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## **NuMI Target Systems AIP FY20 Q1 Updates**

Yun He

Proton PMG / AEM Meeting, February 6, 2020

# Outline

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- Project status
- Org chart 2020
- Activities completed in 2019 summer shutdown
- Activities for 2020
  - Plans for 2020 summer shutdown
  - Horn 1 module drives changeout
  - Absorber hall cooling systems
  - Target autopsy
  - Hadron beam monitor
  - MARS/FEA simulations
- Project performance report
- Summary

More details are available at the project SharePoint:

<https://web.fnal.gov/project/TargetSystems/NuMI-AIP/>

# Project Status

Financials	12/31/2019	1/31/2020
Budget	5,600,000	
Obligated	2,452,508	2,663,082
Remaining	3,147,492	2,936,918

**Project kickoff:** Jan. 2019

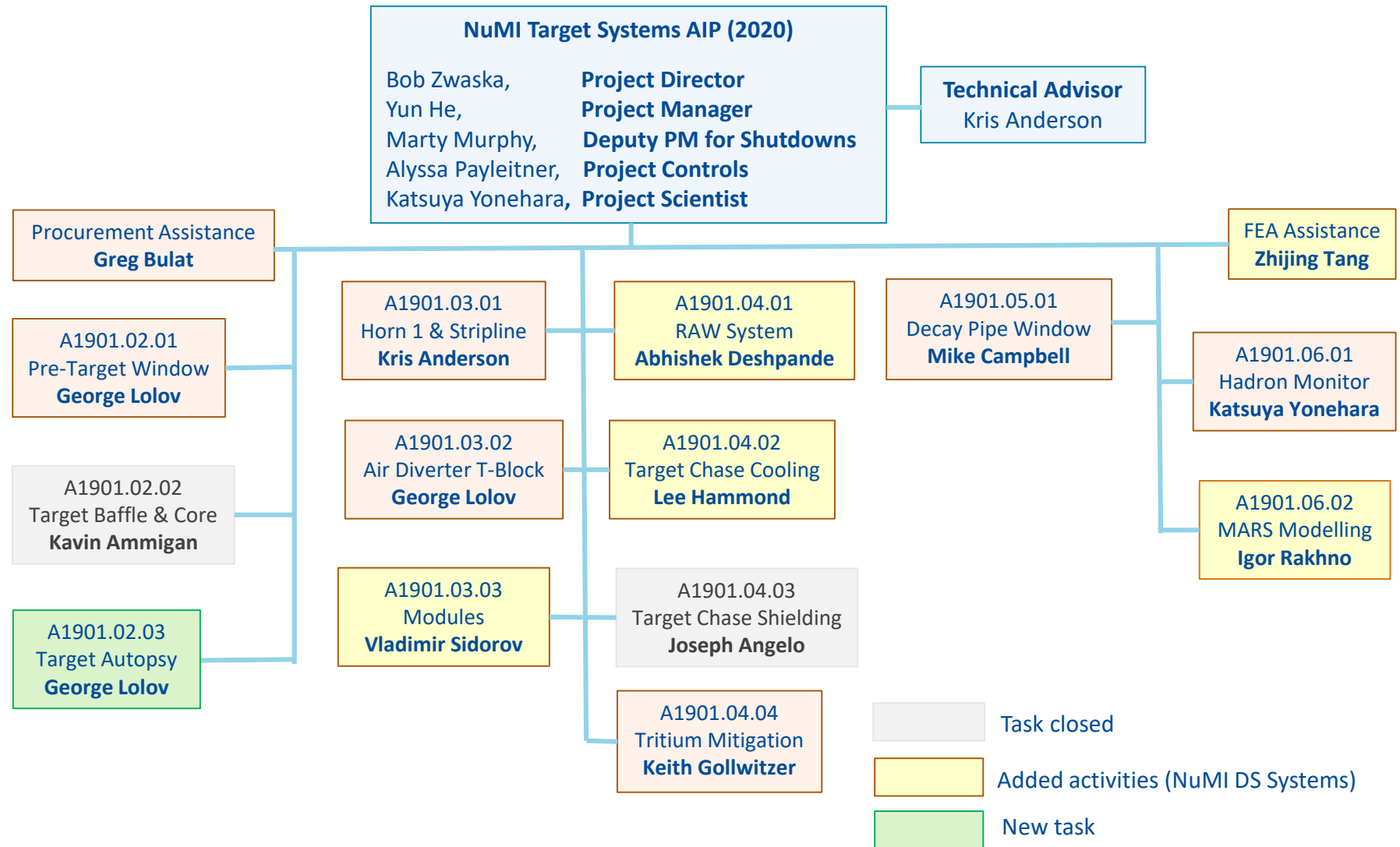
**Mid-term milestone:** End of 2019 summer shutdown

