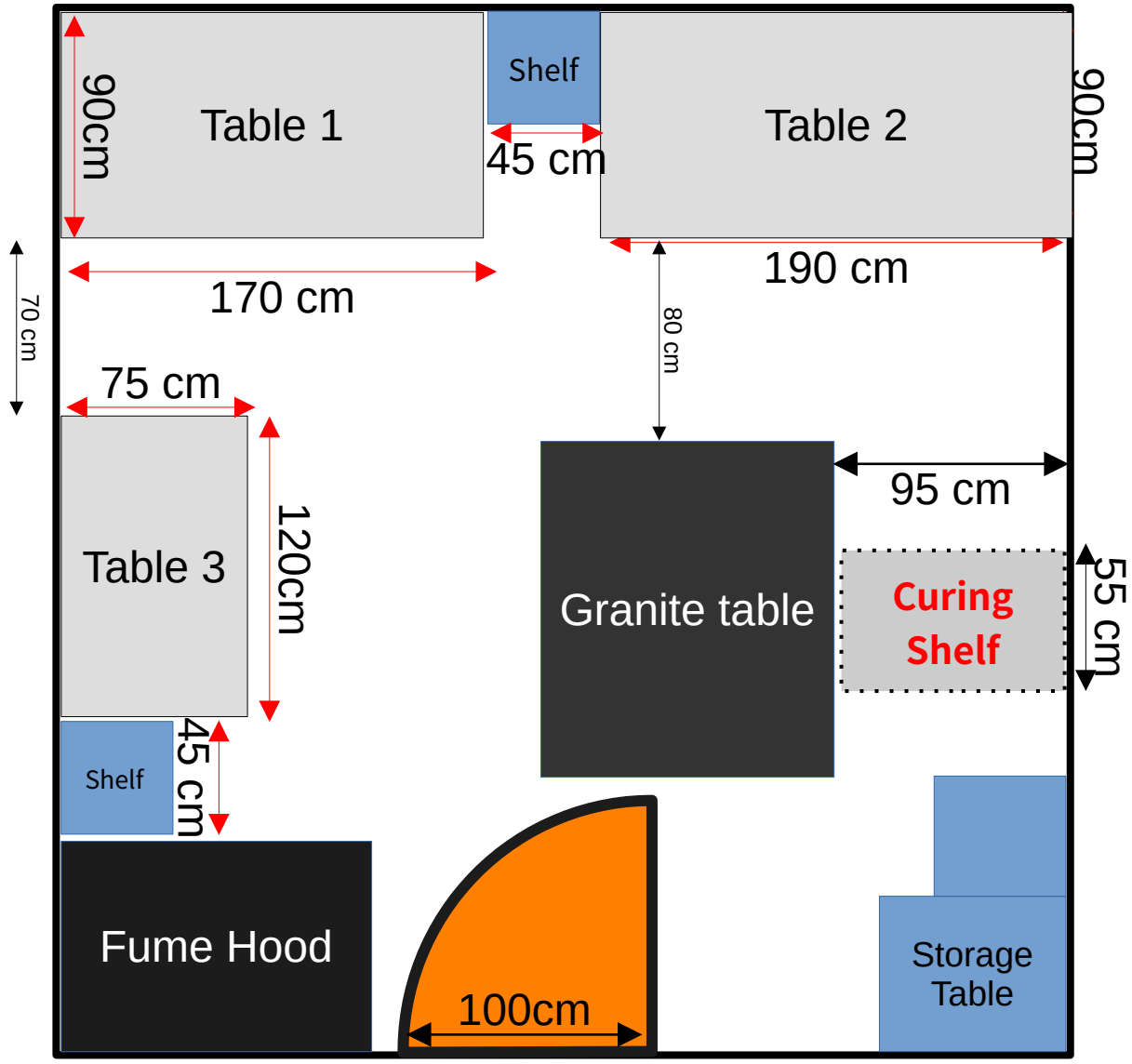
R010 Lamination Process updates

Yi-Mu Chen

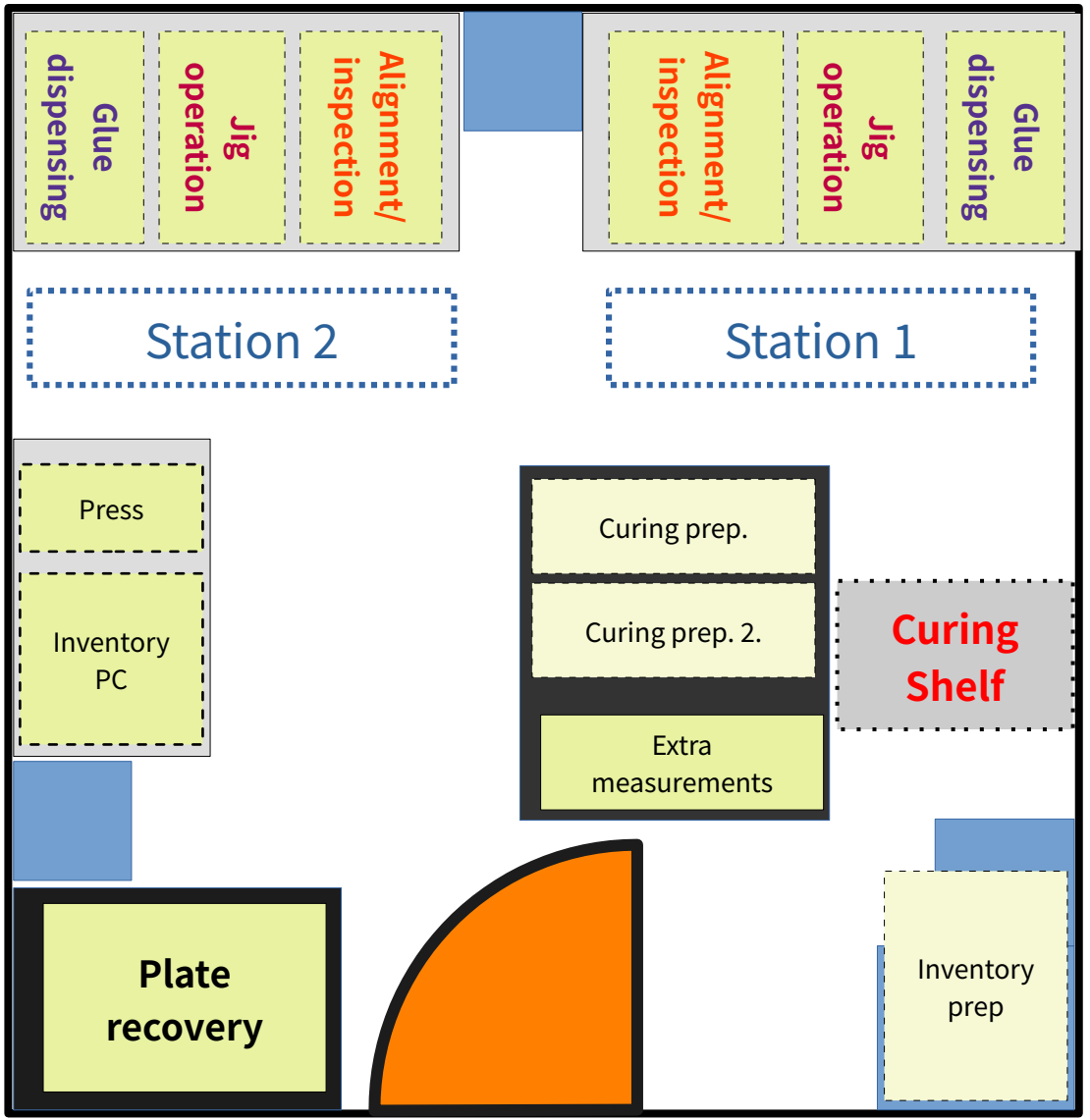
KIT ETP Hardware meeting

2025.Feb.17



Current room layout:

- Immovable
- Keep clear
- Main working space
- Optional
- Not yet in room



More detailed layout + equipment

