Module and Stave Assembly at BNL for the HL-LHC ATLAS tracker

Or how to build half of the silicon strip tracker barrel in 3 years

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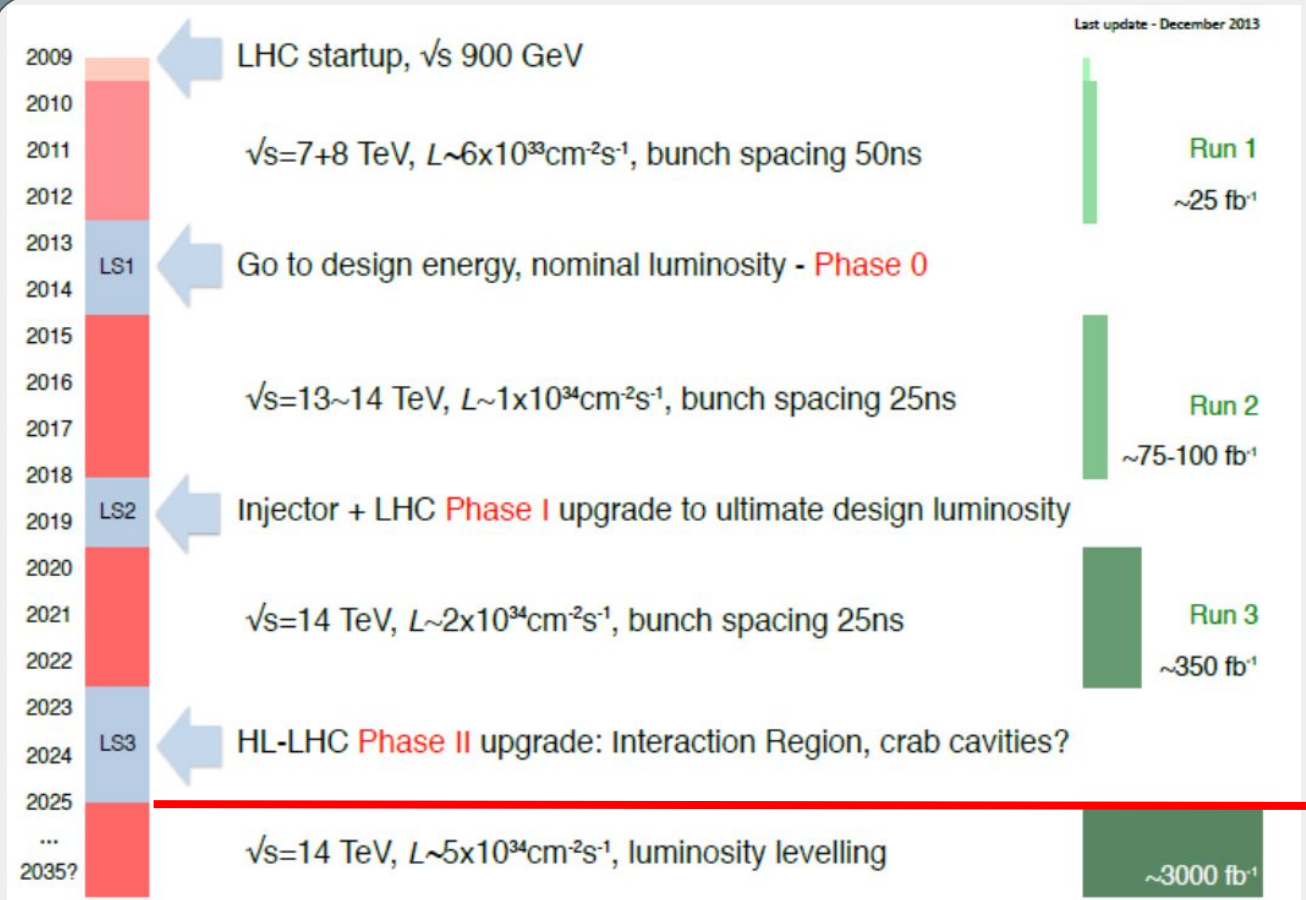
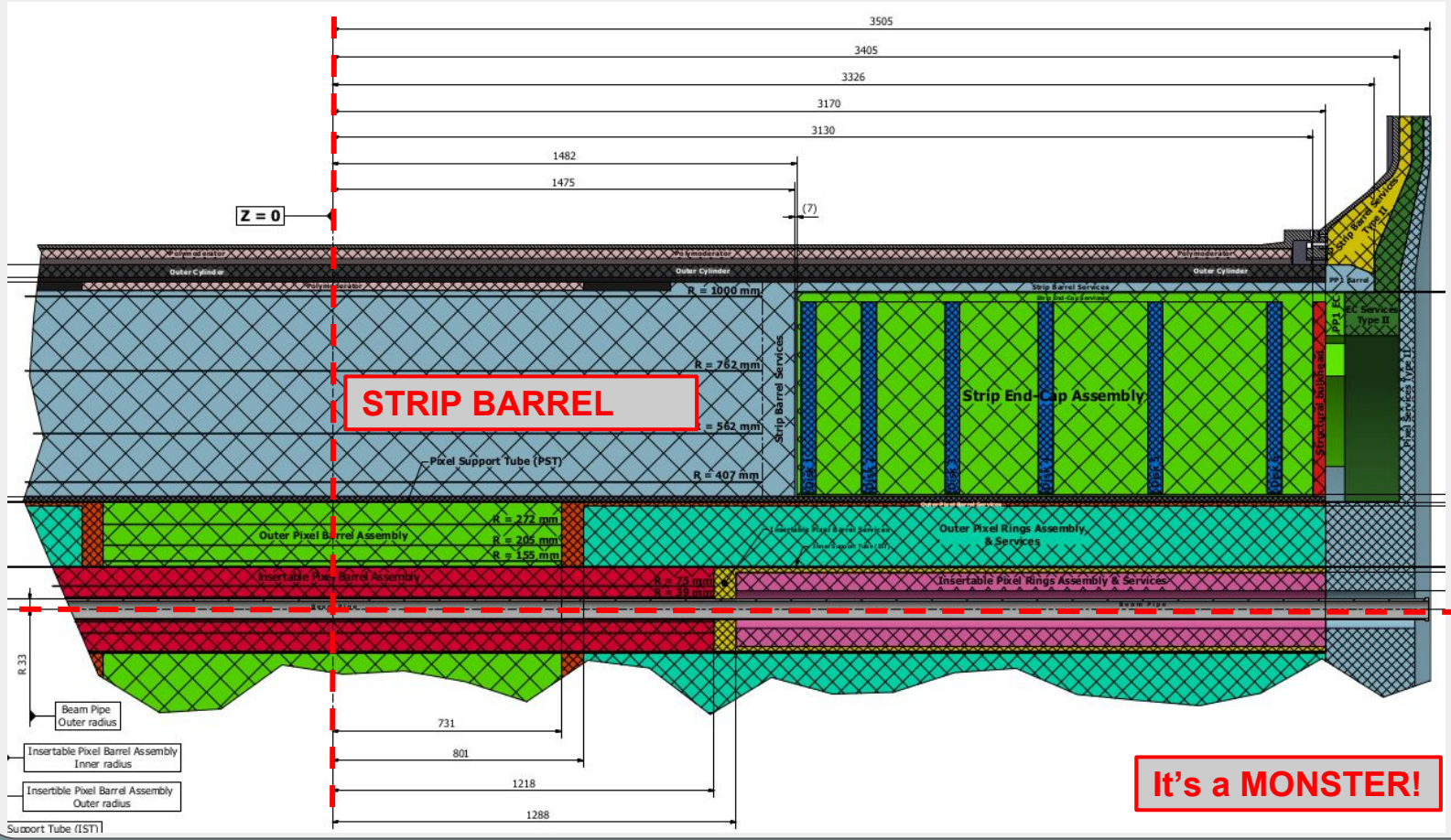
The LHC roadmap