**Resources:** AD/TSD, AD/MSD, PPD, FESS, TD

**Contingency spend down:** Added 6 new activities

Tasks	50%	80%	100%	Status
MARS/FEA simulations				Added DS systems (decay pipe, absorber)
Pre-target Be window				Final welding / leak check
1 MW Target				Closed
1 MW Horn 1				Stripline final machining
Stripline air diverter T-block				Weld SS-steel pipe transition, design coffin
Target / horn 1 module drives				Fabrication and mock-up test, installation
RAW skids				Added Absorber Hall systems
Target hall chiller/air handling				Added Absorber Hall systems
Target chase shielding				Closed
Tritium mitigation				Implementation
Decay pipe window				Drawings generation
Hadron monitor & absorber				Collaboration with U of Texas
Target autopsy				New task

# Org Chart 2020



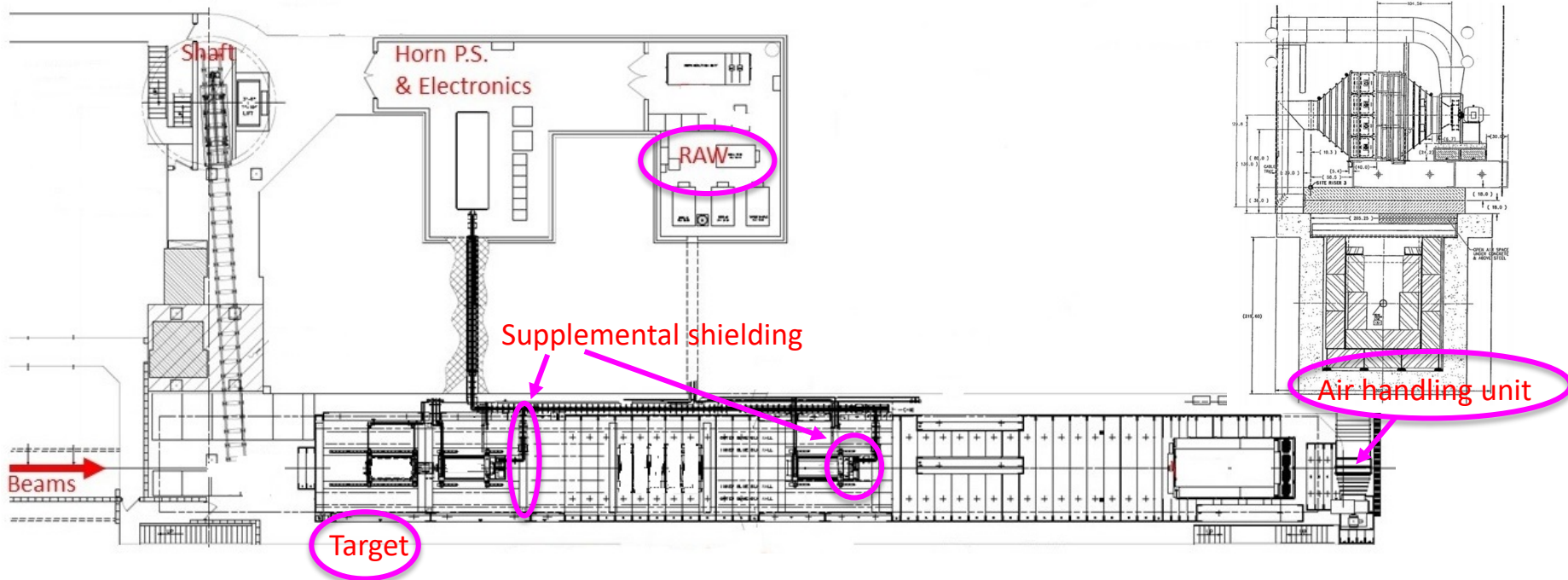
# Activities Completed in 2019

2019 summer shutdown	2020 summer shutdown	Other tasks
1 MW target installation	Horn 1 module drives	MARS simulations
Target & Horn 1 RAW upgrade	1 MW horn 1 installation	Pre-target window spares
Target chase cooling / air upgrade	Stripline air diverter T-block	Decay pipe window
Target chase supplemental shielding	Absorber hall systems	Tritium mitigation

