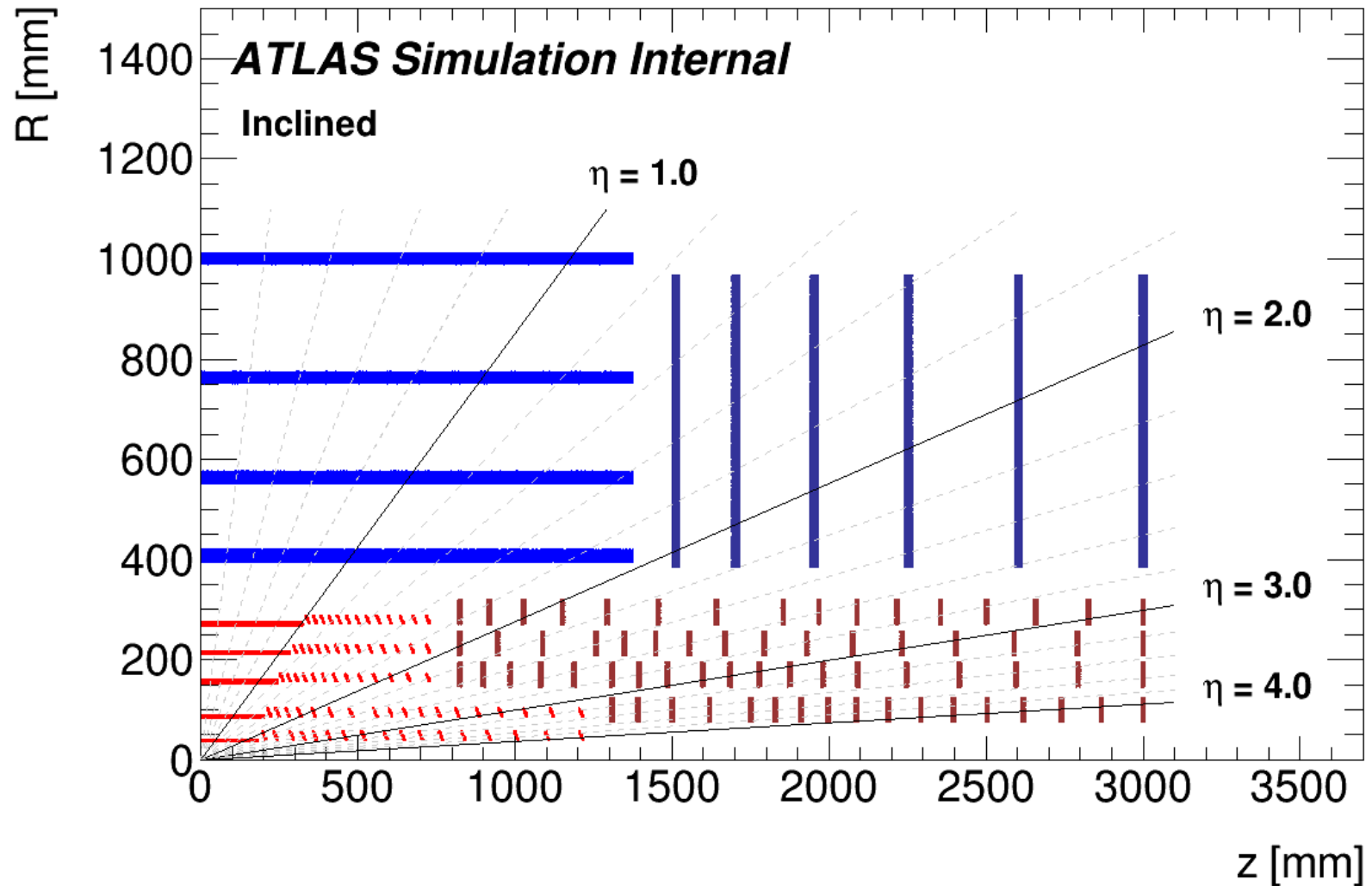


Possibile organizzazione per Itk production in Italia

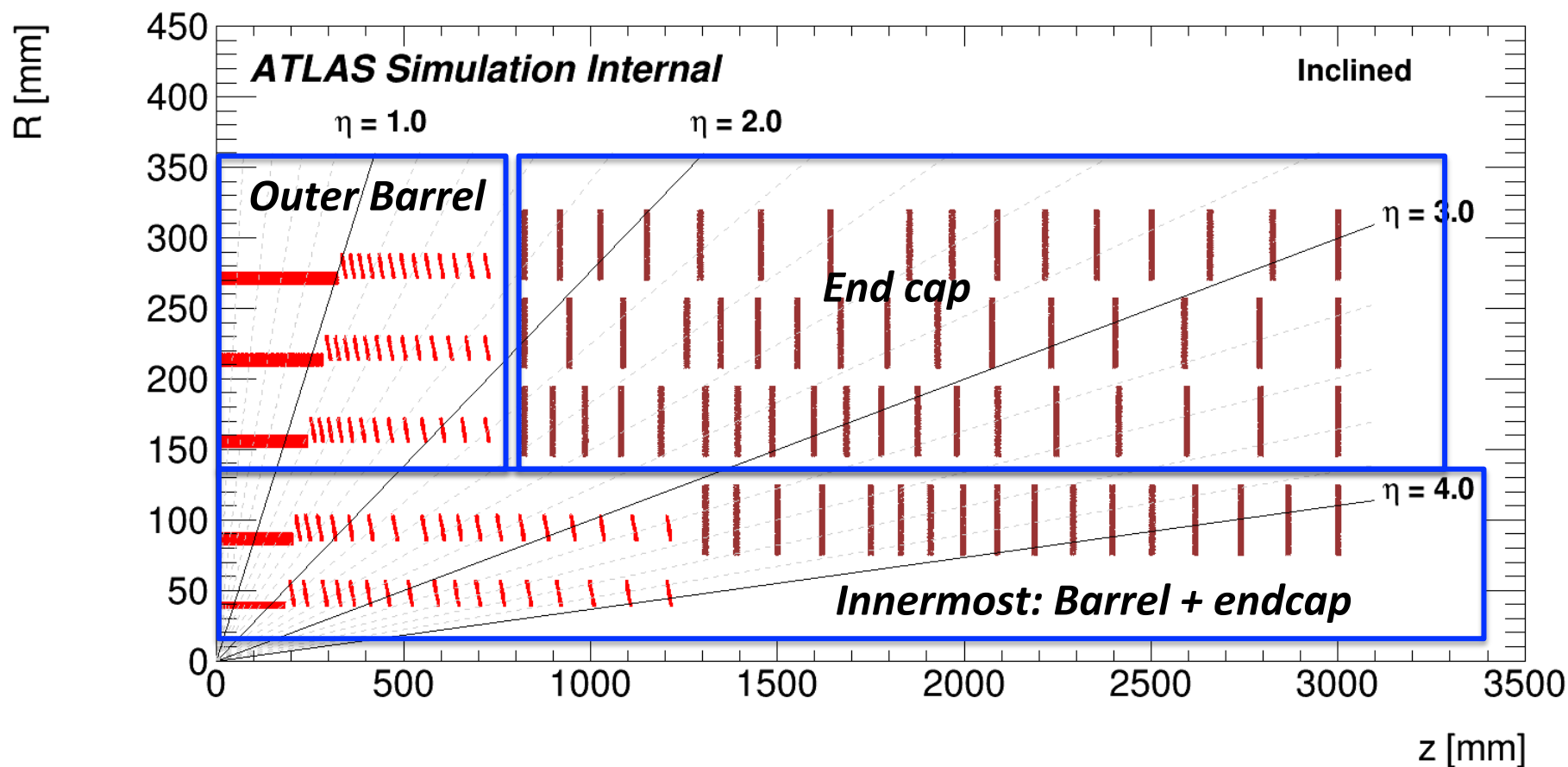
16.12.2016

C.Gemme (INFN Genova)

The ITK Pixel detector



The ITK Pixel detector



Surfaces

Layout Part	Surface [m ²]		
	Inclined	Extended	Inner
Inner Straight	0.35	1.95	0.35
Inner inclined	0.64	–	0.64
Inner Total	1.00	1.95	1.00
Outer Straight	2.53	6.36	6.36
Outer inclined	2.28	–	–
Outer Total	4.82	6.36	6.36
Barrel Total	5.82	8.31	7.36
Rings	7.66		

Inner totale + Row0 (1.1 m²)

