

CURSO INTRODUTÓRIO



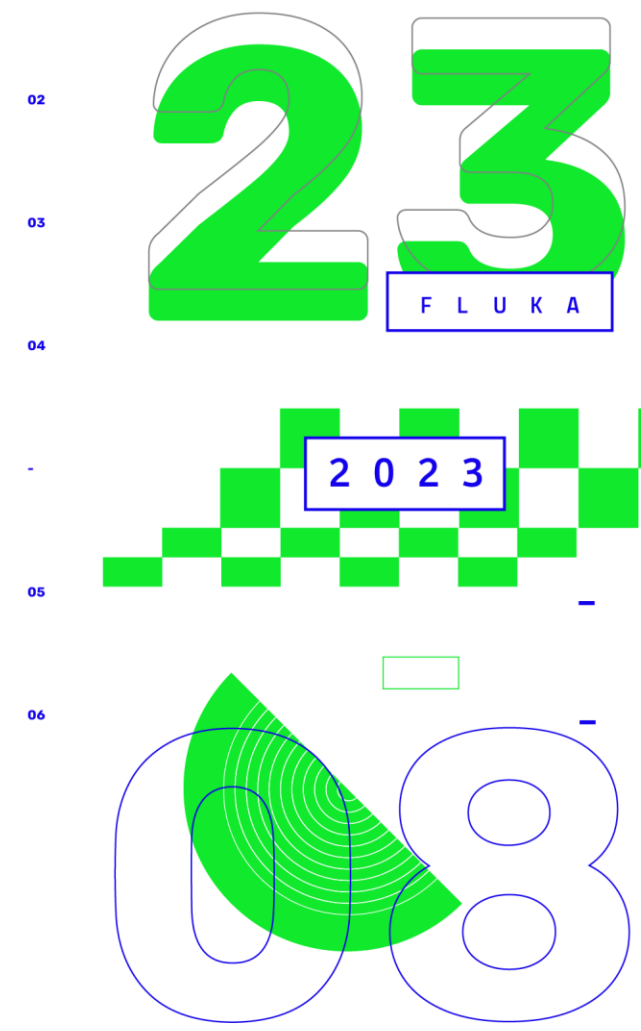
23 DE JANEIRO
A 8 DE MARÇO
DE 2023

AULA 08

Detectores – USRBIN (parte II)

