CDMS 9909007

ICEBOX
A detailed GEANT description of the SUF icebox for use with CDMC

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`http://ppd.fnal.gov/experiments/cdms/mcarlo/documents/icebox.ps`

1 Introduction

In the simulation of penetration of radiation in the CDMS detectors a more detailed geometry was necessary especially for the detector surroundings.
This note describes a geometry as defined by the GEANT routine `icebox.f` used by `CDMC` [2]. Figure 1 shows how the icebox.f is linked with `CDMC`.

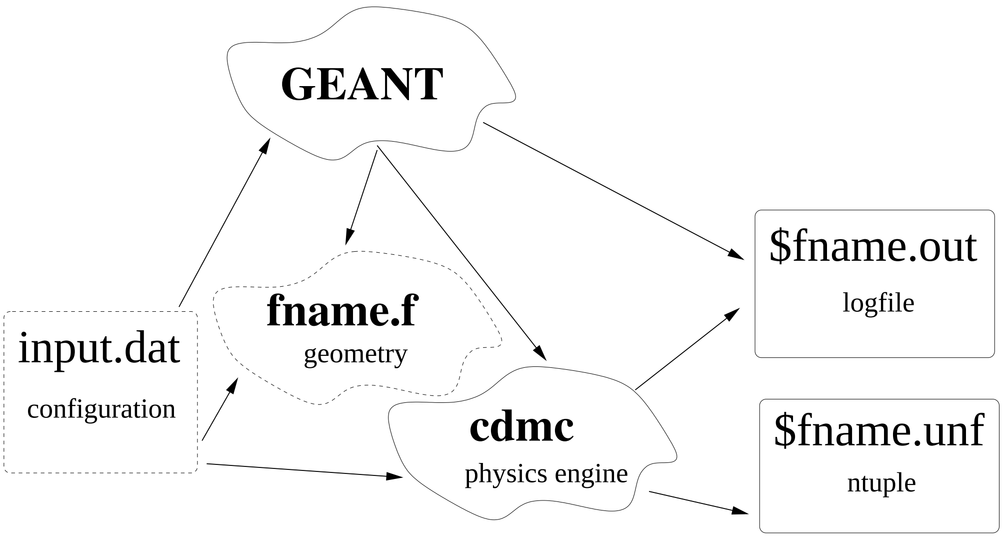

Figure 1: *A functional diagram of the cdmc.f program. The dotted lines indicate user input. The user program* `fname.f` *describes the geometry.* `cdmc` *reads the input file* `input.dat` *and writes out a log file and an event ntuple.*

2 Conventions

A few conventions have been used in the FORTRAN code in this routine.

- Implicit FORTRAN variable types are used, where possible. *i.e.* variables beginning with the letters a-h, and o-z are real*4, i-n are integer*4.
- Distances are in cm, angles in degrees, unless noted.

- variables and subroutines defined by GEANT are in all capital letters, otherwise, lower case letters are used.
- The volume names of the sensors are `SNxy` where x indicates the detector type (b=BLIP,z=ZIP,f=FLIP) and y whether the volume is the dead detector layer (d) or internal part (i). *e.g.* `SNbd` is a dead layer of a BLIP detector.

3 Description

The design of the Geant geometry of the SUF icebox (especailly for the tower) is based on Figure 5.The names given to the volumes in Geant and the names used in this note are also based on Figure 5. The complexity and the depth of the geometrical tree needed for representing the whole arrangement used in the experiment, exceeded GEANT limitations. To solve this, a Fortran subroutine `uvolpos` is used to position a `BOX` or a cylindrical can (`TUBE`) centered in a mother volume. A `BOX` is positioned as six planes and a `TUBE` as a bottom and top tube lids and a hollow tube in between. The `uvolpos` subroutine allows to select which of the individual parts of the constructed volume will be `MANY` or `ONLY`. With `uvolpos` used for volumes outside the tower, the depth of the geometrical tree was reduced to 11. The volumes that are not centered in there mother volume are the only ones positioned directly. Figure 2 shows the geometry tree excluding the details of the tower. Figure 3 shows the geometry tree for the towers.In both these figures volumes positioned more than once are shown with the copy number after their name.

