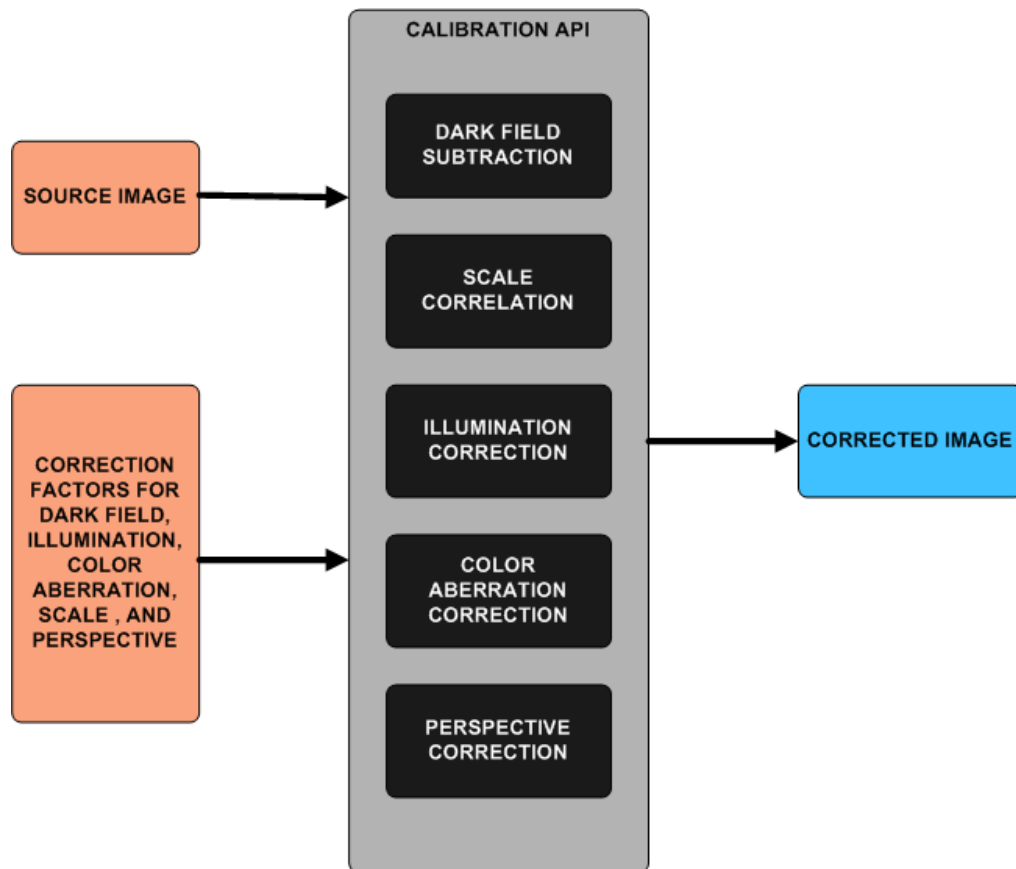# Calibrate and Measure Extensions to Foil

Calibrate

This software suite can be used to calibrate the camera field and measure objects in the camera field of view. The calibrate section lists the routines used to calibrate the camera image as downloaded from the framegrabber. The measure section allows the user to measure the objects in these images.

CALIBRATION API

SOURCE IMAGE →	**DARK FIELD SUBTRACTION**
	SCALE CORRELATION
	ILLUMINATION CORRECTION → **CORRECTED IMAGE**
CORRECTION FACTORS FOR DARK FIELD, ILLUMINATION, COLOR ABERRATION, SCALE, AND PERSPECTIVE →	**COLOR ABERRATION CORRECTION**
	PERSPECTIVE CORRECTION

Calibrate and Measure

Calibration Standard

Ideally a calibration standard is provided, such as an array of dots, which span the whole view of the camera. This allows the calculation of scale and variations in scale across the field of view. Three corrections are typically performed,
- Perspective correction
- Color Aberration correction, and
- Scale Correction

Coordinate Systems

- Raw Image Coordinates : (ix,iy) the coordinates of each pixel in the image. The coordinate system origin is the upper left hand corner of the image, x extends to the right, y extends down.
- Corrected Image Coordinates : (cx,cy) these are the coordinates of each pixel in the corrected image, after Perspective, color aberration, and scale correction. The origin is the center of the image, with x extending to the right, and y extending up.
- Object Coordinates : Object coordinates are used to place measurement tools and report measurements. Object coordinates are reached by and affine transformation from corrected image coordinates.
- Orientation Tools : An initial step in measuring an image is to determine the orientation of the object in the field of view. Locate some prominent features of the object and setting the origin and angle of the world coordinate system to match the orientation of the object to be measured to do this.
- Bounding Box: One method of locating the object is to compute its minimum area bounding box. This algorithm finds the smallest box that can contain the image of the object. The software can then use the long side of the box orient system.
- Find Hole : Sometimes the bounding box is not enough, for example when the part is square, locating a hole can often remove the ambiguity.
- Find Line : Finding a line of the required length can also be used to orient the object.
- Find Corner : Place the intersections of lines in the object. Select a corner pair as the base of the object.

Measure

Image Alignment Tools: After the orientation of the part is determined, an affine transformation is defined which moves the part into the 'standard position and orientation for measurement. This typically requires, rotation, mirroring, and translation of the part. This step sets orientation of the transformation of corrected -image coordinates to object coordinates. The image is not actually transformed; the measurement tools are transformed to align with the image. This reduces the errors in measuring the object.

Photometric Tools

- Color Measurement
- Intensity/Density Measurement

Spatial Metric Tools

Once a point set is determined by a measurement tool, that point set can be measured in several ways.
- **Linear dimensions:** Vertical, Horizontal, Oblique
- **Circular Dimensions:** Diameter, Radius, Center
- **Angular Dimensions:** Between Lines, Circular Arc