Iniciaremos em breve

Código Monte Carlo de interação e transporte de partículas






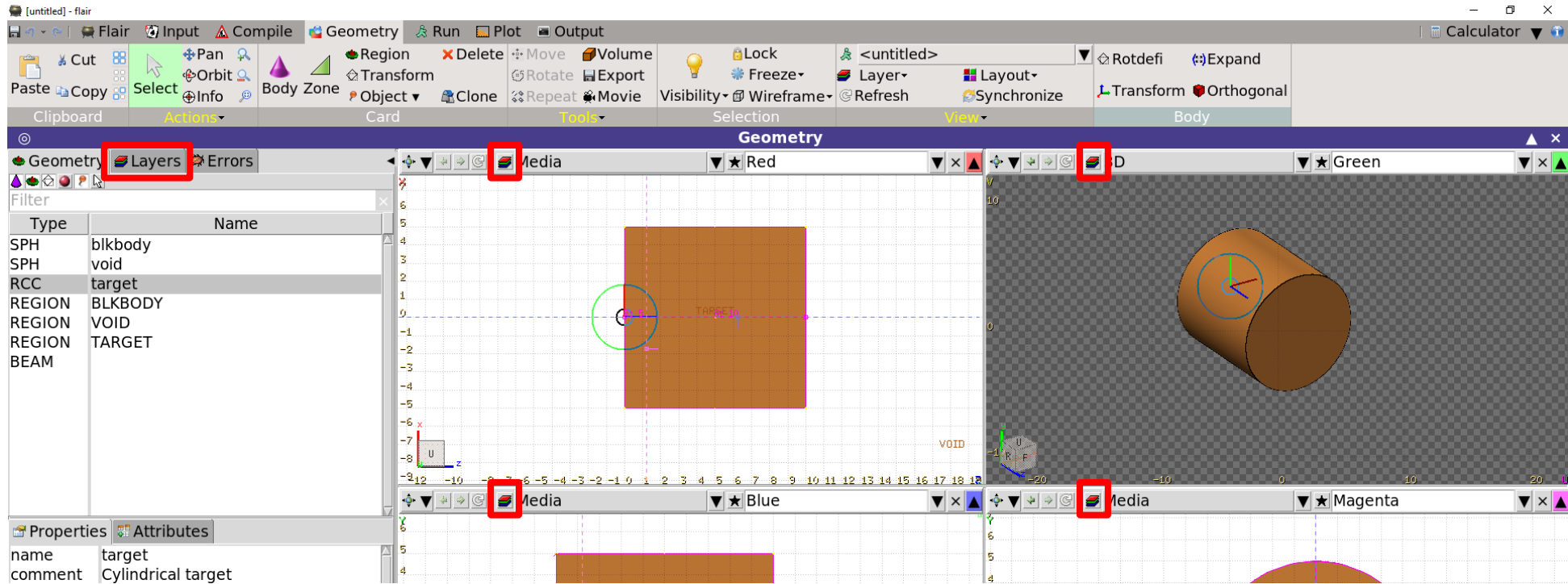
Scoring physical quantities I

Introduction to built-in estimators

3D distributions (**USRBIN**) & 1D-2D plots

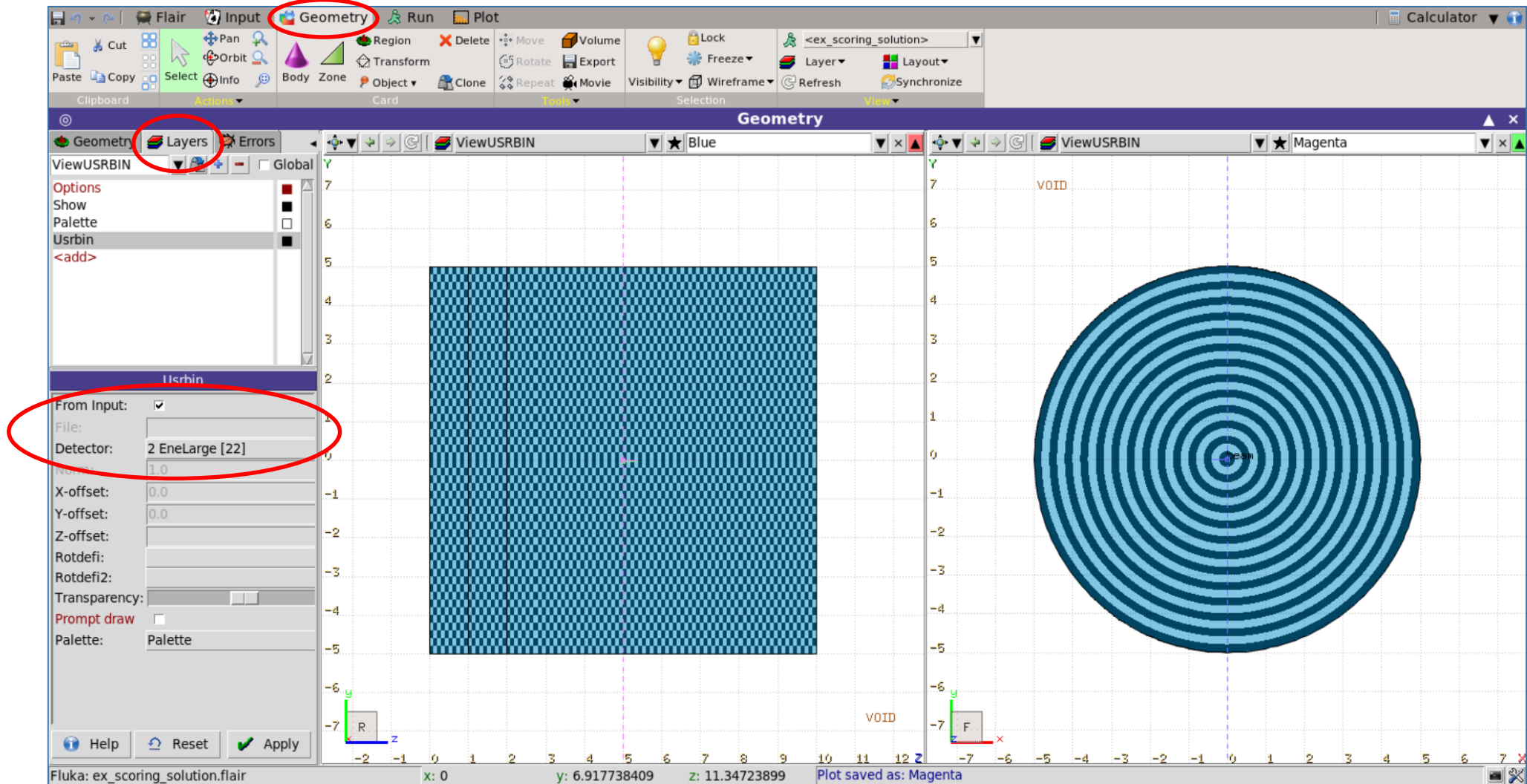
Geometry tab: Layers

- Somewhat introduced in the first Flair lecture
- Custom layers can be defined in the “Configure layer menu” 



Visualisation

- A defined mesh can be overlaid on the geometry to check that it is well-positioned



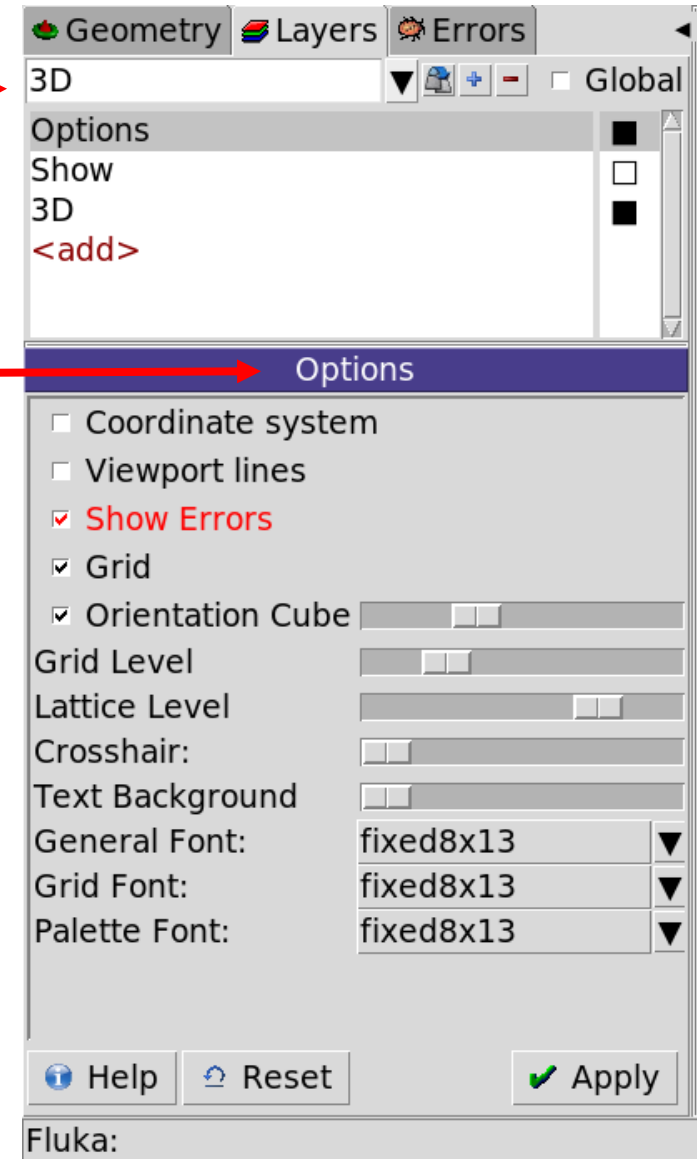
Geometry tab: Layers

- **Toolbar**

- Add / delete / rename / clone layers
- Global: to make a layer available on every project

