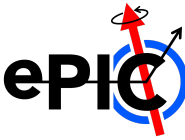


BIC: Production Deliverables & Objectives Planning

Jessica Metcalfe & Green Team Leaders (GTLs)

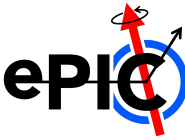
Deliverables/Objectives Planning



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

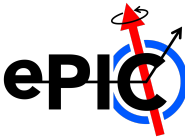
1. PED Objectives

- 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.

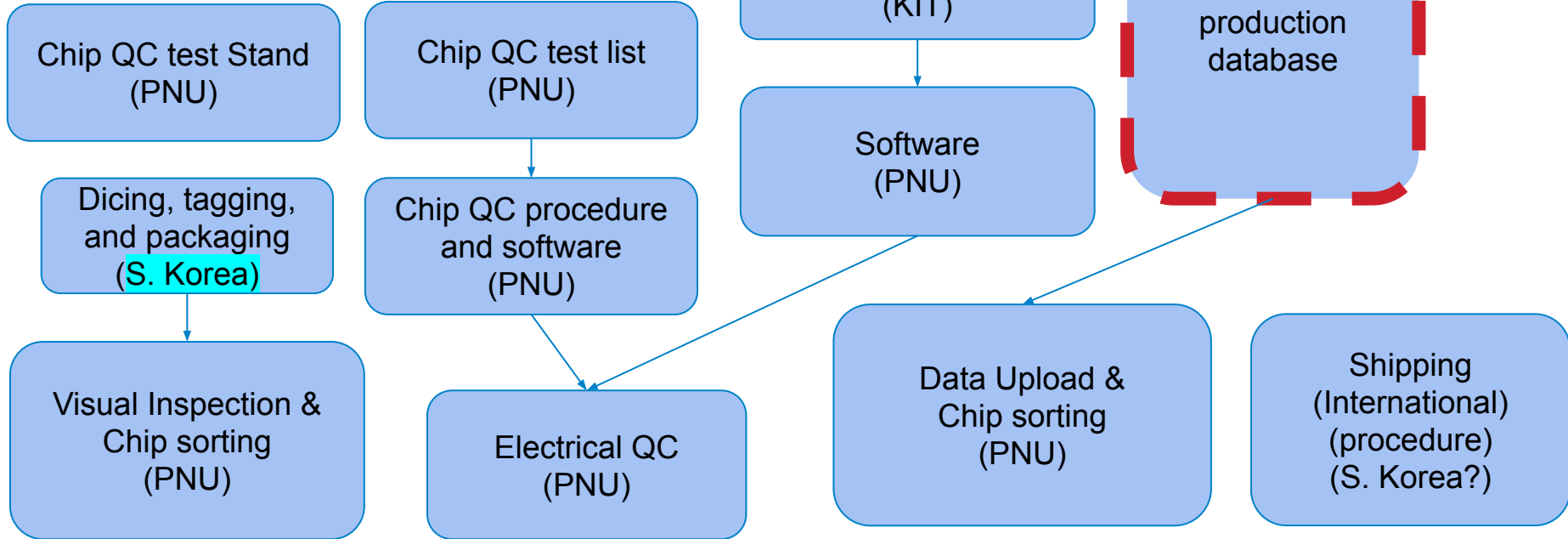
Opportunities for taking on a objective or production deliverable are designated with red dashed lines around the bubble

Objective Deliverables (Before production)

PED Objectives: Modules and Wafers

GTL: Manoj Jadhav

AstroPix Wafer/Chips



AstroPix Chip distribution
-v3 prototypes April 2026
-v5 20 chips December 2026
-v5 preproduction 2027
-v6 updates July 2027

Module Assembly



Toolings
Design, fabrication,
commissioning
(UCSC)

Module assembly
Procedure
(UCSC)

Module assembly
Metrology
(UCSC)

Glue Studies - Finalize
glue, thickness, etc.
(UCSC)

AstroLinx
Module PCB
(OSU)

AstroLinx data loss
studies (OSU)

AstroLinx QC
(OSU)

Wirebond protection
(trials and procedure)
(UCSC)

Module QC
procedure
(ANL)

Module QC
Procedure software
(ANL?)