NuMI Target Hall

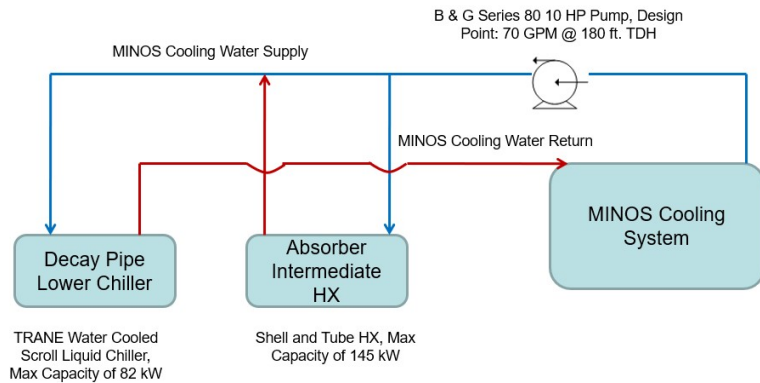
Focus of today's talk

80% completed



# Plans for 2020 Summer Shutdown (Draft)

Tasks	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Absorber hall RAW/chiller															
Horn 1 module drives changeout			TA-03 to C0												
1 MW Horn 1															
Stripline air diverter T-block															



# Horn 1 Module Drives Changeout (Vladimir Sidorov)

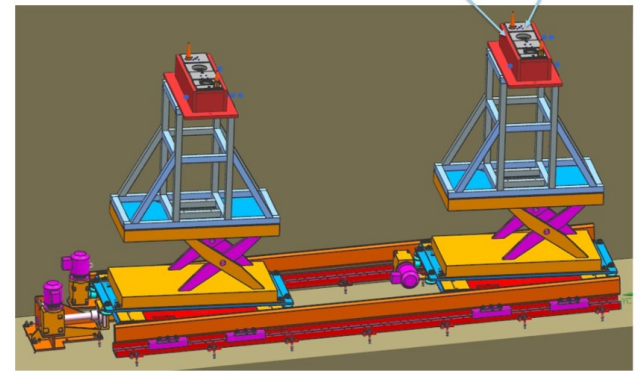
Fabrication: 70%

Remaining:

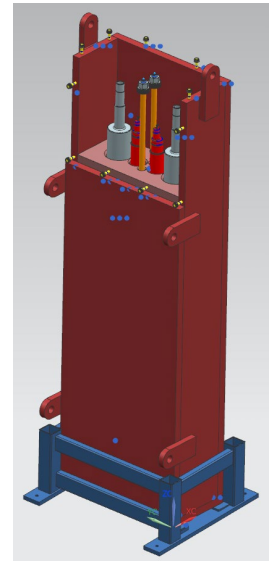
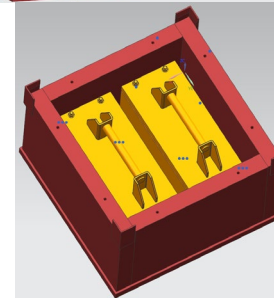
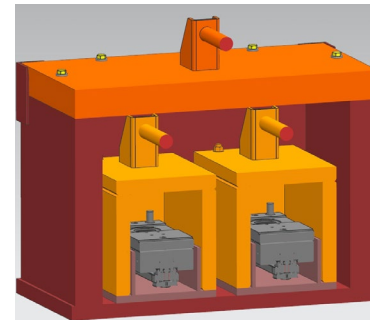
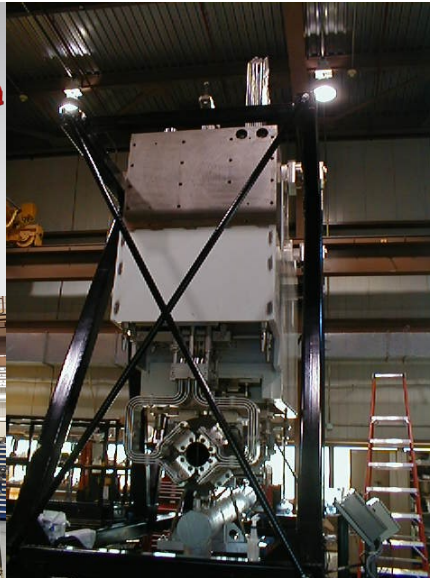
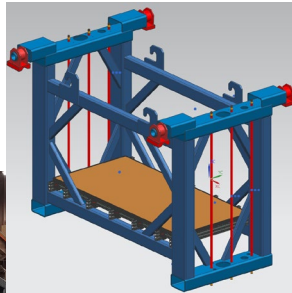
- Shafts, upper/lower blocks
- Casks for spent components, Feb - May
- Platform for mock-up training, Feb - March

