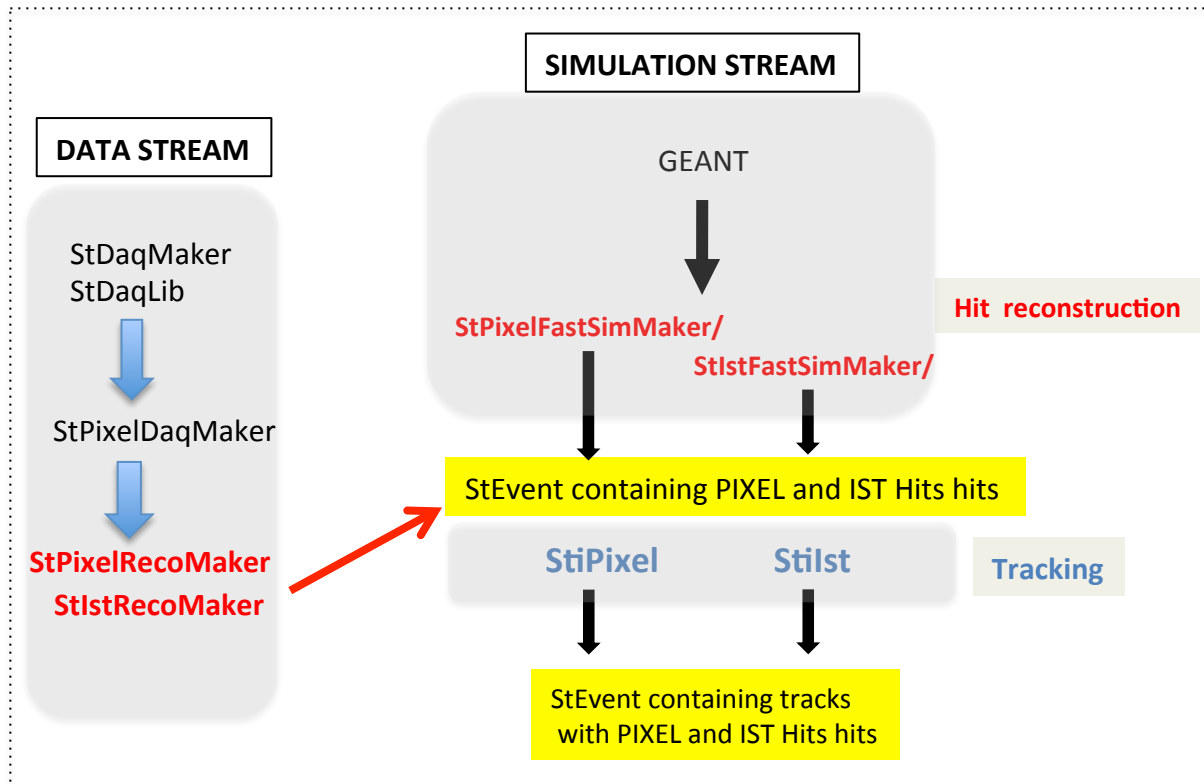# HFT Software Status

WBS 1.6

S. Margetis, KSU

Outline

- Brief overview of subsystem

- Progress since last review

- Outstanding technical issues and plans

- Schedule

- Resources
  - People, institutions

- Risk assessment

- Summary

Overview of Subsystem

- **WBS 1.6** (Software) is the sum of **Online** and **Offline** software tasks

- The *Online* software is a sub-detector deliverable and contains Slow controls, online monitoring etc

- The *Offline* software is responsible for the event reconstruction, starting from raw data all the way to particle quantities. It includes tasks like alignment, hit/track/vertex finding etc
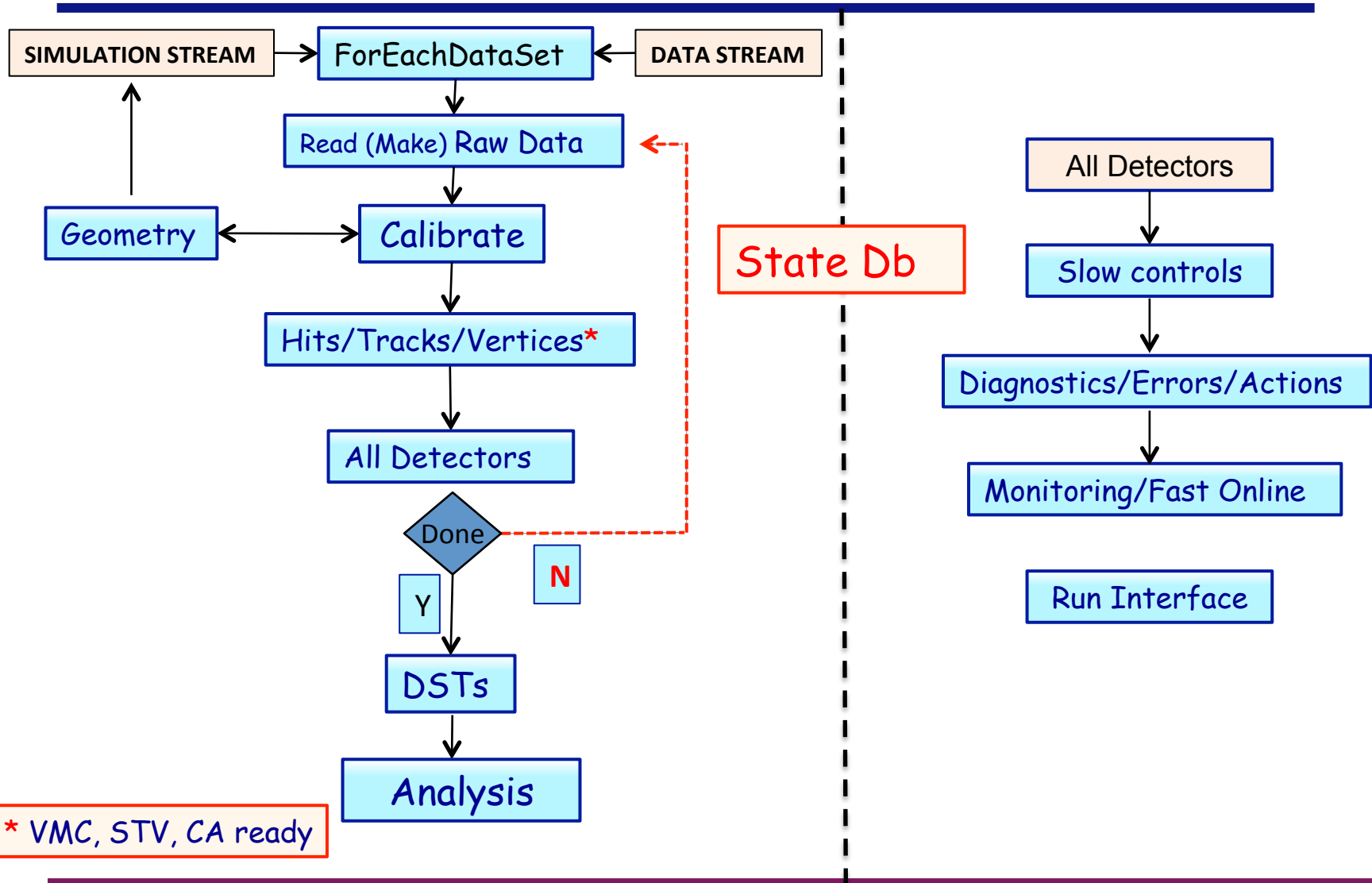
- Software efforts are divided into two parts. *Part one* (on-scope) contains all the essential tasks for the successful operation of the detector (calibrations etc). *Part two* contains the remaining tasks

- *Part one* is included in the HFT WBS and has associated L3 milestones

Subsystem Communication

- Meets weekly to plan work and get updates.

