BIC:
Production Deliverables & Objectives Planning

Jessica Metcalfe & Green Team Leaders (GTLs)

Deliverables/Objectives Planning

Goal: This document was created to facilitate groups picking up areas where they can take a **lead** to deliver items for BIC

- Identified items are those that the current responsible is willing to have a new person/group take over the lead responsibility
  - it does not mean that those items are uncovered
  - being the lead means taking responsibility to get the item completed
    - **other groups can also contribute** (depending on task)

Deliverables/Objectives Planning

Document (slides) are divided into two parts

1. **PED Objectives**
   a. These are studies or development tasks that need to be done before production (or earlier)
   b. Often stand-alone tasks that a new group or individual can take responsibility to deliver
   c. Responsible to work with GTL and other institutes to organize and carry-out the deliverable item

2. **Production Deliverables**
   a. An institution can be responsible to deliver the production items in the full quantity needed and timescale needed by the project
   b. There are some purchasing options to buy certain production items
   c. If a group is delivering an item or percentage (say 50%), then they are also responsible for the preproduction of those items (preproduction is around 5% of the production total, so a 50% share would mean 50% of the 5% of preproduction or 2.5%)

Deliverables/Objectives Planning

This document uses bubble charts in the PED workflow (before production) and the final production flow to identify needed objectives and production deliverables.

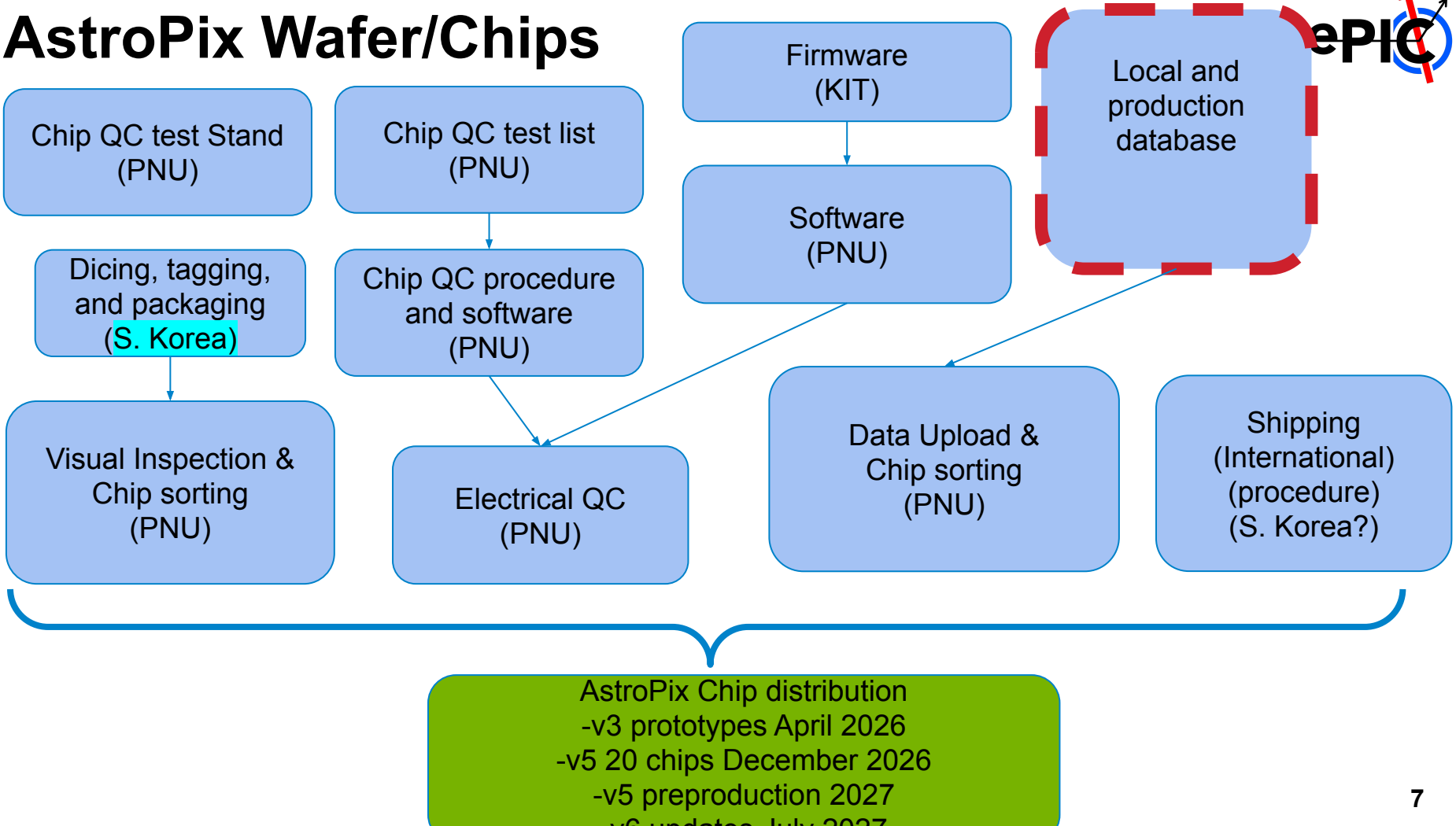
Opportunities for taking on a objective or production deliverable are designated with red dashed lines around the bubble

Objective Deliverables (Before production)

