Overview of STT Activities

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STT working group Meeting 13 April 2022

STT WORKING GROUP

- Activities related to the design and construction of the STT for SAND, the assigned goals being the completion of the detector installation and its readiness for operation.
- ✤ Initial WG chairs: G. Sirri, S. Di Falco, R. Petti
- Dedicated mailing list DUNE-ND-SAND-STT
 - \implies Encourage any interested people to subcribe (if not done yet)
- Material presented and discussed during WG meetings available on Indico: https://indico.fnal.gov/category/1402/
- ◆ By-weekly regular meetings on Wednesday at 11am Central Time / US
 ⇒ May circulate a new Doodle survey at a later time, if needed

STT FOR SAND

70 CH₂ modules 8 C modules 6 tracking modules

~220,000 straws average straw length 3.2 m maximal straw length 3.8 m internal gas volume $\sim 14 \text{ m}^3$ nominal gas pressure ~2 bar



FV mass: $\sim 4.7 t CH_2$ ~600 kg C 3

STT ACTIVITIES & SCHEDULE

◆ Defined scope of activities required for the completion and installation of the STT.

- Preliminary schedule and related deliverables:
 - Input for discussions to be revised following comments/suggestions;
 - Uncertainties on availability of ND site and current situation (covid19, conflict, supplies, etc.).

WBS	Task Start	Finish	2020 2 01 02 03 04 01 02	2021 03 04 01 0	2022 Q2 Q3 Q4	2023 Q1 Q2 Q3 Q4	2024	2025 04 01 02 0	3 04 01 02	2026 Q3 Q4 Q1	2027 02 03 04	2028 Q1 Q2 Q3	Q4 Q1	2029 02 03 04
	Jan 1, 2020	Dec 31, 2029	9	•	•	•						•		
1	STT selected as SAND tracker Sep 2, 202	1 Sep 2, 2021	1	STT selected as	SAND tracker									
2	PDR (DOE CD1RR) TBD Jul 12, 202	2 Jul 12, 2022	2		PDR (DOE CI	D1RR) TBD								
3	TDR (DOE CD2) TBD Jul 12, 202	3 Jul 12, 2023	3			🔷 TDR (DO	E CD2) TBD							
4	ND site available TBD Jan 1, 202	B Jan 1, 2028	3									ND site available	TBD	
5	STT design and prototyping Jan 1, 202	0 Dec 31, 2024	24	STT desig	gn and prototyping									
5.1	STT conceptual design Jan 1, 202	0 Sep 1, 2021	1 STT conceptual design											
5.2	STT preliminary design Sep 2, 202	1 Jan 31, 2023	3	STT prelim	ninary design	l								
5.3	STT final design Feb 1, 202	3 Jan 31, 2024	4			STT final design								
5.4	Fabrication/prototyping of straws Sep 2, 202	1 Dec 31, 2022	2	Fabrication/proto	otyping of straws									
5.5	Fabrication of STT prototypes Jan 1, 202	2 Oct 31, 2023	3		Fabrication of STT ;	prototypes								
5.6	STT readout Jan 1, 202	1 Dec 31, 2024	24		STT read	dout								
5.7	Test of straws and STT prototypes Aug 1, 202	1 Dec 31, 2023	3	Test	of straws and STT pr	ototypes								
5.8	Simulation of STT modules Jan 1, 202	Dec 31, 2023	23	Simulation of STT mod	ules									
6	Preparation of STT production sites Jun 1, 202	1 Jun 30, 2024	24		Preparation of STT pr	oduction sites								
7	STT procurement and fabrication Jan 1, 202	4 Sep 30, 2027	27					STT proc	urement and fabrication	1				
8	STT installation in the magnet Sep 1, 202	6 Jan 31, 2028	8							STT install	ation in the magnet			
9	Service connections and commissioning Jun 1, 202	B Dec 31, 2029	29									Servio	e connections a	ind commissioning