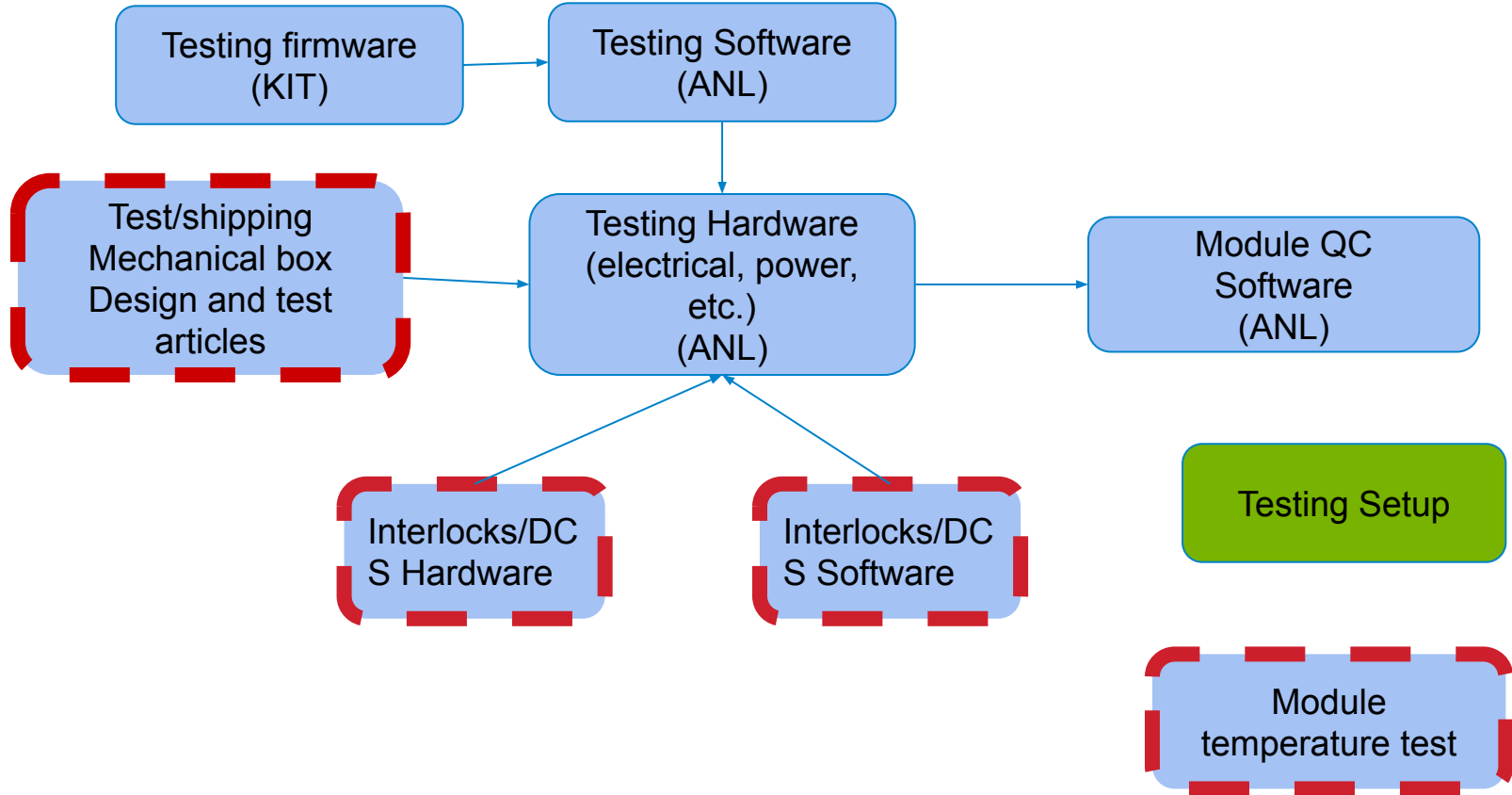
Module
assembly and
QC Database

Stave/Tray Metrology
and tolerances

Tray vibration and
stress test

Module assembly

Test Stand-Modules



PED Objectives: Mechanics & Sectors

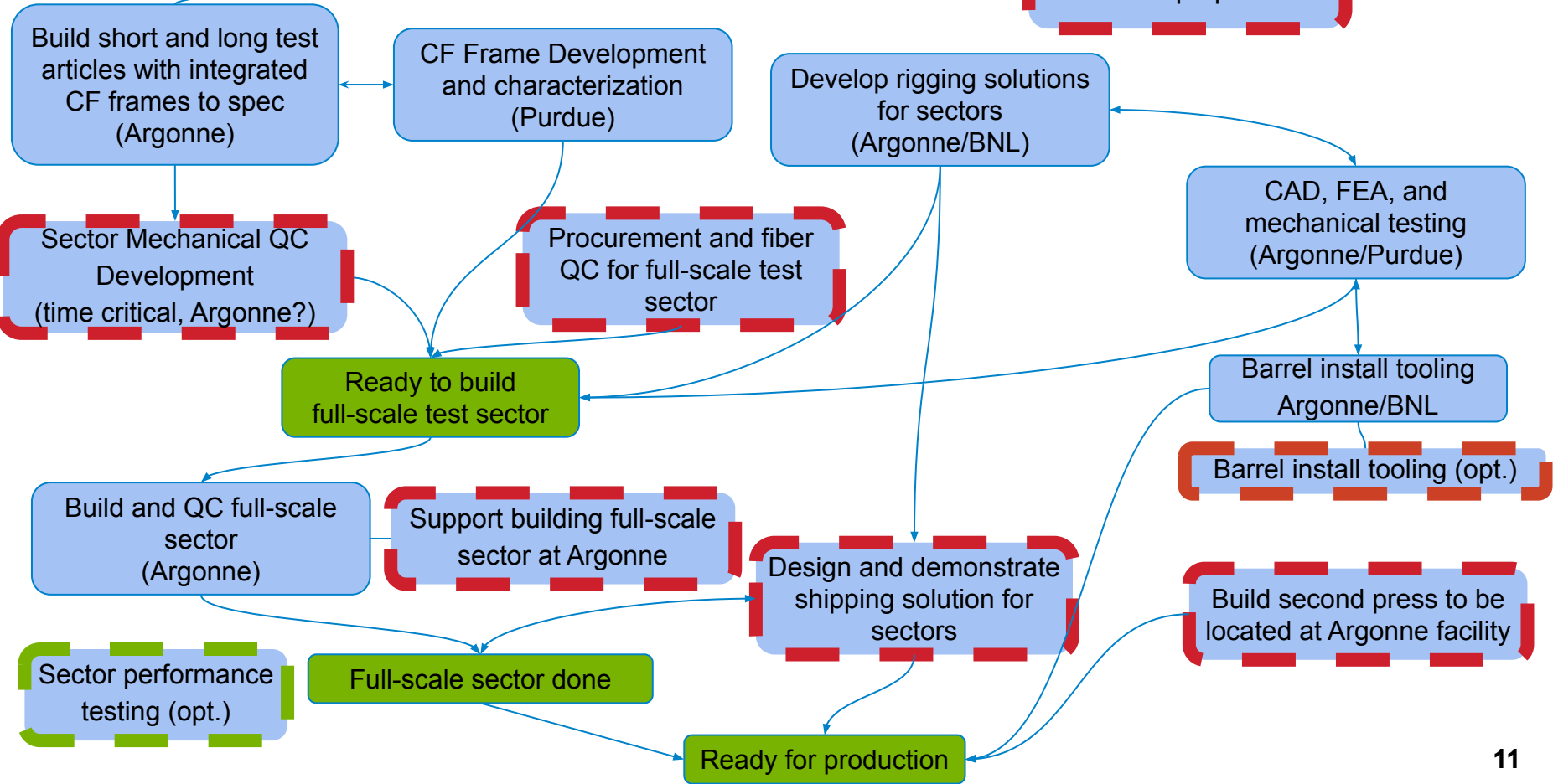
GTL: Sylvester Joosten

Mechanics & Sectors: PED (1/2)