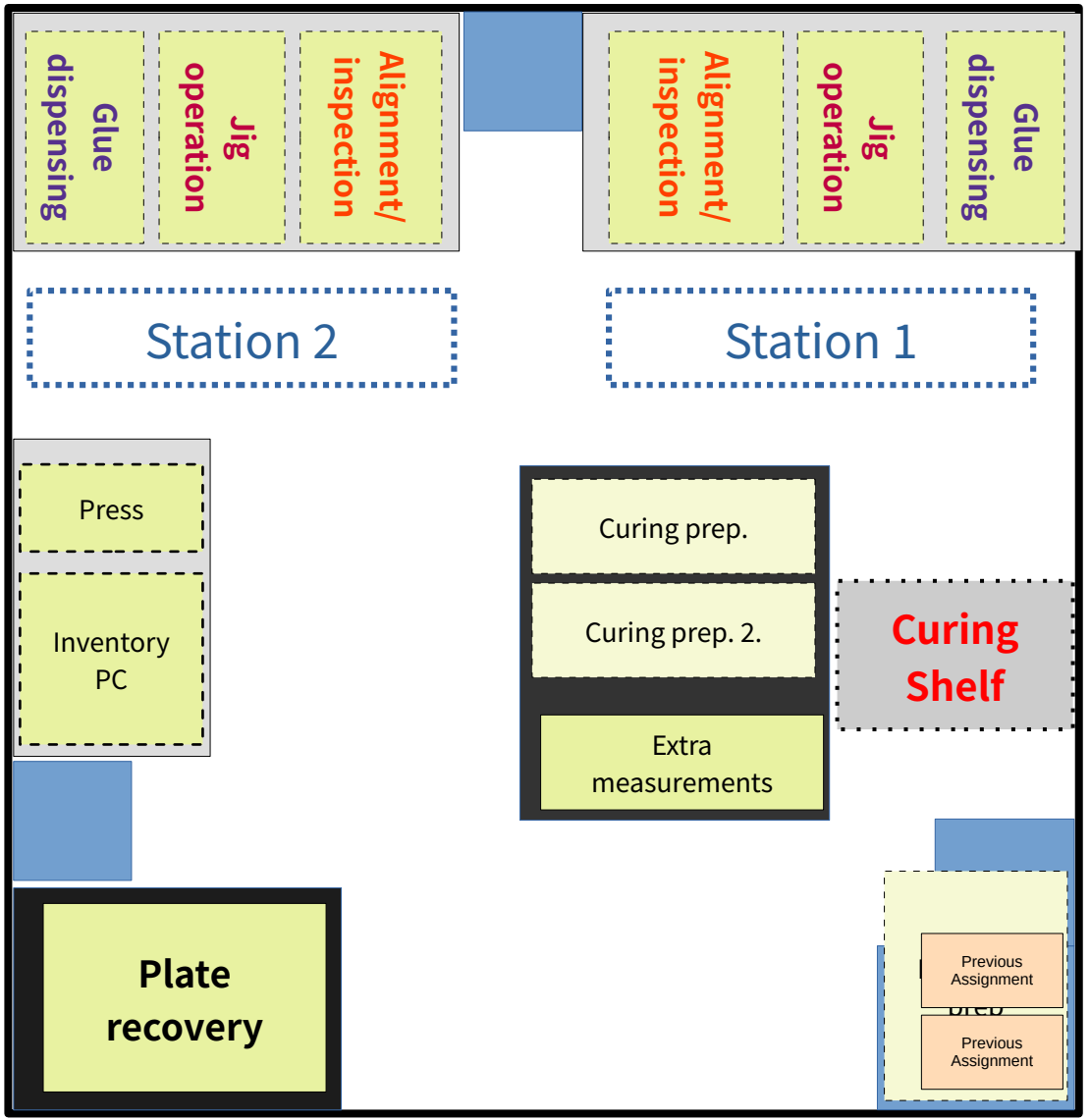
- **Glue dispensing**
  - Roller
  - Dispensing spatula
  - Cleaning Q-tips
  - Glue mixing
  - Precision scale (0.01g)
- **Jig operation:**
  - Jig
- **Alignment/inspection**
  - Microscope

Common:
- Air brush
- Isoprop.
- Clean wipe

Needs to procure!

