HFT Software Status

S. Margetis, KSU

SIMULATION STREAM

GEANT

DATA STREAM

StDaqMaker
StDaqLib

StPixelDaqMaker

StPixelRecoMaker
StIstRecoMaker

StPixelFastSimMaker/

StIstFastSimMaker/

Hit reconstruction

StEvent containing PIXEL and IST Hits hits

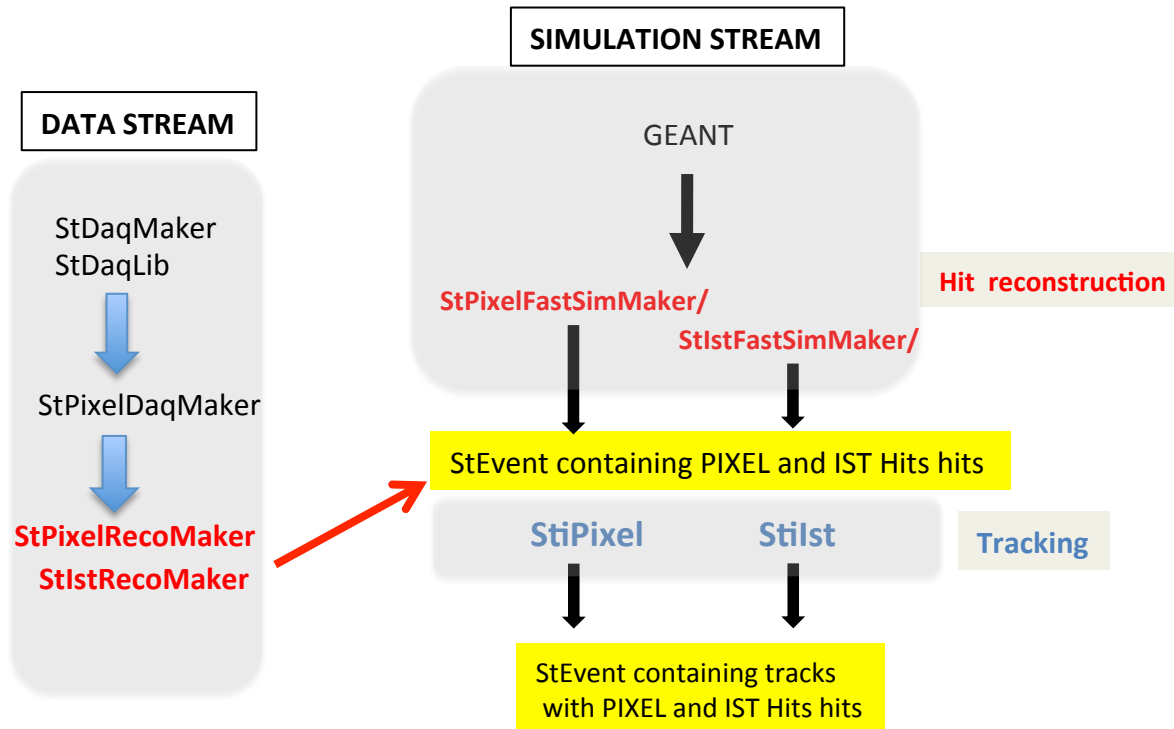**StiPixel**   **StiIst**   **Tracking**

StEvent containing tracks
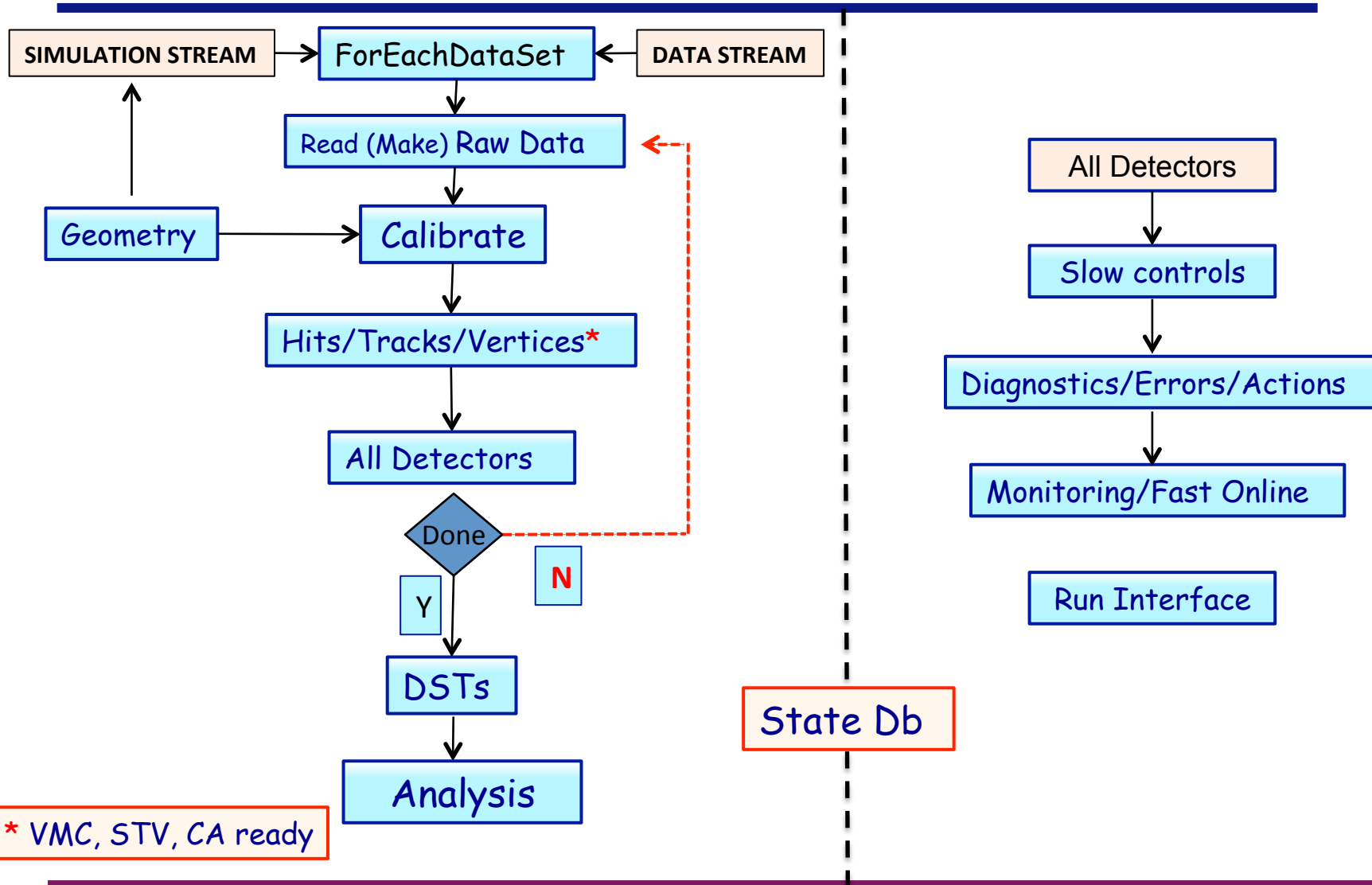with PIXEL and IST Hits hits

Outline

- 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 and
- Risk assessment; value engineering
- 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

- WBS 1.6 is 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.

- Subsystem meets weekly to plan work and get updates. Participates in weekly TC meetings as well.

- Subsystem is an integral part of STAR's S&C environment, interacting very closely with it on a regular basis.

