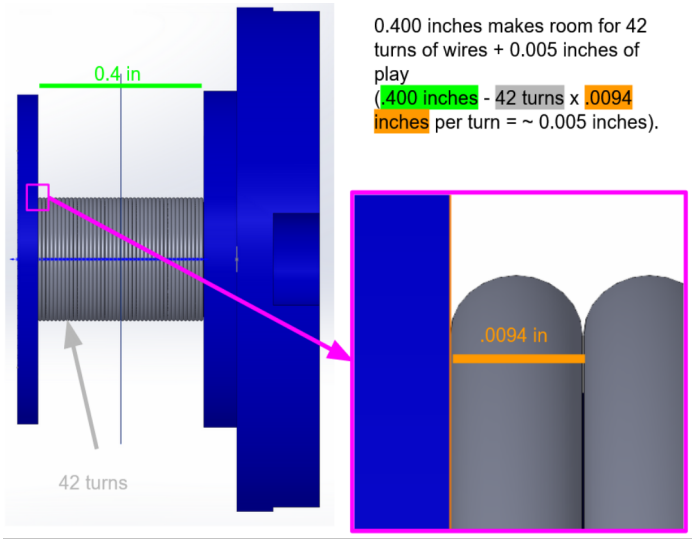
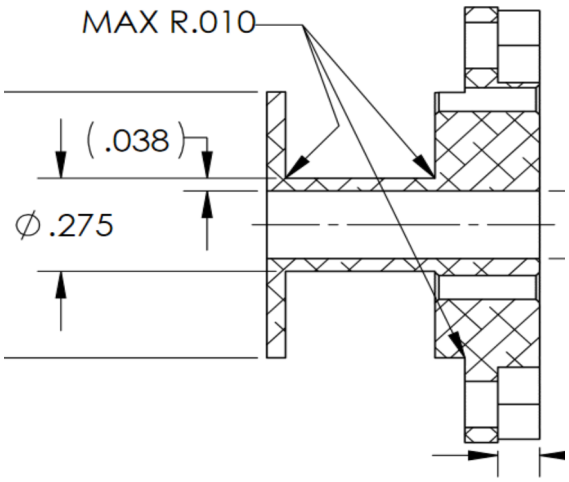
New coil calc for HDDS (Srinath Karat emails, 2021-06-08ff), ø2 mm x 6 mm magnet

length of magnet: 6 mm
radius of magnet: 1 mm
length of coil (as shown below in green): 0.400 inches or 10.16 mm
inner ~~radius~~ [typo: should be diameter] of coil (as shown below in the black and white image): .275 inches or 6.985 mm
outer ~~radius~~ [diameter] of coil: ~~.2238 inches or 5.6845 mm~~ [27" + 2 x (1000/42) x 0.0094" = ~.723"] (1,000 total turns of wire / 42 turns of wire per layer = ~ 23.81 layers --> ~23.81 layers x .0094 inches of wire diameter per layer = ~.2238 inches)
coil turns: 1,000

In[ ]:=



0.400 inches makes room for 42 turns of wires + 0.005 inches of play
(.400 inches - 42 turns x .0094 inches per turn = ~ 0.005 inches).

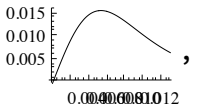


In[•]:=
```
HDDSvals = Recurse[
    LOSvals~Join~{
        kB->1.38 10^-23,
        T->295,
        g->9.8,
        mu0->4 N[Pi] 10^-7,
        rhoeAl->2.65 10^-8,          (* Resistivity of Al *)
        rhoepianowire->30 rhoeAl,    (* Resistivity of P.W., GUESSTIMATE *)
        sigmaeAu->2.67,              (* Resistivity of Au paint, measured *)
        dipoleM->Bresid/mu0,         (* Magnetization *)
        massSOS->0.25,               (* Final design value *)
        massM->rhomM l N[Pi] a^2,
        Bresid->1.25,                (* Residual field *)
        Pi->N[Pi],
        rhomM->7400,                 (* Mass density of magnets *)
        ztube->0.0155,               (* Separation for magnet to push its own weight, measured *)
        zpickup->0.018-l,            (* Separation for magnet to pull its own weight, measured *)
        masspullapart->0.060,        (* Force (in kgf) to separate magnets *)
        (* preferred value of small magnet dipole moment *)
        mzpref->0.007945632135874319,
        (* magnet moment per unit volume for magnet stuff, assumed the same for big and small *)
        mz->mzpref/(lold*N[Pi]*aold^2),
        lold->0.003175,              (* length of small magnets *)
        aold->0.0009525,             (* radius of small magnets *)
        l->0.006,                 (* length, Srinath Karat email, 2021-06-08, as for AODLvals *)
        a->0.002/2,           (* radius, Srinath Karat email, 2021-06-08, as for AODLvals *)
        (* coil length *)
        coillen->0.4*0.0254, (* Srinath Karat email, 2021-06-08 *)
        (* the ends of the coil relative to the centre of the coil *)
        coilz1->-coillen/2,
        coilz2->+coillen/2,
        (* the inner and outer radii of the coil *)
        coilrad1->0.275*0.0254/2, (* Srinath Karat email, 2021-06-08  *)
        coilrad2->coilrad1+coilturns*wirediam/(coillen/wirediam), (* Srinath Karat email, 2021-0
        wirediam->0.0094*0.0254,  (* Srinath Karat email, 2021-06-08 *)
        wirearea -> wirediam^2, (* assume square packing *)
        (* the number of turns *)
        coilturns->1000, (* Srinath Karat email, 2021-06-08 *)
        wireareaAO->6.47708x10^-8, (* for comparison: effective area of AOSEM wire *)
        coilsigma -> coilturns/((coilrad2 - coilrad1)*(coilz2 - coilz1))
    }
]
```