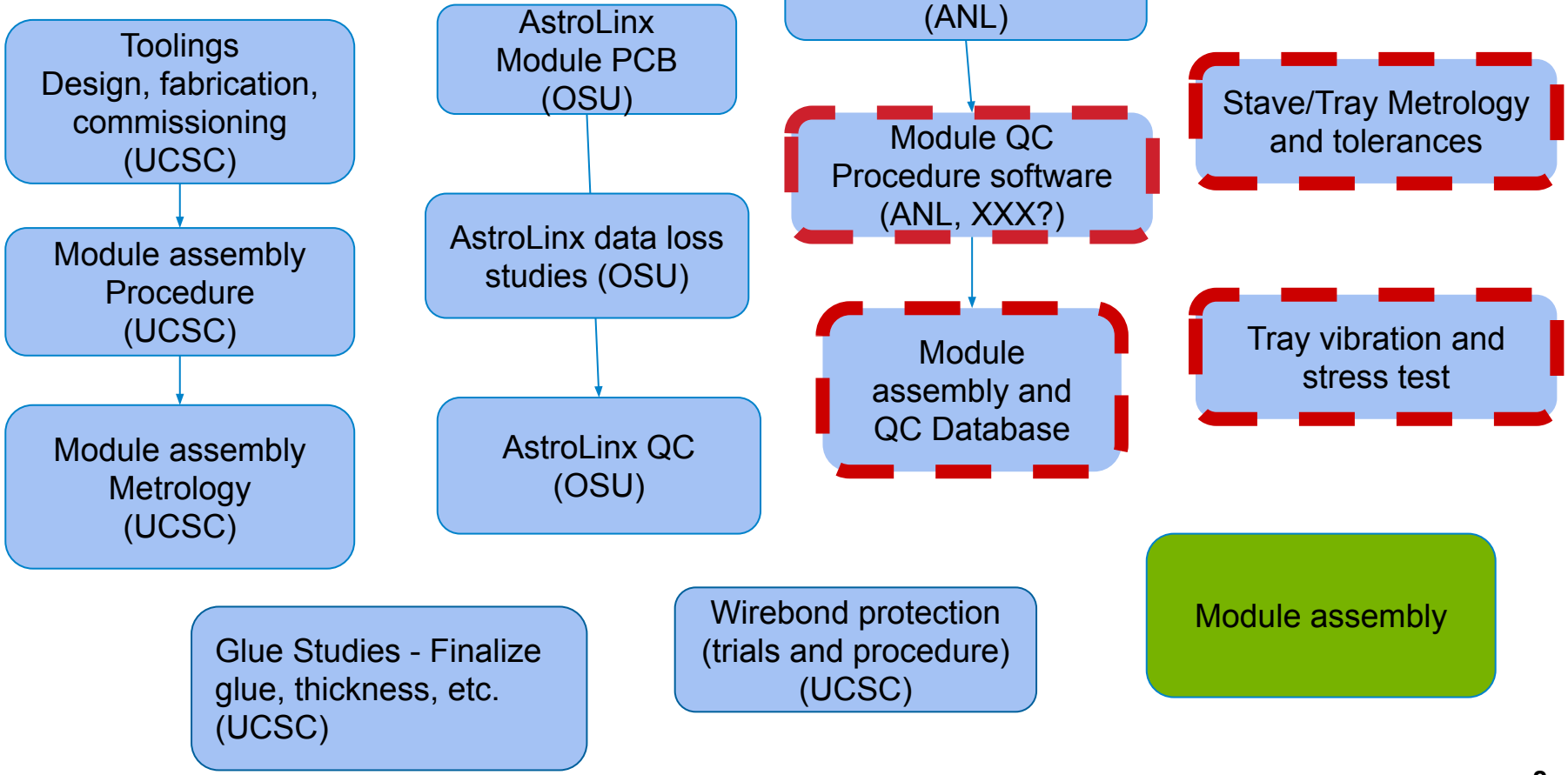
PED Objectives: Modules and Wafers

GTL: Manoj Jadhav

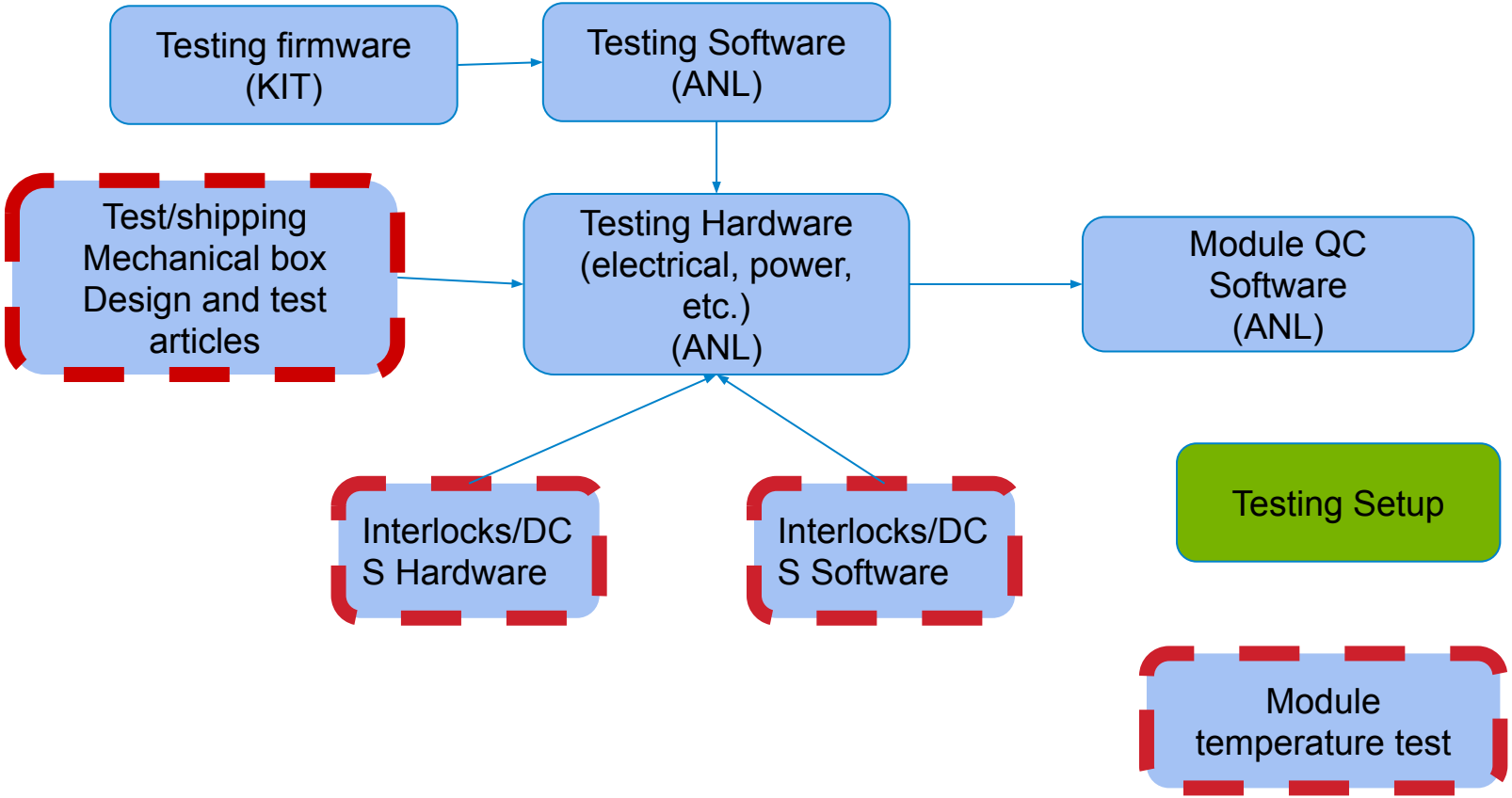
AstroPix Wafer/Chips



Module Assembly



Test Stand-Modules

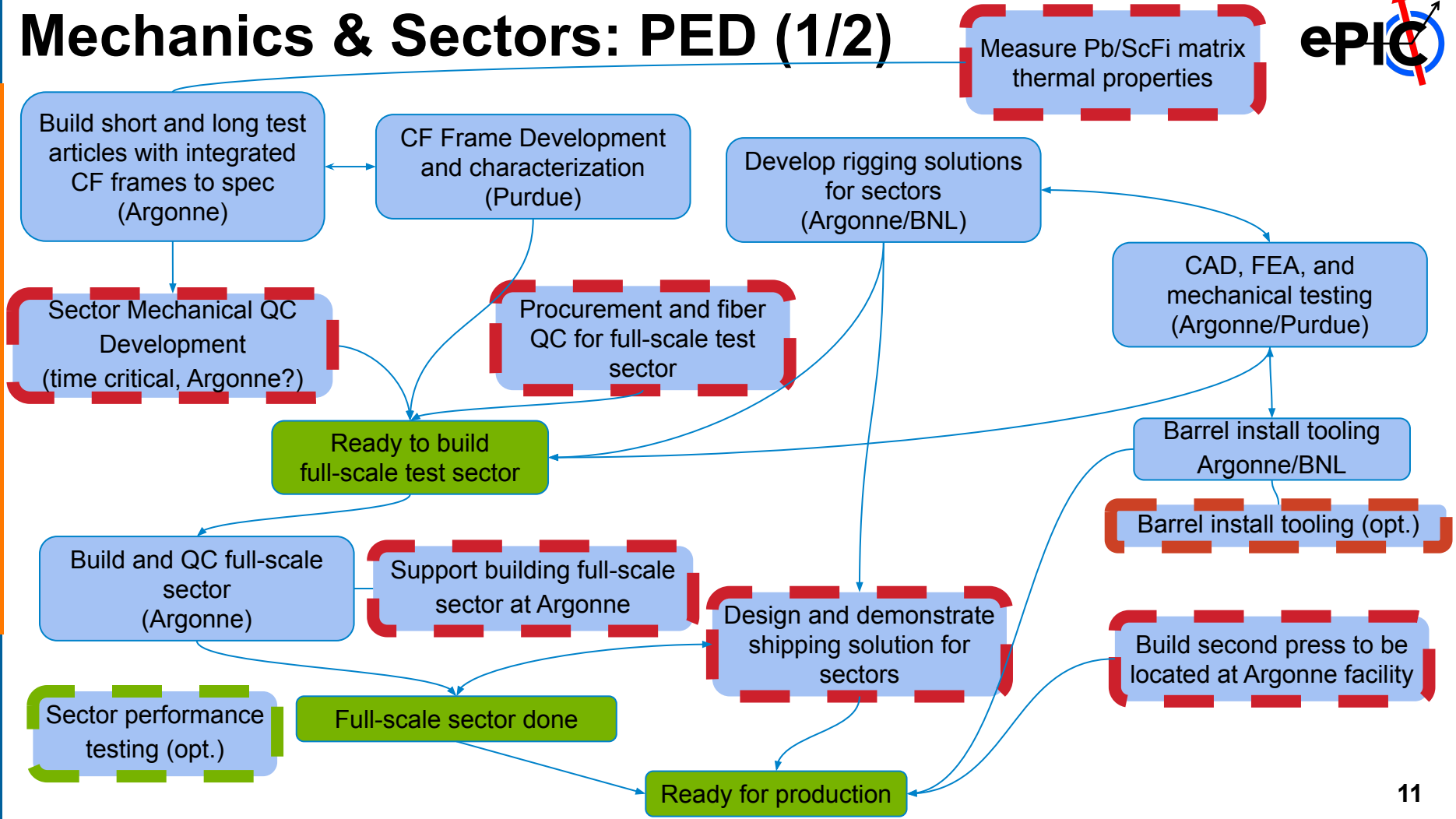