Next:

- Transverse drive pre-assembly, March
  - Lower transverse drive remote handling training, April – May
- challenging:** radiation environment, old parts corroded

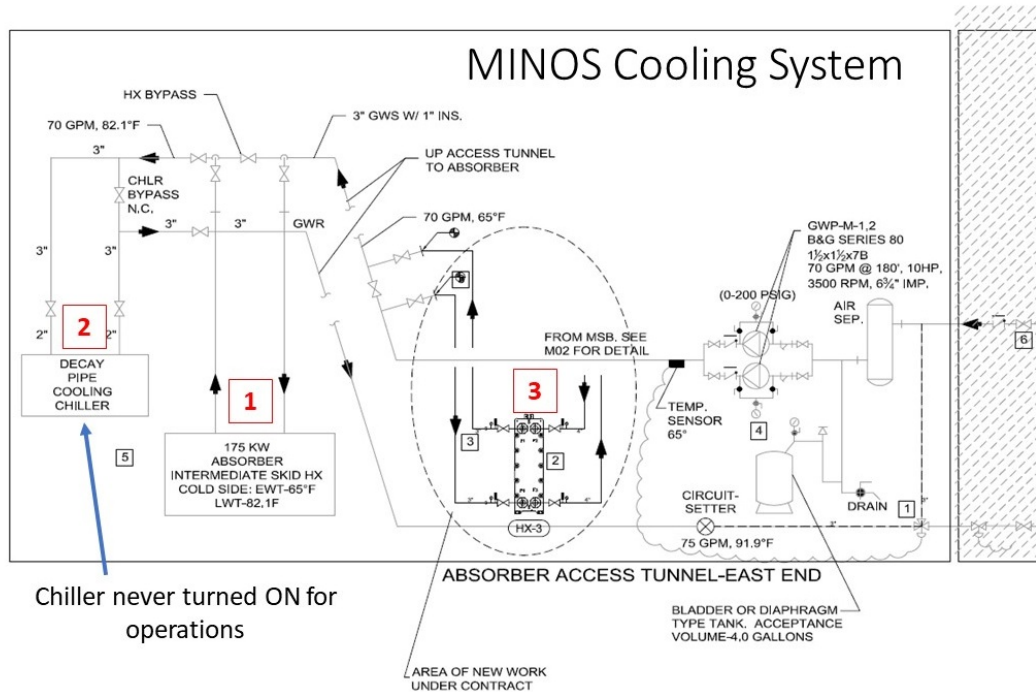


Spent components  
storage/transportation/disposal



# Absorber Hall Colling System (Abhishek Deshpande, Lee Hammond)

- 1). Add a redundant heat exchanger in the Absorber intermediate skid
  - the current HX is old and is in a location hard to perform the changeout work in the event it fails
- 2). Replace the Decay pipe chiller with a heat exchanger
  - this chiller has never been turned on for beam operations
- 3). Piping work in the MINOS cooling system Absorber access tunnel-east end
- 4). MINOS surface chiller upgrade
  - for a dry cooler to provide free cooling to the MINOS CHW loop during winter



