DUCE DEEP UNDERGROUND NEUTRINO EXPERIMENT

DAQ Overview A. Thea, J. Brooke





Science and Technology Facilities Council

DAQ Project

- DAQ will become a project alongside PIP-II, Target, APAs, Physics
 - PI : Jim Brooke / Deputy PI : Alessandro Thea
 - PM : Andra (+ additional PO effort)
 - Project coordination structure to be decided
- Project will run until cosmic commissioning period with FD1+FD2 (~2031)
 - Anticipate 2 grant phases, with mid-grant review
- This change does not significantly affect the planning

Timeline



- Where are we now?
 - Development based around ProtoDUNEs
 - Approaching production/procurement phases, and final development
 - Re-planning the project and preparing for PPRP proposal

The DUNE Trigger and DAQ system

DUNE DAQ System Goals

- Distribute clock and unique timestamping to all detector components
- Collect large amount of data from detector
- Selects only interesting interactions
- Buffers the full data stream for ~100s for supernova physics
- Deliver selected interactions to permanent storage
- Serve both Far and Near detector

Unique key challenges

- High data rate, high uptime
 - Use of commodity networking, computers, and storage
 - High-performance and resilient custom and off-the-shelf software for the remaining DAQ functions
- Remote experimental site
- Deep underground in an active mine



DUNE FD DAQ



Recent Highlights

Summary

Timing

- Integration with TDE
- Approaching pre-production phase

Readout

- Transition to SW-based Ethernet readout
- Preparation for network procurement

ССМ

- Increasing numbers of contributors
- Run Control moving to final design
- Deployment via Kubernetes
- Configuration model

Trigger

- Re-establish development team
- Re-establish SW-based TPG
- Latency measurements

DQM

Development paused

Activities at EHN1

- Three VD coldbox tests (Feb-May)
 - Re-establish SW TPG and Trigger chain
 - Trigger rate and latency measurements
 - Induction plane view of Michel event →
- Integration tests mostly ongoing
 - WIB / Readout (Ethernet)
 - DAPHNE / Readout (FELIX)

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- DAPHNE / Timing
- TDE / Timing



Time ticks



trace 0 TP Trace

Transition to Ethernet Readout

- Tests performed using WIBs and Eth readout servers
 - HermesTx firmware configured by DAQ
 - Data sent via switch to NIC
- Tested both APA and CRP readout configurations
- Successfully tested SW Trigger primitive generation
- Some optimisation achieved
- Still to do :
 - Monitoring and error reporting
 - In-depth performance testing SNB recording demo

 - Network tests at scale



Consortium Planning Exercise

- Targeting four dune-daq releases per year
 - dune-daq-4.0.0 : released
 - dune-daq-4.1.0 : in preparation now
- Release planning exercise
 - Mapping SW deliverables in detail onto forthcoming releases
 - Currently looking ahead to end '24
 - Aim to implement final designs for key components
 - Timing, readout, run control, configuration, operational monitoring
- Planning process is evolving
 - Find ways to build it into the standard release cycle procedure

Reviews

Mid-Grant Review / Jan OsC (UK)

- Midway through UK re-planning exercise
- Highlight some of the issues (readout technology change) and steps to tackle them

Final Design Review (International)

- Major effort in DAQ consortium to document the system design
- <u>https://edms.cern.ch/ui/file/2812882/1/DUNE_DAQ_System_Design_v1.1.pdf</u> (180 pages)
- Positive outcome
- No surprises in feedback known issues highlighted
- June OsC (UK)
 - Presented update on UK planning, overview of testing status
- FNAL Director's Review (US)
 - Review designs, plans, status ahead of CD2/3 review
 - Positive feedback. Recommendations re: spares, personnel risks, trigger algorithm development

Project Planning

Planning Process

- Re-planning project started in late '22
 - Change in readout technology (Ethernet + SW TPG)
 - Original plan pre-dated current consortium organisation and system design
 - Delays/slippage (foreseen) in several areas
- Planning process
 - High-level requirements : for physics and installation
 - Define the scope & deliverables
 - Product breakdown schedule what are we delivering
 - Work breakdown structure what work do we need to do
 - Detailed resource loaded plan
 - Milestones
 - Resources/costs

Schedule Drivers

- DAQ schedule is driven by DUNE requirements at two key milestones :
- Start of detector installation mid '26
 - HW : Timing system, readout network, limited capacity readout/CCM/DQM servers
 - SW : Readout, CCM, DQM
- Start of commissioning with cold detectors late '28
 - Full capacity readout/CCM/DQM servers
 - SW : Trigger (inc TPG), CCM, "uptime" updates

Product Breakdown Schedule

CCM

	1	Hardware	
	1.1	Timing hardware	
	1.1.1	GPS Interface Board (GIB)	Custom electronics
σ	1.1.2	Master Interface Board (MIB)	Custom electronics
C	1.1.3	Fibre Interface Board (FIB)	Custom electronics
Ē	1.1.4	Hardware Signals Interface (HSI)	Custom electronics
<u> </u>	1.1.5	uTCA crate	COTS
H .	1.1.6	Timing optical network	COTS
	1.1.7	GPS receiver	COTS
	1.1.8	Timing ETI server	COTS
	1.2	Readout hardware	
±	1.2.1	Readout switches	COTS
2	1.2.2	Readout optical modules	COTS
ŏ	1.2.3	Readout fibres	COTS
ä	1.2.4	Readout patch panels	COTS
e	1.2.5	Readout cables	COTS
LL.	1.2.6	Stage 1 readout servers	COTS
_	1.2.7	Stage 2 readout servers	COTS
\geq	1.3	CCM/DQM hardware	
O	1.3.1	Stage 1 CCM/DQM servers	COTS
O	1.3.2	Stage 2 CCM/DQM servers	COTS

