ATLAS pixels for 2017/18

ACES 2011

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Introduction

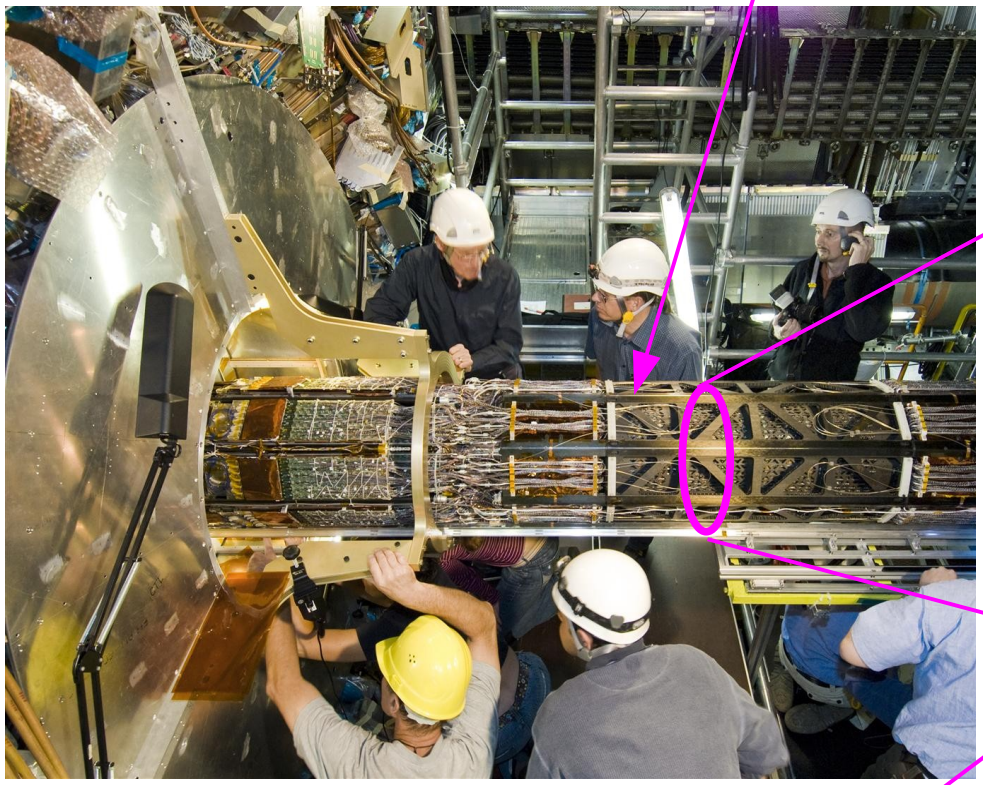
- A few months ago ATLAS baseline plan was
  - IBL in phase 1
  - Full tracker in phase 2
- Not much longer ago phase 2 was in 2019
- Today IBL is being advanced to 2013
  - And phase 1 delayed to 2017/18.
- Reasonable questions being asked are:
  - Can some originally phase 2 upgrades be advanced to 2017?
  - Is this a good idea (does it improve the physics?)
  - New one: can the present pixel detector swallow 200 int./BX ?
- No definite answers today, but a pixel detector is a good candidate for advancement.
- This talk is about what a 2017/18 pixel system would look like.

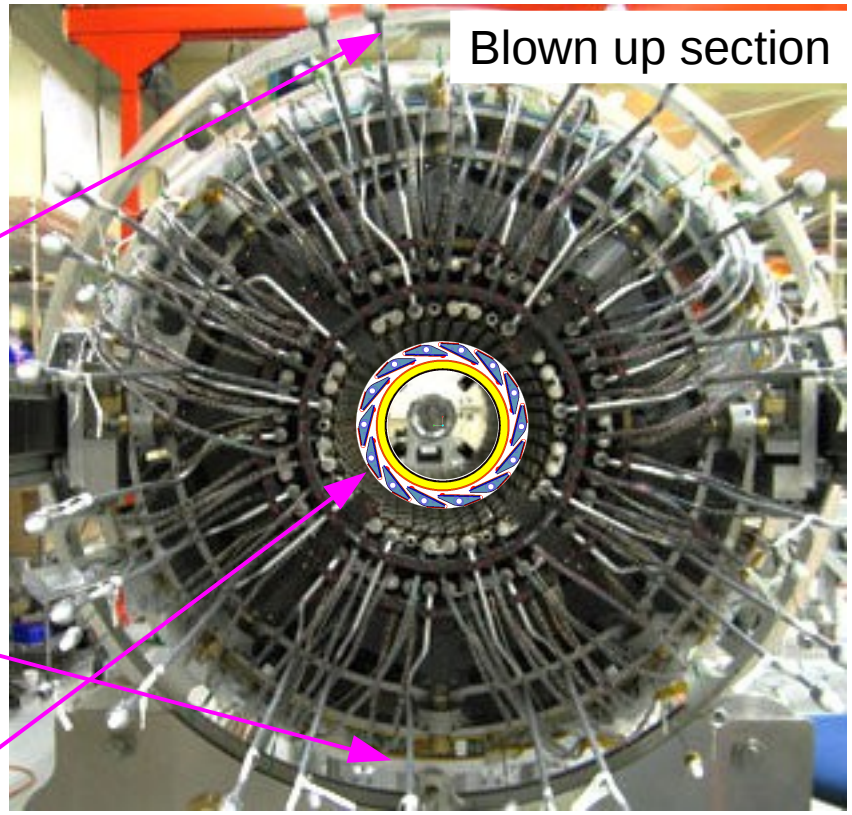
What electrical components would be used for a 2017/18 pixel detector?