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General Flowchart of Software Tasks Offline/Online

- 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 and

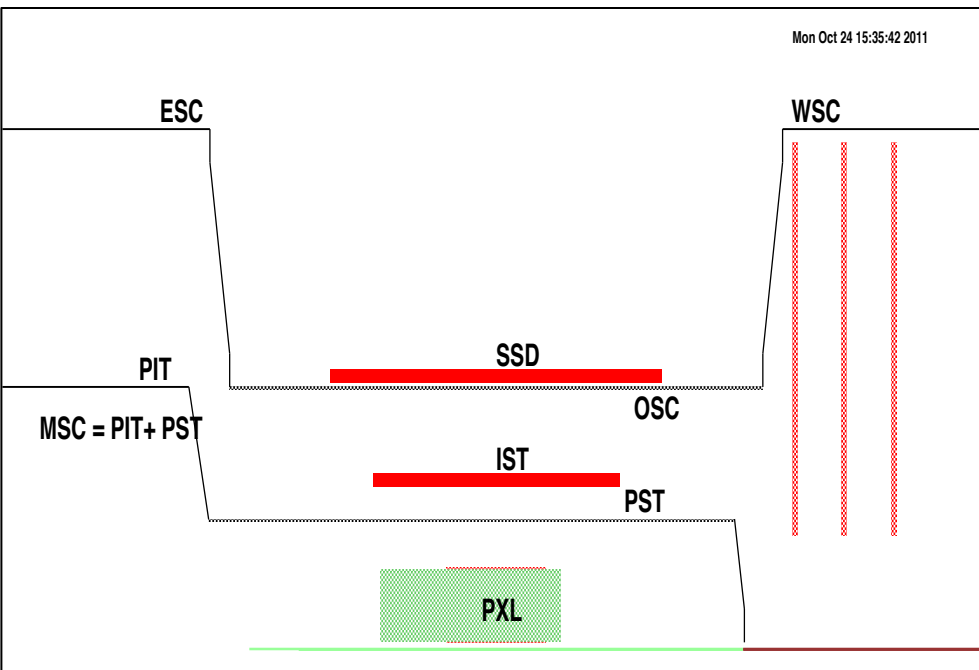- Risk assessment; value engineering
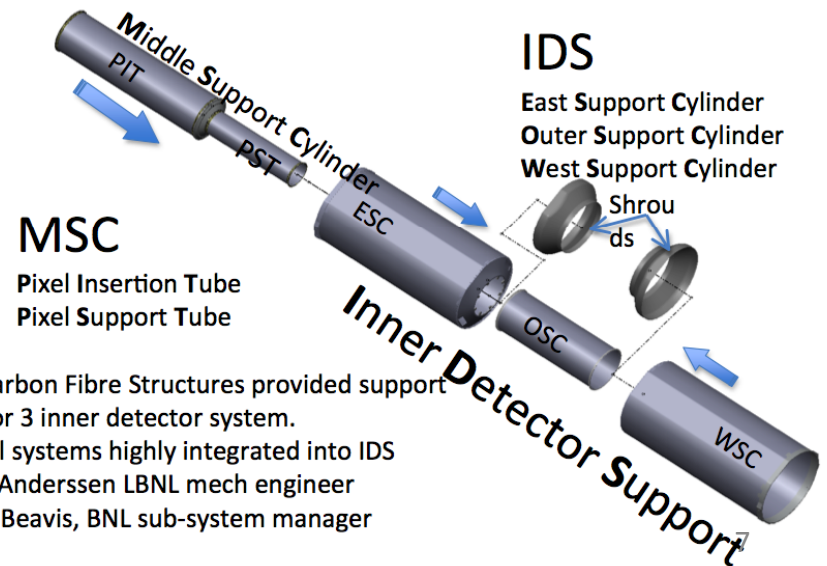
- Summary

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

- HFT Geometry model
- HFT Survey & Alignment related work
- Slow/Fast PXL response simulation
- Prototype (BUR) simulations/tracking
- Offline structures (Hits etc)
- Simulation environment (UPC e⁻ background, Pileup)
- Conventions (naming scheme defined), Db

- 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

RED = On-scope activity

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 in progress
- Work on details of support structures etc in progress
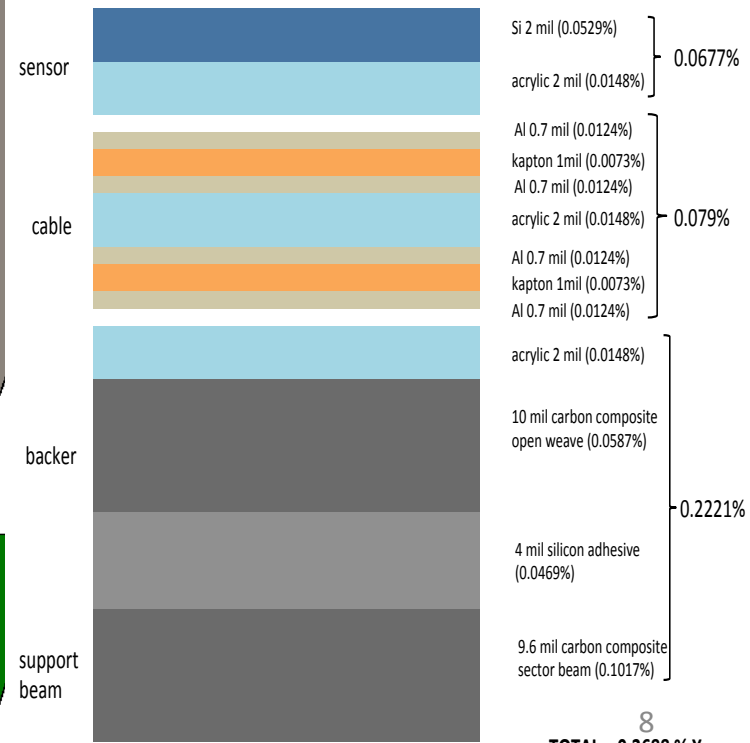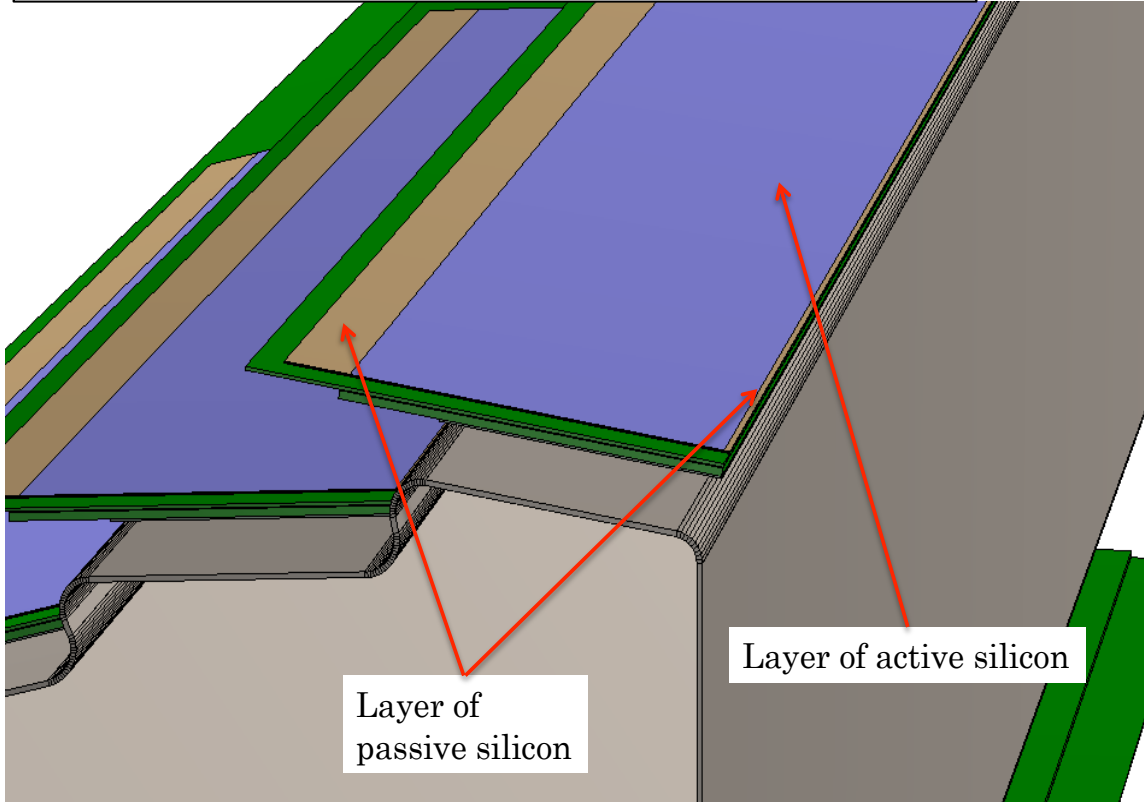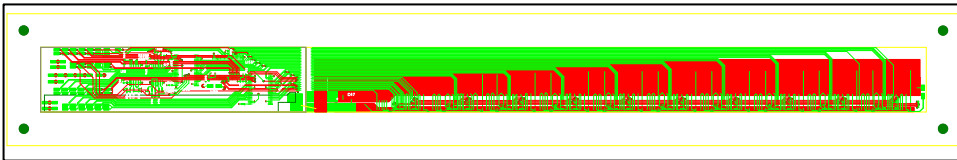- Manpower probably O.K. but we seek more help