Plate recovery:

- No “special” equipment, but will depend of required operations



Lamination, single-person workflow
Target: 12 plates/person/3.5hr
(2 person/station)

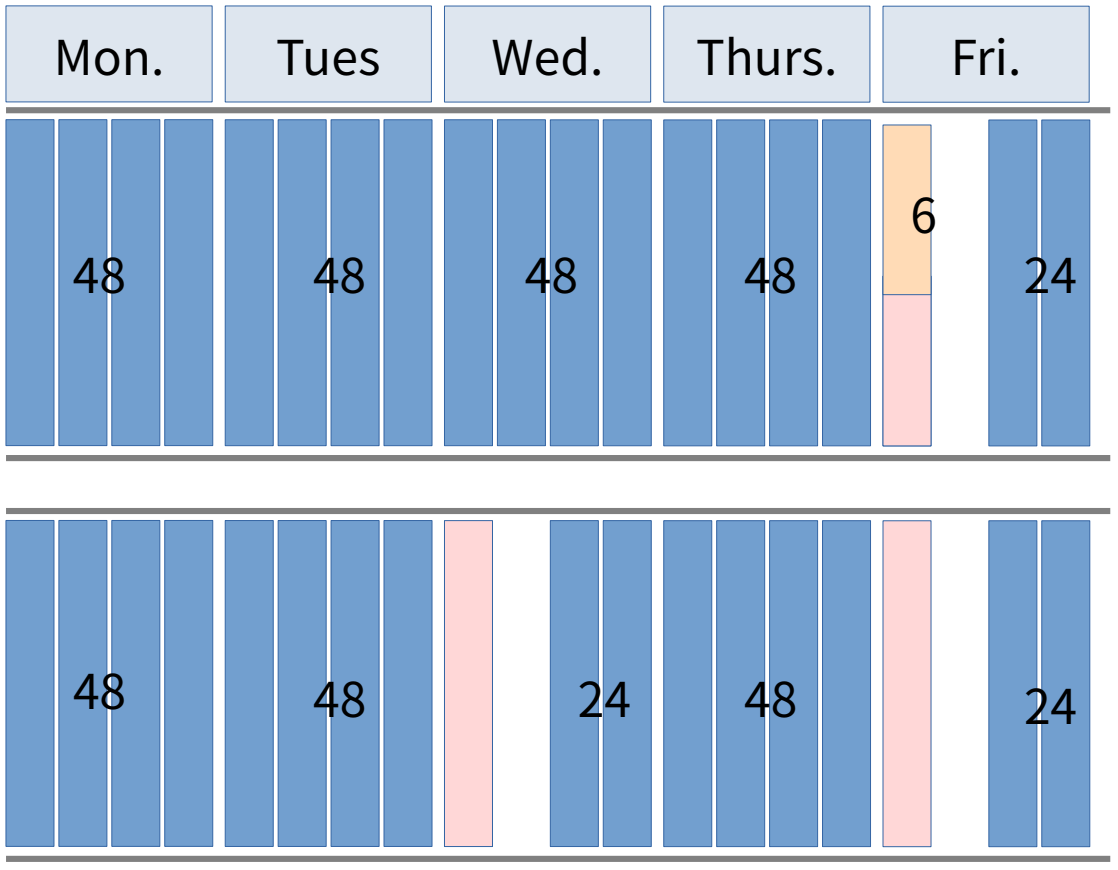
- **Setup (10-15min)**
- **Lamination (2hr/2batchs)**
- **Post-pot Inspection (35hr)**
- **Post-cure Inspection (30min)**

Transfer tape application:
(Reserved for station 2)
Target: 30-50 plates/person/1 hr

Quick overview

- Three primary workflows, these can be mixed depending on person power/immediate request requirements. (1shift = 4hr)
  - **Single person lamination** (12/shift)
  - **Duo-team lamination** (24/shift)
  - **Transfer tape application** (up to ~**200**/shift)
    - This is overly optimistic, having 1 person handle 200 plates starts to run into (human) physics limits (100kg!!!)

Maximum production rate @ KIT (R010 shifts)



Duo team shift

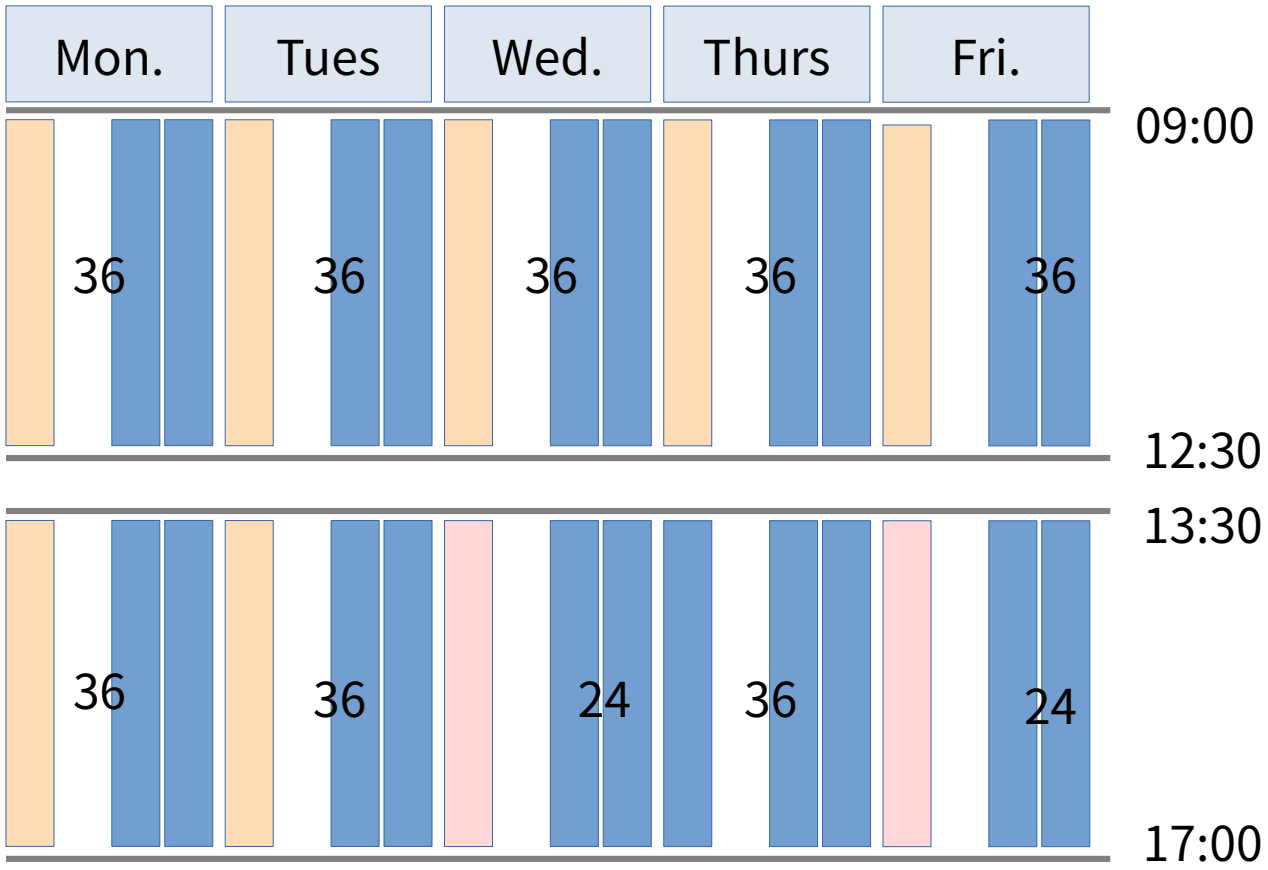
Solo lamination shift

Tape shift

- 37 4hr-shift/week
- 414 plates/week

Required to meet maximum request:
1661 plates/month (2026.Mar)