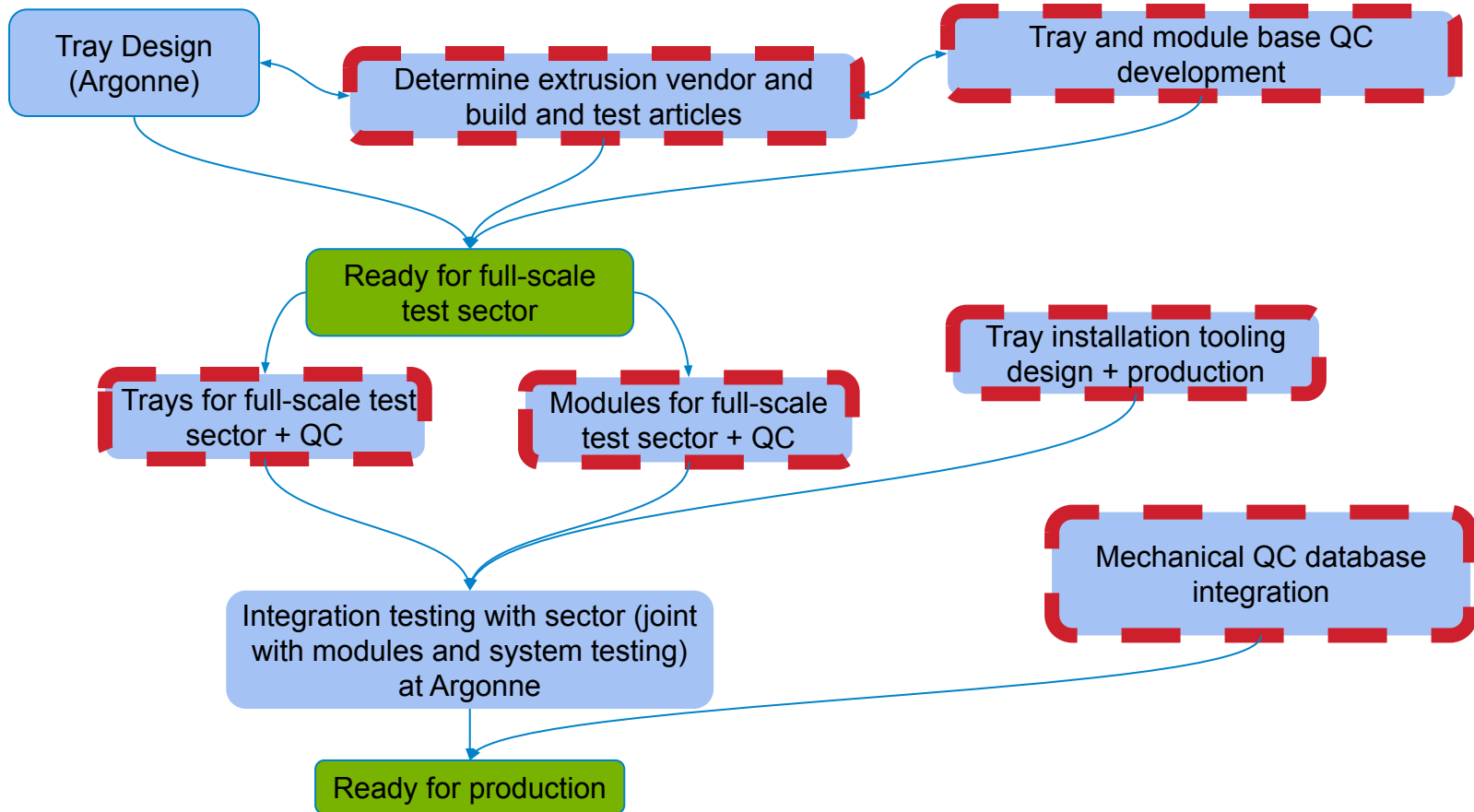
Measure Pb/ScFi matrix thermal properties



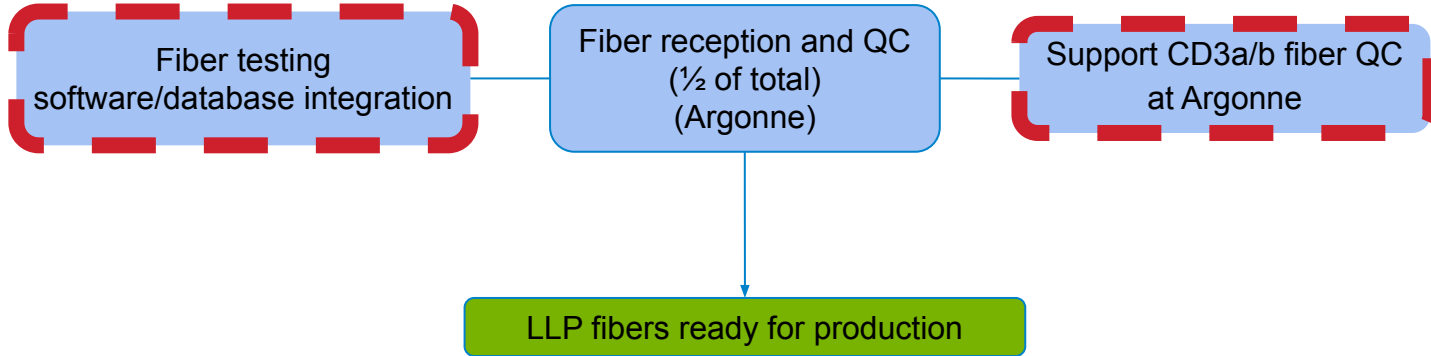
sector



Mechanics & Sectors: PED (2/2)

