# Pressure drop across an orifice in vacuum

## Consider 2 vacuum systems

Vac system 1 – laser side.

* Assume 300l/sec pump – matched by gas load – zero net pumping
* Base pressure of 1e-5 mBar = P1

Vac system 2 – Gabor lens side

* 300l/sec pump = S2
* Vac system 2 has lower gas load (due to construction materials, processing and in vacuum components/systems) and therefore lower base pressure

Pressures are in molecular flow regime.

Vacuum systems connected by an **4mm diameter** ‘pipe’ **50mm long** tapering up with 2 degree included angle. Exit diameter = 4+2\*(50tan1) = 5.74mm.

## Short tube – Dushman tables

Dushman tables gives value for the conductance of round straight tubes. Dushman figures are calculated and are known to deviate from measurement by up to 20% but are sufficiently accurate for this task. 0.2cm radius round tube with length to radius ratio (l/a) = 25 **Ct=0.178 l/s**

## Alternate conductance calculation method:

Long round pipe approximation: Ct= 12.1d^3/l **Ct**= **0.194 l/s.**

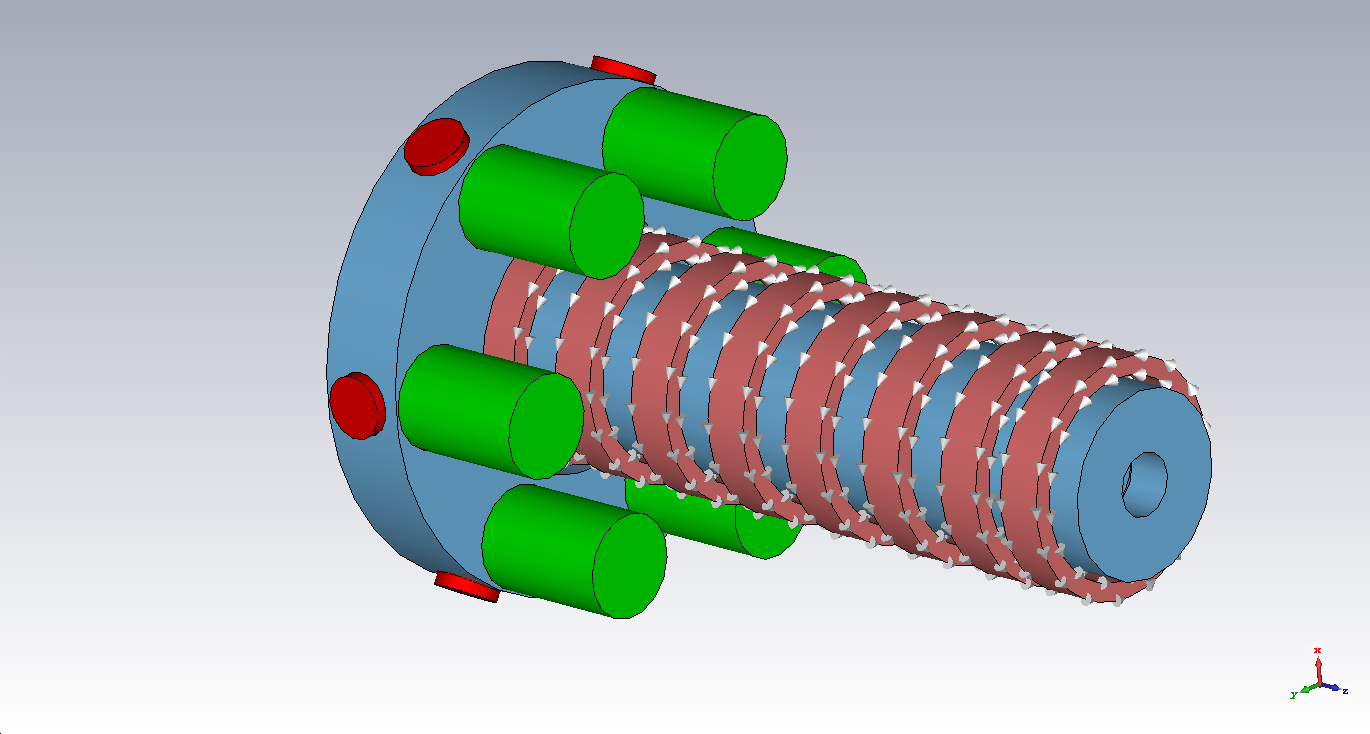
Throughputs (Q) measured at either end of tube are equal (no gas generation inside tube)

