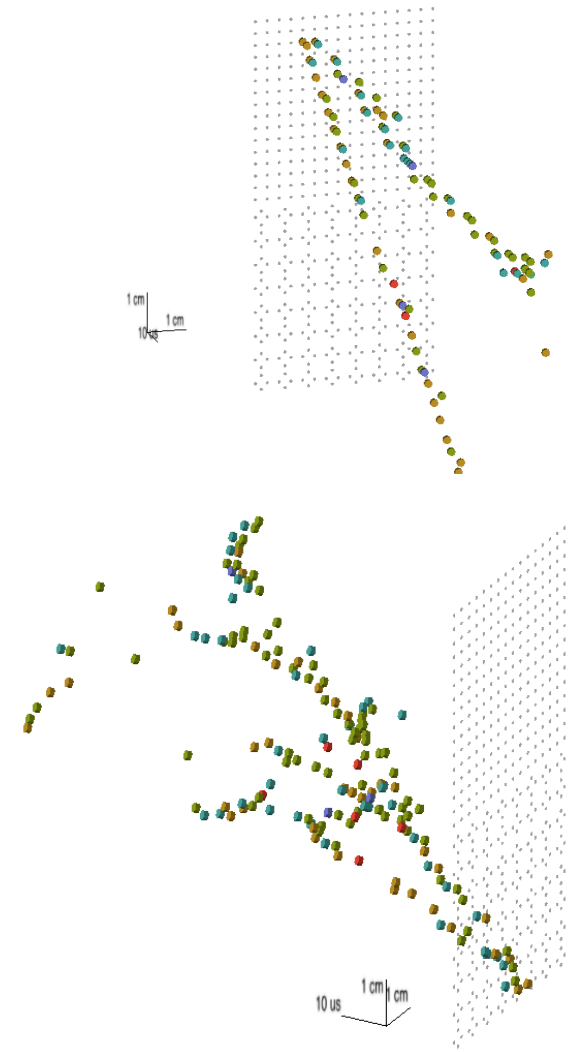
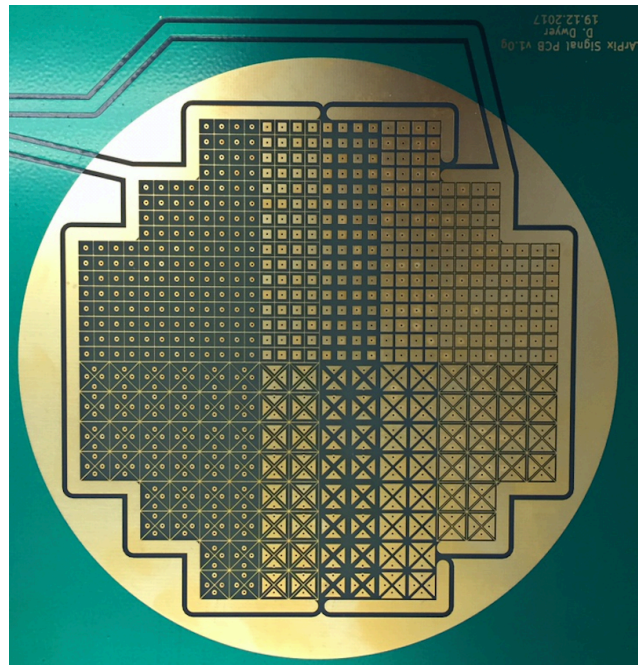
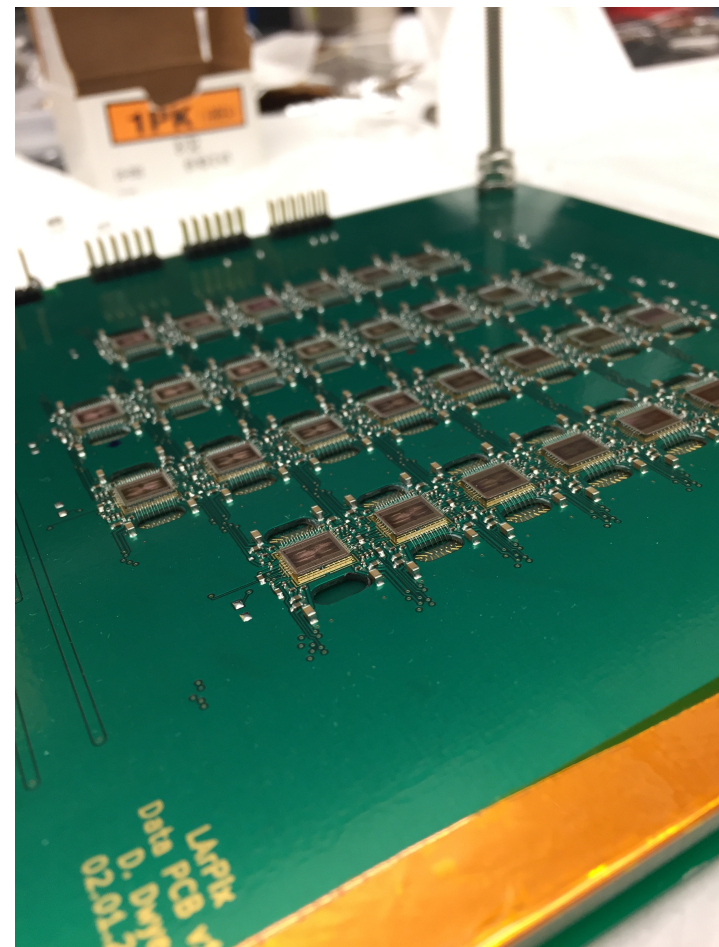