“75%” production rate @ KIT (R010 shifts)



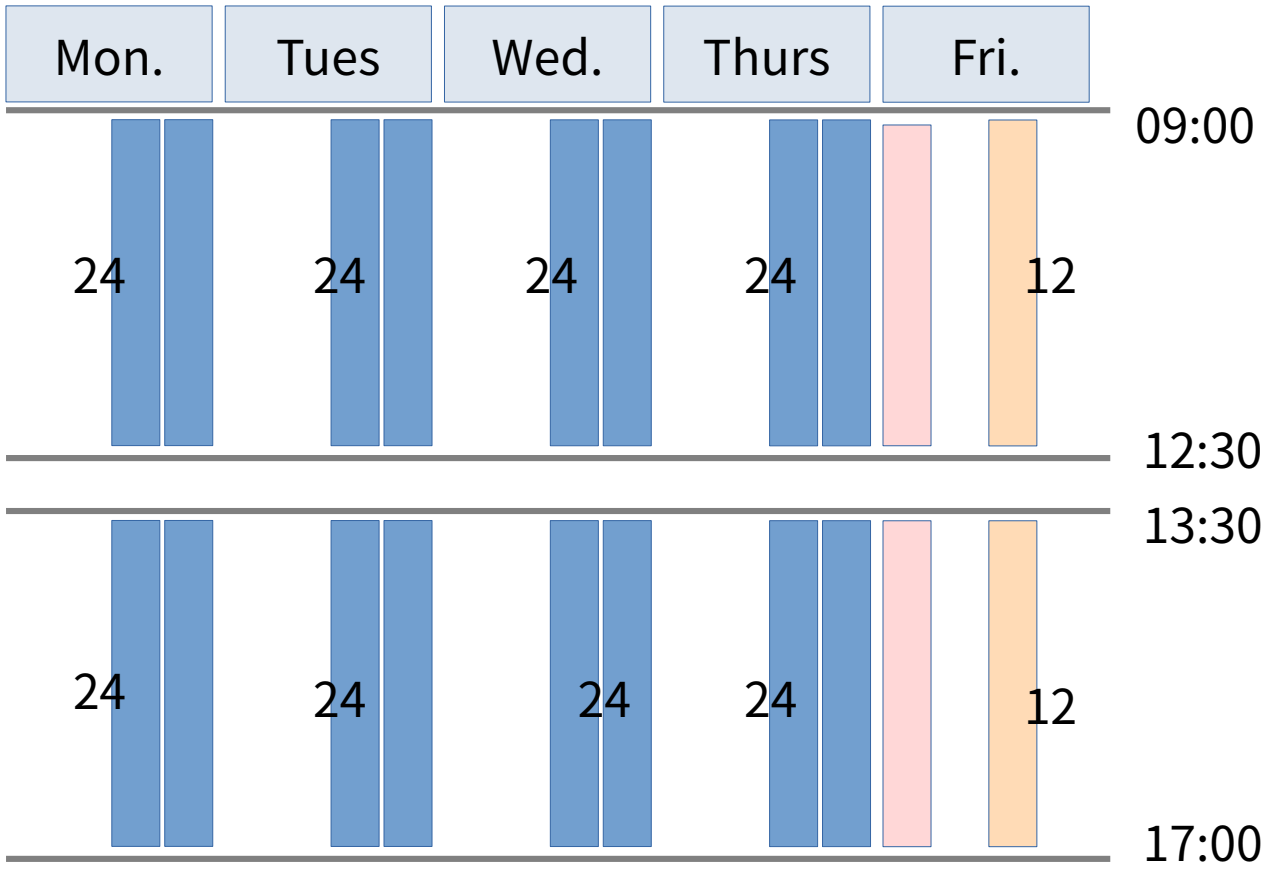
Duo team shift

Solo lamination shift

Tape shift

- 30 4hr-shift/week
- 336 plates/week
- Probably the most healthy to maintain?

“50%” production rate @ KIT (R010 shifts)



Duo team shift

Solo lamination shift

Tape shift

- 20 4hr-shift/week
- 216 plates/week
- If we start this “now”, we don’t actually need to have 100% production rate.

Potential optimization?

From multiple trail this week, current estimations are potentially inaccurate off by a factor of 2

- Yi-Mu (Mar. 4th) 14 HDR /hr (>> 6 /hr!!)
- Obi + Yi-Mu (Mar. 5th) 12 HDB / 0.5 hr (>> 12 /hr!!)
- Yeongseo + Yi-Mu (Mar 6th) 11 LDR/0.6hr (>> 12 /hr!!)

Previous impedance mismatch with glue dispense time > alignment time. This was fixed with a wider roller

Does this generalized?

- Yeongseo being able to keep up with a significantly higher rate indicates this isn't purely an experience effect
- Alignment time is roughly proportional to parameter length, but can be made very small if the jig alignment is consistent enough.
  - Current Jig alignment precision **~50um** (Unlikely to change for jig 2.0) Very good for partials (>150um overhang), not very good for full plates with our **current** Kapton (~20-70 um overhang).
  - Max rate test will likely not be possible until new Ti Kaptons arrive (Mid April)
- Change in workflow with jig 2.0/curing shelf? Dedicated equipment should be overhead is smaller (can potentially be faster!).

Training

All clean room operators should be trained in:

- Full plate lamination (most required operation, least ambiguity)
- At least 1 partial lamination:
  assuming operators can extrapolate to other variants.