Row 0 → 1.11 m²

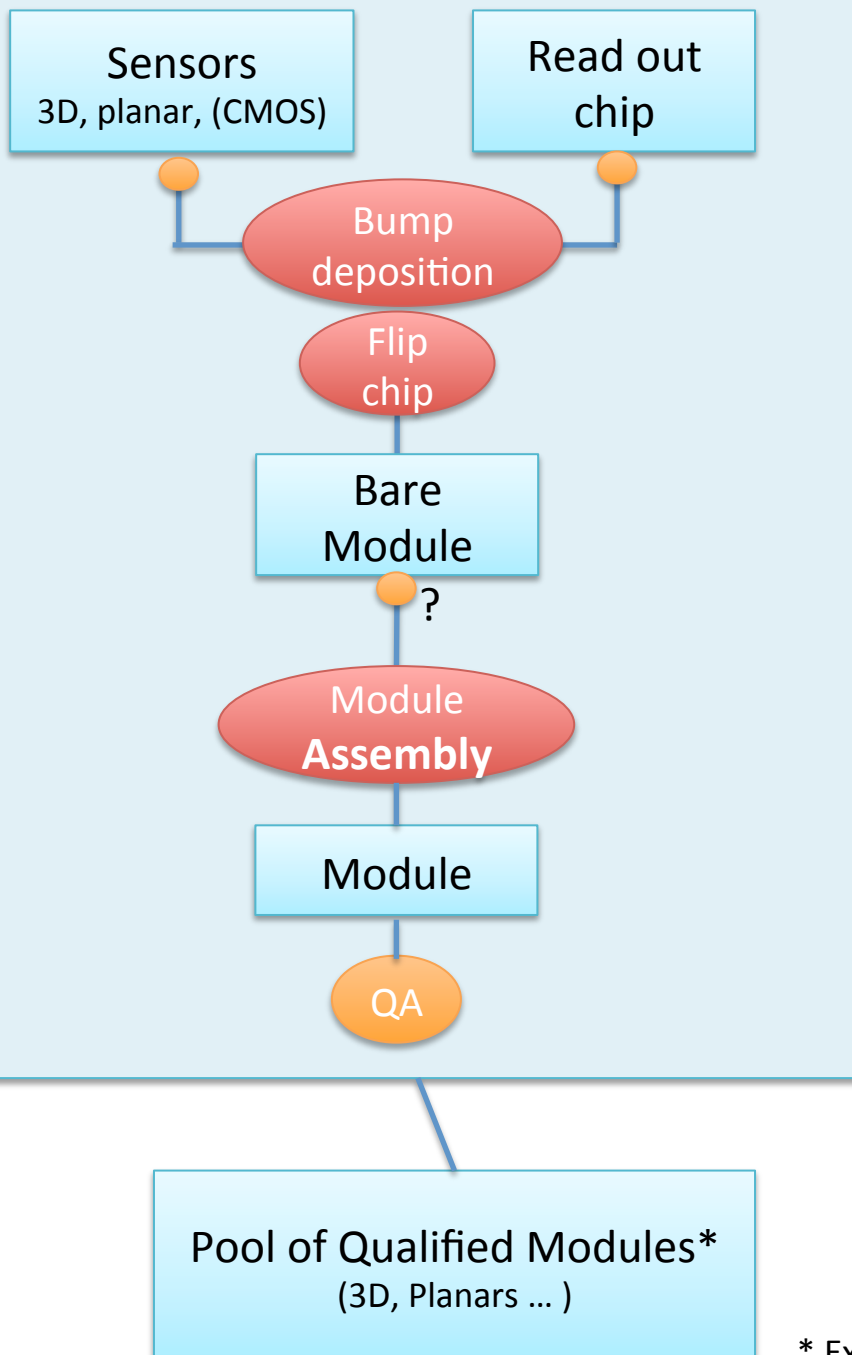
Row 1-3 → **6.55 m²**

Una Endcap → 3.3 m²

Production organization

Modules

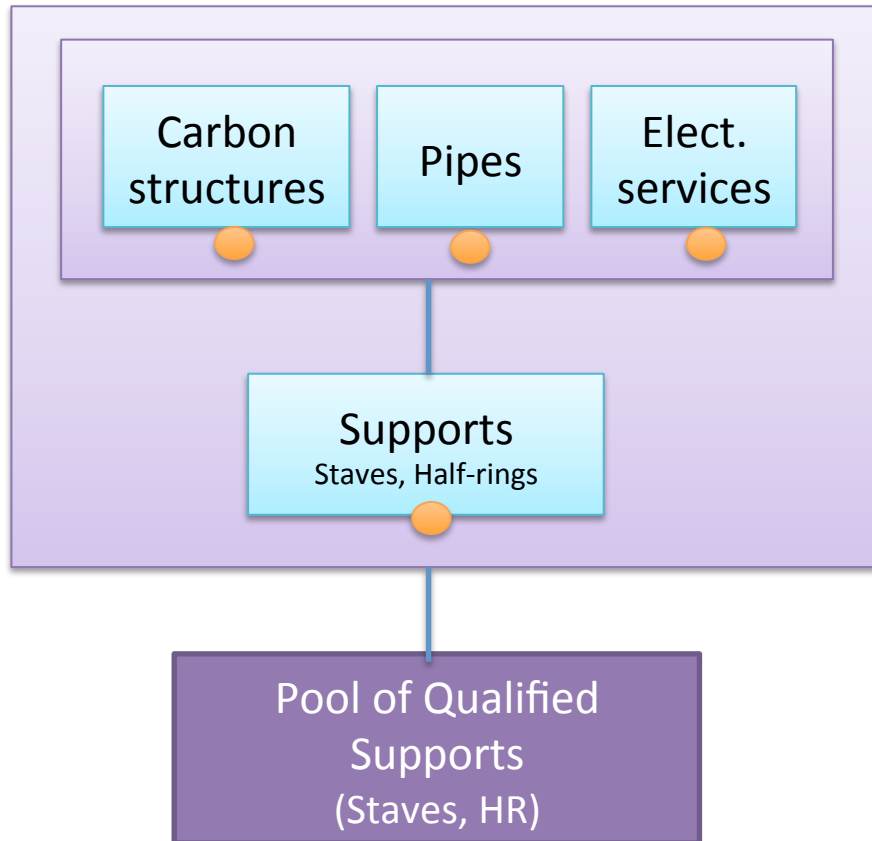
- **Assembly modules**
 - Tools: clean room, precision setup, Wirebonder, pull tester
 - Labs: Ge, ... ?
- **Modules QA**
 - Tools: HW setup, source, cold box
 - Labs: ALL!!