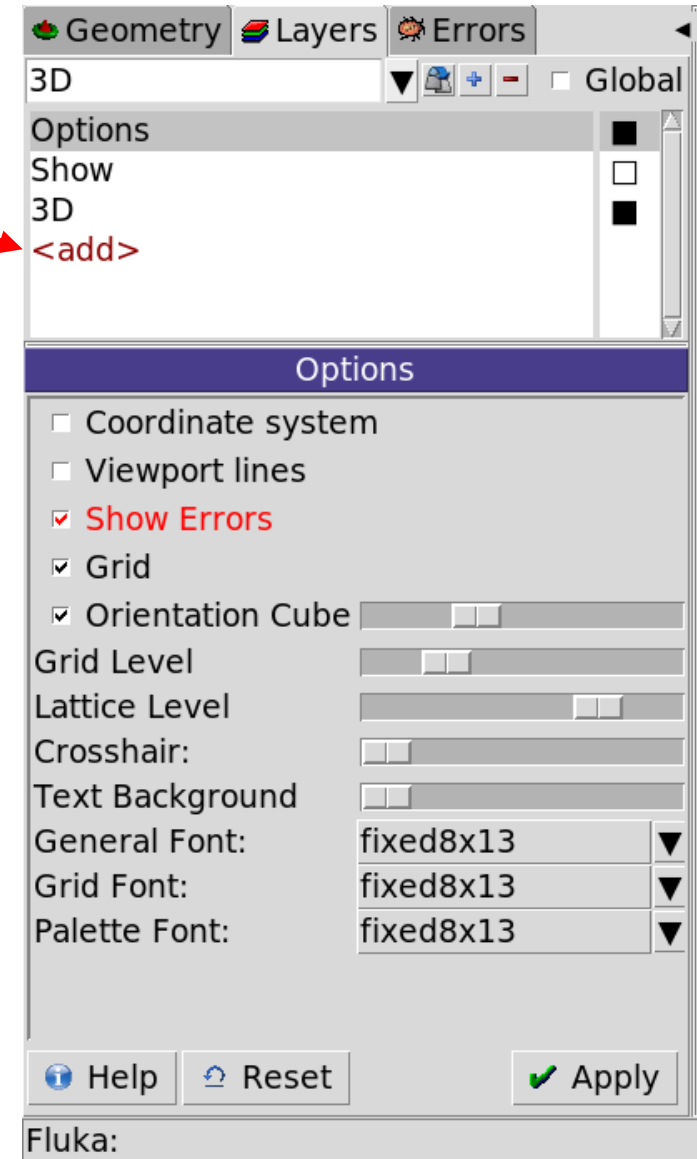
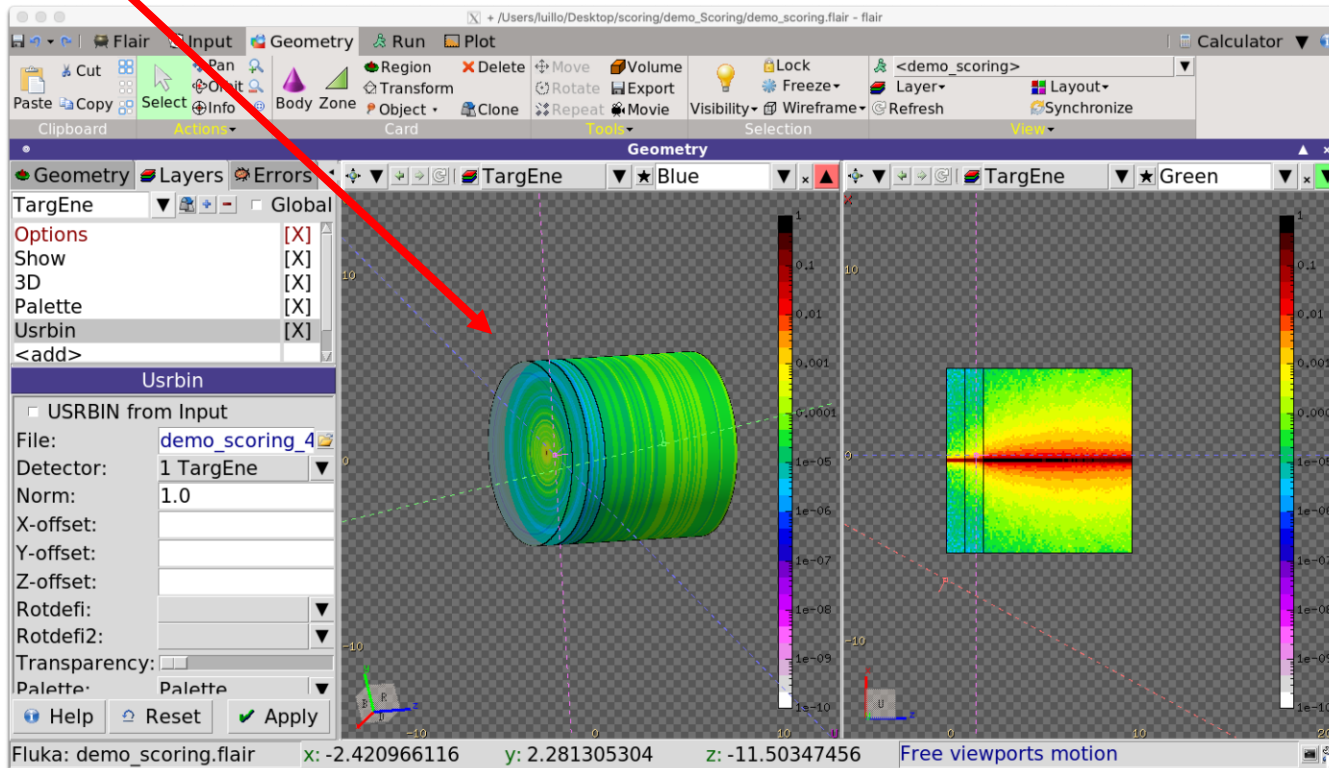
- **Options**

- Enable/disable
 - coordinate system, viewport lines, grid, orientation cube
- Adjust:
 - Grid level (set grid intensity)
 - Lattice level (set lattice hash intensity)
 - Crosshair (set dimension of the cross in the viewport center)
 - Orientation cube size
 - Fonts