Transfer tapes application can be reserved to longer term people
(More variations, more involved checks, more material variation)

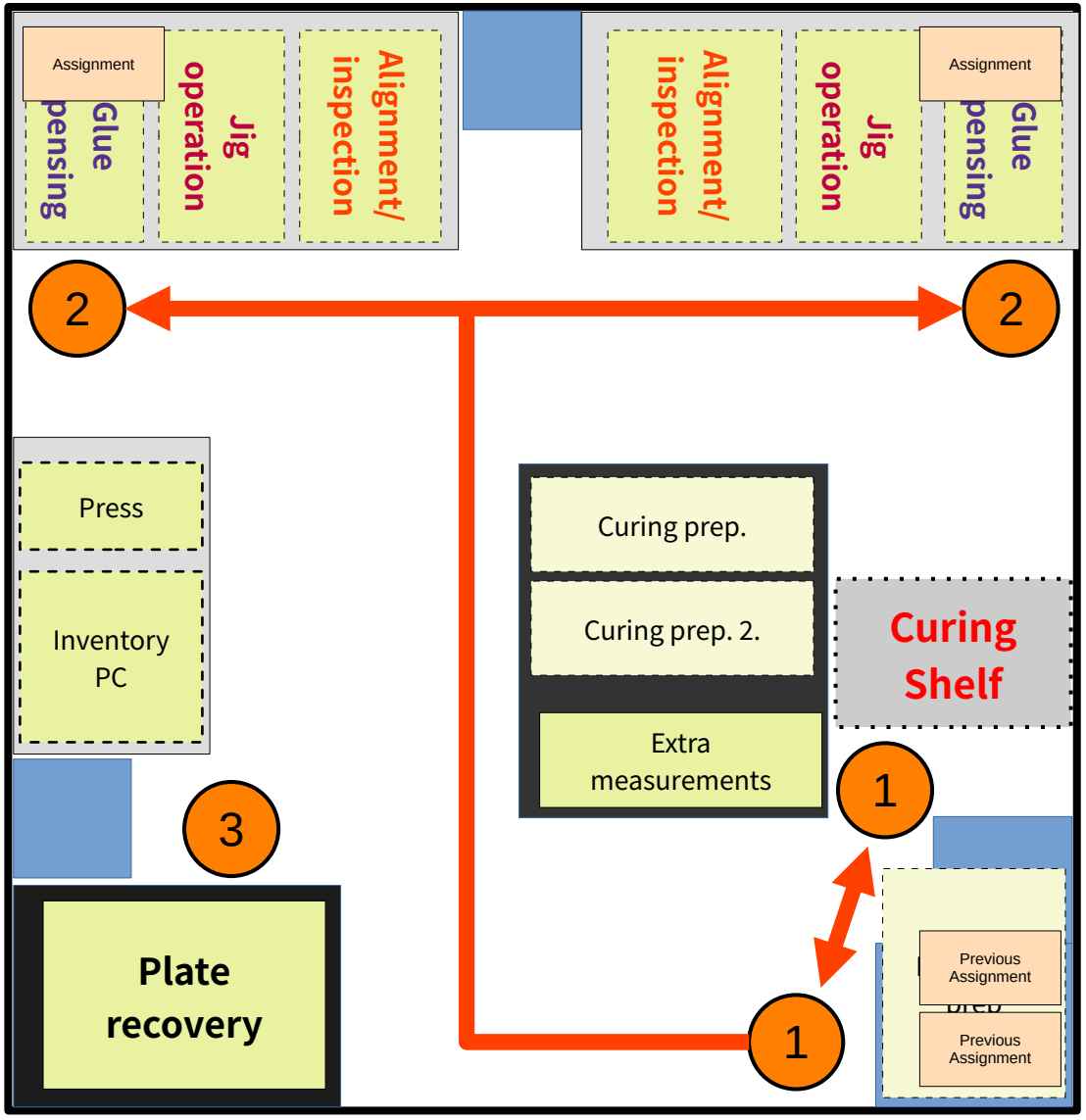
- HiWis/Technicians/HGCAL specialists
- More easily decouples training time to production time
- Exceptional people can also be trained (would this accidentally be a anti-incentive to perform well in nominal tasks?)
- Transfer tape shift can also be the debugger shifter.

Training material - references

- Lamination:
  - Detailed information (en). Still needs pictures
  - Infographics (under construction)
  - Alignment (en/de)
- Inspection:
  - Detailed information (en). Still needs pictures
  - Infographics (en/de). Just a few images missing
- Tape application:
  - Detailed instructions (en). Still needs pictures
  - Infographics (under construction)
  - Alignment (en/de)

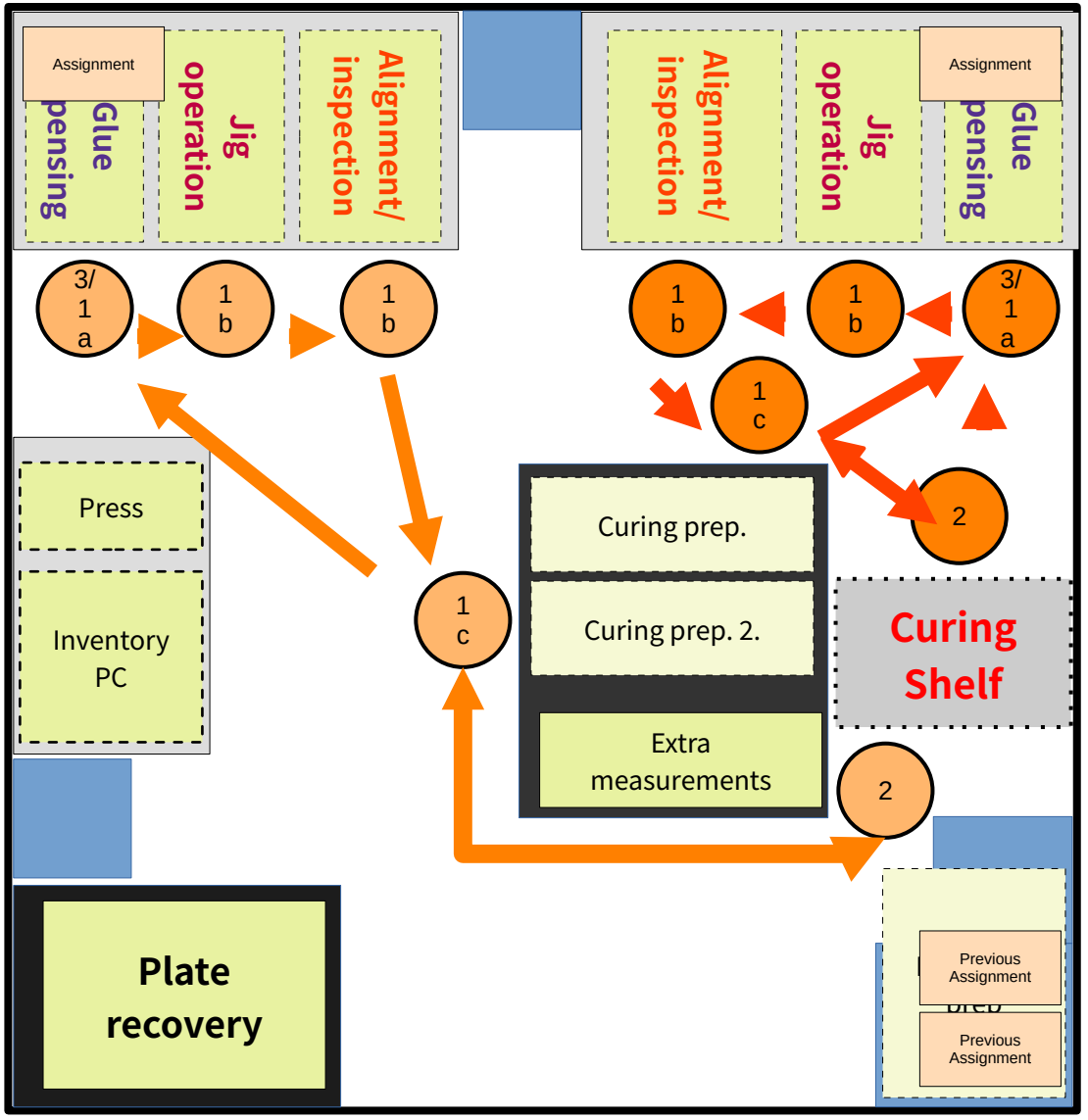
Hopefully I can complete this with a bit of calmer week next week (see production planning slides)

