# Almax Plate DAC Gas Loader (GL) Transmission Kit: A novel system to load compressed gases in a PlateDAC

## GL Transmission Kit description

Almax easyLab developed in collaboration with Top Industrie and Dr. Andreas Zerr from the University Paris 13 (Villetaneuse, Paris, France), this Gas Loader Kit specifically tailored to the purpose of loading the PlateDAC with compressed gas. Due to its original design, PlateDAC makes it particularly suitable for LHDAC use (Laser Heating DAC) if one can load an inert gas as a PTM (Pressure Transmitting Medium).

Recently, Top Industrie (France), developed a self-contained 3000 bar gas compressor loading device suitable for DACs. Our Transmission Kit enables the PlateDAC to be used in conjunction with this device allowing to load Helium compressed to 3000 bar as well as of other inert gases such as argon or nitrogen.

The principle is for the gas to achieve density comparable to that of a liquid, which, in turn, requires pressures to be in the kilobar (100MPa) range. The gas loader developed by the Top Industrie enables loading pressure of up to 3000 bar (300MPa) giving the major benefit that the hole in the gasket not to shrink significantly during loading, thus protecting the sample integrity. This Transmission Kit allows the user to close and trap the compressed gas between the two diamond anvils and the hole in the gasket. The picture of the Transmission Kit alongside a PlateDAC is shown in Fig. 1.

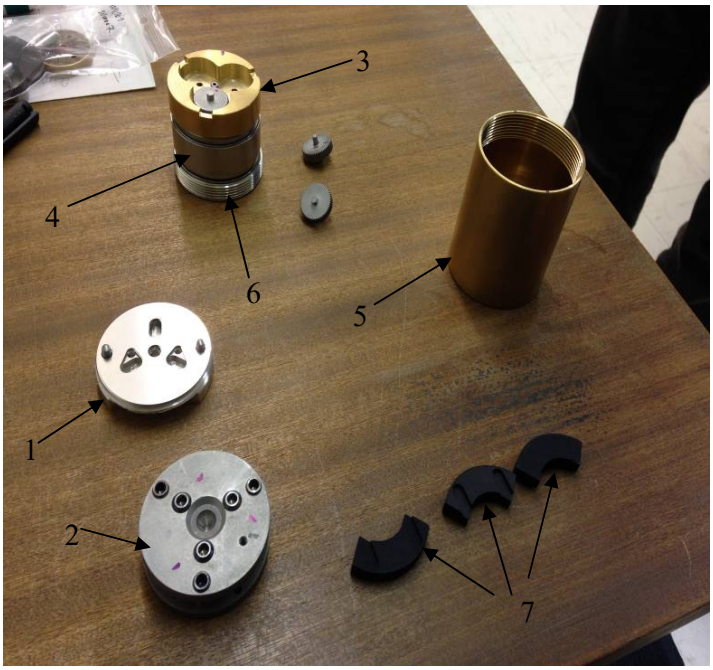


Figure 1: Almax easyLab GL Transmission Kit and PlateDAC. 1—Anti-rotation baseplate; 2—PlateDAC; 3—Gear holder; 4—Gear driving spindle; 5—Outer shell; 6—Gearbox lid; 7—Space reducers.

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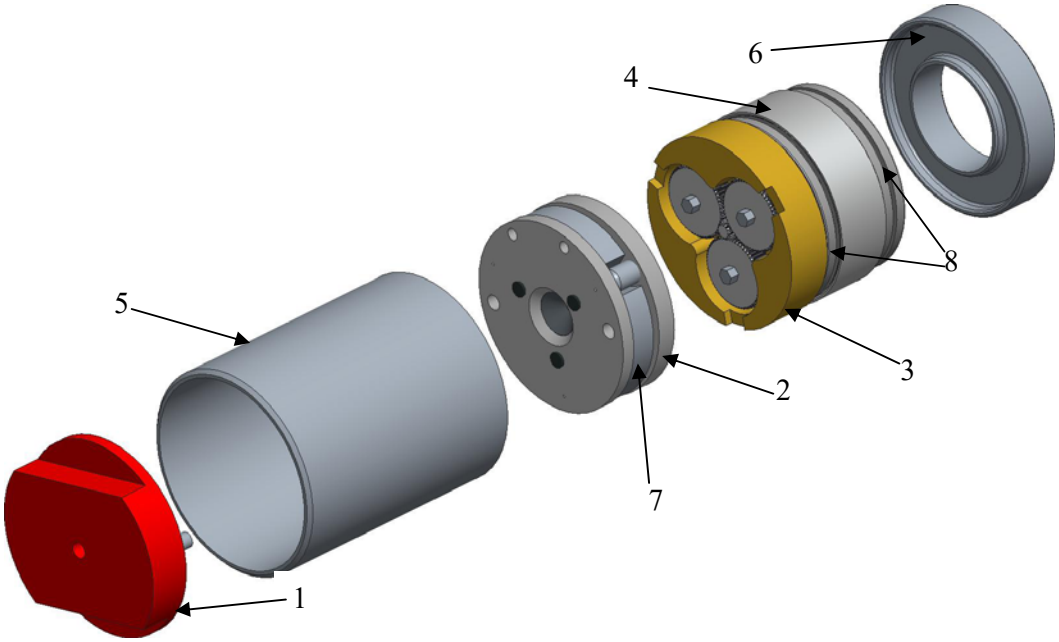


Figure 2. The GL Transmission Kit cross section. 8—Ball bearings. Other numbers see Figure **1**.

The GL Transmission Kit has three main components:

- An anti-rotation baseplate (1),
- A gear driving spindle (4).
- An outside enclosure with a top closing lid.