Table 1 is a listing of all the volumes defined in the `icebox.f` routine with there description. Table 3 is a list of each subroutine used in `icebox.f`. Table 5 lists the user defined include files used.

The material indices are defined as parameters in the include file `materials.inc` as shown below:

```
      parameter ( nmair=15 , nmabs =10 , nmvac =16 , nmrock=36 ,
     .     nmcop=11 , nmlead=13 , nmcad=20 , nmger=25 , nmsil=26 ,
     .     nmpoly=30 , nmscin=32 , nmlif=35 , nmalum=9 , nmss=10 ,
     .     nmlhe=3 , nmcuwl=31 )
```

4 Changing Detector Configuration

The `icebox.f` routine also shares an input file `input.dat` with `cdmc.f` where the configuration of the detectors and towers can be controlled. The section of the file used by `icebox.f` is shown below:

```
tower    1        2        3        4        5        6        7

 $GEOM
 inpsen=201,    307,    313,    319,    325,    231,    137,
        102,    -1,     214,    220,    226,    232,    338,
         0 ,    209,    215,    121,    227,    233,    239,
        304,    310,    116,    322,    328,    334,    340,
        305,    211,    217,    223,    229,    335,    141,
        206,    312,    318,    224,    330,    336,    242,

 ntt=1,1,1,1,3*0,

$END GEOM
```

The variable `inpsen` is a 7x6 array controlling the detector configuration. It takes a three digit number for the case a detector, a 0 if the housing (ZIP housing) is placed without a detector. In the case of a