Backup (Example workflow)



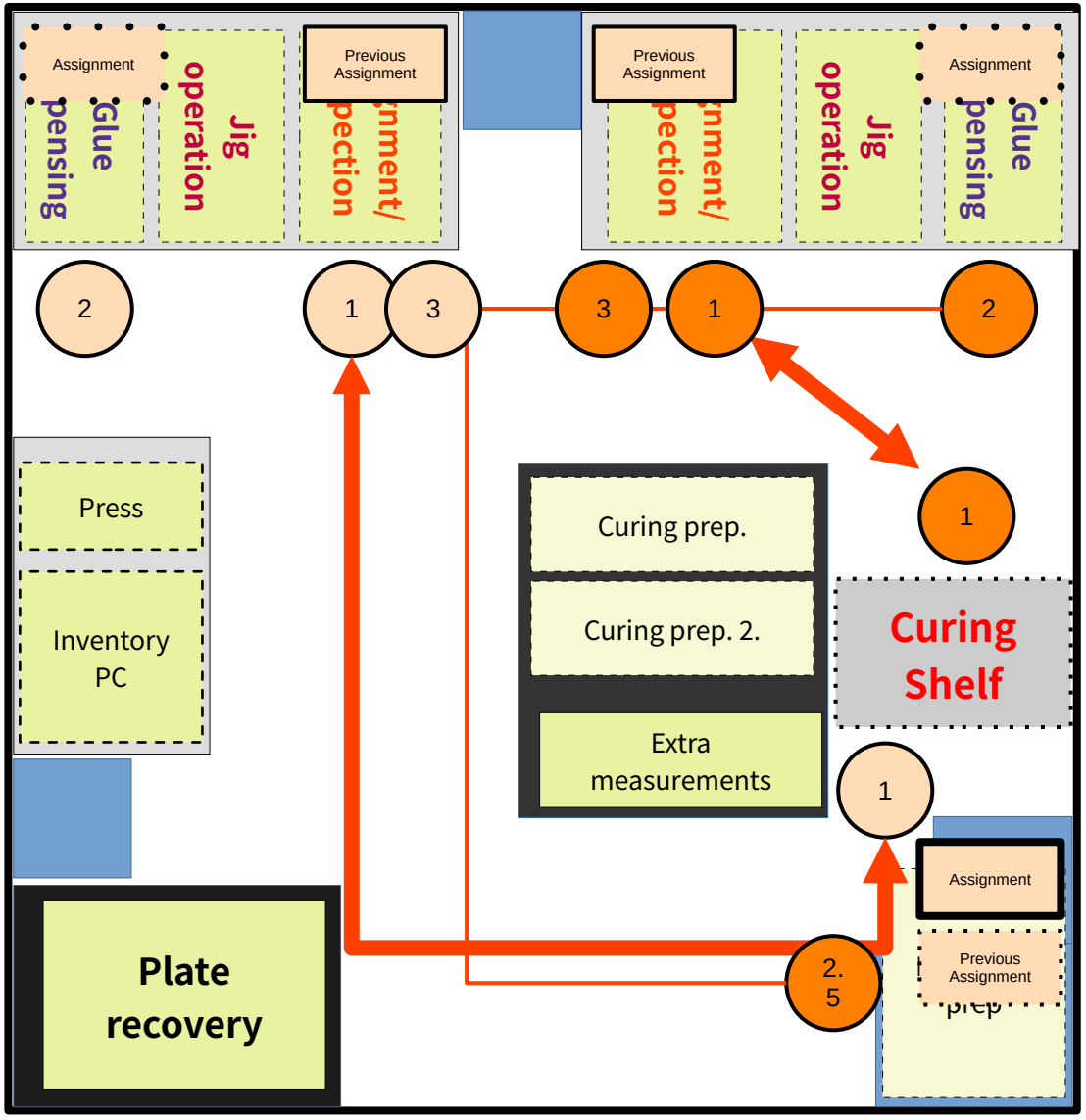
Lamination, single-person workflow
Target: 12 plates/person/4hr

- **Setup (10-15min)**
  1) Collect cured plates complete the day before from curing shelf back into previous "assignment box".
  2) Open assignment box next to glue dispense station
  3) Measure the expected amount of glue at mixing station
- **Lamination (2hr/2batches)**
- **Post-pot Inspection (35min)**
- **Post-cure Inspection (30min)**



