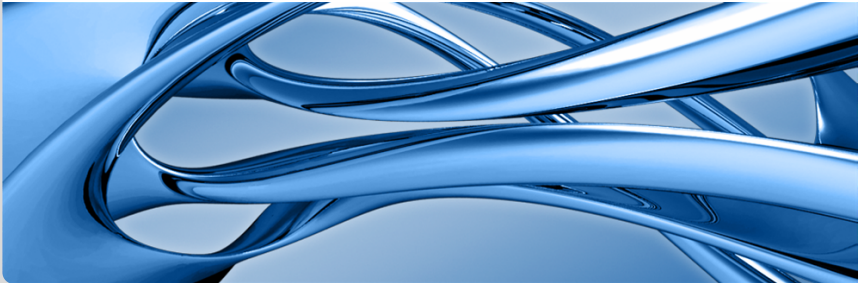


# GQ cards in McCad-generated MCNP input

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## *Evidence of the problem*

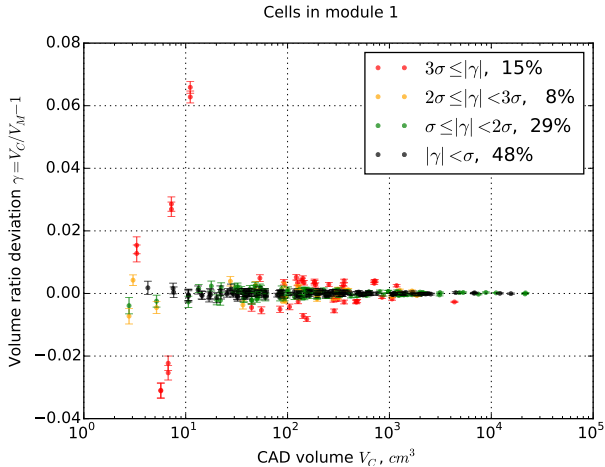


Figure 1: Comparison of volumes for a McCad-generated MCNP input file

*Down to one cell*

# Closer look to the MCNP input file

```
McCad 0.4.0 generated Input
24701 0 (-25099 -25007 25008) imp:n=1
2 0 -1 #24701 imp:n=1
3 0 1 imp:n=0

25007      P      0.7826524      -0.2467693      0.5714544      851.9078788
25008      P      0.7826524      -0.2467693      0.5714544      850.3078797
25099      GQ      0.3874553      0.9391049      0.6734399      0.3862692
                0.2820349      -0.8945003      -251.4879218      79.2938372
                378.6739698      53230.4757183
1 s 791.8655776      -249.67420687      297.03236286 2

sdef sur 1 nrm -1 wgt 12.56637061
nps 1e8
f4:n 24701
sd4 1 1 1
prdmp j j 1
print
```

From SpaceClaim: this is a cylinder  $r=1.20\text{cm}$ ,  $h=1.6\text{ cm}$ , located about 10m from the origin.

# How MCNP interpretes this cylinder

```
10/15/15 10:52:06  
McCad 0.4.0 generated Input
```

```
probid = 10/15/15 10:52:06  
basis:  
( 0.327510, 0.943961, -0.040925)  
(-0.529332, 0.219188, 0.819612)  
origin:  
( 791.87, -249.67, 297.03)  
extent = ( 1.19, 1.19)  
cell labels are  
cell names
```

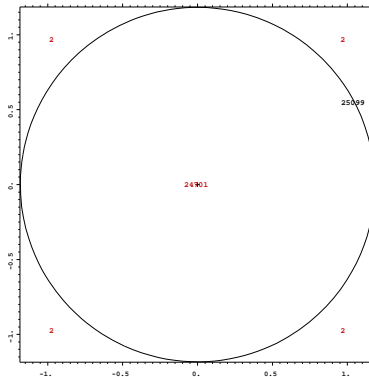


Figure 2: Cell seems smaller than should be (extent 1.85)

# How we interpret this cylinder

```
McCad 0.4.0 generated Input
24701 0 (-25099 -25007 25008) imp:n=1
2 0 -1 #24701 imp:n=1
3 0 1 imp:n=0

25007      P      0.7826524      -0.2467693      0.5714544      851.9078788
25008      P      0.7826524      -0.2467693      0.5714544      850.3078797
c 25099      GQ      0.3874553      0.9391049      0.6734399      0.3862692
c      0.2820349      -0.8945003      -251.4879218      79.2938372
c      378.6739698      53230.4757183
25099 1 c/z -2.30720424e+02 0 1.19968885e+00
1 s 791.8655776 -249.67420687 297.03236286 2

tr1 0 0 0
-5.45005755e-01 1.71839655e-01 8.20633816e-01
3.00705803e-01 9.53716950e-01 2.19973256e-09
-7.82652393e-01 2.46769356e-01 -5.71454387e-01
sdef sur 1 nrm -1 wgt 12.56637061
nps 1e8
f4:n 24701
sd4 1 1 1
prdmp j j 1
print
```