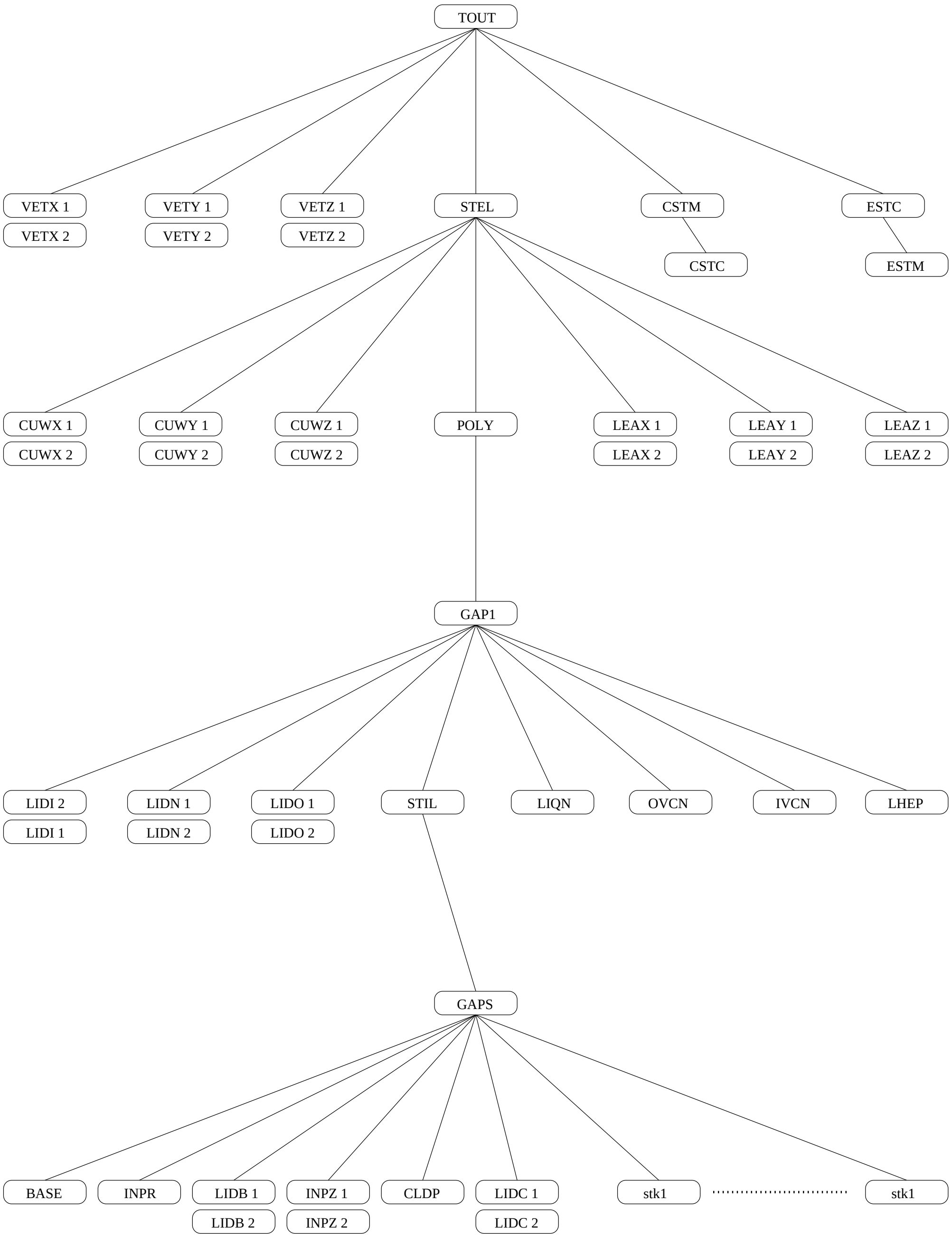

Figure 2: *Tree diagram of the icebox geometry excluding the tower. Names of volumes are the ones used in the GEANT code. Volumes with more than one occurances are shown with a number following the name.*

detector the first digit is its type: BLIP=1, FLIP=2, ZIP=3, and the second two are the serial number of the detector. In the case where the stack has less than 6 detectors -1 must be used in the position after the last detector. You cannot have an unoccupied position and have a detector or a housing below it. For example, in the above, `Tower 2` contains only one detector (307). Each column of the `inpsen` represents a

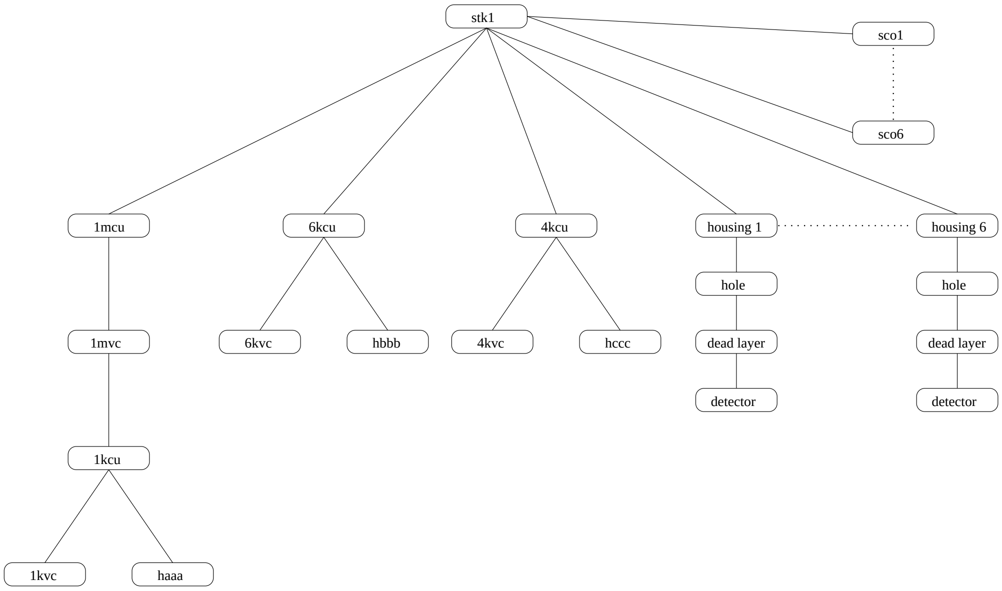

Figure 3: *Tree diagram of the the tower the basement and the stack. Names of volumes are the ones used in the GEANT code. Volumes with more than one occurances are shown with a number following their name.*