Mon Oct 24 15:35:42 2011

ESC

WSC

PIT

MSC = PIT+ PST

SSD

OSC

IST

PST

PXL

Inner Detector Support

Middle Support Cylinder

PIT

PST

ESC

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

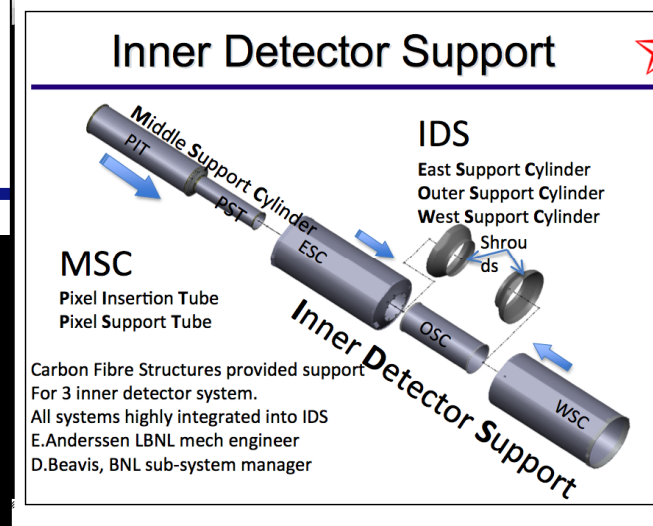Inner Detector Support

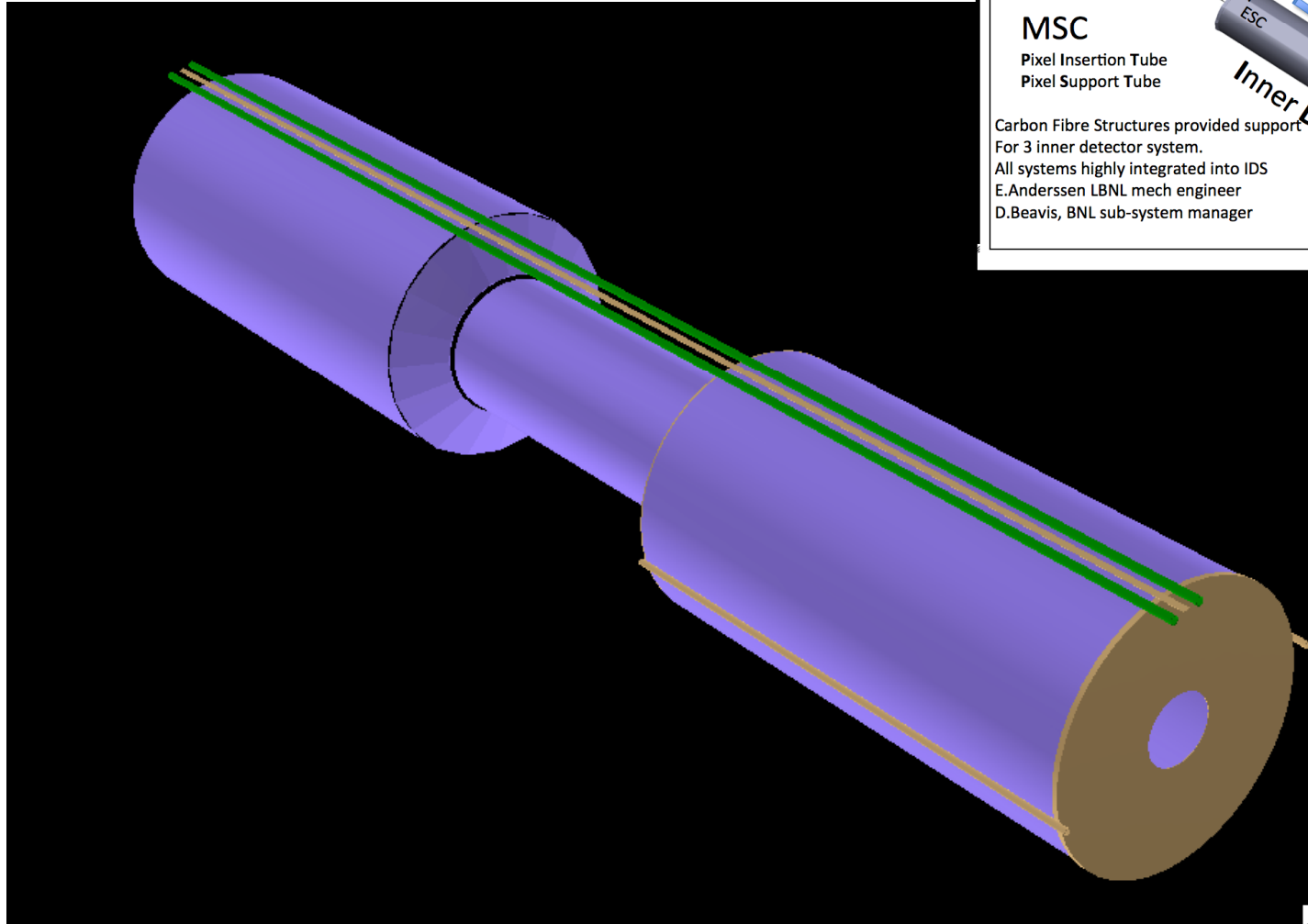OSC

WSC

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%)
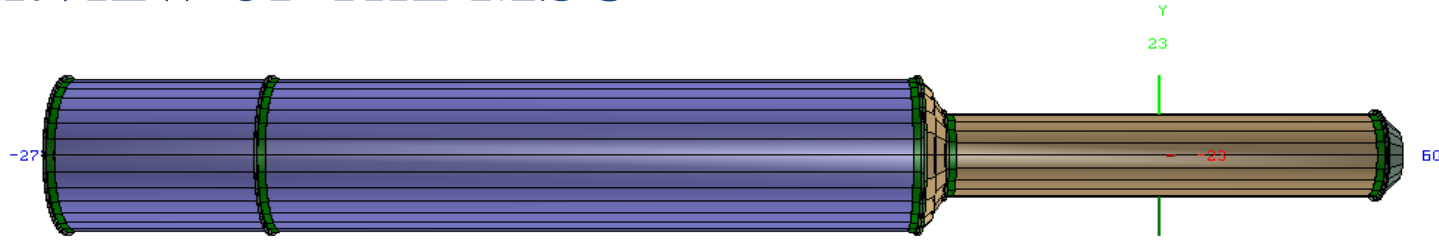- } 0.2221%
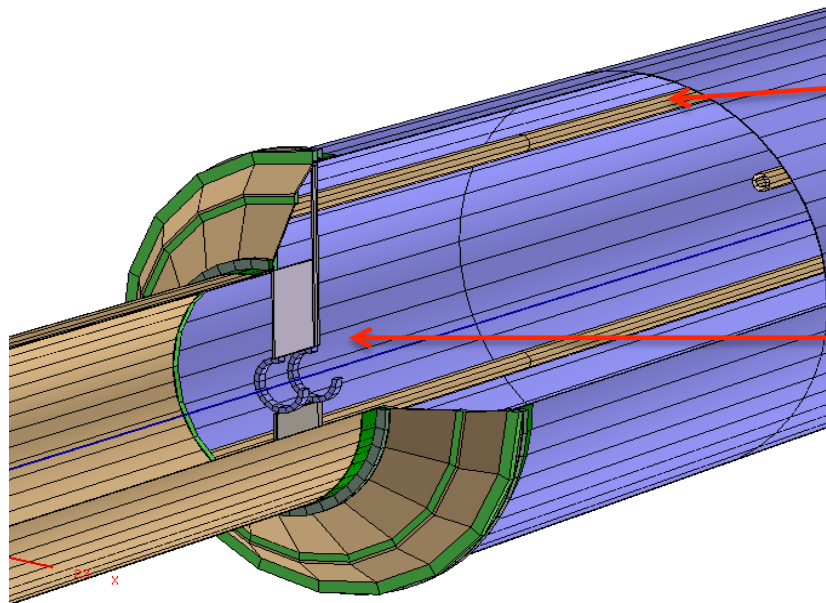
TOTAL = 0.3688 % X_0