# model with C/Z card

10/15/15 11:09:24  
McCad 0.4.0 generated Input

```
probid = 10/15/15 11:09:24  
basis:  
( 0.327510, 0.943961, -0.040925)  
(-0.529332, 0.219188, 0.819612)  
origin:  
( 791.87, -249.67, 297.03)  
extent = ( 1.19, 1.19)  
cell labels are  
cell names
```

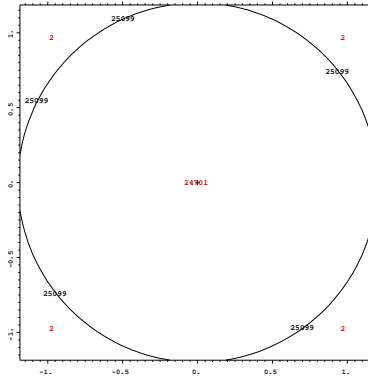


Figure 3: This cell seems okay



Volumes of the cell, cc:

MCNP GQ	:	7.0357	+-0.0000	(nps 1e9)	(-2.80 %)
MCNP C/Z	:	7.2343	+-0.0000	(nps 1e9)	(-0.05 %)
exact value: 7.2382					

- We can interpret GQ card better than MCNP !
- Really ? Why ?

# Parameters of the GQ card:

The gq card syntax:

```
1  GQ      A B C D E F G H J K
```

Meaning:

$$Ax^2 + By^2 + Cz^2 + Dxy + Eyz + Fxz + Gx + Hy + Jz + K = 0$$

Example: cylinder with  $r = 1$  cm, with axis || y-axis through the point  $x_0 = 1000$  cm on x-axis, these parameters are:

A	B	C	D	E	F	G	H	J	K
1	0	1	0	0	0	-2000	0	0	9.99999990e7
						-2x0			xo^2 - r^2

Parameters must be specified with high precision!

*What can we do ?*

# combination of $cz$ or $c/z$ cards with $tr$ cards

- Cylinder at z-axis in an auxiliary CS, rotated and translated with respect to the model CS:

```
1 1      cz      R
...
tr1  x0 y0 z0    ...
```

- Cylinder parallel z-axis in an auxiliary CS, rotated with respect to the model CS:

```
2 2      c/z      x0 y0 R
...
tr2  0  0  0      ...
```

Combination of  $c/z$  and  $tr$  is preferable, since might require less  $tr$  cards.

*Back to volume comparison in complete model*

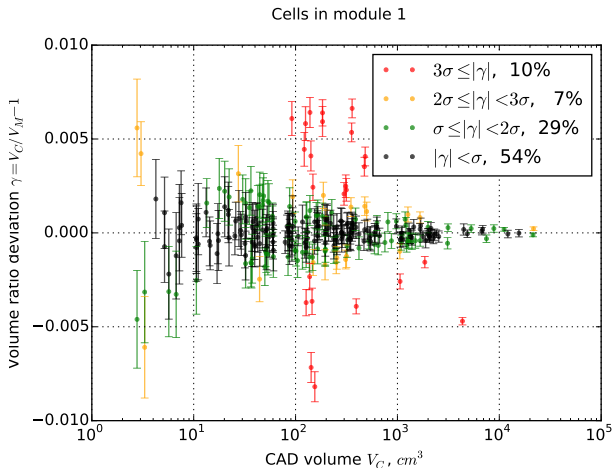


Figure 4: Volumes in the model with c/z cards

# Old result once again:

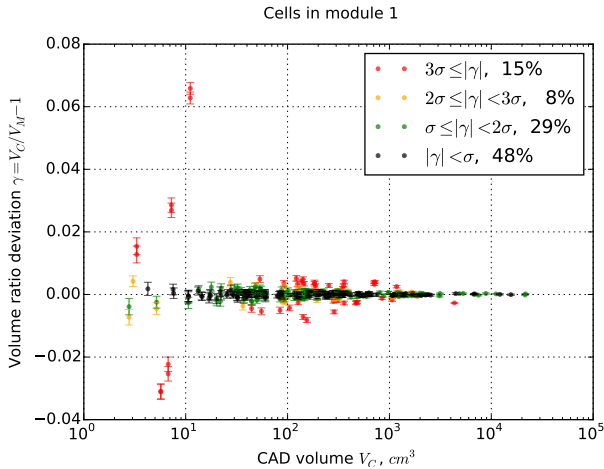


Figure 5: Volumes in the model with GC cards



# How can one convert all GQ to c/z

```
numjuggler --mode nogq m1 > m2
```

This replaces GQ cards that represent cylinders.

- Cones and other surface types not implemented (yet)
- Does not solve the problem completely, as one can see from the above results. Presumably, due to lacking precision of the original GQ parameters
- Depends on `numpy` package: a not-so-simple-to-install python package

- Proposal:
  - Use floating point format for GQ cards in McCad
  - Implement into McCad  $c/z + tr$  representation of cylinders and cones. Single tool is better than two (McCad, than numjuggler)
- Application to another CAD-MCNP converters
- $c/z + tr$  makes input more readable
- Limitation: at most 999  $tr$  cards per input (mcnp5)
- Improves lost particle rate !