PHYSICS PLATFORM USER MANUAL

1315 Century Drive
Suite 150
Louisville, Colorado
303-440-1284

sales@infleqtion.com
www.infleqtion.com

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1. General Information

1.1 User Facilities Requirements

Ensure your lab or experimental setup has ample room to work around the platform for installation and laser safety. Always follow your institutional guidelines concerning a safe work environment.

1.2 Package Contents

The Physics Platform (CP1XXX) is an optical and optomechanical system consisting of two stages:

- CP2XXX – The *2D+ MOT Stage* holds the optics for producing a two-dimensional (2D) magneto-optical trap (MOT) in the lower chamber of a doubleMOT or RuBECi vacuum system. This stage includes the launch optics for the push beam that creates a 2D+ MOT.
- CP3XXX – The *Six-Beam MOT Stage* holds the optics for creating a six-beam three-dimensional (3D) MOT in the upper chamber of a doubleMOT or RuBECi. It also includes optics for optical pumping of cold and ultracold atoms.
- CP1XXX – The combination of both the CP2XXX and the CP3XXX.

See below configuration table for available options:

Rubidium (780 nm)	Cesium (852 nm)
CP1780	CP1852
CP2780	CP2852
CP3780	CP3852

Upon receiving the physics platform, inspect the packaging for damage. If the packaging shows signs of damage, excessive shock or if the shock watch is red, notify the shipping company and then contact Infleqtion.

Infleqtion strongly recommends **two people unpack the physics platform due to the dimensions and weight**. Be particularly careful to avoid dropping it or knocking it against anything, as this may damage the optics.

Keep all original packing materials. Carefully remove the platform and inspect for any damage. Please contact Infleqtion if there are signs of damage.

If any of these items are missing, please contact Infleqtion to obtain replacements.

2. Safety

2.1 Definitions, Labels and Symbols

	Caution! – Risk of electric shock
	Caution! – Risk of damage to equipment

2.2 Warnings

WEIGHT – The 3D MOT physics platform is heavy. Always use two people to lift and carry the physics platform to avoid damage to other equipment and injury to the user.

PINCH POINTS – Both the 2D and 3D MOT platforms have many optics and optomechanical parts. Take care when adjusting any of the mirrors, lenses, or other optomechanical parts not to

2.3 Physical Safety

The physics platform is heavy. Handle with care as to not cause damage to the delicate optomechanical parts.

2.4 Electrical Safety

When placing the 3D MOT platform around the doubleMOT (Section 5.3) be mindful of the ion pump and other electronics associated with the doubleMOT.

2.5 Laser Safety

Disclaimer	This is not a laser product. This is for reference only. Please refer to the manufacturer manual and safety information for each laser system that you will use with this product. Please follow your institutional guidelines concerning laser safety.
DANGER!	If the equipment is used in a manner not specified by the manufacturer, then the protection provided by the equipment may be impaired.

This product contains specular surfaces, including lenses, beam splitters and mirrors. It is intended to be used with laser power, and reflections of the laser may occur. Laser safety glasses should be worn when using this product with a laser. Please follow your institutional guidelines concerning laser safety.

3. Specifications

PRODUCT SPECIFICATIONS	
Dimensions	61 cm x 61 cm x 35 cm 24 in x 24 in x 14 in
Wavelength Options	780 nm or 852 nm
Imaging	Absorption Imaging System (implemented by customer)
Optical Inputs	3x FC/APC fiber optic inputs (CP3XXX) 1x FC/APC fiber optic inputs (CP2XXX)

RECOMMENDED LASER SPECIFICATIONS – for optimal MOT creation				
Beam	2D MOT	3D MOT	Pumping	Imaging
Power (mW)	30-70	30-50, Repump 3-6	<1	<1
Beam Dimensions ($1/e^2$)	15 x 22.5 mm	15.8 mm	7.5 mm	11 mm

4. Regular Product Maintenance

4.1 Handling

Take care when handling the physics platform, as the fragile optics can easily be cracked or chipped.

If the physics platform needs to be moved, Infleqtion recommends two people move it. Only lift the platform as high as is necessary, and be careful of clearance with the bottom optics. Always place the physics platform on a level surface.

4.2 Cleaning

Infleqtion recommends cleaning the optics in a typical optics manner.

- Appropriate cleaners include IPA, methanol, acetone, or deionized water.
- Use a fresh section of wipe each time to avoid glass chips dragging across the coated surface.

5. Installation

5.1 2D MOT Stage Setup

The physics platform comes pre-assembled and ready for use with the doubleMOT. The 2D+ MOT stage shown in Figure 1 mounts directly to the surface of an optical table with four 1/4-20 socket head cap screws. If the system is being used with a metric table, only one of the screw locations will be usable, and it will be necessary to affix the 2D+ MOT stage with clamps. As with all optical inputs on the Physics Platform, the 2D+ MOT stage accepts a single-mode polarization-maintaining fiber with an FC/APC connector. The laser system must provide both cooling and repumping light through the input fiber. For typical 2D+ MOT operation, the experimenter should supply 50 to 80 mW of cooling light (at a detuning of -2.5Γ, where $\Gamma = 2\pi \times 6$ MHz is the natural linewidth of the D2 transition at 780 nm) and 5 to 10 mW of repumping light.

