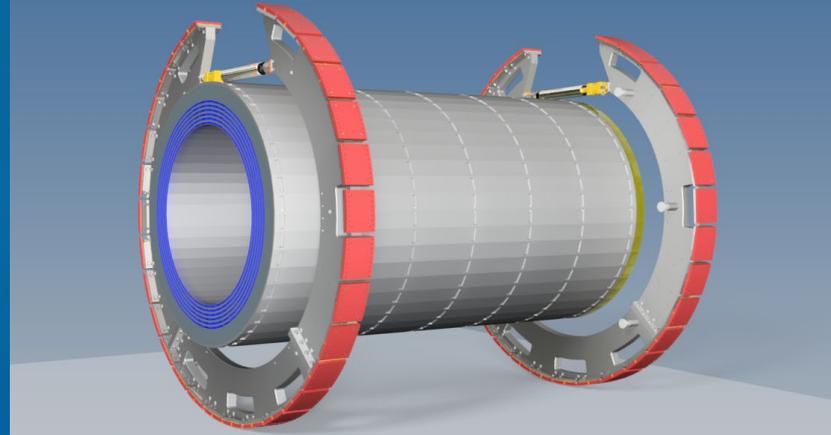


The ePIC Barrel Imaging Calorimeter

Mechanics & Sectors

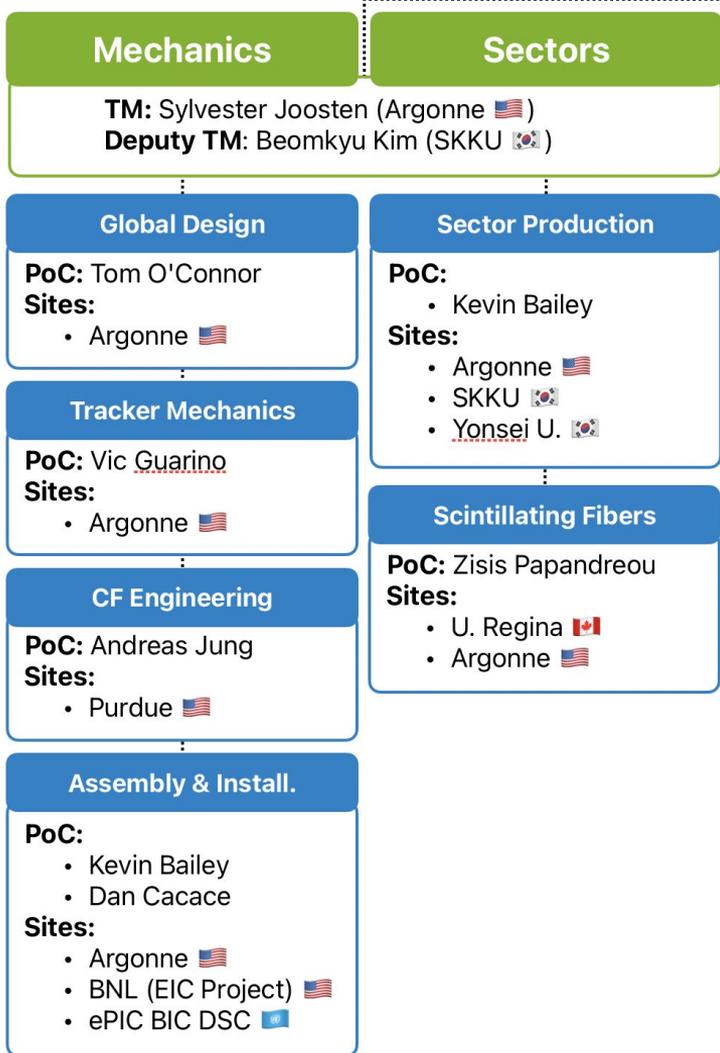


Sylvester Joosten
Argonne National Laboratory

4th BIC In-Person Workshop
April 9-11, 2025



Mechanics & Sectors Organization



Work Package Scopes:

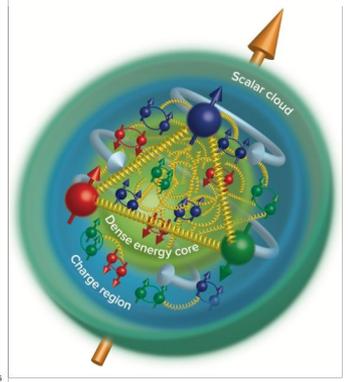
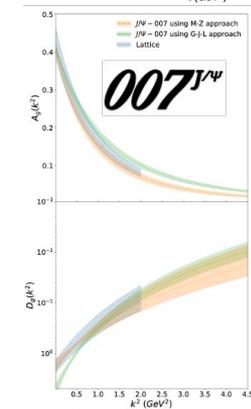
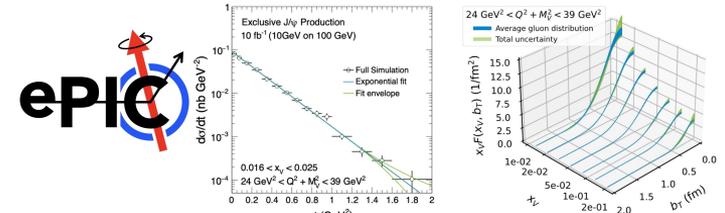
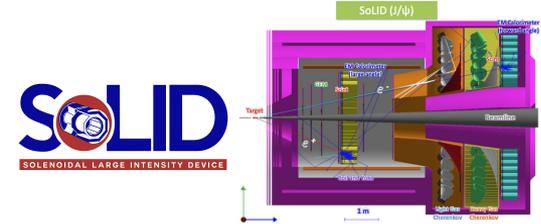
- **Global Design:**
 - Global CAD design and system FEA
- **Tracker Mechanics:**
 - Module/tray mechanics
 - Module/tray installation tooling
 - Ancillary tooling for module/tray production and testing
- **CF Engineering**
 - Destructive testing
 - CF frames
- **Assembly & Install**
 - Barrel assembly & install
 - Sector assembly tooling
 - Test article & sector assembly
- **Sector production**
 - Pb/ScFi matrix production
 - Test article construction
- **Scintillating Fibers**
 - Fiber QA/QC

Bio Page

Sylvester Joosten

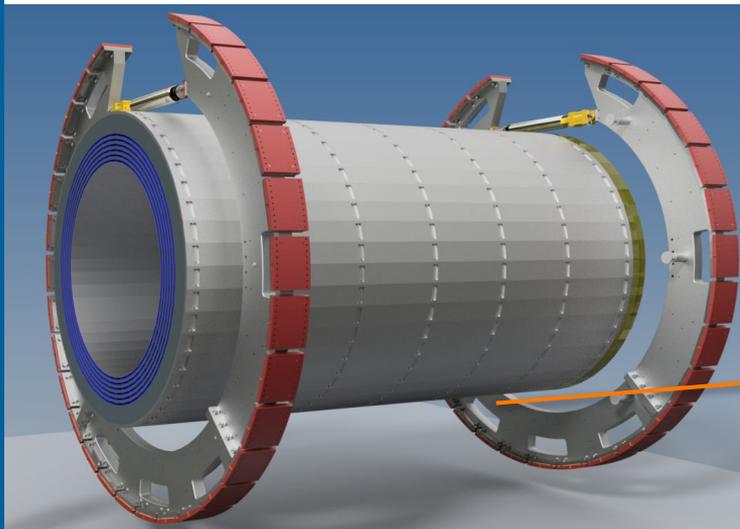


- Physics Division @Argonne since 2018 - deputy group leader for Medium Energy Physics
- PhD at University of Illinois Urbana-Champaign on HERMES@DESY
- JLab experiments since 2013 (Hall C J/psi-007, A1n/d2n, Hall A SoLID, and Hall B CLAS/CLAS12)
- Hardware background in PMTs/MCP-PMTs and Cherenkov detector development (CLAS & SoLID)
- EIC software, detector design, and physics program development since 2018
- Software Convener for ATHENA, former software development coordinator for ePIC
- Main scientific focus is proton mass structure through exclusive quarkonium production
- Other: Like running and climbing, play the violin