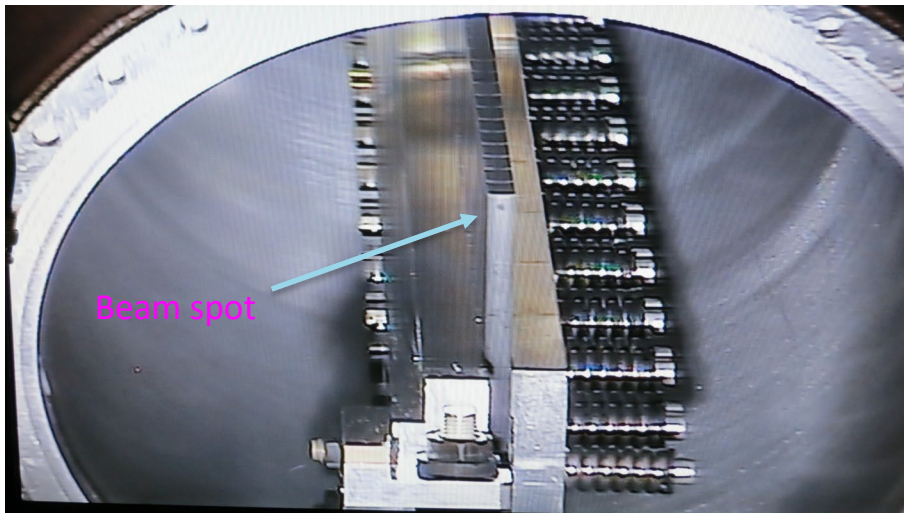


# Target Autopsy (George Lolov)

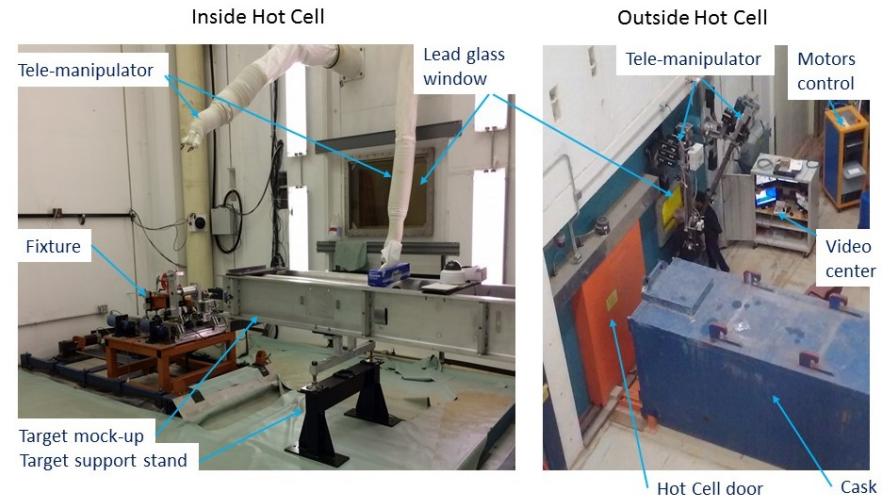
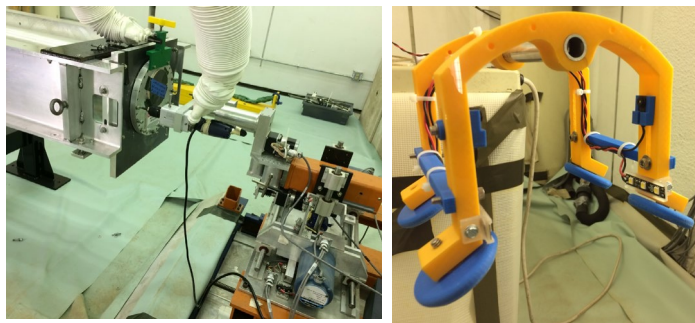
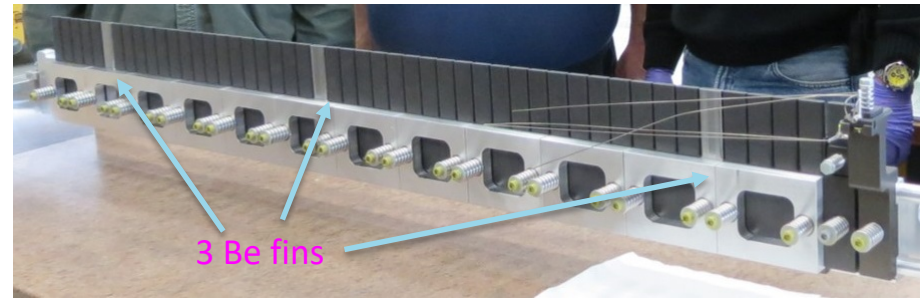
Target autopsies of spent targets **TA-01** and **TA-02** in C0 Remote Handling Facility:

- Visual inspection to provide information regarding target fins condition, beam operation alignment, and beams simulations;
- Extract Graphite / Beryllium fins to understand irradiation effects in Be vs. Graphite.