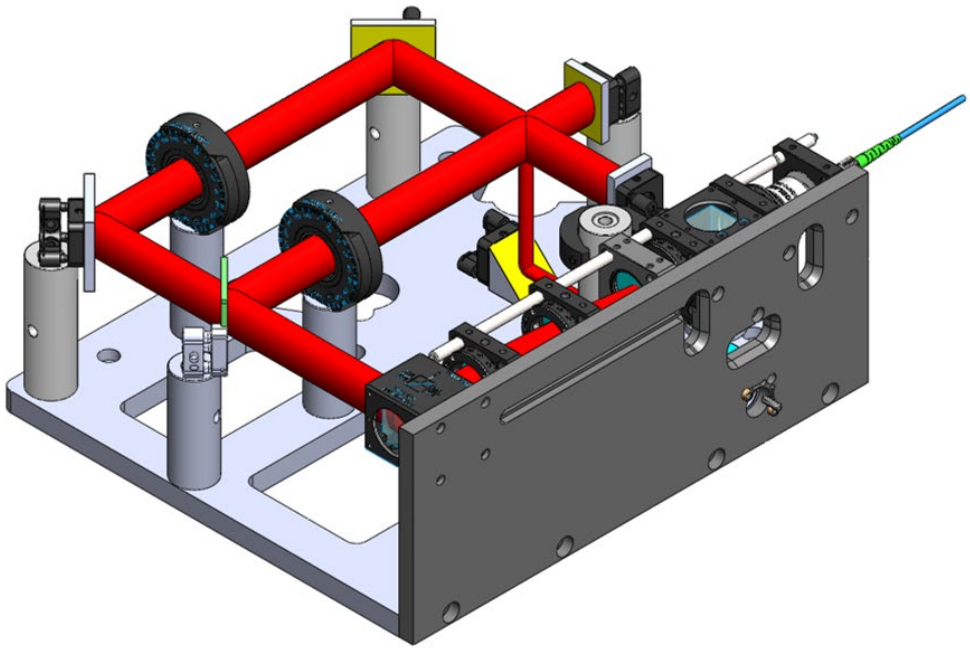


Figure 1: Model of the 2D MOT optics of the physics platform, shown with the beam path (red).

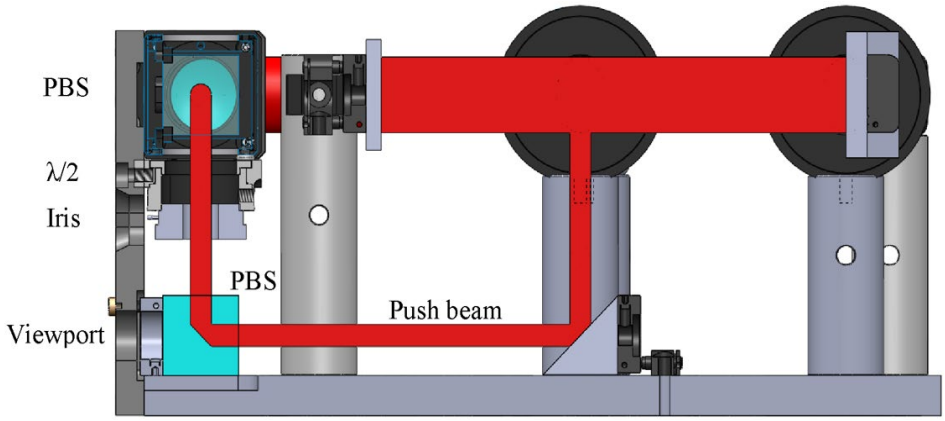


Figure 2: Side view of the 2D+ MOT stage showing the push beam optics.

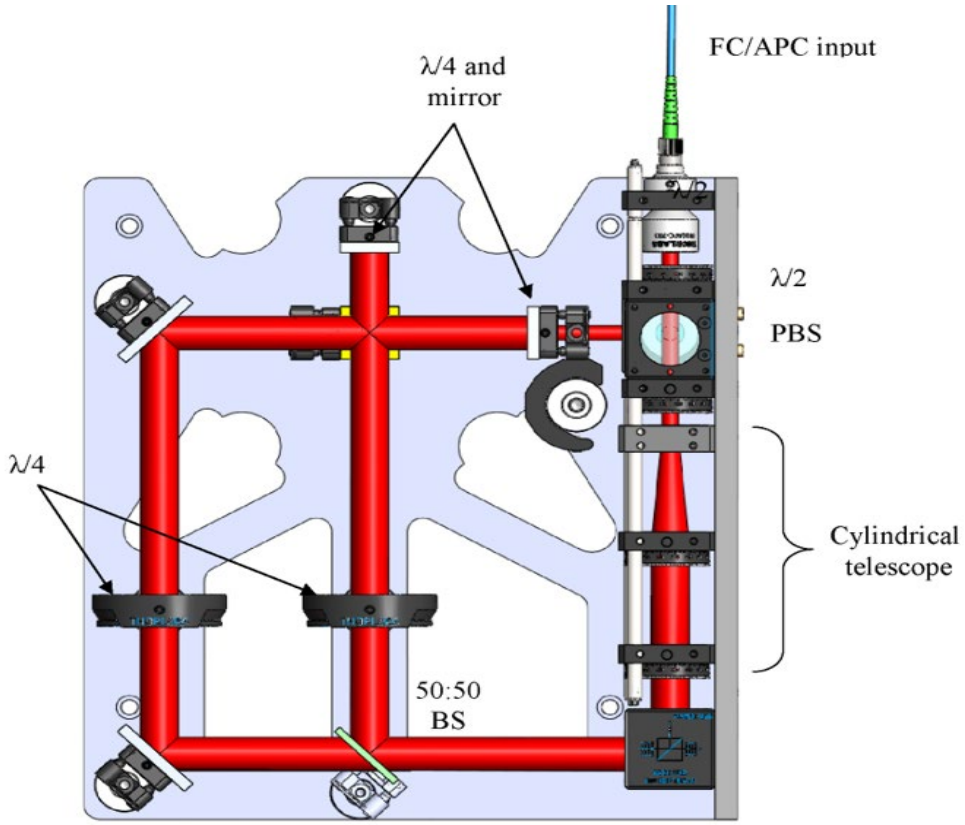


Figure 3. Top view of the 2D+ MOT stage with beam paths.