STT for SAND

DESIGN ACTIVITIES

WBS	Task	Start	Finish		202	20	<u></u>		2021			20	22	.	<u></u>	20	23	<u> </u>	<u> </u>	20	24			202	25	<u> </u>	0.1
		Jan 1, 2020	Dec 31, 2029	Q1	Q2	Q3	Q4 0	Q1 C	12 C	13 Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
1	STT selected as SAND tracker	Sep 2, 2021	Sep 2, 2021							♦ STT 9	elected	as SAN	ID track	ker													_
2	PDR (DOE CD1RR) TBD	Jul 12, 2022	Jul 12, 2022										PDF	R (DOE	CD1RR) TBD											
3	TDR (DOE CD2) TBD	Jul 12, 2023	Jul 12, 2023														TDF	R (DOE	CD2) T	BD							
4	ND site available TBD	Jan 1, 2028	Jan 1, 2028																								
5	STT design and prototyping	Jan 1, 2020	Dec 31, 2024								STT de	sign an	nd proto	otyping													
5.1	STT conceptual design	Jan 1, 2020	Sep 1, 2021		ST	T conce	eptual de	esign	· · · · ·																		
5.2	STT preliminary design	Sep 2, 2021	Jan 31, 2023								STT pre	liminary	y desigi	n													
5.2.1	Design straw tubes	Sep 2, 2021	Dec 31, 2022								Design	stra <mark>w t</mark>	ubes														
5.2.2	Design mechanical wire fixtures	Sep 2, 2021	Dec 31, 2022							Desig	jn mecha	ani <mark>cal w</mark>	vire fixtu	ures													
5.2.3	Design C-composite frame	Sep 2, 2021	Dec 31, 2022							De	sign <mark>C-c</mark>	omposi	ite fram	ne													
5.2.4	Integration with readout electronics	Sep 2, 2021	Dec 31, 2022							Integra	tion with	readou	ut elect	ronics													
5.2.5	Design mechanical support structure	Jun 1, 2022	Dec 31, 2022												Desig	n mecł	nanical	support	struct	ure							
5.2.6	Design polypropylene target	Jun 1, 2022	Dec 31, 2022												Desig	n polyp	oropylei	ne targe	et								
5.2.7	Design graphite target	Jun 1, 2022	Dec 31, 2022												Desig	n grap	hite tarç	get									
5.2.8	Design radiator	Jun 1, 2022	Dec 31, 2022									D	esign ra	adiator													
5.2.9	Design gas system	Jun 1, 2022	Dec 31, 2022												Desig	n gas s	system										
5.2.10	Develop assembly procedure for STT modules	Sep 2, 2021	Dec 31, 2022												Devel	op ass	embly p	rocedu	re for S	STT mo	dules						
5.2.11	Design 1.2m x 0.8m prototype	Sep 2, 2021	Sep 30, 2022							Design [•]	1.2m x <mark>0</mark> .	8m pro	totype														
5.2.12	Design 4m x 0.5m prototype	Nov 1, 2022	Dec 31, 2022												Desig	n 4m x	0.5m p	rototyp	е								
5.2.13	Conduct preliminary design review	Jan 1, 2023	Jan 15, 2023												Cond	duct pr	elimina	y desig	ın revie	w							
5.2.14	Incorporate preliminary design review comments	Jan 16, 2023	Jan 31, 2023												Inc	orpora	te prelir	ninary o	lesign i	review	comme	ents					
5.3	STT final design	Feb 1, 2023	Jan 31, 2024													STT f	inal des	ign									
5.3.1	Perform final design of STT modules	Feb 1, 2023	Dec 31, 2023																Perfo	rm fina	l desig	n of ST	T modu	les			
5.3.2	Perform final design of polypropilene target	Feb 1, 2023	Dec 31, 2023																Perfo	rm fina	l desig	n of pol	ypropil	ene targ	et		
5.3.3	Perform final design of graphite target	Feb 1, 2023	Dec 31, 2023																Perfo	rm fina	l desig	n of gra	phite ta	arget			
5.3.4	Perform final design of radiator	Feb 1, 2023	Dec 31, 2023																Perfo	rm fina	l desig	n of rad	liator				
5.3.5	Perform final design of mechanical support structure	Feb 1, 2023	Dec 31, 2023																Perfo	rm fina	l desig	n of me	chanica	al suppo	rt struc	ture:	
5.3.6	Perform final design of gas system	Feb 1, 2023	Dec 31, 2023																Perfo	rm fina	l desig	n of gas	s syster	n			
5.3.7	Conduct final design review	Jan 1, 2024	Jan 15, 2024																Con	duct fir	nal desi	gn revi	ew				
5.3.8	Incorporate final design review comments	Jan 16, 2024	Jan 31, 2024																Inc	orpora	te final	design	review	comme	nts		