TA-01 with DS flange removed (2018)

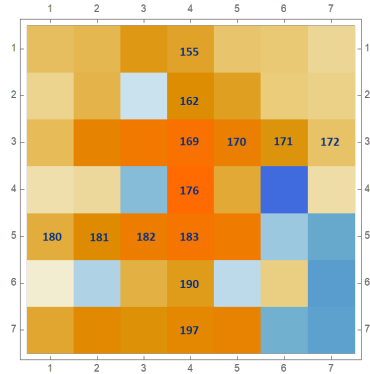
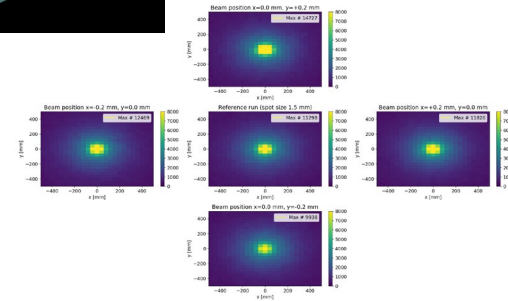
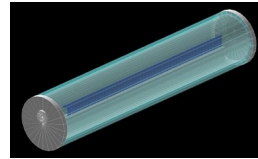
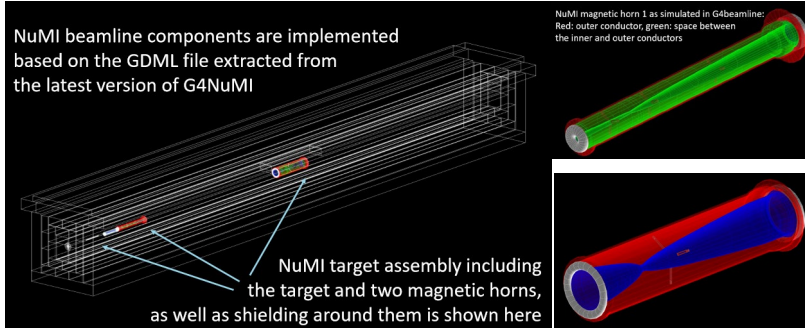


TA-02 target fins prior to installation



# Hadron Beam Monitor (Katsuya Yonehara)

## ➤ Hadron monitor studies (horn current scan) and simulations using G4beamline



## ➤ Helium gas handling system

- Parts received, under installation
- With an improved gas flow control, an automatic gas switch system, a gas purifier, and a bubbler (gas trap) on the exhaust gas line to block backward gas injection into the chamber