2	Firmware
2.1	Timing firmware
2.1.1	Timing master firmware
2.1.2	Timing endpoint firmware
2.1.3	Timing HSI firmware
2.1.4	Timing GPS interface firmware
2.1.5	Timing boards interface firmware
2.2	Readout transmit firmware
2.2.1	UDP Tx block firmware
2.2.2	Readout TxMux block firmware

3	Software	
3.1	Timing software	
3.1.1	Timing system library	
3.1.2	Timing system DUNE-DAQ modules	
3.2	Readout software	
3.2.1	NIC data reception functions	
3.2.2	NIC data reception tools	
3.2.3	TPG framework	
3.2.4	TPG tools	
3.3	Run control software	
3.3.1	Run control appfwk interface	
3.3.2	Access control logic	
3.3.3	Resource control logic	
3.3.4	Process management	
3.3.5	Run control	
3.3.6	Run number	
3.3.7	Run registry	
3.3.8	Run conditions	
3.3.9	Supervisor	
3.4	Configuration software	
3.4.1	Configuration model	
3.4.2	Configuration data access library	
3.4.3	Configuration appfwk interface	
3.4.4	Configuration versioning tools	
3.4.5	Run configuration	
3.4.6	Resource control configuration	
3.4.7	Access control configuration	
3.4	Monitoring software	
3.4.1	Monitoring message software	
3.4.2	Monitoring error report system	
3.4.3	Operational monitoring	
3.4.4	Monitoring user interface	

	3.7	Trigger software
_	3.7.1	Trigger infrastructure
Ð	3.7.2	Module level trigger
D	3.7.3	External trigger interface
0	3.7.4	Trigger primitive algorithms
	3.7.5	Trigger object algorithms
	3.7.6	Trigger-simulation interface
	3.7.7	Trigger menu
5	3.8	DQM software
7	3.8.1	DQM front end
ň	3.8.2	DQM aggregator
	3.8.3	DQM back end

High-Level Plan



- Staged delivery of hardware & software according to DUNE requirements
 - Reduced hardware cost
 - Targetted effort



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Detector installation support																																
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Readout Network

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FD2 operations																				Det in	nstallati	on & s	upport		FD2	Coolir	ng and F	illing					x
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Readout SW

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Implement TP debug/monitoring information																																
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| | Q1 | Q1 Q2 | 2023 Q1 Q2 Q3 R0 R1 R2 | Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 R0 R1 R2 R3 | 2023 Q4 Q1 Q1 Q2 Q3 Q4 Q1 R0 R1 R2 R3 R4 | 2023 2 Q1 Q2 Q3 Q4 Q1 Q2 R0 R1 R2 R3 R4 R5 | Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q1 Q2 Q3 Q4 Q1 Q2 Q3 R0 R1 R2 R3 R4 R5 R6 | 2023 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 PD-II PD-II PD-II Q1 Q1 Q1 Q2 Q3 Q4 PD-II PD-II R0 R1 R2 R3 R4 R5 R6 R7 | Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 PD-II PD-II PD-II PD-II PD-II PD-II PD-II PD-II R0 R1 R2 R3 R4 R5 R6 R7 R8 | 2023 V2 023 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 R0 R1 R2 R3 R4 R5 R6 R7 R8 R9 | 2023 2024 2024 2024 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 R0 R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 | VI VI <th< td=""><td>2023 2024 2024 2025 2026 Q1 Q2 Q3 Q4 Q3 Q4 Q4 Q4 Q4 Q4 Q4 Q4 Q4 Q4<td>Q1 Q2 Q3 Q4 Q1 Q3 Q4 Q1 Q3 Q4 Q1 Q3 <th< td=""><td>PD-II PD-II <t< td=""><td>2023 2024 2025 2026 Q1 Q2 Q3 Q4 Q1 Q2 Q3</td><td>VICTOR VICTOR VICTOR</td><td>VICTOR VICTOR VICTOR</td><td>VI VI 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02</td></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></ii<></td></t<></td></th<></td></td></th<> | 2023 2024 2024 2025 2026 Q1 Q2 Q3 Q4 Q3 Q4 Q4 Q4 Q4 Q4 Q4 Q4 Q4 Q4 <td>Q1 Q2 Q3 Q4 Q1 Q3 Q4 Q1 Q3 Q4 Q1 Q3 <th< td=""><td>PD-II PD-II <t< td=""><td>2023 2024 2025 2026 Q1 Q2 Q3 Q4 Q1 Q2 Q3</td><td>VICTOR VICTOR VICTOR</td><td>VICTOR VICTOR VICTOR</td><td>VI VI VIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII</td><td>PD-II PD-II PD<ii< th=""> PD<ii< th=""> PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iii< th=""> PD PD<iii< th=""> PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iiii< th=""> PD<</iiii<></iii<></iiii<></iii<></iiii<></iii<></iii<></iii<></iii<></iiii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></ii<></ii<></td><td>PD-II PD-II PD-III PD-III PD-II</td><td>PD-II PD-II PD<ii< th=""> PD<iii< th=""> PD PD<td>P2023 V 2023 Q4 Q1 Q2 Q3 Q4</td><td>VI VI VI VI VI VI VI VI VI VI 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PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iii< th=""> PD PD<iii< th=""> PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iiii< th=""> PD<</iiii<></iii<></iiii<></iii<></iiii<></iii<></iii<></iii<></iii<></iiii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></ii<></ii<></td><td>PD-II PD-II PD-III PD-III PD-II</td><td>PD-II PD-II PD<ii< th=""> PD<iii< th=""> PD PD<td>P2023 V 2023 Q4 Q1 Q2 Q3 Q4</td><td>VI VI VI VI VI VI VI VI VI VI VIIII VIIIII VIIIIIIII VIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII</td><td>PD-II PD-II PD-III PD-III PD-II</td><td>PD-II PD-II PD-III PD-III PD-II</td><td>VI VI VIIII VIIIII VIIIIIIIII VIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII</td><td>Image: Series of the series of t</td><td>VI VI VII VIII</td><td>VI VI VI</td><td>01 02 03 04 01 02</td></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></ii<></td></t<> | 2023 2024 2025 2026 Q1 Q2 Q3 Q4 Q1 Q2 Q3 | VICTOR VICTOR | VICTOR VICTOR | VI VIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII | PD-II PD <ii< th=""> PD<ii< th=""> PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iii< th=""> PD PD<iii< th=""> PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iiii< th=""> PD PD<iii< th=""> PD<iiii< th=""> PD<</iiii<></iii<></iiii<></iii<></iiii<></iii<></iii<></iii<></iii<></iiii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></ii<></ii<> | PD-II PD-III PD-III PD-II | PD-II PD <ii< th=""> PD<iii< th=""> PD PD<td>P2023 V 2023 Q4 Q1 Q2 Q3 Q4</td><td>VI VI VI VI VI VI VI VI VI VI VIIII VIIIII VIIIIIIII VIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII</td><td>PD-II PD-II PD-III PD-III PD-II</td><td>PD-II PD-II PD-III PD-III PD-II</td><td>VI VI VIIII VIIIII VIIIIIIIII VIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII</td><td>Image: Series of the series of t</td><td>VI VI VII VIII</td><td>VI VI VI</td><td>01 02 03 04 01 02</td></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></iii<></ii<> | P2023 V 2023 Q4 Q1 Q2 Q3 Q4 | VI VIIII VIIIII VIIIIIIII VIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII | PD-II PD-III PD-III PD-II | PD-II PD-III PD-III PD-II | VI VIIII VIIIII VIIIIIIIII VIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII | Image: Series of the series of t | VI VII VIII | VI | 01 02 03 04 01 02 |