5.2 Mounting the doubleMOT or RuBECi

The RuBECi and doubleMOT come supplied on a mount that interfaces with the 2D+ MOT stage, as shown in Figures 5 and 6. It is recommended to pre-align and demonstrate a 2D MOT at this point in the assembly, as it will simplify alignment of the 3D MOT. The 2D+ MOT stage features cut-outs for clamps to secure the vacuum system to the optical table.

It is recommended to position the doubleMOT or RuBECi as shown below, with the ion pump opposite the periscope plate. This will make the connection to the ion pump easier and mitigate any laser path issues.

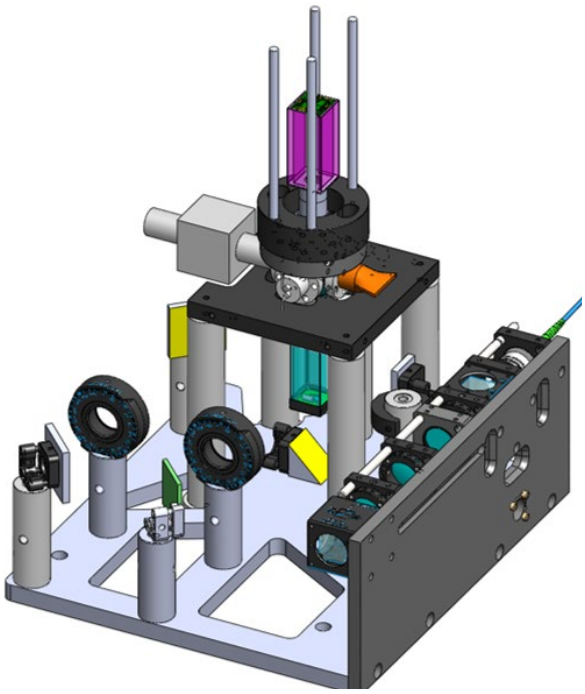


Figure 5. RuBECi or doubleMOT mounted in the 2D+ MOT stage.

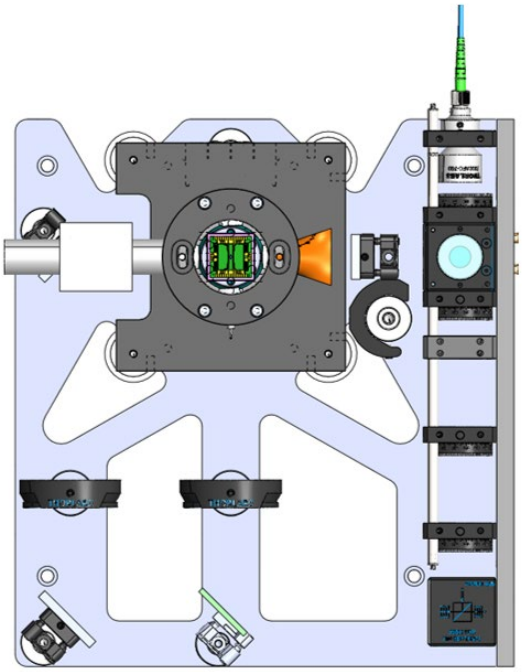


Figure 6. Top view of the RuBECi or doubleMOT in the 2D+ MOT stage.

5.3 3D MOT Stage Setup

The six-beam MOT stage is an optical table that enables the user to build an experiment around the RuBECi or doubleMOT vacuum system. A top-view of the stage without the RuBECi is shown in Figure 7. These holes can be used for mounting user-supplied optics and hardware, such as imaging systems. Both FC/APC inputs for the 3D MOT are located on the underside of the physics platform. The FC/APC input for the imaging beam is under the platform as well; this is an optional setup depending on your specific experimental.

- **Locate the fiber collimation assemblies for the 3D MOT in Figure 7 below**.
    - As with the 2D+ MOT, cooling and repumping light must be delivered via the same single-mode polarization-maintaining fiber. For typical 3D MOT operation, the laser system should supply 30 to 50 mW of cooling light and 3 to 6 mW of repumping light.

- **Carefully lift and place the 3D MOT stage over the doubleMOT or RuBECi.**
    - Infleqtion advises two people lift and place the 3D MOT stage to complete this step.
    - Determine placement and rotate the 3D MOT stage away from the doubleMOT or RuBECi and 2D MOT (if applicable).

- Carefully align the doubleMOT or RuBECi with the opening in the 3D MOT stage, and carefully lower the stage around the vacuum unit.
- Secure the feet with clamps and fasteners.
- While the orientation of the platform will not impact MOT production, be mindful of where the FC/APC inputs are for your specific lab setup or experiment.

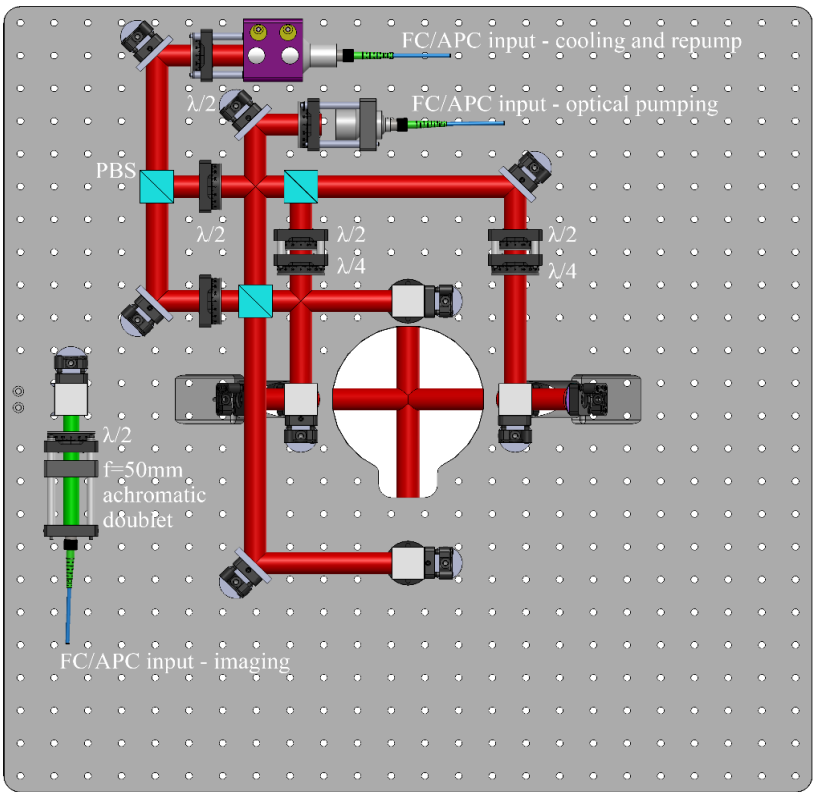


Figure 7: Bottom view of the six-beam MOT stage.