- A: Exactly those that were planned for phase 2 pixel outer layers in a full tracker replacement, originally 2019.
- Development started with a 2019 installation date, and is if anything ahead of schedule.

What a new pixel detector in 2017/18 means

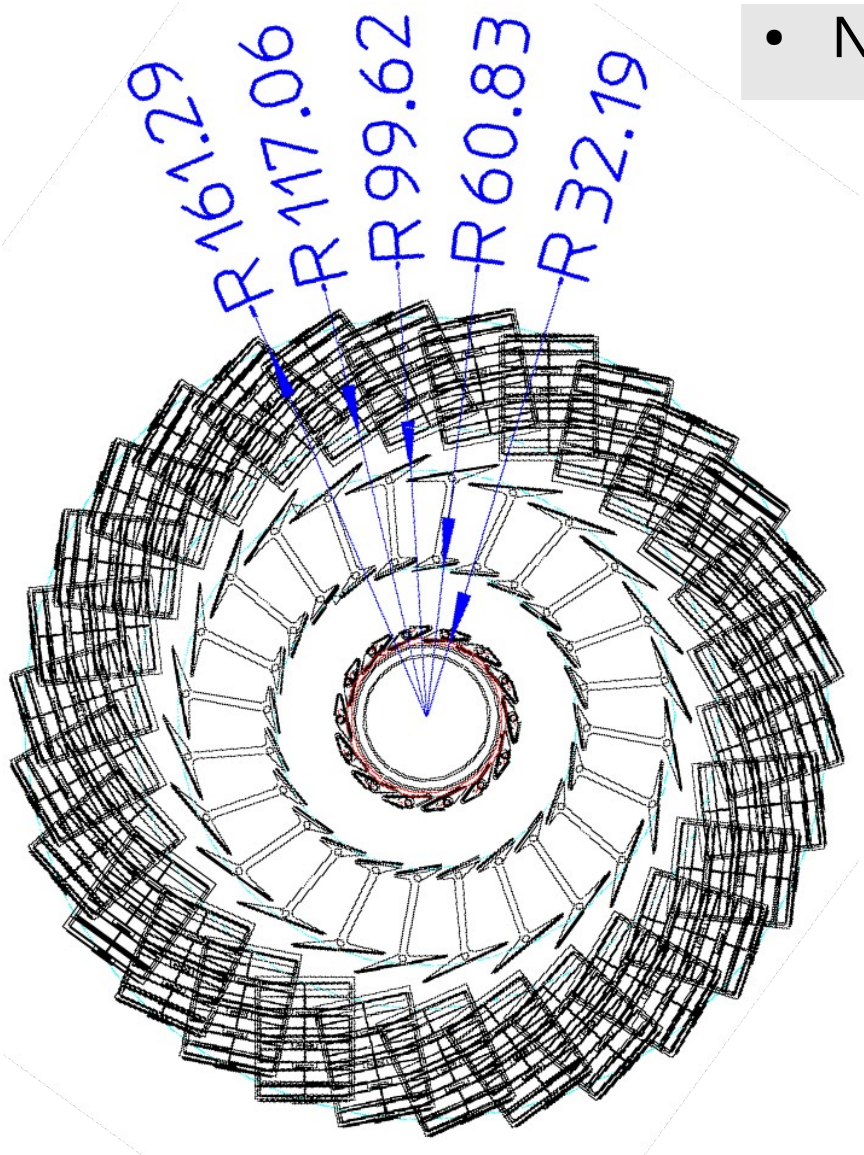
Replace this (slides out of Inner Detector)