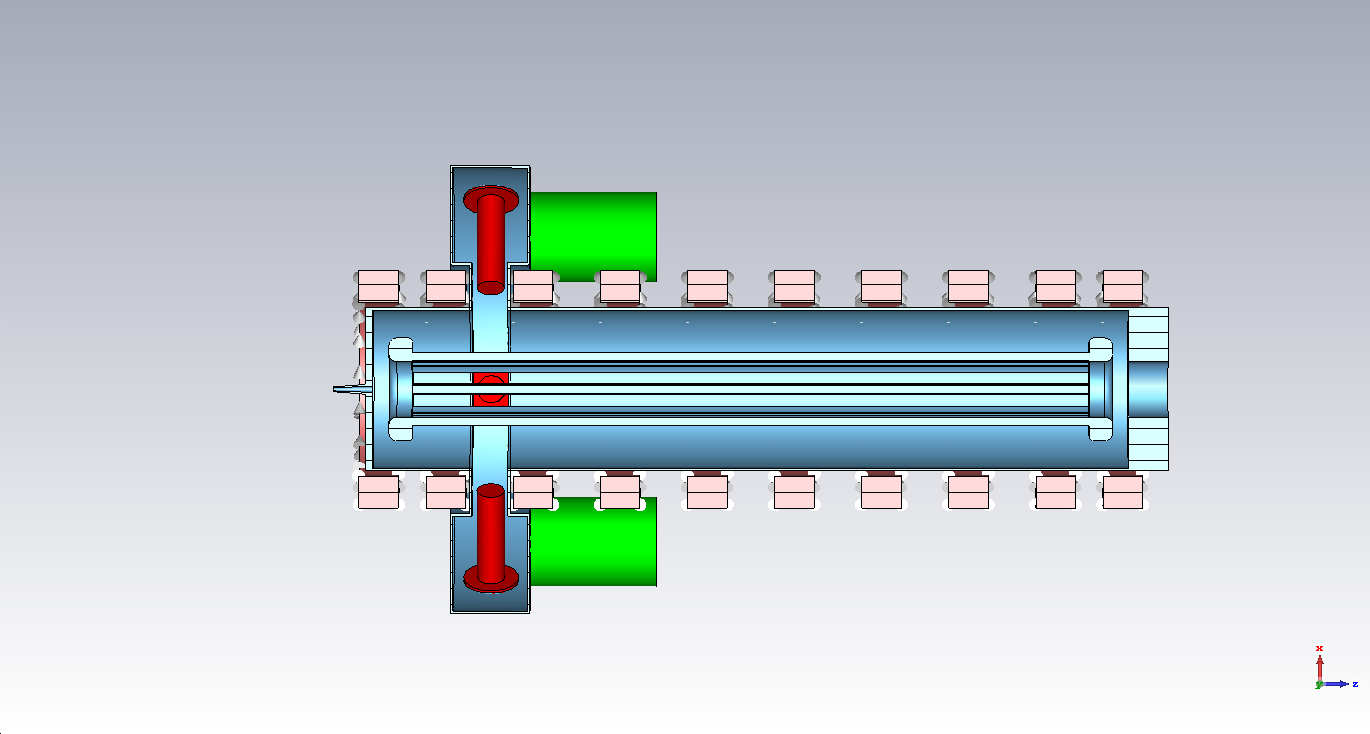
Q1=p1S1=p2S2= Ct (p1-p2)=Q2 p2=p1 Ct /(S2+ Ct)