PROTOTYPING & TESTS

Demonstrate all aspects of the STT design in increasing order of complexity:

- \square Produce straws of required quality & maximal length with ultrasonic welding (UW) \implies Validation of model production lines at JINR (5m) and GTU (2m)
- ☑ Verify UW straws fulfill requirements from STT conceptual design & assembly procedure
 - ⇒ Measurement of maximal internal pressure, radial and longitudinal deformations vs. pressure, relaxation vs. time and humidity, gas tightness, etc.
- ☑ Verify XXYY straw layer assembly
 - \implies Gluing and pressure tests of $1m \times 1m$ XXYY test assembly
- Verify assembly procedure of XXYY straws to frame, gas tightness, etc.
 Mockup prototype(s) with plexiglass frame (in progress)
- □ Verify module design with C-composite frame and related performance \implies Complete 1.2m × 0.8m prototype with XXYY straws and actual STT frame design
- □ Verify full scale module (module 0) with maximal straw length and complete assembly \implies Complete 4m × 0.5m prototype with XXYY straws and C-composite frame

Demonstrate readout performance:

- \checkmark Verify charge measurement with 55 Fe source & cosmics
 - \implies Readout small STT prototype with Mu2e FE boards with VMM3/VMM3a ASICs
- ☑ Verify time measurement with signal generator
- □ Verify time and charge measurement at testbeam
 - ⇒ Readout small STT prototype with FE boards with VMM3/VMM3a ASICs





1.1 m long straws produced by GTU for mockup assembly









Straws glued together with epoxy ELK5 (~ 20cm spacing)

T. Enik (JINR)

Cycled multiple times complete glued XXYY assembly from 1 bar to 5 bar: no problems nor apparent damages for the straw assembly