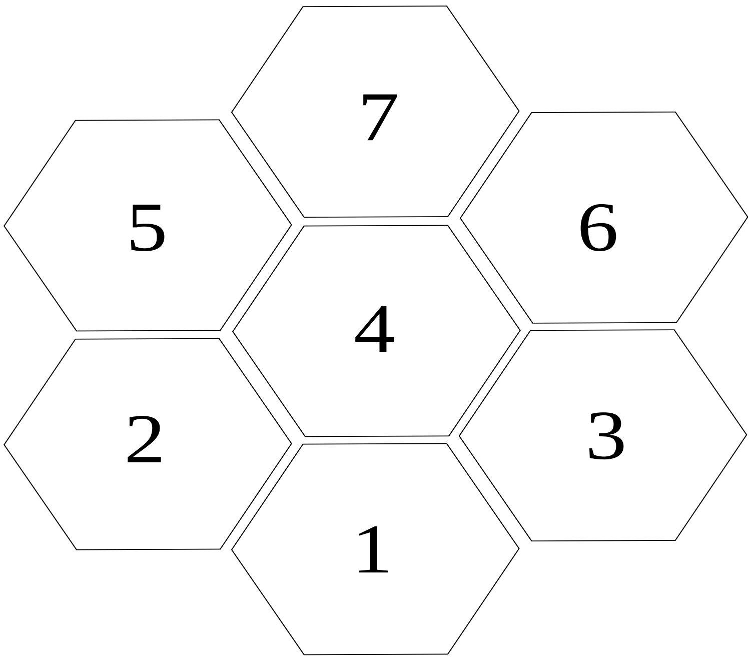

Figure 4: *Tower positions with respective copy numbers.*

tower with corresponding values of the detectors. The side coaxes are positioned only if the corresponding detector is positioned.

Geant volume name	Material index	Shape	Description
TOUT	15	BOX	Mother Volume
NMDR	15	BOX	space used for neutron calibration
VETX	32	BOX	yz plane of veto box
VETY	32	BOX	xz plane of veto box
VETZ	32	BOX	xy plane of veto box
STEL	10	BOX	steel veto support
LEAX	13	BOX	yz plane of outer lead box
LEAY	13	BOX	xz plane of outer lead box
LEAZ	13	BOX	xy plane of outer lead box
CUWX	31	BOX	yz plane of copper wall box
CUWY	31	BOX	xz plane of copper wall box
CUWZ	31	BOX	xy plane of copper wall box
POLY	30	BOX	polyethylene box
GAP1	15	TUBE	gap
OVCN	11	TUBE	outer vacuum can
LIDO	11	TUBE	lid of outer vacuum can
LIQN	11	TUBE	nitrogen can
LIDN	11	TUBE	lid of nitrogen can
IVCN	11	TUBE	inner vacuum can
LIDI	11	TUBE	lid of inner vacuum can
LHEP	11	TUBE	
STIL	11	TUBE	still temperature can
GAPS	16	TUBE	gap in still can
CLDP	11	TUBE	cold plate
LIDC	11	TUBE	lid of cold plate
BASE	11	TUBE	base temperature can
LIDB	11	TUBE	base temperature lid
INPR	13	TUBE	inner lead can radial part
INPZ	13	TUBE	inner lead can top and bottom lids
ESTM	16	TUBE	electronics stem vacuum
ESTC	11	TUBE	electronics stem copper
CSTM	16	TUBE	cold stem vacuum
CSTC	11	TUBE	cold stem copper
haaa	16	TUBE	
hbbb	16	TUBE	
hccc	16	TUBE	
6kcu	11	PGON	600mK floor copper
6kvc	16	TUBE	600mK floor vacuum
4kcu	11	PGON	4K floor copper
4kvc	16	TUBE	4K floor vacuum
1kcu	11	TUBE	50mK floor copper
1kvc	16	TUBE	50mK floor copper
1mcu	11	PGON	10mK floor copper
1mvc	16	TUBE	10mK floor copper