IDS modeling

MSC modeling

OVERVIEW OF THE MSC
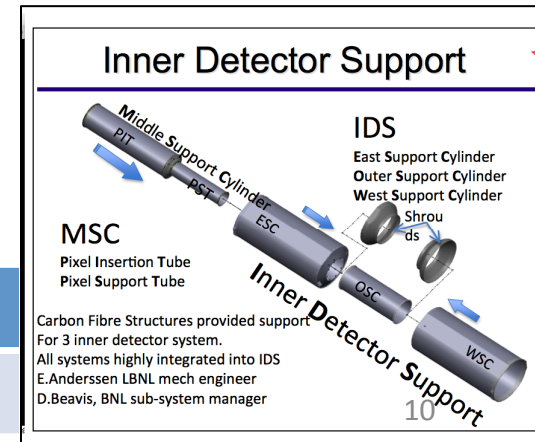

rails

Rings surroundings
the beam pipe

• : temporary until
implementation of
real material (slide 39)

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

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

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- 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
- We had an internal review on procedures/general scheme in May
- A lot of detailed work in front of us, but expertise is building up
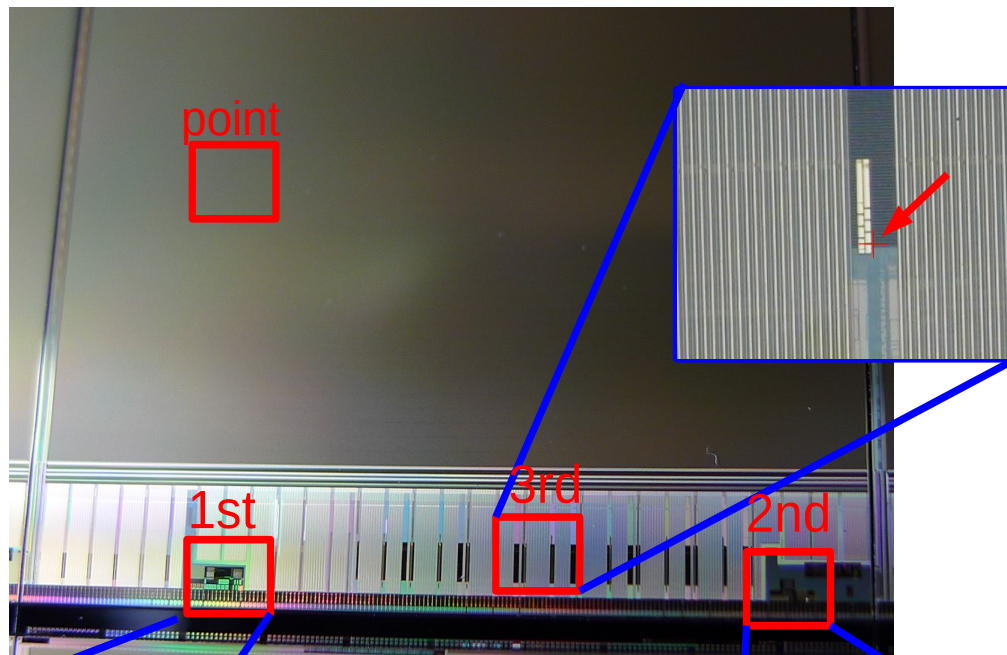- Manpower issues addressed (most) but there are tasks available
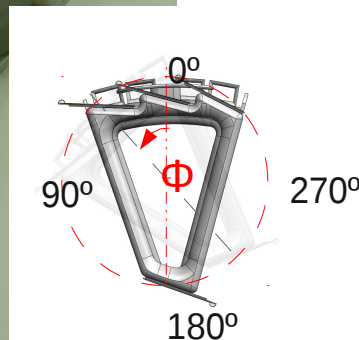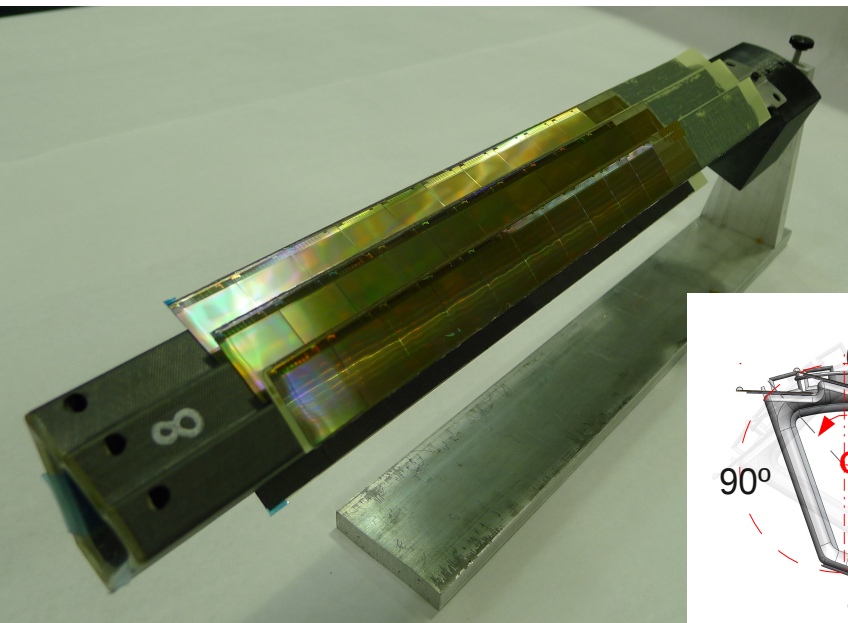
Difference from plane