- Participate in the weekly HFT-TC meetings

- Is an integral part of STAR's S&C environment, interacting closely on a regular basis

General Flowchart of Software Tasks
Offline/Online

SIMULATION STREAM → ForEachDataSet ← DATA STREAM

ForEachDataSet → Read (Make) Raw Data

Read (Make) Raw Data → Calibrate

Geometry ↔ Calibrate

Calibrate → Hits/Tracks/Vertices*

Hits/Tracks/Vertices* → All Detectors

All Detectors → Done

Done — N → Read (Make) Raw Data

Done — Y → DSTs

DSTs → Analysis

State Db

All Detectors → Slow controls → Diagnostics/Errors/Actions → Monitoring/Fast Online

Run Interface

* VMC, STV, CA ready

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- Brief overview of subsystem

- **Progress since last review**

- Outstanding technical issues and plans

- Schedule

- Resources

  – People, institutions and

- Risk assessment

- Summary

Areas of activities since CD2/3 (a year ago)

- HFT Geometry model
- HFT Survey & Alignment related work
- Slow/Fast PXL response simulation
- Prototype simulations
- Offline structures (Hits etc)
- Simulation of UPC e$^-$ background, Pileup
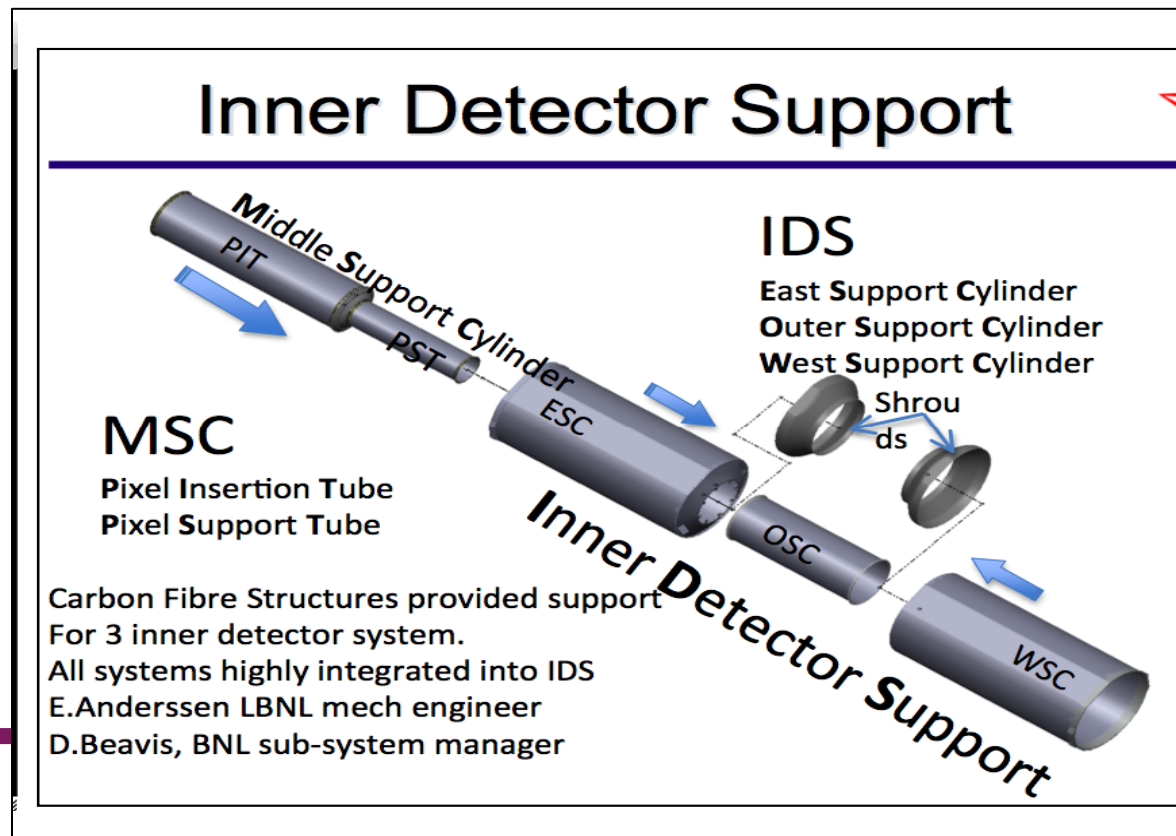- Naming scheme/configurations defined, Db

Blue = In progress

- Hit/Event vertex finders/Kalman fitter for decays
- Evaluation/Analysis framework
- Tests of new STV tracker, VMC environment

- 'Online' data format/slow controls/online QA/Db considerations
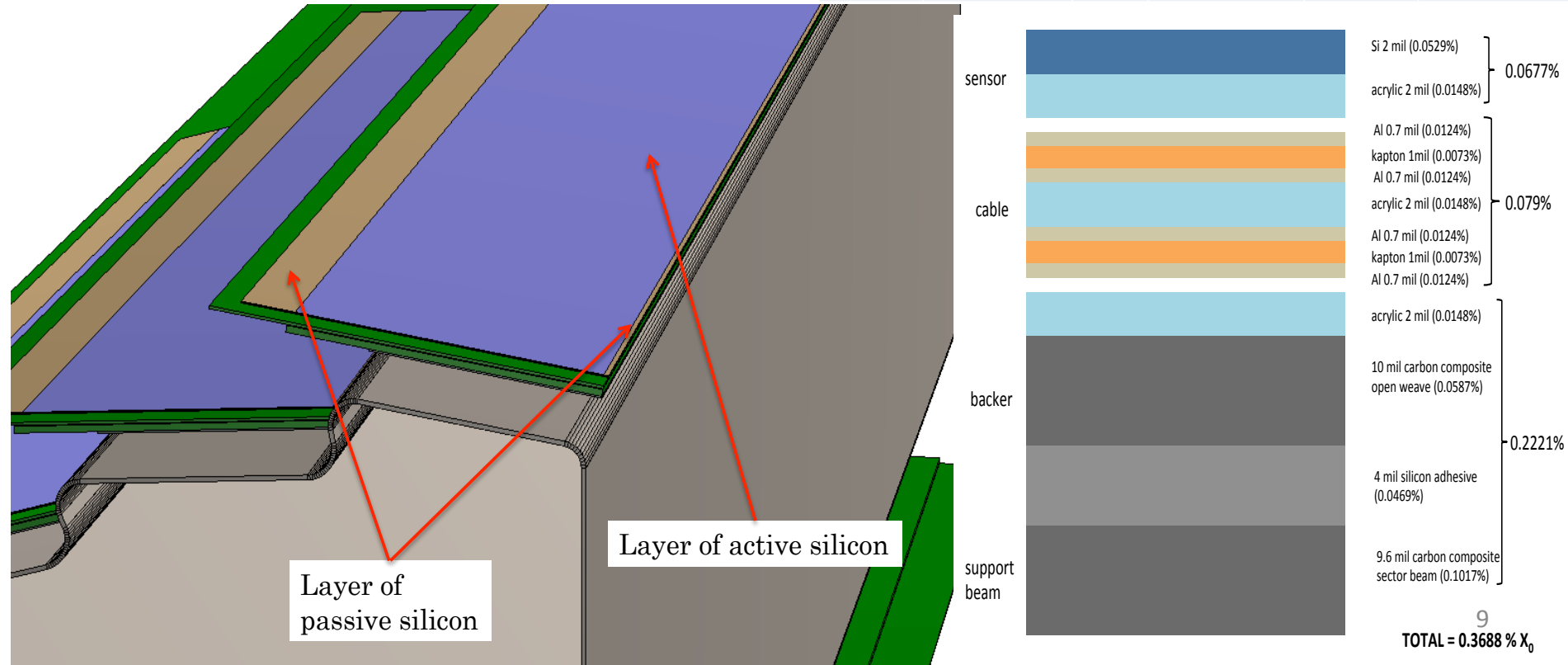
HFT Geometry model update

- Creating the Y2013/14 geometry in AgML based on Solid-Works Models
- We had an internal *review* in March, working on recommendations etc
- Work on SSD/IST details in progress
- Work on details of support structures in progress
- Manpower probably O.K. but we seek more help

Inner Detector Support

IDS

East Support Cylinder
Outer Support Cylinder
West Support Cylinder
Shrouds

MSC

Pixel Insertion Tube
Pixel Support Tube

Carbon Fibre Structures provided support
For 3 inner detector system.
All systems highly integrated into IDS
E.Anderssen LBNL mech engineer
D.Beavis, BNL sub-system manager