The complete Gas Loader Kit is self-contained. The use of two ball bearings (8) ensures a smooth operation of the Transmission Kit even when compressed at 3000 bar. Three plastic inserts are put into the PlateDAC and serve as space reducers (7) to decrease the amount of gas present in the system. The whole assembly can be put into or taken out of the gas loader using two steel rods with M3 thread (left picture of Fig. 3).

We have performed several successful loadings of Argon into the PlateDAC at different gas pressures, up to the maximum pressure, with the success rate being close to 100%. This was done using the procedure described below. At 3000 bar, the sample chamber hole did not shrink appreciably, confirming the concept and opening the door to loading of other compressed gases with the simultaneous preservation of the sample chamber volume.

The loading is done by performing the following steps:

1) Prepare the DAC with the diamonds touching the gasket
2) Create small (~10 micron) separation between the top anvil and the gasket
3) Assemble the gas loading gearbox and put it into the gas loader. Tighten the plug
4) Pressurize the pressure vessel to 60 bar and then compress to 3000 bar
5) Using large wrench, rotate the central spindle by about 120-130 degrees counter clockwise
6) Release the gas pressure and extract the Transmission Kit
7) Check the gasket and the cell upon loading. Measure the pressure inside the cell using ruby fluorescence or any other suitable method.

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The Fig. 3 shows the steps of the Plate DAC loading with Argon.

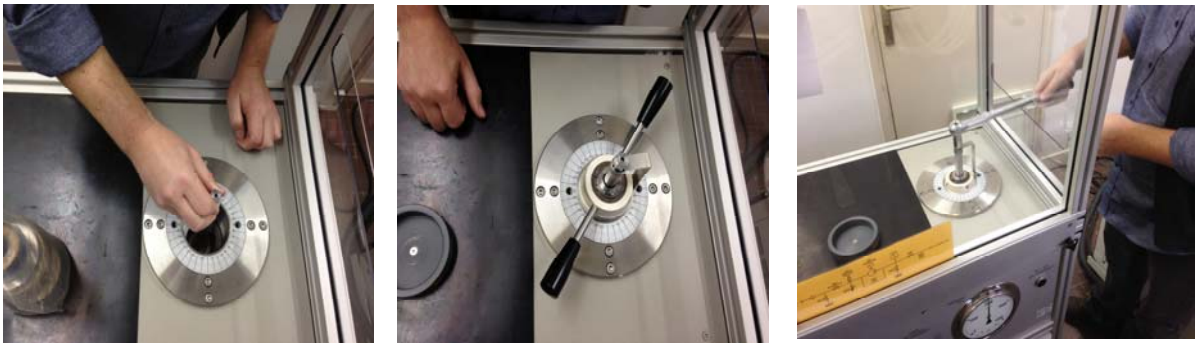

Figure 3: The loading of the PlateDAC with Argon. The Almax easyLab gearbox is put into the gas loader (left) and the loader is sealed from the environment (centre). The spindle driver is rotated using the large wrench to close the cell (right).

Fig. 4 shows the loading test results obtained at loading pressure of 2000 bar (200 MPa). A pressure of 1.5 GPa was reached inside the PlateDAC upon loading the cell with argon. The cell was equipped with 0.38 mm anvils Boehler-Almax design. The gasket was 200 microns thick, pre-indented to 57 microns. The hole drilled was 160 microns in diameter. The sample chamber shrank about 40% of its original volume at 5 GPa, showing the importance of being able to use the maximum gas pressure during loading.

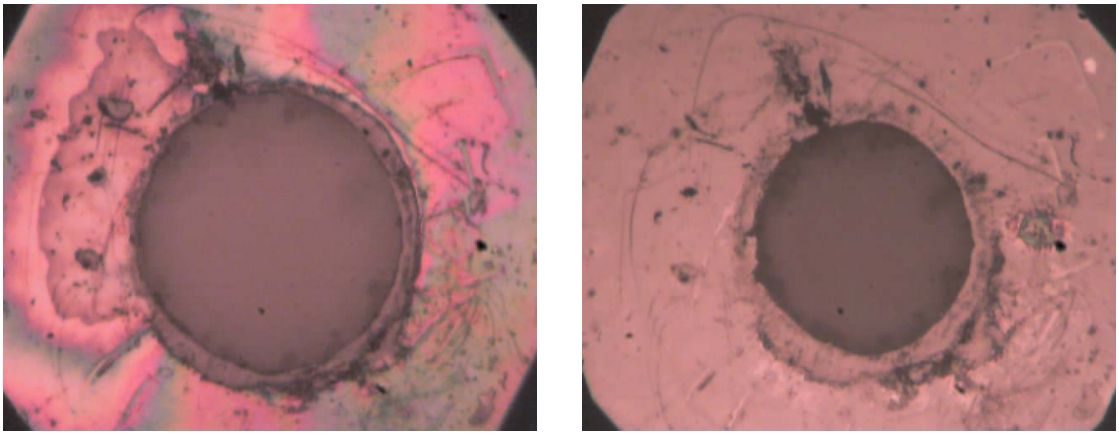

Figure 4: PlateDAC sample chamber just before loading (left) and just after the argon has been loaded into it (right). The anvil culets are 0.38mm, the hole diameter is 160 microns. The loading pressure is 1.5 GPa. Gas loading pressure was 2000 bar (200 MPa). The hole shrank about 36% of its initial volume.

We have also tried argon loading at 3000 bar of pressure and in that case determined that the shrinkage of the sample volume is only 23% at 5 GPa. This permits the loading of complex experimental setups without the risk of damaging or destruction of the sample.

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