11
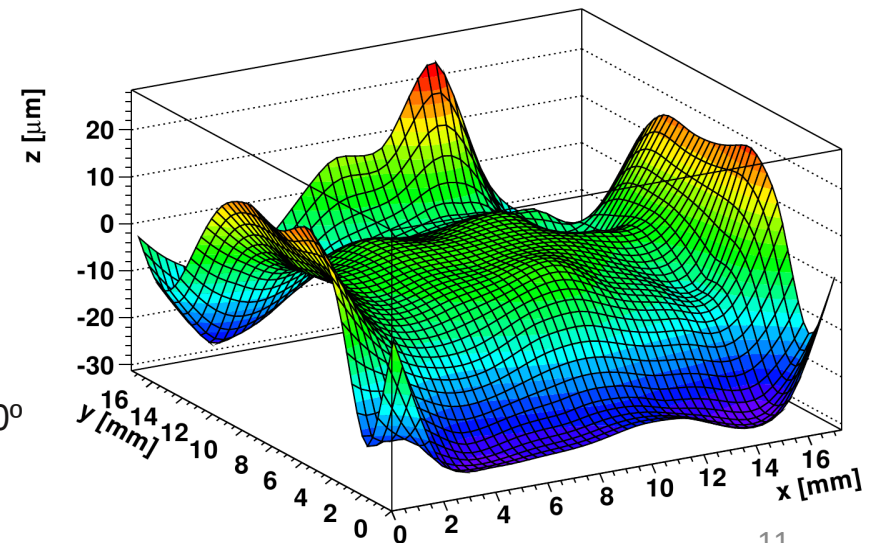
Sensor's features for individual pixel coordinates identified
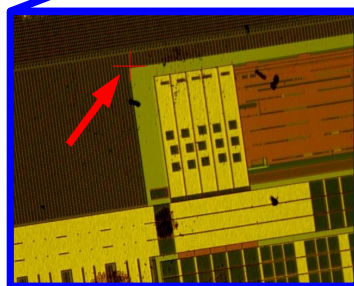## - Need be programmable for automating process

x=4594.225 µm
y=10000.00 µm
z=0 µm

point

x=? µm
y=? µm
z=0 µm

1st   3rd   2nd

x=4594.225 µm
y=920.775 µm
z=0 µm

x=18165.075 µm
y=871.6 µm
z=0 µm

8

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Reference point
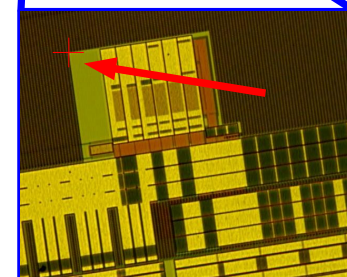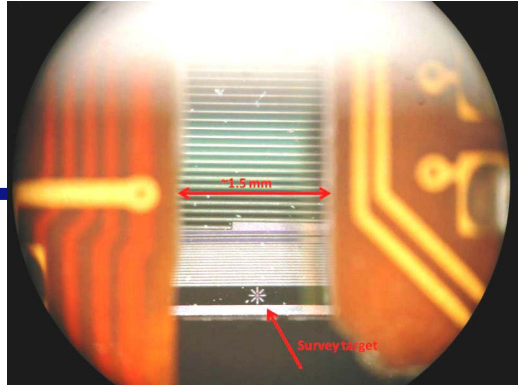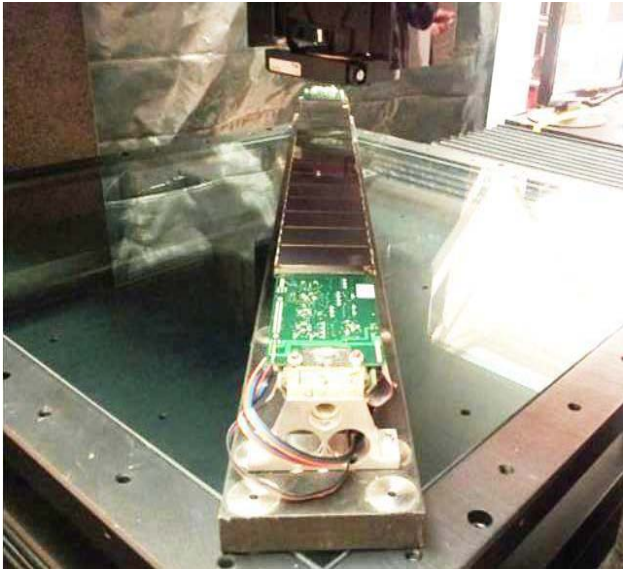
Jim Thomas - LBL

Target on end of wafer (backside)
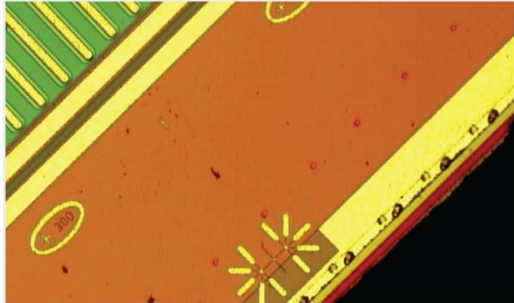
Targets on edges of wafer (front)

9

SSD ladder survey

SSD Test Ladder Video Probe - 0Degrees #1 - 2012-18- 4
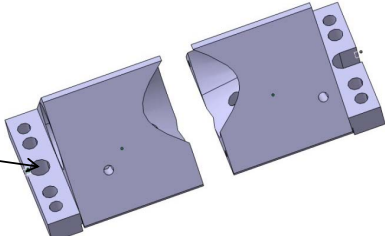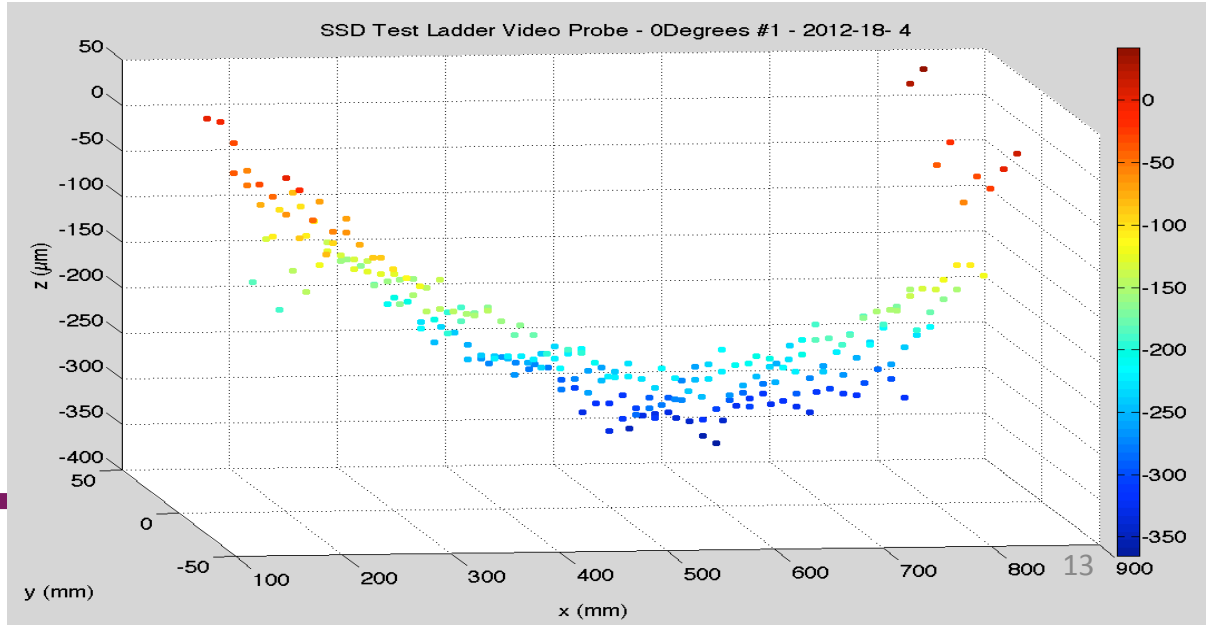
Slow/Fast PXL response simulation

- Most work done by IPHC (Strasburg) Collaborators
- The 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
- These are low priority tasks but need to start