Global Design

Envelopes mostly frozen with EIC Project

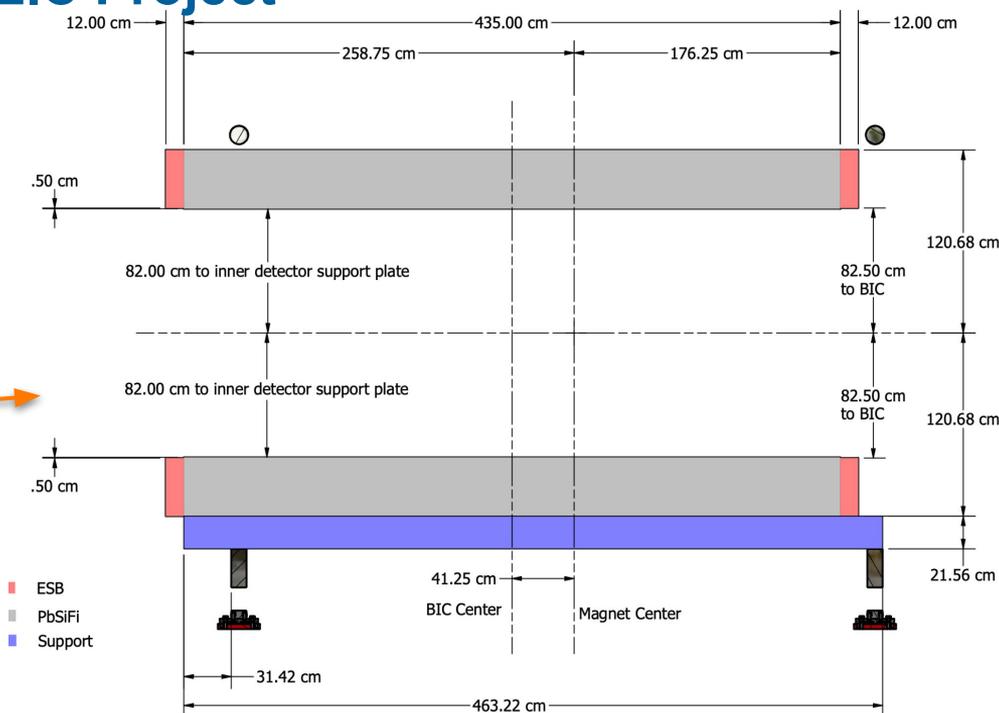


Sector weight: 1769 pounds (not including ESBs)

Total BIC weight: 84,912 pounds (42.5 US tons)

Fibers per sector: 21,981

Total number of fibers: 1,055,088



Main priority is system FEA to demonstrate self-supporting design.
Pending destructive delamination testing of CF/PbScFi and internal Pb/ScFi

Engineering Envelopes

Global BIC Envelopes



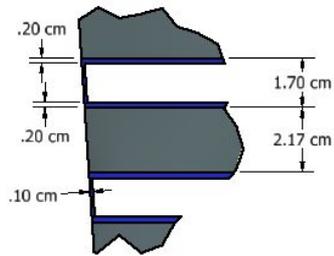
82.5cm Inner Radius:

Sector Weight = 1769 pounds (not including EOS Boxes)