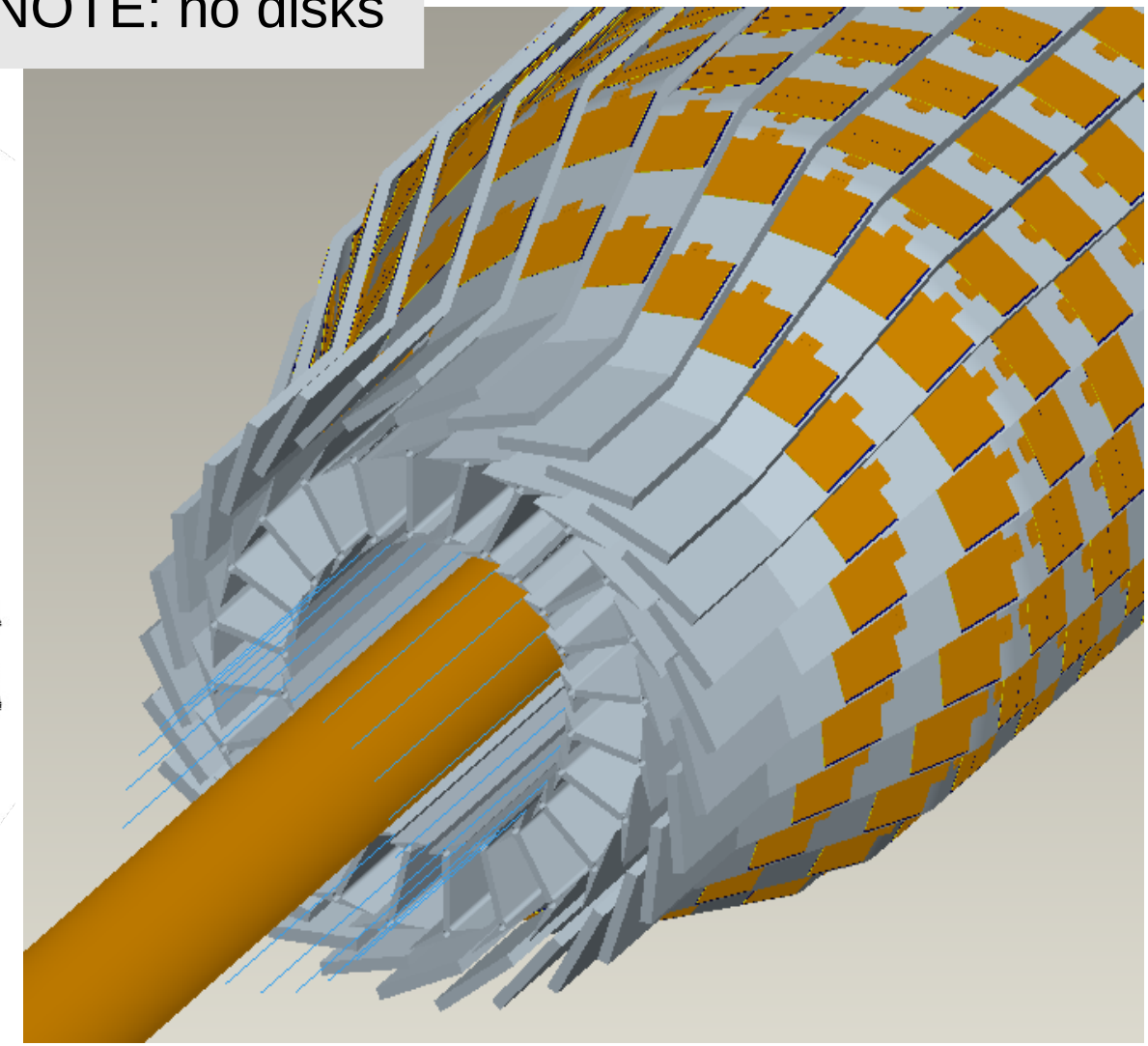


Not this (IBL on new beam pipe)