Need
New Tracker
that is
Radiation hard
High speed

The ATLAS Inner Tracker Upgrade

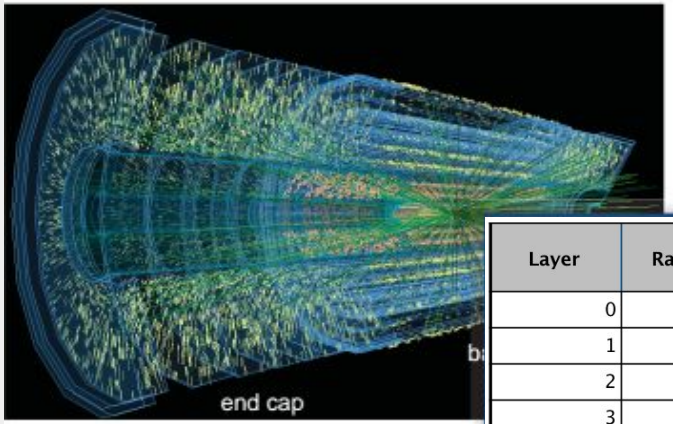


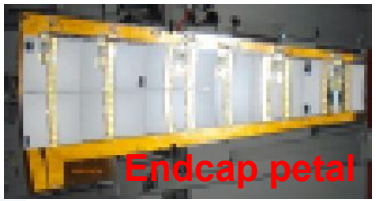
STRIPS

PIXELS

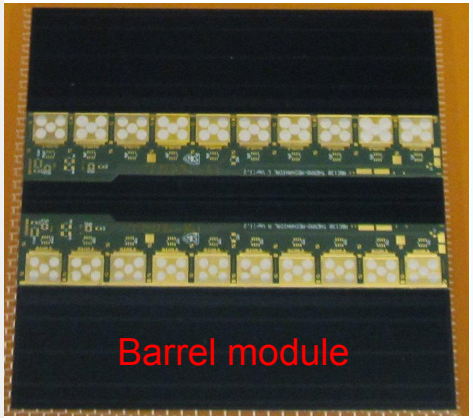
It's a MONSTER!

The ITk strips upgrade



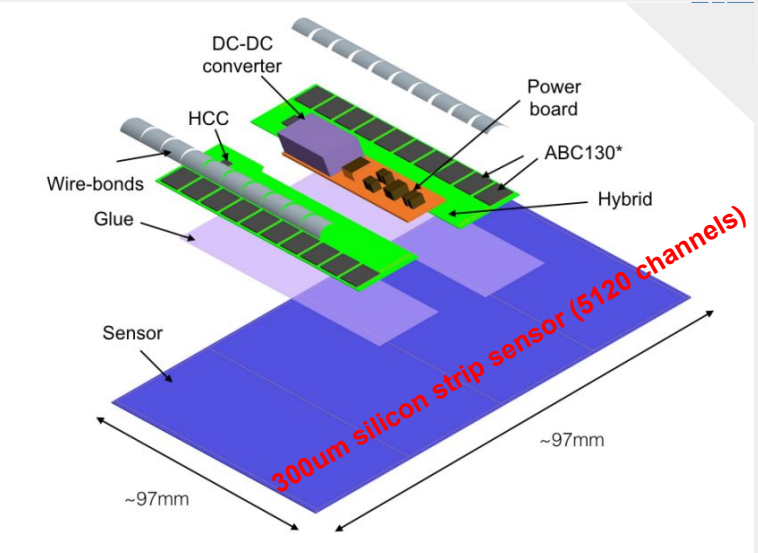


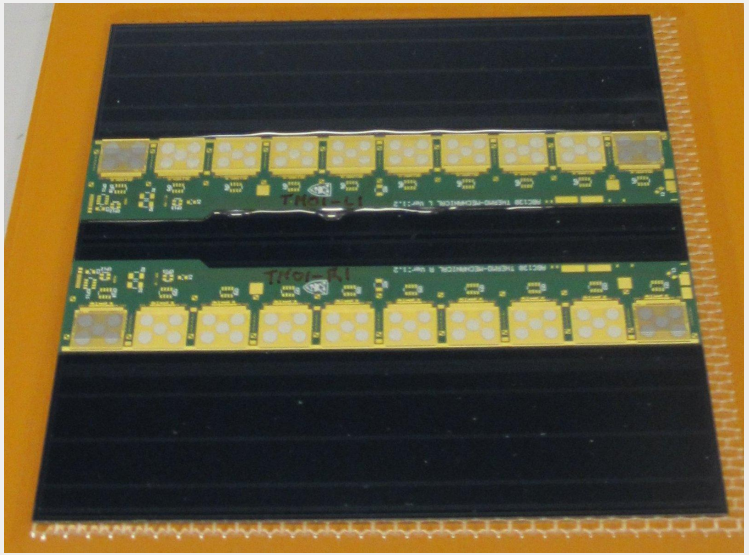
~200 by



Layer	Radius	staves per layer	# of modules	# of hybrids	# of ABC130	# of channels	m²
0	405	28	784	1568	15680	4,01	7,45
1	562	40	1120	2240	22400	5,73	10,53
2	762	56	1568	1568	15680	4,01	14,75
3	1000	72	2016	2016	20160	5,16	18,96
Total full barrel		**392**	**10976**	**14784**	**147840**	**37,85**	**103,43**
Disk	**z-position**	**petals per disk**	**#modules**	**# of hybrids**	**# of ABC130**	**# of channels**	**m²**
0	1512	32	576	832	7168	1,83	5,03
1	1702	32	576	832	7168	1,83	5,03
2	1952	32	576	832	7168	1,83	5,03
3	2252	32	576	832	7168	1,83	5,03
4	2602	32	576	832	7168	1,83	5,03
5	3000	32	576	832	7168	1,83	5,03
Total end-caps		**384**	**6912**	**9984**	**86016**	**11 Mio**	**60,39**
Total total			**17888**	**24768**	**233856**	**48,9 Mio**	**163,82**