* Extremely simplified, there might be 4/5 types of modules

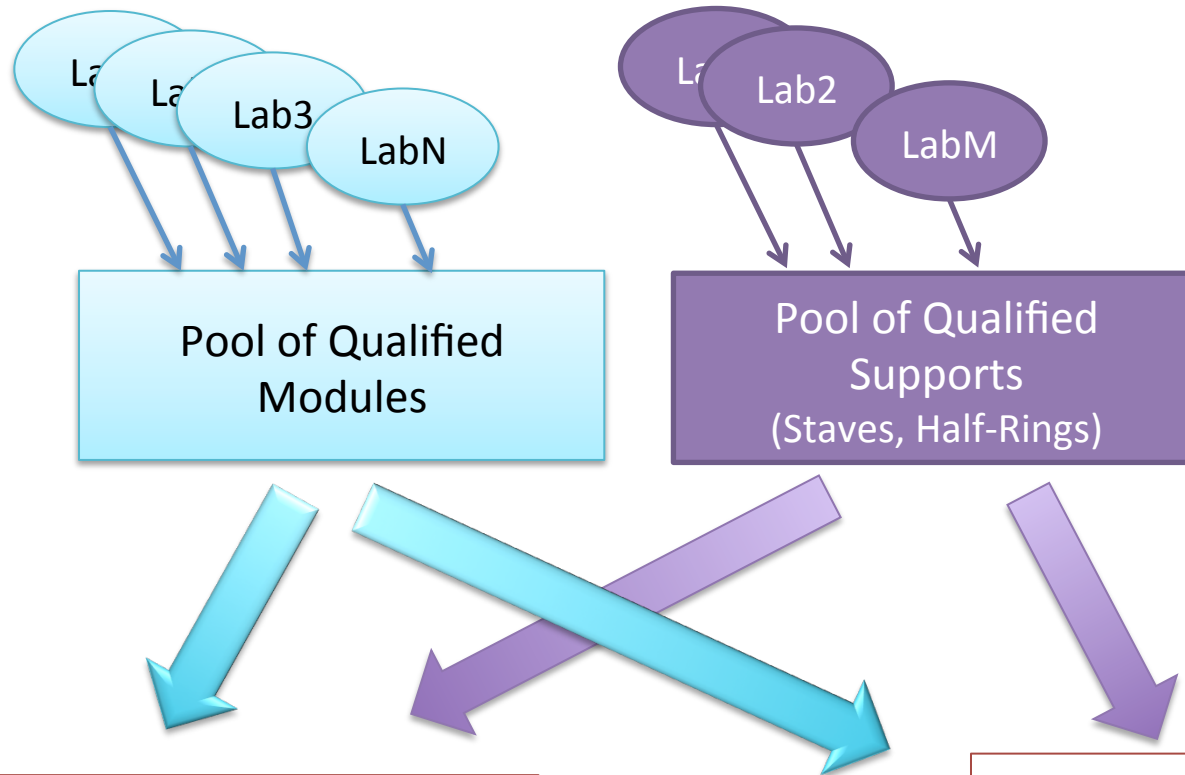
Production organization

Supports



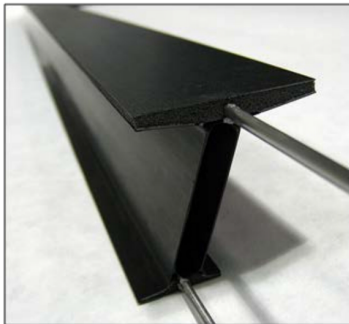
- Of course the process is a much more complex than this simplification.
- But at the end there are qualified supports....

Production organization: **Loading**



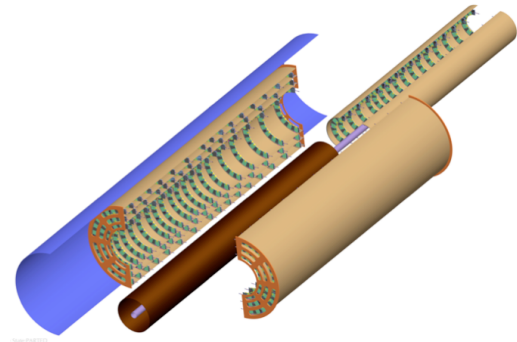
Modules and Supports QA sites are not necessarily correlated to the Loading sites