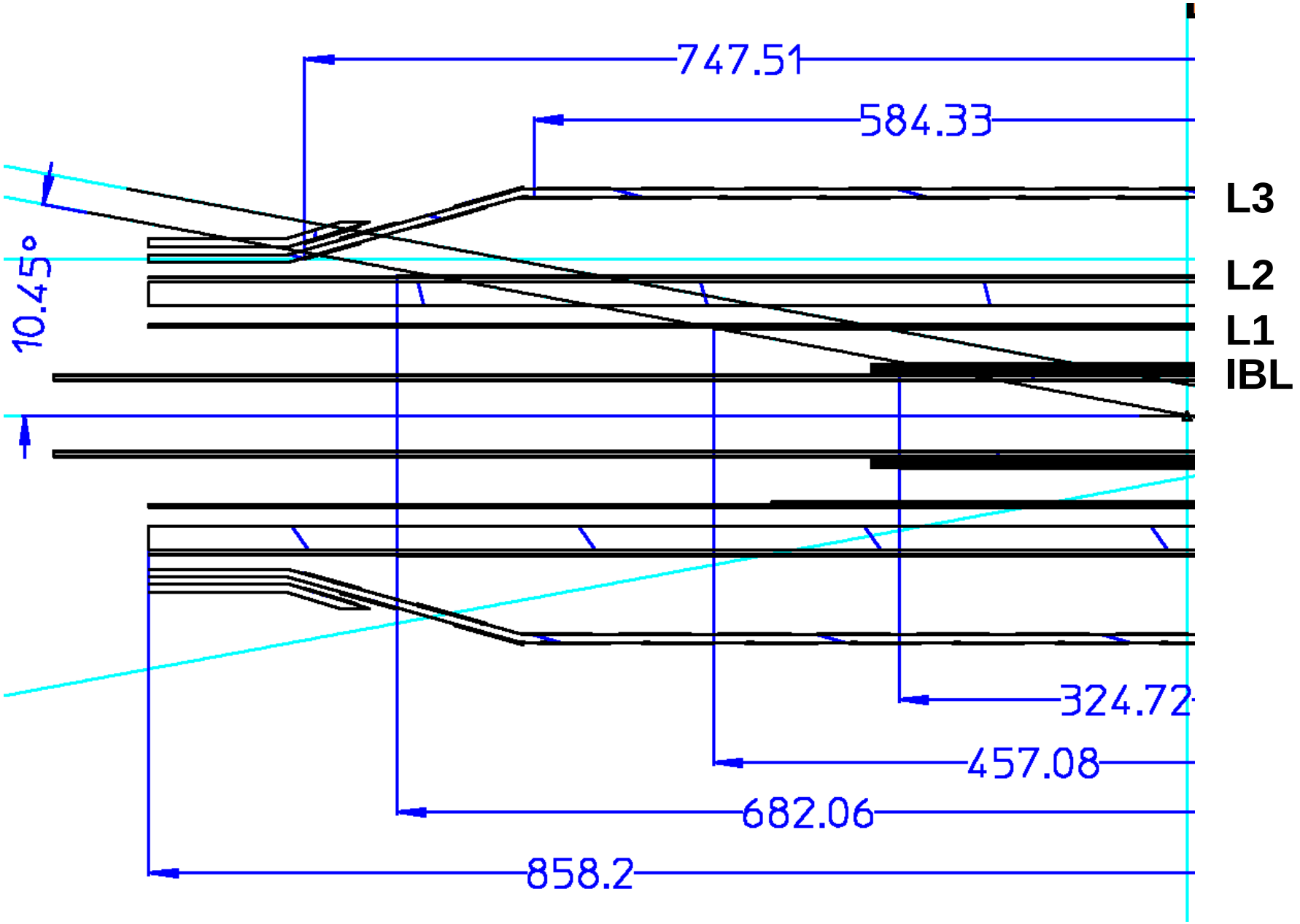
Replace with something like this



- NOTE: no disks

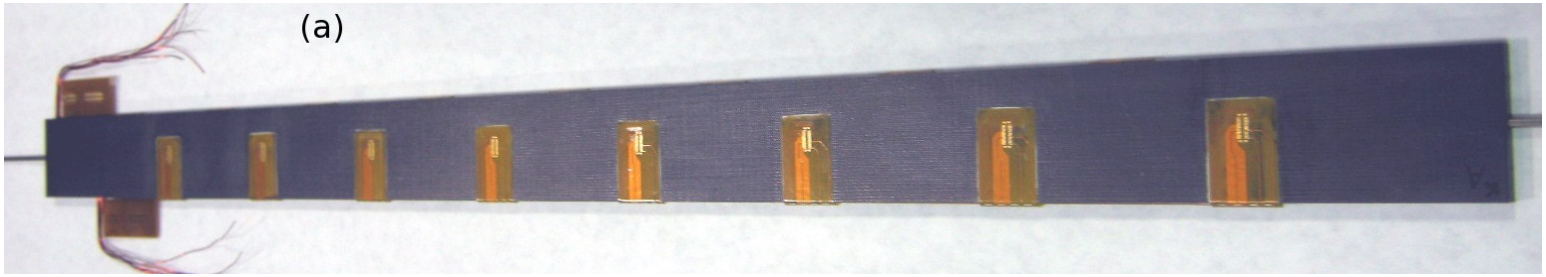


R-Z view



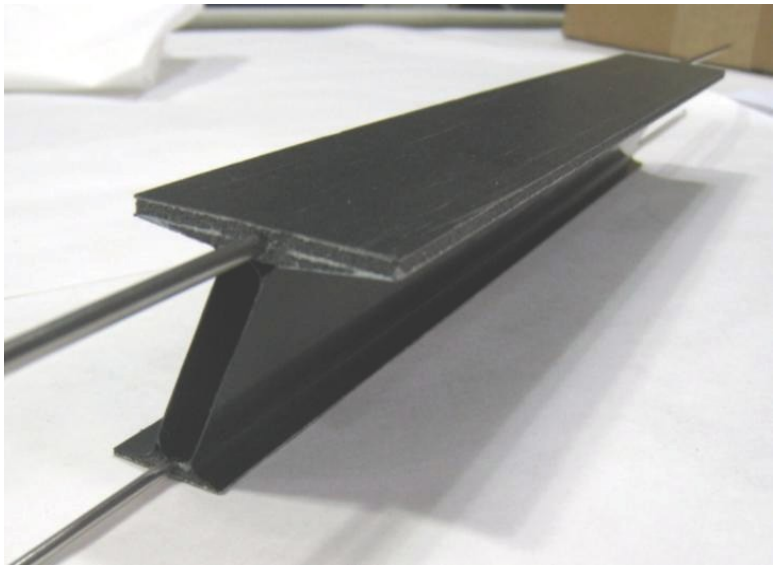
Design uses newly available phase 2 technology

