Conventional Strip Sensor (CSO) Option

Abhay Deshpande

For the Silicon Strip Group

Outline

- Motivation for Conventional Sensor Option
- Strategy developed
- Plan for realization & Impact on schedule
- R&D costs, sensor availability & manpower issues
- Status of CSO today

Motivation for CSO

- Stripixel design (one sided-two dimensional readout) novel!
- Challenging but possible:
  - Felt not only by its promoters but also by VTX reviewers
- At the time of last June'08 VTX review, a number of performance questions remained
- In June 08:
  - A full module with ROC3 and Stripixel sensor had been available for lab testing for less than a month
  - A number of outstanding performance questions remained
  - A MIP peak was seen
  - **Concerns:**
    - **S/N**
    - **Automated large scale production**
    - **ideas for simple modifications of ROC3 too premature**

Back-up plan effort initiated…

- For these reasons, it seemed prudent to consider if there were any other options available as reliable “back-up” plan
- Conventional Strip Task Force was setup
- Charge to the task force:
  - To prepare a plan in the next few months
  - Look in to R&D issues and availability of hardware for test
  - Help the collaboration make decisions in the end

Plan

Showed in June08 Review

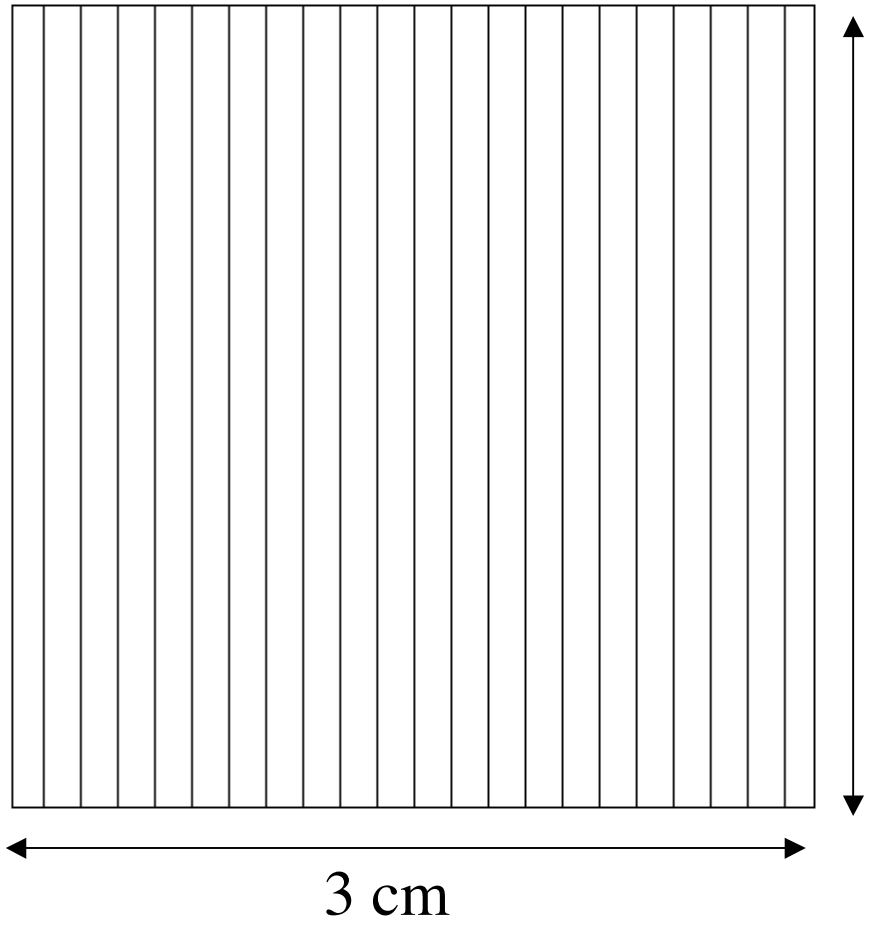
- Build upon the experience gained until that time (June08)
  - Use developed parts of the ROCs
  - Plan on minimal R&D for costs (which also would save time)
- Replace Stripixels with Conventional Strip Sensors (CSOs) that match our Stripixels in its physical requirements: dimensions
- Using CS and ROC3 or ROC2 to make a module and proceed with the same tests that were originally planned for the Stripixel detector
- Evaluate signal-to-noise and compare each stage of the performance with the Stripixel
- Make the final decision based on these tests