DUNE Pixel Readout Group: Kick-off Discussion

Dan Dwyer

May 9, 2019



DUNE Pixel Readout Group

Group Goal:

Develop, produce, and commission the pixelated charge readout system for the DUNE Near Detector LArTPC.

Path Forward:

Use the near-term ProtoDUNE-ND (a.k.a. ArgonCube 2x2 Detector) to:

- Develop pixel readout technology for the DUNE ND
- Establish the production, testing, commissioning processes
- Establish institutional roles and capabilities

→ *Prepare a credible plan as part of the upcoming US DOE DUNE ND proposal*

Organizational Details

Email list: dune-larpix@fnal.gov

To subscribe, send an email to listserv@listserv.fnal.gov with the following body:
subscribe dune-larpix FirstName LastName

Slack Channel:

#larpix: <https://dunescience.slack.com/messages/CJHSX24UU>

Weekly Meeting: Thursdays, 1pm CT

Agendas:

Connection: <https://fnal.zoom.us/j/272084897>

Shared Directory:

Relevant documents, schematics, meeting notes:

<https://drive.google.com/open?id=1WSRoQhp7BPbIF5GF7YKJWjXvqGOUDO4M>

ArgonCube:

Send email to James Sinclair (james.sinclair@lhep.unibe.ch) to join ArgonCube email list.

Bi-weekly meetings: Thursdays, 11am CT

ArgonCube 2x2 Demonstrator



ArgonCube 2x2 Demonstrator

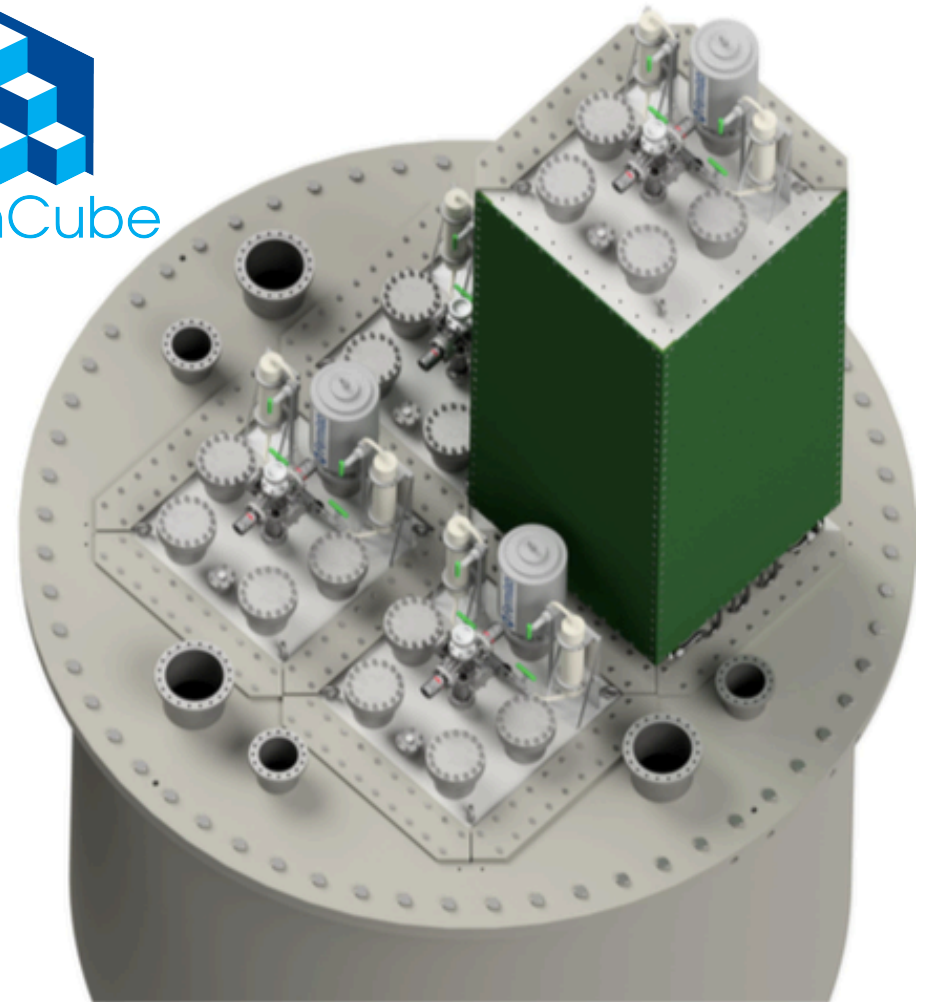
Integrated test of ArgonCube technologies

