# FPU Verification Process Flowchart

## Key

- Manual step
- Automated step
- Decision
- Write data to database
- Set flag
- Stop
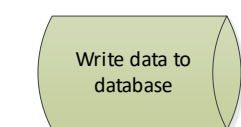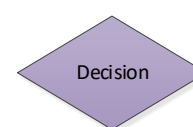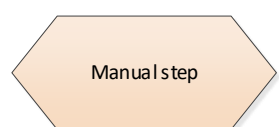
**Test station designations**
- pos_rep = positional repeatability
- met_pos = metrology positional calibration
- met_ht = metrology height calibration
- pup_aln = pupil alignment
- col_det = collision detection

Position 0 (~14° from home)
pos_rep | col_det | X | 5 | 1 | 2 | 3 | 4 | met_pos & met_ht | pup_aln

Position 1 (~44° from home)
pos_rep | col_det | 1 | X | 5 | 2 | 3 | 4 | met_pos & met_ht | pup_aln

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### FPU INSPECTION AND FIBRE INTEGRATION

- Inspection checklist and photographic record
- Unscrew drive PCB
- Pass fibre through chassis feedthrough
- Insert and fix FFA into beta arm
- Fit fibre retainer clip
- Apply black paint to top of beta shaft
- Set CAN address on drive PCB
- Mount to verification rig frame
- Mount frame into verification rig
- Make fibre connections

### PROCESS INITIALISATION

- Assign rig frame positions to FPU serial numbers & positions
- Set options for:
  - datum repeatability
  - positional cal loops
  - positional verification
- Start
- Flash FPU serial numbers
- Initialise position database
- findDatum on all FPUs
- All successful? → Yes / No
  - No → Flag relevant FPUs as datum failed → Stop

### VERIFICATION RIG SETUP

- Home both stages and turn off all lights
- Rotate stage to position 2
- Move linear stage to fibre 1
- Set met_pos camera exposure time to 100 μsec
- Set fibre backlight to 5V
- Grab image (met_pos)
- Analyse image to verify that fibre is backlit (total flux)
- Verified? → Yes / No
- Set fibre backlight to 0V Turn on ambient light
- Set pos_rep camera exposure time to 500k μsec
- Grab image (pos_rep)
- Analyse image to verify that targets are found (check distance between)
- Verified? → Yes / No
  - No → Flag verification rig as faulty → Stop

### COLLISION DETECTION TEST

- Rotate stage to position 1
- executeMotion (0,90) on relevant FPU
- Recover FPU and return to datum. Increment stage to next position
- Did collision detection trigger? → Yes / No
  - No → Flag FPU as col_det failed
- All FPUs tested? → Yes / No
  - Yes → Rotate stage to position 0 → Stop

### LIMIT TEST AND CHARACTERISATION

- executeMotion (360,0) on all FPUs
- Did all FPUs register alpha limit breach? → Yes / No
  - Yes → Flag FPU as alpha limit failed
  - Interrogate position database → Record angle & step count of alpha positive limit
- Return all FPUs to datum
- executeMotion (0,155) on all FPUs
- Did all FPUs register beta limit breach? → Yes / No
  - Yes → Flag FPU as beta limit failed
  - Interrogate position database → Record angle & step count of beta positive limit
- Return all FPUs to datum
- executeMotion (0,-185) on all FPUs
- Did all FPUs register beta limit breach? → Yes / No
  - Yes → Flag FPU as beta limit failed
  - Interrogate position database → Record angle & step count of beta negative limit
- Return all FPUs to datum
- All successful? → Yes / No
  - No → Stop

### DATUM REPEATABILITY (OPTION)

- Option selected? → Yes / No
- Turn on ambient light
- Set pos_rep camera exposure time to 500k μsec
- Grab image (pos_rep)
- 10 images taken? → Yes / No
  - No → Save image as XXXX_datrep_XXX
- findDatum on relevant FPU
- Grab image (pos_rep)
- 10 images taken? → Yes / No
- executeMotion (180,90) on relevant FPU
- reverseMotion on relevant FPU
- findDatum on relevant FPU
- Grab image (pos_rep)
- 10 images taken? → Yes / No
- Analyse images → Record datum repeatability errors
- FPU within specification? → Yes / No
  - No → Flag FPU as out of datum spec
- All FPUs tested? → Yes / No
  - No → Rotate stage to next position