		2	023			2	2024				2025			2	2026			2	027			2	028			2	029		1	5	2030	
Major DAQ activities	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
ProtoDUNE-II HD operations							PD-I	I HD op	peratio	ns																						
ProtoDUNE-II VD operations								PD-I	I VD o	peration	าร																					
Surface DAQ installation													Surfa	ace DA	Q insta	allation																
FD1 DAQ installation															FD1	DAQ ir	nstallat	ion (sta	ge 1)	FD1	DAQ in	stallatio	on (sta	ge 2)								
FD2 DAQ installation																			FD2	DAQ in	stallati	on (stag	ge 1)				FD2	DAQ in	stallatin	on (sta	ge 2)	
FD1 operations															Det	installat	tion & s	support		FD1	Cooling	and Fi	illing			Com	mission	ing and	Physi	ics		
FD2 operations																			Det i	nstallat	ion & s	upport		FD2	Coolir	ng and F	illing					x
Task	R0	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31
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Implement online latency monitoring																																
Review MLT logic / deadtime accounting																																
Develop trigger offline model																																
Characterise trigger performance in simulation																																
Implement online trigger testbed																																
Characterise trigger performance in testbed																																
Trigger infrastructure design review		T P	rep	arıı	۱g	X																										
Implement infrastructure update		tł		iroi	Ind									1	Fri a	der	' eti	Idie	s													
Finalise baseline trigger algorithms			10 5	,											'''y	90	Bu															
Maintain baseline trigger algorithms																														Eir	nal (dov
Study advanced trigger algorithms																																aev
Final trigger development cycle													1																			
Maintain PD-II system																																
Maintain DUNE system																																
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Support & maintenance