Demonstrator for DUNE Near Detector, at slightly smaller scale:

Four LArTPC modules, 1.7 ton active (total)

Each module: 0.7m x 0.7m x 1.4m

→ Designed to fit existing cryostat



Status:

Cryostat commissioned

First module assembled, w/small TPC

Recent test operation: Feb-Mar 2019

Targets:

Late 2019: Commission system at Bern

2020: Operate in neutrino beam @FNAL

Dec. 2020: Complete DUNE ND TDR

ArgonCube 2x2 Demonstrator



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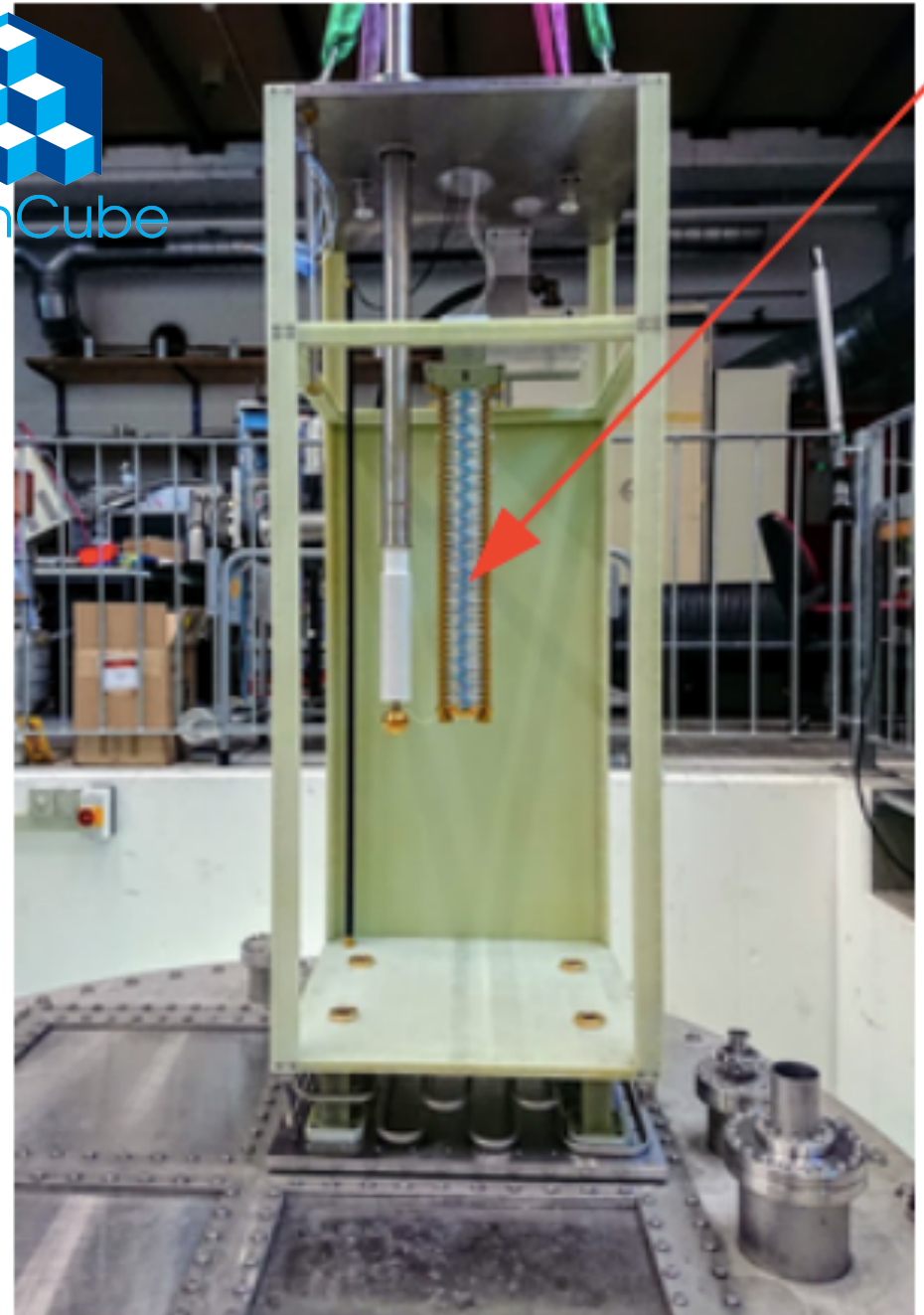
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2x2 Schedule