### PUPIL ALIGNMENT TEST

- Turn off ambient light Set fibre backlight to 5V
- Rotate stage to position 4
- Is FPU flagged? → Yes / No
  - Yes → Rotate stage to next position
- executeMotion (0,-135) on relevant FPU
- Grab image (pup_aln) → Save image as XXXX_pup_α_β
- executeMotion (0,90) on relevant FPU
- Grab image (pup_aln)
- FPU beta arm at +135°? → Yes / No
  - No → executeMotion (90,-270) on relevant FPU
- FPU alpha arm at +270°? → Yes / No
  - No
- executeMotion (-270,-135) and findDatum on relevant FPU
- Analyse images → Record pupil alignment errors
- FPU within specification? → Yes / No
  - No → Flag FPU as out of alignment spec
- All FPUs tested? → Yes / No
  - No → Rotate stage to next position Move linear stage to relevant fibre

### METROLOGY CALIBRATION IMAGE

- Turn on ambient light Set fibre backlight to 0V
- Rotate stage to position 2
- Is FPU flagged? → Yes / No
  - Yes → Rotate stage to next position
- Rotate stage to -2 from current position
- Set pos_rep camera exposure time to 500k μsec
- Grab image (met_pos) → Save image as XXXX_met_pos_tar
- Turn off ambient light Set fibre backlight to 0.1V
- Set pos_rep camera exposure time to 100 μsec
- Grab image (met_pos) → Save image as XXXX_met_pos_fib
- Set fibre backlight to 0V Turn on silhouette light
- Set met_ht camera exposure time to 100 μsec
- Grab image (met_ht) → Save image as XXXX_mat_ht
- Analyse images → Record metrology parameters

### POSITIONAL CALIBRATION

- Rotate stage to next position
- Turn on ambient light Turn off silhouette light
- Set pos_rep camera exposure time to 500k μsec
- Grab image (pos_rep) → Save image as XXXX_pos_rep_α_β
- executeMotion (20,0) on relevant FPU
- Grab image (pos_rep)
- FPU alpha arm at +340°? → Yes / No
  - Yes → executeMotion (-340,-170) on relevant FPU
- Grab image (pos_rep)
- executeMotion (0,20) on relevant FPU
- Grab image (pos_rep)
- FPU beta arm at +130°? → Yes / No
  - Yes → executeMotion (0,-130) on relevant FPU
- Positional cal loops condition met? → Yes / No
  - No
- findDatum on relevant FPU
- Analyse images → Record: positional repeatability, motor calibration lookup tables, arm lengths
- Repeatability within spec? → Yes / No
  - No → Flag FPU as out of repeatability spec
- All FPUs tested? → Yes / No
  - No

### POSITIONAL VERIFICATION (OPTION)

- Option selected? → Yes / No
- Rotate stage to position 0
- Is FPU flagged? → Yes / No
  - Yes → Rotate stage to next position
- Grab image (pos_rep) → Save image as XXXX_pos_ver_XXX
- executeMotion (90,0) on relevant FPU
- Grab image (pos_rep)
- FPU alpha arm at +90°? → Yes / No
- Analyse images → Record coordinates of alpha axis
- executeMotion (-90,0) on relevant FPU
- Grab image (pos_rep) → Save image as XXXX_pos_ver_XXX
- executeMotion (0,30) on relevant FPU
- Grab image (pos_rep)
- FPU beta arm at +90°? → Yes / No
- Analyse images → Record coordinates of beta axis at datum
- executeMotion (0,-90), findDatum on relevant FPU
- executeMotion (rand,rand) on relevant FPU
- Grab image (pos_rep) → Save image as XXXX_pos_ver_XXX
- Turn off ambient light Set fibre backlight to 0.1V
- Set met_pos camera exposure time to 100 μsec
- Grab image (pos_rep)
- Turn on ambient light Set fibre backlight to 0V
- Set met_pos camera exposure time to 500k μsec
- 10 images taken? → Yes / No
- Analyse images → Record absolute positional accuracy and residual errors in fibre position prediction from metrology targets
- All FPUs tested? → Yes / No

### (Final)

- Flag all successful FPUs as passed → Stop