Plexiglass frame for the mockup prototype ready for assembly





WBS	Task	Start	Finish				2023		2025	2026	2027	
		Jan 1, 2020	Dec 31, 2029									24 Q ♦
5	STT design and prototyping	Jan 1, 2020	Dec 31, 2024			STT design and prototyping					4.4	
5.1	STT conceptual design	Jan 1, 2020	Sep 1, 2021	STT conceptual de	sign 🗸						- 1 1	
5.2	STT preliminary design	Sep 2, 2021	Jan 31, 2023			STT preliminary design						
5.3	STT final design	Feb 1, 2023	Jan 31, 2024				STT final design					
5.4	Fabrication/prototyping of straws	Sep 2, 2021	Dec 31, 2022		Fab	rication/prototyping of straws						
5.4.1	Fabrication of straws for initial prototyping & tests (UW)	Sep 2, 2021	Dec 31, 2021			Fabrication of straws for init	ial prototyping & tests (UW)					
5.4.2	Fabrication of straws (ultrasonic welding - UW)	Apr 1, 2022	Dec 31, 2022				Fabrication of straws (ultrasoni	c welding - UW)				
5.4.3	Procure straw samples (winding technology - WT)	Apr 1, 2022	Jun 30, 2022			Procure straw	v samples (winding technology -	WT)				
5.5	Fabrication of STT prototypes	Jan 1, 2022	Oct 31, 2023			Fabrication of STT	prototypes					
5.5.1	Procure of components for XXYY test assembly	Jan 1, 2022	Feb 28, 2022			Procure of components	for XXYY test assembly					
5.5.2	Fabrication of XXYY test assembly	Mar 1, 2022	Mar 15, 2022			Fabrication of XXYY te	est assembly					
5.5.3	Procure components for 1st mockup prototype	Jan 1, 2022	Apr 15, 2022			Procure component	ts for 1st mockup prototype					
5.5.4	Fabrication of 1st mockup prototype	Apr 15, 2022	May 31, 2022			Fabrication of 1s	st mockup prototype					
5.5.5	Procurement & fabrication of site mockup prototypes	Jun 1, 2022	Dec 31, 2022				Procurement & fabrication of si	te mockup prototypes				
5.5.6	Procure components 1.2m x 0.8m prototype	Jun 1, 2022	Aug 31, 2022			Procure e	components 1.2m x 0.8m prototy	ype				
5.5.7	Fabrication 1.2m x 0.8m prototype	Aug 1, 2022	Oct 31, 2022			Fabr	rication 1.2m x 0.8m prototype					
5.5.8	Procure components and tooling for $4m \ x \ 0.5m$ prototype	Jan 1, 2023	May 31, 2023				Procure component	ts and tooling for 4m x 0.5r	m prototype			
5.5.9	Fabrication 4m x 0.5m prototype	Jun 1, 2023	Oct 31, 2023				Fabrica	tion 4m x 0.5m prototype				
5.5.10	Radiator and target prototypes	Sep 1, 2022	Oct 31, 2023			Radiator	and target prototypes					
5.6	STT readout	Jan 1, 2021	Dec 31, 2024			STT rea	adout					
5.6.1	Procurement of VMM3a ASICs	Jan 1, 2021	Jun 1, 2021		Procuremer	nt of VMM3a ASICs						
5.6.2	Acceptance test of VMM3a ASICs	Sep 2, 2021	Oct 31, 2021			Acceptance test of VMM3a ASIC	s					
5.6.3	Validation of VMM3a readout	Sep 1, 2021	Aug 31, 2022			Validatio	n of VMM3a readout					
5.6.4	ASIC revision	Sep 1, 2022	Dec 31, 2024				ASIC revision					
5.6.5	Design of FE readout	Sep 1, 2022	Dec 31, 2024				Design of FE readou	ıt				
5.7	Test of straws and STT prototypes	Aug 1, 2021	Dec 31, 2023			Test of straws and STT p	prototypes					
5.7.1	Test of straw properties (UW)	Aug 1, 2021	Dec 31, 2022		Tes	st of straw properties (UW)						
5.7.2	Test of straw properties (WT)	Jul 1, 2022	Dec 31, 2022				Test of straw properties (WT)					
5.7.3	Gluing & pressure tests of XXYY assembly	Mar 15, 2022	Mar 31, 2022			Gluing & pressure te	sts of XXYY assembly					
5.7.4	Test & instrumentation of XXYY assembly	Apr 1, 2022	May 31, 2022			Test & instrume	ntation of XXYY assembly					
5.7.5	Test of 1st mockup prototype	May 1, 2022	May 31, 2022			Test of 1st mock	kup prototype					
5.7.6	Test of 1.2m x 0.8m prototype	Nov 1, 2022	Dec 31, 2022				Test of 1.2m x 0.8m prototype					
5.7.7	Test of 4m x 0.5m prototype	Oct 1, 2023	Dec 31, 2023				Te	st of 4m x 0.5m prototype				
5.7.8	Beam tests of prototypes at CERN	Oct 25, 2021	Nov 1, 2022			Bea	m tests of prototypes at CERN					
5.7.8.1	Small XX+YY with VMM3a readout at H4 RD51	Oct 25, 2021	Nov 7, 2021			Small XX+YY with VMM3a reado	out at H4 RD51					
5.7.8.2	Small XX+YY with VMM3/VMM3a at GIF	Apr 25, 2022	May 3, 2022			Small XX+YY with	VMM3/VMM3a at GIF					
5.7.8.3	Small XX+YY at H4 RD51/GIF	May 18, 2022	Jun 7, 2022			Small XX+YY at	H4 RD51/GIF					
5.7.8.4	XX+YY & mockup at RD51/GIF	Jul 13, 2022	Jul 26, 2022			XX+YY & m	ockup at RD51/GIF					
5.7.8.5	XX+YY & mockup at RD51/GIF	Oct 19, 2022	Nov 1, 2022			XX+	YY & mockup at RD51/GIF					
5.8	Simulation of STT modules	Jan 1, 2020	Dec 31, 2023		Simulation	for 511 modules						
5.8.1	Finite element analysis	Jan 1, 2021	Dec 31, 2023			Finite element analysis						
5.8.2	I hermal analysis	Jan 1, 2021	Dec 31, 2023			Thermál analysis						
5.8.3	Simulation of drift properties (Garfield)	Jan 1, 2021	Mar 31, 2021		Simulation of dri	nt properties (Garfield)						
5.8.4	optimization of operating conditions (Garfield) & validation	Apr 1, 2022	Dec 31, 2022		Circular in the second		opumization of operating cond	nions (Gameid) & validatio	211			
5.8.5	Simulation of physics performance	Jan 1, 2020	Dec 31, 2023		Simulation of p	physics performance	physics performance					
5.8.6	opumization of physics performance	Apr 1, 2022	Dec 31, 2023			Optimization of	physics performance					