Barrel Loading Sites receive QA Staves + QA module



Module Loading:
Robot, Survey
Loaded supports QA:
HW setup, source, cold box

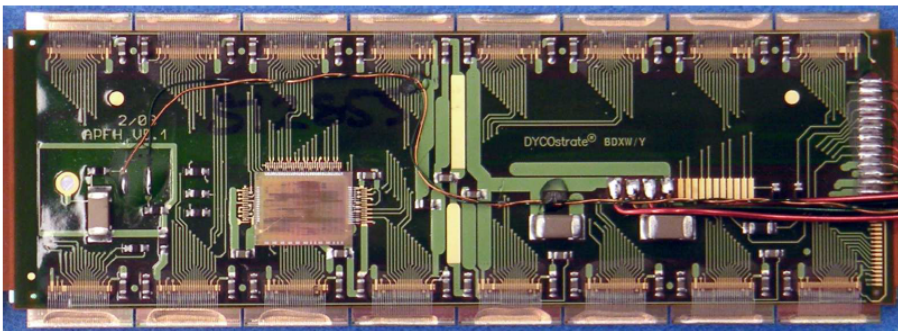
EC Loading Sites receive QA Half-rings + QA modules



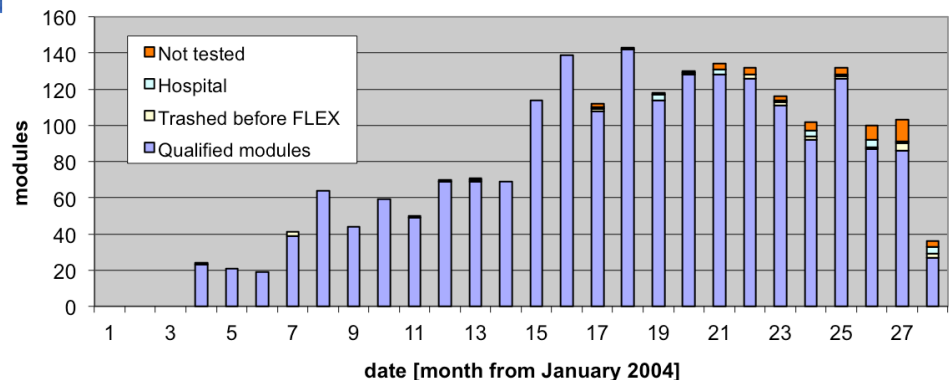
ATLAS Pixel Module Production

- Production: 2004-2006
- Surface: 1.73 m²
- **1744** modules installed
- 16 FE chips per sensor tile
- Paper: 2008 JINST 3 P07007