Fermilab Test Beam Project T-1563

Schedule and Resource Summary

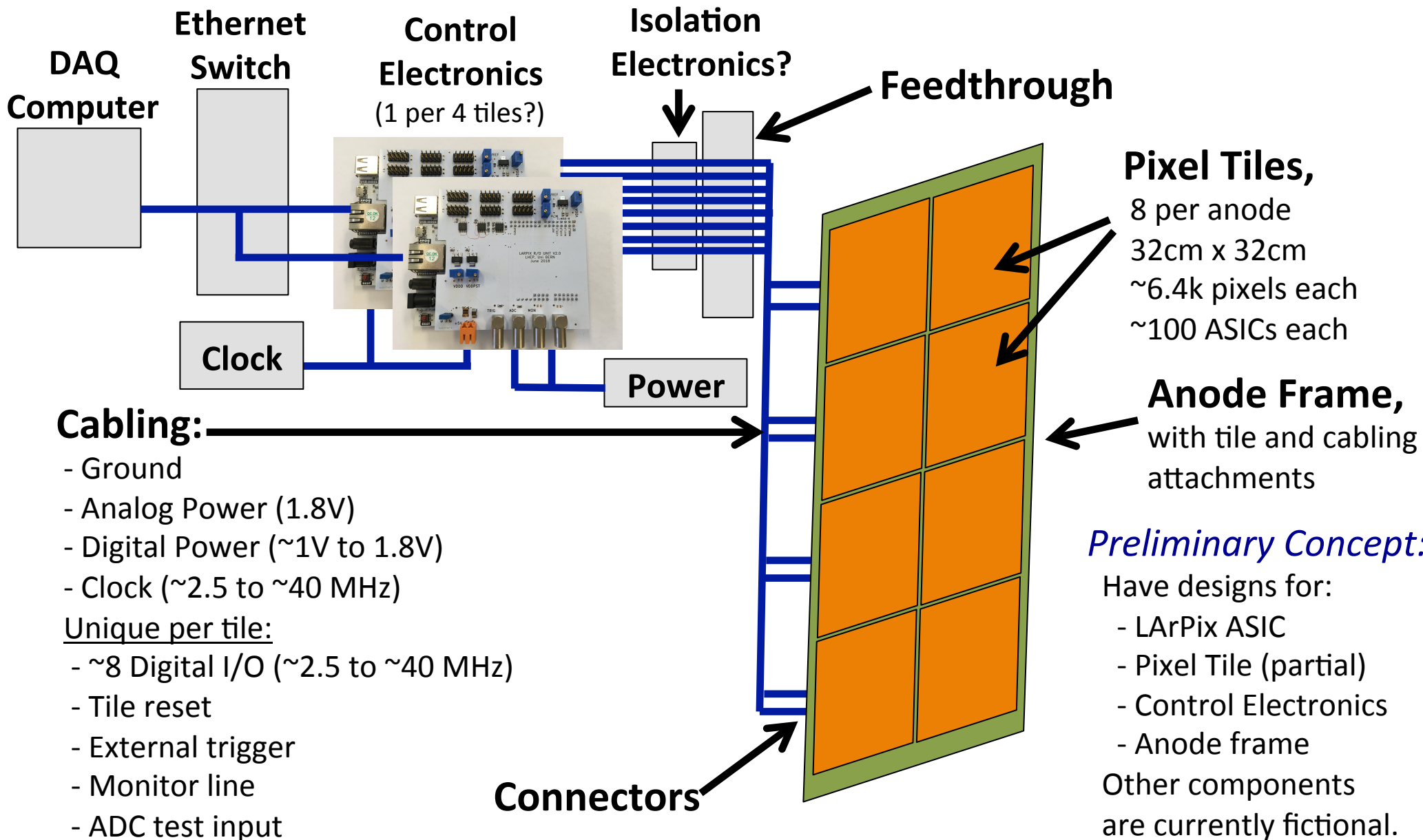
From T. Miao

WBS Element	WBS Description	Lead Institutions	Start Date	Finish Date	FNAL Labor (type : working days)	M&S (\$)
1	ArgonCube 2x2 Installation in MINOS Hall		10/25/18	2/4/21		
1.1	Preliminary Installation Design		10/25/18	6/20/19		
1.1.1	Review of argonCube 2x2 detector installation concept	BERN	10/25/18	4/23/19	Eng.Phys:70d + CryoE:125d + ME,FEA:10d	
1.1.2	Detector installation and transportation layout	FNAL	4/24/19	6/21/19	Eng.Phys:10d + Mech.Design:30d+ME:10d	
1.1.3	Cryogenic equipment requirement and layout	FNAL/BERN	10/25/18	8/20/19	CryoE:180d+ME,FEA:20d+ME:45d+ Mech.Design:70d+Eng.Phys:50d	
1.1.4	Electronics support requirement and layout	FNAL/BERN/LBNL/UTA	1/25/19	11/20/19	EE:95d+CompSP:40d +CryoE:10d+Mech.Design:5d	
1.1.5	<i>Preliminary detector and cryogenic installation design review</i>	FNAL/BERN	8/21/19	9/19/19	CryoE:5d+ME:5d+Mech.Design:5d + EE:5d + Eng.Phys:5d	
1.1.6	Preliminary electronics installation design review	FNAL/BERN/LBNL/UTA	11/21/19	12/6/19	EE:5d+Mech.Design:5d +CompSP:5d	
1.2	ArgonCube 2x2 Installation Design		9/20/19	3/25/20		
1.2.1	Cryostat and TPC module shipping container designs	BERN/FNAL	9/20/19	11/19/19	ME:5d+Mech.Design:5d+Eng.Phys:5d	
1.2.2	<i>Contract and ship ArgonCube 2x2 to FNAL from BERN</i>	BERN	11/20/19	3/18/20		
1.2.3	Detector support and access platform in MINOS hall		9/20/19	12/19/19	ME:30d+Mech.Design:30d+ CryoE:5d+Eng.Phys:10d	