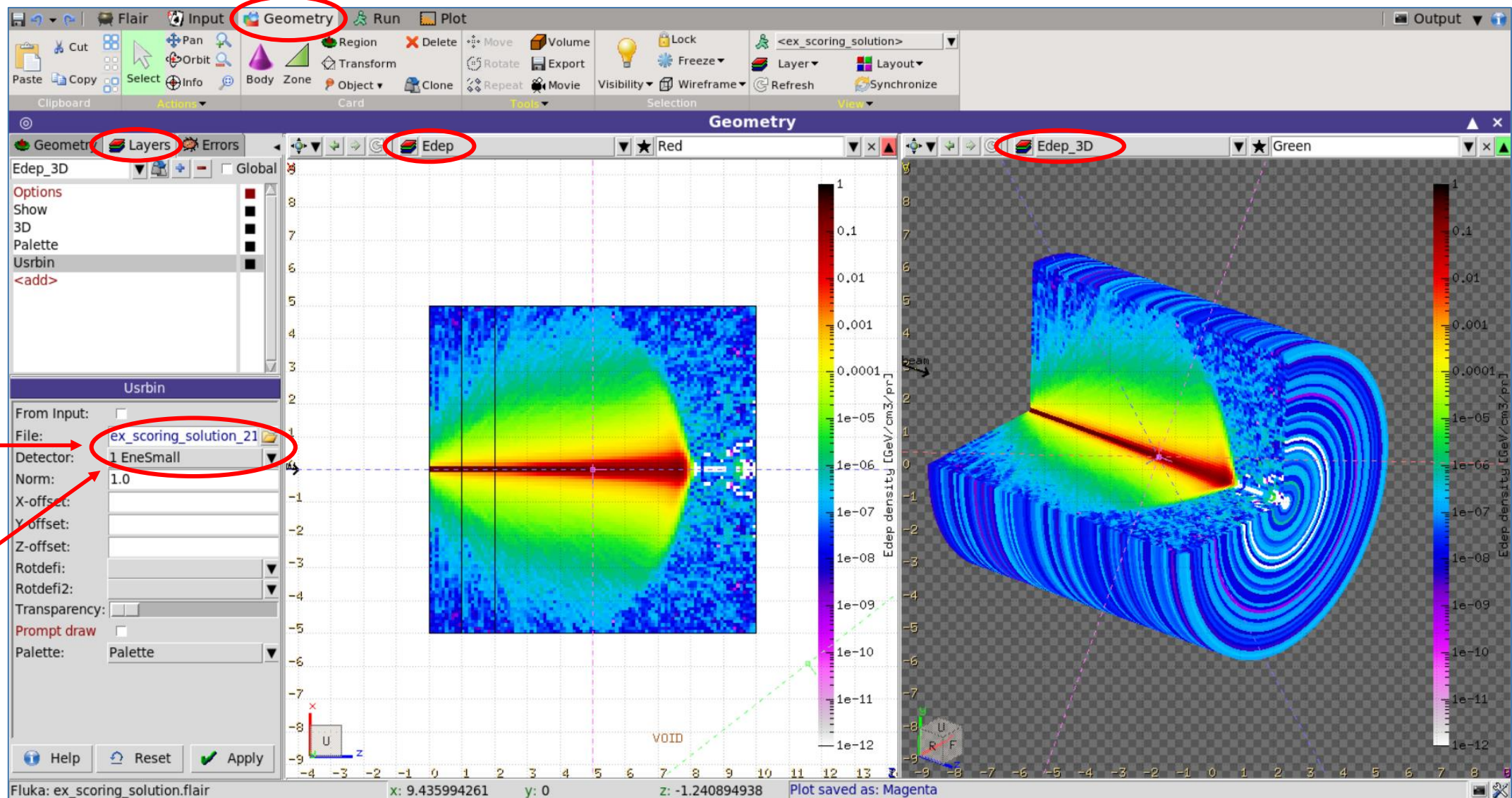


Geometry tab: Layers combination

- “(Sub-)layers” can be combined together via <add> button
 - Image & USRBIN
 - Custom color values & 3D
 - USRBIN & 3D
 - ...



Overlaying USRBIN mesh results on 2D/3D geometry

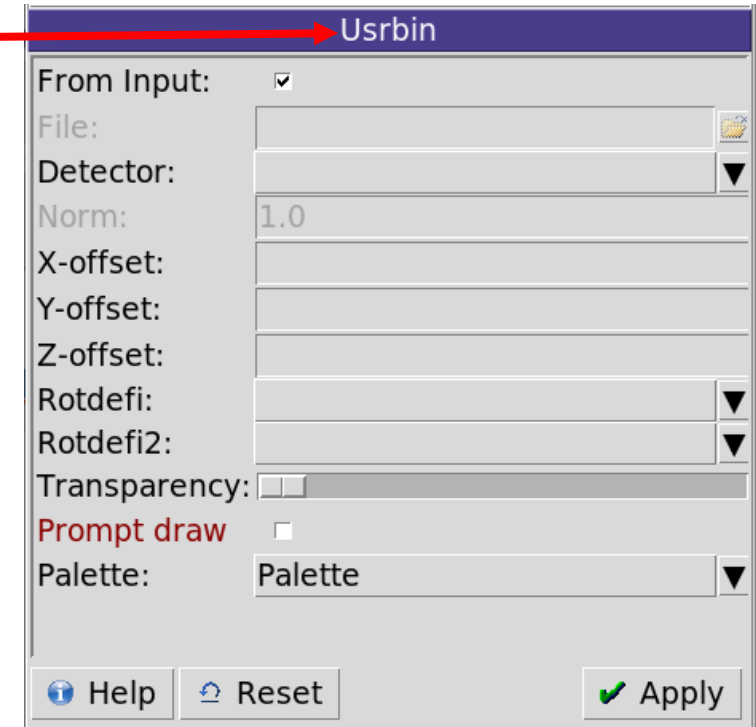
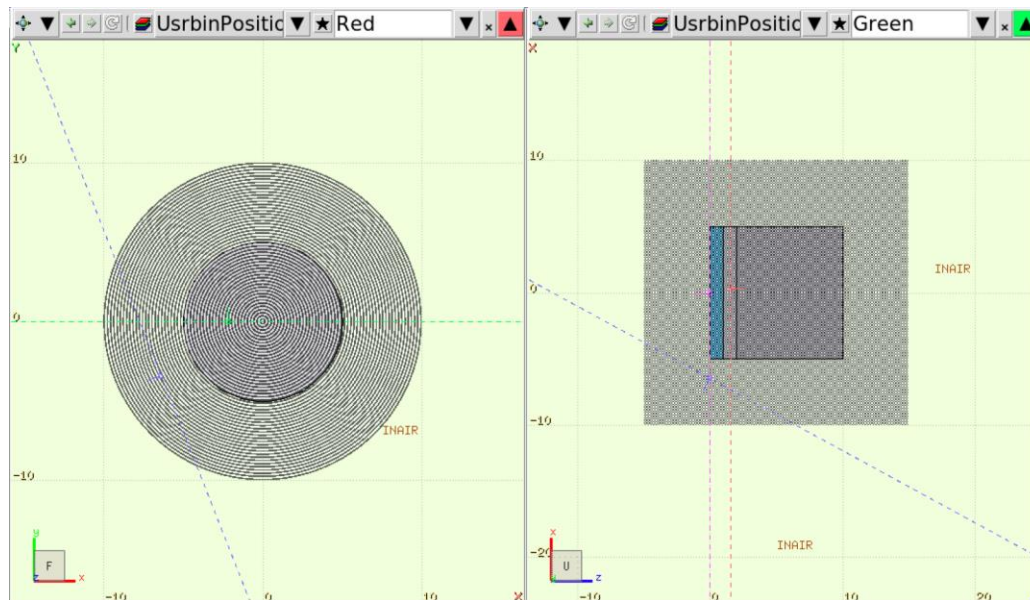