Work Breakdown Structure

			Proje	t Schedule DAQ				
		Remaining			Ma tor Mar	2023		Max
ID	Name	Duration	Start	Finish	26 02 09 16 23 30 07 14 21	128104111191251021091951251501061	3 20 27 03 10 17 24 01 06 15	22 29 05 12 19
WP21253.A1030	Test MIB prototype power & basic functionality	5d	12-May-25	18-May-23		It MB prototype power & basic functionality		
W8S - 4 - Prototype I	MB passes basic tests	5d	19-May-25	25-May-23		WBS - 4 - Prototype MIB passes basic tests		
WP21234,A1040	Prototype MIB passes basic tests	5d	19-May-23	25-May-23	JI ""	Prototype MIB passes basic tes/s		
WBS - 4 - Develop MIB	prototype v2	35d	03-Apr-23	25-May-23		WB5 - 4 - Develop MIB prototype x2		
W8S - 1 - Design ME	3 prototype v2	15d	03-Apr-23	25-Apr-23	MRS-1-Design	Mill prototype v2		
WP21241.A1010	Capture MIB prototype schematic	5d	03-Apr-23	11-Apr-23	Eapture MB prototype sc	heratic		
WP21241A1020	Design MIB prototype layout	5d	12-Apr-23	18-Apr-23	* Besign MB prototop	e layout	10	Name
WP21241,A1030	Design MIB prototype front-panel	5d	19-Apr-23	25-Apr-23	Hill Design MIS proto	stype front-panel	WP21311A1010	Capture GIB pre
WBS - 2 - Procure MI	B prototype v2	25d	03-Apr-23	11-May-23	/ with -	2 - Procure Mill prototype x2	WP21311A1020	Design GIB pre-
WP21242.A1010	Order MIB prototype standard components	5d	26-Apr-23	03-May-23	Him - Oxder Mill p	antatype standard components	WP21311.A1030	Design GIB pre-
WP21242.A1020	Order MIB prototype custom printed circuit board	Sd	05-Apr-23	11-Apr-23	Order MIB prototype cust	tors printed circuit board	WBS - 2 - Procure Gi	B pre-production
WP21242.A1030	Ship MIB prototype components to manufacturer for assem	Sd	04-May-23	11-May-23	Hind Ship M	IB prototype components to manufacture	WP21312.A1010	Order GIB pre-p
WBS - 3 - Test MIB pr	rototype power & basic functionality	5d	12-May-23	18-May-23	PR 14	35 - 3 - Test MIB prototype power & basis	WP21312.A1020	Order GIB pre-p
WP21243.A1010	Test MIS prototype power & basic functionality	5d	12-May-23	18-May-23	985-14	at MIB prototype power & basic functions	WP21312.A1030	Ship GIB pre-pr
W8S - 4 - Prototype I	MIB passes basic tests		19-May-25	25-May-23		W85 - 4 - Prototype MIB passes basic t	WBS - 3 - Test GIB pr	e-production pro
WP21244,A1010	Prototype MIB passes basic tests	5d	19-May-23	25-May-23] 🤎	Protetype MIB passes basic tests	WP21313.A1010	Test GIB pre-pro
WBS - 5 - Develop FIB p	arototype v1			25-May-23		WBS - 5 - Develop FID prototype v1	W8S - 4 - Pre-produ	ction GIB passes b
W8S - 1 - Design FIB	prototype v1		03-Apr-23	25-Apr-23	MES-1-Design	FID prototype v1	WP21314,A1010	Pre-production
WP21251,A1010	Capture FIB prototype schematic	5d	05-Apr-23	11-Apr-23	Capture FIB prototype sch	hematic	WBS - 5 - Procure fin	el GIB
WP21251A1020	Design FIB prototype layout	5d	12-Apr-23	18-Apr-25	Design FIB protetype	layisut	WP21315.A1010	Ship final GIB co
WP21251,A1030	Design FIB prototype front-panel	5d	19-Apr-23	25-Apr-23	Oesign Fill proto	type front-panel	WP21315.A1020	Test final GB po
W8S - 2 - Procure FIE	3 prototype v1		03-Apr-23	11-May-23	/ WDS - 2	2 - Procure FIB prototype v1	W85 - 6 - GIB produc	tion complete
WP21252.A1010	Order FIB prototype standard components	5d	26-Apr-23	03-May-23	Hand Oxder Fill pr	ratotype standard components	WP21316.A1010	GIB production
WP21252.A1020	Order FIB prototype custom printed circuit board	5d	05-Apr-23	11-Apr-23	Order FIB prototype custo	am printed circuit board	WBS - 2 - Produce MIB	
WP21252.A1030	Ship FIB prototype components to manufacturer for assembly	5d	04-May-23	11-May-23	Ship 70	B prototype components to manufacture	WBS - 1 - Design Mil	B pre-production
WBS - 3 - Test FIB pro	ototype power & basic functionality		12-May-23	18-May-23	P R R	35 - 3 - Test FIB prototype power & basic	WP21321A1010	Capture MIB pri
WP21253.A1010	Test FIB prototype power & basic functionality	5d	12-May-23	18-May-23	900-10	It Fill prototype power & basic functional	WP21321A1020	Design MB pre
W8S - 4 - Prototype I	FIB passes basic tests		19-May-25	25-May-23	•	WBS - 4 - Prototype FIB passes basic te	WP21321A1030	Design MIB pre
WP21254,A1010	Prototype FIB passes basic tests	5d	19-May-23	25-May-23	1 🌳	Prototype FIS passes basic tests	WBS - 2 - Procure M	B pre-production
WBS - 6 - Develop FIB p	arototype v2	35d	03-Apr-23	25-May-23		WB5 - 6 - Develop FIB prototype v2	WP21322.A1010	Order MIB pre-p
W8S - 1 - Design FIB	prototype v2		03-Apr-23	25-Apr-23	WRS - 1 - Design	FIB prototype x2	WP21322.A1020	Order MIB pre-p
WP21261,A1010	Capture FIB prototype schematic	5d	03-Apr-23	11-Apr-23	Capture FB prototype sch	hematic	WP21322.A1030	Ship MIB pre-pr
WP21261A1020	Design FIB prototype layout	5d	12-Apr-23	18-Apr-23	Besign FIB prototype	layout	WBS - 3 - Test MIB p	re-production pro
WP21261,A1030	Design FIB prototype front-panel	5d	19-Apr-23	25-Apr-23	Genige Fills proto	type front-panel	WP21323.A1010	Test MIB pre-pr
W8S - 2 - Procure FIE	3 prototype v2	25d	03-Apr-23	11-May-23	- was	2 - Procure FIB prototype v2	W8S - 4 - Pre-produ	tion MB passes I
WP21262.A1010	Order FIB prototype standard components	5d	26-Apr-23	03-May-23	Him-Ender Fill pr	ratotype standard components	WP21324,A1010	Pre-production
WP21262,A1020	Order FIB prototype custom printed circuit board	5d	05-Apr-23	11-Apr-23	Order FIB profetype custe	am printed circuit board	WBS - 5 - Procure fin	al MB
WP21262,A1030	Ship FIB prototype components to manufacturer for assembly	5d	04-May-23	11-May-23	900-Shp78	8 prototype components to manufacture	WP21325.A1010	Ship final MB c
WBS - 3 - Test FIB pro	ototype power & basic functionality	5d	12-May-23	18-May-23	1	25 - 5 - Test FIB prototype power & basic	WP21325.A1020	Test final MB p
WP21263.A1030	Test FIB prototype power & basic functionality	5d	12-May-25	18-May-23	95	It FIB prototype power & basic functional	W85 - 6 - MIB produ	ction complete
WIS - 4 - Prototype	FIII casses basic tests	Sd	19-May-25	25-May-25		W85 - 4 - Prototype FIB passes basic to	WP21326,A1010	MB production
WP21264,A1040	Prototype FIB passes basic tests	Sd	19-May-25	25-May-23	1 🛸	Prototype FIB passes basic tests	WBS - 3 - Produce FIB	
WBS - 7 - Develop HSI		5d	03-Apr-23	11-Apr-23	WES - 7 - Develop HS		W8S - 1 - Design FIB	pre-production p
WP2127,A1010	Develop HSI	5d	03-Apr-23	11-Apr-23	Develop HSI		WP21331,A1010	Capture FIB pre
WITS - 3 - Produce timing	watern custom hardware	70d	05-Apr-25	14-34-25		w85 - 3	WP21331,A1020	Design FIB pre-
and a second sec								