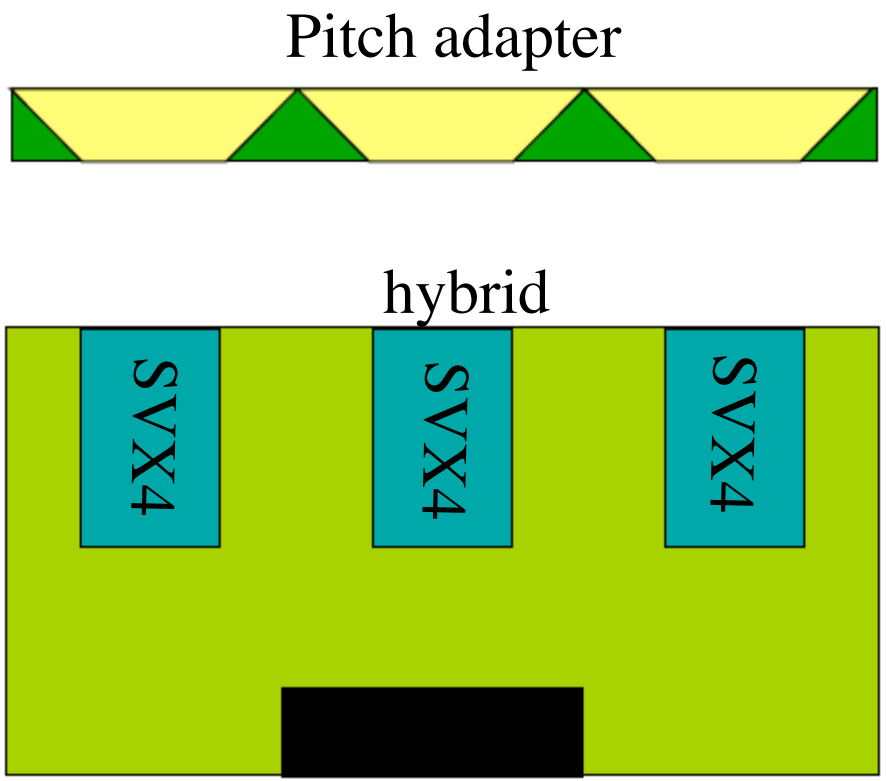
Possible realization path (envisioned in June'08)

- CDF has shown SVX4 + HPK's off-the-shelf conventional sensors to work: **We decided to be as close to that model as possible**
- HPK has 3x6 cm strip sensors (80 micron pitch) made for ATLAS which we thought we could use:
  - Anticipated: a ~2 may be available for free
  - Five or more at a minimal cost
  - Other fall back options from CDF/D0 groups
- If any of these sensors work, we planned to ask HPK to produce the appropriate sized wafers for us
  - **In June'08, we did not have cost estimates for this**