6. Operation

6.1 Normal Operation

Once positioned, it is easy to optimize the beams on both the 2D and 3D MOT platform. See Figure 8 for an overview of the 3D MOT beams, including the imaging beam. The physics platform has been designed to allow the user to customize the 3D MOT stage to their specific experimental needs, thus there is plenty of room to add additional optomechanical parts to the setup.

To move the position of the MOT relative to the science cell, the entire Physics Platform assembly can be raised vertically by inserting spacers between the platform tabletop and the platform legs. The quarter waveplates for the horizontal MOT beams are integrated into the tabletop and are shown in the cross-sectional view in Figure 9. Note that the quarter waveplates

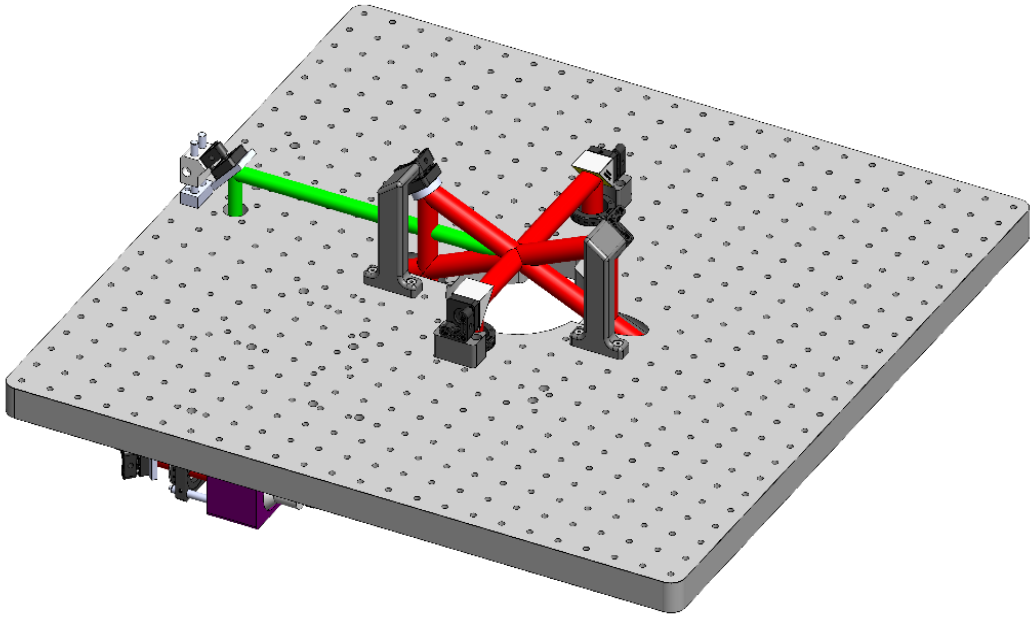


Figure 8: View of the six-beam MOT stage showing the six MOT beams (red) and absorption imaging beam (green).

(QWs) for those beams are integrated into the table directly below the steering mirror.

Shown in the cross-sectional view in Figure 10, the angled beams are each aligned through the cell with a pair of mirrors to allow for exact alignment of the two beams relative to the horizontal beam. These two beams are designed to be 22° above the stage, which allows for the MOT to be closer to the atom chip in the RuBECi. The polarization of each of these two beams is set with a half-waveplate (HW) and a quarter-waveplate (QW), as shown in Figure 10.

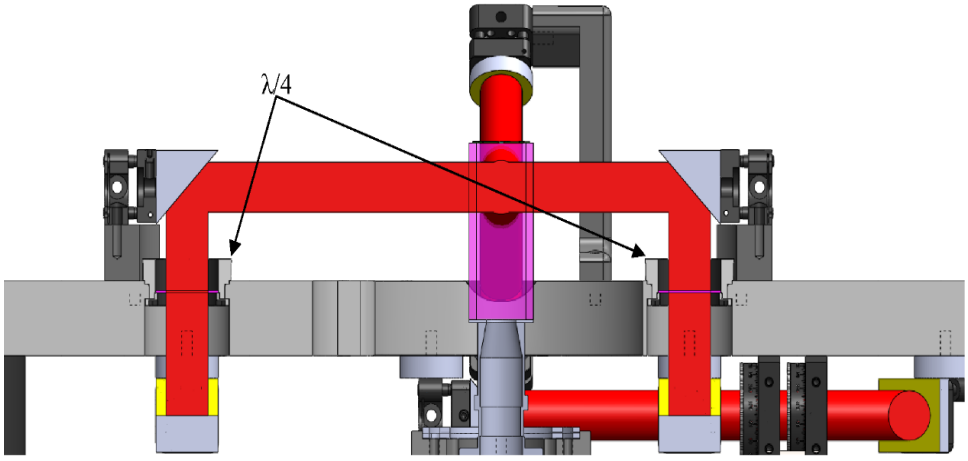


Figure 9: Cross-sectional view of the six-beam MOT stage showing the

The angled beams are retroreflected with a first-surface mirror to which a quarter-waveplate has been affixed to create a single optic. The Physics Platform is configured with these mirrors directly retro-reflecting the incident laser beams back onto themselves. This is not necessarily the ideal alignment and must be adjusted during optimization.