Merged file

Detector from file

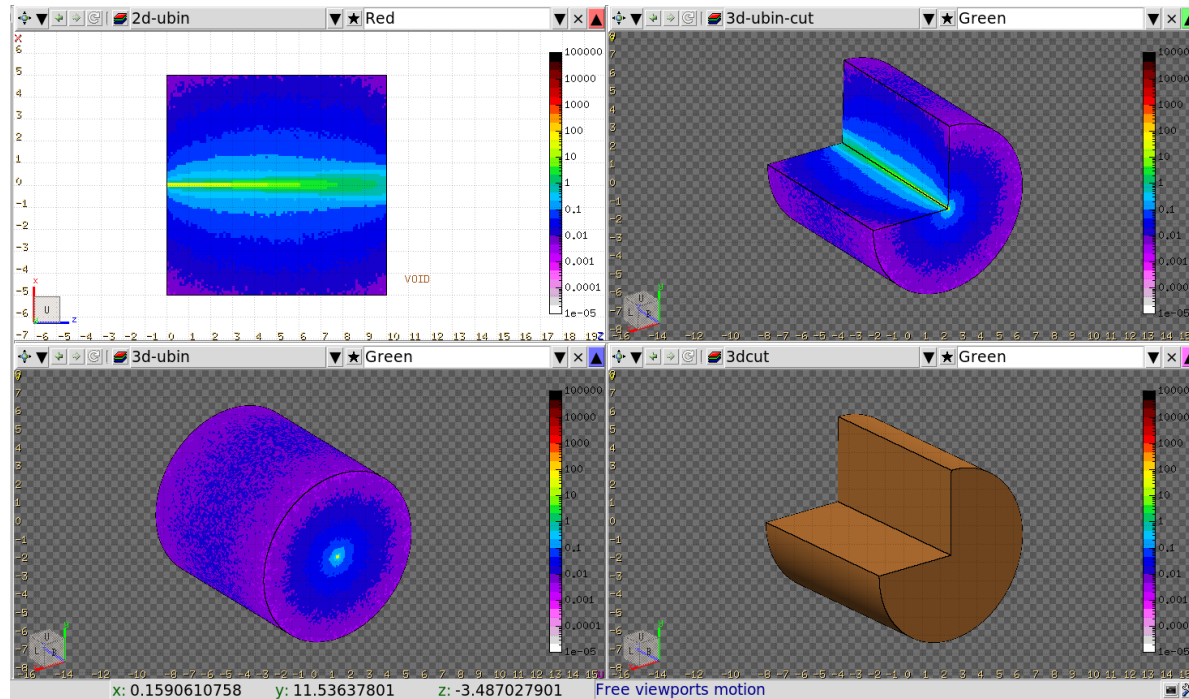
Geometry tab: Layers

- USRBIN (to show a USRBIN scoring)
 - Already seen in the first Flair lecture
 - Possible to add more USRBIN on the same layer
 - Possible to load a USRBIN from the input
 - Displayed with a checker pattern
 - Useful to the its location before running



Geometry tab: Layers

- 3D (to enable 3D rendering)
 - Plenty of options
 - **Red** indicate time consuming options
 - Select up to 3 bodies to cut the view
 - Project USRBIN info on up to 3 bodies



3D

Projection: Orthographic

FOV: [Slider]

Def. Lights:

Ambient Light: 64 [Slider]

Antialias: [Slider]

Quality: [Slider]

Shadows:

Ambient Occlusion: [Slider]

Edge Detection:

Skip BLCKHOLE:

Xray Level: 0 [Slider]

Clipped by: mycut

Clipped by #2:

Clipped by #3:

Project body: [Dropdown]

Project body #2: [Dropdown]

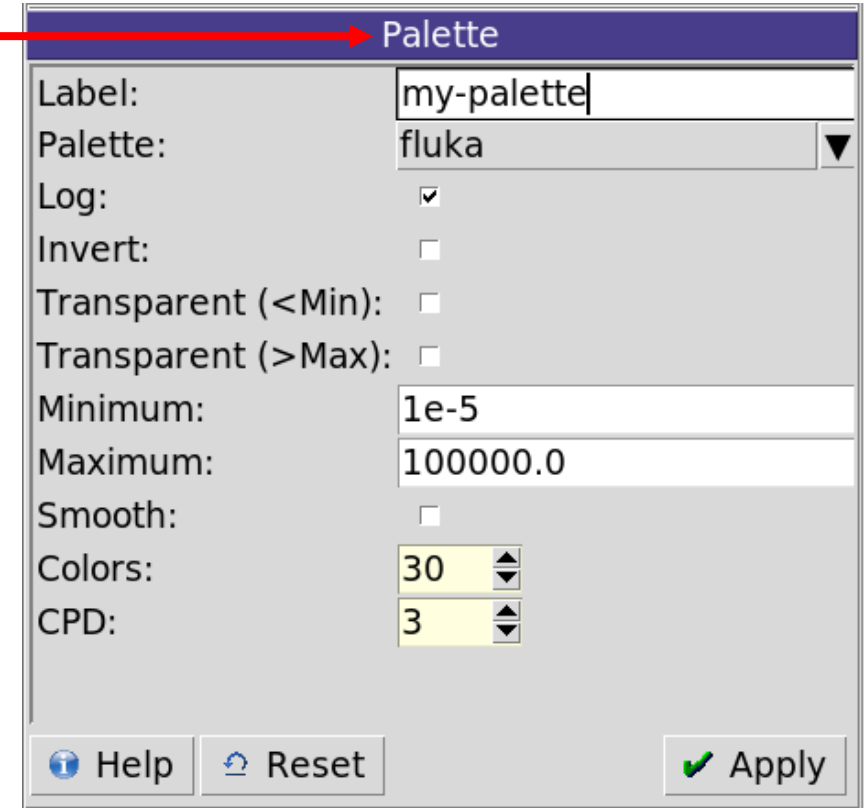
Project body #3: [Dropdown]

Usrbin as texture:

Help Reset Apply

Geometry tab: Layers

- Palette (to set palette properties)
 - Assign label
 - Change palette colors
 - Set linear or log scale
 - Set minimum and maximum values
 - Set color range



Palette

Label: my-palette

Palette: fluka ▼

Log:

Invert:

Transparent (<Min):

Transparent (>Max):

Minimum: 1e-5

Maximum: 100000.0

Smooth:

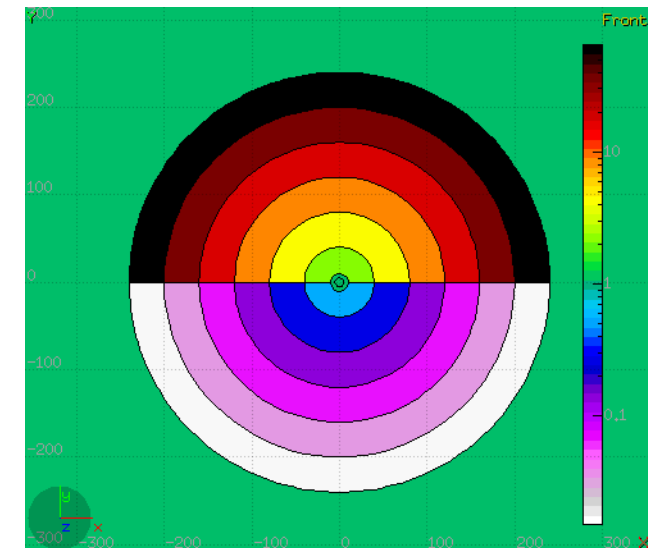
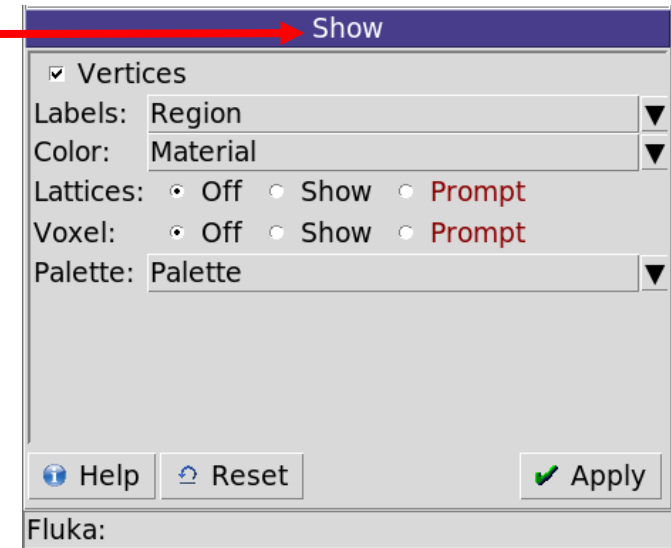
Colors: 30 ▲▼