= Collecting diodes
= seed diode
= Impact position
= seed-impact distance
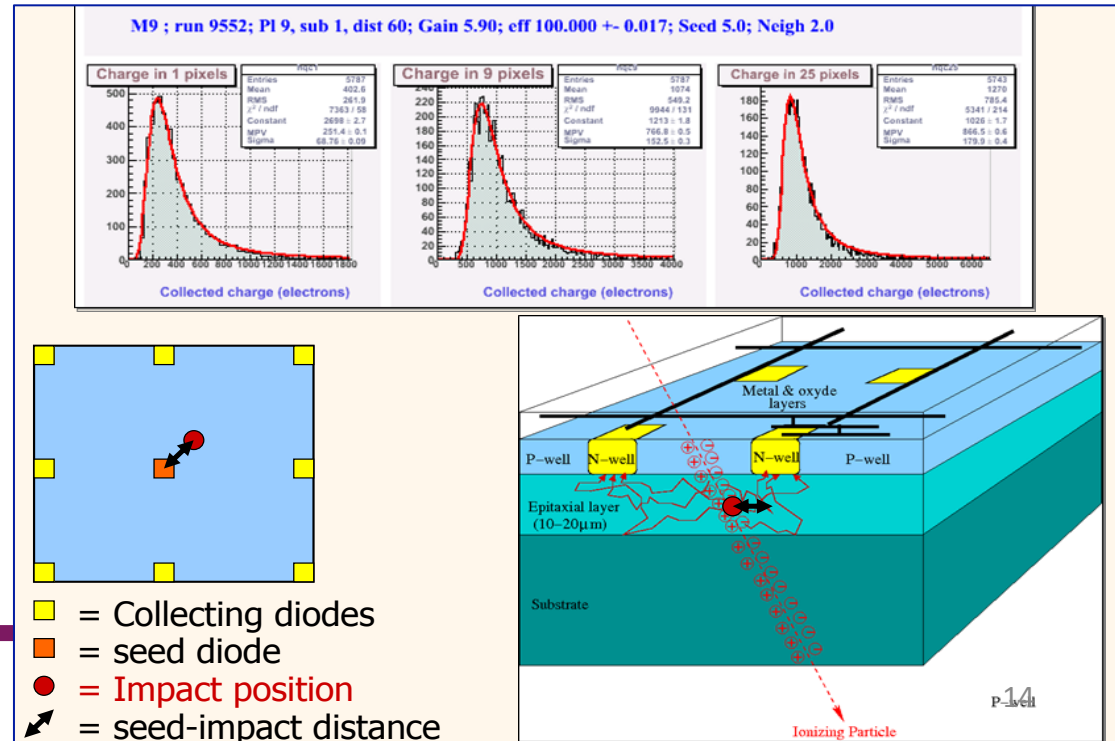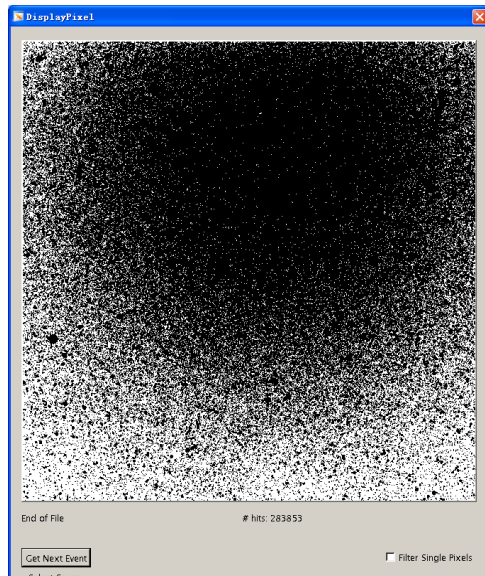
Tracking (Physics?) with TPC+PXL prototype ?

- BUR simulations done, presented and used as input
- Simulations show (see next slide too) that there might some physics opportunities
- This connects to the bigger issue of Tracking and whether inside-out tracking is possible. Is CA useful? Work in this direction is scheduled
- This is vital work for the project. ANY help and idea is invaluable.

pt>.1, |η|<1 ,tpc >10, pixl =2, patch=mercedes

pt>.1, |η|<1 ,tpc >10, pixl =2, patch=joined

acceptance D0
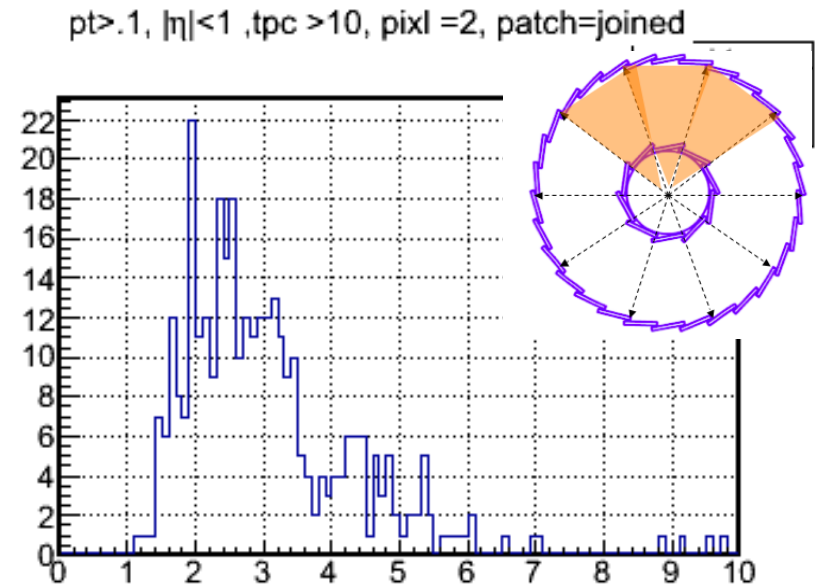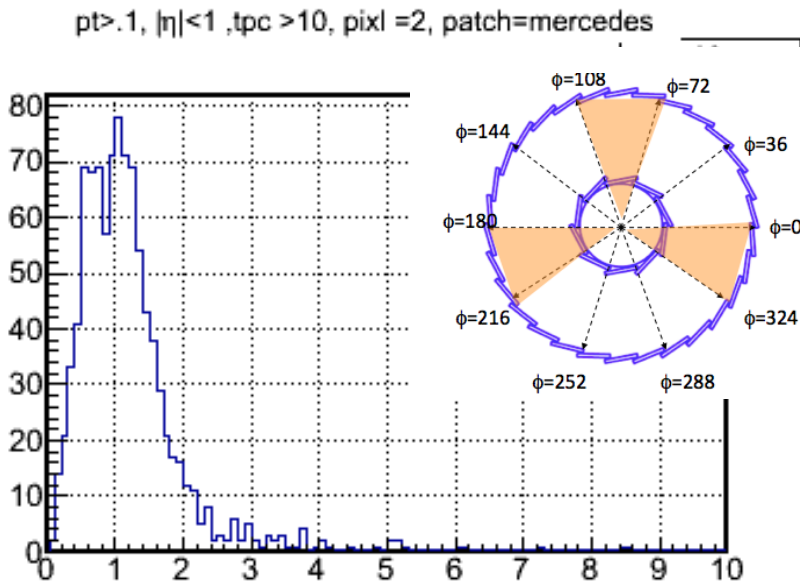
BUR results based on full simulations

patch=mercedes

patch=joined

patch

X Mercedes patch
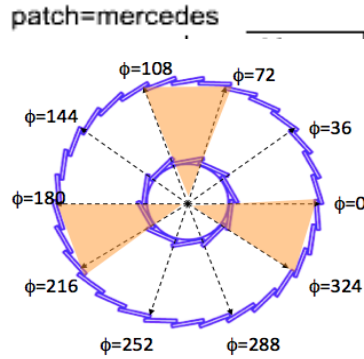
500 M AuAu mbias events