Strip barrel modules





3 sites assembling about 2000 modules each
→ includes producing about 3000 hybrids
Each module needs ~6000 (3000) Al wire bonds
→ this is currently the bottle neck
→ requires dedicated, fast and automated machines

Wire bonding machine

Hesse Mechatronic BondJet 820

Theoretically can do 7 Al wedge wire bonds per second
→ in our case we expect 3 wire bonds per second
→ translates to roughly 1 to 2 hours per module
(= wire bonding + setup time + …)

Has production software installed
→ machine will stop in case of a bad bond!
→ All bonds will be logged in a central server DB

In principle can operate automatically after setup
→ frees up operator for other tasks

There will be 2, one for modules and one for staves

Strip barrel staves

2 global sites for stave production

Science & Technology Facilities Council
Rutherford Appleton Laboratory

BROOKHAVEN NATIONAL LABORATORY

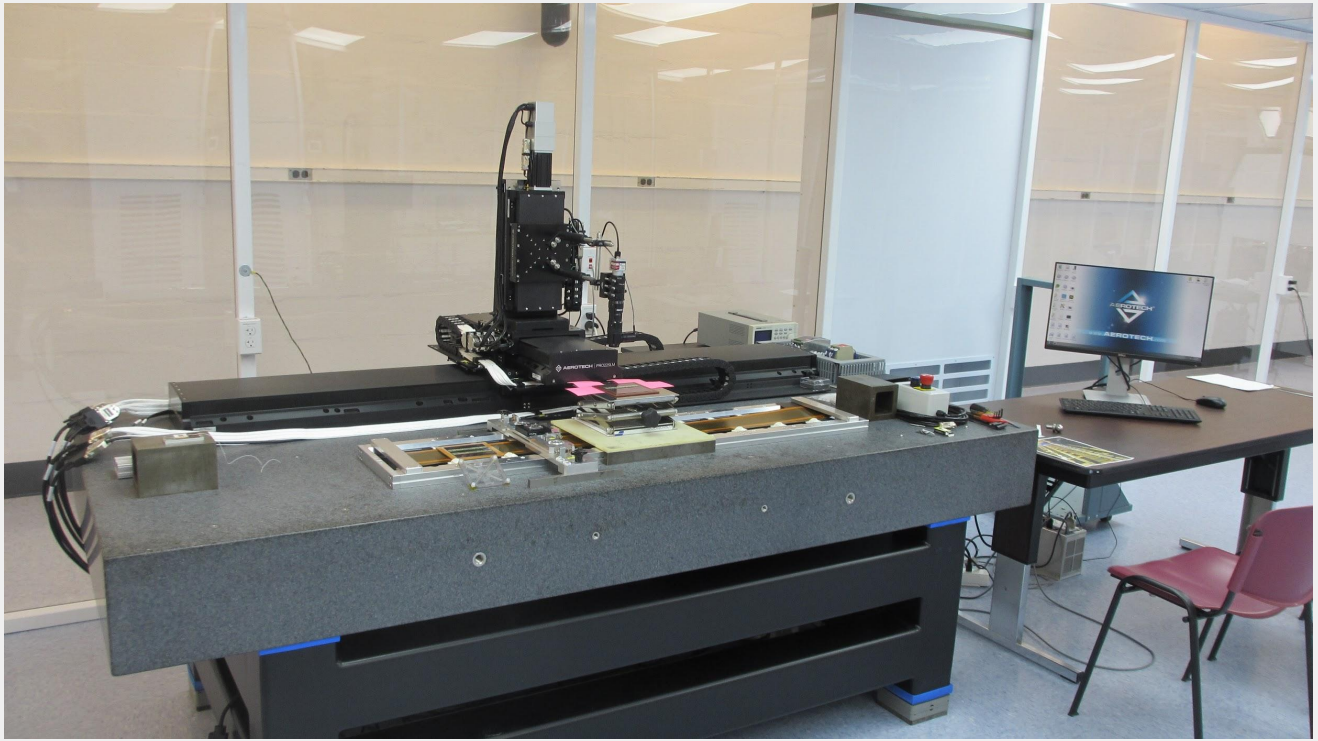
A stave will have 14 modules on each side