1.2.4	Installation and transportation tooling		12/20/19	3/10/20	ME:25d+Mech.Design:50d + Eng.Phys:10d	
1.2.5	Cryogenic design and review		9/20/19	2/20/20	cryoE: 150d+ Mech.Design:65d +Eng.Phys:50d	
1.2.6	Review of installation tooling procurement plans	BERN/FNAL	3/11/20	3/25/20	Eng.Phys:5d	
1.3	Detector Support and Installation Tooling Procurement	FNAL	3/26/20	5/21/20	ME:5d+ Eng.Phys:5d	\$20 K
1.4	Cryogenic System and Support Procurement	FNAL	3/26/20	5/21/20	Eng.Phys:10d	\$300 K
1.5	Electronics Support Design and Procurement		12/9/19	4/3/20	EE:100d+CompSP:100d +ME.Process:40d	\$70 K
1.6	Assembly and Installation		3/26/20	8/19/20	ME:30d+CryoE:55d+EE:45d+MT:160d+ ET:40d+CompSP:20d+Eng.Phys:50d+ ME.Process:10d	\$110 K
1.7	ArgonCube 2x2 Commissioning		6/23/20	11/18/20	ME.Process:25d+CompSP:55d+CryoE:40d +ME:15d+EE:15d+Eng.Phys:60	\$20 K
1.8	Detector Operation and Maintenance Tests		11/19/20	2/4/21	ME.Process:5d+CompSP:30d+CryoE:20d+ ME:10d+EE:10d+MT:30d+Eng.Phys:20d	\$20 K

	Cryo Engineer + Eng. Physicist	Mech Engineer + Designer	Electrical Engineer	Mech Techs + Elec Techs	Computing Specialist
Technical support for WBS 1.1 to 1.2 Designs (2019+)	475d + 205d	255d+265d	105d		45d
Technical support for WBS 1.3 to 1.8 Installation & commissioning & test (2020)	185d + 175d	75d	190d	190d + 40d	205d

System Concept

Rough concept for the ArgonCube 2x2 pixel readout system



Pixel Tile Anode

Current CAD model for ArgonCube 2x2 Pixel Anode (K. Skarpass)

Inner face (pixels)

Outer face (ASICs)

