Study on ATLAS ITk module production rate

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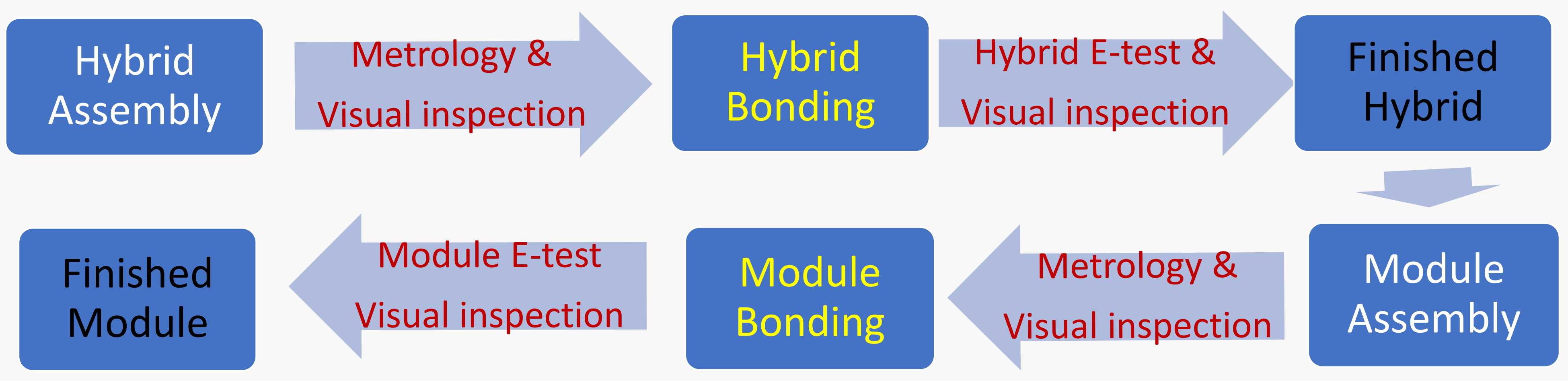
Motivation

- To prepare against any need to increase module production rates at the strip institutes, a range of solutions should be investigated.
- This will include optimizing the procedure of the production and QC processes.

Production procedure



Procedure interpretation

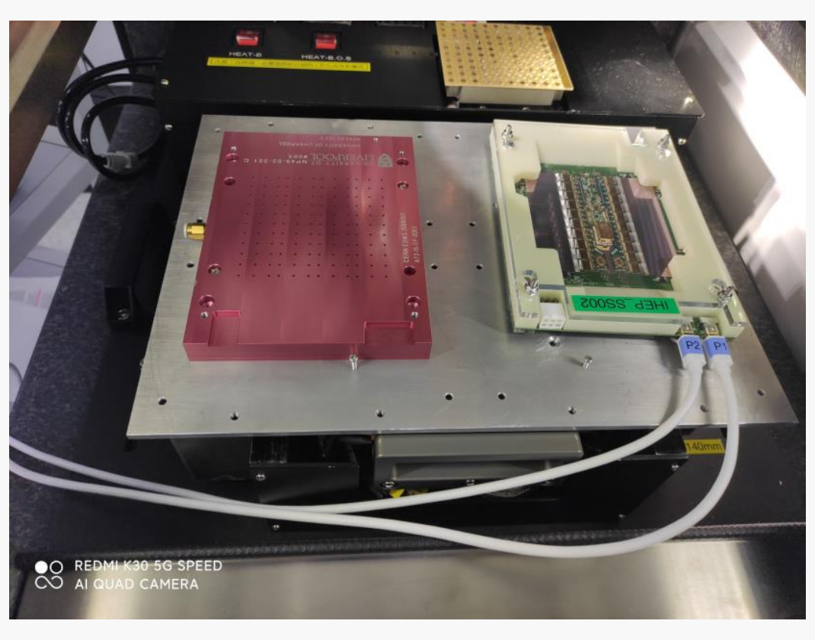
- Hybrid Assembly: Glue the ABCStar Chips onto the hybrid.
- Module Assembly: Glue the hybrid and the powerboard to the sensor.
- Bonding: After assembly, the different components are only attached mechanically, but not electrically. Bonding is required to make it electrically working.
- Metrology: To measure if the positions and heights of the components are in the tolerable range.
- E-test: Electrical test, to test if the channels can work.
- Visual Inspection: To check if there are any problems with eyes and microscopes.