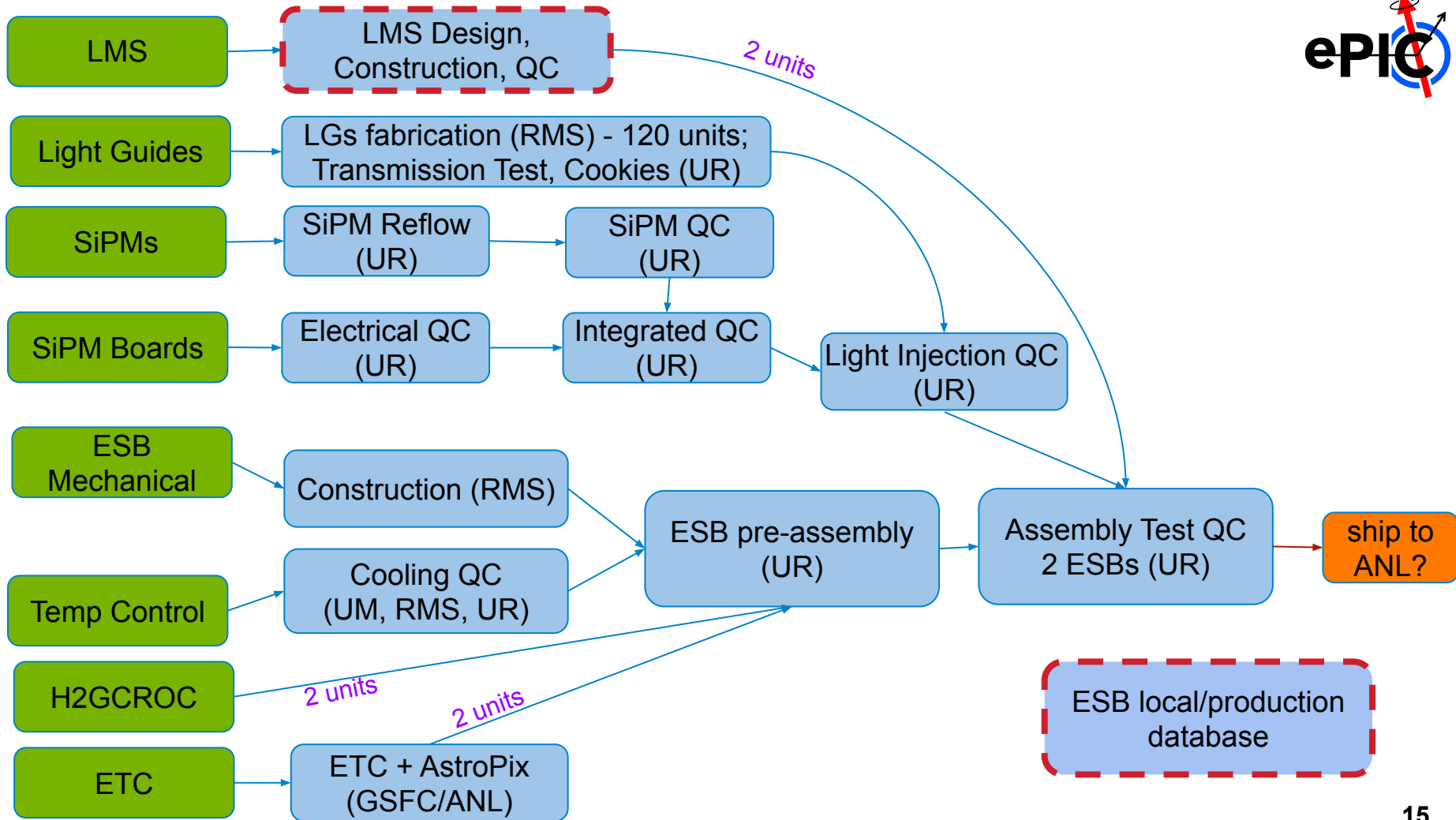


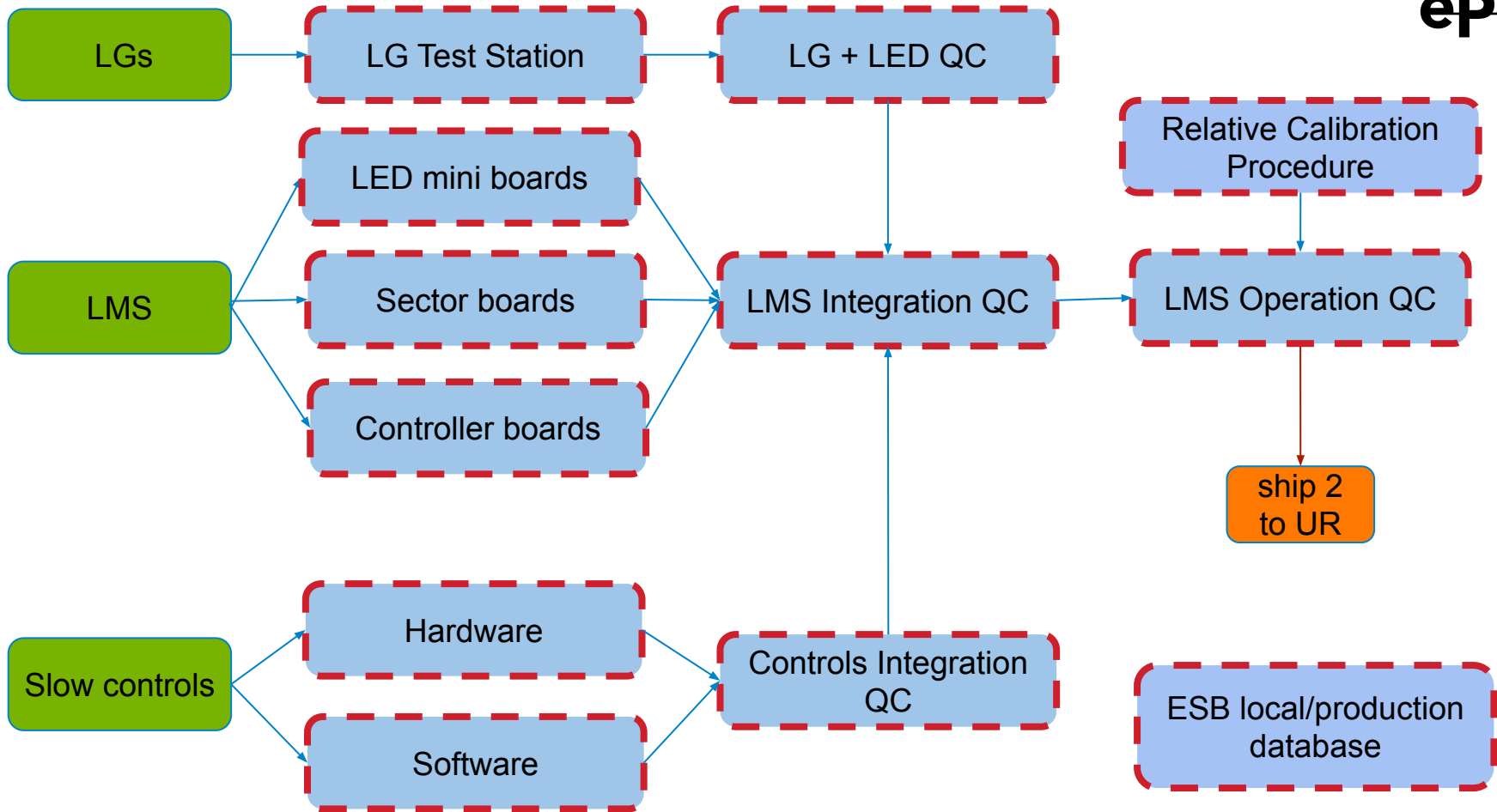
Mechanics & Sectors: LLP



PED Objectives: ESB

GTL: Zisis Papandreou

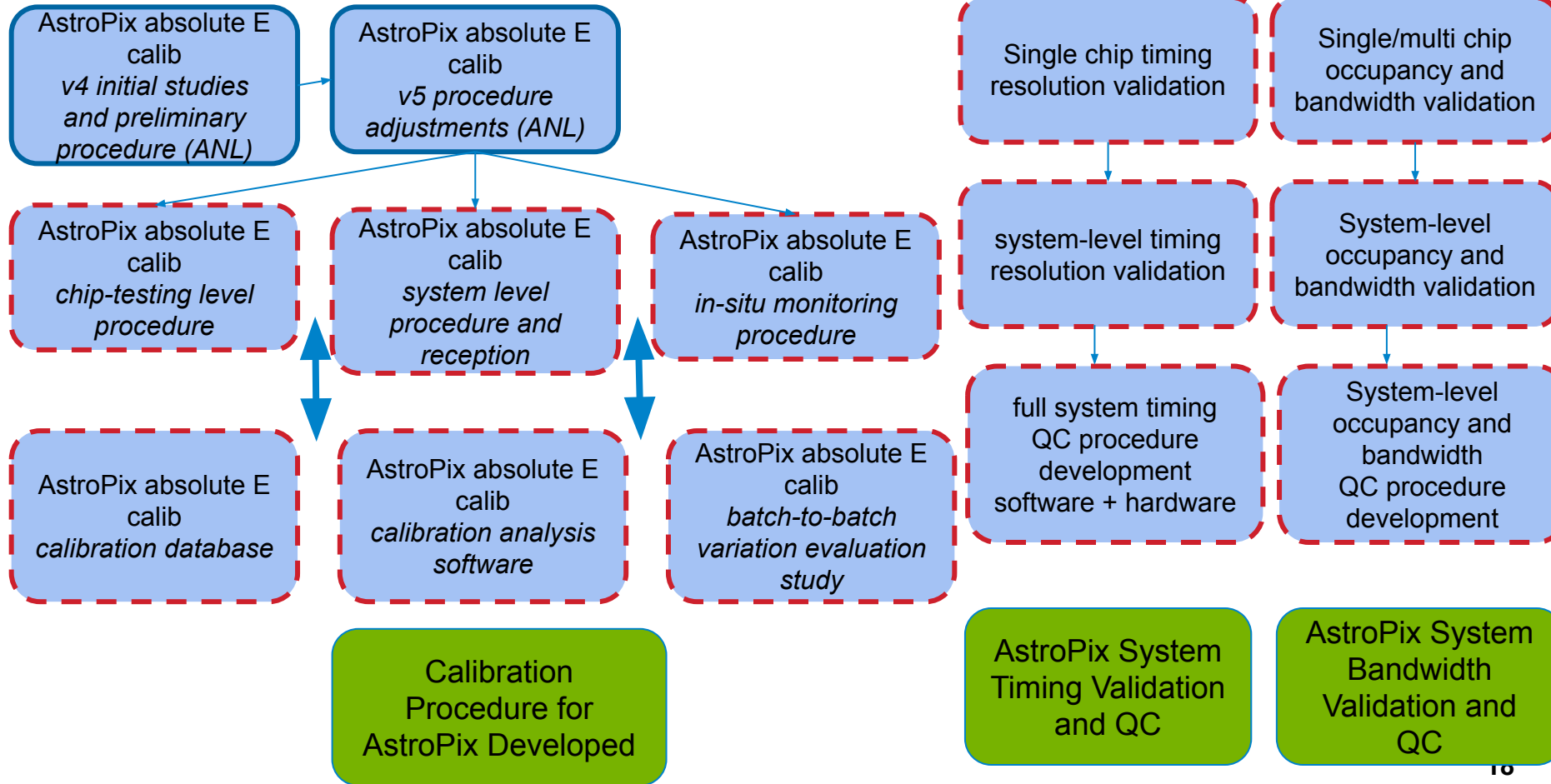




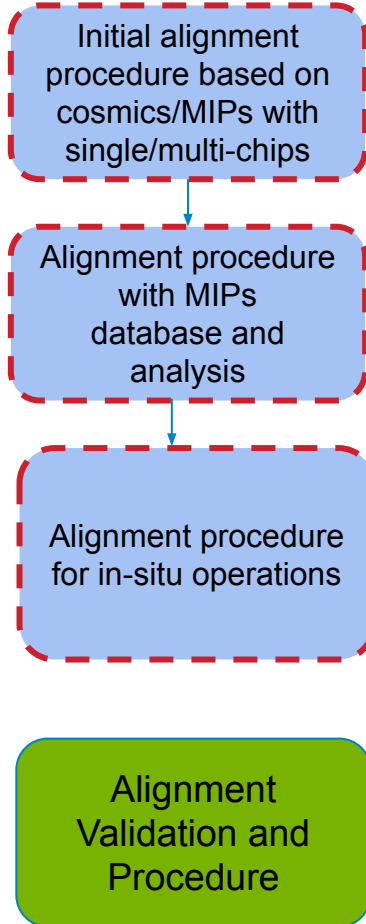
PED Objectives: *System Level QC and Validations*

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
system timing and energy calibration procedure and validation

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

SciFi calib
calibration analysis software and database

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)

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

Position resolution validation with v5/v6

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

Data rate validation with v5/v6

Stability of (bench) calibration validation in the beam

Validation of the System Calibration procedure for AstroPix in the beam

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

Validation of timing resolution in beam environment

Irradiation studies for AstroPix (ANL)

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)