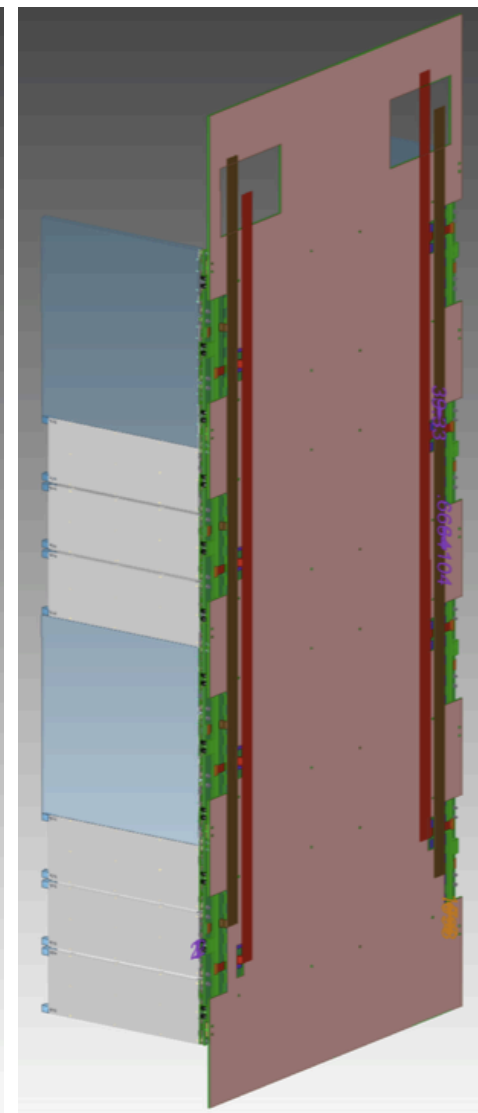
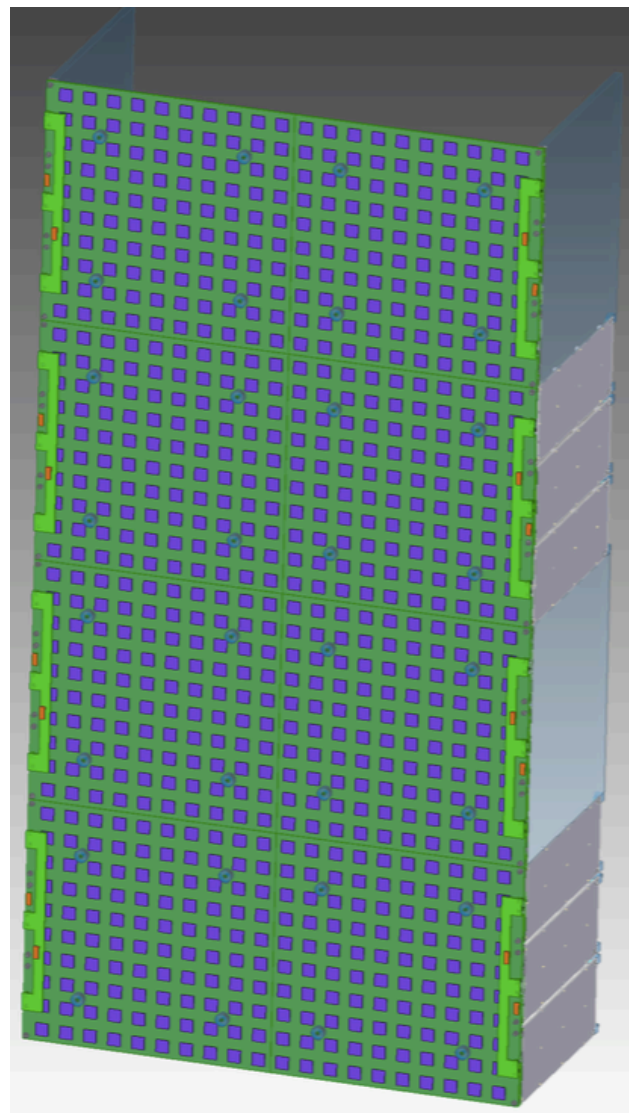
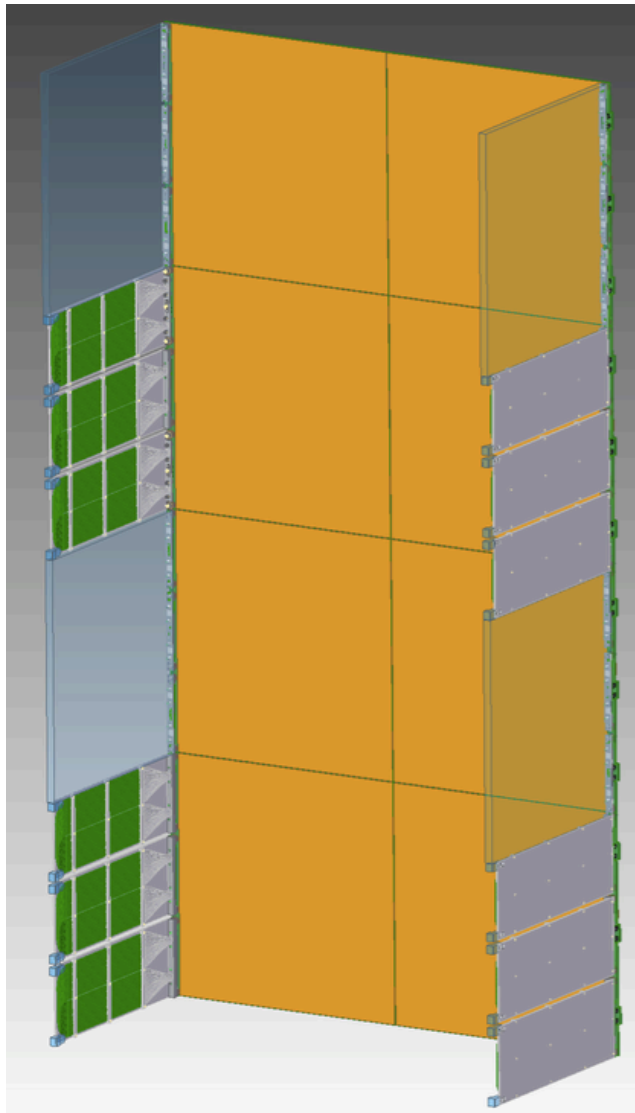
Frame (G10)