Figure 11 shows a detailed view of the absorption imaging system. The two-mirror system acts as a periscope to bring the imaging beam to the top level of the breadboard. The beam height can be adjusted by loosening the shaft clamp on the side of the beam elevator (shown as yellow in the figure). The imaging launching optics are provided with a f=50 mm achromatic doublet lens for collimating the beam out of the fiber, but the system is designed so that lens can be replaced to achieve different beam sizes. Replacement of this lens may require realignment of the beams, which is the sole responsibility of the end user. If the user moves or removes any optics on the physics platform, they do so at their own risk, and it will void the Infleqtion warranty.

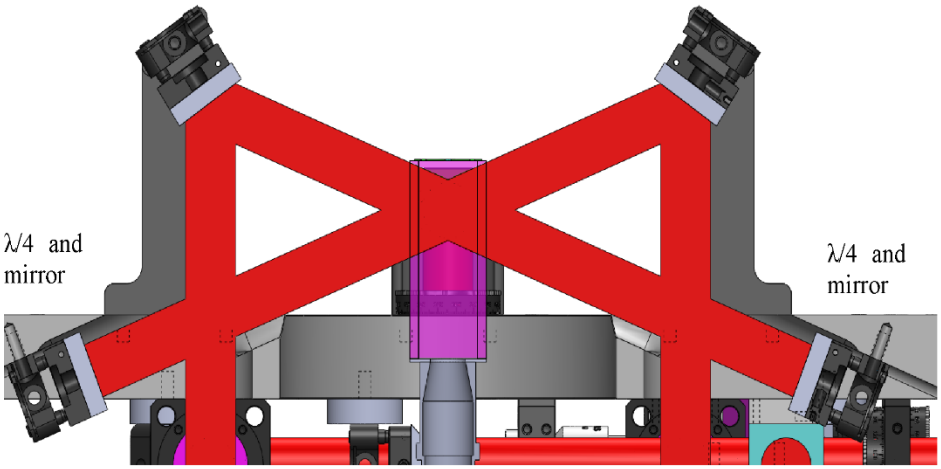


Figure 10: Cross-sectional view of the six-beam MOT stage showing the angled beam path.

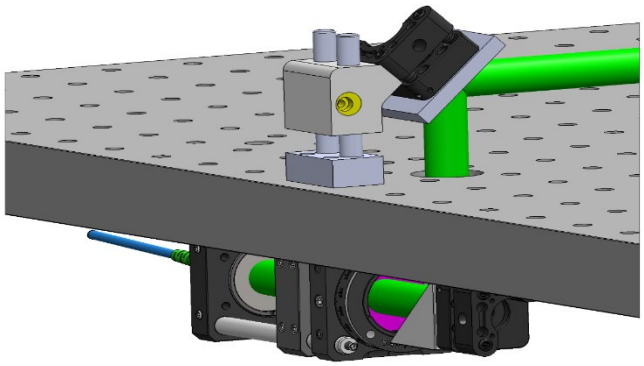


Figure 11: Detailed view of the imaging launching optics.

7. Troubleshooting

Problem	Solution
Beam not travelling in the correct direction	• Angle of the optic could be incorrect. Check each optic to ensure AR coated parts are facing the correct direction based on the beam diagrams (Section 9) • Check beam path for any misaligned pieces that may have moved during shipment. • Call Infleqtion.
Polarization not as expected	• Examine the periscope plate for inconsistencies during manufacture, and call Infleqtion if noted. • Check beam path for any misaligned pieces that may have moved during shipment, including any part that is backwards. • Call Infleqtion.
Power losses	• Ensure fiber optic is collimated into input and subsequent beam path is as expected. • Examine the periscope plate for inconsistencies during manufacture, and call Infleqtion if noted.
Unwanted back reflections occurring	• Examine the periscope plate for inconsistencies during manufacture, and call Infleqtion if noted.