Out[•]=
$$\{w0 \to 4.66841,\ rwire \to 0.00155,\ awire \to 7.54768 \times 10^{-6},\ dpend \to 0.45,\ dyaw \to 0.0333,$$
$$massoptic \to 10.7,\ loptic \to 0.1,\ roptic \to 0.125,\ Ioptic \to 0.0507135,\ wpitch \to 3.76991,$$
$$wpend \to 4.67469,\ wyaw \to 3.14159,\ kpitch \to 0.720753,\ kyaw \to 0.500523,$$
$$pitchlever \to 0.0808,\ yawlever \to 0.0808,\ kxpitch \to 8.9202,\ kB \to 1.38 \times 10^{-23},\ T \to 295,$$
$$g \to 9.8,\ mu0 \to 1.25664 \times 10^{-6},\ rhoeAl \to 2.65 \times 10^{-8},\ rhoepianowire \to 7.95 \times 10^{-7},$$
$$sigmaeAu \to 2.67,\ dipoleM \to 994\,718.,\ massSOS \to 0.25,\ massM \to 0.000139487,\ Bresid \to 1.25,$$
$$\pi \to 3.14159,\ rhomM \to 7400,\ ztube \to 0.0155,\ zpickup \to 0.012,\ masspullapart \to 0.06,$$
$$mzpref \to 0.00794563,\ mz \to 878\,021.,\ lold \to 0.003175,\ aold \to 0.0009525,\ l \to 0.006,$$
$$a \to 0.001,\ coillen \to 0.01016,\ coilz1 \to -0.00508,\ coilz2 \to 0.00508,\ coilrad1 \to 0.0034925,$$
$$coilrad2 \to 0.00910336,\ wirediam \to 0.00023876,\ wirearea \to 5.70063 \times 10^{-8},$$
$$coilturns \to 1000,\ wireareaAO \to 6.47708 \times 10^{-8},\ coilsigma \to 1.75419 \times 10^{7}\}$$

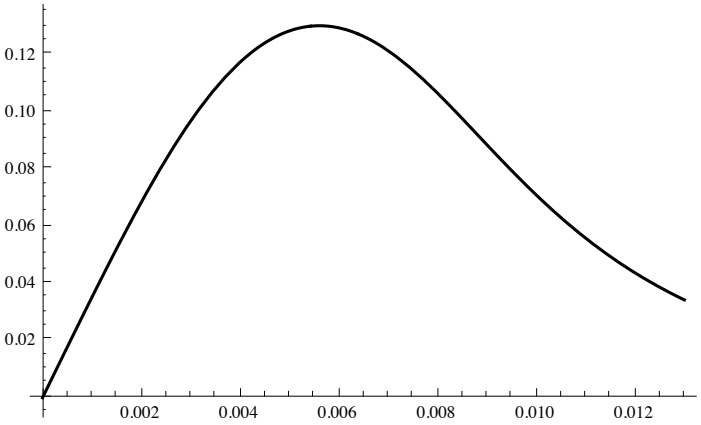
In[•]:=
```
vals[HDDS] := HDDSvals;
```

```
In[•]:= optdata[HDDS] = If[
          useprecomputed,
          {-0.13030351516936053`, {z → 0.005607360550285311`}},
          FindMinimum[-fz[HDDS, z], {z, 0.005}]
         ]
Out[•]= {-0.130304, {z → 0.00560736}}
In[•]:= plot[HDDS] = If[
          useprecomputed,
```




```
          ,
          Plot[fz[HDDS, p], {p, 0, 0.013}, PlotStyle → {Black}]
         ]
```

Out[•]=

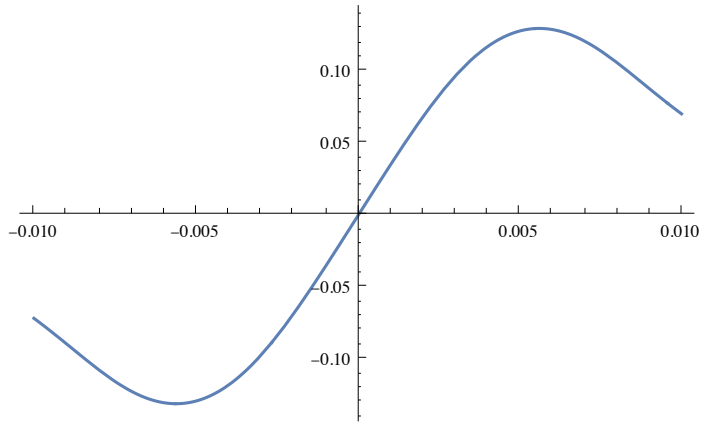



```
In[•]:= zmax[HDDS] = z /. optdata[HDDS] [[2]]
Out[•]= 0.00560736
In[•]:= fmax[HDDS] = -optdata[HDDS] [[1]]
Out[•]= 0.130304
In[•]:= fzi[HDDS] = FunctionInterpolation[fz[HDDS, z], {z, 0, 0.013}]
Out[•]= InterpolatingFunction[ Domain: {{0., 0.013}}
                               Output: scalar ]
In[•]:= coupling[HDDS] = -2 * Coefficient[Normal[Series[fzi[HDDS][z], {z, zmax[HDDS], 2}]], z^2]
Out[•]= 9622.73
```

Sweet spot relative to centre of coil

In[•]:=
```
Plot[fz[HDDS, p], {p, -0.010, 0.010}]
```

Out[•]=



In[•]:=
```
Plot[fz[HDDS, p], {p, 0.0, 0.01}]
```

Out[•]=