Showed in June08 Review

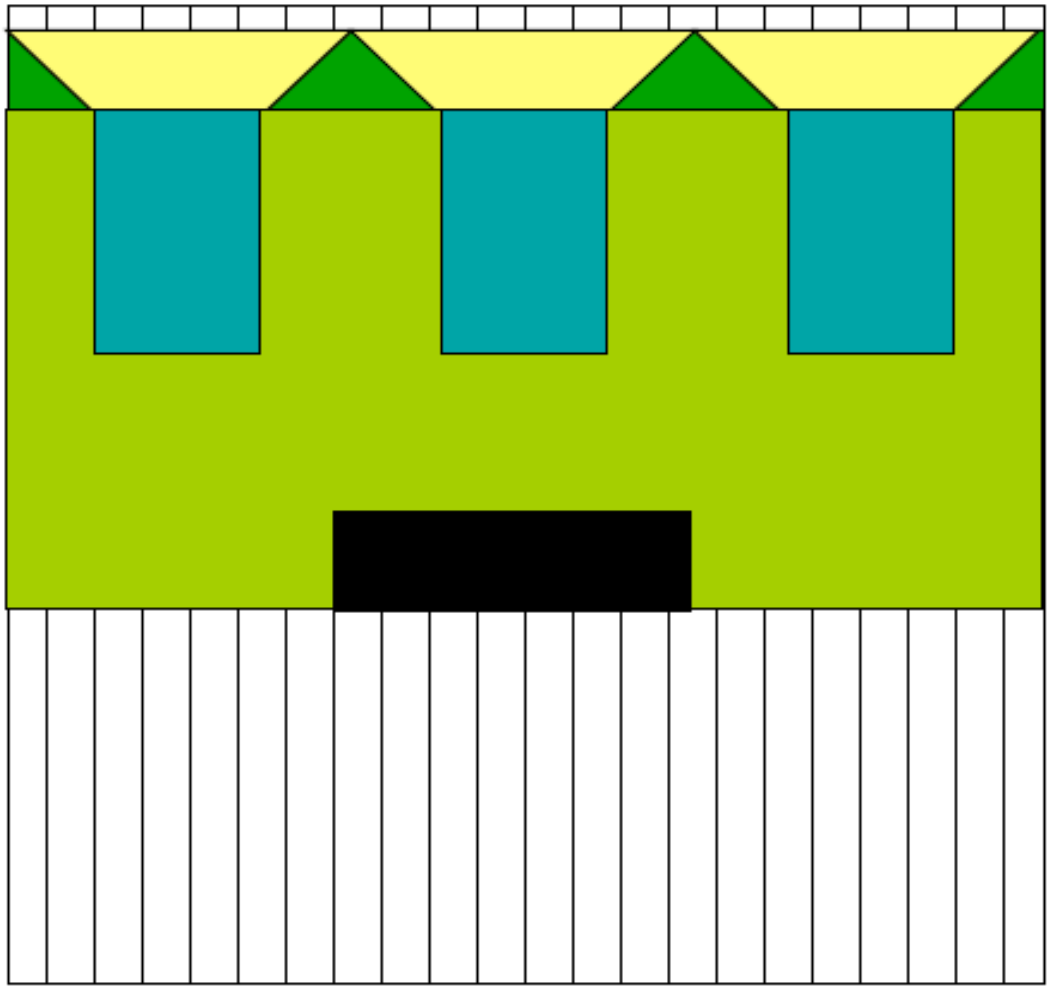
Sensor, pitch adapter, hybrid





Sensor module

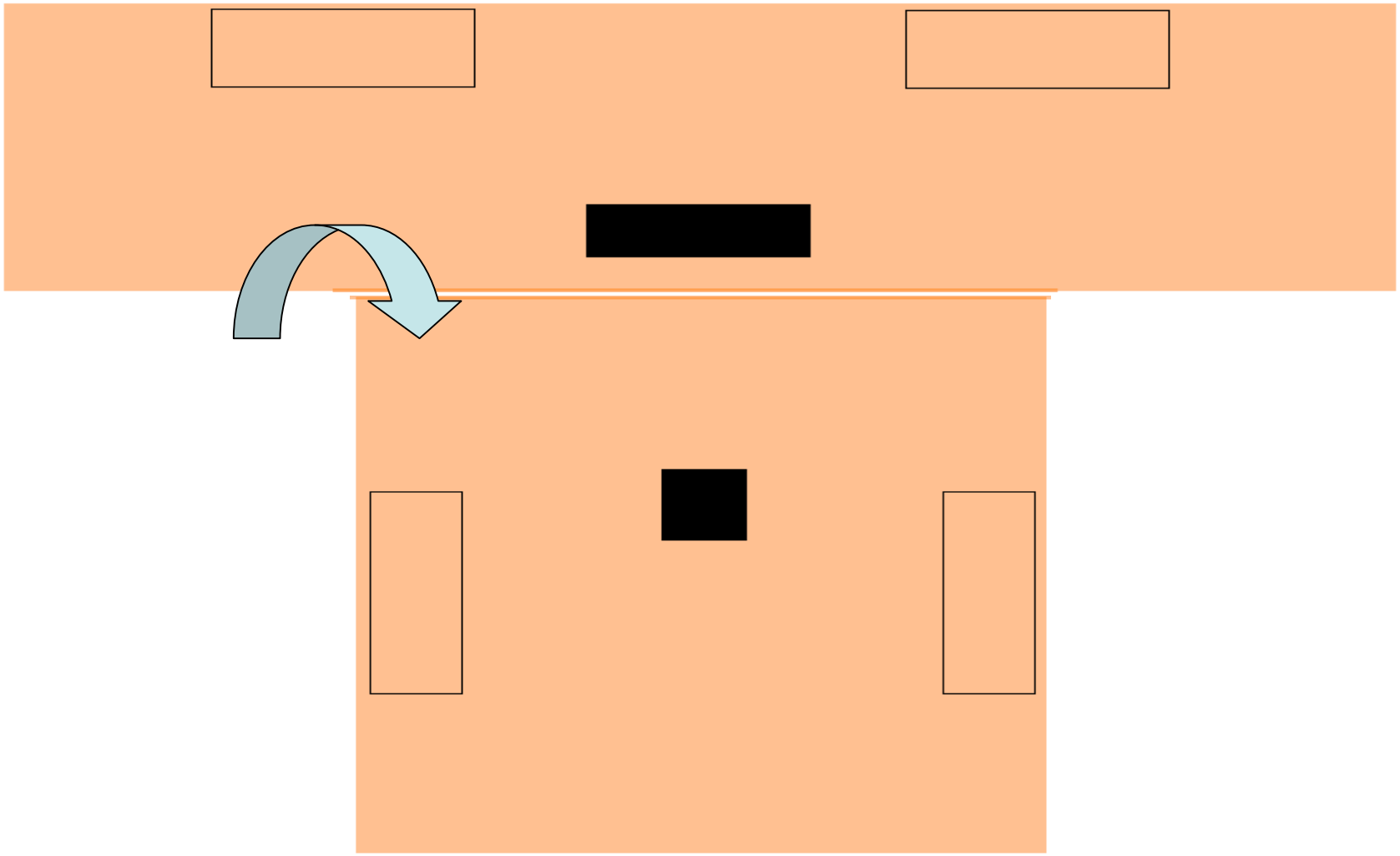
Showed in June08 Review



Glue or wire-bond the hybrid to the sensor