PIT
PST
Middle Support Cylinder
ESC
OSC
WSC
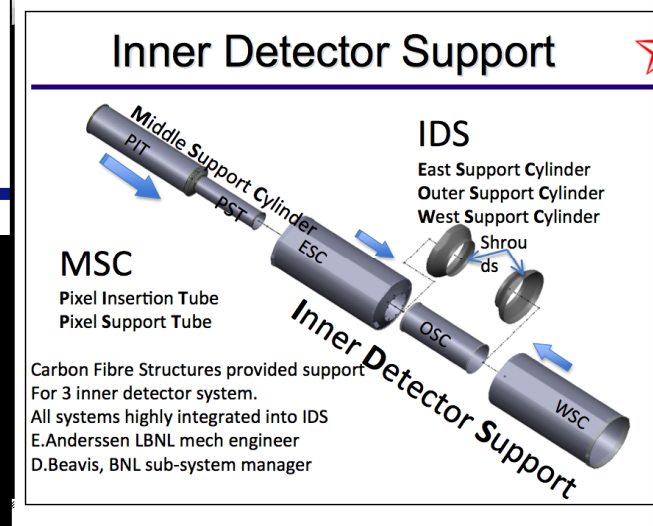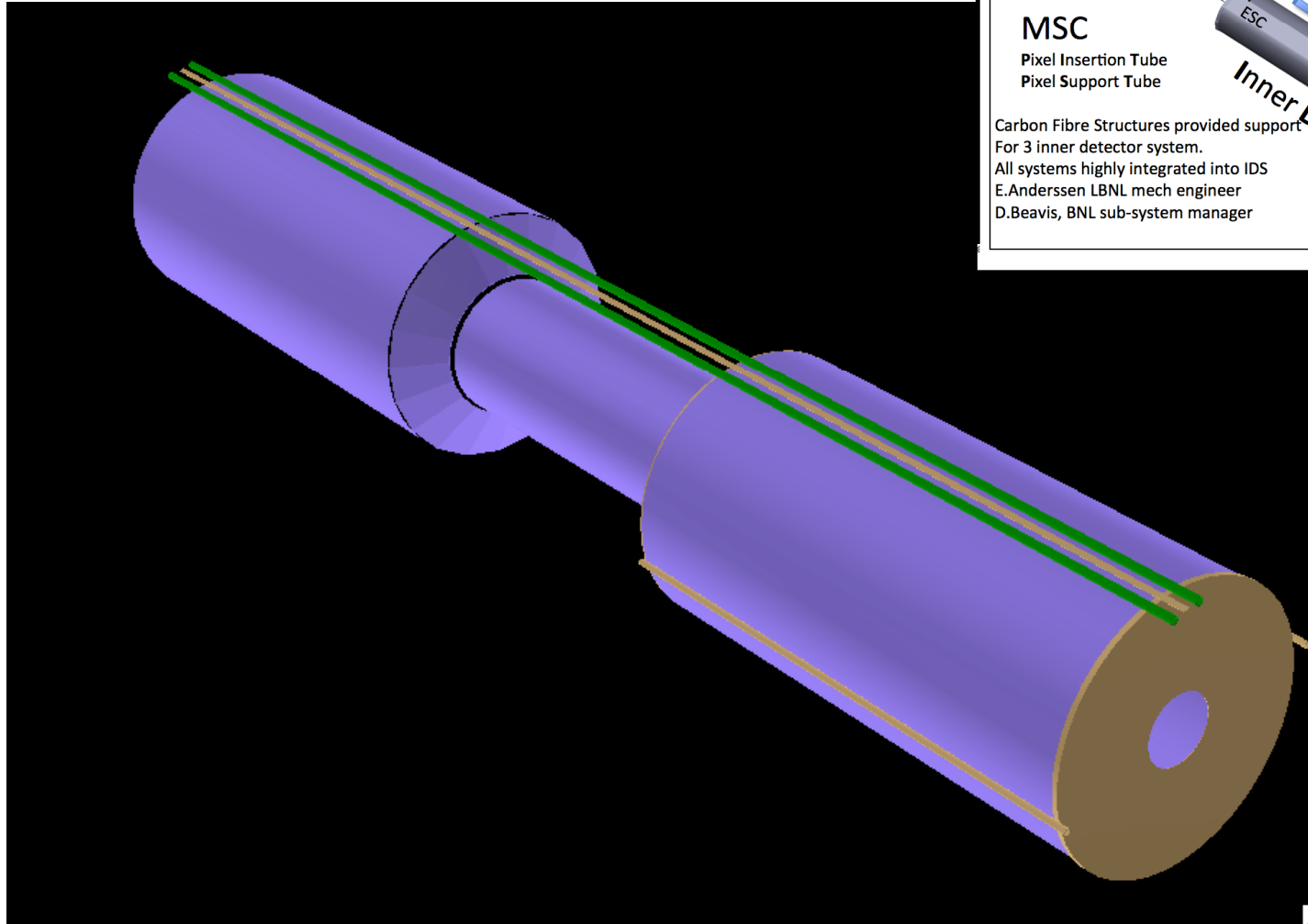Inner Detector Support

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PXL sector modeling in GEANT

- detailed work on structure and thickness (shape and material)
- optimization in progress

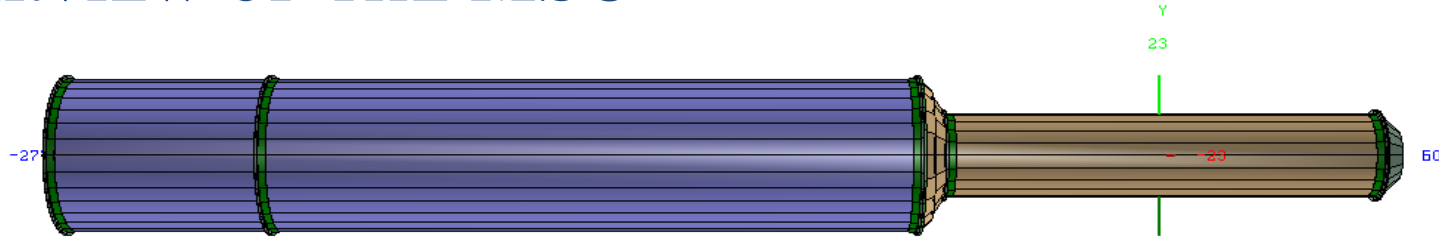| GEANT NAME	piece	shape	Composition / mixture	Radiation length [cm]	Density[g/cm³]
PLAC	Silicon active	box	Si	9.36	2.33
SIFR	Silicon passive	box	Si	9.36	2.33
SIFL	Silicon passive	box	Si	9.36	2.33
GLUA	adhesive	box	O(0.164) C(0.763) H(0.073)	34.7	1.2(*)
GLUB	adhesive	box	O(0.164) C(0.763) H(0.073)	34.7	1.2(*)
GLUC	adhesive	box	O(0.164) C(0.763) H(0.073)	34.7	1.2(*)
ALCA	Aluminum cable	box	Al	23.7(*)	2.7(*)
CBFK	Carbon Fiber backing	box	C	68(*)	1.3(*)

Layer of active silicon
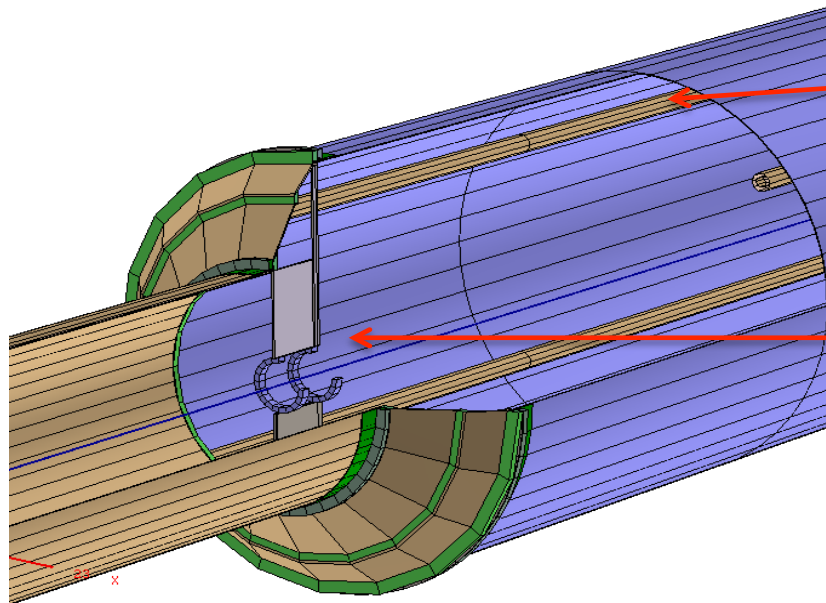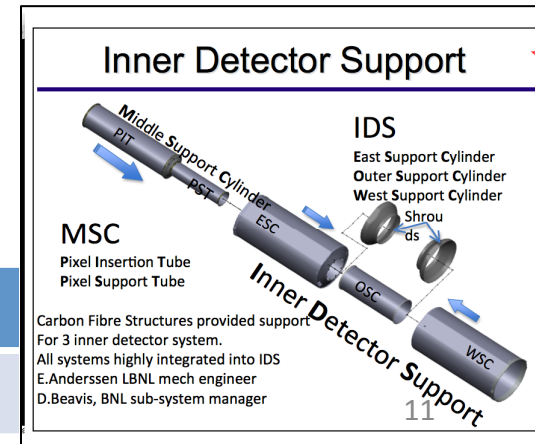
Layer of passive silicon