In full production close to 2 staves per week!
→ over a 3 to 4 year period

Assembled on dedicated machines

Metrology on the same machines

The stave assembly machine



Aerotech custom made XYZ stage

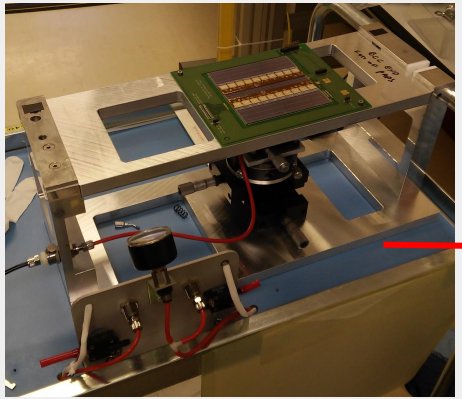
Resolution ~ microns

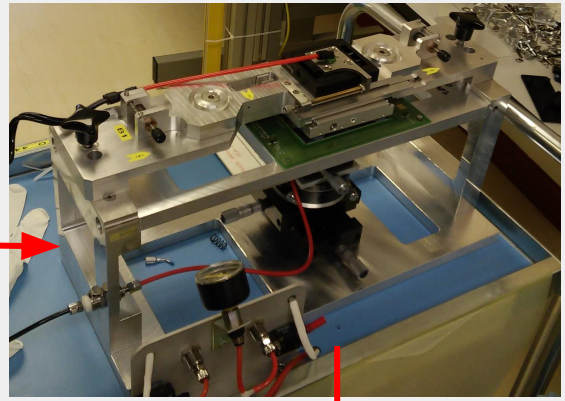
LabView operated

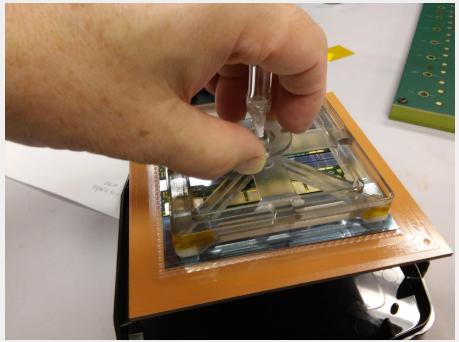
Vision system for placing modules and metrology

Currently being set up to assemble thermo-mechanical stave at end of Feb.