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

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

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

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



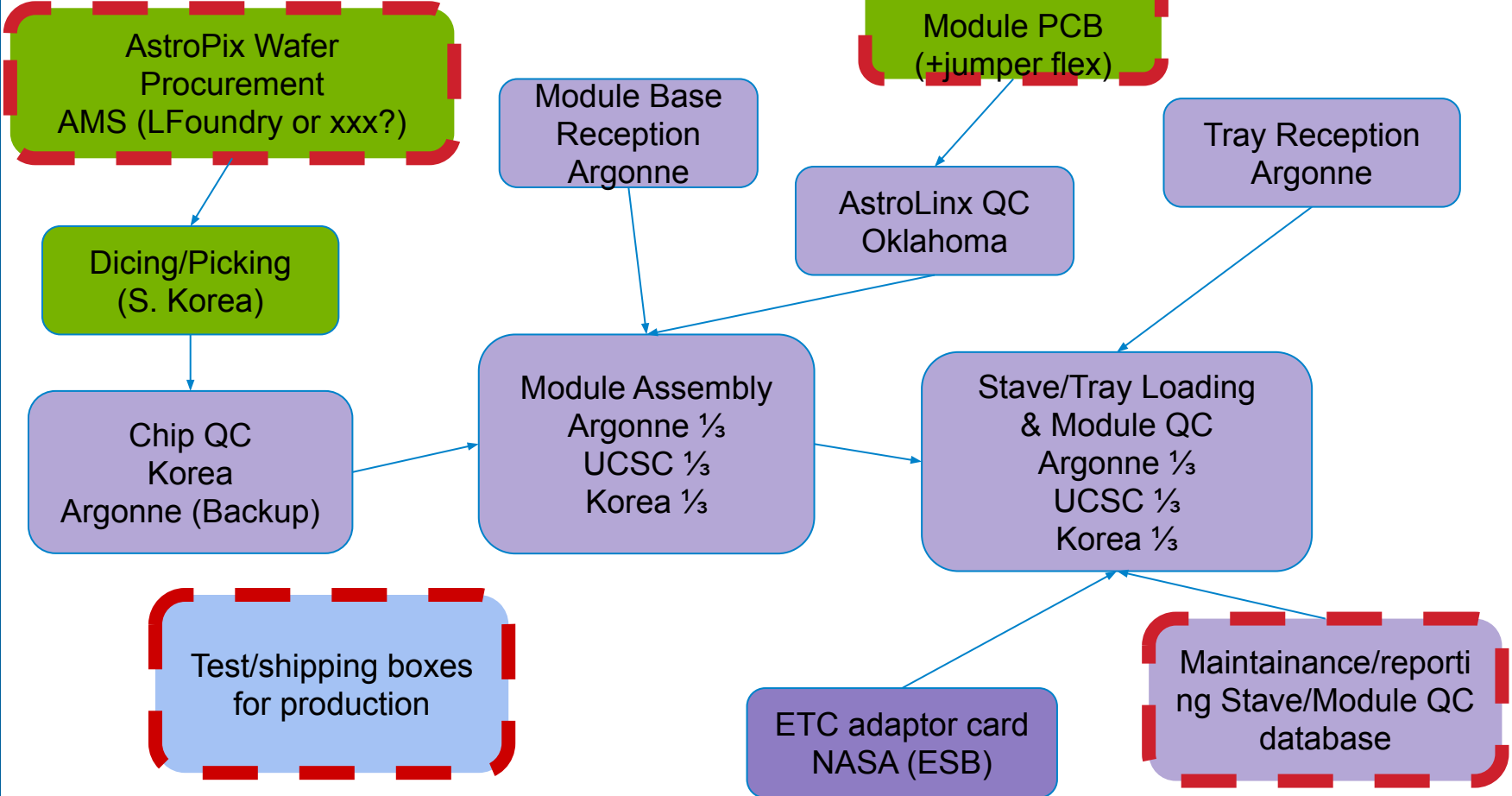
	Total on-detector	Yield at step	Cumulative Yield	Total # parts to produce
sectors	48			
trays	384	99%	99%	388
staves	2592	98%	97%	2,672
modules	31104	95%	92%	33,747
AstroPix chips	279936	85%	78%	357,319
wafers				5,956
end-of-tray cards	384	90%	90%	427
tray support rails	384	95%	95%	405
module PCBs	31104	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

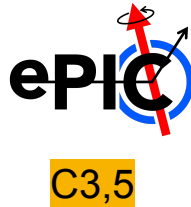
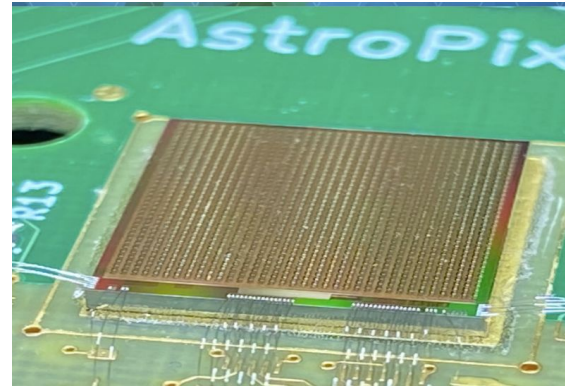
GTL: Manoj Jadhav

Tracker Layers-Production



Wafer QC Probing

1. Purchase wafers
2. Dicing
 - a. picked by vendor, comes in waaffle 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

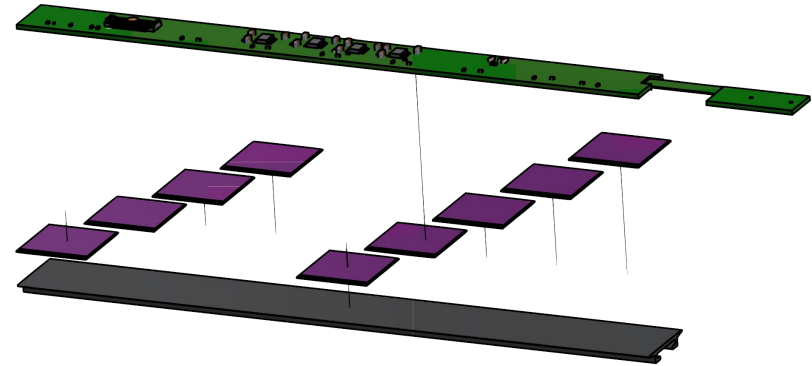


→Expect to have a high yield after chip testing until glued on a module

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)



