**Fire exercise**

**Produce a new Calcam calibration**

1. Save a reference frame from the chosen movie. Frames from large events such as disruptions often illuminate the most vessel structures, giving the best calibration images. Image enhancements such as histogram equalisation generally make features much easier to pick out. A [script in ir\_tools](https://git.ccfe.ac.uk/mast-u-diagnostics/ir_tools/-/blob/dev/ir_tools/calcam_calibration/generate_calcam_calib_images.py#L373) can be used to identify, enhance and save suitable calibration images for a given shot.

I~/air/ir\_tools/calcam/calibration/generate\_calcam\_calib\_images.py

Edit file – at bottom of the file modify

Pulse etc – can also modify n\_start to only look at the last few frames

Due to file wall issues had to modify

~/fire\_user\_dir/fire\_config.json to remove the places it looks for movie files (removed all those starting /net)

>python generate\_calcam\_calib\_images.py

Produces a set of images – figure 1 shows the frames it has chosen to analyse based on max signal

A picture containing graphical user interface

Description automatically generated

The images from each of the selected frames are produced

A picture containing text

Description automatically generated

And stored in ~/calcam2/input\_images/rit/43989/ - there is a summaries directory as well as the best images the \_glob is often best

1. Perform the calcam calibration. If the image contains sufficiently many clearly identifiable points a point pair calibration is preferable, otherwise (as in the case of the MWIR radial views) a manual alignment calibration might be necessary. If a calibration already exists for this view, it can often be useful to load that calibration as a starting point, load your new calibration image and save the resulting calibration under a new filename. Calcam has good [online documentation](https://euratom-software.github.io/calcam/html/gui_intro.html) to follow at this stage. Save the calibration with an informative name indicating the camera, shot number, calibration image and calibration quality (eg RMS pixel fit value).

In ~/air/calcam run calcam

Graphical user interface, text, application

Description automatically generated

Settings can be used to configure where the code looks for cad and image sources as well as the vtk release

Graphical user interface, text, application

Description automatically generated

3d viewer allows you to load in the cad model and look at views

calcam calibration tools (point fitting) is the main option

1. Load in camera image from ~/calcam2/input\_images/rit/43989/rit\_43989\_180\_nuc\_eq\_glob.png

Set image orientation “original”

1. Rotate image clockwise by 90 degrees
2. Machine model: load in jan 2017 variant for MAST-U
3. 3D viewport – select Hl04 or a custom made one – we used rit\_45360\_486\_nuc\_calcam\_enhance-v1\_rms06 from ~/air\_calib/mast\_u/calcam/calibrations
4. Select the points neeede – select point on cad and then on image – ctrl click to move to next point – to select point already moarked click near it – can hit delete to remove
5. Calibration points: can look at point selected – when you have at least 6 points go to
6. Calibration fitting – typical disable K3 but may need to disable k1 and k2 – check residual is <~0.5 pixels – and check the lines fitted
7. Calibration fitting: Fit result inspection sleect show CAD overlay: wireframe
8. Save the new calibration (using disk at top) ~/air\_calib/mast\_u/calcam/calibrations
9. Copy the new calcam calibration .ccc file to a location where FIRE can find it based on the calibration file paths in you fire\_config.json. Typically this should be in the *air\_calib* repository (e.g. air\_calib/mast\_u/calcam/calibrations) so that all calibrations are collected together. While the calibration image is saved in the .ccc calibration file, it is also a good idea to copy the calibration image that you used (e.g. to air\_calib/mast\_u/calcam/input\_images) so that other users can see examples of calibration images or use them for their own calibrations.

**Update the Calcam calibration lookup file**

The Calcam calibration lookup file now needs updating to tell FIRE which shots to use the new calcam calibration. This is achieved by adding a new row to the appropriate file (e.g. air\_calib/mast\_u/calcam\_calibs-mast\_u-rit-defaults.csv). Specify:

1. The stand *and* end (inclusive) shot range numbers for which the calibration should be used. Ensure the shot range doesn’t overlap with that specified in any other rows as this will result in an error when the file is read. By specifying the end shot it is possible to leave shot ranges without a specified calibration file, so that trying to analyse a shot without a valid calibration will raise an error and prompt the user to produce a new calibration.
2. The *name* of the calibration file, including the .ccc extension, but excluding the file path.
3. The name of the the author of the calibration, so they can be contacted for clarification about it.
4. A comment describing the quality and context/reason for the updated calibration.

calcam\_calibs-{machine}-{diag\_tag\_raw}-defaults.csv[¶](http://mast-u_scheduler.gitpages.ccfe.ac.uk/air/usage/exercise.html#calcam-calibs-lookup)

pulse\_start,pulse\_end,calcam\_calibration\_file,author,comments

43123,43647,rit\_43141\_218\_nuc\_eq\_glob-v1.ccc,Tom Farley,Manual alignment calibration from first diverted plasmas