PED Objectives: Mechanics & Sectors

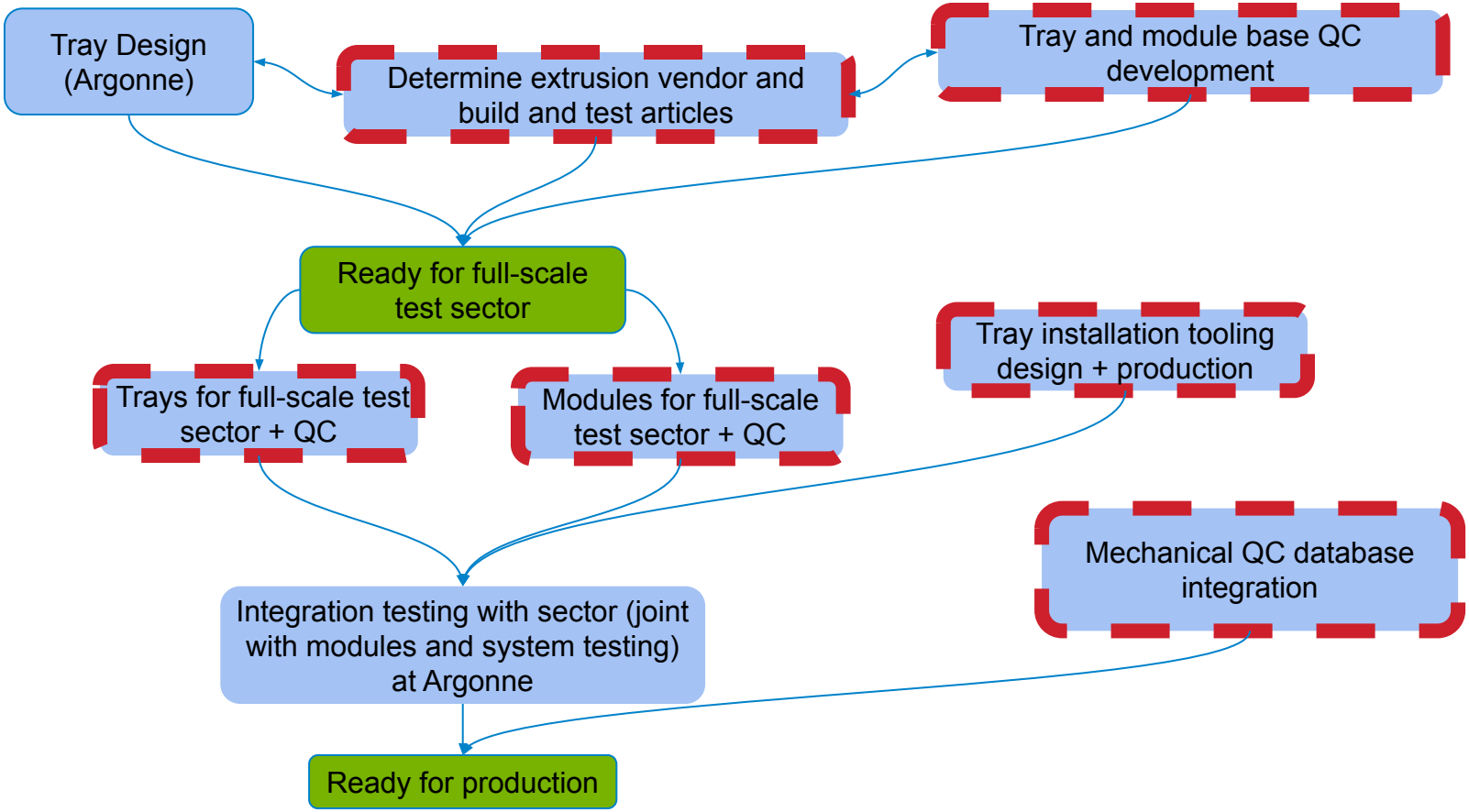
GTL: Sylvester Joosten

Mechanics & Sectors: PED (1/2)

sector

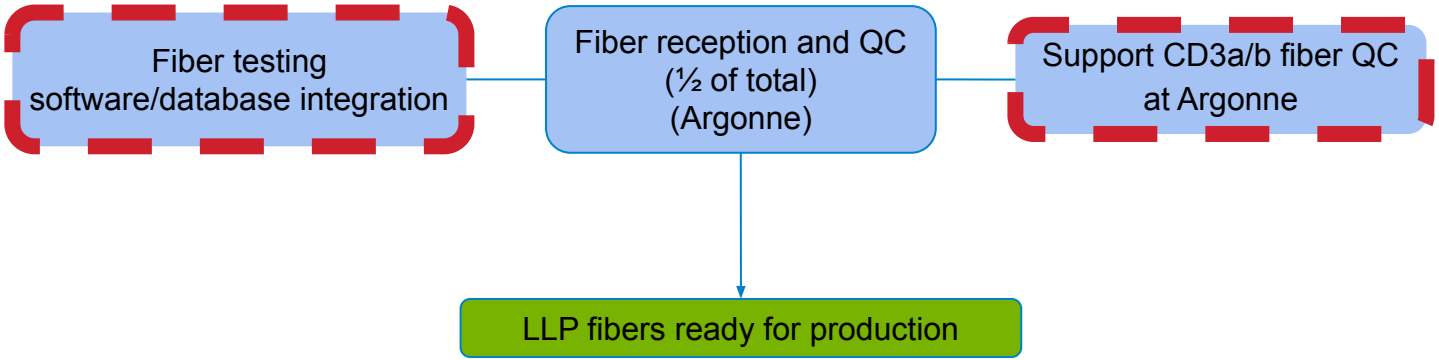


Mechanics & Sectors: PED (2/2)