Table 1: *Description of the volumes used in the GEANT geometry in* `icebox`

Geant volume name	Material index	Shape	Description
sco1	11	BOX	side coax 1
sco2	11	BOX	side coax 2
sco3	11	BOX	side coax 3
sco4	11	BOX	side coax 4
sco5	11	BOX	side coax 5
sco6	11	BOX	side coax 6
DEHL	11	PGON	detector housing top and bottom lids
gecu	11	PGON	ZIP copper housing
geem	16	PGON	vacuum in ZIP housing
SNzi	25	TUBE	ZIP internal layer
SNzd	25	TUBE	ZIP dead layer
sicu	11	PGON	FLIP copper housing
siem	16	PGON	vacuum in FLIP housing
SNfi	26	TUBE	FLIP internal layer
SNfd	26	TUBE	FLIP dead layer
blih	11	PGON	BLIP copper housing
hole	16	PGON	vacuum in BLIP housing
SNbi	25	TUBE	BLIP internal layer
SNbd	25	TUBE	BLIP dead layer
stk1	16	PGON	tower 1
stk2	16	PGON	tower 2
stk3	16	PGON	tower 3
stk4	16	PGON	tower 4
stk5	16	PGON	tower 5
stk6	16	PGON	tower 6
stk7	16	PGON	tower 7

Table 2: *Description of the volumes used in the GEANT geometry in* `icebox`

subroutine name	Description
`icebox_data`	dimensional data for parts outside the tower
`tower_stack_data`	dimensional data for tower, stack and basement parts
`guvol`	creates the volumes outside of the tower, calls ushield,(uvolpos when necessary)
`ugmat`	defines user media
`gupos`	calls gpcans, gpstem, gptow to position volumes
`gpcans`	positions the vacuum/fridge cans inside the shields
`gpstem`	positions the stems
`gptow`	geometry configuration (towers and detectors), positions towers, calls gpstk
`gpstk`	defines a tower with all its daughter volumes and positions them
`UGEOM`	called by GEANT to initialize geometry, calls guvol, gupos
`ushield`	defines, positions parts `(MANY)` through which STEMs pass(calls `uvolpos` when necessary)
`uvolpos`	defines and positions some volumes, to allow insertion of many in the same depth

Table 3: *A list of all the GEANT subroutines used in* `icebox.f` *and their descriptions*

The variable ntt is an array of 7 numbers to control the tower type. Only one tower is implemented at the moment: the zip tower with index 1. For no placement in a given position (see Figure 4) 0 is used for

Material Name	Material Number	Variable Name
Lithium Fluoride	35	nmlif
Absorber	10	nmabs
Air	15	nmair
Aluminium	9	nmalum
Cadmium	20	nmcad
Copper	11	nmcop
Copper Walls	31	nmcuwl
Germanium	25	nmger
Lead	13	nmlead
Liquid Helium	3	nmlhe
Polyethylene	30	nmpoly
Rock	36	nmrock
Scintillator	32	nmscin
Silicon	26	nmsil
Stainless Steel	10	nmss
Vacuum	16	nmvac

Table 4: *A list of the material indices held in a parameter block in* `materials.inc`

file name	Description
`materials.inc`	definition of material indices
`tower_dimen`	dimensional data for tower, stack and basement parts
`stack_dimen`	icebox dimensional data (excluding tower)
`user.inc`	

Table 5: *Descriptions of the include files used in icebox.f*

that array element.

To provide a method for CDMC to identify a sensor, a unique copy number is assigned to each sensor. This is accomplished by enclosing the detector's serial number, type, tower and position in the copy number of the detector volume (detector type and serial given in `input.dat` file as described above). A five digit number is used as copy number with the following convention:

```
       A BC D E
where: A  is the detector type: 1 BLIP
                                2 ZIP
                                3 FLIP
       BC is a two digit detector serial number
       D is the tower the detector is in (see figure~\ref{fig:towerpos} )
       E is the detector position in the the tower (1 top - 6 bottom)
```

References

[1] CERN Application Software Group
GEANT Detector Description and Simulation Tool. October, 1994
`http://wwwinfo.cern.ch/asd/geant/index.html`