PRODUCTION SITES, PROCUREMENT & FABRICATION

WBS	Task	Start	Finish	2020 2021 2022 2023 2024 2025 2026 2027	202	8 2029
		Jan 1, 2020	Dec 31, 2029	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Q4 Q1 Q2	Q3 Q4 Q1 Q2 Q3 Q
	Preparation of STT production sites	Jun 1, 2021	Jun 30, 2024	24 Preparation of STT production sites		
.1	Validation of existing straw production lines (UW)	Jun 1, 2021	Dec 31, 2021	21 Validation of existing straw production lines (UW)		
.2	Identification of STT production sites	Apr 1, 2022	Jun 30, 2022	22 Identification of STT production sites		
.3	Preparation and tooling at production sites	Jul 1, 2022	Jan 31, 2024	24 Preparation and tooling at production sites		
.3.1	Develop factory layout	Jul 1, 2022	Dec 31, 2022	22 Develop factory layout		
.3.2	Define requirements for assembly/test fixtures	Jul 1, 2022	Dec 31, 2022	22 Define requirements for assembly/test fixtures		
.3.3	Design straw production lines	Jul 1. 2022	Dec 31, 2022	22 Design straw production lines		
.3.4	Design assembly/test fixtures	Jan 1. 2023	Dec 31, 2023	23 Design assembly/test fixtures		
.3.5	Design site gas system	Jan 1, 2023	Dec 31, 2023	23 Design site gas system		
.3.6	Conduct factory design review	Jan 1. 2024	Jan 15, 2024	14 Conduct factory design review		
.3.7	Incorporate factory design review comments	Jan 16, 2024	Jan 31, 2024	14 Incorporate factory design review comments		
.4	Setup straw production lines at sites (UW)	Jul 1. 2022	Jun 30, 2024	24. Setus straw production lines at sites (UW)		
.5	Setup assembly and test facilities at sites	Jan 1. 2023	Jun 30, 2024	24 Setup assembly and test facilities at sites		
.6	Acceptance criteria for straws & STT modules	Jan 1. 2023	Jun 30, 2024	Acceptance criteria for straws & STT modules		
	STT procurement and fabrication	Jan 1, 2024	Sep 30, 2027	27 STT procurement and fabrication		
1	Procurement of STT components	Jan 1. 2024	Dec 31, 2024	24 Procurement of STT components		
1.1	Procure mylar film with AI metallization	Jan 1, 2024	Feb 29, 2024	24 Procure mylar film with AI metallization		
1.2	Procure end-plugs	Jan 1, 2024	Apr 30, 2024	24 Procure end-plugs		
1.3	Procure wire spacers	Jan 1, 2024	Apr 30, 2024	24 Procure wire spacers		
.1.4	Procure crimping pins	Jan 1, 2024	Apr 30, 2024	24 Procure crimping pins		
1.5	Procure anode wire	Jan 1, 2024	Mar 31, 2024	24 Procure anode wire		
1.6	Procure gas and electrical connectors	Jan 1, 2024	Mar 31, 2024	24 Procure gas and electrical connectors		
.1.7	Procure miscellaneous components for assembly	Jan 1, 2024	Mar 31, 2024	Procure miscellaneous components for assembly		
.1.8	Procure C-composite frames	Jan 1, 2024	Dec 31, 2024	24 Procure C-composite frames		
.1.9	Procure polypropylene targets	Jun 30, 2024	Dec 31, 2024	24 Procure polypropylene targets		
.1.10	Procure graphite targets	Jun 30, 2024	Dec 31, 2024	24 Procure graphite targets		
.1.11	Procure radiator foils	Jun 30, 2024	Dec 31, 2024	24 Procure radiator foils		
.2	Straw fabrication services	Mar 1, 2024	Dec 31, 2026	26 Straw fabrication services		
.3	Assembly of STT modules	May 1, 2024	Aug 31, 2027	27 Assembly of STT modules		
.4	Acceptance tests of STT modules	Jul 1, 2024	Sep 30, 2027	27 Acceptance tests of STT modules		
.5	Procurement and assembly of STT electronics	Jan 1, 2025	Aug 31, 2027	27 Procurement and assembly of STT electronics		
5.1	Procure ASICs	Jan 1, 2025	Dec 31, 2025	25 Procure ASICs		
5.2	Acceptance tests of ASICs	Jan 1, 2026	Jun 30, 2026	26 Acceptance tests of ASICs		
5.3	Procure FE electronics	Jun 1, 2026	May 31, 2027	27 Procure FE electronics		
.5.4	Procure BE electronics	Jun 1, 2026	May 31, 2027	27 Procure BE electronics		
.5.5	Assembly, test, and installation of STT electronics	Jul 1, 2026	Aug 31, 2027		Assembly, test, and inst	allation of STT electronics
.6	Procurement of HV and LV components	Jan 1, 2027	Aug 31, 2027	27	Procurement of HV and	LV components
6.1	Procure HV components	Jan 1, 2027	Aug 31, 2027		Procure HV components	s
6.2	Procure LV components	Jan 1, 2027	Aug 31, 2027		Procure LV components	3
6.3	Procure distribution boards	Jan 1, 2027	Aug 31, 2027		Procure distribution boa	ards
6.4	Procure cables and connectors	Jan 1, 2027	Aug 31, 2027		Procure cables and con-	nectors
7	Procure STT gas system	Jan 1, 2027	Sep 30, 2027		Procure STT gas syst	em
8	Procure STT cooling system	Jan 1, 2027	May 31, 2027		e STT cooling system	
9	Procure mechanical support structure	Jan 1, 2027	Sep 30, 2027		📕 Procure mechanical s	support structure