CPD: 3 ▲▼

Help Reset Apply

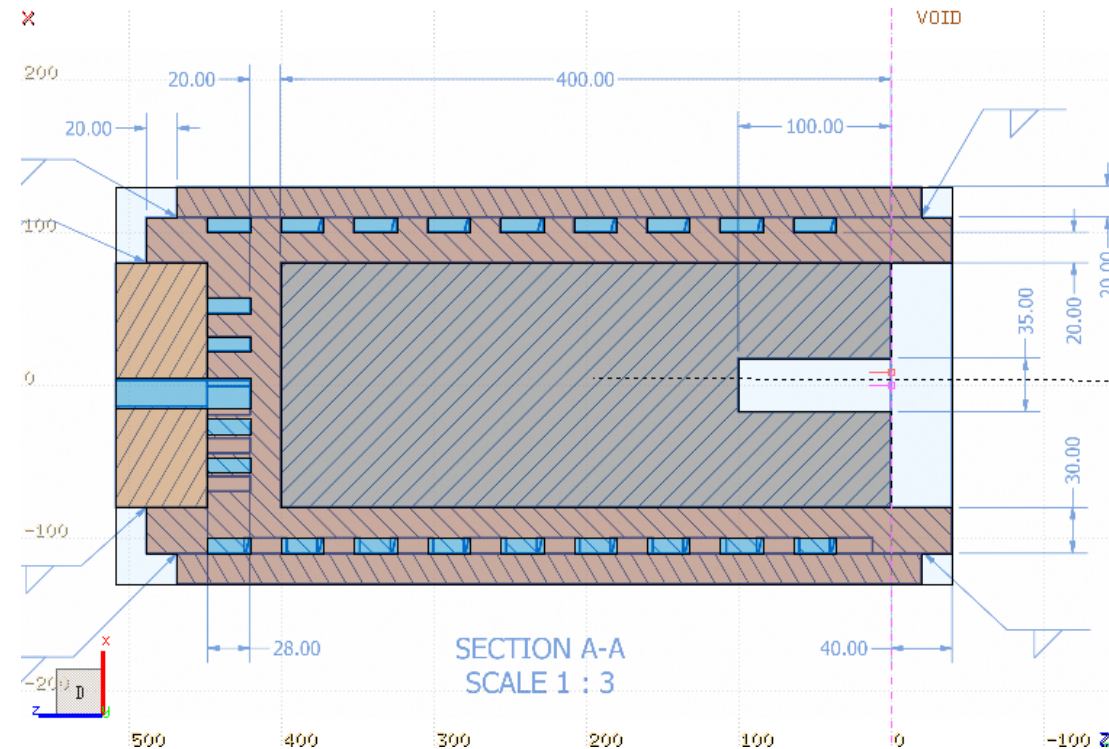
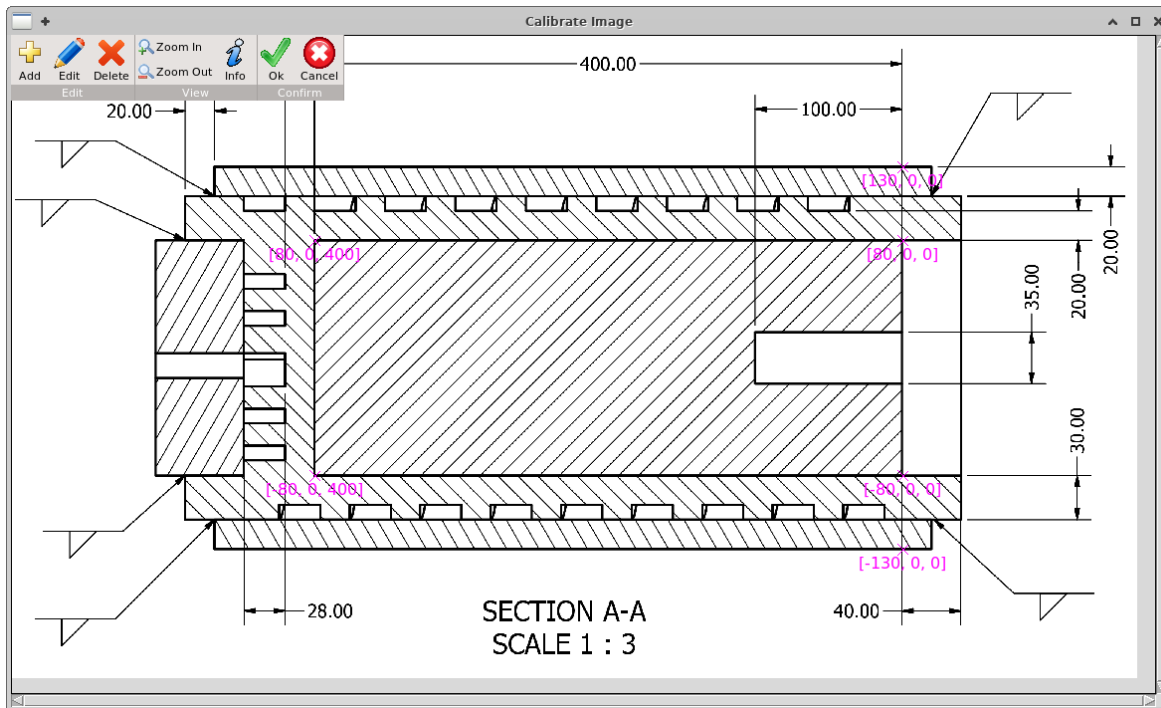
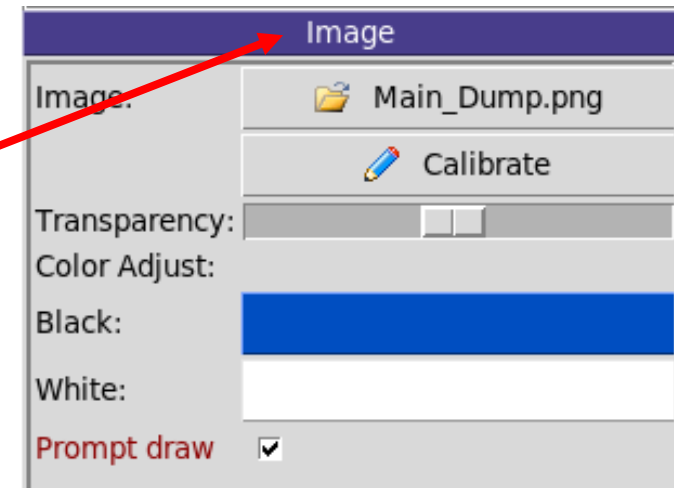
Geometry tab: Layers

- Show (to set visualization details)
 - Visibility of Vertices, Lattices, and Voxels
 - Set label (Region, Material, Value, or none)
 - Choose palette
 - Associate region color to:
 - Regions
 - Material
 - Density
 - Region Importance
 - Thresholds
 - ...