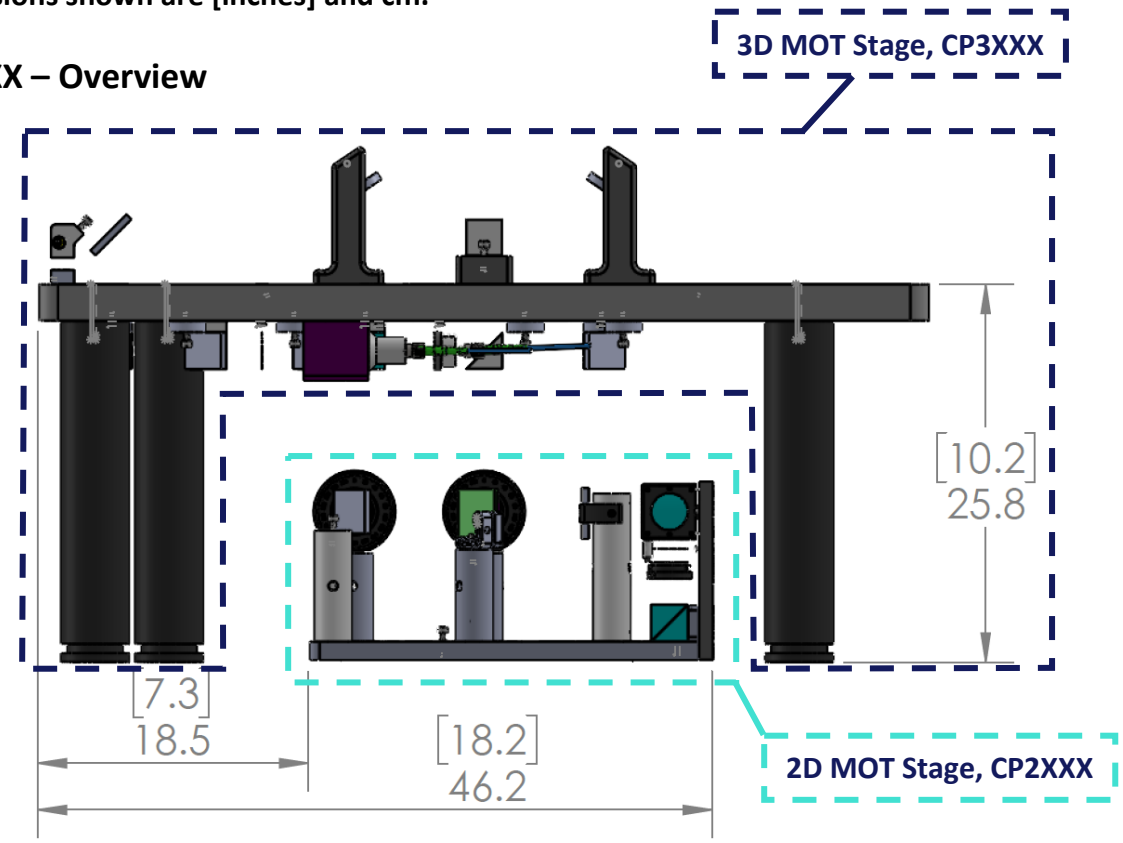
8. Warranty

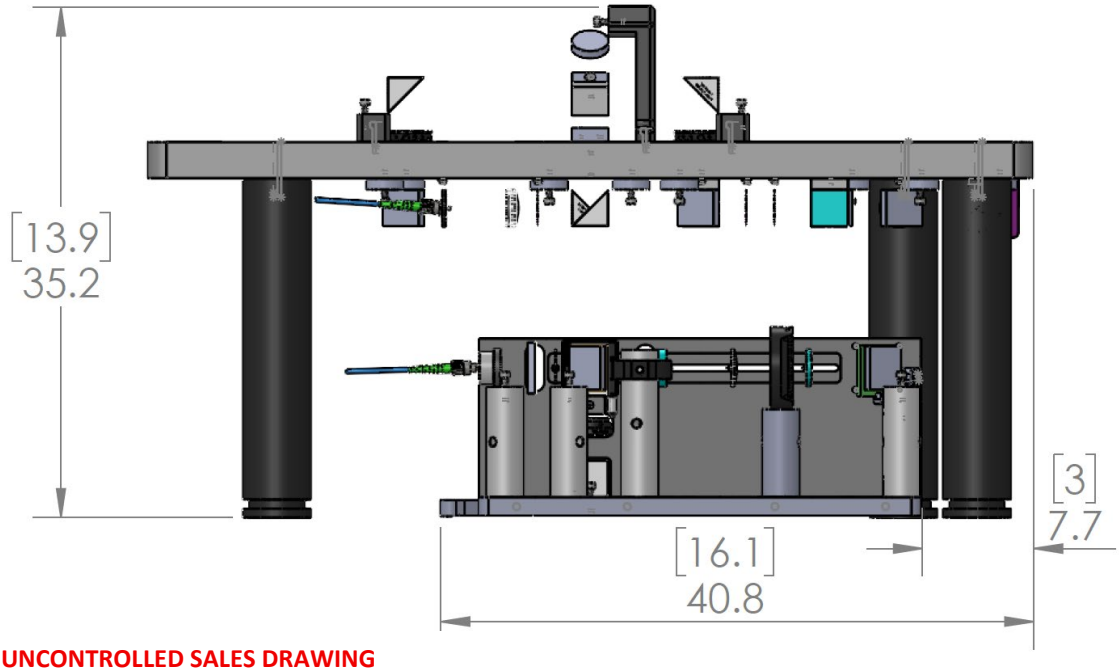
Infleqtion's Terms and Conditions, including the warranty, can be found at: https://infleqtion.com/terms

9. Technical Drawings and Dimensions

Dimensions shown are [inches] and cm.