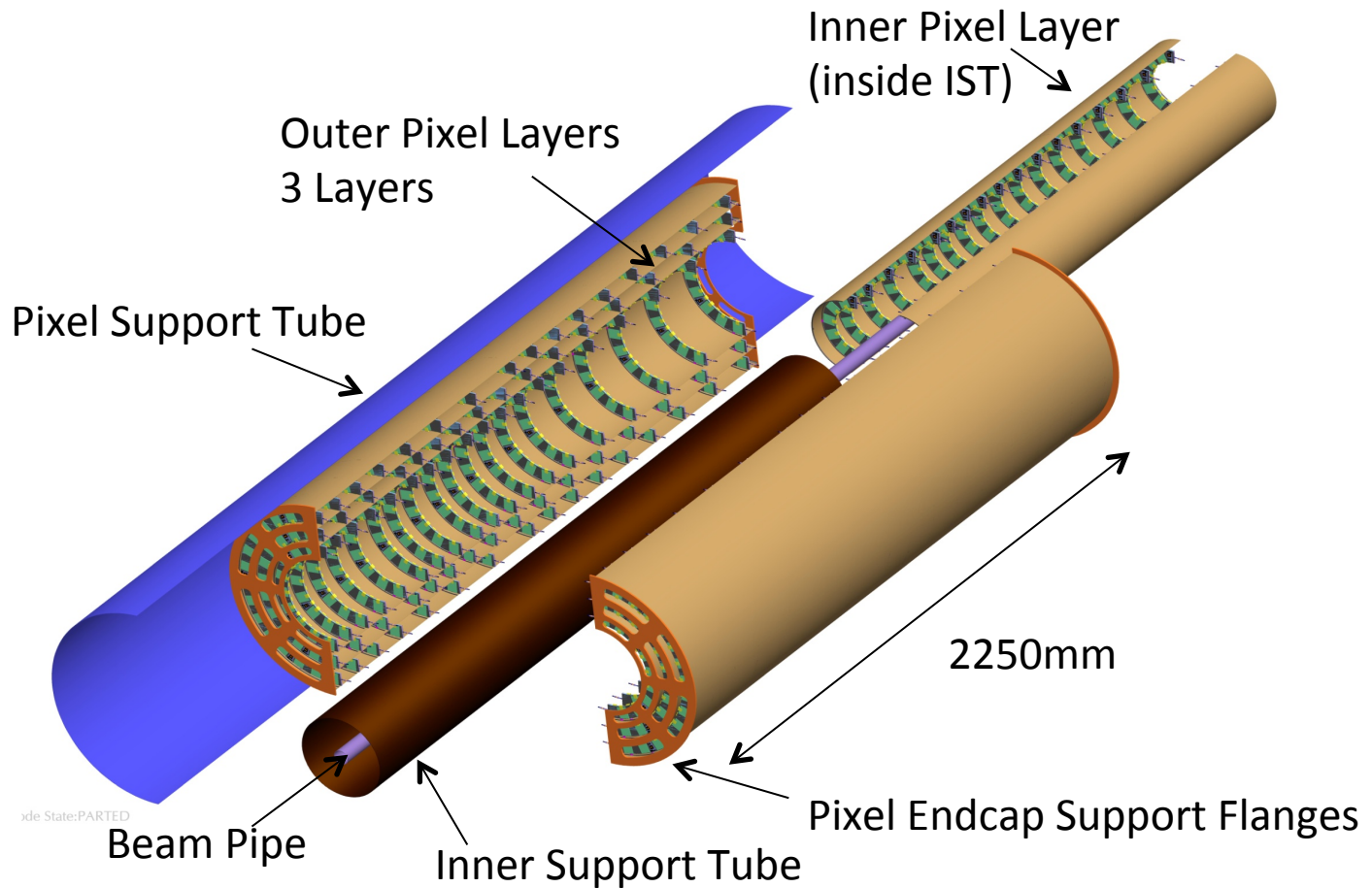
- Sites:
 - 3 (MI, DO, BN): Bare module QA
 - 6 (GE, DO, BN, SIE, LBL+CPPM): Assembling and testing modules
 - 4 (CPPM, WUP, GE for barrel +LBL for Disk): Loading modules on structures and QA supports.
- Production peak:
 - 140 modules/month