8 tiles / anode

Per tile:

- 6.4k pixels
- 100 ASICs
- 1 connector
- 4 mount points

Light collectors
mounted along
anode edges



DAQ Electronics

Cable to pixel tile(s)

Current: 50-pin ribbon cable

2x2 plan: kapton flex? (inside cryostat), ? (outside cryostat)



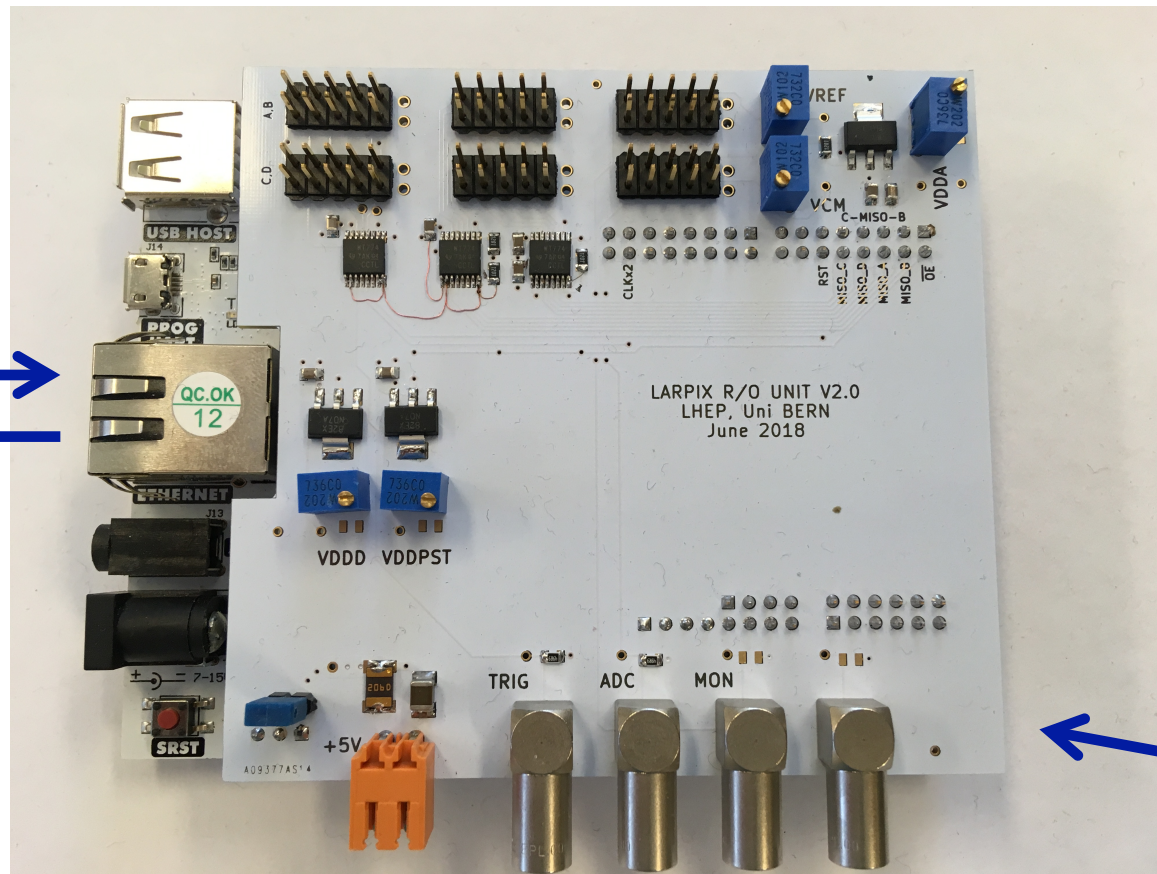
Power: GND, VDDA, VDDD

I/O: CLK_2X, RESET, EXT_TRIG, MOSI/MISO (2x2: ~8 pairs, 4 active)

Analog: ADC_TEST_IN, MONITOR_OUT

Design:

Custom mezzanine
on Arty 7 FPGA board



Data capacity:

100 kHz pixel hits
per MOSI/MISO pair
(at 10 MHz CLK_2X)

Expected operation:

~64 kHz pixel rate/tile
(on surface)
~6 kHz pixel rate/tile
(underground)

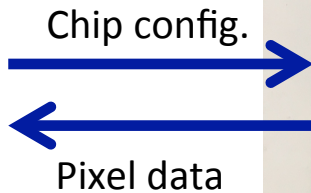
System Clock:

Arty 7 accepts
external clock

System Power: +5V

Extras: External Trig., ADC Test, Monitor

**DAQ
Computer**
(via ethernet hub)



Format: ZeroMQ

High-performance
asynchronous messaging

Protocol:

TCP/IP over RJ-45

LArPix-v2 Schedule

Tight schedule between v2 ASIC production and 2x2 installation

Start of production set by v2 ASIC submission.

→ Has slipped from March, but is now converging on a realistic date (early June).

Component testing:

- 1) Detailed characterization of the unpackaged LArPix-v2 ASIC (Aug-Sep)
- 2) Detailed characterization of the packaged LArPix-v2 ASIC (Aug-Sep)
- 3) LArPix-v2 ASIC qualification (Sep-Jan)

Targets: Sep ~100-200 ASICs; Oct ~2000 ASICs; Dec ~8000 ASICs

- 4) Unloaded Pixel tile PCB qualification (Sep-Dec)

Brief assessment of each PCB before component/ASIC loading.

Targets: Sep ~5-10 small prototype tiles; Oct ~20 tiles; Dec ~100 tiles

