



Alignment of articulated arms

The **AlignMeter** can serve as an accurate and simple device for the alignment routine of robotic arms or articulated arms.

The instrument can measure both the positional and angular beam runout of the articulated arms used as part of the laser beam delivery system on several of medical laser products.

A typical articulated beam delivery arm comprises of a series of hollow tubes connected to rotational mirror knuckles. The beam travels through the tubes and is directed by the reflected mirrors along the tube axis. Connecting several knuckles and tubes allow multiple degrees of freedom, which is built by rotating each tube in respect to each other. This multiple degrees of freedom articulated arm can deliver the beam to a working volume by hand moving the end tip of the arm. Building a roboting beam delivery arm is a very challenging task due to the alignment problems of the rotating mirrors in the knuckles.

The design process of the **AlignMeter** was specifically targeted to solve these problems, and allow fast and accurate alignment. The alignment process is based on the alignment of each knuckle from the first (closest one to the laser) to the last, and is performed by replacing the downstream mirrors with the **AlignMeter** system to align the non-replaced mirrors.

Solution 1 - Static:

A calibrated **AlignMeter** assembly can be easily mounted on a robotic arm, by using the adapting nut. If the mechanical datum is accurately aligned relative to the optical axis of the robotic arm, then the **AlignMeter** will provide the centration deviation and angular deviation instantaneously.

Solution 2 - Dynamic:

In case the mechanical datum is not accurate enough for the application you can mount the **AlignMeter** at the elbow as in the previous case and then perform the usual rotation of the arm. The beam deviation will be recorded by the AlignMeter as a circle. The user must then align the previous elbow so that the "circle" will only be one point.

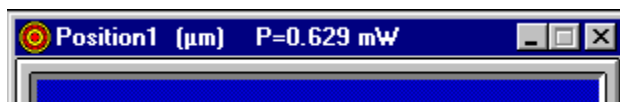


Calibrating the AlignMeter:

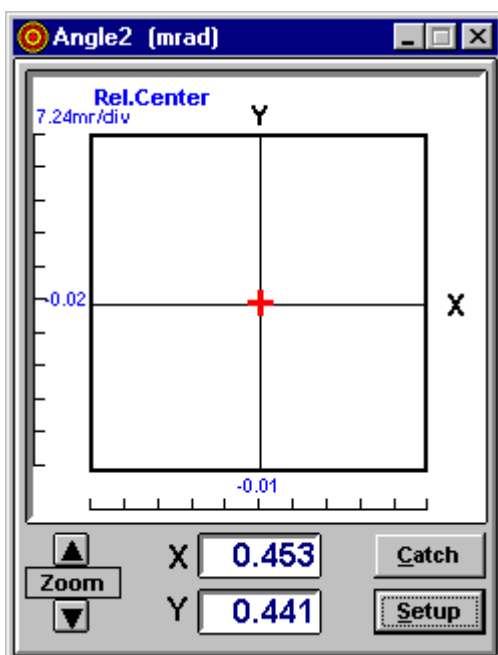
For calibrating purposes the software enables defining a reference point as the new “zero” of the **AlignMeter**; This function is called “Catch” and when operated will cause the system to declare this center as “Zero”. This new center will be displayed as center of alignment and all other systems can be aligned to it using the previous methods.

Instructions: Alignment of Robotics arms

- Attach the AlignMeter head to the robotic arm using the adapter nut.
- Check that the laser beam is aligned in a way it strikes both detectors, approximately at the center.
- It is important to check the Power readings during the alignment and centering routine. Sometimes, even though the laser is not centered, the detector will still show the cross at the center of the target display because of ambient light readings.
- It is recommended to activate option **PowerScr** via **Position Setup / Angle Setup** screens in order to view power readings at the Title Bar of the Position / Angle windows, without the need to open the power measuring windows of these detectors (more room on the screen, slow response, etc.)

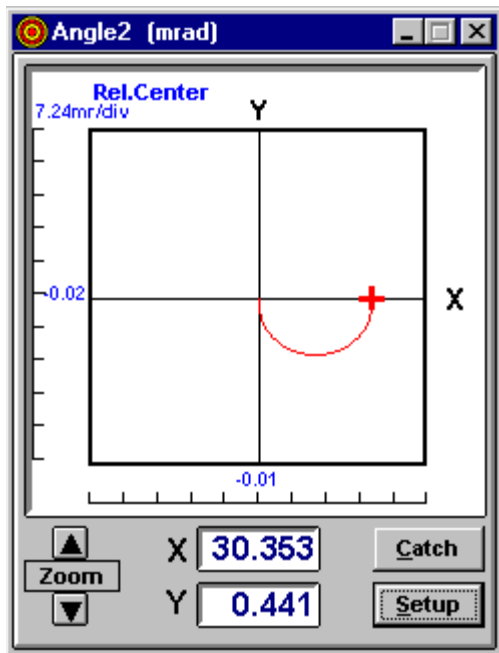


- After assuring that your system is properly mounted and the beam is centered, the next step would be to use the **Relative Center** function by pressing the **Catch** button on either the Position / Angle screens (button located at the window panel, but one should firstly activate the Relative Center measuring On via Position Setup / Angle Setup screens).

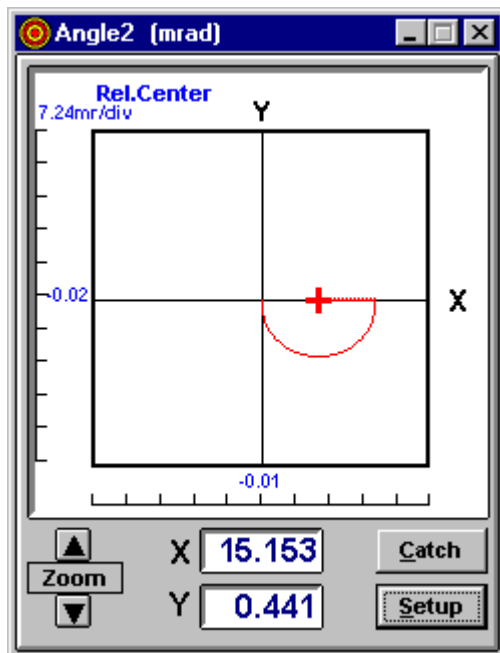


- Activate option **Trace On** via **Position Setup / Angle Setup** functions in order to leave a trace on screen of beam wondering during the alignment routine.

- Rotate the knuckle you are aligning by making a movement of 180° with the arm knuckle, to observe the following display on screen:



- By using the alignment knobs located on the knuckle mirror bring the beam to the center point between the two end points of the arm movement.
- Press **Catch** button again
- Repeat the process until the rotation of the knuckle will not generate any movement of the laser beam center on the target (the graphical presentation on screen would be a cross at the center of the Relative center).



When done with the alignment of this knuckle, continue with the alignment of the next knuckle - attach the AlignMeter head to this new knuckle and repeat the same routine until the whole robotics arm is aligned.

When you are close to complete alignment - it is recommended to use the **Zoom** function in **Position Setup / Angle Setup** in order to complete the alignment. By using the Zoom-In operation you can increase the graphics resolution. One can get down to 0.02 milliradians/ division using the Angle Zoom function, which is a real nice resolution.