C= 0.018 p2=p1\*6e-4 C=0.02 p2=p1\*4e-4

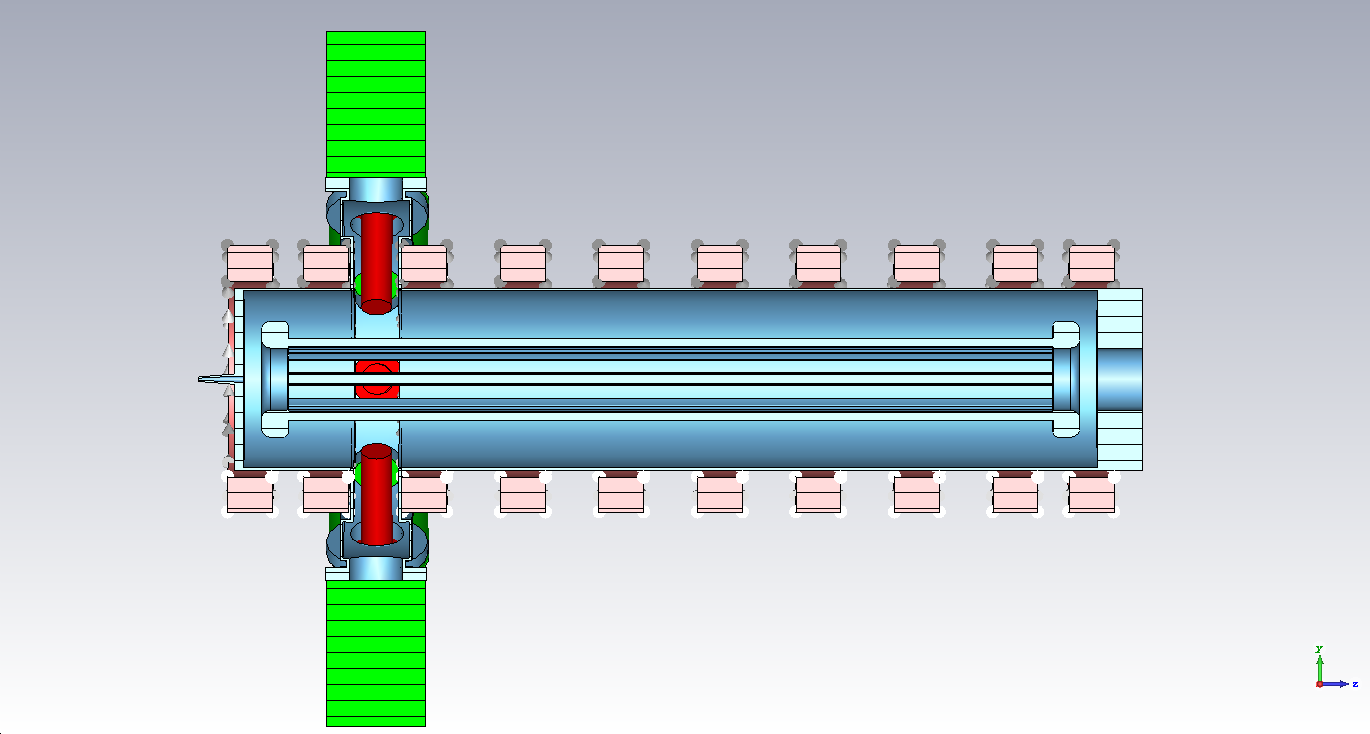
Pressure on low pressure side will be between 3 and 4 orders of magnitude down on pressure on high side.

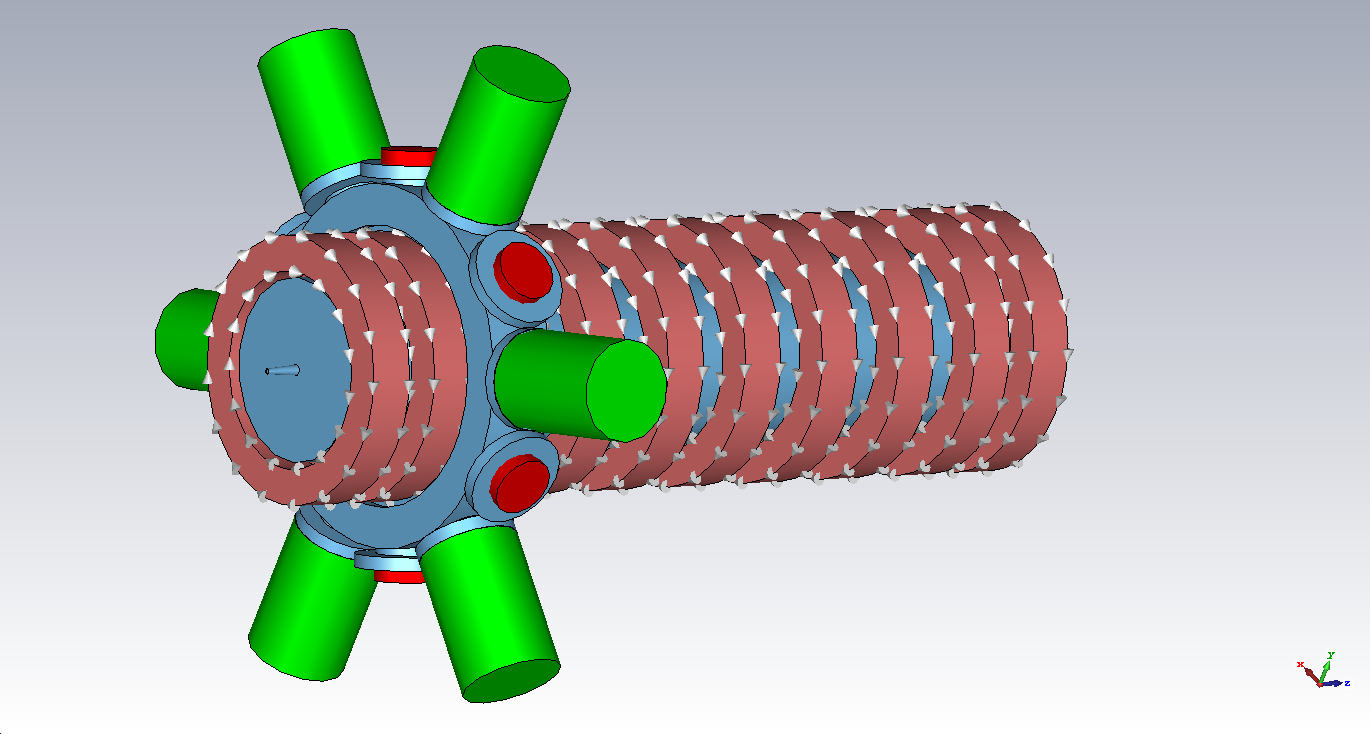
Tube will provide more than 3 orders of magnitude pressure drop.