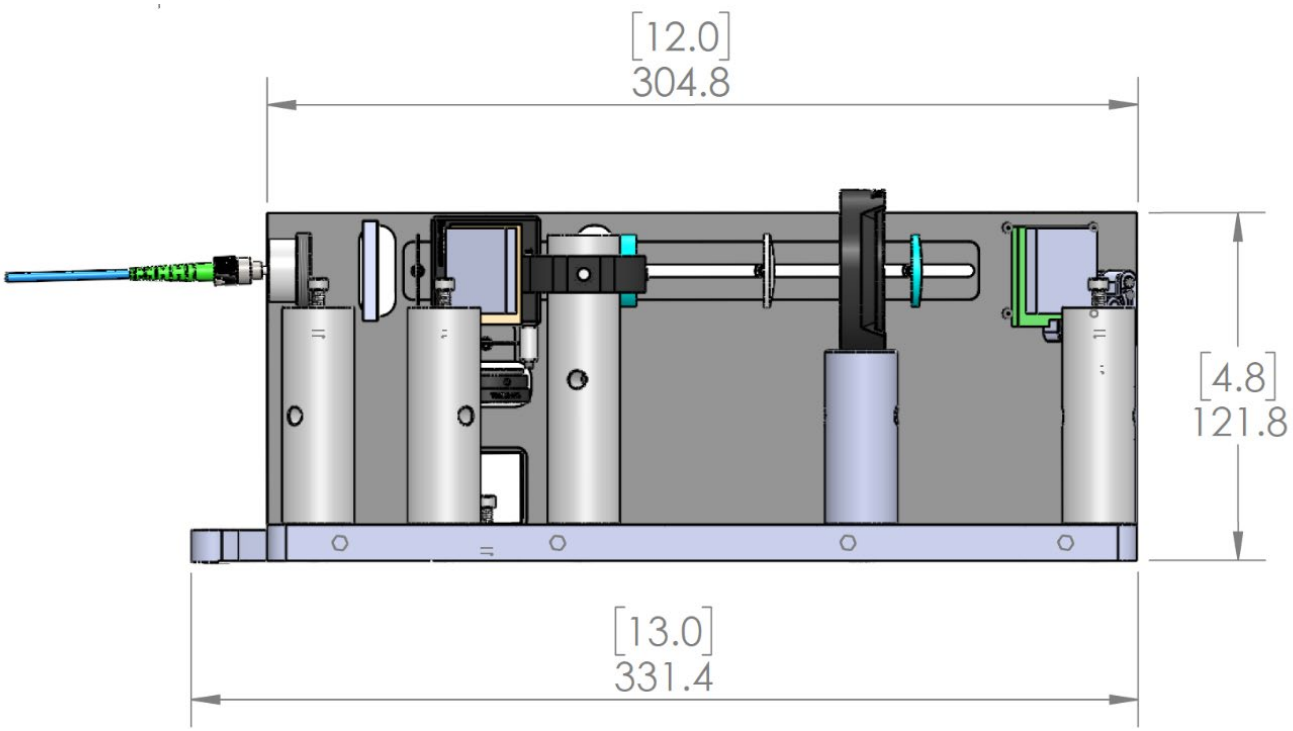
CP1XXX – Overview

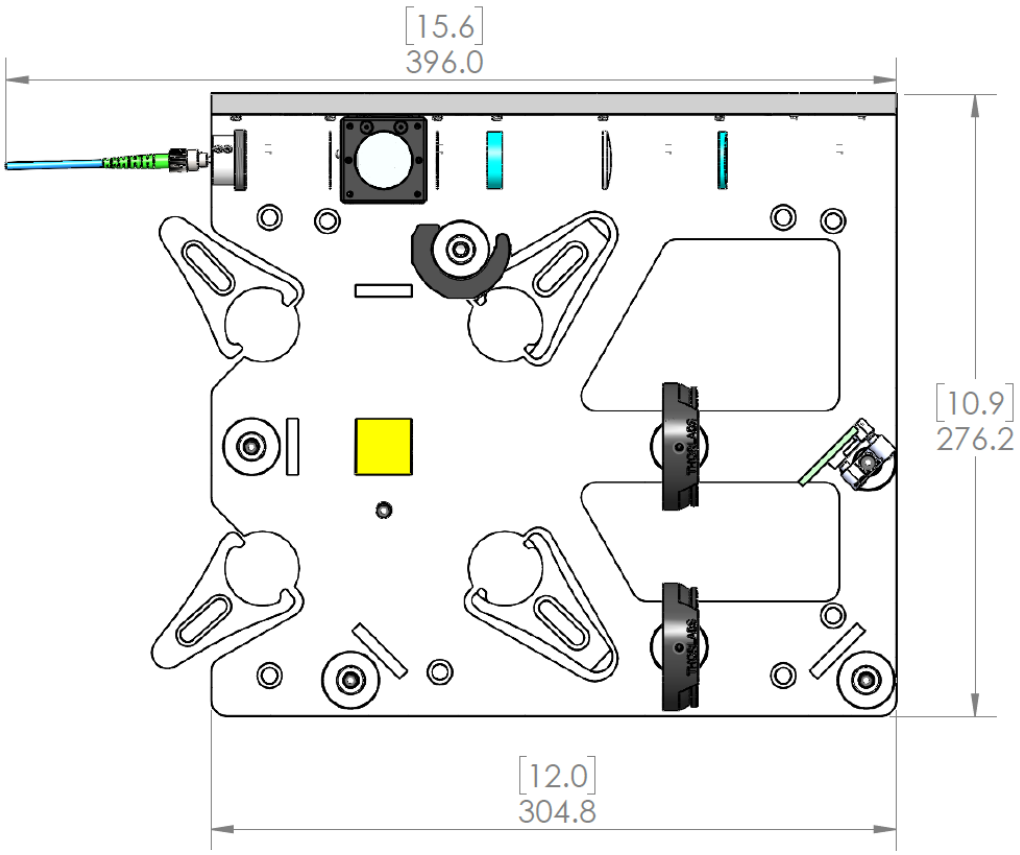




UNCONTROLLED SALES DRAWING

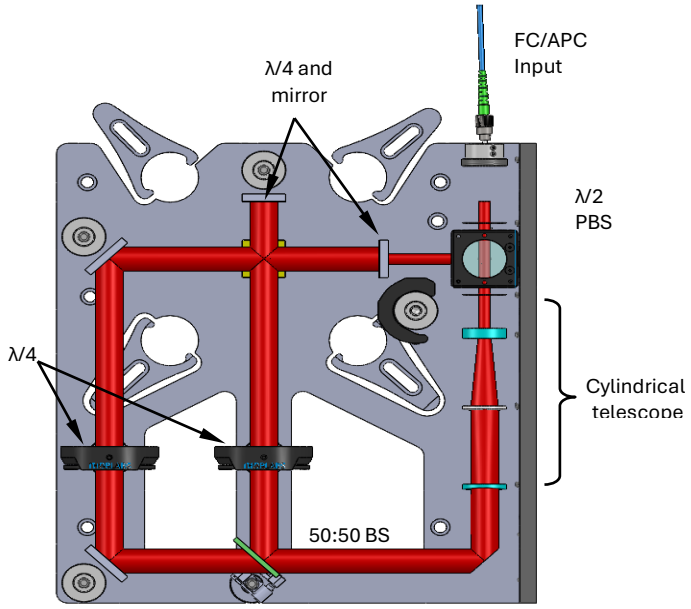
2D MOT Optics (CP2XXX)