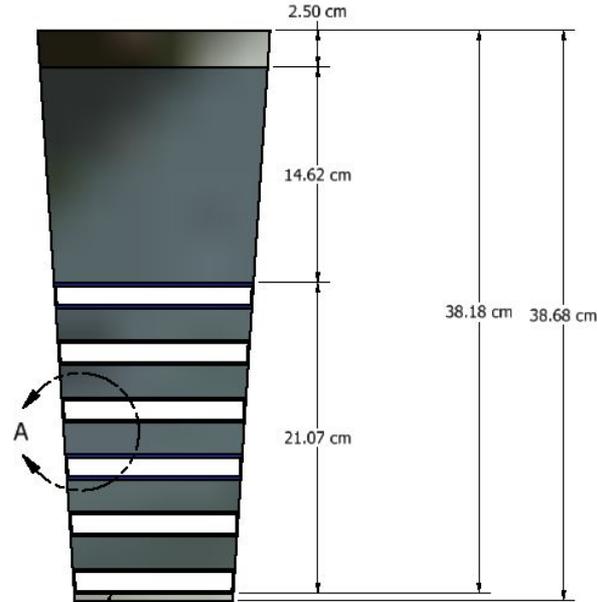
Total BCAL Weight = 84,912 pounds

Fibers per Sector = 21,981

Total Number of Fibers = 1,055,088



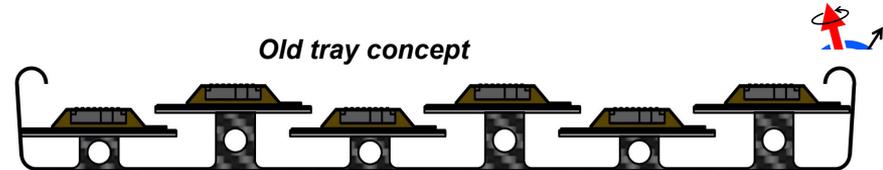
DETAIL A
SCALE 3 / 4



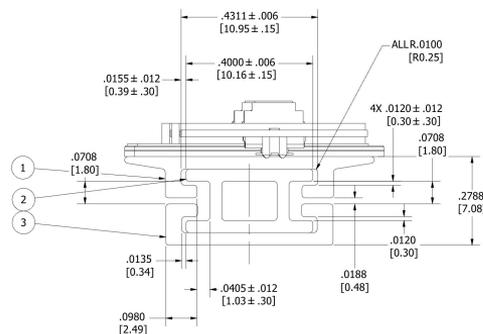
82.5cm to Astropix Layer 1

Tracker Mechanics

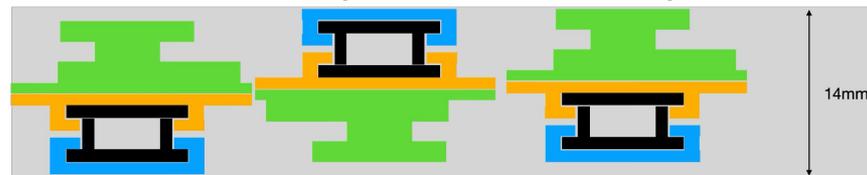
- First iteration of mechanical test articles
 - Initial concept: mount 9-chip AstroPix **modules** on **staves**, then slide **staves** on **rails** integrated in the CF frames
 - Components made out of extruded aluminum to minimize cost, due late this month.
 - Known that design is too tall (does not fit), but important to validate tolerances with extruded aluminum are acceptable
- Concept for second iteration: staveless tray-based design to minimize height and simplify installation, similar to older conceptual design
 - Trays positioned at outer radius has sensors pointing inwards and leverages trapezoidal design to stay locked in place