Mercedes

Mercedes
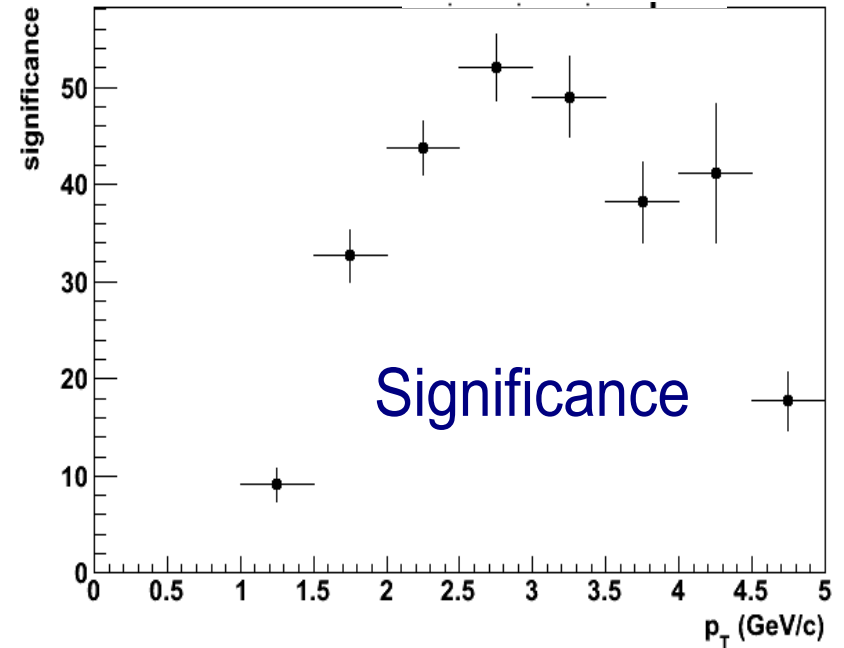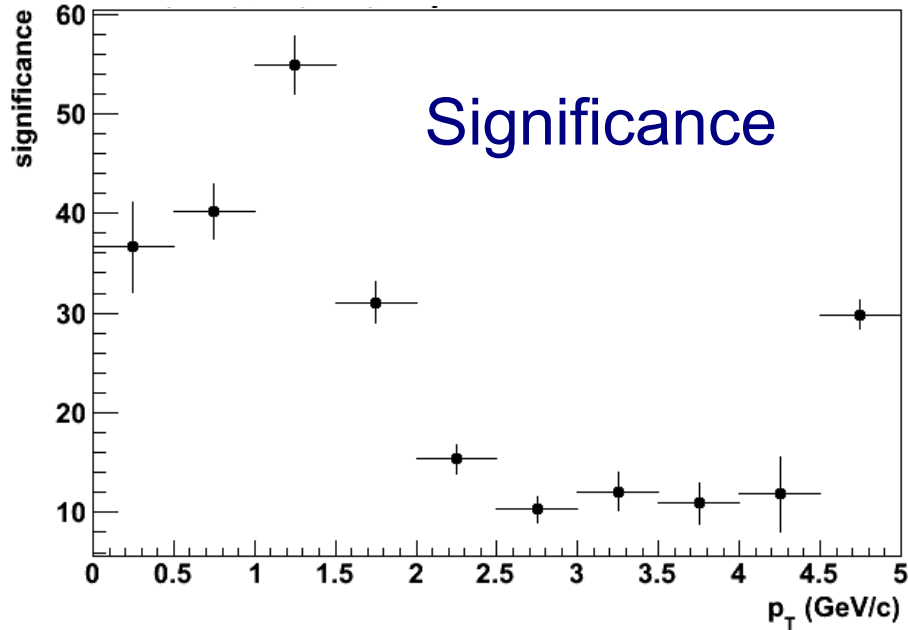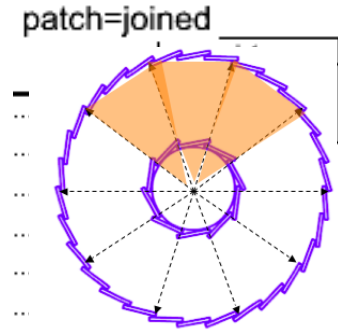
Offline chain - Update

- Establishing a working offline chain
- Modify structures/makers to our needs
- Closely tied to S&C territory !
- Need to stay informed and implement new strategies (e.g. no minimc etc)
- We 've gone through initial loops but not done yet(see 2 slides)
- Expert help invaluable

Actual structures

Proposed structures

StEvent → StRndHit StRndHitCollection

StEvent → StHftHit StHftHitCollection
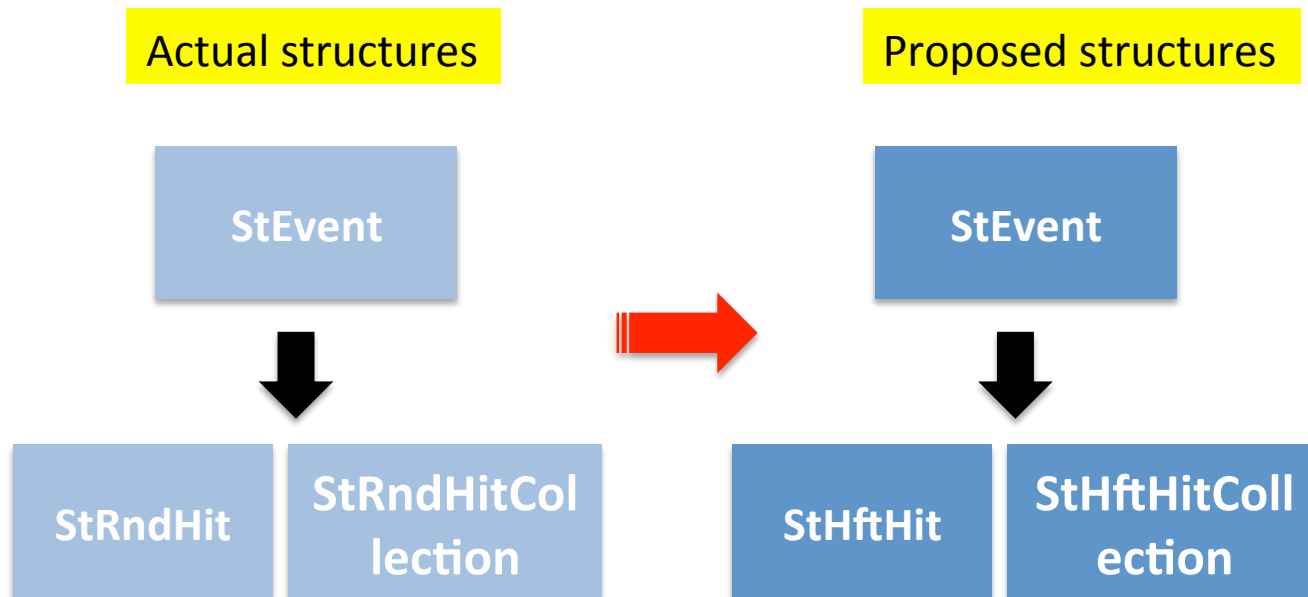
Numbering convention/Configuration of detector elements