sensor
- Si 2 mil (0.0529%)
- acrylic 2 mil (0.0148%)
  } 0.0677%

cable
- Al 0.7 mil (0.0124%)
- kapton 1mil (0.0073%)
- Al 0.7 mil (0.0124%)
- acrylic 2 mil (0.0148%)
- Al 0.7 mil (0.0124%)
- kapton 1mil (0.0073%)
- Al 0.7 mil (0.0124%)
  } 0.079%

backer
- acrylic 2 mil (0.0148%)
- 10 mil carbon composite open weave (0.0587%)
- 4 mil silicon adhesive (0.0469%)

support beam
- 9.6 mil carbon composite sector beam (0.1017%)
  } 0.2221%

9

TOTAL = 0.3688 % X$_0$

IDS modeling

MSC

Middle Support Cylinder
PIT
PST

ESC

IDS

East Support Cylinder
Outer Support Cylinder
West Support Cylinder

Shrouds

OSC

WSC

Inner Detector Support

Pixel Insertion Tube
Pixel Support Tube

Carbon Fibre Structures provided support
For 3 inner detector system.
All systems highly integrated into IDS
E.Anderssen LBNL mech engineer
D.Beavis, BNL sub-system manager

MSC

Pixel Ins
Pixel Sup

Carbon Fibr
For 3 inner d
All systems l
E.Andersser
D.Beavis, BN

MSC modeling

OVERVIEW OF THE MSC

rails

Rings surroundings
the beam pipe

•: temporary until
implementation of
real material

GEANT NAME	piece	Composition / mixture	Radiation length	density
ALL(*)	Carbon Fiber	C	23.9	1.3(*)

Inner Detector Support

IDS
East Support Cylinder
Outer Support Cylinder
West Support Cylinder
Shrouds

Middle Support Cylinder
PIT
PST
ESC
OSC
WSC

MSC
Pixel Insertion Tube
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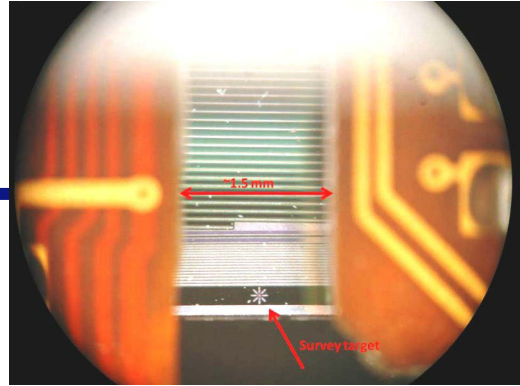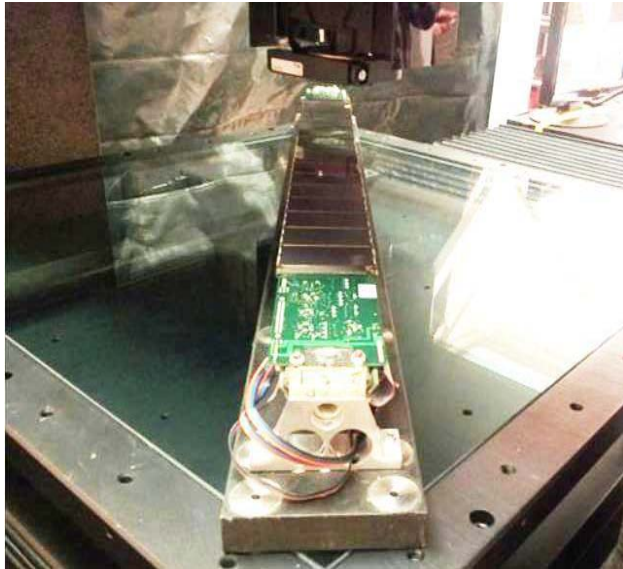Inner Detector Support

HFT Survey work

- PXL+SSD work has already begun, IST is setting up
  - Single chip and 3-chip ladder done. Full PXL sector (photo) in progress
  - SSD ladder preliminary survey done, parameter space defined
  - IST preliminary work on prototype ladder about to begin at BNL/Fermilab
- We had an internal *review* on procedures/general scheme in May
- Expertise is building up
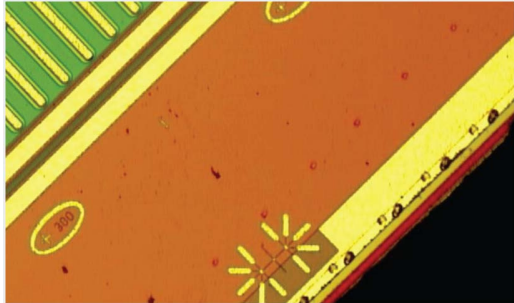- Manpower issues addressed (most)
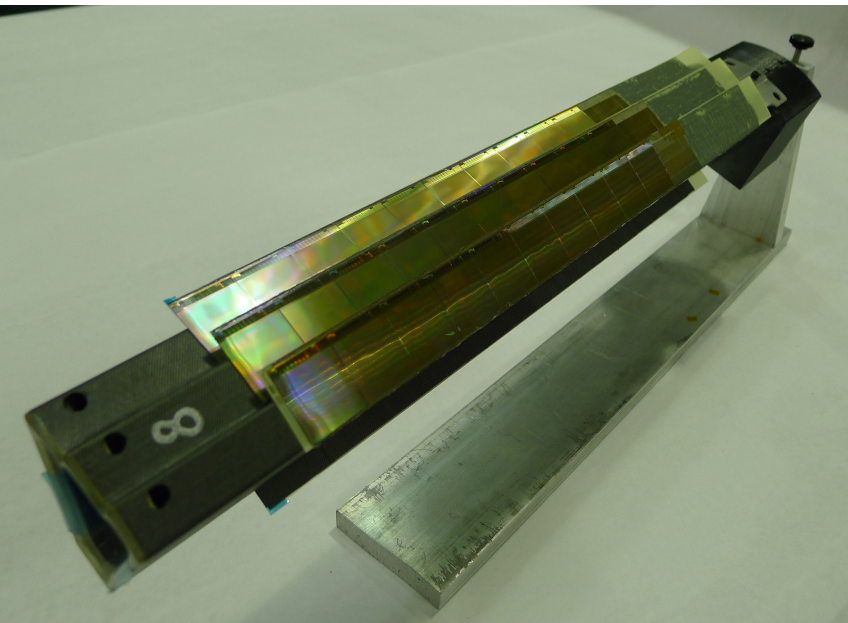
Difference from plane