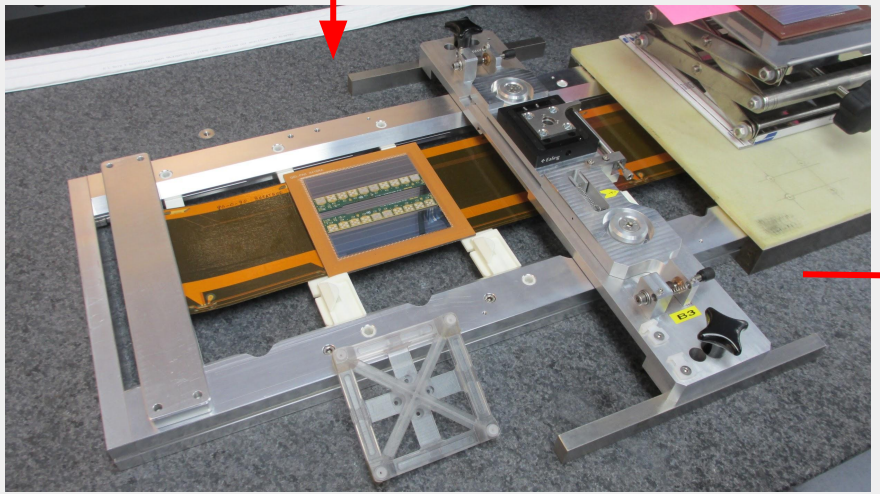
The module mounting process

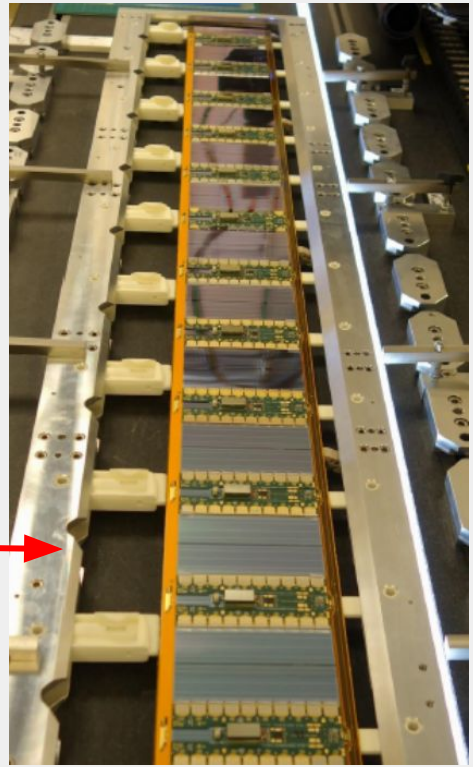






3d printed suction pickup tool





The ATLAS HL upgrade clean room at …….

BROOKHAVEN NATIONAL LABORATORY

800 sqft

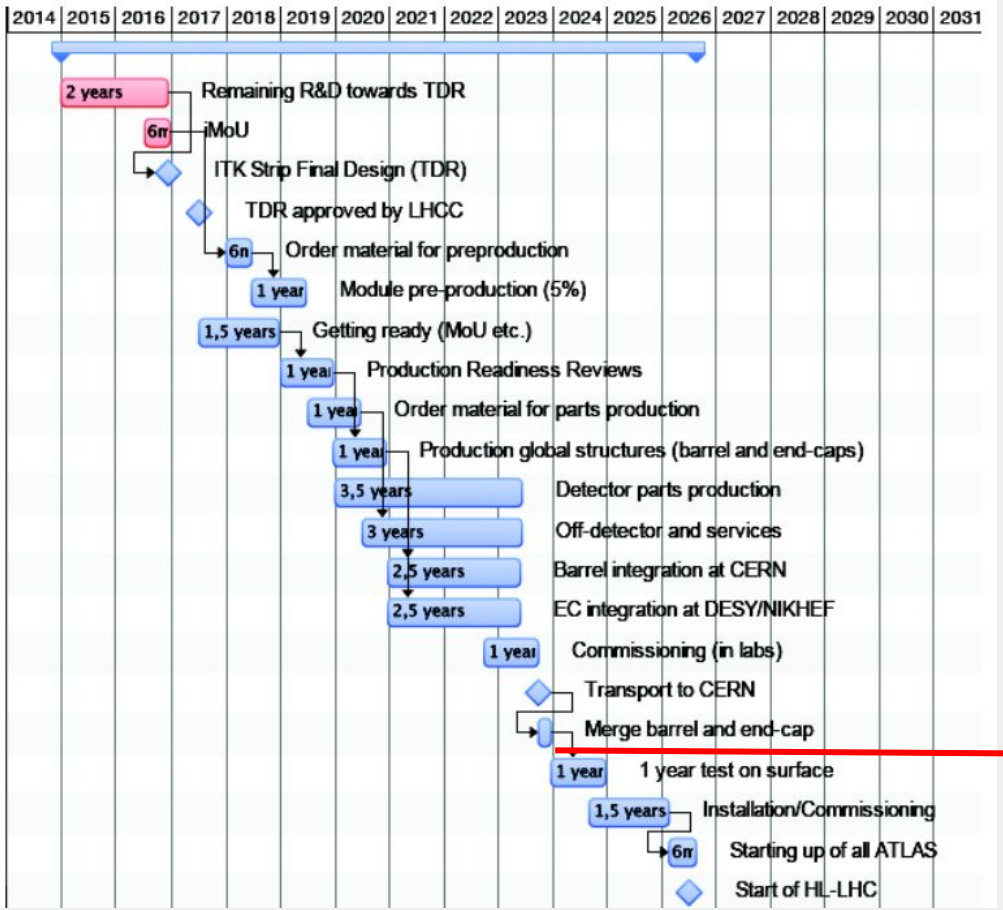
Class 10,000
(ISO 7)

3 standalone ACs
→ independent
→ 1 cold room

Reliable vacuum
→ lots of tools

Close to operations, but this took a ...long...time……..regulations!

The ITk strip schedule



And we are done!

Why is this important for novel rad detectors?

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There will be a lot of silicon expertise at BNL
→ most of the upgrade people are involved with silicon detector R&D too

There will be a state of the art facility at BNL
→ 2 wire bonding machines
→ 1 stave assembly machine
→ high end glue jet dispensing system
→ test equipment
→ inspection equipment
→ Class 10k clean room

After completion we hope to keep the facility alive…….