Integrated stave prototype with embedded cable (looks the same on the back)



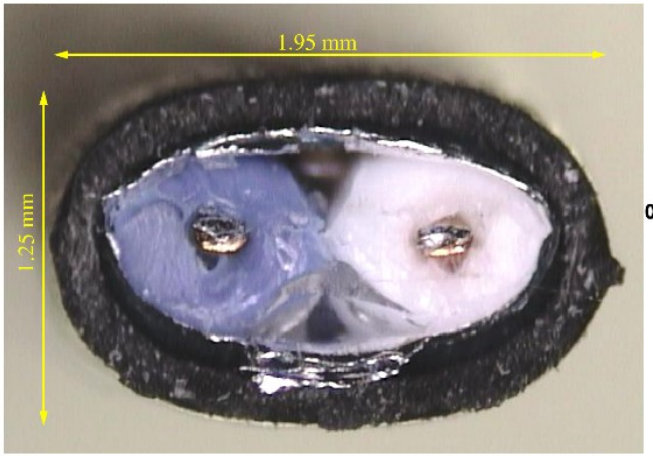
Prototype of bent section for above (a la BaBar)

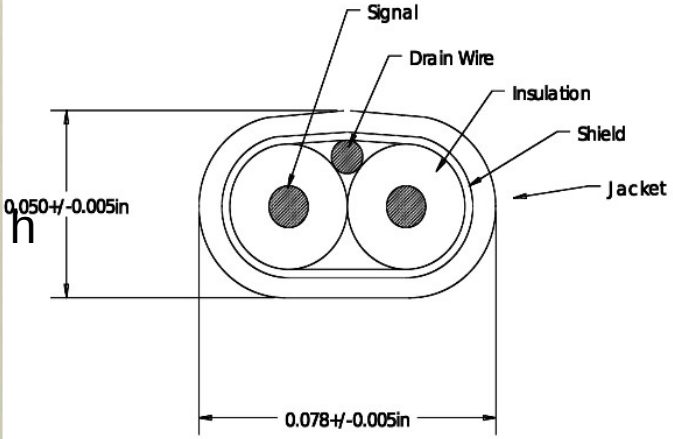
I-beam prototype for inner 2 layers
(shared support structure a la Alice)