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

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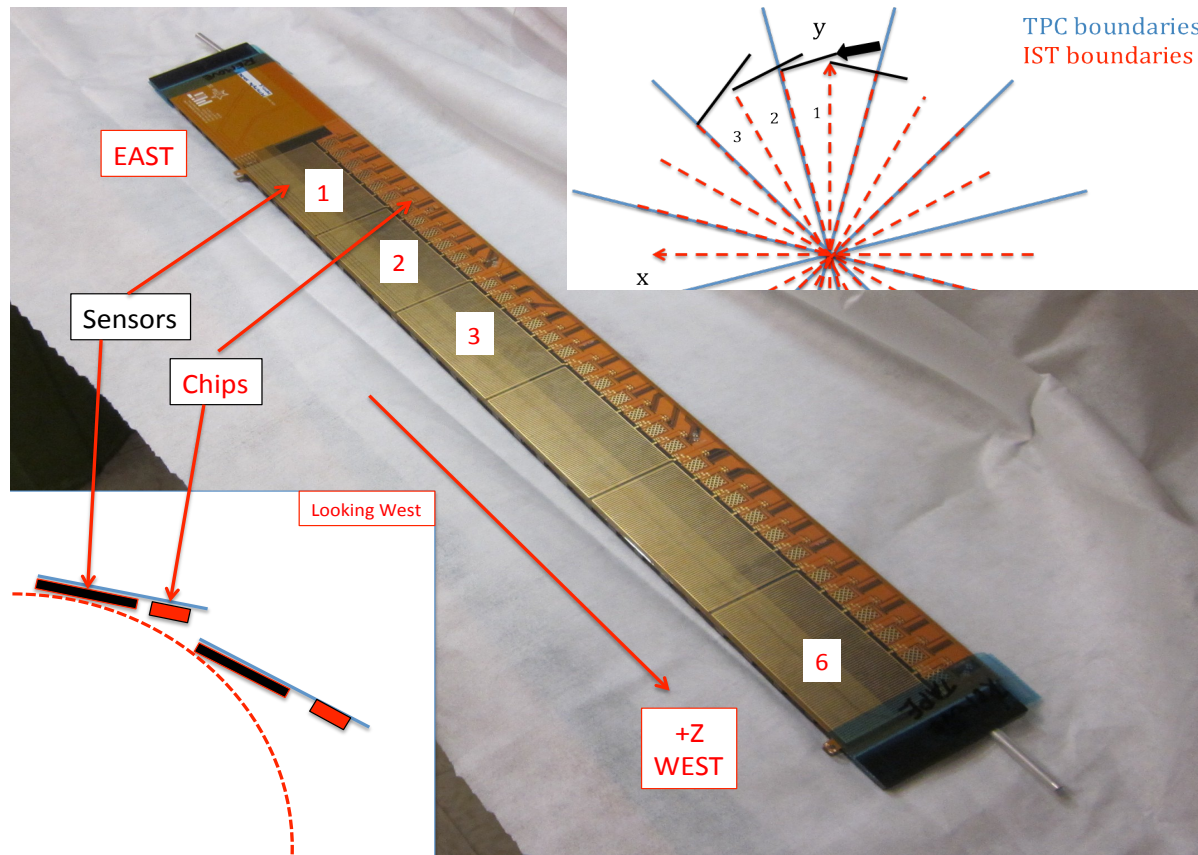
- Simulation environment (UPC e⁻ background, Pileup mechanism)
  - We did improve our understanding and way of generating this
  - We still need to put all this to work with STAR's official pileup scheme

- Event vertex finders
  - Important evaluation work goes on now

- Web Docs
  - Jonathan and I are organizing better our Off-Drupal personal doc areas
  - S&C provided an AFS area for Off-Drupal (really public) access
  - Drupal pages need rework from scratch

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Planned work to do

– *Besides things I have already mentioned above*

- Raw data un-packers/Cluster-Hit finders

- Tests of CA/new STV tracker, VMC environment

- 'Online' data format/slow controls/online QA/Db considerations

With the prototype PXL installation and the new institutional involvement the Collaboration will refocus some of its effort to the new device.

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NOW   10/2012

STAR HFT

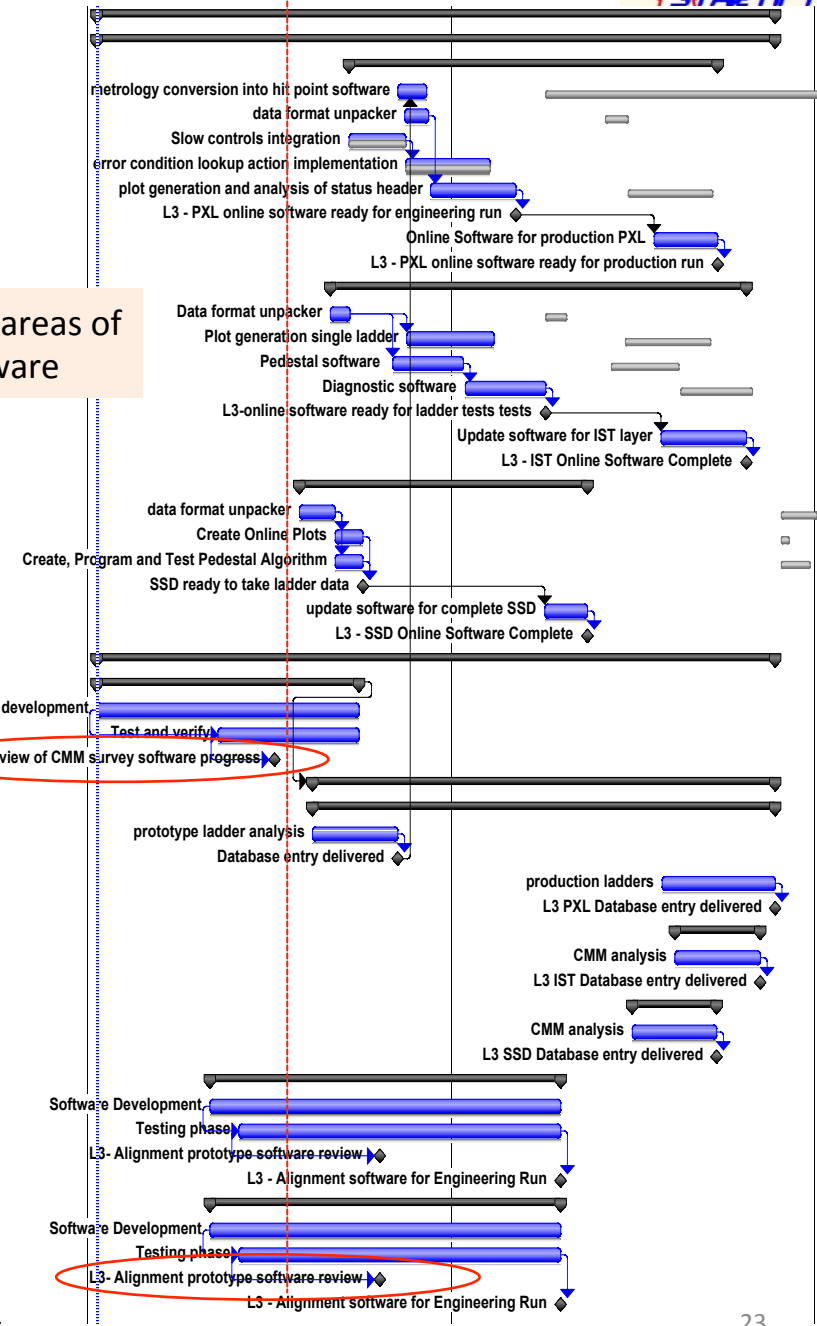| WBS	Task	%	Duration
1.6	Software	0%	464 days
1.6.1	Online	0%	464 days
1.6.1.1	PXL	0%	251 days
1.6.1.1.1	metrology conversion into hit point software	0%	20 days
1.6.1.1.2	data format unpacker	0%	17 days
1.6.1.1.3	Slow controls integration	0%	40 days
1.6.1.1.4	error condition lookup action implementation	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%	284 days
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 tests tests	0%	0 days
1.6.1.2.6	Update software for IST layer	0%	60 days
1.6.1.2.7	L3 - IST Online Software Complete	0%	0 days
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

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

LEVEL-3 Milestones

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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Software task	
Offline	
Hit Reconst.	IST
	Pixel
Tracking	
Event Vertex	
Decay Vertex	
Calibration Db	SSD
	IST
	PXL
Alignment	SSD
	IST
	PXL
Simulation	
Geometry	SSD
	IST
	PXL
Fast/Slow Sim.	SSD
	IST
	PXL
Embed./Pileup	IST
Assoc/Analysis	

IPHC   UCLA   KSU   NPI   MIT   LBL   Purdue   USTC

- List is for *Offline* tasks only

- Following FTE estimate *does not* include BNL- core group contributed effort in tracking/vertexing/calibrations etc. Also, numbers are on the under-estimate side

- It comes down to about 4 FTE/year for ~two years
  - We have about half of that
  - The rest will come as we near the hardware completion, the prototype development and institutional manpower redirection

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

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- Software Risks (rather Challenges) are related to:

  – People: (in)sufficient manpower for tasks
    - We are addressing this by prioritizing tasks and management actions

  – Overall environment functionality (tracking etc)
    - We engage in discussions with STAR S&C management for overall timeline development/understanding

  – Our value engineering is to use field-proven techniques

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Summary

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