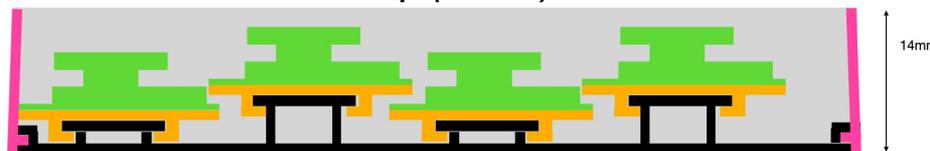
Initial stave concept beign produced



Initial stave concept does not fit with overlaps



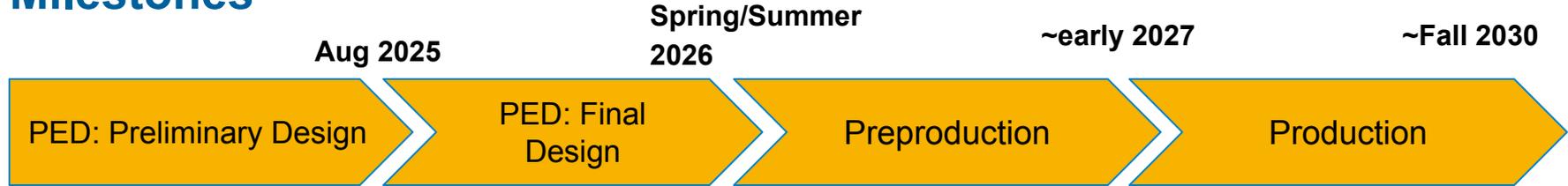
Second iteration concept (cartoon) does fit



Tracker Mechanics



Milestones



#	Title	Expected End
317	AVAIL: Tracker Mechanics Mockup	May 12, 2025 at 5:00 PM
320	AVAIL: Tracker Mechanics Preliminary Design	Jun 30, 2025 at 5:00 PM
321	Tracker Mechanics PDR-ready	Jun 30, 2025 at 5:00 PM

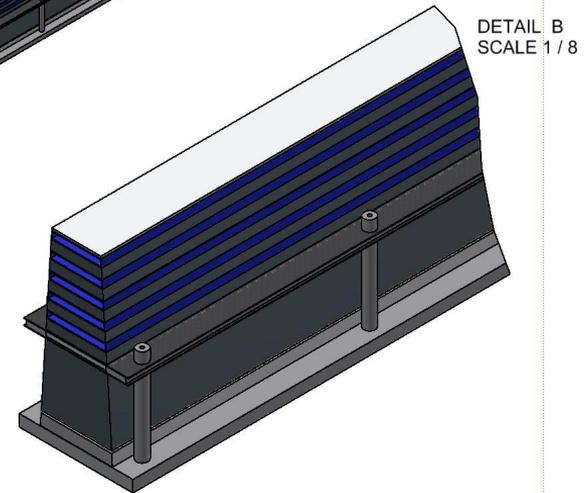
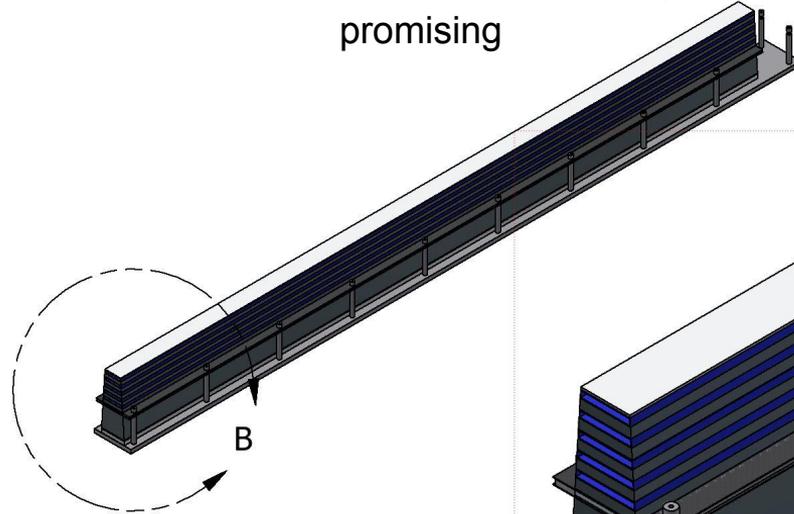
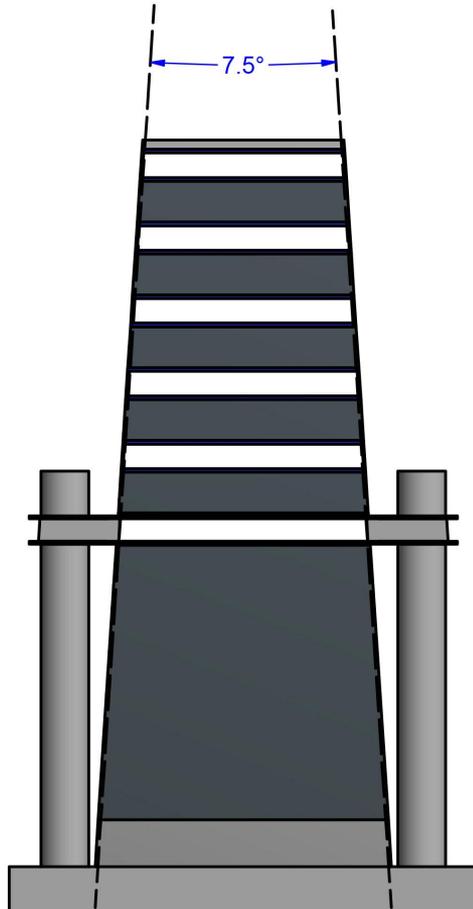
#	Title	Expected End
486	AVAIL: long mechanical tracker components	Apr 2, 2026 at 5:00 PM
488	AVAIL: modules	May 14, 2026 at 5:00 PM
490	AVAIL: assembly tooling for staves	Jun 11, 2026 at 5:00 PM
493	AVAIL: Ancillary tooling for stave/tray testing	Aug 6, 2026 at 5:00 PM
494	Tracker Mechanics ready for PRODUCTION	Aug 6, 2026 at 5:00 PM

