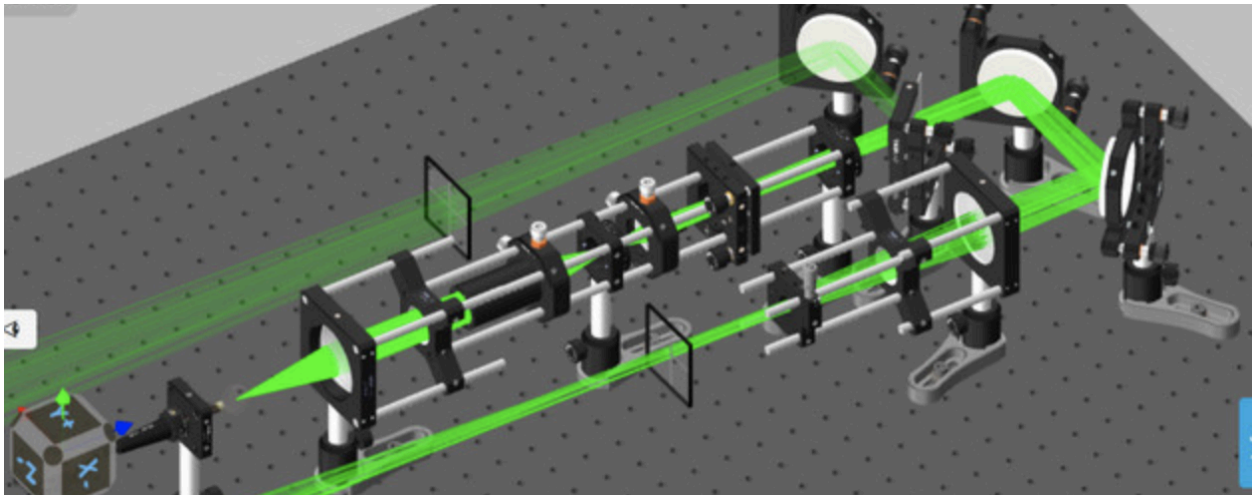
diffraction grating flexural kinematic mount

overview:
I'm making a laser that requires light to be back-coupled from diffraction grating, incident at an actively-stabilized angle. This will all be open-sourced and made available within ~2 months, and I want something that is more stable + easier to print + easier to assemble for any future potential users.

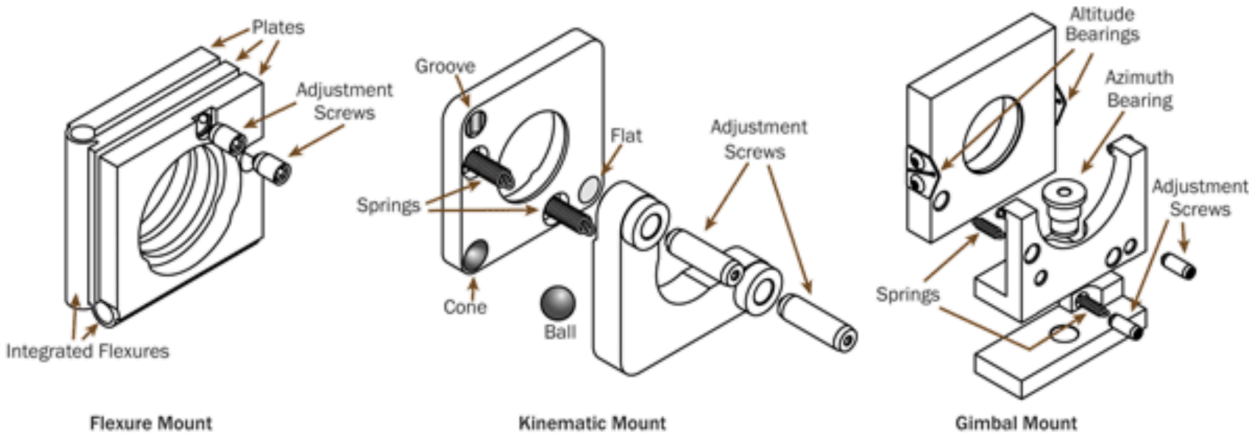
The optical system is using the 'cage system' paradigm to simplify assembly and alignment:



Each optical element is mounted in a plate that has bores for four 6mm ground steel rods that take care of the bulk of coarse alignment. I'd like to be able to mount the laser on this cage system as well for elegance + convenience. The laser mount is one of the 'ends' of the system and emits light through a collimator and onto the grating, which will reflect at roughly a 45° angle (44.60516° to be more accurate) into the next element, similar to one of these:

The mount needs 2 tunable degrees of freedom - both axes that are perpendicular to the axis defined by the incident light. The rotation about the ‘z’ (vertical) axis should be coarsely-aligned with a 100 TPI screw and finely aligned by a piezo stack; this angle needs to be stable to 0.00001°. The rotation about the remaining axis just needs to back-couple the light into the laser cavity and so needs to be stable to about 0.1°

Any flexural mechanism should be preloaded with e.g. a tension or compression spring as otherwise the inherent creep of FDM polymers will lead to destabilization; here are how most optical mounts are fabricated:



requirements:

- 3D printable (4-40 heat-set inserts for adjustment are o.k. / recommended)
- 1° < full range of motion for the ‘phi’ degree of rotation < 3°
- base angle (pre-adjustment) should be around ~44°
- 1° < theta range of rotation < 5°; base should be 0°
- diffraction angle (phi) needs to be able to be actively stabilized to 0.00001° with a piezo
    - https://www.thorlabs.com/thorproduct.cfm?partnumber=PK4DLP1
    - there should be a coarse adjustment with a fine-pitch screw (100 TPI)
        - https://www.thorlabs.com/thorproduct.cfm?partnumber=N100B2P
        - https://www.thorlabs.com/thorproduct.cfm?partnumber=F19ST050
- any flexural mechanism should be preloaded with e.g. a tension or compression spring
- grating tip angle (theta) needs to be aligned to within 0.1° or so (and then fixed in place)
- mounts on 6mm steel rods in a 30x30mm grid

bonus:

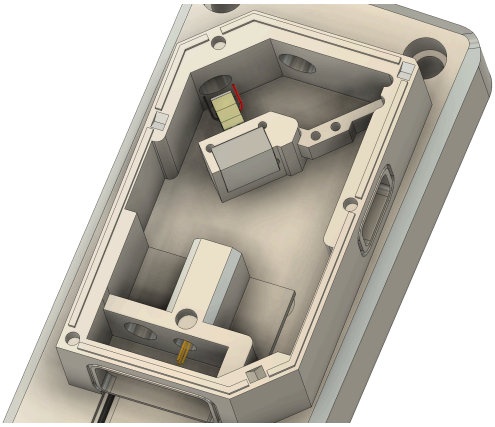
- with small modifications, this mount should be machinable or SLS printable in aluminum
- OR - something where the grating arm can be made from COTS metal parts

bom (roughly):

- piezo: https://www.thorlabs.com/thorproduct.cfm?partnumber=PK4DLP1

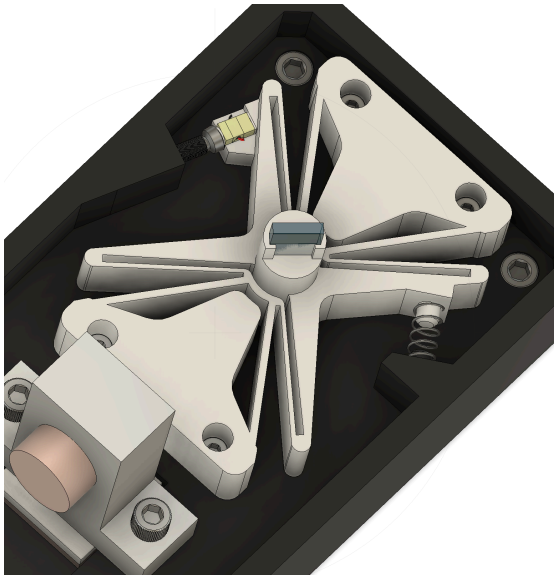
- coarse adjustment screw/bushing:
    - https://www.thorlabs.com/thorproduct.cfm?partnumber=N100B2P
    - https://www.thorlabs.com/thorproduct.cfm?partnumber=F19ST050
- grating: https://www.thorlabs.com/thorproduct.cfm?partnumber=GH13-18V
- 4-40 bolts/heat set inserts
- tension or compression springs

some old versions and attempts by various people including myself:



issues:

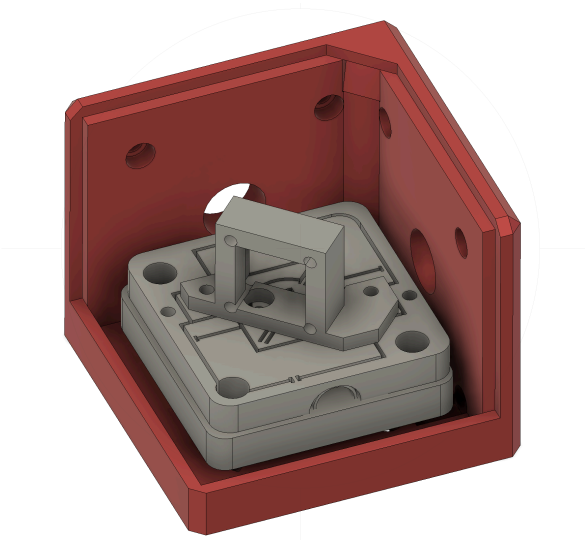
not printable (I machined it)
too big
no good grating mounting mechanism (I glued it)
piezo was loosely tensioned against lever arm from behind



issues:

no vertical adjustment mechanism

bad grating mounting mechanism
net force pushing grating away from laser internal cavity
too big
not cage mountable

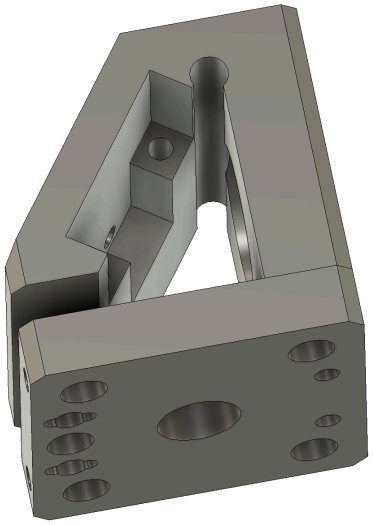


pros:

cage mountable
compact

issues:

very difficult to assemble
more degrees of freedom than necessary
hard to print
no preload on piezo



pros:

- cage mountable
- compact
- better grating mounting (clamped from above)

issues:

- no vertical adjustment mechanism
- very difficult to assemble