Time Consuming

Hybrid	Glue dispenser calibration	10min
	Assembly	40min
	Metrology	30min
	Bonding	40min
	Visual Inspection	15min
	E test	5min
Module	Glue mixing	15min
	Hybrid attachment	25min+6h
	Visual Inspection	5min
	Powerboard attachment	15min+6h
	Metrology	25min
	Bonding	70min
	Visual Inspection	30min
	E test	30min

Optimizing

1. Bonding Jig & Rowtest
Using a bonding jig to bond 2 modules together, and using the software Rowtest to check the wire bonding.
It can save the time of setup the devices (save 10 mins) and visual inspection on the wires (save 20 mins).



2. Visual Inspection GUI
Use the VI GUI to mark the area with problems, save a smaller file instead of a high-resolution photo, which could make the communication of VI easier.

3. Hybrid Work in Parallel
We can do the hybrid work based on a multiple of six hybrids being assembled at a time, for it works best with the panel.
As for bonding, if the hybrid can be fixed in its position precisely, we can save the time of locating about 2 mins every hybrid.
As for electrical test, ITSDAQ support testing multiple hybrids in parallel. It takes about 10 mins to setup and test 6 hybrids.

Time spent on Itk production database

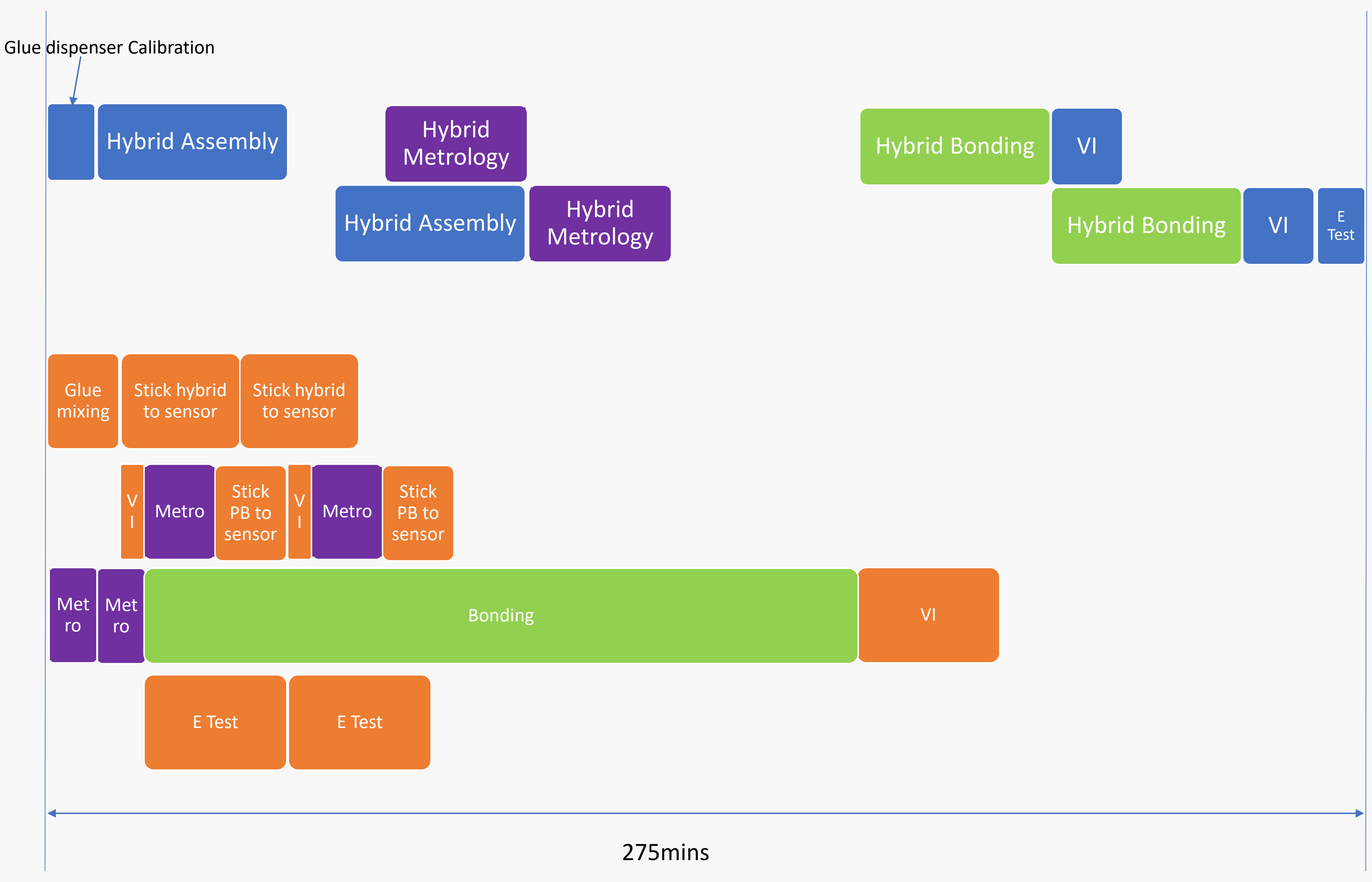
For hybrid and module, we need to do such things on database:
Register component (3 min)
Link the child components to the this component (3 min)
Upload metrology results (If we have script, it would be less than 5 min)
Upload VI results (1 min)
Upload E-test results (5 min)