#	Title	Expected End
325	AVAIL: Updated Tracker Mechanical Mockup	Sep 25, 2025 at 5:00 PM
327	AVAIL: Rail/CF Integration Mockup	Dec 12, 2025 at 12:00 PM
331	AVAIL: Tracker Stave Install Tooling	Dec 23, 2025 at 5:00 PM
332	Tracker Mechanics FDR-ready	Dec 23, 2025 at 5:00 PM

Tracker Frame Integration Concept

Filler material serves multiple purposes

- Direct integration during sector assembly
- Assists in aligning and stabilizing the build
- Supports the tracker frame during assembly
- Initial FEA results by Purdue engineers are promising

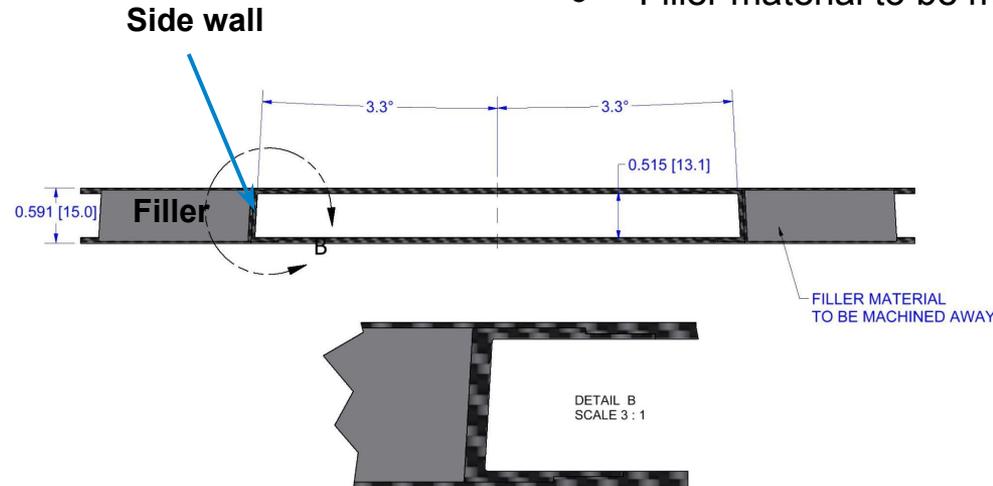


CF Engineering: Tracker Frame Integration Concept



Tracker frame consists of four pieces:

- Machined top and bottom plates
- C shaped side pieces with filler material (to be machined away later)
- Fabricated in longitudinal sections with non-overlapping seams
- Filler material to be machined away



CF Engineering



Milestones



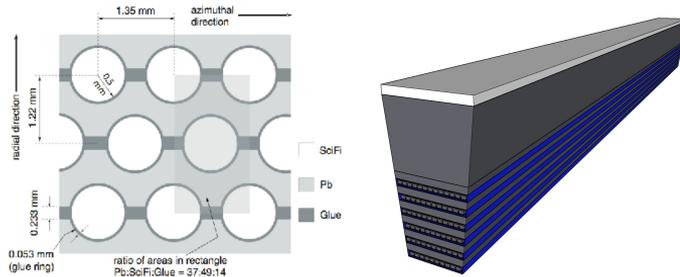
#	Title	Expected End
334	<i>START WORK WITH PURDUE</i>	<i>Apr 21, 2025 at 12:00 AM</i>
336	<i>AVAIL: CF parts for destructive tests</i>	<i>May 9, 2025 at 5:00 PM</i>
338	<i>Initial frame design complete</i>	<i>May 9, 2025 at 5:00 PM</i>
340	<i>Tracker frame test article (short)</i>	<i>May 23, 2025 at 5:00 PM</i>
343	<i>Destructive Tests Complete</i>	<i>Jun 24, 2025 at 5:00 PM</i>
345	<i>AVAIL: CF parts for HamburgerCal & ClubBIC</i>	<i>Jul 29, 2025 at 5:00 PM</i>
346	<i>CF Frame Design PDR-ready</i>	<i>Jul 29, 2025 at 5:00 PM</i>

#	Title	Expected End
350	<i>AVAIL: CF parts for long frame</i>	<i>Nov 28, 2025 at 12:00 PM</i>
352	<i>CF Frame Design FDR-ready</i>	<i>Dec 5, 2025 at 12:00 PM</i>

#	Title	Expected End
498	<i>AVAIL: CF components</i>	<i>Aug 10, 2026 at 5:00 PM</i>
499	<i>CF Engineering ready for PRODUCTION</i>	<i>Aug 10, 2026 at 5:00 PM</i>

Sector Production Model

Based on the proven BlueX BCAL approach



- **Fiber reception + QC**
 - Baseline: fibers come in canes (pre-cut, in contract!)
 - *Mitigation: fibers come in spools, requires cutting + additional QC + relaxation*
- **Lead reception** (rolls to size) + swaging
- **CF frame** component reception, produced as subcontract
- **Manufacture matrix** (lead-epoxy-fiber), mayan pyramid
 - ~ 0.5-1 layer / press / day, continuous QCIntegrate CF frames in production process (monolith)
- **Machine sectors** at external machine shop
- **Polish ScFi + final QC**
- **Ship to BNL**

Production process development and optimization
important component to PED program