Roberto Petti

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INSTALLATION & COMMISSIONING

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 Marting and prototyping Marting and prototyping<	4	ND site available TBD	Jan 1, 2028	Jan 1, 2028																				ND site	available T	BD		
Provention of STI production sites Provention of STI productio	5	STT design and prototyping	Jan 1, 2020	Dec 31, 2024				STT d	esign and proto	otyping																		
Type STP occument and fabrication Supp. 200 Supp. 2	6	Preparation of STT production sites	Jun 1, 2021	Jun 30, 2024					Preparation	of STT pro	duction sites																	
B FT istallation in the magnet Sep 1, 202 Sin 2,	7	STT procurement and fabrication	Jan 1, 2024	Sep 30, 2027												STT pro	curement	and fabri	ication									
81 Shipping of STT modules to Fermilab Sep 1, 2020 Cot, 2020 82 Test of STT modules on surface Apr, 2020 Cot, 2020 83 Installation of STT agets May, 2020 Nay, 2020 84 Installation of STT modules in magnet Jun, 2020 Jun, 2020 94 Service connections and commissioning Jun, 2020 Service connections and commissioning 91 Installation of STT agets Jun, 2020 92 Installation of STT agets Sep 2, 2028 93 Cabling and gas connections Sep 2, 2028 94 Commissioning of STT Sep 2, 2028 94 Commissioning of STT Sep 2, 2028 94 Sep 2, 2028 Sep 2, 2028 94 Commissioning of STT Sep 2, 2028 94 Commissioning of STT Sep 2, 2028 94 Sep 2, 2028 Sep 2, 2028 94 Commissioning of STT Sep 2, 2028 94 Commissioning of STT Sep 2, 2028 94 Sep 2, 2028 Sep 2, 2028 94 Cabling and gas connections Sep 2, 2028 94 Sep 2, 2028 Sep 2, 2028 94 Sep 2, 2028 Sep 2, 2028 94 Alignment with cosmics Sep 2, 2028 94 Alignme	8	STT installation in the magnet	Sep 1, 2026	Jan 31, 2028																ST	T installa	tion in the	e magnet					
82 Tett of STT modules on surface April 2029 Cot 31 202	8.1	Shipping of STT modules to Fermilab	Sep 1, 2026	Oct 1, 2027																			Ship	oing of STT	modules to	o Fermilab		
8.3 Installation of STT targets May 1, 2027 No 3, 2027 8.4 Installation of STT modules in magnet Jan 1, 2028 Jan 1, 2028 9.1 Fore connections and commissioning Jan 1, 2028 Sea 2, 2028 1 Installation of STT gas system Jan 1, 2028 Sea 2, 2028 1 Installation of STT gas system Jan 1, 2028 Sea 2, 2028 2 Installation of STT gas system Jan 1, 2028 Sea 2, 2028 3 Installation of STT gas system Jan 1, 2028 Sea 2, 2028 3 Installation of STT gas system Jan 1, 2028 Sea 2, 2028 4 Installation of STT gas system Jan 1, 2028 Sea 2, 2028 5 Commissioning of STT Sea 2, 2028 Sea 2, 2028 6 Sea 2, 2028 Sea 2, 2028 Sea 2, 2028 9.4 Installation of STT gas system Jan 2, 2028 9.5 Jan 1, 2028 Sea 2, 2028 9.6 Jan 2, 2	8.2	Test of STT modules on surface	Apr 1, 2027	Oct 31, 2027																			Те	st of STT m	odules on :	surface		
8.4 Installation of STT modules in magnet Jun 1,202	8.3	Installation of STT targets	May 1, 2027	Nov 30, 2027																				Installation	of STT targ	gets		
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9.2 Installation of the HV and LV components Jul 30, 2028 Sep 25, 2028 Installation of the HV and LV components Installation of the HV and LV compon	9.1	Installation of STT gas system	Jun 1, 2028	Sep 28, 2028																						Installatio	n of STT gas	system
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9.5 Alignment with cosmics Jun 1, 2029 Dec 31, 2029 Alignment with cosmics	9.4	Commissioning of STT	Dec 30, 2028	May 31, 2029																				Com	nissioning	of STT		
	9.5	Alignment with cosmics	Jun 1, 2029	Dec 31, 2029																					Align	ment with c	osmics	