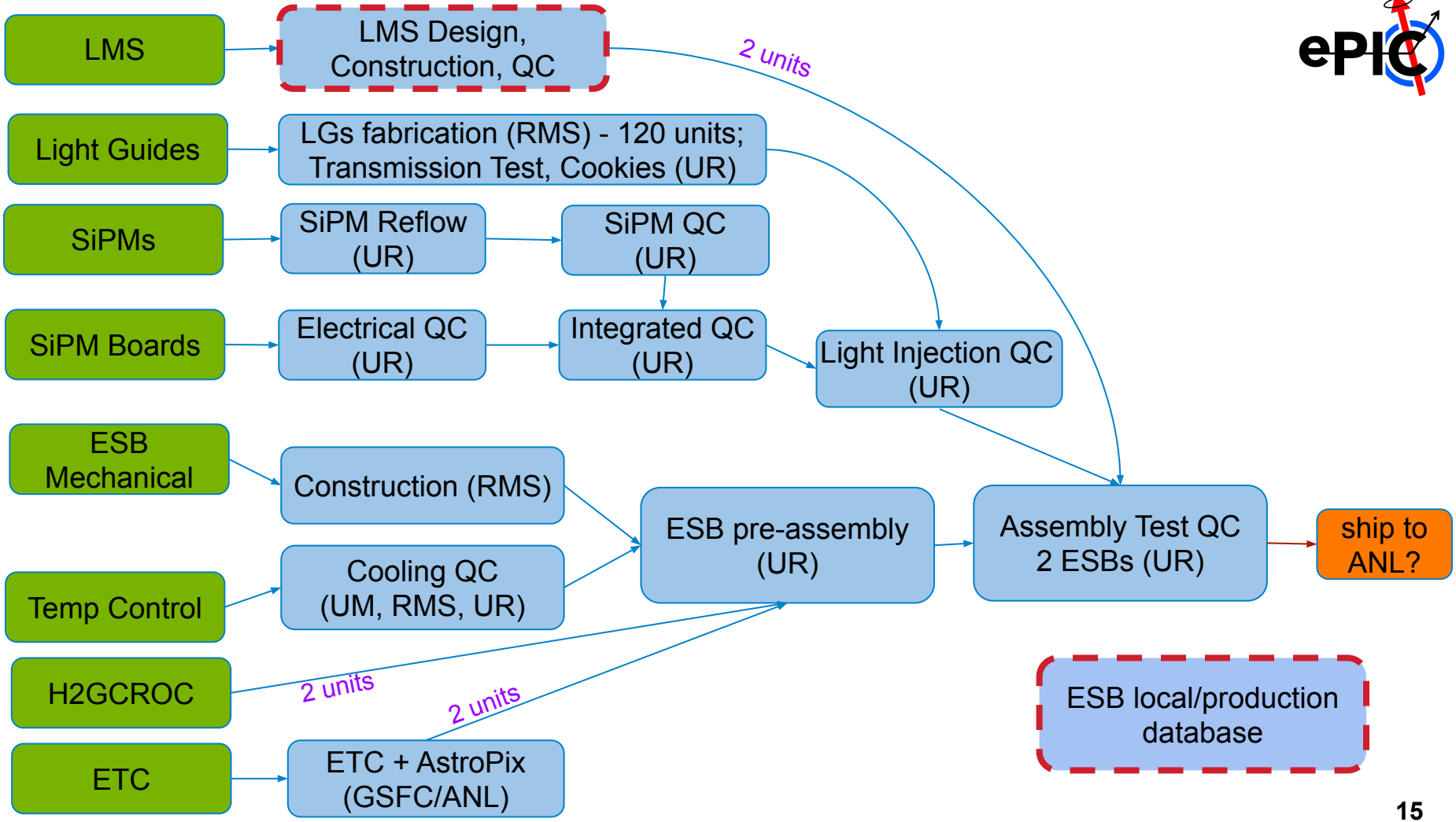
Mechanics & Sectors: LLP

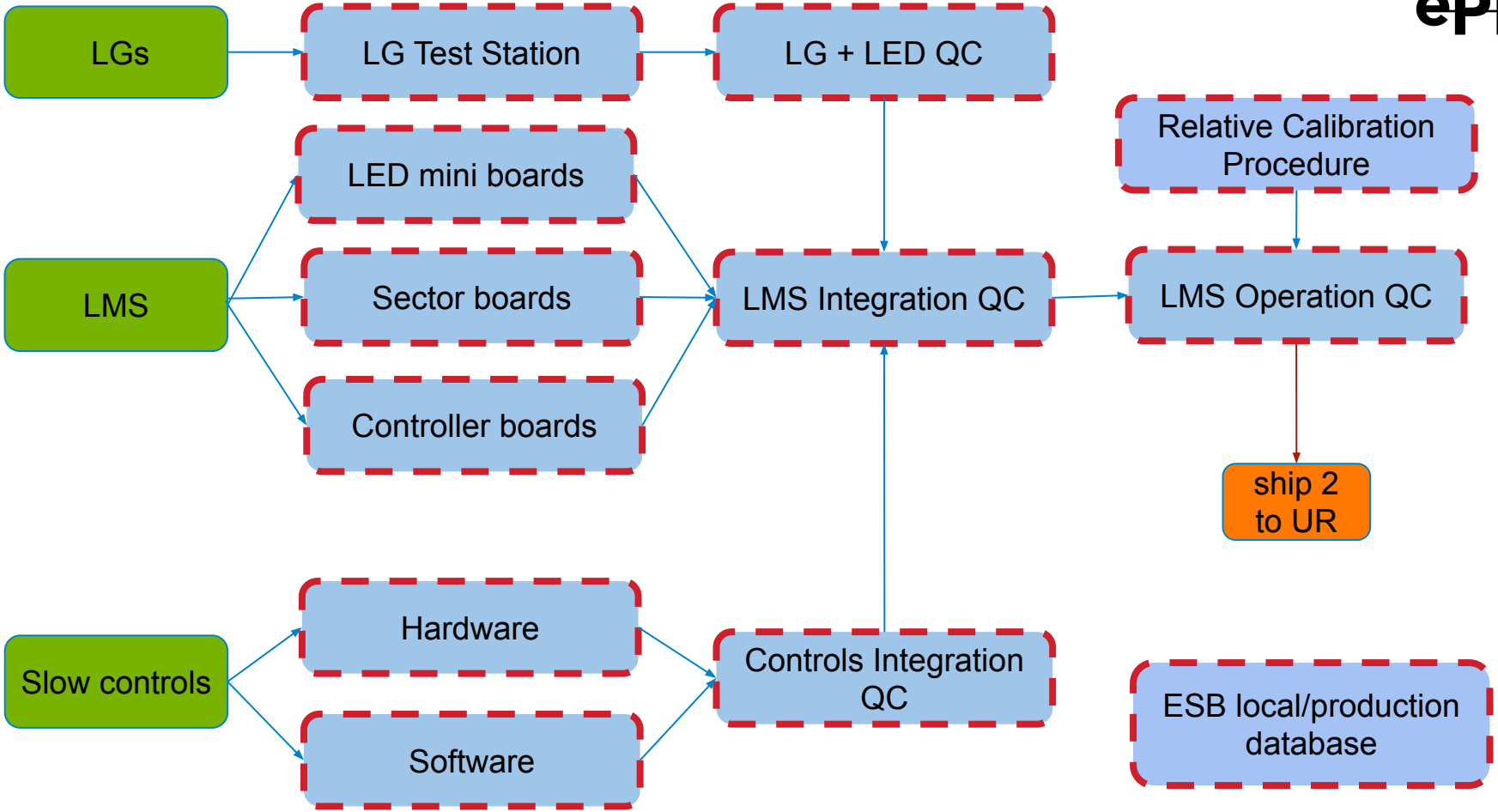
sector



PED Objectives: ESB

GTL: Zisis Papandreou

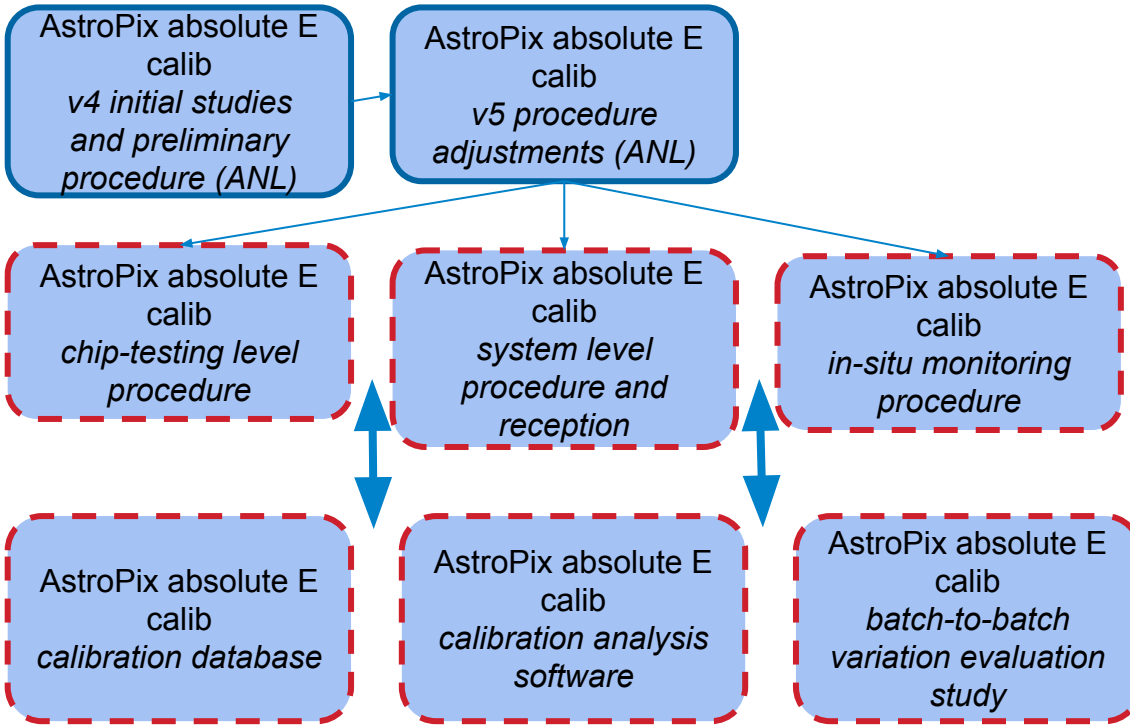

LMS
LMS Design, Construction, QC
2 units
Light Guides
LGs fabrication (RMS) - 120 units; Transmission Test, Cookies (UR)
SiPMs
SiPM Reflow (UR)
SiPM QC (UR)
SiPM Boards
Electrical QC (UR)
Integrated QC (UR)
Light Injection QC (UR)
ESB Mechanical
Construction (RMS)
ESB pre-assembly (UR)
Assembly Test QC 2 ESBs (UR)
ship to ANL?
Temp Control
Cooling QC (UM, RMS, UR)
H2GCROC
2 units
2 units
ETC
ETC + AstroPix (GSFC/ANL)
ESB local/production database