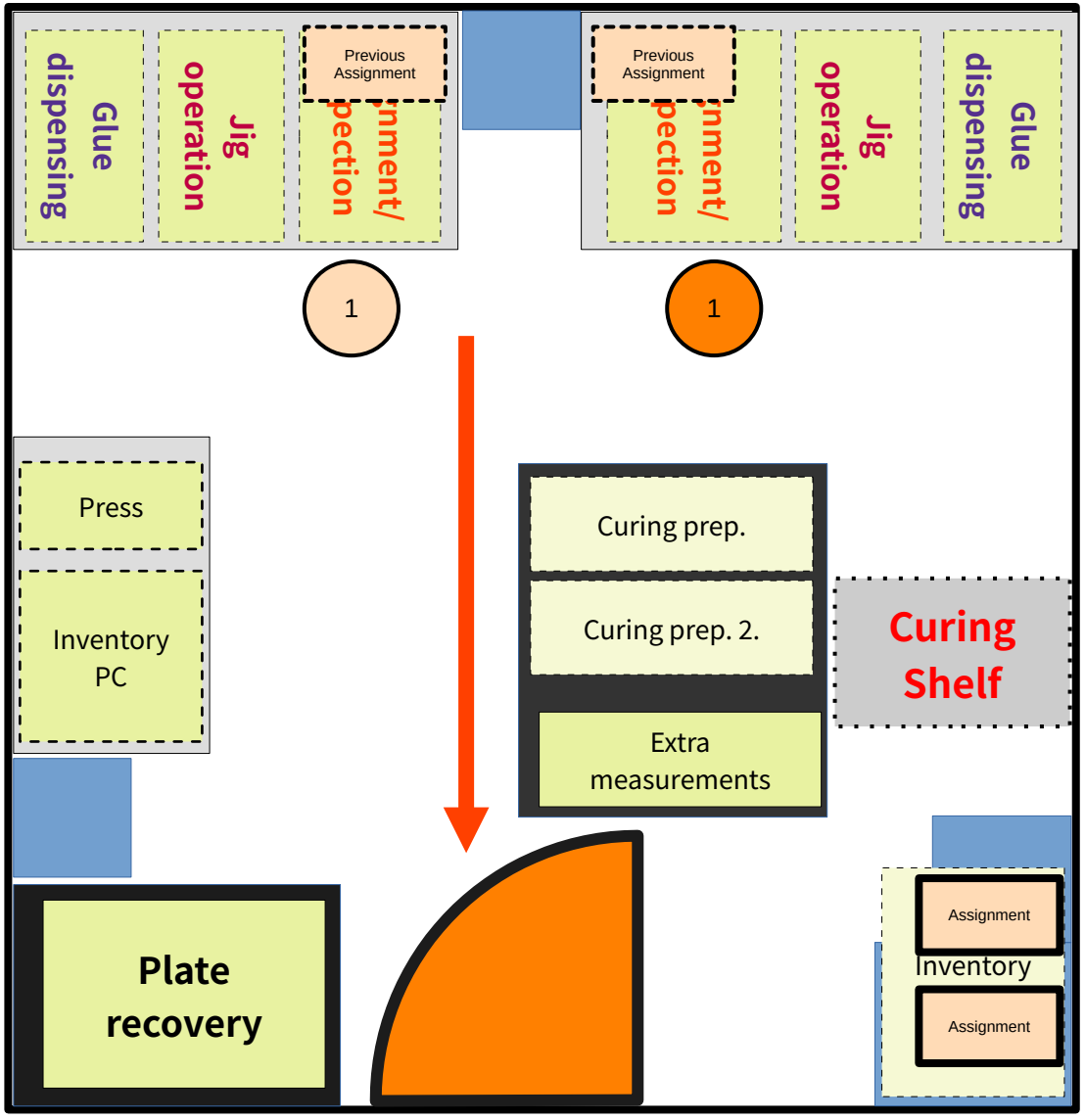
Lamination, single-person workflow
Target: 12 plates/person/4hr

- Setup (10-15min)
- **Lamination (2hr/2batches)**
  1) Batch 1 (~6 plates)
     a) Dispense glue (5 min/plate)
     b) Jig → Aligment (5 min/plate)
     c) Lay plate in curing preperation
  2) Properly place the plates into the curing shelf
  3) Prepare glue for batch 2 **(Irreducible clash??)**
  4) Batch 2 (~6 plates)
- Post-pot Inspection (35min)
- Post-cure Inspection (30min)



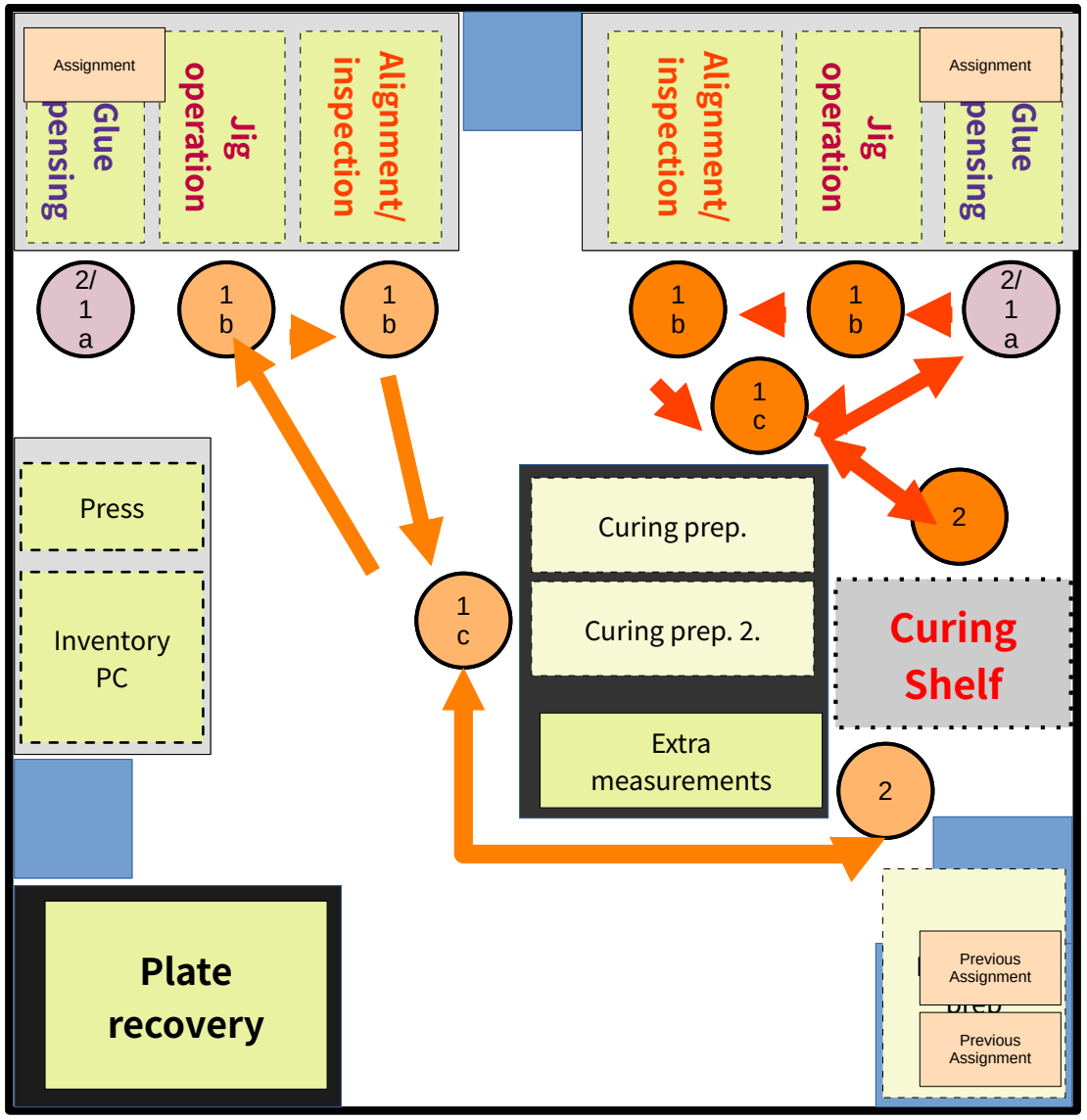
Lamination, single-person workflow
Target: 12 plates/duo/3.5hr

