn: Ming Liu - Ph: 630-840-5708

Item	Product code	Description	Q.ty	U. P.	Disc.%	Subtot.
1	WSY4527FLLXA	SY 4527F - SY4527 - Universal Multichannel Power Supply System - FULL 600W	1	12,104.00	8	11,136.00
2	WA2518XAAAAA	A 2518 - A2518 - SYx527 L.V. channels 8V 10A (50W) - Individual Floating (8 ch)	2	2,904.00	8	5,343.00
3	WE3009XAAAAA	A3009 - EASY3000 L.V. channels 8V, 9A, 45W Floating - APP Conn. (12 Ch.)	2	10,976.00	8	20,196.00
4	WEASY3000MBO	EASY3000 - Crate for EASY3000 Power SUpply System for Hostile Area - APP Conn.	1	3,977.00	8	3,659.00
5	WA1676AXAAAA	A1676A - EASY Branch Controller (up to 6 EASY Crates Controlled)	1	2,086.00	8	1,919.00
					Total USD	**42,253.00**

Notice: **PLEASE MAKE PURCHASE ORDER OUT TO:**
CAEN TECHNOLOGIES INC

Figure 4. Actual costs of the CAEN power modules and controllers for the LANL R&D work. Very similar or identical moduels are used for the MVTX power system.

WBS Number: 3.02.03 Mechanics and Detector Assembly

Technical scope:

This item contains all the mechanical supporting structures required to integrate and operate the MVTX detector in the sPHENIX system.

Work statement:

Design and produce mechanical supporting structures to integrate the MVTX detectors into the sPHENIX system, including MVTX detector design, fabrication and assembly, MVTX detector services, low mass carbon structures.

Assumptions used in developing estimate:

We will use the modified staves and carbon supporting structures based on the ALICE/ITS Inner Barrel design. The amount of design work and carbon structure production cost are based on ALICE/ITS upgrade work and also our previous experience with similar detectors, including the recent STAR HFT and PHENIX FVTX silicon detector upgrades at BNL.

Cost Summary: (Burden AY$)

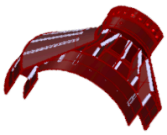
Total $ (K)	M&S	Labor	Contingency (average)
1701	679	1022	40%

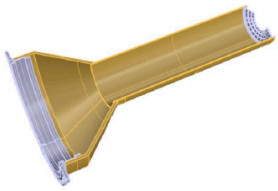
Since the carbon structure production is one of the major high cost items, we have obtained preliminary quotes on both CYSS and the 3rd layer of End Wheels for the ALICE ITS IB design from a commercial fabrication shop in France, see below.

For the current project planning purpose, we use the estimated numbers from LBNL.

Technical clarifications about ALICE ITS upgrade and sPHENIX MVTX upgrade

-Moulds and parts surfaces
-parts finishing



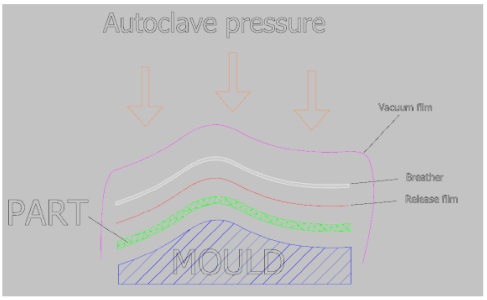


WORK | SHAPE
conception . prototypage

A. Moulds and parts surfaces

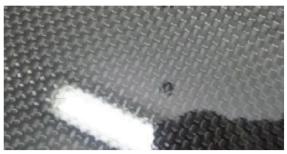
There is a lot of different ways to build a composite part; I will focus on the autoclave way to show what will be the differences in the finished part surface depending on the way you mould it

1. Classic vacuum bagging and autoclave curing



Result:

Part has a smooth surface (the one on the mould side)- we call it the « clean side » or « A-side », and the other is more rough – «B-side »