Geometry tab: Layers

- Image (to set a background image, i.e. a CAD drawing)
 - Image: select .png, .gif, or .jpg file
 - Calibrate: to input coordinates of specific points
 - Prompt draw: immediate image draw for idle display (warning: it slows flair)



Plotting example – energy deposition density

The screenshot displays the FLUKA software interface with the **Plot** window open. The window title is "Energy deposition density - small radial bin".

Plot ranges: The **Axes** section shows the following configuration:

Label	Log	Min	Max
x: Depth [cm]	<input type="checkbox"/>		
y: R [cm]	<input type="checkbox"/>	0.	
cb: Energy deposition density [GeV / cm ³ / primary]	<input checked="" type="checkbox"/>		

Merged file: The **Binning Detector** section shows the file "ex_scoring_solution_21.bnn" and the title "Scoring I exercise".

Mesh summary: The **Binning Info** section displays the following parameters:

- Det: 1 EneSmall
- R: [0 .. 5] x 50 (0.1) Min: 3.54415356E-15
- Type: 11: R- Φ -Z Φ : [-3.14159 .. 3.14159] x 1 (6.28319) Max: 0.269326478
- Score: ENERGY Z: [0 .. 10] x 100 (0.1) Int: 9.7808099523483308E-002

Type of plot: The **Projection & Limits** section shows the following configuration:

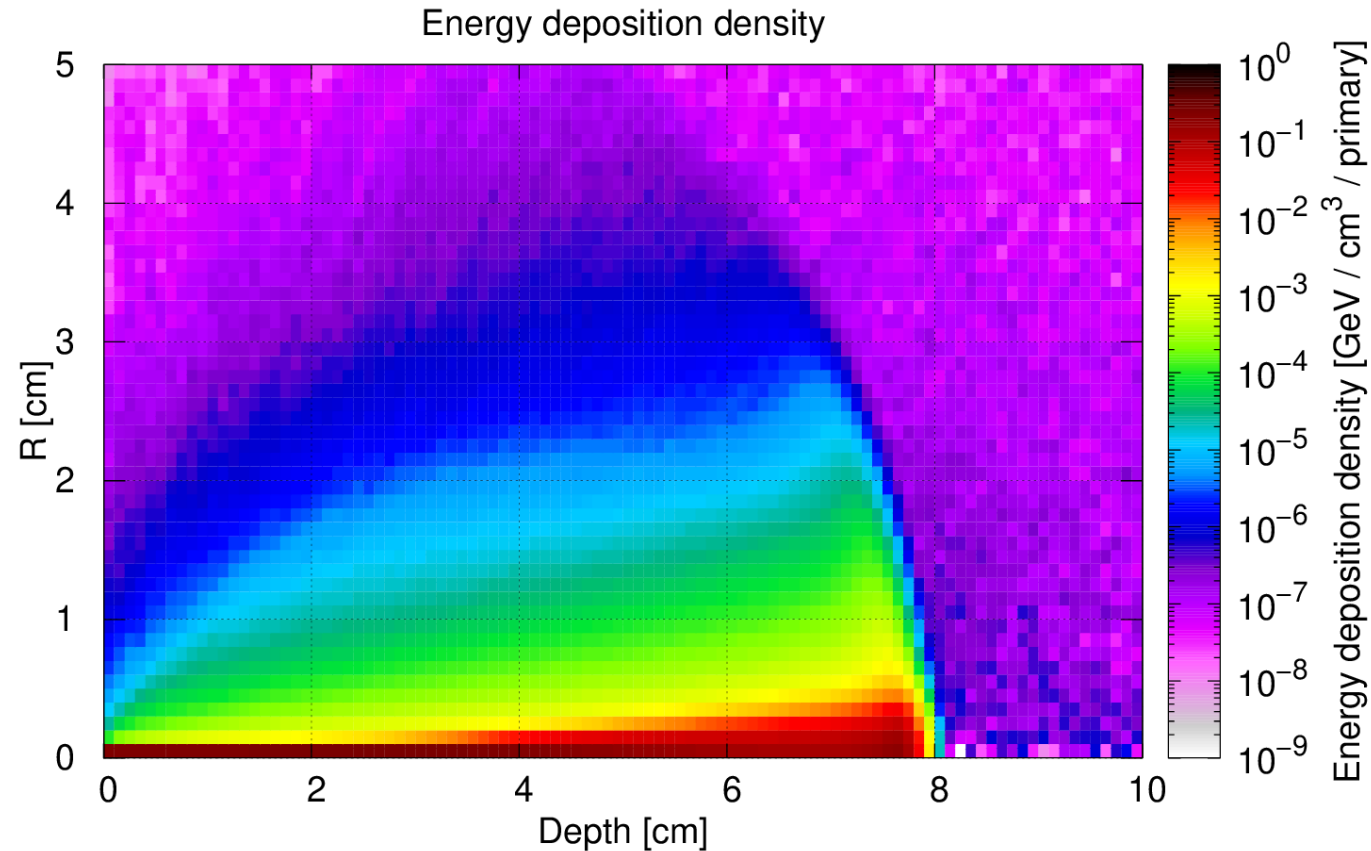
- R: 1
- Φ : 1
- Z: 1
- Norm: (empty)
- Type: 2D Projection
- Geometry: Use: -Auto-
- Pos: (empty)
- Axes: Auto

Detector from file: The **Plot List** on the left shows the following items:

- Red
- Green
- Blue
- Magenta
- 1_Bragg_peak
- 2_Energy_density_small_bin
- 2_Energy_density_small_bin_2D
- 2_Energy_density_large_bin
- 2_Edep_small_vs_large_bin
- 3_Edep_per_region
- 3_Edep_in_grid

The **Geometry** menu item in the top toolbar is circled in red. The **2_Energy_density_small_bin_2D** item in the **Plot List** is circled in red. The **1 EneSmall** detector name in the **Binning Info** section is circled in red. The **2D Projection** type in the **Projection & Limits** section is circled in red. The **Φ** radio button in the **Projection & Limits** section is circled in red.