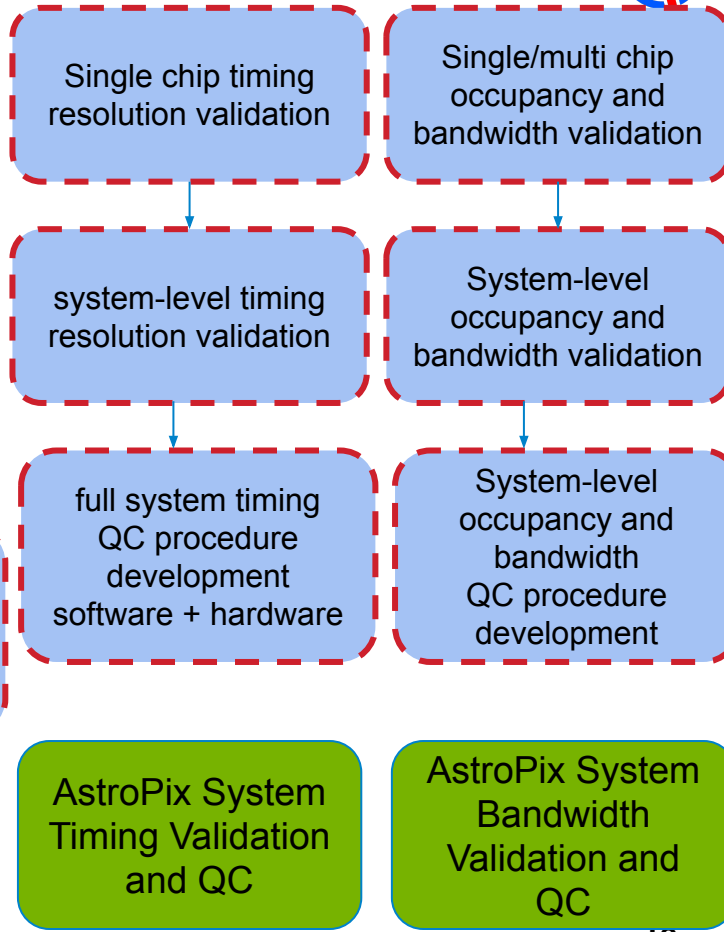

LGs
LG Test Station
LG + LED QC
Relative Calibration Procedure
LED mini boards
LMS
Sector boards
LMS Integration QC
LMS Operation QC
Controller boards
ship 2 to UR
Hardware
Slow controls
Controls Integration QC
ESB local/production database
Software

PED Objectives: *System Level QC and Validations*

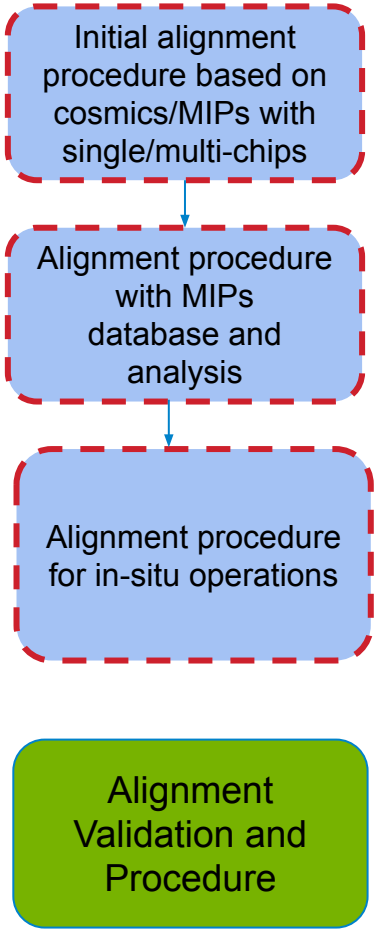
GTL: Maria Zurek

AstroPiX Calibration and System Tests





AstroPiX Calibration and System-Level Tests



SciFi Calibration and System Tests

SciFi E calib
Relative energy/gain calibration w/ LMS system

SciFi calib
calibration analysis software and database

SciFi calib
system timing and energy calibration procedure and validation

This includes full procedure for z-dependent energy and timing calibration in-situ

Mechanical Integration and test of PREP Sector (ANL)

Electrical Integration and test of PREP Sector (ANL)

Validation of the System Calibration procedure for ScFi (ANL)

Validation of the System Calibration procedure for AstroPix (ANL)

Validation of the full readout chain (ANL)

Validation of the QC procedure and adjustments (ANL)

Calibration Procedure for ScFi Developed

Light output validation (MIPs) (ANL)

Slice Testing for PREP Sector with cosmics

Beam Test Validations

Finalizing the optimal summing scheme and shaping of SciFi signal w/ CALOROC (Regina/ORNL)

Validation of position resolution and shower separation in long/full TA

Validation of energy resolution in the full depth TA with CALOROC (ANL)

Efficiency (tracking and shower!) validation with v5/v6

Position resolution validation with v5/v6

Data rate validation with v5/v6

Stability of (bench) calibration validation in the beam

Validation of timing resolution in beam environment

Irradiation studies for AstroPix (ANL)

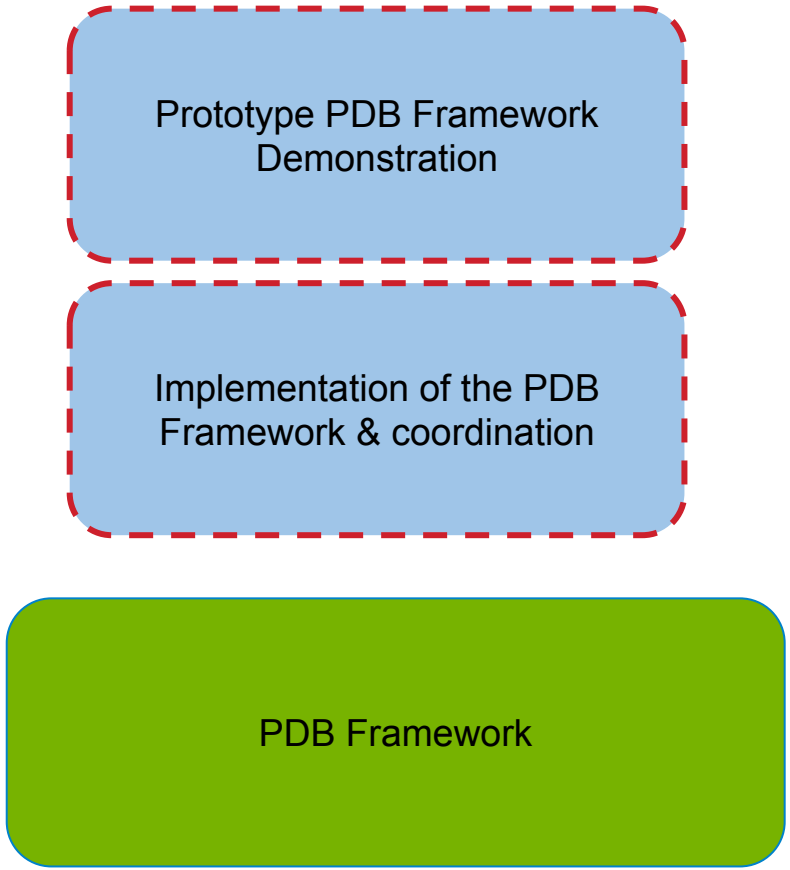
Validation of the System Calibration procedure for AstroPix in the beam

Validation of the System Calibration procedure for ScFi in the beam

Validated full E and position resolution of the integrated system with CALOROC readout

Imaging capabilities of AstroPiX and SciFi layers (electron, pion) benchmarked

Calibration procedure validated in the beam test (full/large scale prototype)


Prototype PDB Framework Demonstration
Implementation of the PDB Framework & coordination
PDB Framework

PED Objectives: *Reception and Integration at BNL*

GTL: Maria Zurek

Integration @ BNL (Procedures)

LG glueing procedure developed, tested, and documented (reception staff training)

SciFi reception procedure developed, tested, and documented (ANL)

Sector “pre-installation” (AstroPix trays, ESB) (ANL)

Full system electrical QC and (possible) MIP calibration (ANL)

Tray reception procedure developed, tested, and documented (reception staff training)

ESB reception procedure developed, tested, and documented (reception staff training) (URegina)

Barrel installation procedure (BNL?)

Electrical QC and (possible) MIP calibration in-situ (ANL)

Space preparation in BNL

Full Reception Procedure Developed and Validated

System Installation and System QC and Calibration

Production Deliverables

including share of preproduction (~5%)