Flex module rate



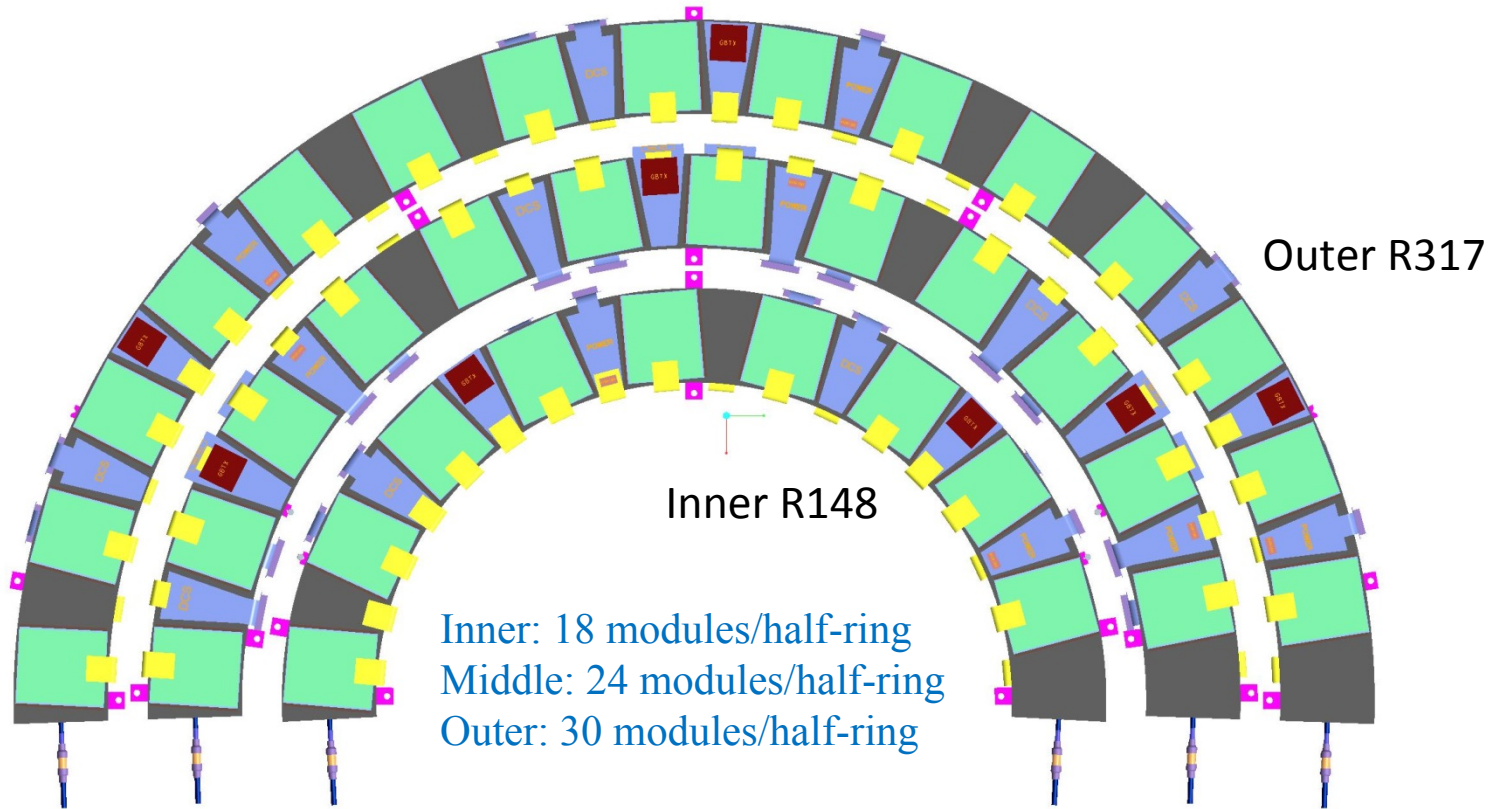
Pixel Outer endcap overall layout



19 Inner Rings
16 Middle Rings
16 Outer Rings

2412 Quad-Module per EC

Pixel endcap half-rings



- The half-rings will be assembled into a complete end-cap.
- Here, I am concerned with timescales for mounting pixel quad modules onto half-rings and testing of the assembled half-rings
- How long will it take ? Does it fit the schedule?

Most recent proposed schedule

- UK Endcap needs to arrive at CERN at start of 2023
- Module to local supports loading starts late 2020/early 2021
- Near 2 years for module loading onto half-rings during production phase
- FEIC production is Q1 2020
- Jun 2019 – Mar 2020 is module pre-production
- We must aim for loading to start ramping asap (late 2019)
- By Jan 2021 we have must have amassed significant experience
- Let's be sure this is achievable.... First a quick reminder of how we propose to do it

Numbers of modules to mount (1)

- 19 inner 16 middle and 16 outer rings
36, 48, 60 quads/ring respectively
- The natural sub-unit for assembly discussions is the **half-ring**:
- 38 inner 32 middle and 32 outer half-rings
18, 24, 30 quads/half-ring respectively
- We would mount 684 inner, 768 middle, 960 outer = **2412** modules
- Add spare half-rings: 1 inner, 2 middle, 2 outer = **2538** modules
- **Most naïve assumption:**
- 1 hr to mount a module, say 35 hr/week
- 73 weeks, close to **1 year 9 months** (44 working weeks/year)

Realistic that the assembly site would likely have at least one physicist and 2 technicians, full time, working normal 8 hour days.