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

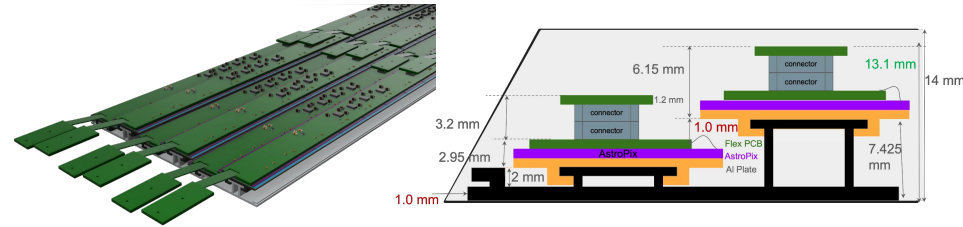


C3,5

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

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

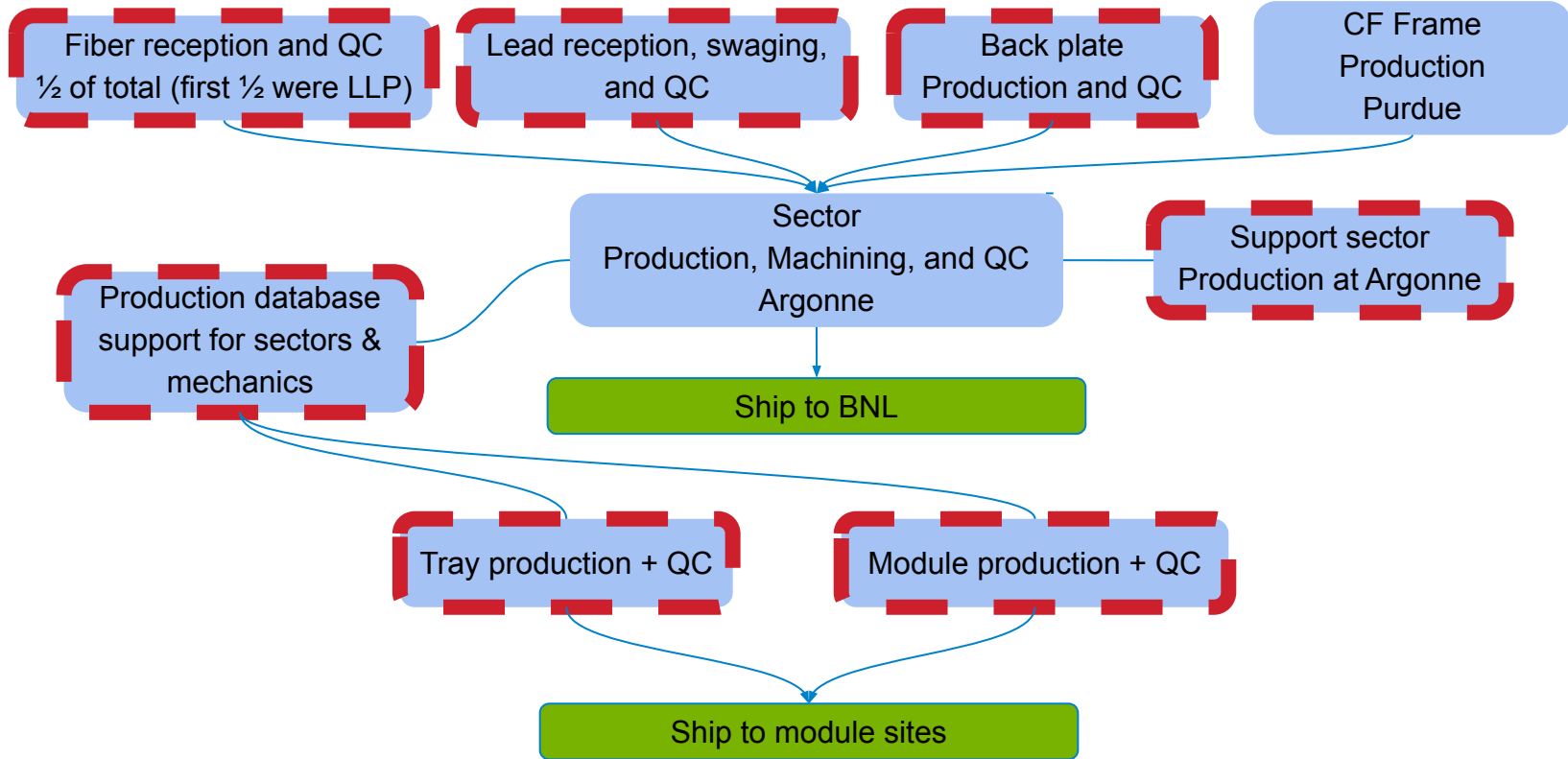
GTL: Sylvester Joosten

Mechanics & Sectors: PRODUCTION



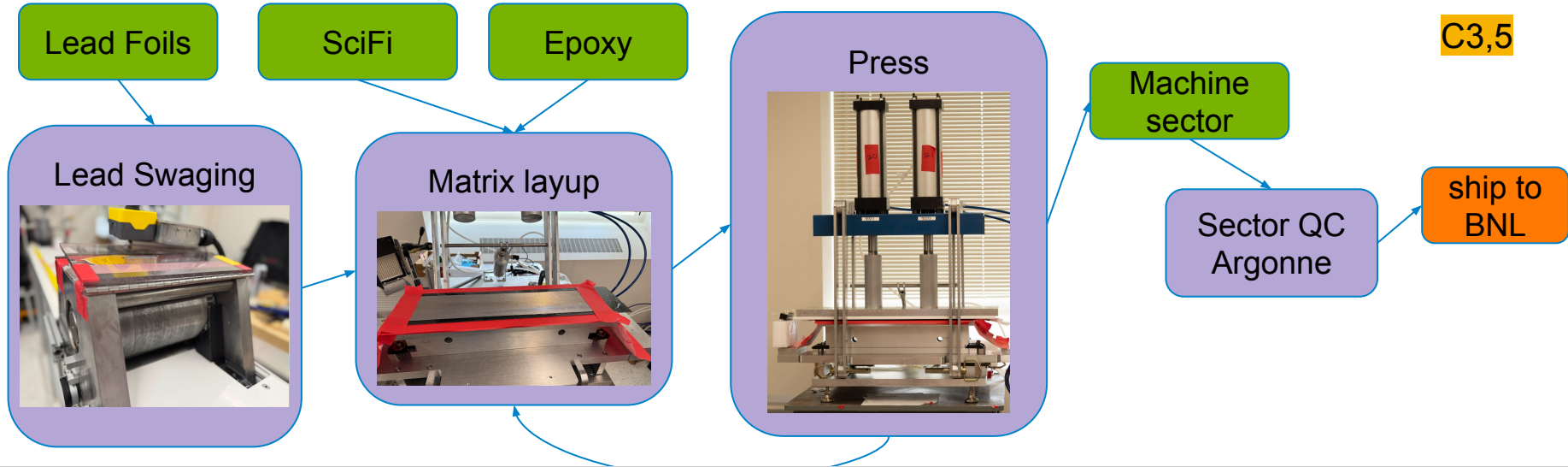
sector

tracker mechanics



Production Plan: Mechanical Sector