Sector Production



Milestones



#	Title	Expected End
361	<i>Able to swage lead</i>	<i>Apr 15, 2025 at 5:00 PM</i>
367	<i>First dummy SFIL built at Argonne</i>	<i>May 6, 2025 at 5:00 PM</i>
369	<i>Able to machine Pb/ScFi test articles</i>	<i>May 27, 2025 at 5:00 PM</i>
373	<i>AVAIL: test articles for destructive testing</i>	<i>Jun 10, 2025 at 5:00 PM</i>
380	<i>AVAIL: Short SFIL with GlueX Scintillating fibers</i>	<i>Jul 9, 2025 at 12:00 PM</i>
390	<i>AVAIL: Short Bulk Pb/ScFi (SFBL) with GlueX Scintillating Fibers</i>	<i>Jul 30, 2025 at 12:00 PM</i>
391	<i>Sector Design PDR-Ready</i>	<i>Jul 30, 2025 at 12:00 PM</i>

#	Title	Expected End
398	<i>AVAIL: HamburgerCal</i>	<i>Aug 22, 2025 at 12:00 PM</i>
404	<i>AVAIL: ClubBIC</i>	<i>Sep 19, 2025 at 12:00 PM</i>
407	<i>Finished production development in Rm B102</i>	<i>Sep 24, 2025 at 12:00 PM</i>
410	<i>Start preparing for work in building 369</i>	<i>Jun 1, 2025 at 12:00 AM</i>
430	<i>B369 ready for PED article construction</i>	<i>Oct 29, 2025 at 12:00 PM</i>
435	<i>AVAIL: Long SFIL</i>	<i>Dec 10, 2025 at 12:00 PM</i>
440	<i>AVAIL: LankyTeenagerBIC</i>	<i>Jan 9, 2026 at 12:00 PM</i>
441	<i>Sector Design FDR-Ready</i>	<i>Jan 9, 2026 at 12:00 PM</i>

Sector Production (con't)



Milestones



#	Title	#	Title	Expected End
361	Able to swage	398	AVAIL: HamburgerCal	Aug 22, 2025 at 12:00 PM
367	First dummy S	404	AVAIL: ClubBIC	Sep 19, 2025 at 12:00 PM
369	Able to machir	407	Finished production development in Rm B102	Sep 24, 2025 at 12:00 PM
373	AVAIL: test art testing	410	Start preparing for work in building 369	Jun 1, 2025 at 12:00 AM
380	AVAIL: Short S Scintillating fit	430	B369 ready for PED article construction	Oct 29, 2025 at 12:00 PM
390	AVAIL: Short B GlueX Scintilla	435	AVAIL: Long SFIL	Dec 10, 2025 at 12:00 PM
391	Sector Design	440	AVAIL: LankyTeenagerBIC	Jan 9, 2026 at 12:00 PM
		441	Sector Design FDR-Ready	Jan 9, 2026 at 12:00 PM

#	Title	Expected End
522	Ready for pre-production bulk manufacturing	Jul 30, 2026 at 5:00 PM
545	Sector ready for machining	Oct 29, 2026 at 8:19 AM
553	AVAIL: Preproduction sector	Jan 7, 2027 at 8:19 AM
554	Sectors ready for PRODUCTION	Jan 7, 2027 at 8:19 AM

Scintillating Fibers



CD3a/b procurement ongoing

- Open bidding ongoing
- Bidding requires vendors to send sample of 100 fiber canes for testing, (canes are production length, i.e. 4.55m)
- Test results factor in ultimate choice of fiber vendor
- Multiple vendors are participating in the bidding, and most fibers for testing are currently at U. Regina, with some backups at Argonne
- U. Regina has performed initial testing
- Procedure to choose fiber vendor has started this week
- CD3a included a first portion of our fibers, CD3b will include a next batch



Plan for this workshop



- Today, We April 9
 - Mechanics Schedule Review (A323)
 - Joint Mechanics & Modules (D172)
 - Test articles, Module-tray integration, Module locking system, Envelope, Overlap between staves, ETC mounting strategy, Cooling/AstroPix power, Installation strategy and tooling, Module overlap and flex design
- Tomorrow, Thu April 10
 - Joint Mechanics & ESB (A323)
 - Mechanics Planning (A323)
- Fri, April 11
 - Mechanics Wrap-up (A323)