SSD ladder survey

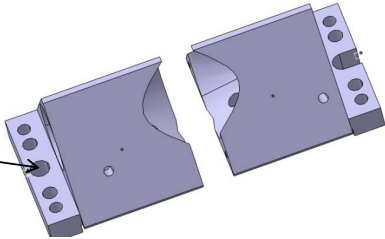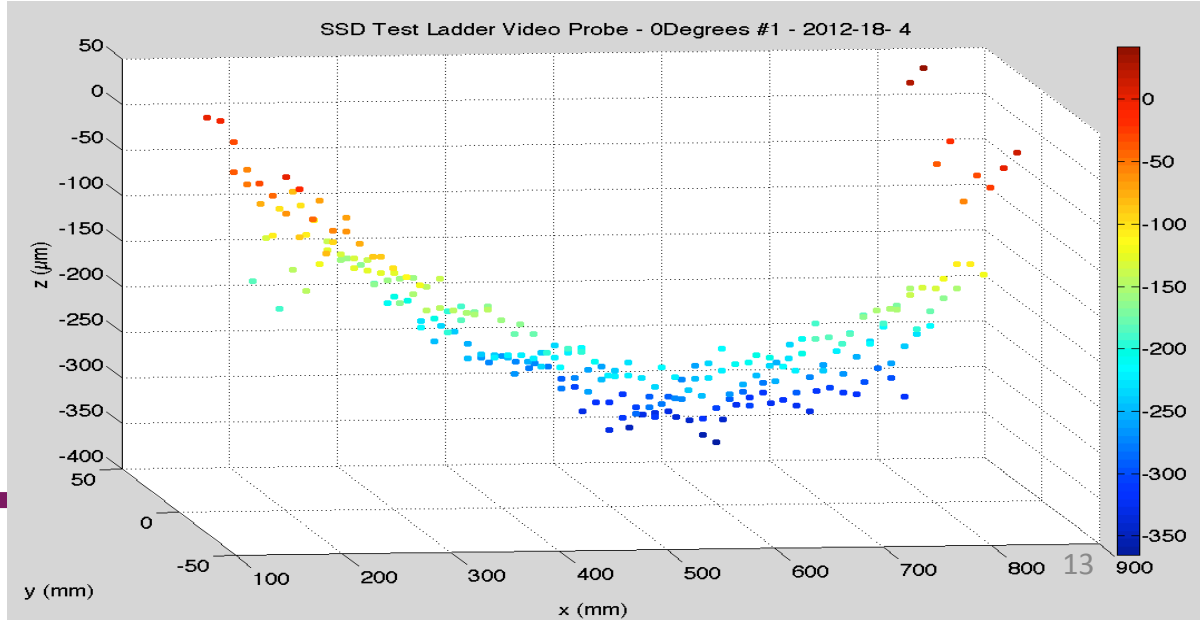Anticipated survey precision well within tolerances
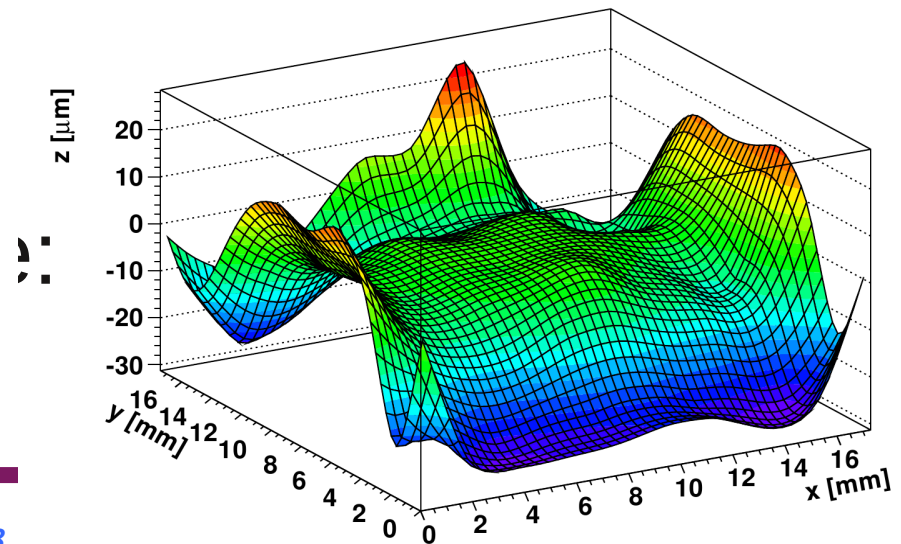
Target on end of wafer (backside)

~1.5 mm

Survey target

Reference point

Jim Thomas - LBL

Targets on edges of wafer (front)

9

SSD Test Ladder Video Probe - 0Degrees #1 - 2012-18- 4

z (µm)

y (mm)

x (mm)

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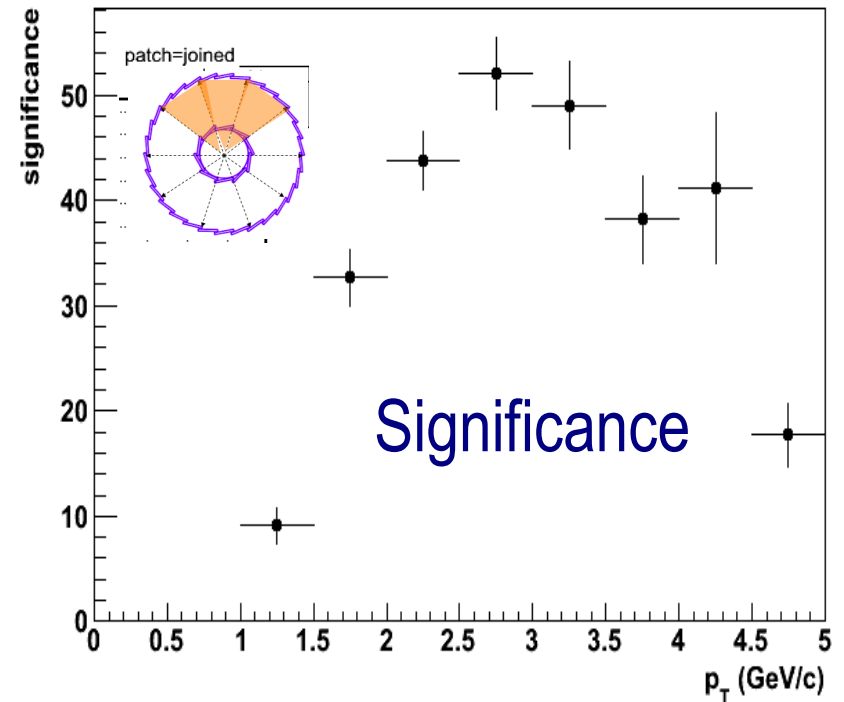
Slow/Fast PXL response simulation

- Most work done by IPHC (Strasburg) Collaborators
  - They have developed a Root program, DIGMAPS, for response studies
  - Analyzed CERN test-beam data with our sensors to fix parameters
- We are about to get their tune to use for our studies and compare with default "geometrical mean" approach. Then, build fast simulator with appropriate errors
- SSD simulators exist, IST is relatively simple, but still not there yet