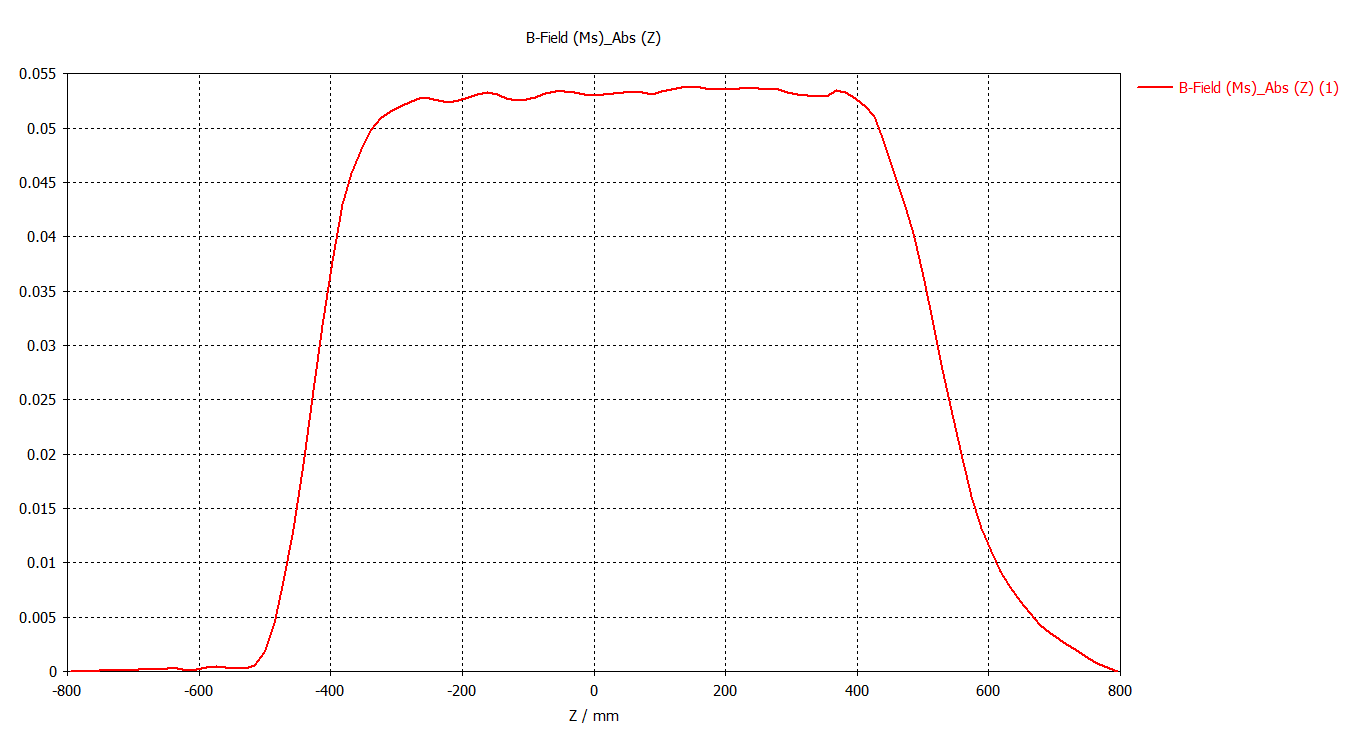


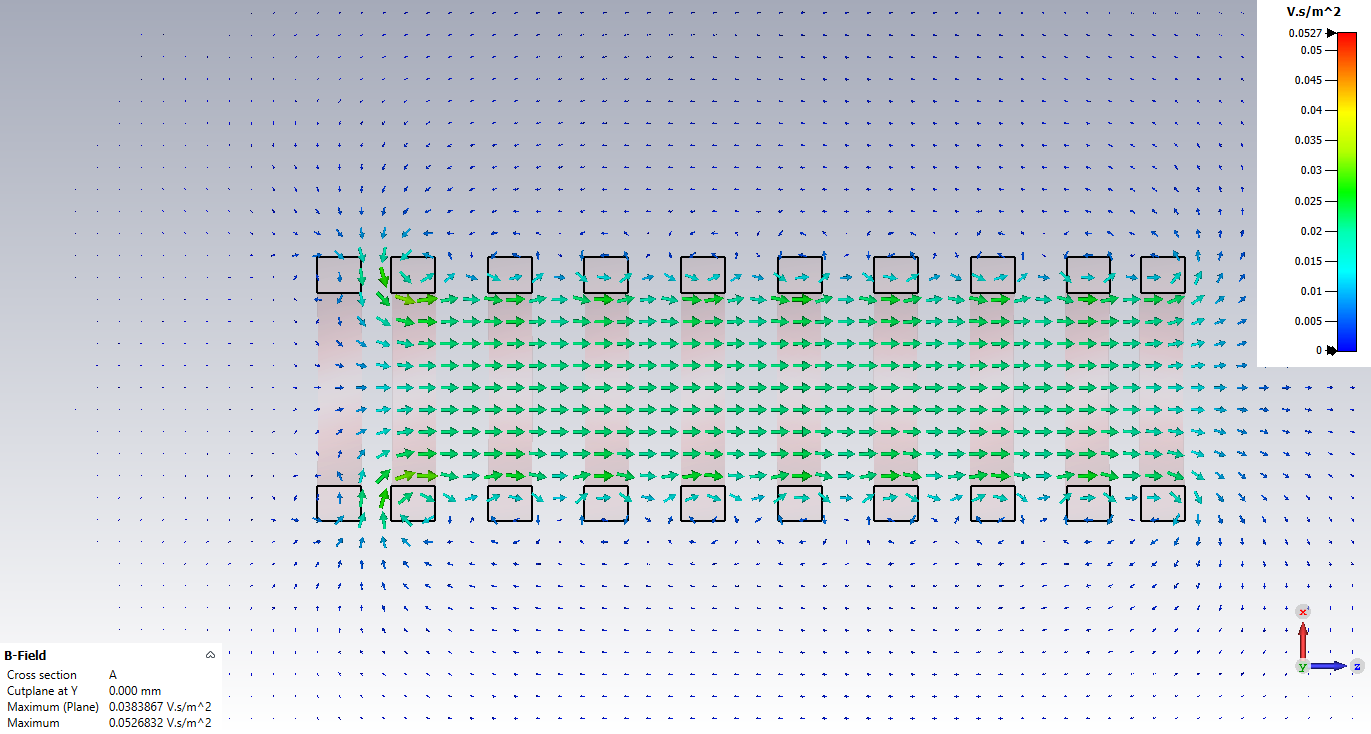


* 10 coils, ~15V 10A, 150W/coil, for 300W total, 7kg per coil – possible to reduce weight at cost in power.
* Coils will run at this level with no active cooling
* Coil nearest to target is run in reverse direction to ‘shape’ magnetic field lines. Objective is to arrange magnetic field lines perpendicular to anode-cathode gap to provide some magnetic insulation and resist breakdown.
* 2nd to end coil requires higher current – will need more volume of conductor to reduce power.
* Current arrangement is not ideal, optimisation may offer some improvement.
* Alternatives – could locally increase B field at ends – similar improvements to B field profile – also offer particle containment by magnetic ‘bottle’
* Pumping by small turbo pumps – pump port will throttle larger pumps at annular gap – distributed pumping is almost always better
* Supplementary pumping by NEG pumps – once system reaches 1e-7mBar possible to close off turbos and use only NEG pumps.
* Only one pump port to allow magnetic coils to slide into place.









* Hollow anode – field relieving electrodes facing cathodes.
* Sectional ‘cylinder’ to allow vacuum pumping. Field relieving to anode ‘bars’ required to manage radial E field enhancement.
* Possible electron injection between ‘bars’
* Not suitable for electron density measurement by RF (only possible for e density at 1017/m3)