Numbers of modules to mount (2)

- **Refinement: How well does the modularity fit with a working week ?**
- I assume we can populate every second position and leave overnight to cure the glue. One side at a time.
- 18-module half-rings:
 - 9 modules takes 2 days $\Rightarrow$ 4 days/half-ring $\Rightarrow 39 \times 4 = 156$ days
- 24-module half-rings:
 - 12 modules takes 2 days $\Rightarrow$ 4 days/half-ring $\Rightarrow 34 \times 4 = 136$ days
- 30 module half-rings:
 - 15 modules takes 3 days $\Rightarrow$ 6 days/half-ring $\Rightarrow 34 \times 6 = 204$ days
- 496 working days at 22 working days/month $\Rightarrow$ 23 months
- Not far off **2 years**

1 site only

Without spares: $117 + 128 + 192 = 20$ months. Middle rings fit this working day best !

How much time needed to test the half-rings (1) ?

- If we only have 1 HSIO setup (Glasgow) then we probably need about 1 hour to test basic functionality of 4 quads.
 - DAQ is easily expandable so below is worst case.
 - 3 hours/side inner half-ring => 6 hours/half-ring => 234 hours total
 - 3 hours/side middle half-ring => 6 hours/half-ring => 204 hours total
 - 4 hours/side outer half-ring => 8 hours/half-ring => 272 hours total
- Naively looks near 20 weeks **not including** time for cabling, cooldown, warmup, flushing with dry N2.... Quicker if more quads can be tested in parallel.
 - I would add contingency to this, but:
 testing time << assembly time
 should be done in parallel to the mounting operations (needs enough hands !)

1 site only

How much time needed to test the half-rings (2) ?

- What if we use a mobile source to check for disconnected bumps ?
- IBL used a 30 MBq Sr-90 source, exposure time 7 minutes per FEIC
- Pixel size not the same as IBL, may be some leeway in source rate or possibility to use >1 source
- Say 0.5 - 1hr per quad exposure time ?
- Something like 50+ more weeks, also in parallel. Could be significant.

If we make a measurement of noise vs sensor bias, maybe don't need to do this at all....

Summary

- Just under 2 years going **flat out** to populate the half-rings for one EC with one mounting site. Obviously gets easier with more sites !
- The testing time is shorter and mostly run in parallel, should not impact the schedule as long as staffing sufficient.
- Little contingency WRT the schedule.
- Smart use of ramp up during pre-production needed.
- There are detail changes one could make to buy a little time.

Achievable but definitely not easy !

If more speed were needed, something might be gained by a change in philosophy. Mounting using jigs could be faster, using the gantry for surveying. This would lead to reduced accuracy as a trade-off. More automation using the gantry system (e.g. for glue application) is also possible.

My View: Module Assembly and QA

- Assumo che per i moduli Assembly e QA faremo il nostro share:
 - Contribuiremo **all'assembly e QA dei 3D** ($\sim 1 \text{ m}^2 / 2$ vendors) – per paragone 0.04 m^2 sono i 3D installati in IBL.
 - Altro se necessario.
 - **→ Coinvolgere piu' lab, almeno due per module assembly, 4-5 per module QA.**
 - **E' MOLTO importante per il formare expertize per l'operazione negli anni futuri!**

Endcap Loading and QA

- A Genova montati in passato ~ 40 staves (~500-600) moduli.
 - Procedura lenta , va sicuramente ottimizzata.
 - lo cercherei di preparare 2 siti per il Loading (oppure se uno solo fosse Genova, lo alleggerirei degli altri compiti come Module e HR QAs).
 - Almeno 2 siti per la QA dei HRs.

Endcap assembly

- L'oggetto ha dimensioni:
 - Lungo ~ 2.5 m
 - Diametro di 60 cm
- Serve un lab con spazio per assemblaggio degli HR nelle shell e possibilita' di test.
 - Cern se disperati?
 - Oppure un lab che abbia le risorse di per se', mi sembra difficile che altri lab possano mandare manpower in un sito italiano per lunghi periodi di tempo.