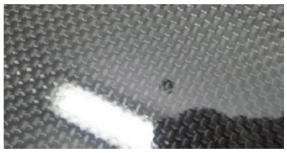


A-side / Clean side

B-side / rough side

WORK | SHAPE
conception . prototypage

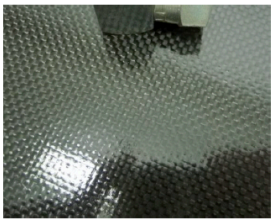
A. Moulds and parts surfaces



A-side has a perfect accuracy, matching the mould. We can imagine manufacturing parts with accuracy reaching 0,1mm (it's possible to do better, but it's difficult).

B-side has a « rough » finish; accuracy is not as good, since the weave/pattern of the fiber will be present, as no mould shapes this side, only the pressure. On this side, accuracy is mainly defined by the prepreg layers and the way the part has been manufactured (if you have some more layers, you will have more thickness…); precision of this side is in general around 0,4 to 0,7mm , worse in the sharp corners.

To make the B-side smoother and more accurate, it's possible to use a silicone caul plate to help making the surface more « even »; however, thickness will still not be perfectly calibrated.

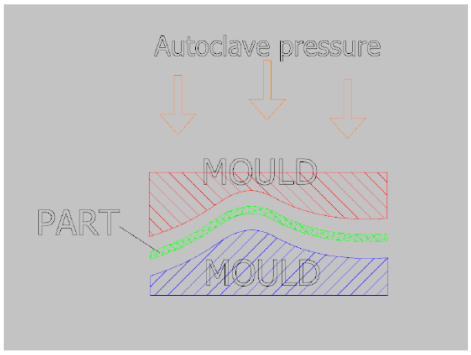


Anyway, advantages of this manufacturing way is to have only a 1 face mould, and therefore is more economic.

WORK | SHAPE
conception . prototypage

A. Moulds and parts surfaces

2. <u>Two sided mould</u>



Closed mould manufacturing

Result:

Part is A-side both sides. General accuracy is better, and thickness can be better calibrated. The only drawback is that it requires a second mould, which nearly double the cost of this manufacturing way.

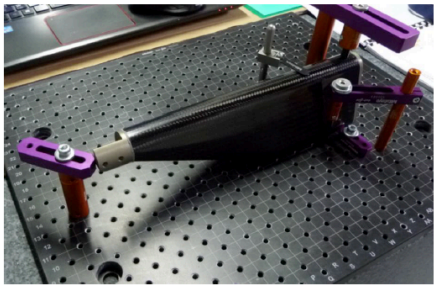
WORK | SHAPE
conception . prototypage

Part finishing

Part finishing is only the finishing work on the manufactured part: when manufacturing this kind of composite part, we will nearly always make it larger/bigger than it will be at the end, to be sure that the mechanical characteristics will be respected. So, after the curing, part will be CNC cutted, and then smoothly sanded on all the edges. Other finishing could consist on some assembly.

Manufactured part just after demolding. The lines on the part show the size of the finished part.

Assembly after cnc cutting



Finished assembled part

WORK | SHAPE
conception . prototypage

WBS Number: 3.02.04 Integration and Infrastructure

Technical scope:

This item contains all the MVTX detector system integration into the sPHENIX experiment.

Work statement:

Design and produce MVTX mechanical supporting structures to interface the sPHENIX global supporting frame; design and build MVTX detector safety system; install and commission the MVTX detector in the sPHENIX IR.

Assumptions used in developing estimate:

We will use the modified cooling and mechanical supporting structures based on the ALICE/ITS Inner Barrel design. The amount of design work and mechanical structure production cost are based on ALICE/ITS upgrade work and also our previous experience with similar detectors, including the recent STAR HFT and PHENIX FVTX silicon detector upgrades at BNL.

Cost Summary:

Total $ (K)	M&S	Labor	Contingency (average)
873.3	416.5	456.8	40%