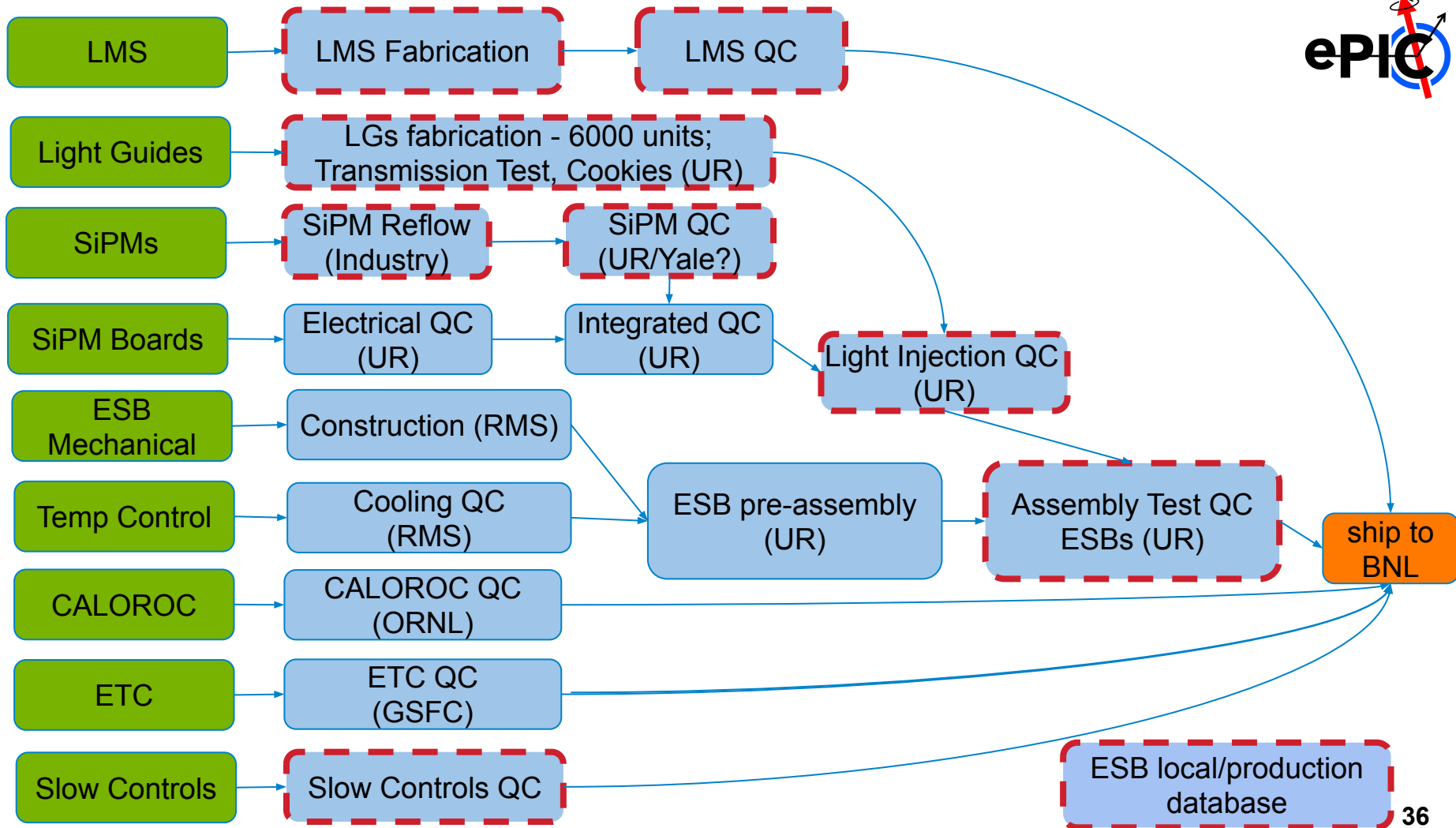
C3,5



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

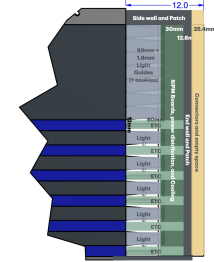


Production Plan: End-of-Sector Boxes



C3,5

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



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

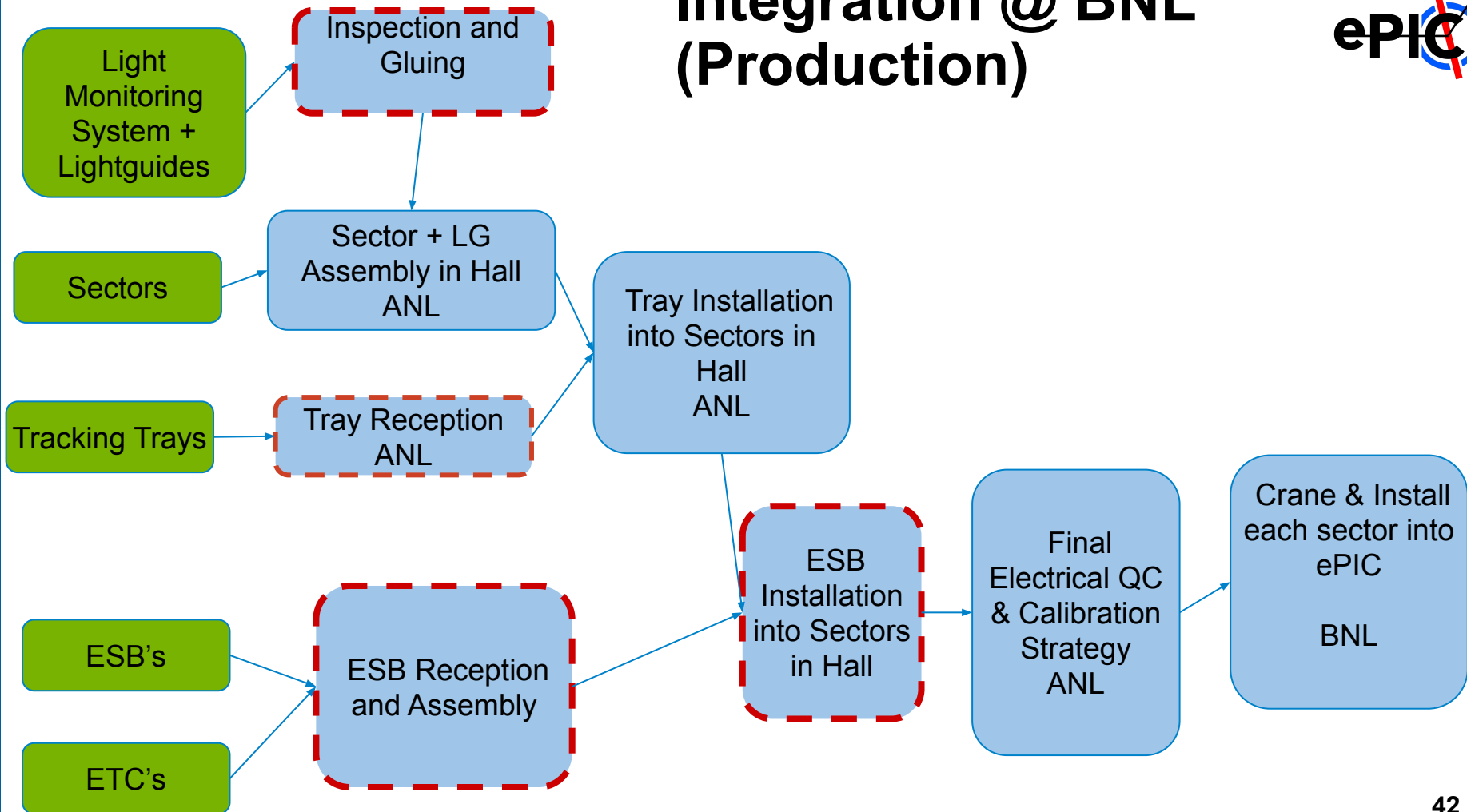
Packing and shipping
logistics
URegina

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](#)