Production Plan

Numbers of Parts

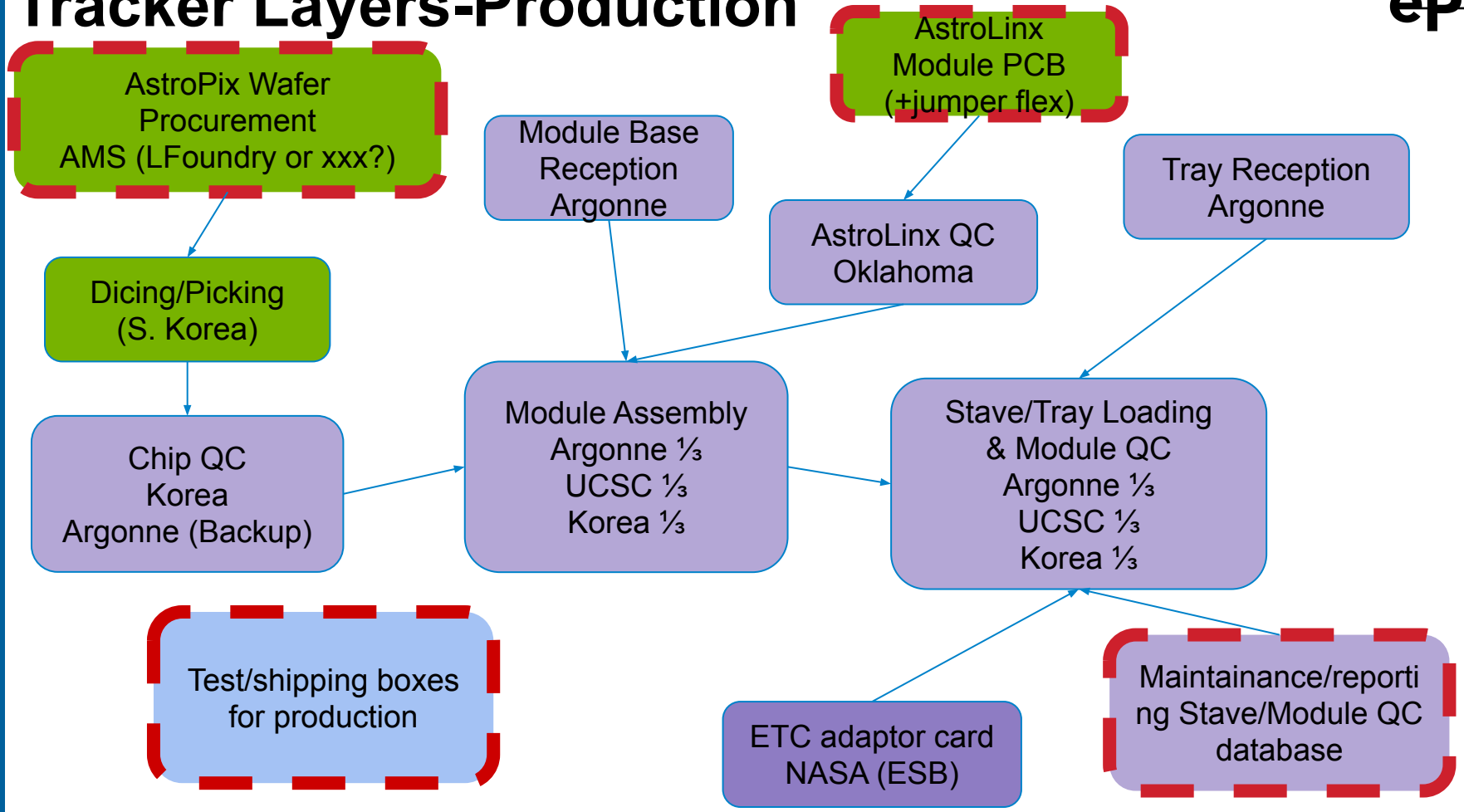
	Total on-detector	Yield at step	Cumulative Yield	Total # parts to produce
sectors	48			
trays	384	99%	99%	388
staves	2592	98%	97%	2,672
modules	31104	95%	92%	33,747
AstroPix chips	279936	85%	78%	357,319
wafers				5,956
end-of-tray cards	384	90%	90%	427
tray support rails	384	95%	95%	405
module PCBs	31104	90%	81%	41,663
module base plate	31104	95%	87%	35,523
fiber canes	1M	98%	98%	4900 km
end-of-sector-boxes	96	96%	96%	100
SiPM's	5760	96%	96%	6022
CALOROC PCB	96	95%	95%	101

exact numbers could still change before production

Production: Modules and Wafers

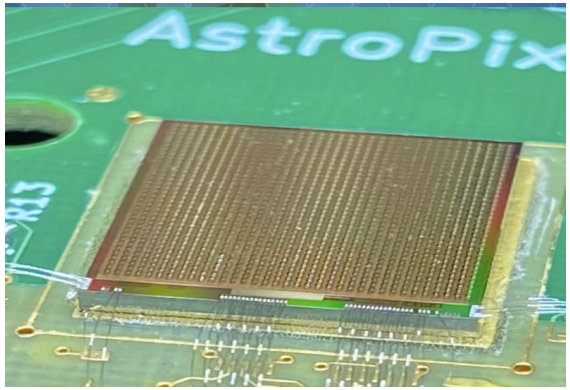
GTL: Manoj Jadhav

Tracker Layers-Production



Wafer QC Probing

1. Purchase wafers
2. Dicing
   a. picked by vendor, comes in waffle pack
3. Automated wafer (or chip) QC probing
   a. Visual inspection
   b. Full chip functionality
   c. Sensor IV
   d. Pixel-by-pixel performance
4. Ship to module assembly sites



ePIC

C3,5

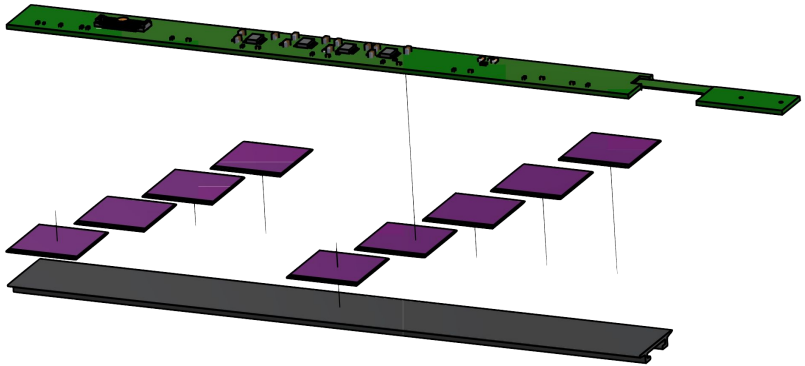
→Expect to have a high yield after chip testing until glued on a module

Wafer QC	# parts	# per batch	# batches	hours/batch	minutes/piece	# people	Total Person hours	Inactive hours/batch	Batches/week/production line	# of production lines	Total production weeks	Total production years (w/ 85% annual efficiency)
chip probing	357,319	60	5,956	5	5	1	596	4.9	15	6	66	1.5

Module Assembly

1. Stage chips and module base plates onto tooling
2. Glue chips to base plate, cure
3. Stage module and AstroLinx onto tooling
4. Glue AstroLinx to module, cure
5. Wire bond
6. Pot wire bonds (under consideration)

C3,5



Module Assembly	# parts	# per batch	# batches	hours/batch	minutes/piece	# people	Total Person hours	Inactive hours/batch	Batches/week/production line	# of production lines	Total production weeks	Total production years (w/ 85% annual efficiency)
chip reception	303721	100	3037	0.17	0.1	1	506	0	240	3	4	0.10
module gluing	33747	6	5625	5	-	1	2812	4.5	5	18	63	1.4
gluing AstroLinx	33747	6	5625	5	-	1	2812	4.5	5	18	63	1.4
wire bonding	33747	1	33747	0.25	15	1	8437	0	160	3	70	1.60
potting	33747	6	5625	0.17	1.7	1	937	8	240	3	8	0.18

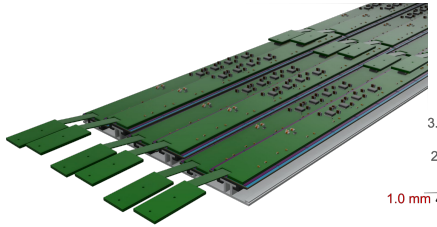
Stave/Tray Assembly

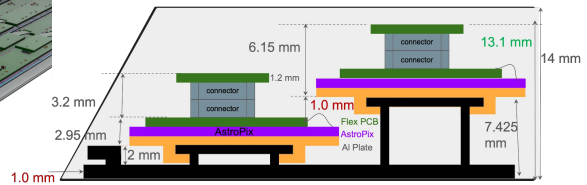
1. Slide modules onto *bottom row* of the tray support rails
2. plug connectors, quick test, rework
3. Slide modules onto *top row* of the tray support rails
4. plug connectors, quick test, rework
5. Full electrical QC w/ end-of-tray card
6. Pack and ship to BNL

C3,5

Reworkable design:

- connectors rated for mating cycles
- no gluing





Tray Assembly	# parts	# per batch	# batches	hours/batch	minutes/piece	# people	Total Person hours	Inactive hours/batch	Batches/week/production line	# of production lines	Total production weeks	Total production years (w/ 85% annual efficiency)
assemble modules on tray	388	1	388	5	300	1	1940	0	8	3	16	0.37
Tray electrical QC	388	1	388	0.5	30	1	194	48	3	3	43	0.98
packing	388	1	388	0.5	30	2	388	0	80	3	2	0.04