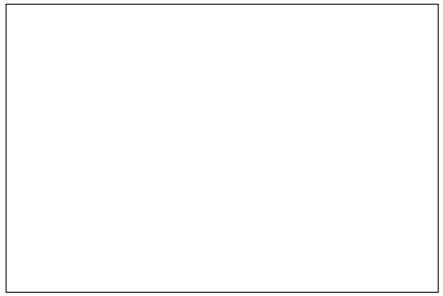
More newly available technology

Low mass microtwinax for data transmission

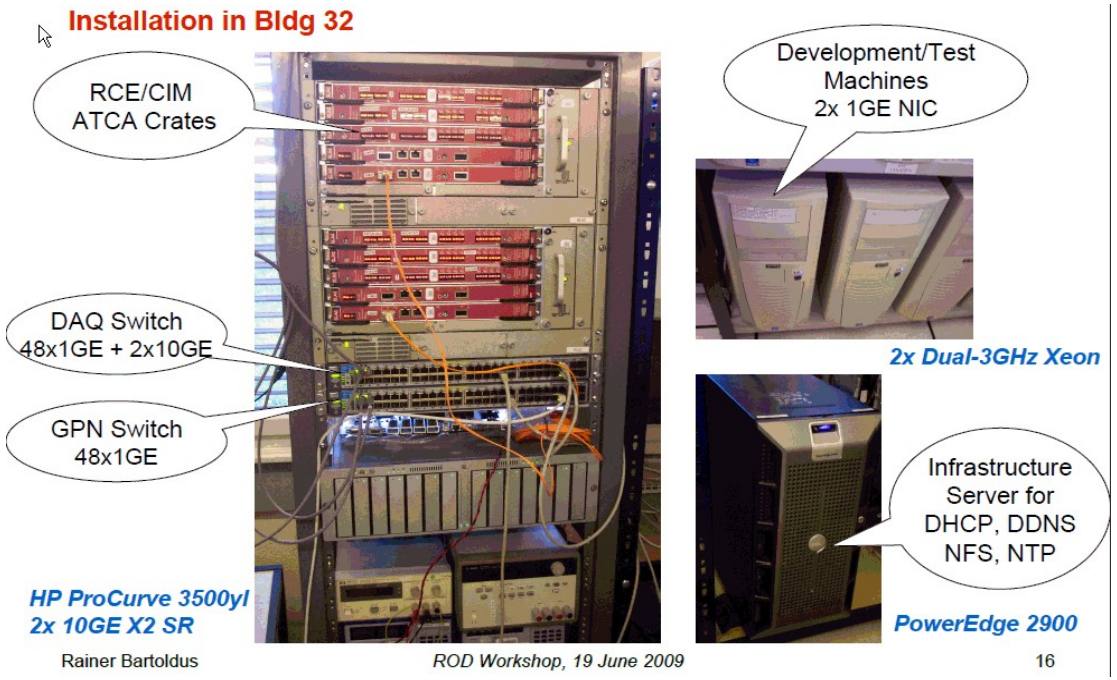




GBT SERDES chip

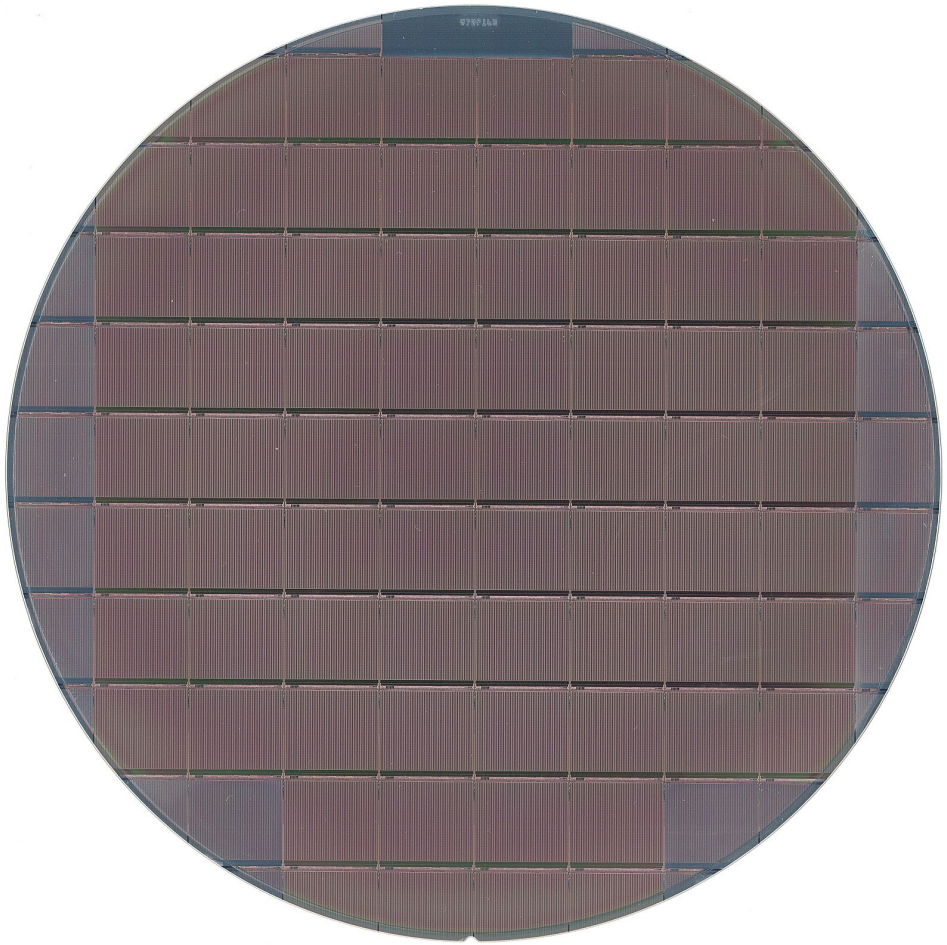


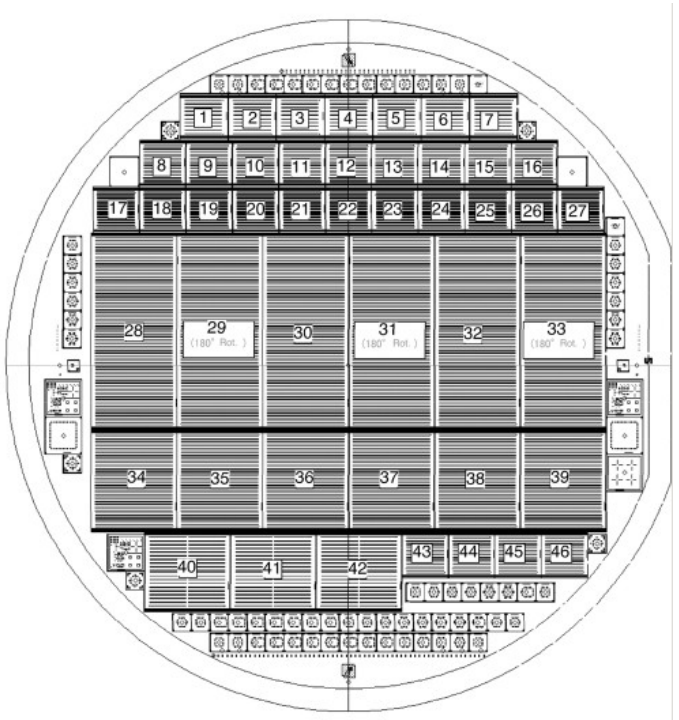
RCE DAQ system in ATCA crates



And more newly available technology

FE-I4



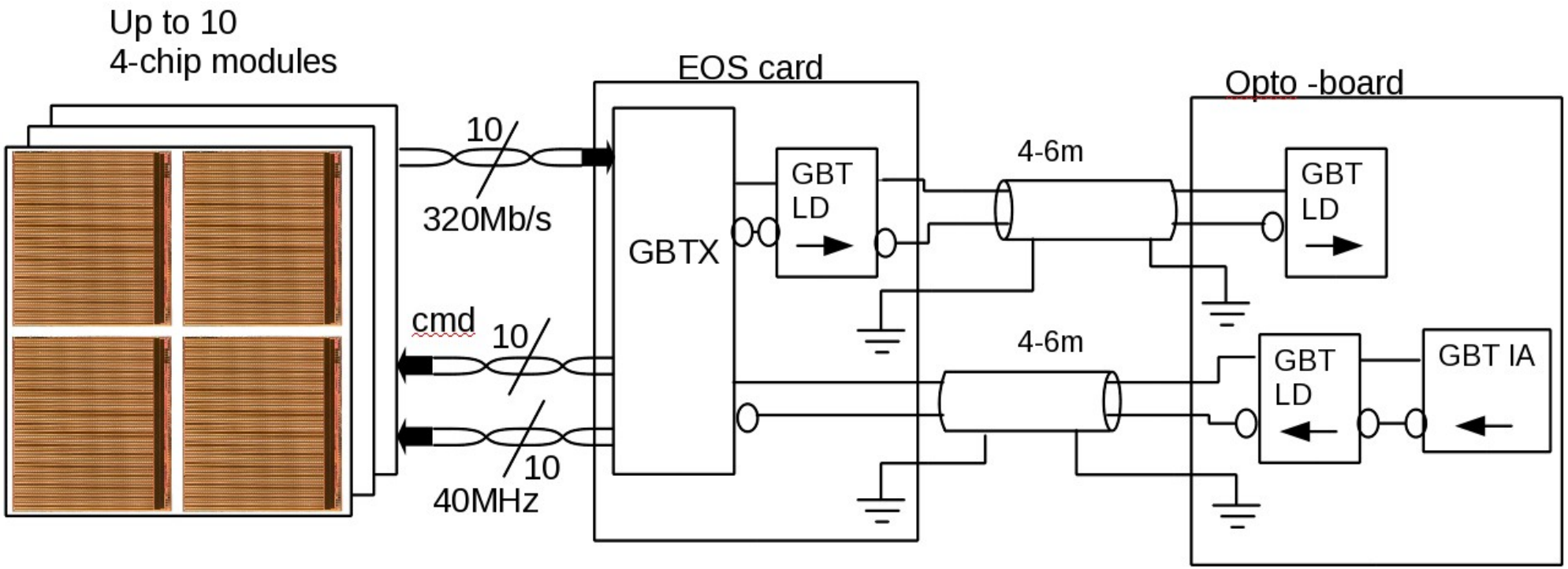


N-on-p pixel sensors on 6” wafers
(lower cost pixel sensors for larger detectors)

Numbers of parts

	Present detector Excl. IBL	**New Excl. IBL**
Layers	3	3
Staves + sectors	112 + 48	78 + 0
Modules	1774	3252
Optical links	**272 8-way arrays**	**218 single fibers**
Pixels	80×10^6	270×10^6
Active area	$1.8\ m^2$	$3.5\ m^2$

Proposed communication



Proposed power distribution

- Discrete DC-DC conversion is NOT an option for pixels. It is far too massive due to high power density per unit sensor area
  - About 10x higher power density than strip systems
- Integrated in-chip DC-DC conversion may be an option, but still to be demonstrated
  - X2 charge pump DC-DC in FE-I4A works, but so shows increased noise in preliminary tests. Too early to say if there is a fundamental noise issue
  - BUT, x2 is not enough. Need x4 minimum to have mass of stave cable be competitive with serial power.
  - A X4 in-chip converter is NOT being developed for 130nm node so far, so seems unlikely on a 2018 installation timescale.
- Serial power is a likely choice.
  - ShuLDO regulators needed for serial power already included in FE-I4A.