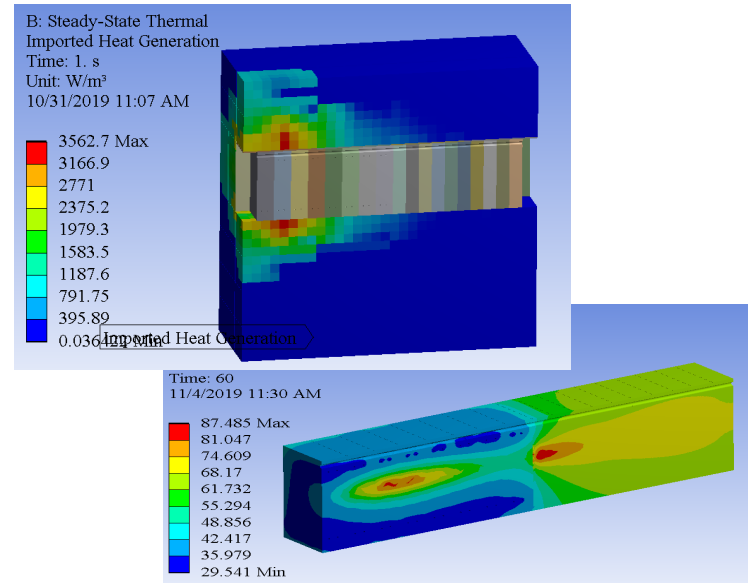
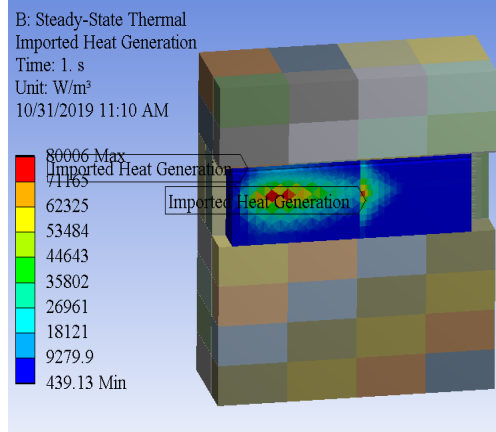
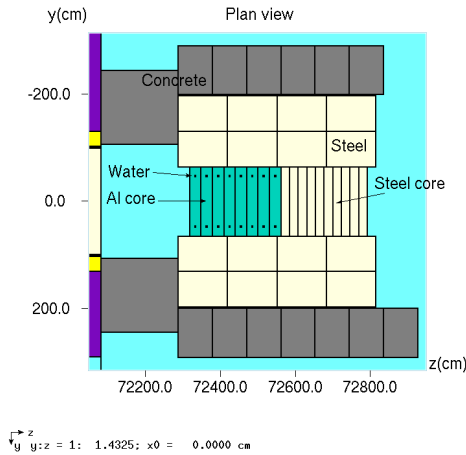
## ➤ New design:

- 5 x 5 pixels (instead of the original 7 x 7 pixels)
- U. of Texas at Austin to fabricate qty. 3 HMs, ready for procurement

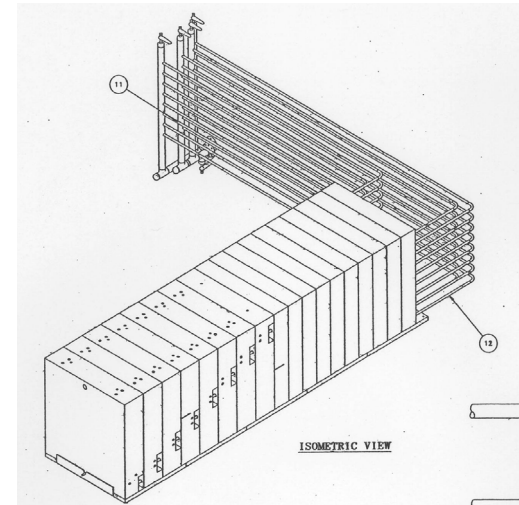
# MARS/FEA Simulations (Igor Rakhno / Zhijing Tang)

## MARS/FEA simulations for Beam Absorber

- Conclusion: current cooling capacity is acceptable
- RAW system upgrade is for addressing aging issues



Normal Operation	Core		shielding		Total
	Aluminum	Steel	steel	concrete	
Total ED (GeV/proton)	4.9691	0.694	2.7362	0.0314	8.4307
Normal heating (W)	43066	6015	23714	272	73067
Accidental Case	Core		shielding		Total
	Aluminum	Steel	steel	concrete	
Total ED (GeV/proton)	32.0188	4.7946	4.6678	0.084	41.5652
Accidental heating (W)	277496	41553	40455	728	360232