**Define a new analysis path**

The analysis path defines a set of ordered spatial points that are joined to produce an analysis path. Many path definitions can be given in the same path definitions file (see e.g. air\_calib/mast\_u/analysis\_path\_dfns-mast\_u-rit-defaults.json). Following json file formatting conventions each path definition is a top level ‘object’ (i.e. *“name”: {…}*). The ‘name’ is the string used to select the analysis path in the next step. Each path definition is made up of:

1. A list of coordinate points.
2. A description string explaining the purpose/origin of the analysis path.

Each coordinate point on the analysis path should specify:

1. A name for the point e.g. “start”/”end”.
2. The R, z and phi coordinates of the point.
3. The order of the point in the path sequence.
4. Whether to include the next interval between this point and the next in the sequence in the analysis path. Specifying *false* enables obstructions in the view to be skipped so the path jumps to another point in the image.

analysis\_path\_dfns-{machine}-{diag\_tag\_raw}-defaults.json[¶](http://mast-u_scheduler.gitpages.ccfe.ac.uk/air/usage/exercise.html" \l "id1" \o "Permalink to this code)

"MASTU\_S3\_lower\_T2\_radial\_1":

{

"coords":

[

["start", {"R": 0.771, "z": -1.743, "phi": 21.5, "order": 0, "include\_next\_interval": true}],

["end", {"R": 0.903, "z": -1.875, "phi": 21.5, "order": 1, "include\_next\_interval": false}]

],

"description": "Outward radial path down lower divertor tile 2 in sector 3."

},

NOTE: some paths have additional label and label\_long attributes – this is just additional meta data used for plotting etc

Note there are several MASTU\_lower\_T2T3T4T5 radial paths – used to go around the LP cable – radial 3 tries to keep to the same phi relative to the toroidal ripple periodicity

Text

Description automatically generated

In Muo2 when the LP cable is not there then could go from T2\_strt to T3 bot in one go but would need to choose phi appropriately

NOTE: whilst the reconstruction is done in continuously in r the parts are set into labelled segments a segment goes between a true and and false i.e. here we have 8 segments

**Update the analysis path lookup file**

The analysis path lookup file follows the same principals as the calcam calibraiton lookup file discussed above. Add a row to specify the shot range for which the new analysis path should be used, specifying the name given in the path definition file.

Example file: air\_calib/mast\_u/analysis\_paths-mast\_u-rit-defaults.csv

Note this is only a single line so nearest pixel in chosen – Tom did have plans for making multiple lines – multiple analysis paths can be handled by putting a sepate path in analysis\_paths-mast\_u-rit-defaults.csv separated by a semi colon

I think this means (Tom please check)

43615,43647,MASTU\_lower\_T2T3T4T5\_radial\_2;MASTU\_lower\_T2T3T4T5\_radial\_3,Tom Farley,two different radial paths

## Update the camera settings file

This is also a shot lookup file similar to the calcam calibration lookup file.

Example file: air\_calib/mast\_u/camera\_settings-mast\_u-rit.csv

A picture containing table

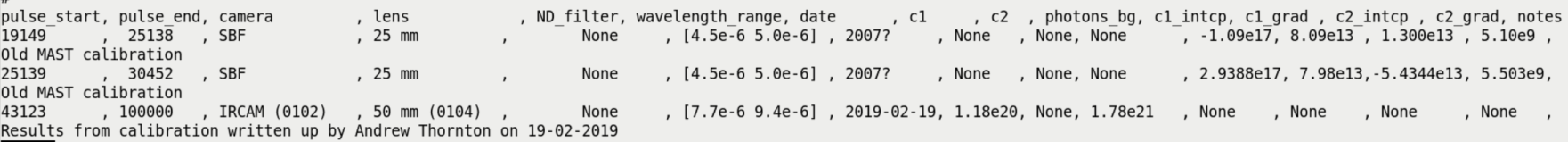
Description automatically generated

## Update the temperature (black body) calibration

This is also a shot lookup file similar to the calcam calibration lookup file.

Example file: air\_calib/mast\_u/temperature\_coefs-mast\_u-rit.csv

I haven’t looked at this maybe we should discuss



## Update the material properties (THEORDOR) input file

This file specifies the parameters used by THEODOR including the alpha parameter.

Example file: air\_calib/mast\_u/material\_props-mast\_u-defaults.json

Text

Description automatically generated

## Produce an analysed UDA netcdf file

A scheduler run can be initiated with:

$ python air/fire/scripts/run\_fire.py <camera\_tag> <shot\_number> -p <pass\_number> -a <alpha\_param>

In the call to scheduler\_workflow() you can specify alpha\_user which will override the alpha parameter value specified in the material properties file.