Total:20 mins.
Considering the hybrid and the module, for a long strip module, we need 40 mins on database.

Optimization of the Production Procedure

Considering the whole procedure and the optimization, we can rearrange the procedure in this way, in order to make 2 modules everyday.

Since when assembling the modules we need to wait the glue drying for at least 6 hours, we use the component finished yesterday, and continue today's work.



Device used:
Metrology: marked in Purple
Wire-bonder: marked in Green

Bonding takes 230 mins in this 275 mins procedure, occupies 84% of the time.

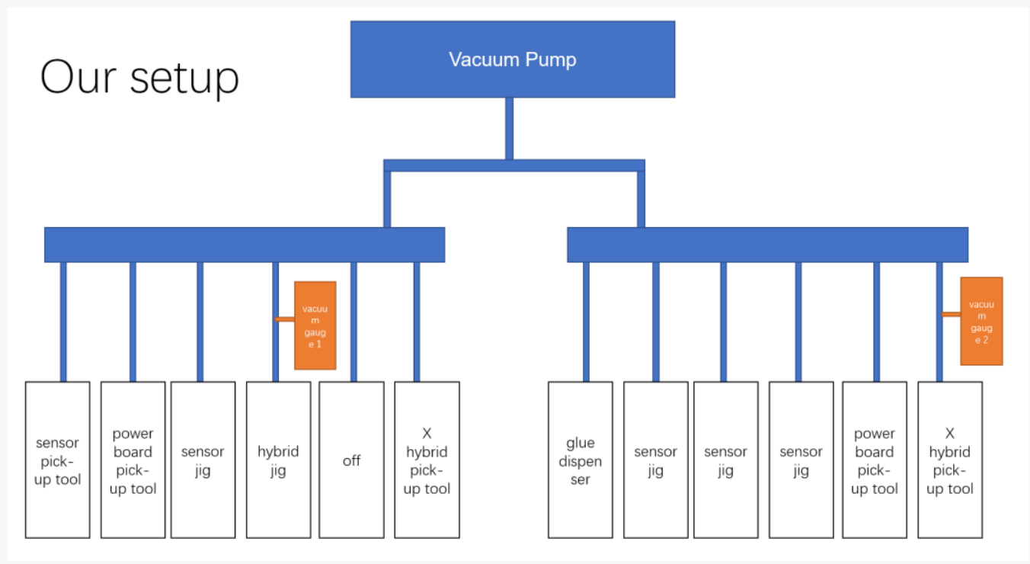
Metrology takes 110 mins in this 275 mins procedure, occupies 40% of the time.