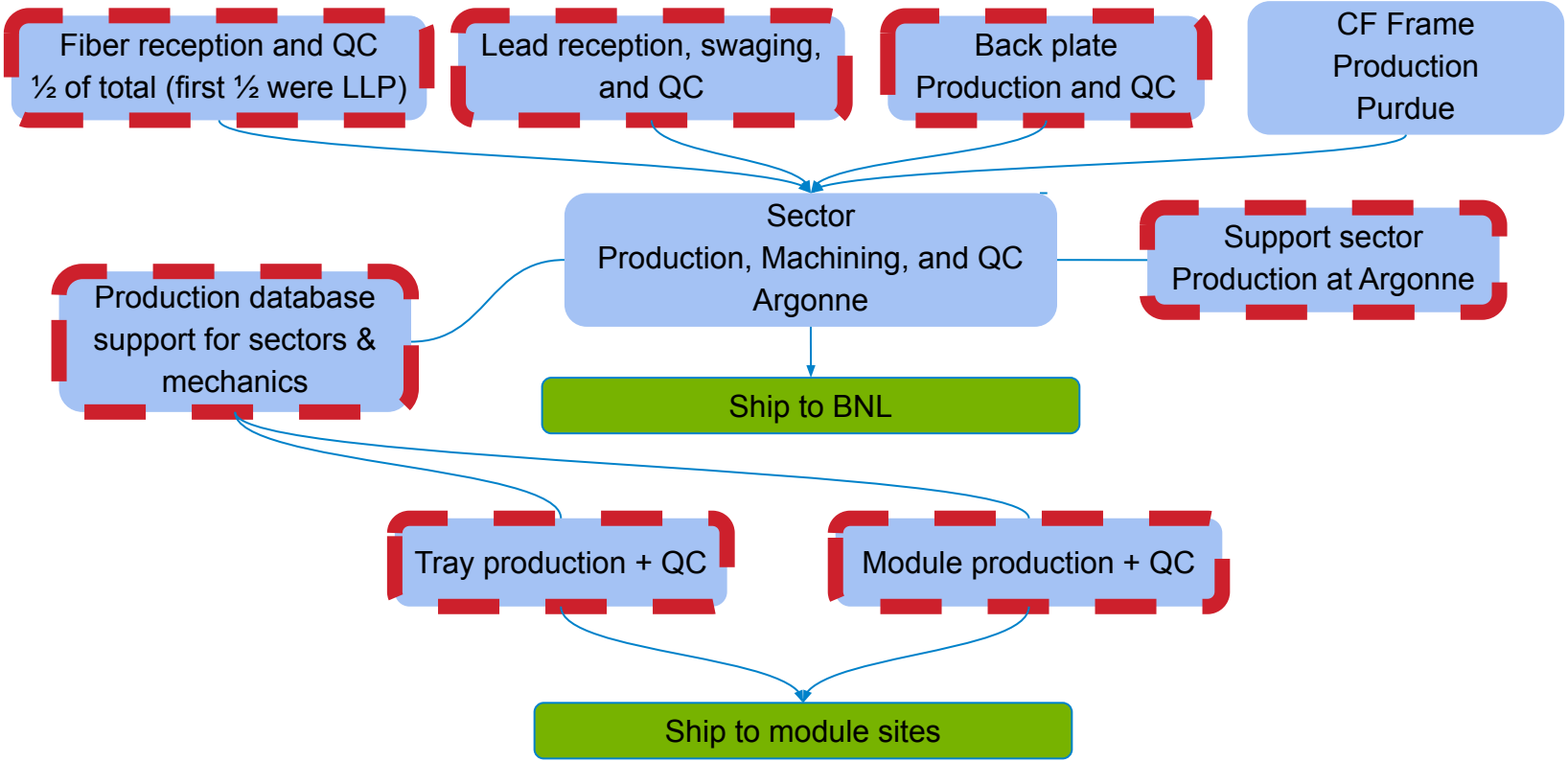
Production: Mechanics & Sectors

GTL: Sylvester Joosten

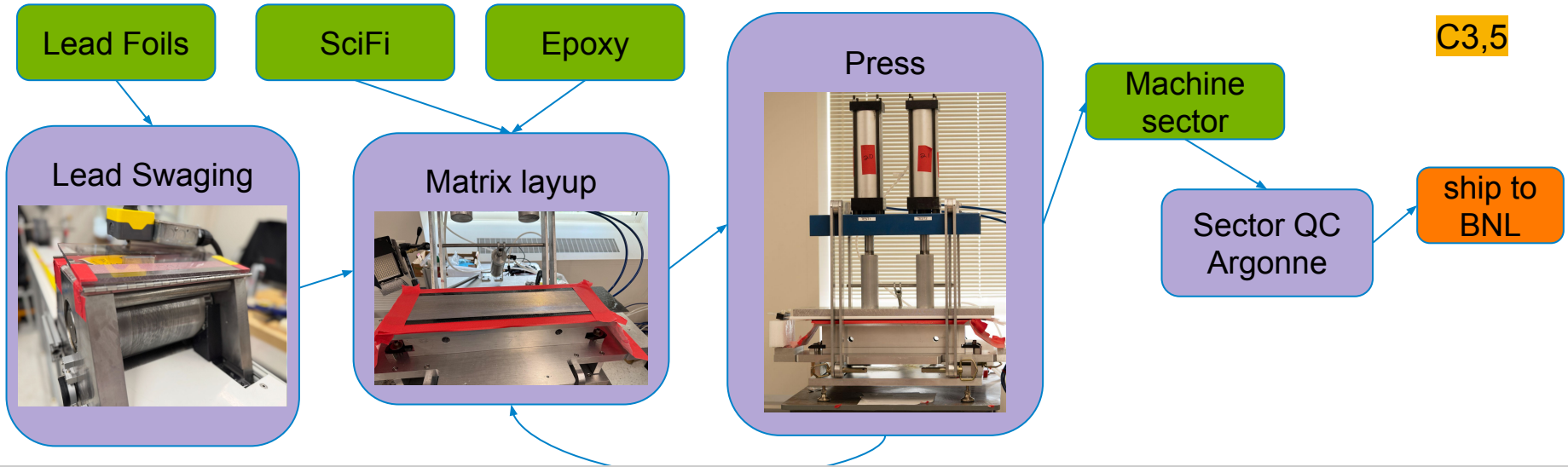
Mechanics & Sectors: PRODUCTION

sector

tracker mechanics



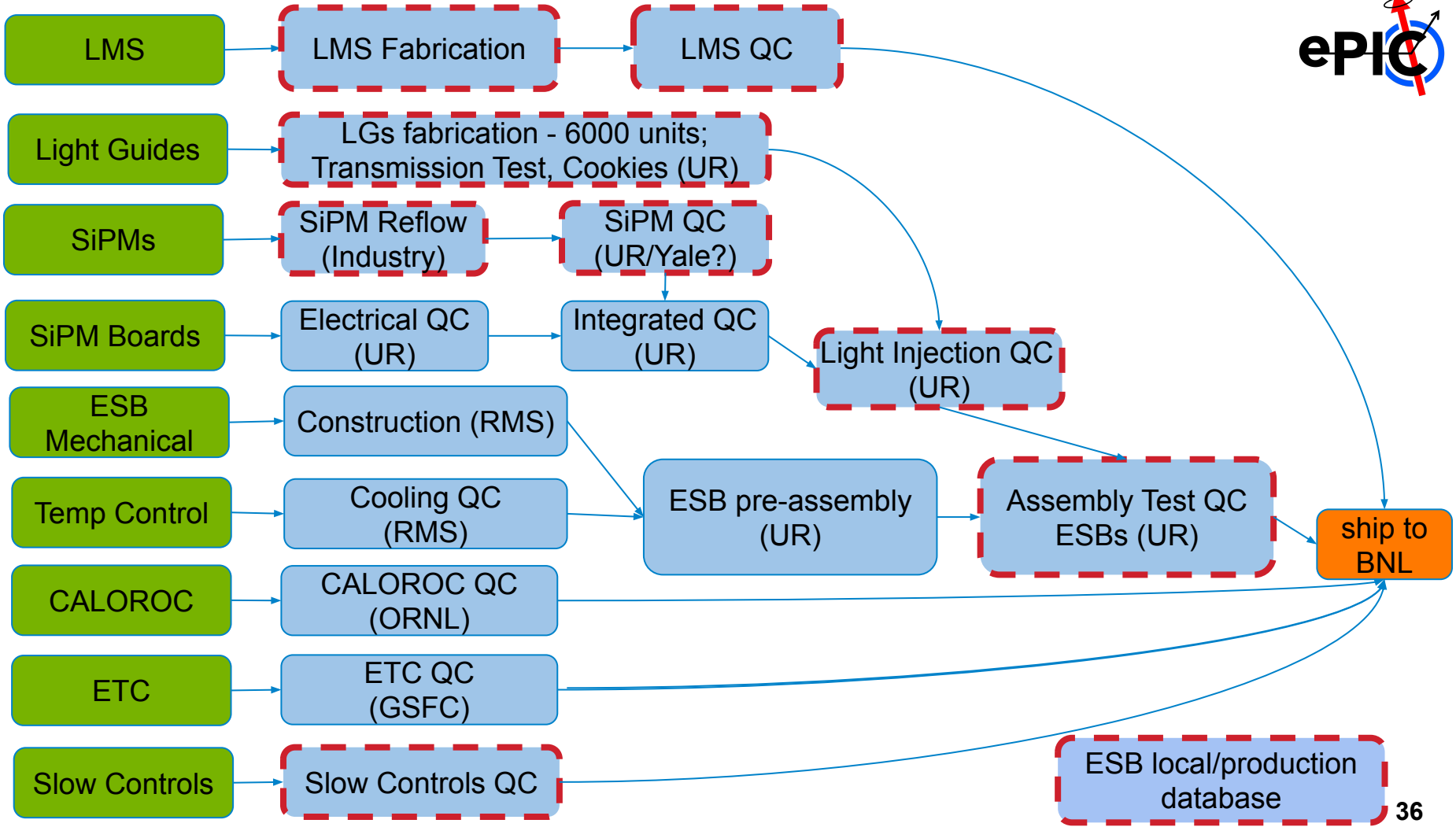
Production Plan: Mechanical Sector



Sector Assembly	# parts	# per batch	# batches	hours/batch	minutes/piece	# people	Total Person hours	Inactive hours/batch	Batches/week/production line	# of production lines	Total production weeks	Total production years (w/ 85% efficiency)
Fiber QC (1%)	10000	208	48	52	15.0	2	104	104	0.8	1	62	1.4
Matrix layup	576	12	48	75	377	5	377	377	0.3	2	90	2.0
CF Frame Integration	288	6	48	16	160	2	32	80	1.3	2	19	0.4
Sector QC	48	1	48	8	480	2	16	16	5.0	1	10	0.2

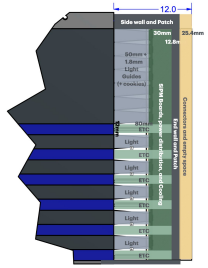
Production: ESB

GTL: Zisis Papandreou


LMS
LMS Fabrication
LMS QC
Light Guides
LGs fabrication - 6000 units; Transmission Test, Cookies (UR)
SiPMs
SiPM Reflow (Industry)
SiPM QC (UR/Yale?)
SiPM Boards
Electrical QC (UR)
Integrated QC (UR)
Light Injection QC (UR)
ESB Mechanical
Construction (RMS)
Temp Control
Cooling QC (RMS)
ESB pre-assembly (UR)
Assembly Test QC ESBs (UR)
ship to BNL
CALOROC
CALOROC QC (ORNL)
ETC
ETC QC (GSFC)
Slow Controls
Slow Controls QC
ESB local/production database

Production Plan: End-of-Sector Boxes

- component parts QC
- pre-assembly of ESB
  - SiPM's, CALOROC, cooling
- ESB QC
- Final assembly at BNL



C3,5

Sector Assembly	# parts	# per batch	# batches	Active hours/batch	minutes/piece	# people	Total Person hours	Inactive hours/batch	Batches/week/production line	# of production lines	Total production weeks	Total production years (w/ 85% annual efficiency)
Light guide	5933	60	99	2	2	1	198	12	5	1	20	0.45