= Collecting diodes
= seed diode
= Impact position
= seed-impact distance
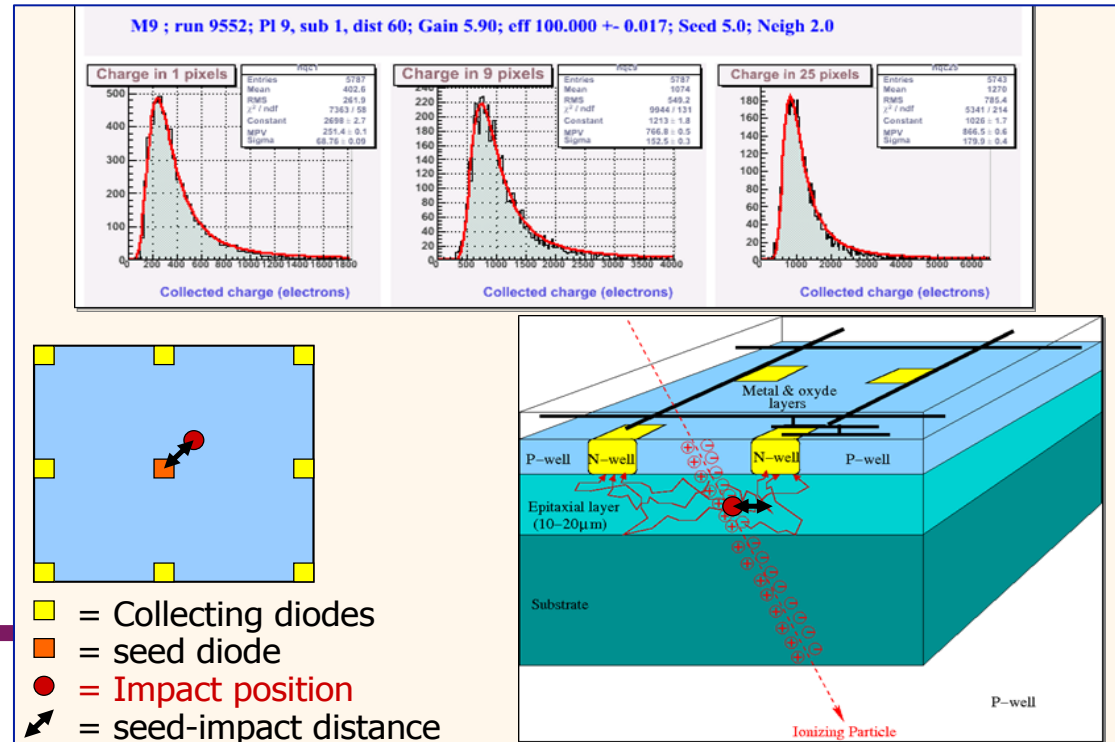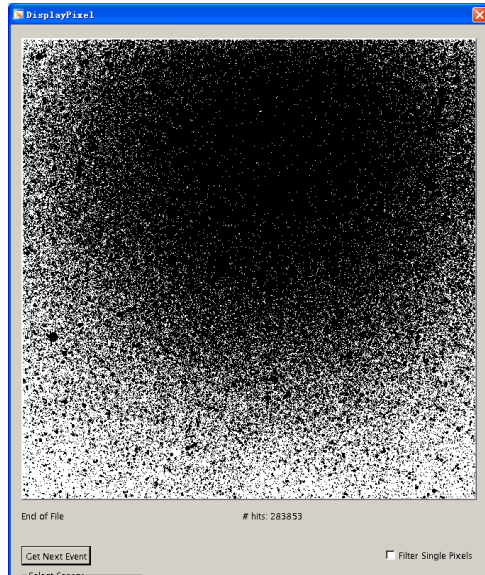
Simulations for the PXL prototype

500 M AuAu mbias events

Mercedes patch
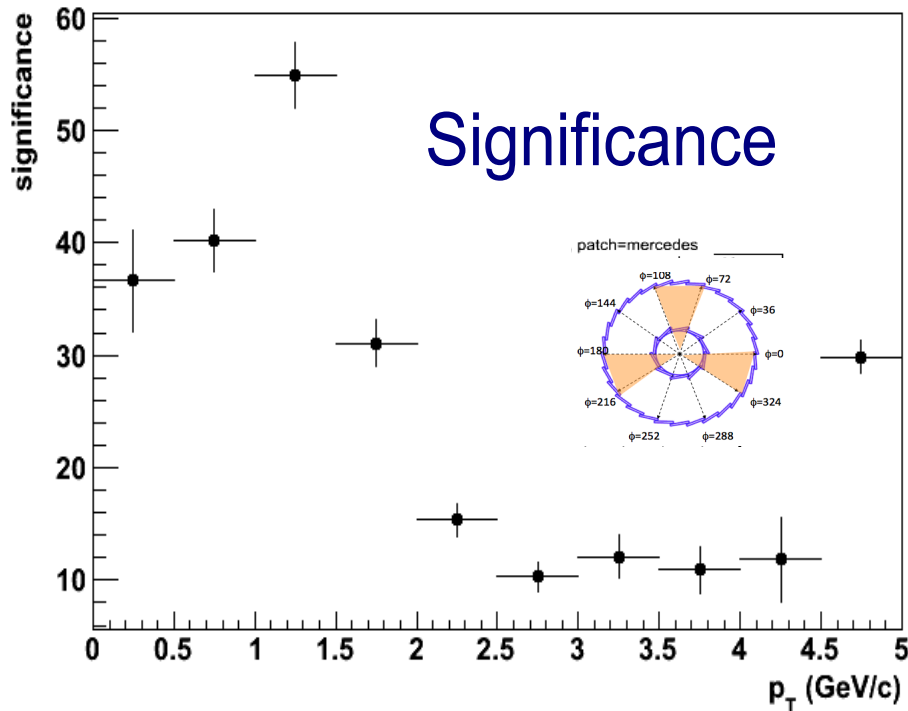
Offline chain - Update

- Establishing a working offline chain
- Modify structures/makers to our needs
- One example is shown below on Hit structures
  - Need to touch everything that uses it

Actual structures

Proposed structures

StEvent

StEvent

StRndHit

StRndHitCollection

StHftHit

StHftHitCollection
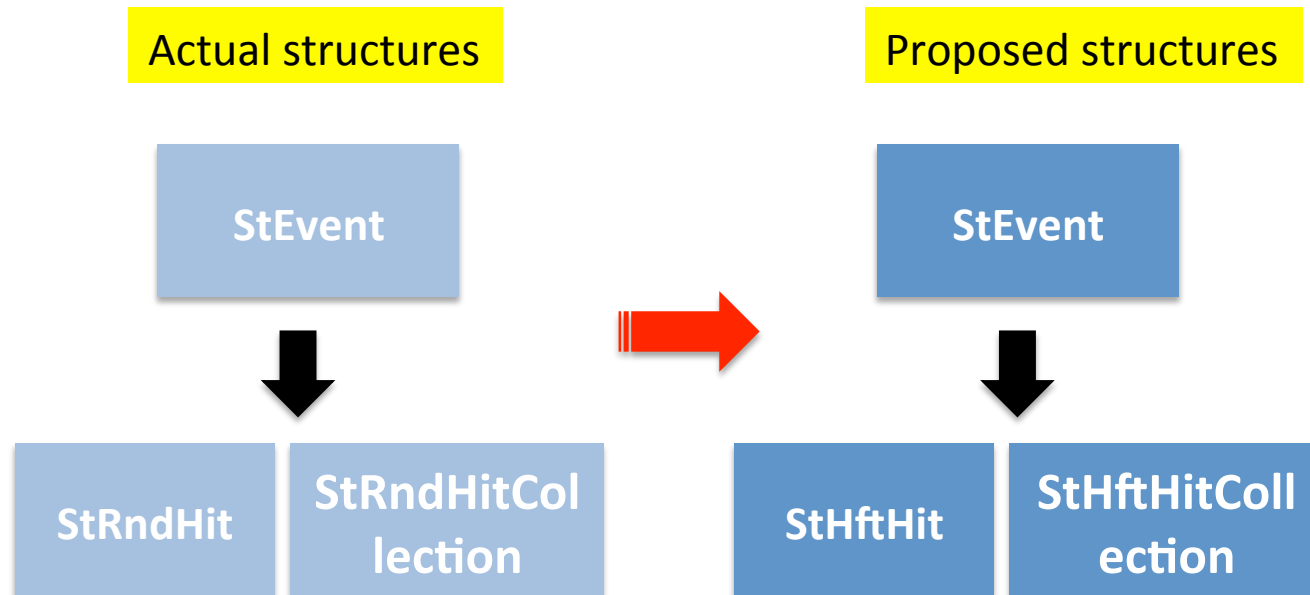
Numbering convention/Configuration of detector elements