Pixel tile testing:

- 1) Prototypes tile testing (Sep-Oct)

Test a small number (5 to 10) small-scale (~16cm x ~16cm, ~25 ASICs) prototype tiles using the v2 ASIC.

Key questions:

- Is tile design adequate?

- 2) Initial full-scale tile testing (Nov-Dec)

Test a moderate number (~20) of production scale (~32 x ~32, ~100 ASICs) pixel tiles.

Send to Bern and install in first 2x2 module.

- 3) Remaining full-scale tile testing (Dec-Mar)

Test ~80 production scale pixel tiles to instrument the 3 other 2x2 modules, plus 1 spare module, plus ~10% spares.

Send to FNAL and install in the remaining 2x2 modules.

Emerging Roles

Establishing clear institutional roles in pixel system for the 2x2 detector

UPenn:	System design review and revision, PCB design, evaluation
Caltech:	Packaged ASIC and pixel tile assessment at room temperature
UCSB:	Detailed ASIC characterization at room temp (room, cryo?)
CSU:	Detailed pixel tile characterization, tuning, and calibration (room, cryo)
UTA:	Large-scale cryogenic tile testing and integration before 2x2 installation
SLAC:	TPC mechanical structure design, interfaces with pixel tile
Rutgers:	DAQ hardware/software interfaces and development

Also:

Expect most groups will engage with pixel TPC simulation and analysis studies

Near term:

- 1) Share knowledge with all partners: weekly meetings, email, slack, shared directory, etc.
- 2) Establish detailed 2x2 production plan: description of tasks, schedule, resources
- 3) Setup v1 systems (4-chip tile, DAQ board, software) at partner institutions by end of May