				Proje	ct Schedule DAQ									
D		Name	Remaining Duration	Start	Finish	쏊	A \$0]22	0 23 10 07	Vay 14 2	2023	Aug 0 06 13 20 27	5ep [03] 10 [12	Oct	Nev 29 [05] 12]
	WP21311A1010	Capture GIB pre-production prototype schematic	5d	03-Apr-23	11-Apr-23	TP	-	appure GB pre-p	roduct	tion prototype schematic				
	WP21311A1020	Design GIB pre-production prototype layout	5d	12-Apr-23	18-Apr-23	11	196	Besign GB pr	+ 214	fuction prototype layout				
	WP21311.A1030	Design GIB pre-production prototype enclosure	5d	19-Apr-23	25-Apr-23	11		Him Design G	18 pre-	production prototype enclosure				
	WBS - 2 - Procure GI	B pre-production prototype	25d	03-Apr-23	11-May-23		_	_	WES -	2 - Procure GIB pre-production prototype				
	WP21312.A1010	Order GIB pre-production prototype standard components	5d	26-Apr-23	03-May-23	1		90-046	H GR	pre-production prototype standard compo	nerts			
	WP21312.A1020	Order GIB pre-production prototype custom printed circuit	5d	03-Apr-23	11-Apr-23	14	-	inder GB pre-pro	éco	in prototype custom printed circuit baard				
	WP21312.A1030	Ship GB pre-production prototype components to manufac	5d	04-May-23	11-May-23	11			\$hp 0	IB pre-production prototype components	to menufecturer for	r assembly		
	WBS - 3 - Test GIB pr	e-production prototype power & basic functionality	5d	12-May-23	18-May-23			,	÷.,	BS - 3 - Test GIB pre-production prototype	pewer & basic furs	ctionality		
	WP21313.A1010	Test GIB pre-production prototype power & basic functionality	5d	12-May-23	18-May-23	11		98	-	est GIB pre-production prototype power &	basic functionality			
	W8S - 4 - Pre-produ	ction GIB passes basic tests		19-May-23	25-May-23				-	WIS-4 - Pre-production GIB passes bo	nic tests			
	WP21314A1010	Pre-production GIB passes basic tests	5d	19-May-23	25-May-23	11			9	Pre-production GIB passes basic tests				
	WBS - 5 - Procure fin	el GIB	10d	19-May-25	02-Jun-23				- 12	1885 - 5 - Procure final GIB		_		
	WP21315.A1010	Ship final GIB components to manufacturer for assembly	5d	19-May-23	25-May-23	11			P#	- Ship final GIB components to manufact	uner for assemb	-		
	WP21315.A1020	Test final GB power & basic functionality for acceptance	5d	26-May-23	02-Jun-23	11			T	Test final GIB power & basic function	eality for accep			
	WIS - 6 - GIB produc	tion complete			02-Jun-25					+ 1095 - 6 - GB production complete		ID.		N
	WP21316.A1010	GB production complete	Od		02-Jun-23	11				 +Gill production complete 			WBS - 5 - Pro	cure final F
	WBS - 2 - Produce MIB			03-Apr-23			_		-	W15-2-	Produce MIB	-	WP21335.	41010 S
	WBS - 1 - Design Mil	3 pre-production prototype		19-May-23					- +	W25 - 1 - Design MID pre-prod	luction prototys		WP21335.	A1020 Te
	WP21321A1010	Capture MIB pre-production prototype schematic	5d	19-May-25	25-May-23	11			P*	Capture MB pre-production prototype	sheratic		WBS - 6 - FIB	production
	WP21321A1020	Design MIB pre-production prototype layout	5d	26-May-25	02-Jun-23					Contraction 148 pre-production prototy	gie layout		WP21356.3	41010 F
	WP21321A1030	Design MIB pre-production prototype front-panel	5d	05-Jun-23	09-Jun-23	11				Contraction Pre-production pre-	ofotype front-p		WBS - 4 - PTCOU	CE HSI
	WBS - 2 - Procure M	B pre-production prototype		03-Apr-23		1.	_		++	WES - 2 - Procure ME	pre-productio		WP2134,A10	10 P
	WP21322.A1010	Order MIB pre-production prototype standard components	5d	12-Jun-23	16-Jun-25					Toder MB pre-production	prototype stan		With the second	0111112 555
	WP21322.A1020	Order MIB pre-production prototype custom printed circuit	5d	03-Apr-23	11-Apr-23	1 1	_	inder MB pre-pro	share	in pratotype custom printed circuit board			WP214,41010	
	WP21322.A1030	Ship MIB pre-production prototype components to manufa	5d	19-Jun-23	23-Jun-23	11				Ship Mill pre-product	on prototype o		WP214041020	
	WBS - 3 - Test MIB p	re-production prototype power & basic functionality								H HOS - 3 - Test MI	a pre-productic		WP214A1030	
	WP21323.A1010	Test MIB pre-production prototype power & basic functiona	5d	26-Jun-23	30-Jun-23					Test MB pre-prod	luction presony		WP214 A1050	-
	W8S - 4 - Pre-produ	ction MB passes basic tests								WRS-4-Pre	areduction M		WITS - 5 - Develop	timine for
	WP21324,A1010	Pre-production MIB passes basic tests	5d	03-Jul-23	07-Jul-23	11				Pre-productio	MB passes t		WR215 A1010	
	WBS - 5 - Procure fin	al MB								wes-s-	Procure final 8		WP215A1020	0
	WP21325.A1010	Ship final MB components to manufacturer for assembly	5d	03-Jul-23	07-Jul-23					Plan Ship Shail ME	components t		WP215.61030	D
	WP21325.A1020	Test final MB power & basic functionality for acceptance	5d	10-Jul-23	14-Jul-23					Section 1	MB power & b		WP215.A1040	D
	WBS - 6 - MIB produ	ction complete	od		14-34-23					+W25-6-	MB productio		WP215.A1050	D
	WP21326.A1010	MB production complete	Od		14-Jul-23					 <td>duction comple</td><td></td><td>WP215.A1060</td><td>D</td>	duction comple		WP215.A1060	D
	WBS - 3 - Produce FIB			03-Apr-23		1	_		++	WEG - 3	Produce FIB		WP215.A1070	D
	W8S - 1 - Design FIB	pre-production prototype		19-May-23					1+	W25 - 1 - Design Fil2 pre-prode	action prototyp		WBS - 6 - Develop	timing sof
	WP21331A1010	Capture FIB pre-production prototype schematic	5d	19-May-23	25-May-23				14	Capture FIB pre-production prototype s	chernatic		WP216.A1010	D
	WR21551 A1020	Dering EB one-production prototype Invovt	64	26.May. 25	02.100.23	11			1 5	Cesign FIB pre-production prototy	pe layout		WP216 A1020	0