- We have defined and documented the scheme for all HFT elements
- Complies with STAR conventions
- IST example is shown below
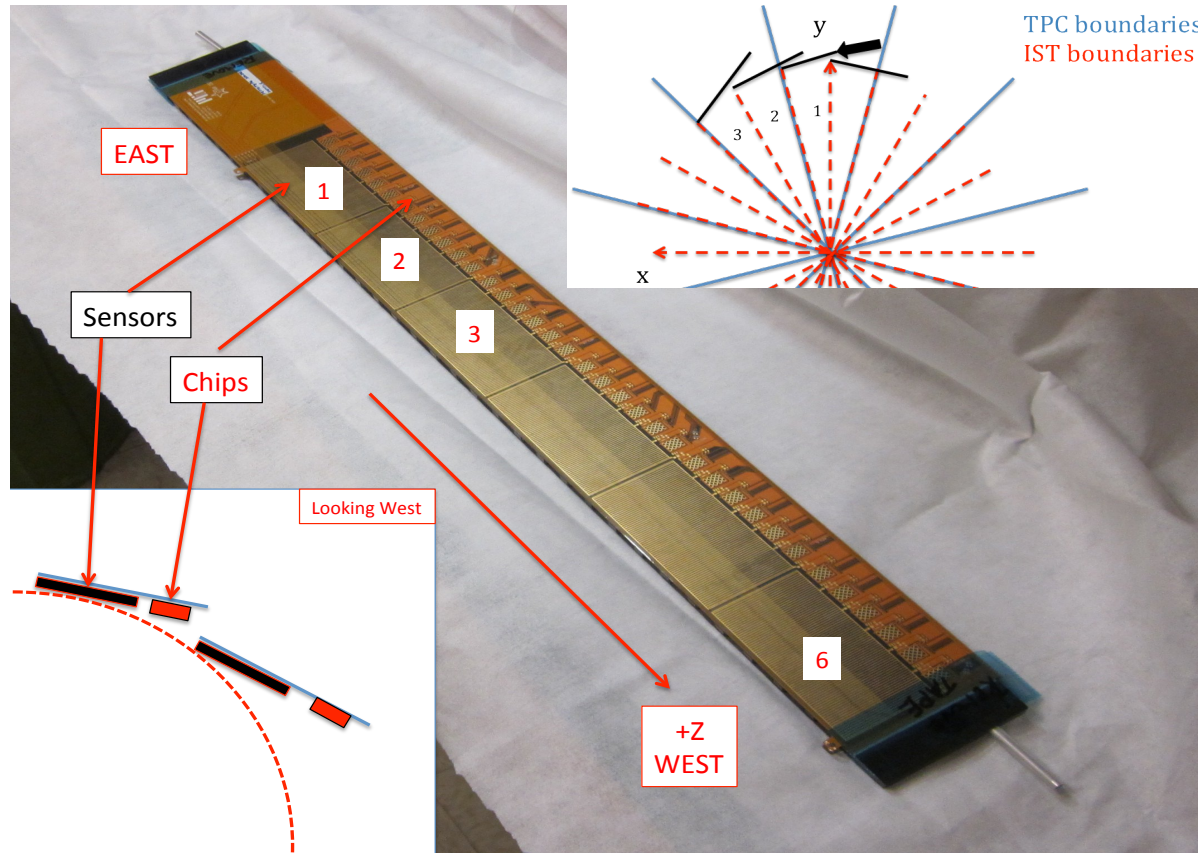
doc in eroom

Miscellaneous

- Simulation environment (UPC e- background, Pileup mechanism)
  - We did improve our understanding and way of generating this
  - We still need to put all this to work within STAR's official pileup scheme

- Event vertex finders (in pileup)
  - Important evaluation work goes on now

- Organize Web Docs

- Brief overview of subsystem
- Progress since last review
- **Outstanding technical issues and plans**
- Schedule
- Resources
  - People, institutions
- Risk assessment
- Summary

Planned work to do

- Besides things I have already mentioned above
- Raw data un-packers/Cluster-Hit finders
- Tests of CA, the new STV tracker and VMC environment
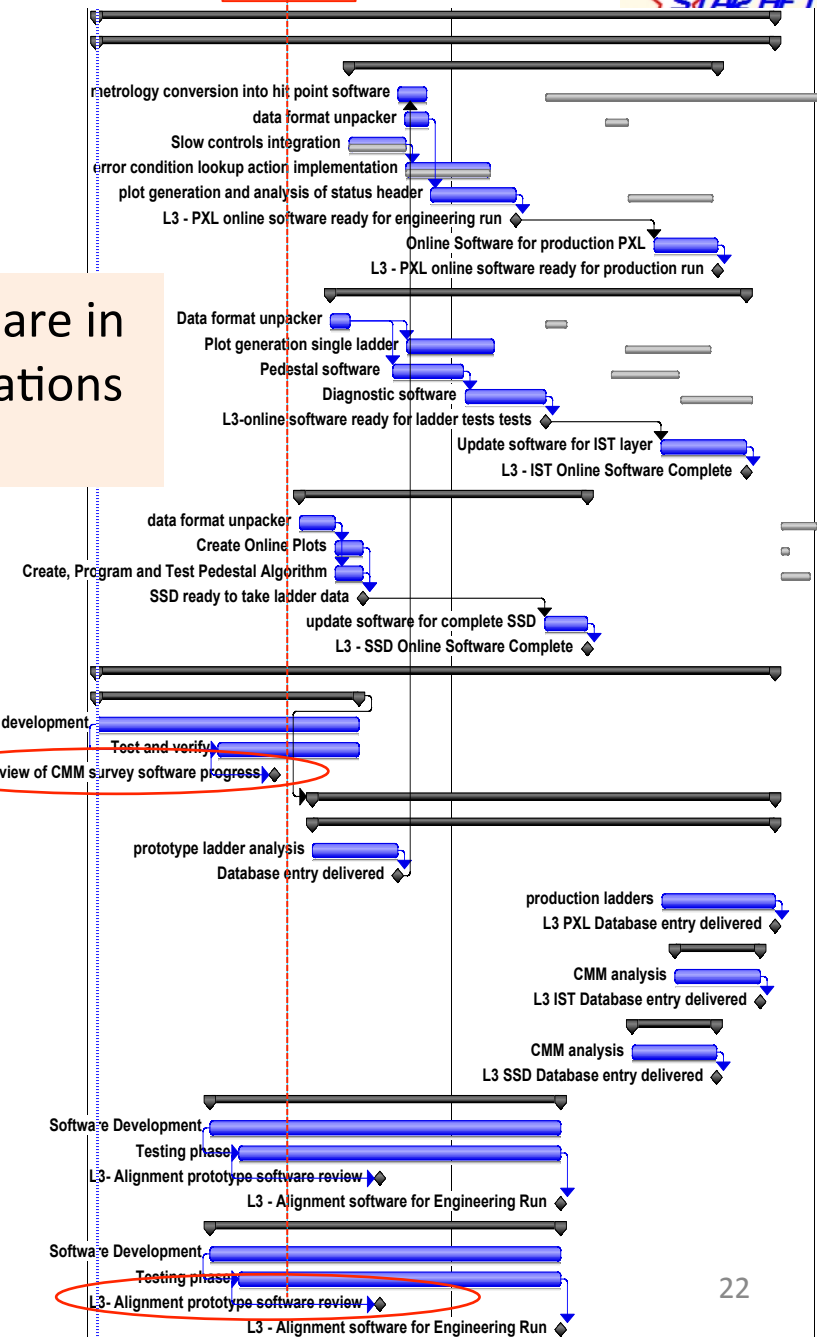- 'Online' data format/slow controls/online QA/Db considerations

With the prototype PXL installation and new institutes joining we anticipate to increase net effort.

- Brief overview of subsystem
- Progress since last review
- Outstanding technical issues and plans
- **Schedule**
- Resources
  - People, institutions
- Risk assessment
- Summary