URGENT TASKS

Tasks to be completed by early summer 2022:

- Preparation for CD1RR review (July 2022)
 Based on conceptual design, review resources and costs
- Decision about VMM3 readout and need of ASIC revision
 Walidation of ASIC capabilities with testbeam exposure at CERN in May-June
- List of candidate sites for production of straws and/or STT modules
 Required for resource planning and site prepration
- Completion of assembly and test of first mockup prototype
 Required to finalize design of 1.2m × 0.8m prototype and for preliminary design of STT modules
- ◆ Testbeam exposure of small XX+YY prototype and mockup with VMM3 readout
 ⇒ Required to verify that VMM3 performance fulfills STT requirements

AVAILABLE RESOURCES

Contributing institutions (expressed interest / already working):

- Georgia: Georgian Technical University;
- Germany: University of Hamburg;
- India: IIT Guwahati, NISER, Panjab University, University of Lucknow;
- Italy: INFN/Univ. Bologna, Genova, Pisa; INFN/Lab. Frascati, INFN/Lab. Catania;
- Joint Institute for Nuclear Research (JINR), Dubna;
- USA: BNL, Duke University, University of South Carolina, Virginia Tech.
- Assign resources to various tasks identified
 ⇒ Encourage anybody interested in specific tasks to contact WG conveners by 27 April
- + Preliminary survey indicates need of electronics experts for readout tasks.
- Evaluate impact of Russia-Ukraine conflict and possible mitigations

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Backup slides

STRAW PRODUCTION

Production of straws with ultrasonic welding techology:

- JINR line producing 5m long straws \sim 6 straws/hour;
- GTU line producing $<\!2m$ long straws \sim 80 straws/day.

◆ *Demonstrated double AI* coating on inner and outer surfaces:

- Protection against humidity for more reliable long term operation;
- Improved gas tightness from reduction of diffusion through straw walls;
- May simplify ground connections through external layer.

• Tested/compared different straw types $(4.9 \pm 0.05 \text{ mm})$:

- Wall thickness 12 μm with single AI metallization 70 nm;
- Wall thickness 20 μm with single AI metallization 70 nm;
- Wall thickness 20 μm with double AI metallization 70 nm + 40 nm.

MEASUREMENTS OF STRAW PROPERTIES

- ◆ *Measurement of maximal internal pressure* achievable without plastic deformations.
- ◆ Measurement of radial deformations vs. internal gas pressure (GTU):
 - Straws with 4.9mm diameter, 20 μm walls, produced by both JINR and GTU;
 - Comparison of different types of mylar film and AI metallization.
- Measurements of straw elongation and tension vs. internal gas pressure (GTU):
 - Straws with 4.9mm diameter, 12 μm & 20 μm walls;
 - Studied tension drop with increase of internal pressure starting from initial pre-tension.