WBS	exists	in P	rimavera
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- Timing & Readout at advanced state of planning
- CCM reasonably complete
 Expect Trigger and DQM to evolve
 Some resources allocated

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- Need to estimate task duration •

1855 - 5 - Procure final G	8									
+ Ship final GIB components to	manufacturer for assemb				Proje	ect Schedule DAQ				
Test final GIB power & ba	nic functionality for accep	10	Name	Remaining	Start	Finish	Md 361/021	Apr M	202 ley Jun Jul 91 31 36 Jul 191 36 Jul 201 30 1 30 1	
w HES - 6 - US productor	n complete	WBS - 5 - Procure for	W RR	104	05-36-23	14.1-1.23	in the second	10101001001	Wis-	- Procure final FID
- Cas productor cample	-	WP21335 A1010	Shin final FIB components to manufacturer for assembly	54	03-36-23	07-bit-23	11	1 1	Film-Ship final F	D components to manufacturer for assem
	WES - 2 - Produce MIB	WP21335 A1020	Test final FIR nower & basic functionality for accentance	54	10.36.23	14.bd.23	11	1 1	Hill-Test for	al FJB power & basic functionality for acce
W25 - 1 - Design ME	pre-production prototys	WBS - A - FIB oracled	tion corrolete	01		14-34-23		1 1	+W25	- TIB production complete
* Capture MIB pre-production p	indulype schematic	WP21336 A1010	EB production complete	94		14.bd.23	11	1 1	6-18p	oduction complete
The sector respectively	on presorighe syloca	WBS - 4 - Produce HSI		5d	03-Apr-23	11-Apr-23		WES-4-Produce	HEA	
	success prototype more-p	WP2134,A1010	Produce HSI	5d	03-Apr-23	11-Apr-23	1 –	Resource HSI		
WEG-2-Pr	ocure MIB pre-productio	WBS - 4 - Procure timing	system COTS components	85d	03-401-23	04-Aug-23				WES - 4 - Procure timing system CO
The Dider Mill pre-p	roduction prototype stan	WP214A1010	Procure final timing system uTCA hardware	5d	31-34-23	04-Aug-23	11			Procure final timing system uTCA ha
uction praticitype custom privited care	uit board	WP214.A1020	Procure final timing system GPS-DO	5d	03-Apr-23	11-Apr-23	11=	Procure final timing	system GPS-DO	
• Ship Mill per	e-production prototype o	WP214.A1030	Procure final timing system AFC	5d	03-Apr-23	11-Apr-23	11-	Procure final timing	system AFC	
M H05-3	- Test Mill pre-productic	WP214.A1040	Procure final timing system fibres & patch panels	5d	03-Apr-23	11-Apr-23	1 –	Procure final timing	cyystern fibres & patich panels	
HEP-Test Mil	8 pre-production presory	WP214.A1050	Timing system COTS procurement complete	Od		04-Aug-23	11	1 1		•Timing system COTS procurement
M MS	5 - 4 - Pre-production M	WIIS - 5 - Develop timing	firmware	50	05-Apr-25	11-Apr-23		WES-5-Develop	ining ferries re	
400 Pre-	-production MIB passes t	WP215A1010	Develop FMC firmware	5d	03-Apr-23	11-Apr-23	1 –	Bevelop FMC firms	are	
	WES - 5 - Procure final 8	WP215.A1020	Develop GB firmware	5d	05-Apr-25	11-Apr-23	1 –	Bevelop GB firmw	**	
*D -SN	p final MB components t	WP215.A1030	Develop MIB firmware	5d	03-Apr-23	11-Apr-23	1 –	Bevelop MIS from	ee .	
96	Test final Mill power & b	WP215.A1040	Develop fine delay measurement firmware	5d	05-Apr-25	11-Apr-23	1 –	Bevelop fine delay	Vision entert firmware	
+	WIS-6-MB productio	WP215.A1050	Develop endpoint scanning firmware	5d	03-Apr-23	11-Apr-23	1 –	Bevelop endpoints	carning formulae	
•	 MB production completion 	WP215.A1060	Develop accelerator interface firmware	5d	03-Apr-23	11-Apr-23	1 –	Bevelop accelerate	interface firmwore	
_	WES - 3 - Produce FIB	WP215.A1070	Develop redundancy firmware	5d	05-Apr-25	11-Apr-23	1 –	Bevelop redundan	p formulae	