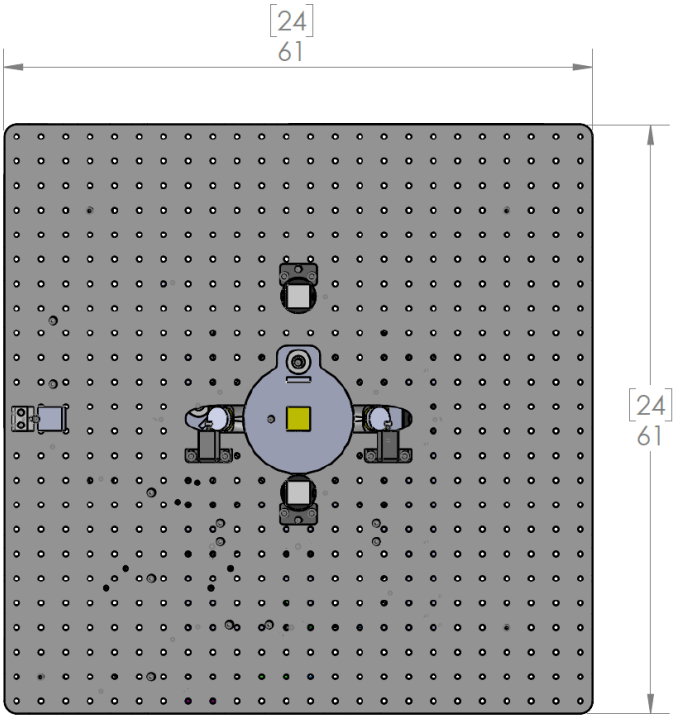


UNCONTROLLED SALES DRAWING

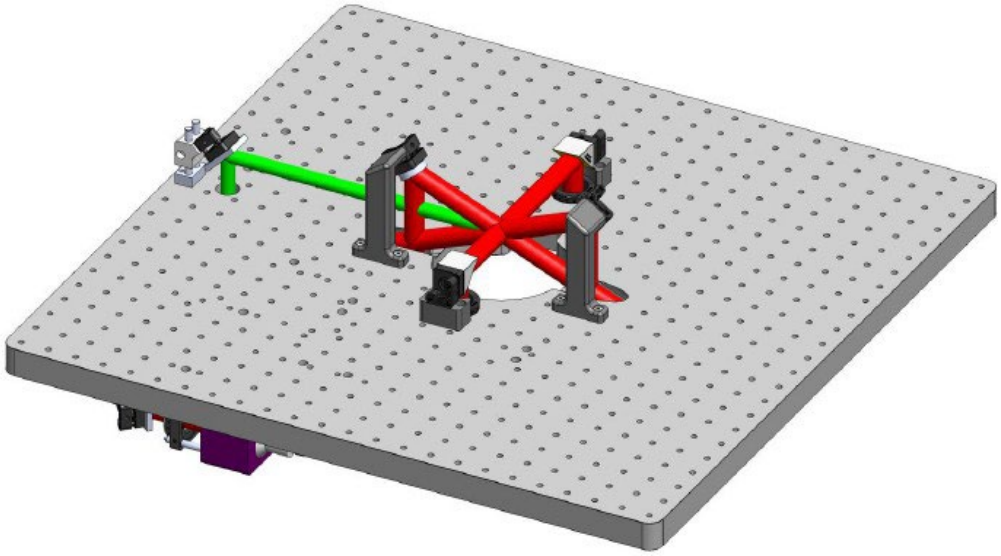
2D(+) MOT Beam Path

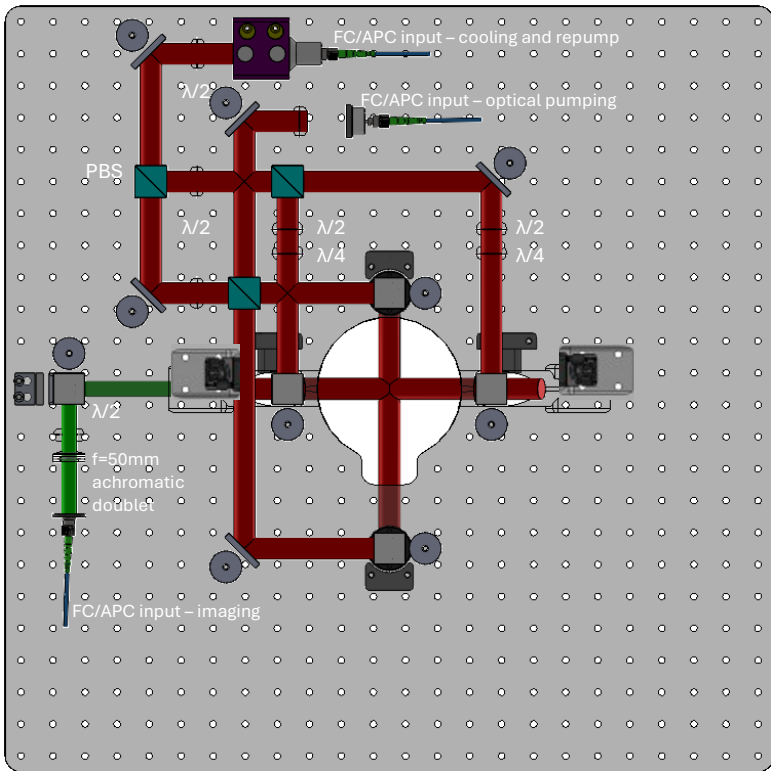


3D MOT Optics (CP3XXX, under stage)



3D MOT Beam Path
Red shows MOT beams, Green shows imaging beam (user provided)





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REVISION CONTROL

When any part of this procedure requires amendment, the document shall be re-issued in its entirety; requests for change shall be addressed to the document owner.

Revision	Date	Change Description	ECO	Originator(s)
Previous	April 2014	Document Creation		D. Anderson
1.0	September 2025	• New format and new Infleqtion branding • Technical drawings updated • Drawings rearranged to distinguish CP1, CP2 and CP3 • More emphasis on direction of use of product	S1025	C. Ward C. Williams