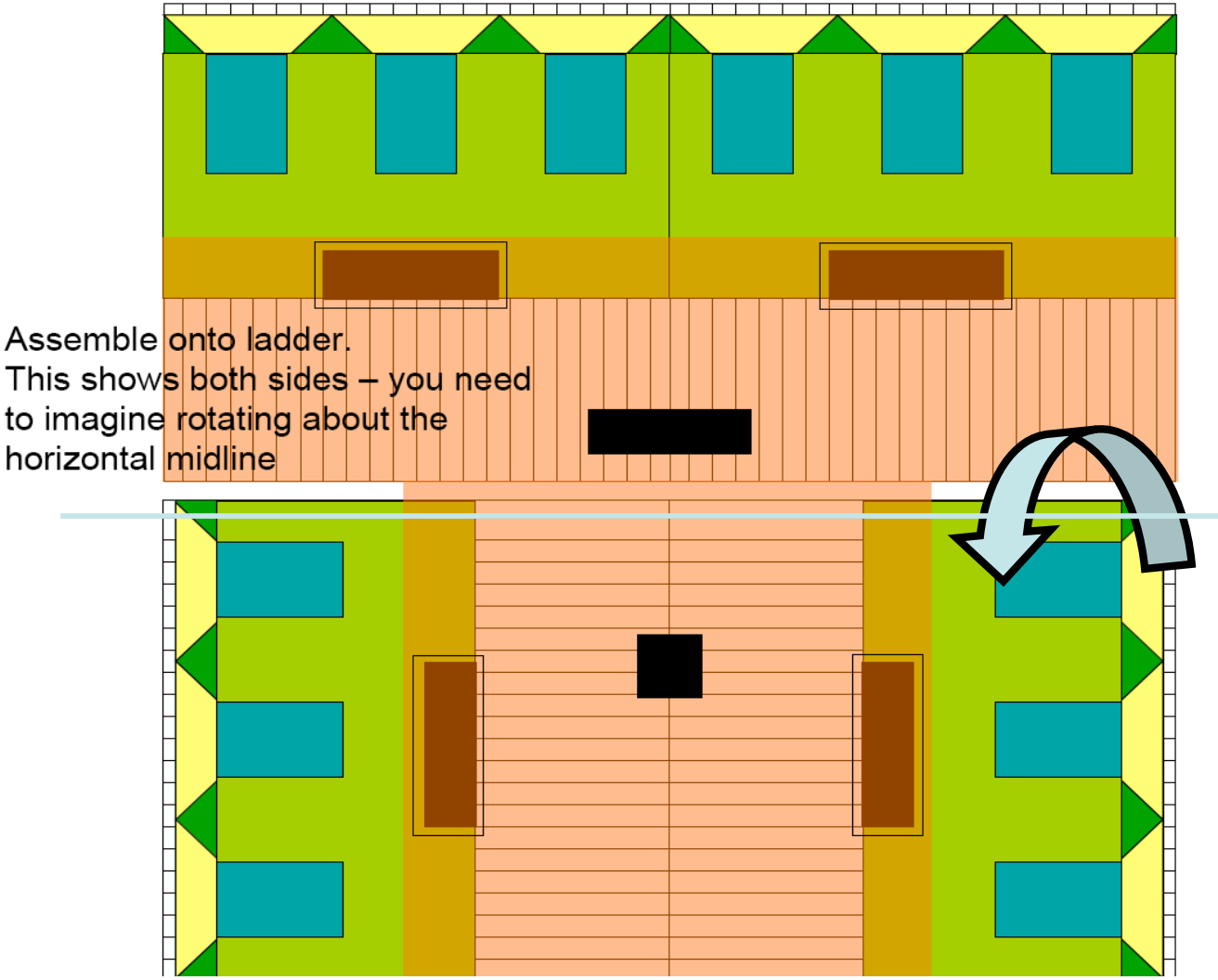
RCC board, connectors, RCC flex cables

Showed in June08 Review



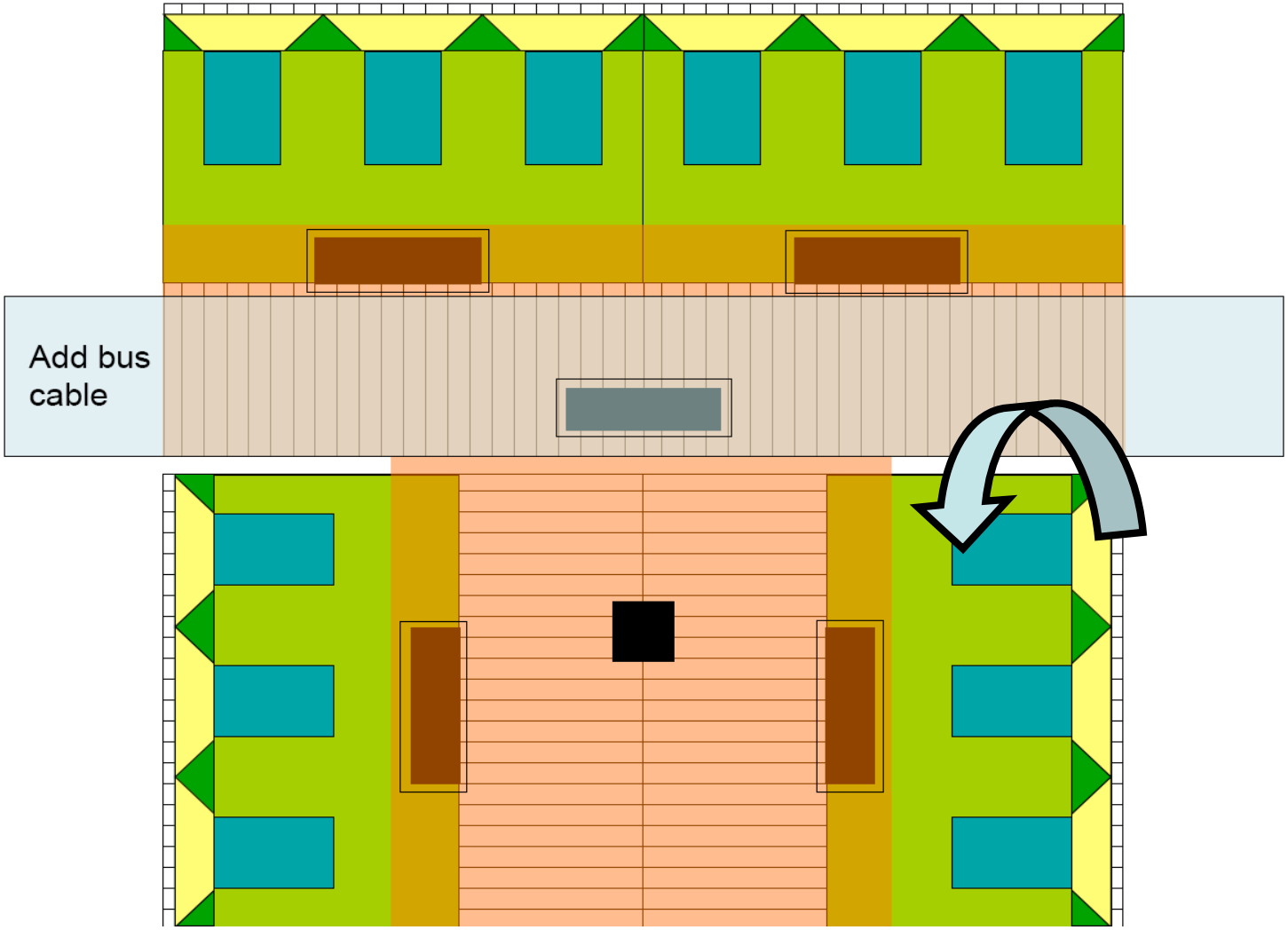
Showed in June08 Review

4 sensor modules to read 2 views



Final configuration on to the ladder…

Showed in June08 Review



Building up confidence and making an informed decision

- Each step mentioned would have had to be thoroughly tested
- Multiple hybrids, modules tested independently and finally together on a ladder…