◆ Measurement of straw relaxation vs. time and humidity starting from initial tension.

Production	Diameter	Wall	Metallization	Length	P_{\max} tested		
JINR	4.92 mm	20 µm	Single 70 nm	20 ст	6 bar		
GTU	4.96 mm	20 µm	Double 70+40 nm	20 ст	6 bar		

Measurement of radial deformation vs. pressure for straws 1.1 m long Measurement of elongation and tension vs. pressure for straws 1.0 m long

GLUING AND PRESSURE TESTS

- Completed first gluing tests of a XXYY straw layer assembly (JINR):
 - Built test stand $1m \times 1m$ allowing a variation of internal gas preessure in the glued straws;
 - Straws glued together with ELK5 (NA64) epoxy and internal overpressure;
 - Initial spacing left between glued points \sim 20 cm.
 - ⇒ Validation of the concept of XXYY glued assembly
- ✦ Measurement of deformations of glued XXYY assembly vs. internal gas pressure.
- Additional measurements on XXYY glued assembly:
 - Gas leak test to verify damages to straw walls;
 - Straw resistivity to check metallization damage induced by pressure.

MOCKUP PROTOTYPE(S)

◆ *Mockup prototype(s)* 35cm × 35cm for preliminary validation tests:

- Completed design of mock frame (Hamburg, UofSC);
- Machining of first plexiglass mockup frame being completed in Hamburg;
- Required straws produced by GTU (4.9mm diameter, 20 μm walls);
- End-plugs machined from simplified design;
- Assembly of first mockup prototype at JINR.

Main goals of mockup prototype(s):

- Validate assembly procedure using same geometry/frame as in STT;
- Test the connection/gluing of straws to the frame;
- Test sealing and gas leaks vs. internal pressure;
- Evaluate different design options.
- Additional mockup prototypes expected to be built at various collaborating institutions following the completion of the first one at JINR.

TESTS OF VMM3 READOUT

- ◆ Tests and calibration of FE boards from Mu2E (BNL) with VMM3 at JINR:
 - Timing calibration using signal generator and timing resolution;
 - Readout of small straw tracker and tests with 55 Fe source & cosmics.

Testbeam exposure of small straw tracker with VMM3 readout in RD51 at CERN:

- Two double layers XX+YY with straws staggered by half diameter (20cm \times 20cm active area);
- Independent tracking system with 3 GEM detectors ($\sigma \sim 50 \mu m$) equipped with VMM3 readout;
- Setup installed in H4 beamline (JINR) and exposed to μ, π with $E \sim 160$ GeV;
- Usable data taken in Oct.-Nov. 2021 (JINR, PNPI, UofSC).

Ongoing analysis of testbeam data:

- DAQ instability found at high rates in Time-over-Threshold mode being investigated;
- Stable data taking when operated with peaking time.

 \implies New testbeam exposure with VMM3 readout at CERN in May 2022

TIMING CALIBRATION

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✤ Procedure to test and validate VMM3a ASICs used for 42,000 chips in ATLAS NSW

- ✦Automatized VMM3a test stand
- Optical system to read serial numbers of the VMM3a chips being tested
- VMMT: multi-functional test board for testing and characterization of VMM3 ASICs developed by Tomsk State University (Russia) for ATLAS

♦ All VMM3a chips procured by UofSC tested at CERN using ATLAS NSW procedure: average yield about 70% for best selection (green) for a total of 150 chips.

PREPARATION FOR 1.2m × 0.8m PROTOTYPE

◆ Prototype 1.2m × 0.8m based on design & parts as in full scale STT modules:

- Build at JINR with help from GTU & other institutions;
- Maximal size compatible with existing tooling & similar to NA64 detectors recently built at JINR;
- 4 straw layers XXYY: 672 straws total, no target, no radiator;
- C-composite frame and assembly as in STT modules.

 \implies Aim to build the prototype in 2022 (summer?)

+ FE analysis of deformations induced by gas pressure, wire and straw tension:

- Removable lids giving access to gas manifolds and FE boards, gas tightness (O-rings, etc.);
- Connection of individual straws to C-composite frame and related gas sealing;
- Study interplay between internal overpressure and wire/straw tension.
- Evaluating options for procurement of required components.
- Contributing institutions:

JINR, GTU, IIT Guwahati, Panjab, Duke, INFN, Hamburg, UofSC.