Next: MARS/FEA simulations for Decay Pipe

# Monthly Performance Report – Jan. 2020

CONTRACT PERFORMANCE REPORT											DOLLARS IN			
FORMAT 1 - WORK BREAKDOWN STRUCTURE											Dollars			
1. CONTRACTOR			2. CONTRACT				3. PROGRAM			4. REPORT PERIOD				
a. NAME Fermi National Accelerator Laboratory			a. NAME				a. NAME			a. FROM (YYYYMMDD) 2020 / 01 / 01		2020 / 01 / 31	b. TO (YYYYMMDD)	
8. PERFORMANCE DATA														
ITEM (1)	Contingency for Whole Project			Contingency for Remaining Activities			CUMULATIVE TO DATE					AT COMPLETION		
	Labor	Materials	Total	Labor	Materials	Total	BUDGETED COST		ACTUAL COST WORK PERFORMED (9)	VARIANCE		BUDGETED (14)	ESTIMATED (15)	VARIANCE (16)
							WORK SCHEDULED (7)	WORK PERFORMED (8)		SCHEDULE (10)	COST (11)			
A1901.01 NuMI Target Systems A Project Management	79,065	0	79,065	34,809	0	34,809	304,044	304,044	272,693	0	31,351	515,653	484,301	31,351
A1901.02.01 Pre-Target Beam Window	1,144	1,344	2,489	0	0	0	39,435	31,962	21,900	(7,474)	10,062	39,435	29,558	9,878
A1901.02.02 Target Baffle/Core	44,543	30,730	75,273	0	0	0	277,495	277,495	267,315	0	10,180	277,495	267,315	10,180
A1901.02.03 Target Autopsy	31,266	15,376	46,642	31,266	15,376	46,642	0	0	0	0	0	310,946	310,946	0
A1901.03.01 Horn 1	42,416	27,730	70,145	5,087	7,875	12,962	202,616	222,177	312,480	19,561	(90,303)	267,284	357,587	(90,303)
A1901.03.02 Air Diverter T-Bloc	26,059	24,079	50,138	4,300	10,197	14,497	197,626	117,347	99,015	(80,279)	18,332	262,011	165,255	96,756
A1901.03.03 Modules	94,728	156,016	250,744	57,560	94,450	152,010	357,461	351,543	408,203	(5,918)	(56,660)	835,815	892,475	(56,660)
A1901.04.01 Radioactive Water (RAW) System Upgrades	27,779	62,105	89,884	12,272	31,375	43,647	253,747	248,542	294,587	(5,205)	(46,044)	449,418	495,607	(46,189)
A1901.04.02 Target Chase Chill and Air Handling Unit Upgrade	25,562	67,901	93,463	7,843	14,380	22,223	346,751	318,902	359,082	(27,849)	(40,180)	445,626	481,730	(36,104)
A1901.04.03 Target Chase Shield Upgrades	2,555	28,809	31,364			0	116,419	116,419	130,459	0	(14,041)	116,419	130,459	(14,041)
A1901.04.04 Tritium Mitigation	6,340	11,766	18,106	3,238	11,766	15,003	21,116	17,509	27,002	(3,607)	(9,493)	120,704	130,197	(9,493)
A1901.05.01 Decay Pipe and Window Assessment/Repair Mechanism	42,634	2,561	45,195	8,177	0	8,177	179,455	129,483	62,463	(49,972)	67,021	201,261	134,240	67,021
A1901.06.01 Hadron Absorber Instrumentation and Beam Monitoring	74,216	101,162	175,378	32,834	46,945	79,779	349,394	246,449	179,946	(102,945)	66,503	584,594	518,939	65,654
A1901.06.02 MARS Modeling							67,096	67,096	56,286	0	10,809	67,096	56,286	10,809
d. UNDISTRIBUTED BUDGET												0	0	0
e. SUBTOTAL	3,355	0	3,355	0	0	0	2,712,655	2,448,968	2,491,431	(263,688)	(42,463)	4,493,756	4,454,897	38,860
f. MANAGEMENT RESERVE	501,661	529,578	1,031,239	197,386	232,364	429,750						0		
g. TOTAL							2,712,655	2,448,968	2,491,431	(263,688)	(42,463)	4,493,756	4,454,897	38,860

Management reserve **674,496**

Will plan for further contingency spend down

# Summary

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- NuMI-TS-AIP has reached its mid-term milestone;
- For contingency fund spend down, 6 activities have been added:
  - Horn 1 module drives changeout
  - Absorber hall RAW system upgrade
  - MINOS surface chiller upgrade
  - Target autopsy
  - Beam absorber FEA thermal analysis
  - Decay pipe FEA thermal analysis
- Since the Megawatt target TA-05 installation, the maximum operational beam power has been set for 777 kW;
- Horn 1 module drives changeout is the most challenging task, but the team is preparing for mock-up trainings at MI-8 in April-May before summer shutdown;
- By the time when the megawatt Horn 1 is installed in summer 2020, NuMI neutrino beamline system will be able to accept beam power up to 1 MW;
- Accelerator beam power roadmap: Operational cycle time is 1.2 sec since the fall of 2019; Spacing between cycles remains at 1.4 sec for Muon campus operation, will be ready for 900 kW operation in 2022