SiPM board QC	6022	60	101	2	2	1	202	12	5	1	22	0.5
CALOROC PCB QC	101	1	101	2	120	1	202	0	20	1	5	0.11
End-of-tray card QC	106	1	106	2	120	1	212	0	20	1	5.3	0.12
Cooling QC	100	1	100	0.5	30	1	50	0.5	40	1	2.5	0.06
ESB pre-assembly/ QC	100	1	100	2	120	2	400	0	20	1	5	0.11

Production: System Testing

GTL: Maria Zurek

AstroPix Tray System Testing

Tray QC and Calibration data collection - Site 1 Argonne

Tray QC and Calibration data collection - Site 2 UCSC

Tray QC and Calibration data collection - Site 3 Korea

Calibration Database Maintenance and Calibration Validation from Data

QC Database Maintenance

Packing and shipping logistics

ESB and Sector System Testing

Integrated ESB + Cooling QC
URegina

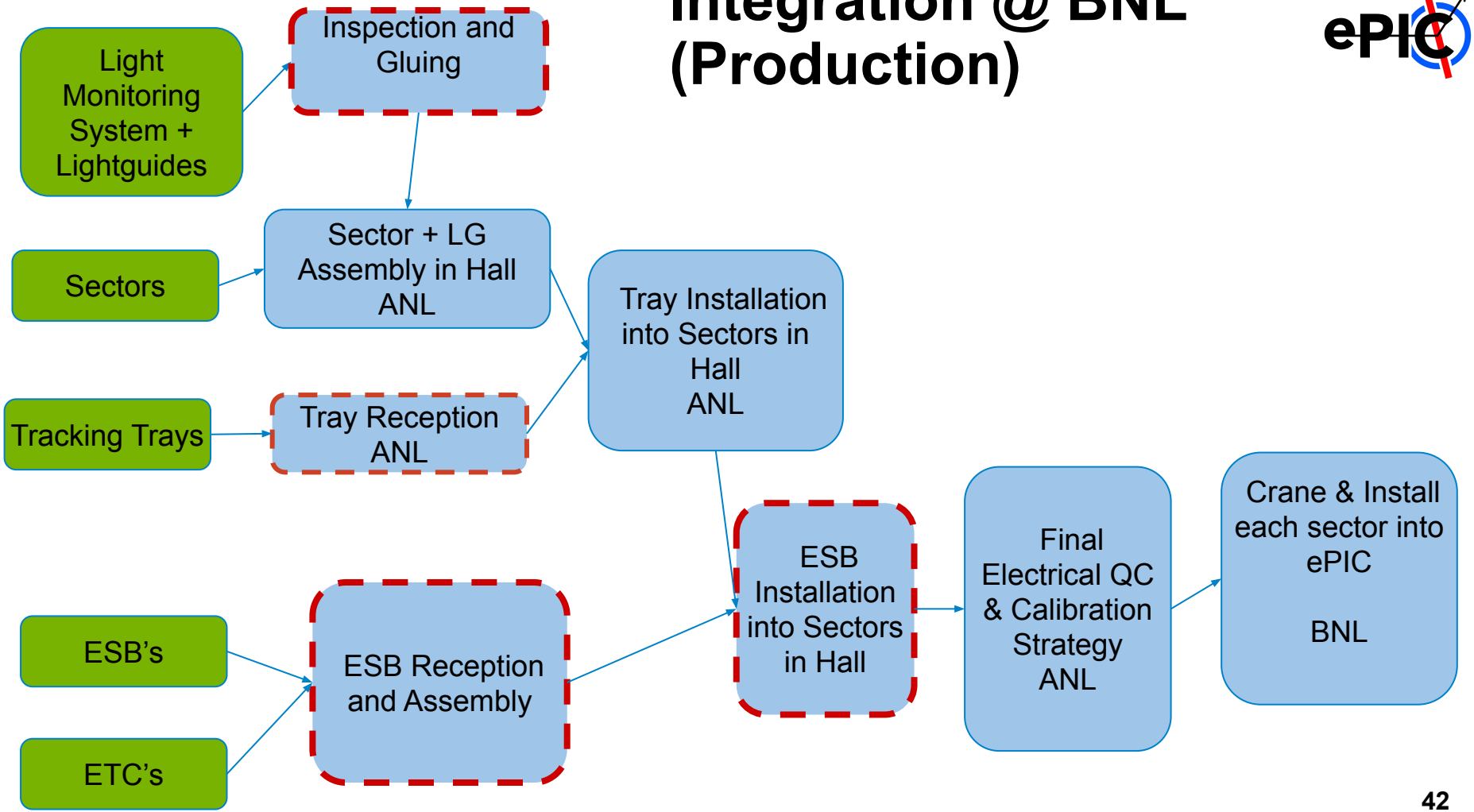
Packing and shipping logistics
URegina

Sector System QC (if any) and packing and shipping logistics
ANL

Production: ***Reception and Integration at BNL***

GTL: Maria Zurek

Integration @ BNL (Production)



Back Up

BIC Teams

USA

- Argonne National Laboratory
- NASA Goddard Space Flight Center
- Oklahoma State University
- Oakridge National Laboratory
- University of California Santa Cruz
- University of Connecticut
- Purdue University

Canada

- University of Manitoba
- University of Regina
- Mount Allison University
- NSERC
- Canada Fund for Innovation

Korea

- Kyungpook National University
- Yonsei University
- University of Seoul
- Pusan National University
- Korea University
- Sungkyunkwan University
- Hanyang University
- Gangneung-Wonju National University

Germany

- Karlsruhe Institute of Technology
- University of Giessen

~80+ team members

scientists, engineers, postdocs, students

link to full list