Now we have a theoretically 275 mins procedure.

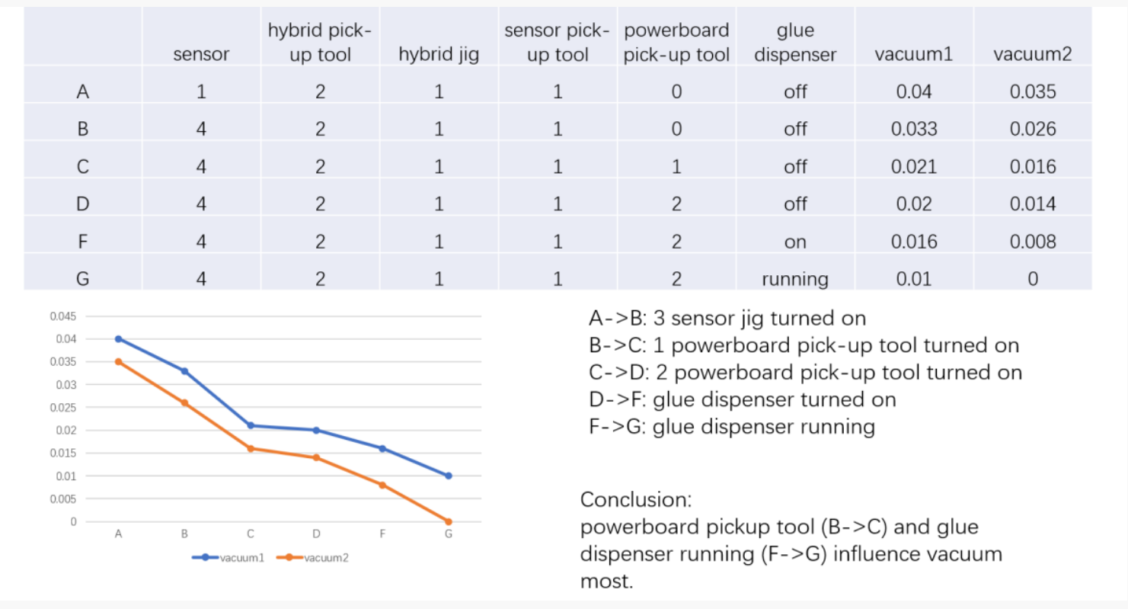
Vacuum

Can our vacuum hold so much devices at the same time?
We use the following setup to investigate such question.

Our setup



Conclusion: The vacuum of glue dispenser and powerboard pickup tool should be treated with a single vacuum pump.



	sensor	hybrid pick-up tool	hybrid jig	sensor pick-up tool	powerboard pick-up tool	glue dispenser	vacuum1	vacuum2
A	1	2	1	1	0	off	0.04	0.035
B	4	2	1	1	0	off	0.033	0.026
C	4	2	1	1	1	off	0.021	0.016
D	4	2	1	1	2	off	0.02	0.014
F	4	2	1	1	2	on	0.016	0.008
G	4	2	1	1	2	running	0.01	0

A->B: 3 sensor jig turned on
B->C: 1 powerboard pick-up tool turned on
C->D: 2 powerboard pick-up tool turned on
D->F: glue dispenser turned on
F->G: glue dispenser running

Conclusion:
powerboard pickup tool (B->C) and glue dispenser running (F->G) influence vacuum most.

Summary

Bonding jig can save the time of bonding; Rowtest reduces the time on VI; VI GUI helps communication on VI; Hybrid work in parallel can save time on hybrid bonding and E-test.

Theoretically we can produce 2 modules in 275 mins.

Considering the time spent on database: for 2 LS modules, we have 2 hybrids and 2 modules, totally 80 mins.

Adding 60mins redundant time, we can produce 2 modules in 420 mins.

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