- Signal/Noise ratio compared with the stripixel sensors
  - Study with beam test (?)
- This will then make one of the criteria for the decision

Showed in June08 Review

Impact on Physics

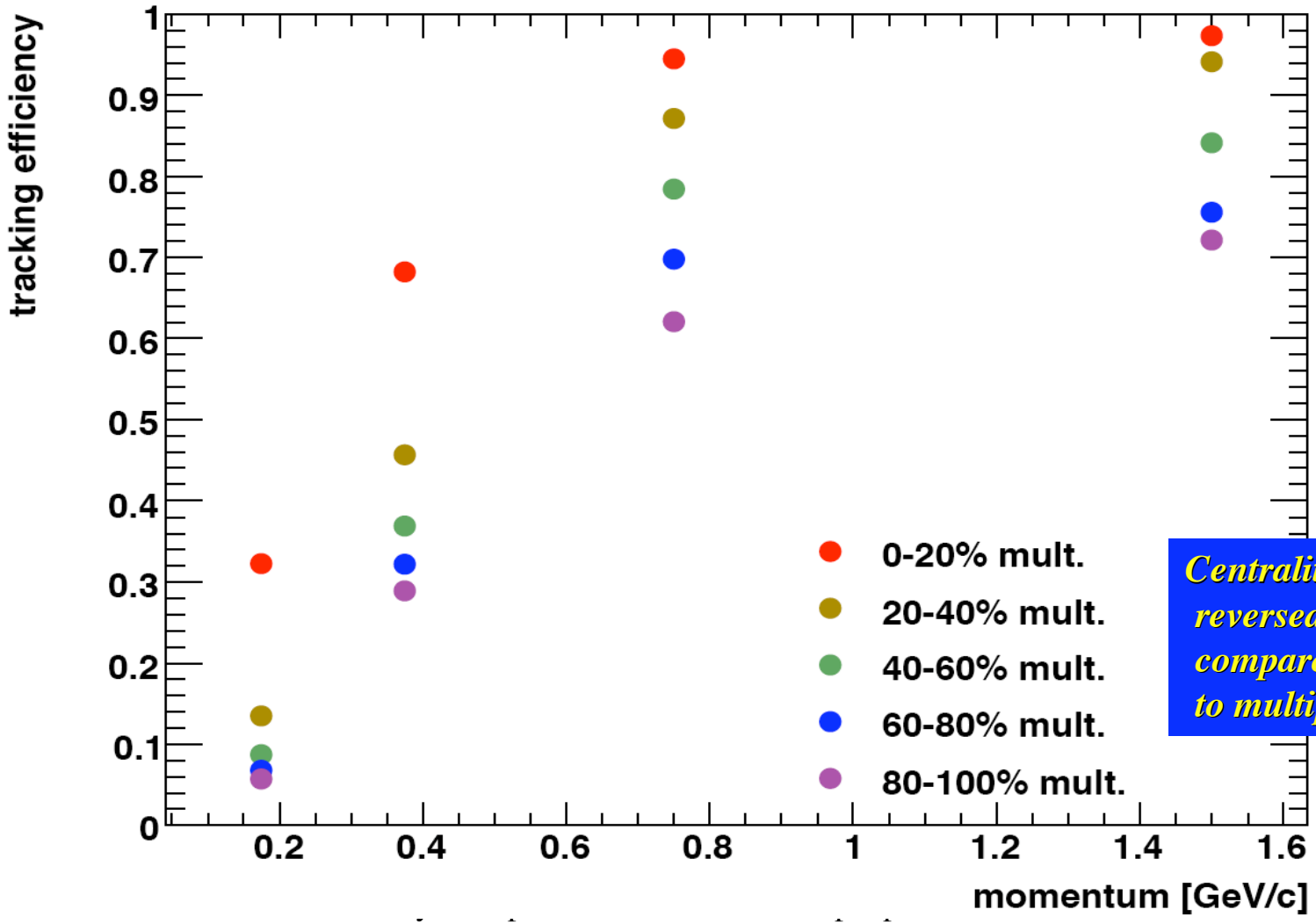
Monte Carlo studies

Showed in June08 Review

- Preliminary stand alone tracking studies initiated
- Early results summary:
  - Two layers with stereo angles needed for high multiplicity collisions
  - 90^0 stereo angle gives
    - slightly worse tracking efficiency but
    - better vertex resolution than the original strip-pixel sensors (80 x 80 μ vs. 80 x 1000 μ)
  - Small(er) stereo angle gives worse efficiency and no better vertex than strip-pixel sensors
- If the "90^0 option" is chosen, it will have consequence for the ROC design