W25 - 1 - Design Fill	pre-production prototyp	W8S - 6 - Develop timing	software	5d	03-Apr-23	11-Apr-23		WES - 6 - Develop	timing satisase	
Capture FIB pre-production pr	retotype schematic	WP216A1010	Develop FMC software	5d	05-Apr-25	11-Apr-23	1 –	Bevelop FMC softw	are .	
Cesign FIB pre-production	en prototype layout	WP216A1020	Develop GB software	5d	03-Apr-23	11-Apr-23	1 =	Bevelop GB saftw	**	
	n prototype front-pa	WP216.A1050	Develop MIB software	5d	05-Apr-25	11-Apr-23	1 =	Bevelop MB softw		
	* FB pre-production	WP216.A1040	Develop software state recovery	5d	03-Apr-23	11-Apr-23	1 =	Bevelop software o	tale recovery	
	tion prototype stars	WP216A1050	Develop fine delay measurement software	5d	05-Apt-25	11-Apr-23		Bevelop fine delay	reasoners safware	
	bard	WP216.A1060	Develop endpoint scanning software	5d	03-Apr-23	11-Apr-23		Bevelop endpoint of	carning software	
	duction prototype co	WP216.A1070	Develop accelerator interface software	5d	03-Apr-23	11-Apr-23	1 =	Bevelop accelerato	interface saftware	
	st FIB pre-productio	WP216.A1080	Develop monitoring and logging software	5d	03-Apr-23	11-Apr-23		Bevelop monitorin	and logging software	
חמ	production prototyp	WP216A1090	Develop redundancy software	5d	03-Apr-23	11-Apr-23		Bevelop redundan	y saftware	
IU	- Pre-production ps	WP2161,A1000	Develop ETI software	5d	03-Apr-23	11-Apr-23	1 –	Hevelop [T] softwa		
0	duction prototype Fill	WBS - 7 - Integrate and to	est timing system components		03-Apr-23	14-Jul-23			wis-	Integrate and test timing system compo
		WBS - 1 - Integrate firm	rware and software for prototype timing boards and test stan		19-May-23			1 1	WES - 1 - Integrate firmware and	addowsee for prototype timing boards and
		WP2171,A1010	Integrate prototype GIB firmware, software and hardware	5d	19-May-23	25-May-23			Here integrate prototype GIB firmware, soft	ware and hardware
		WP2171,A1020	Test prototype GIB standalone with firmware and software	5d	26-May-23	02-Jun-23	11	1 1	Him Test prototype GIB standalone w	th firmware and software
		WP2171.A1030	Integrate prototype MB firmware, software and hardware	5d	19-May-23	25-May-23			Here integrate prototype Mill firmware, sof	overs and hardware
		WP2171,A1040	Test prototype MIB standalone with firmware and software	5d	26-May-23	02-Jun-23		1 1	Him Fast prototype MB standalone w	th firmware and software
		WP2171,A1050	Integrate prototype FIB firmware, software and hardware	5d	19-May-23	25-May-23			Integrate prototype FIB finmware, soft	rate and hardware
		WP2171.A1060	Test prototype FIB standalone with firmware and software	5d	26-May-23	02-Jun-23		1 1	Heat prototype FIB standalone w	in freewore and software
		WBS - 2 - Test full func	tionality of prototype timing system in Bristol lab	15d	05-Jun-23	23-Jun-23		1 1	WES-2-Testfull fr	nctionality of prototype timing system in
		WP2172.A1010	Test prototype GIB with GPS-DO	5d	05-Jun-23	09-Jun-23	11	1	Test protetype GIB with GPS	80
		WP2172.A1020	Test prototype GIB with MIB	5d	05-Jun-23	09-Jun-23	11	1	Test prototype GIS with MIS	
		WP2172.A1030	Test prototype MIB with AFC/prototype FIB	5d	05-Jun-23	09-Jun-23	11	1	Test proteitype MIB with APC	Apripticitype 718
		WP2172.A1040	Test prototype FIB with test endpoint FMC(s)	5d	05-Jun-23	09-Jun-23	11	1	Test prototype FIB with test	ridpoint FMC(s)
		WP2172.A1050	Test full prototype timing system	58	12-Jun-23	16-Jun-23	11	1	Heat Test Full prototype timin	ç sijakera
		WP2172.A1060	Prototype timing system operational in Bristol lab	5d	19-Jun-23	23-Jun-23	11	1	Prototype timing sy	Aptri operational in Dristol lab