NOW — 10/2012

STAR HFT

WBS	Task	%	Duration
1.6	Software	0%	464 days
1.6.1	Online	0%	464 days
1.6.1.1	PXL	0%	251 days
1.6.1.1.1	metrology conversion into hit point software	0%	20 days
1.6.1.1.2	data format unpacker	0%	17 days
1.6.1.1.3	Slow controls integration	0%	40 days
1.6.1.1.4	error condition lookup action implementation	0%	60 days
1.6.1.1.5	plot generation and analysis of status header	0%	60 days
1.6.1.1.6	L3 - PXL online software ready for engineering run	0%	0 days
1.6.1.1.7	Online Software for production PXL	0%	45 days
1.6.1.1.8	L3 - PXL online software ready for production run	0%	0 days
1.6.1.2	IST	0%	
1.6.1.2.1	Data format unpacker	0%	
1.6.1.2.2	Plot generation single ladder	0%	
1.6.1.2.3	Pedestal software	0%	
1.6.1.2.4	Diagnostic software	0%	
1.6.1.2.5	L3-online software ready for ladder test	0%	
1.6.1.2.6	Update software for IST layer	0%	
1.6.1.2.7	L3 - IST Online Software Complete	0%	
1.6.1.3	SSD	0%	195 days
1.6.1.3.1	data format unpacker	0%	25 days
1.6.1.3.2	Create Online Plots	0%	1 mon
1.6.1.3.4	Create, Program and Test Pedestal Algorithm	0%	20 days
1.6.1.3.5	SSD ready to take ladder data	0%	0 days
1.6.1.3.7	update software for complete SSD	0%	30 days
1.6.1.3.8	L3 - SSD Online Software Complete	0%	0 days
1.6.1.4	Calibration and alignment	0%	464 days
1.6.1.4.1	Survey Software	0%	180 days
1.6.1.4.1.2	CMM analysis software development	0%	9 mons
1.6.1.4.1.1	Test and verify	0%	5 mons
1.6.1.4.1.9	Internal Review of CMM survey software progress	0%	0 days
1.6.1.4.5	CMM analysis	0%	318 days
1.6.1.4.5.1	Analysis of PXL	0%	318 days
1.6.1.4.5.1.10	prototype ladder analysis	0%	3 mons
1.6.1.4.5.1.11	Database entry delivered	0%	0 days
1.6.1.4.5.1.12	production ladders	0%	4 mons
1.6.1.4.5.1.13	L3 PXL Database entry delivered	0%	0 days
1.6.1.4.5.2	Analysis of IST	0%	60 days
1.6.1.4.5.2.5	CMM analysis	0%	3 mons
1.6.1.4.5.2.6	L3 IST Database entry delivered	0%	0 days
1.6.1.4.5.3	Analysis of SSD	0%	60 days
1.6.1.4.5.3.1	CMM analysis	0%	3 mons
1.6.1.4.5.3.2	L3 SSD Database entry delivered	0%	0 days
1.6.1.6	Global Alignment	0%	240 days
1.6.1.6.1	Software Development	0%	12 mons
1.6.1.6.2	Testing phase	0%	11 mons
1.6.1.6.3	L3- Alignment prototype software review	0%	0 days
1.6.1.6.4	L3 - Alignment software for Engineering Run	0%	0 days
1.6.1.8	Self Alignment	0%	240 days
1.6.1.8.9	Software Development	0%	12 mons
1.6.1.8.10	Testing phase	0%	11 mons
1.6.1.8.11	L3- Alignment prototype software review	0%	0 days
1.6.1.8.12	L3 - Alignment software for Engineering Run	0%	0 days

Most immediate activities are in the areas of Online, Calibrations and Offline software

22

LEVEL-3 Milestones

3	L3 - First Article IDS at BNL	9/23/11	10/14/11(A)
3	L3- PXL Platform Design Complete	1/2/12	4/25/12(A)
3	L3 - First Article PST Assembled	2/1/12	6/22/12
3	L3 - HSSD modification designed	2/1/13	2/1/13
3	L3 - First Article IDS Engineering review	8/1/13	8/1/13

Software			
3	Review of CMM software progress	4/5/12	5/17/12
3	Alignment software Review	9/20/12	9/20/12
3	PXL CMM database delivered for prototype	11/15/12	11/15/12
3	PXL online software ready for engineering run	12/4/12	12/4/12
3	IST online software for ladder tests	1/13/13	1/13/13
3	Alignment software ready for engineering run	1/18/13	1/18/13
3	SSD online software complete	5/14/13	5/14/13
3	IST online software complete	7/24/13	7/24/13
3	IST CMM database delivered	8/17/13	8/17/13
3	PXL CMM database delivered for production sectors	8/22/13	8/22/13
3	PXL online software ready for production run	10/1/13	10/1/13

- Survey/Alignment/Db/Online are immediate on-project activities
- Geometry/Offline/Analysis are *hidden* but essential tasks

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- Brief overview of subsystem
- Technical Progress since last review
- Construction Plans
- Outstanding technical issues and plans
- Schedule & Cost
  - Cost to date and projection (from Sarah)
- **Resources**
  - **People, institutions**
- Risk assessment; value engineering
- Summary

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		IPHC	UCLA	KSU	NPI	MIT	LBL	Purdue	UST
Offline									
Hit Reconst.	IST					x			
	Pixel						x	x	
Tracking		x							
Event Vertex		x			x				x
Decay Vertex									
Calibration Db	SSD					x	x		
	IST				x				
	PXL						x	x	
Alignment	SSD				x		x		
	IST		x			x			
	PXL					x	x		
Simulation									
Geometry					x		x		
	IST					x			
	PXL						x		
Fast/Slow Sim.	SSD		x			x			
	IST		x		x				
	PXL	x					x	x	
Embed./Pileup	IST		x		x	x	x	x	
Assoc/Analysis			x	x					

- *Offline* tasks only

- Following FTE estimate *does not* include the STAR S&C group contributed effort

- It comes down to about 4 FTE/year for ~two years
  - We have about half of that
  - The rest will be contributed by the Collaboration

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Institutions and Tasks

- BNL: DB, Geometry, Tracking, Vertex, Calibrations
- IPHC: PXL Simulators
- UCLA: Simulations
- KSU: Calibrations, Testing, Offline Chain, Analysis Tools
- NPI: Calibrations, Simulations
- UIC: IST related tasks, TBD
- LBL: Calibrations, Online, Offline reconstruction (mostly PXL)
- Purdue: Simulators, Simulations
- USTC: Simulations, TBD

- Brief overview of subsystem

- Progress since last review

- Outstanding technical issues and plans

- Schedule Resources

  – People, institutions

- **Risk assessment**

- Summary

Software Risks (rather Challenges)

- ## Mitigations
  - Our approach is to use field-proven techniques as implemented in STAR (Kalman tracking, Calibrations, Analysis etc)

- ## Risks/Challenges
  - People: (in)sufficient manpower for tasks
    - We are addressing this by prioritizing tasks and management actions. Priority is given to on-scope activities
  - Overall environment functionality (tracking etc)
    - We work closely with STAR S&C management to ensure the soundness of the environment. Also to plan the timely deployment of new tools and infrastructure
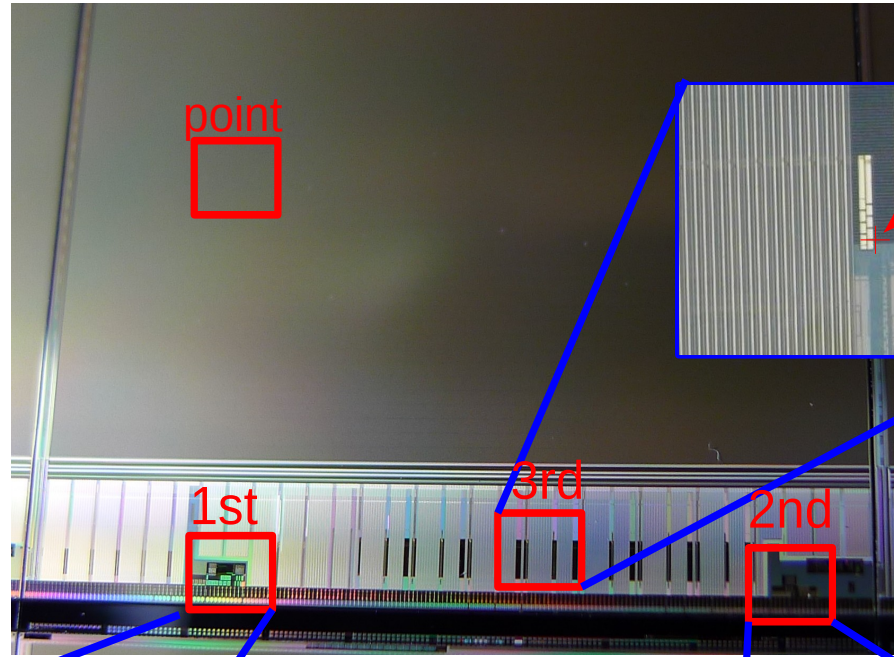
Summary

- – We have made initial progress on critical tasks

- – We heavily depend on STAR S&C support group

- – We need to double our efforts (FTE) for next year in order to meet increasing needs

Sensor's features for individual pixel coordinates defined
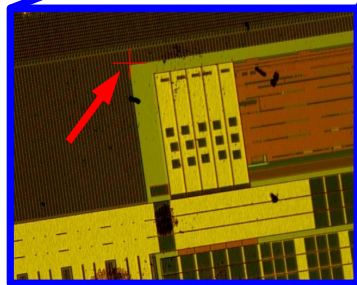## - Need be programmable for automating process

x=4594.225 μm
y=10000.00 μm
z=0 μm

x=? μm
y=? μm
z=0 μm

x=4594.225 μm
y=920.775 μm
z=0 μm

x=18165.075 μm
y=871.6 μm
z=0 μm