Tracking efficiency for 2 Sensors crossed at 90°

Showed in June08 Review



Schedule Impact

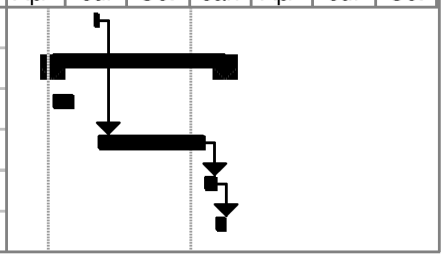
Schedule Impact (June 2008 estimate)

Showed in June08 Review

This assumed an R&D project could start in July with no upfront costs

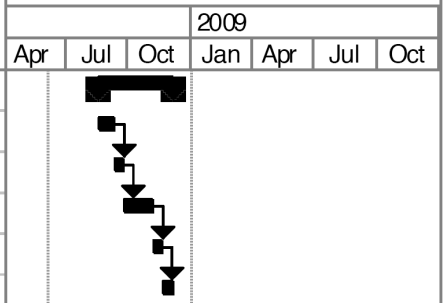
- Sensor

Task Name	Start	Finish	Duration
Technical review of altenative sensor module	Mon 8/11/08	Fri 8/15/08	1 wk
pre-production conventional sensors	Thu 6/12/08	Thu 2/19/09	165 days
borrow sensors from HPK	Thu 6/12/08	Fri 7/11/08	4 wks
purchase 10 pre-production conventional sensors	Mon 8/18/08	Thu 1/22/09	20 wks
test pre-production conventional sensors	Fri 1/23/09	Thu 2/5/09	2 wks
contingency	Fri 2/6/09	Thu 2/19/09	2 wks



- ROCx

Task Name	Start	Finish	Duration
rocx pre-production board	Mon 8/18/08	Wed 12/3/08	75 days
design of rocx pre-production board	Mon 8/18/08	Mon 9/8/08	3 wks
layout of rocx pre-production board	Tue 9/9/08	Mon 9/22/08	2 wks
fab of rocx pre-production board	Tue 9/23/08	Mon 11/3/08	6 wks
test of rocx pre-production board	Tue 11/4/08	Mon 11/17/08	2 wks
contingency	Tue 11/18/08	Wed 12/3/08	2 wks