- Setup (10-15 min)
- Lamination (2hr/2batches)
- **Post-pot Inspection (35min)**
  1) Single plates from curing shelf to inspection station, return to curing shelf after you are done (3 min/plate ~= 35 min for 2 batches)
  2) Place assignment box to inventory prep box
  3) Take assignment box from previous day to inspection station
- Post-cure Inspection (30min)



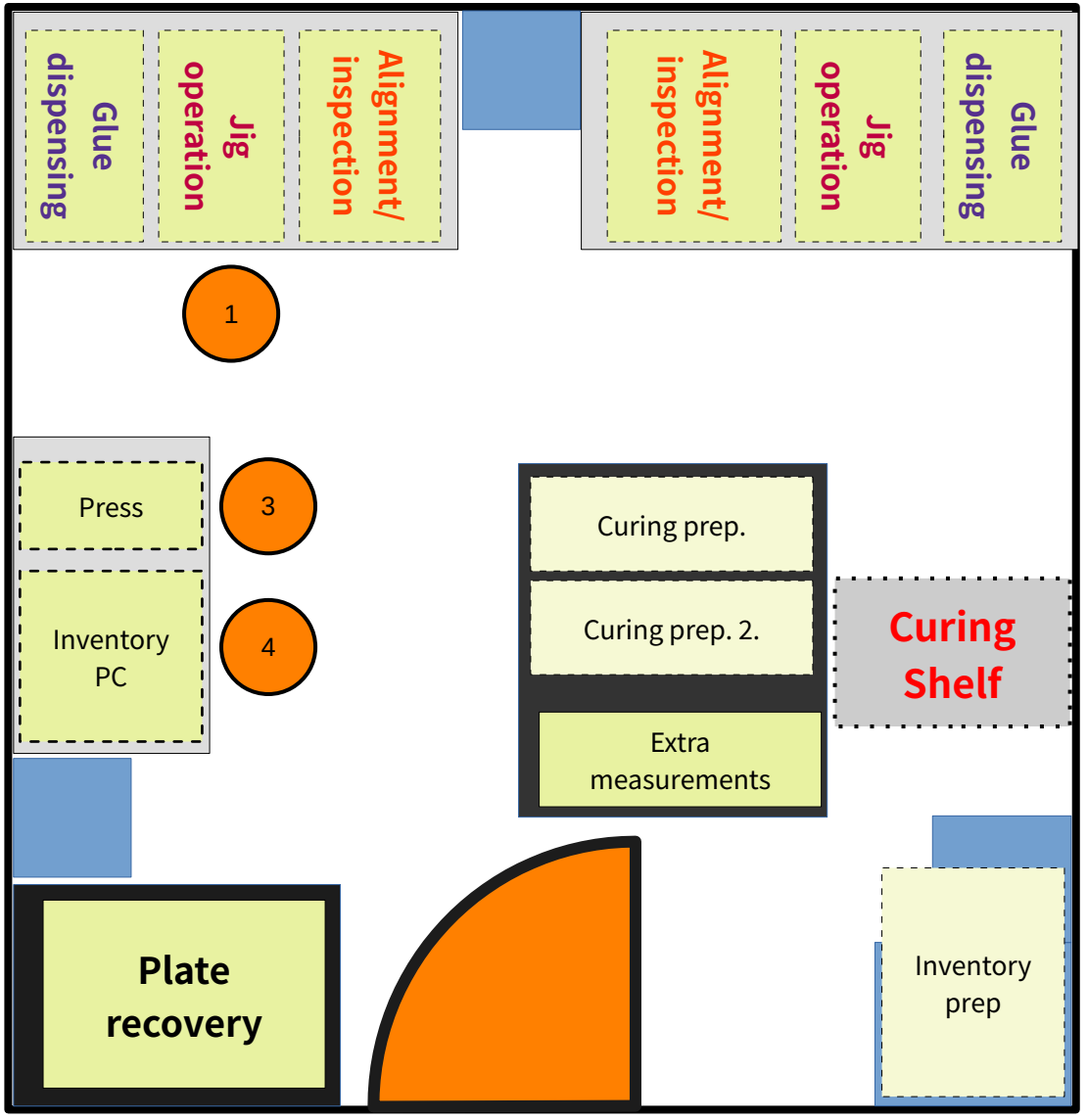
Lamination, single-person workflow
Target: 12 plates/person/3.5hr

- Setup (10-15min)
- Lamination (2hr/2 batches)
- Post-pot Inspection (35min)
- **Post-cure Inspection (30min)**
  - ~1-2 min/plate (up to 24 plates)
  - Collect good plates in previous assignment box, move to R011 for post lamination QC



Lamination, duo-team workflow
Target: 24 plates/person/3.5hr

- **Setup (10-15min)**
- **Lamination (2hr/2batchs)**
  1) Batch 1 (~**12** plates)
     a) Dispense (5 m/plate) || Aligment (5 /plate)
     b) Lay plate in curing preperation
  2) Properly place the plates into the curing shelf || **Prepare glue for batch 2 (Irreducible clash??)**
  3) Batch 2 (~**12** plates)
- **Post-pot Inspection (35hr)**
- **Post-cure Inspection (30min)**



Transfer tape, application

Target: 30-50 plates/person/1 hr

1) Preparing box (only at Table 1!!)
2) Apply tape with jig (1min/plate)
3) Place tape in press (batches of ~5) (3min)
4) When removing from plate, assign CMS barcode
5) Repeat until complete, back to R011 for shipment processing.