[2] S. Eichblatt.
CDMC – A Monte Carlo Simulation Tool for CDMS CDMS Note, 1999. CDMS 9903002
`http://ppd.fnal.gov/experiments/cdms/mcarlo/documents/cdmc.ps`

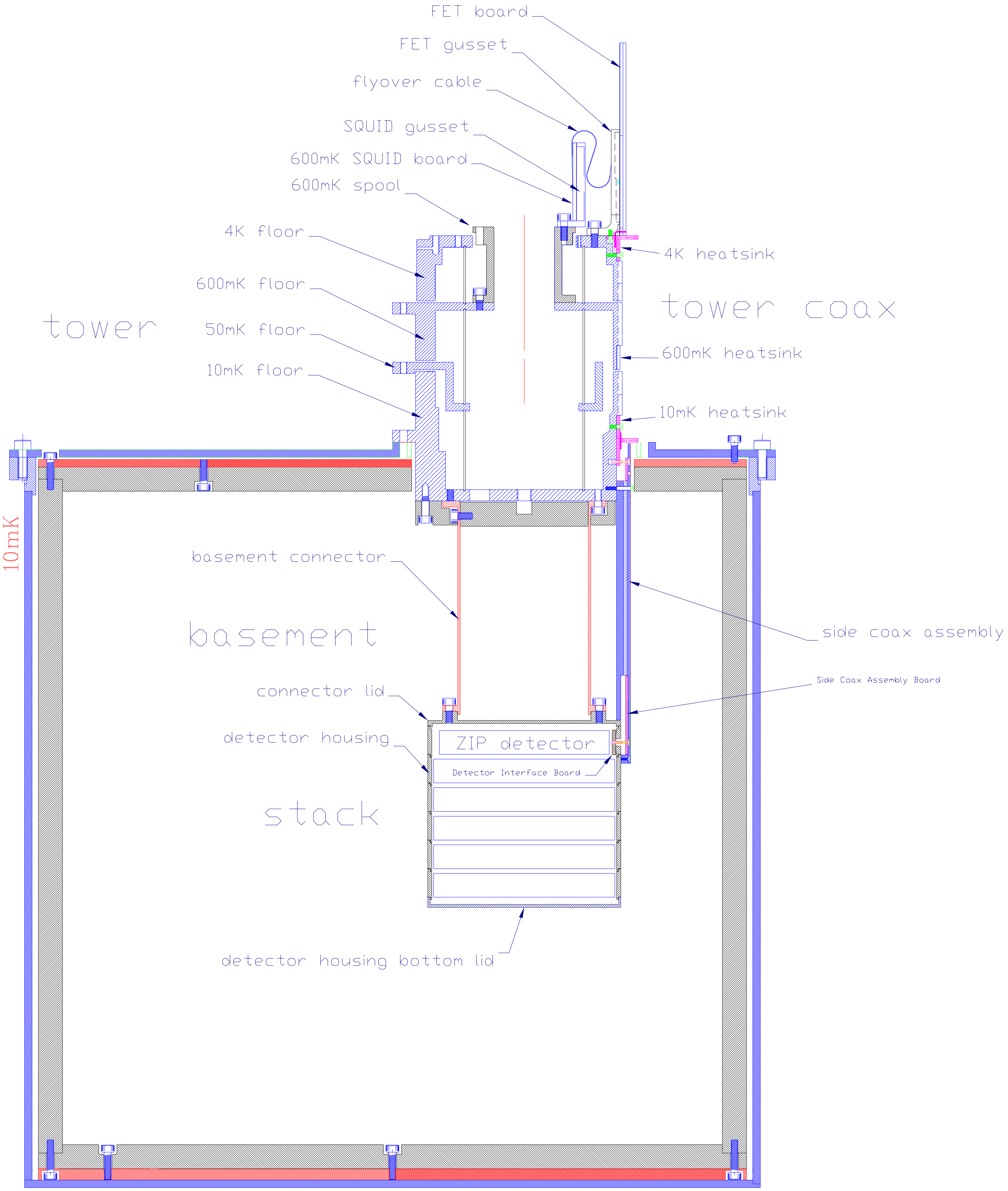

Figure 5: *Tower design*