WBS - 1 - Design GIB pre-

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Equipment

			Prototyping		Stag	je 1	Stage 2		
	Item	Unit cost	N	Total (kGBP)		Total (kGBP)		N Total (kGBP)	
	CCM/DQM servers								
	Worker node	4.96	0	0.0	10	49.56	44	218.06	
COTS servers	Readout servers	40.75		05.0		047.00	75	4404.00	
	Readout node	19.75	્ય	25.0	-11	217.20	/5	1481.29	
	ETI server								
	General purpose node	1.79	0	0.0	0	0.00	4	7.17	
	Timing system	· Askenser Sele							
Custom production	Timing system prototypes	15.4	2	30.8	0	0.00	0	0.00	
· · · · · · · · · · · · · · · · · · ·	Timing system production	287.8	0	0.0	1	287.83	0	0.00	
Г	Barda da da da		1						
	Readout network	00.40				170 11			
	Switch (40G/100G)	28.13	0	0.0	1/	478.14	0	0.00	
	Switch (10G/100G)	26.64	0	0.0	38	1012.37	0	0.00	
COTS network items	QSFP+	0.11	0	0.0	368	41.07	0	0.00	
COTS Hetwork Items	SFP+	0.03	0	0.0	3007	81.19	0	0.00	
	100G DAC	0.06	0	0.0	384	23.50	0	0.00	
		177.00				177.00			
	Fibres & Ancillary	177.92		0.0	1	177.92	0	0.00	
	Total		-	55.76		2368.83		1706.52	
	Grand total							4131.11	

Next Steps

Outstanding Planning

- Resource requirements for '27-'30
 - Some taper in effort clearly expected
 - But difficult to draw a clear line between "construction" and "commissioning"
- Key performance parameters
 - ie. definition of successful delivery
 - Discussion started within consortium
- Detailed resource loaded schedule
 - Preparation underway
- Milestones
 - Tracking milestones will follow from detailed schedule
- Project coordination structure
 - Work streams & coordinators

Realising the Plan

- Problem :
 - Plan relies on substantial expertise in software engineering
 - Reliability & scalability requirements come into focus
 - Need to increase the UK DAQ capability for software engineering
- Possible solutions :
 - Hire more staff
 - Efforts to do so underway
 - Use University "Research Software Engineering" groups
 - Discussions with several institutes underway, some look promising
 - Training
 - Will start an activity within UK DAQ project to deliver this

Funding

- Asked to submit an outline proposal for feedback from OsC ahead of full proposal
 - Covering the full scope, ie. completion in ~2030
 - Deadline Sept '23
- Followed by full proposal for review by PPRP
 - Deadline late Nov/early Dec for PPRP meeting in early '24
 - Assume grants starting Oct '24, funding in two tranches
 - Concern raised about time for feedback between outline and full proposals
- Work on proposal documents about to start
 - Will be requesting input from PIs and activity coordinators

Summary

- New project but planning remains largely unchanged
- Key areas of the project (Timing, Readout) approaching the production/procurement phase
- Project re-planning is now well advanced
 - Finalising the detailed schedule, plans for commissioning, and project coordination
- Identified software engineering capability within UK as an issue
 - Solution will include new hires, potential use of RSE groups, and training
- Proposal preparation will start shortly

Backup

The DUNE Trigger and DAQ system

DUNE DAQ System Goals

- Distribute clock and unique timestamping to all detector components
- Collect large amount of data from detector
 - Receiving and buffering of detector data with custom high-performance firmware and software
- Selects only interesting interactions
 - Extraction of trigger primitives
 - Triggering on interesting detector activity using software algorithms
- Buffers the full data stream for ~100s for supernova physics
- Deliver selected interactions to permanent storage
- Serve both Far and Near detector

Unique key challenges

- High data rate, high uptime
 - Use of commodity networking, computers, and storage
 - High-performance and resilient custom and off-the-shelf software for the remaining DAQ functions
- Remote experimental site
- Deep underground in an active mine