What electronics R&D would need to be done

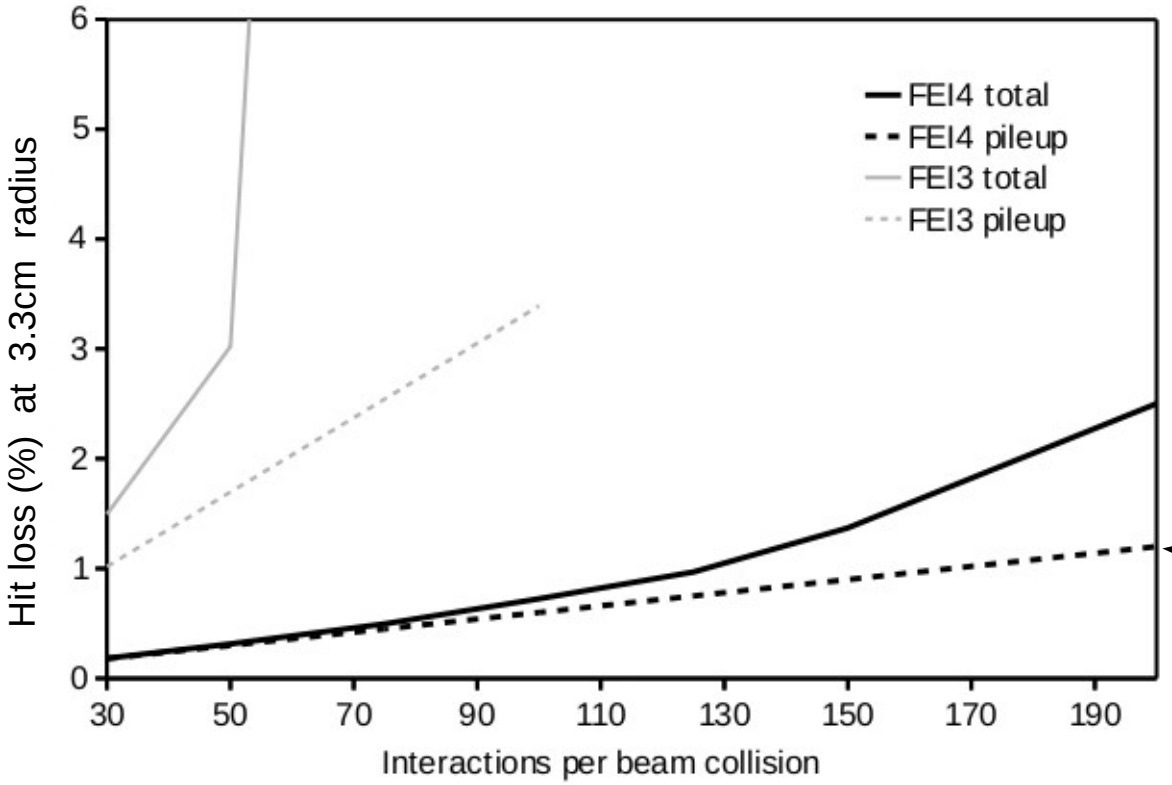
- Demonstrate FE-I4 -> GBTx -> microtwinax -> versatile link data transmission chain
  - Including AC coupled data transmission in case of serial power
- Develop new version of FE-I4 with circuitry for 4-chip module operation
  - Or a separate module data switch chip
- Prototype power distribution schemes with FE-I4 modules.
- Demonstrate hybridization of 4-chip modules with (probably thin) n-on-p sensors. Make sure HV on same side as bumps is not a problem.
- Develop services for fast connection / disconnection

- Most of this will be done anyway to advance towards phase2.

Summary

- Replacing the ATLAS pixel detector in 2017/18 seems technically feasible
- Whether it would be a benefit remains to be determined
- Electrical system uses the technology that is being developed for phase 2 outer pixel layers.
  - Development has gone quite well so far
- Some R&D remains to be done, but all critical elements will be available soon.
- R&D will continue because it would be needed anyway for phase 2.

Backup 1



~1/
number of counters
in region

~ pixel area
~ return to baseline