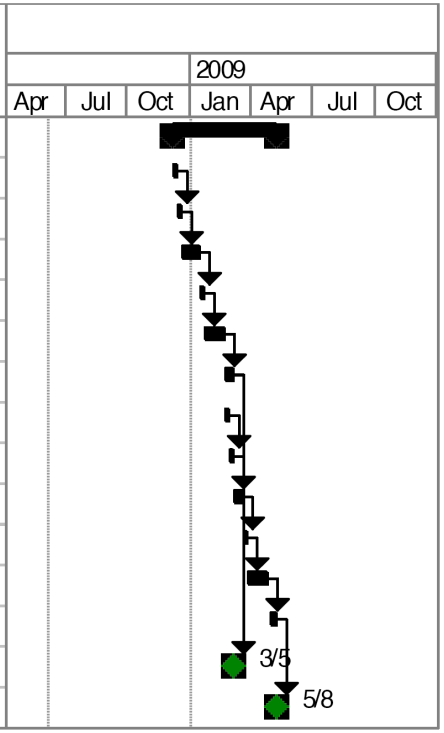
Schedule: preliminary

Showed in June08 Review

Impact estimate

ROCx + sensor modules

S	Task Name	Start	Finish	Duration
	pre-production rocx sensor module	Thu 12/4/08	Fri 5/8/09	100 days
	gluing of pre-production rocx+ borrowed sensor modules	Thu 12/4/08	Wed 12/10/08	1 wk
	send pre-production rocx+ borrowed sensor modules to FNAL	Thu 12/11/08	Wed 12/17/08	1 wk
	wire-bonding pre-production rocx+borrowed sensor modules at FNAL	Thu 12/18/08	Thu 1/15/09	2 wks
	send pre-production rocx+ borrowed sensor module back to BNL	Fri 1/16/09	Thu 1/22/09	1 wk
	test pre-production rocx+ borrowed sensor module at BNL	Fri 1/23/09	Thu 2/19/09	4 wks
	contingency	Fri 2/20/09	Thu 3/5/09	2 wks
	gluing of pre-production rocx sensor modules	Fri 2/20/09	Thu 2/26/09	1 wk
	send pre-production rocx sensor modules to FNAL	Fri 2/27/09	Thu 3/5/09	1 wk
	wire-bonding pre-production rocx sensor modules at FNAL	Fri 3/6/09	Thu 3/19/09	2 wks
	send pre-production rocx sensor module back to BNL	Fri 3/20/09	Thu 3/26/09	1 wk
	test pre-production rocx sensor module at BNL	Fri 3/27/09	Fri 4/24/09	4 wks
	contingency	Mon 4/27/09	Fri 5/8/09	2 wks
	milestone: pre-production rocx+ borrowed sensor module performs to spec	Thu 3/5/09	Thu 3/5/09	0 days
	milestone: pre-production rocx sensor module peforms to spec	Fri 5/8/09	Fri 5/8/09	0 days



WBS: About 2 months delay: **Optimistic**

This is only the pre-production delay

Production: Delivery, QA, module construction: **too early** to estimate

Cost (Preliminary)

Showed in June08 Review

- Based on the known costs of 3x6 sensors recently costed for FVTX project in PHENIX
  - $586.6 including HPK R&D
  - For 3x3 unit the cost can be any where between $300-$600
- We needed 246 working 3x6 stripixel sensors
- Assuming 38% contingency we need 246 --> **400** sensors
- Of the conventional 3x3 then we need 4 times as many
- Estimate: [4 * (**400**) * ($300-$600)] + $50k (NRE)
  - $480k (assuming $300/sensor) $960k (assuming $600/sensor)
  - Other pre-production costs ~$50k
  - Total Cost Range: $530k -- $1M
- **These was to become firm as we learnt from HPK more details**

Issues & Concerns in June 2008

- Conventional Strip Sensor Option should work **but**
  - Will ROC-on-Sensor design (proposed) work?
  - What (minimal) design modifications might be needed?
  - What is the over all schedule impact?
  - What will be the total cost of going this way?

- **Manpower needs significant,** although the ideas and plan seemed straight forward

… and finally input from HPK

Costs associated with initiation of Backup project: input from HPK (July'08: a month after the June'08 review)

Pre-production Sensor:

- David Faltowitz (HPK) via Alan Dion
- ATLAS-Z sensor:
  - No charge for photomask & tooling
  - $1495/- per sensor for the first 20 sensors!
    - Lead time 3 weeks for 1st 7 in stock and 2.5 months for remaining 13 (new production)
  - **$30k + setup equipment etc. & at no real startup until Nov.2008**
  - IF new photomask and tooling is needed (same structure but half the size)
    - NRE charge $52k
    - $995/- per sensor, minimum order 30
    - Lead time 4 months
  - **$80k+ and no real startup until Jan. 2008**

Significantly larger costs associated with INITIATING the BACK-UP Conventional Strip Option!!

Status now:

- **Realization:** Costs for SIGNIFICANTLY higher than initially anticipated
  - Preproduction costs $80k+
  - Production sensors $500k
- Tried to get sensors from friends and well-wishers: CDF/D0, FNAL…
  - No success in acquiring the number of sensors we need to do ALL things we need to do
  - Delay start of CSO R&D at least until January 2009
- The Stripixel Group has showed significantly improved understanding of the problems and hence the recent demonstration of success
  - Continuing demand on manpower focused on problems but indeed leading toward success
- Manpower nneds for CSO also significant: If we were to dedicate ONE person to this project that would mean ONE LESS person for the Stripixel Progress

Present status of the CSO:

- Successful tests in the lab as well as the FNAL beam test **gives us confidence in the Stripixel technology**
  - Electronic signal to noise issues addressed
  - Efficiency measured in beam test within spec (>98%)
  - Multiple Stripixel Modules worked together with little or no performance degradation
  - Design changes for mass production of ROC understood and feasible
  - Optimization of Stripixel readout enables us to correct for pedestal variation

- Costs and manpower for Conventional Strip Option are too high, as such, we have not been able to proceed with its R&D.