Plotting example – energy deposition density



- **N.B.:** This plot is a **2D projection** of a 3D structure → **the result is the average over the 3rd coordinate** (Φ in the above case)
- Projection limits can be set in Flair

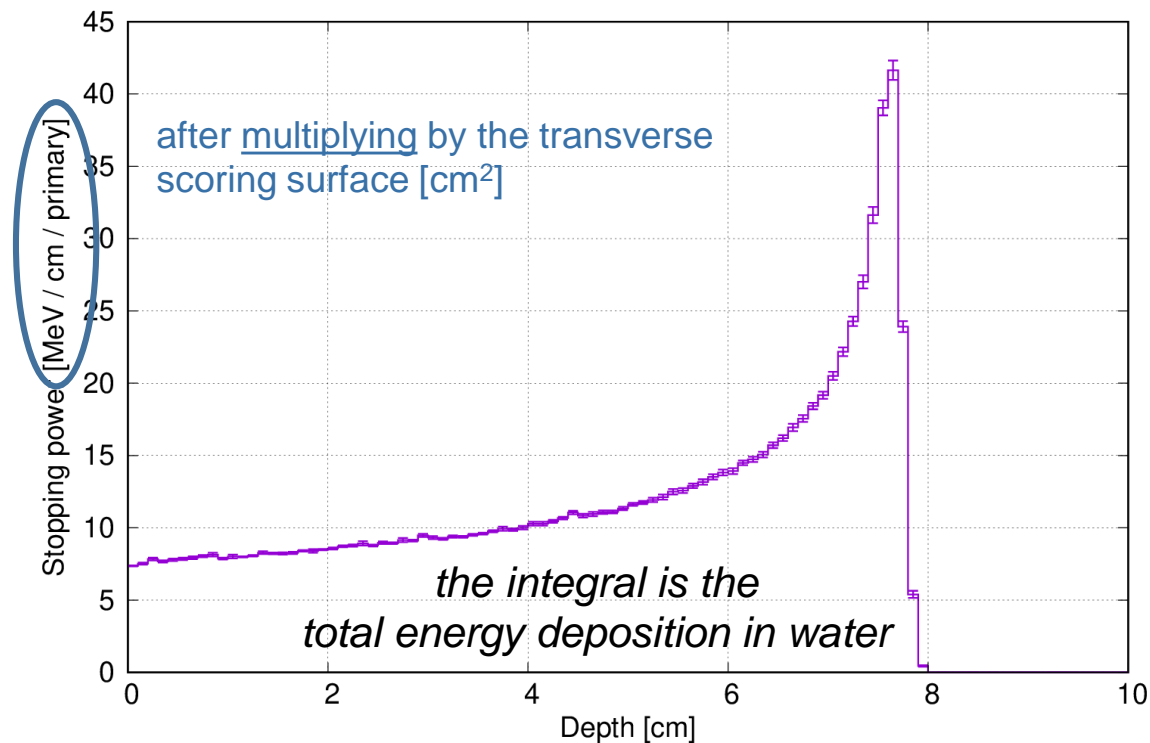
One dimensional plots

- 1D plots can be obtained from 3D **USRBIN** meshes, e.g. (for an R- Φ -Z mesh):

1D Projection

- The average of the values in each z-bin (i.e. over all R, Φ)

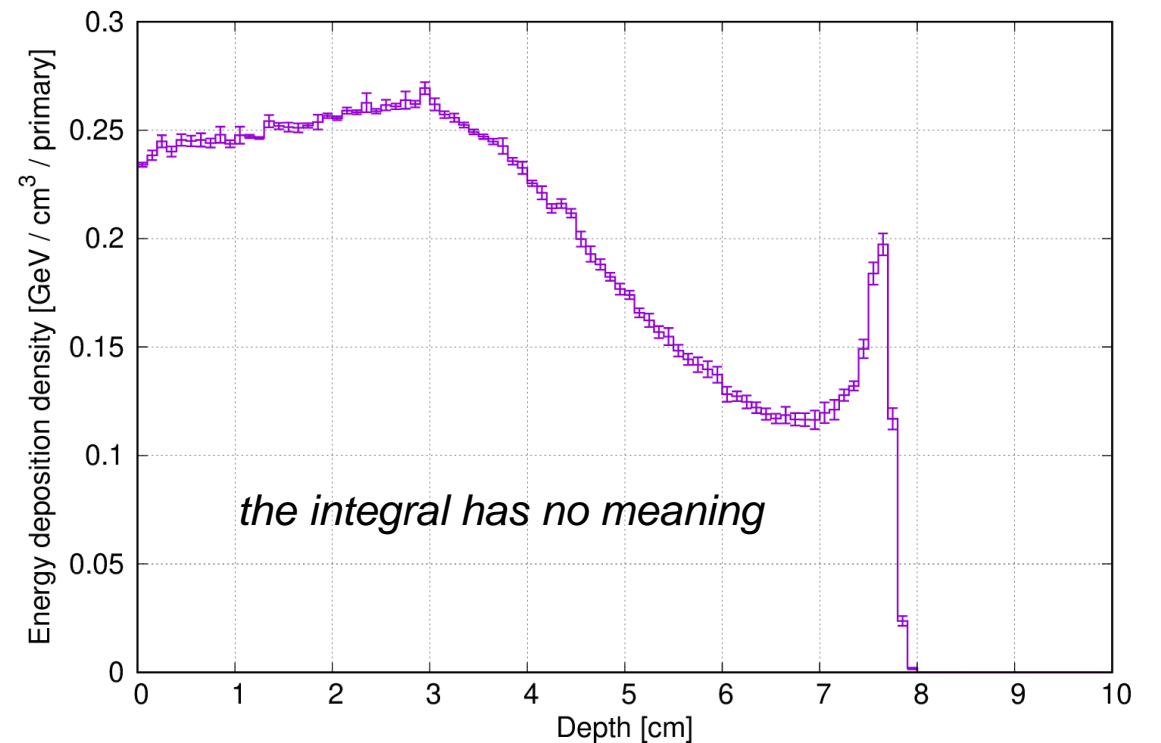
100 MeV proton Bragg peak in water



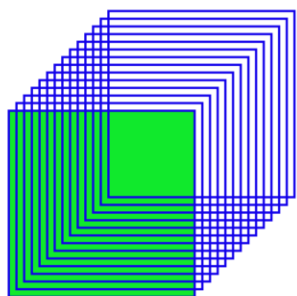
1D Max

- The highest value in each z-bin

Peak energy deposition density







FLUKA

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Código Monte Carlo de interação e transporte de partículas

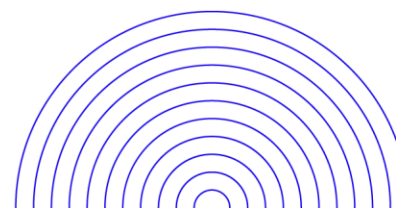
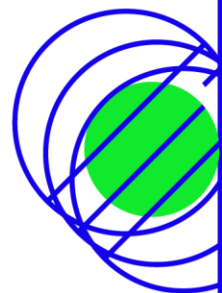
Pausa

Voltamos em 15 minutos

FLUKA

FLUKA

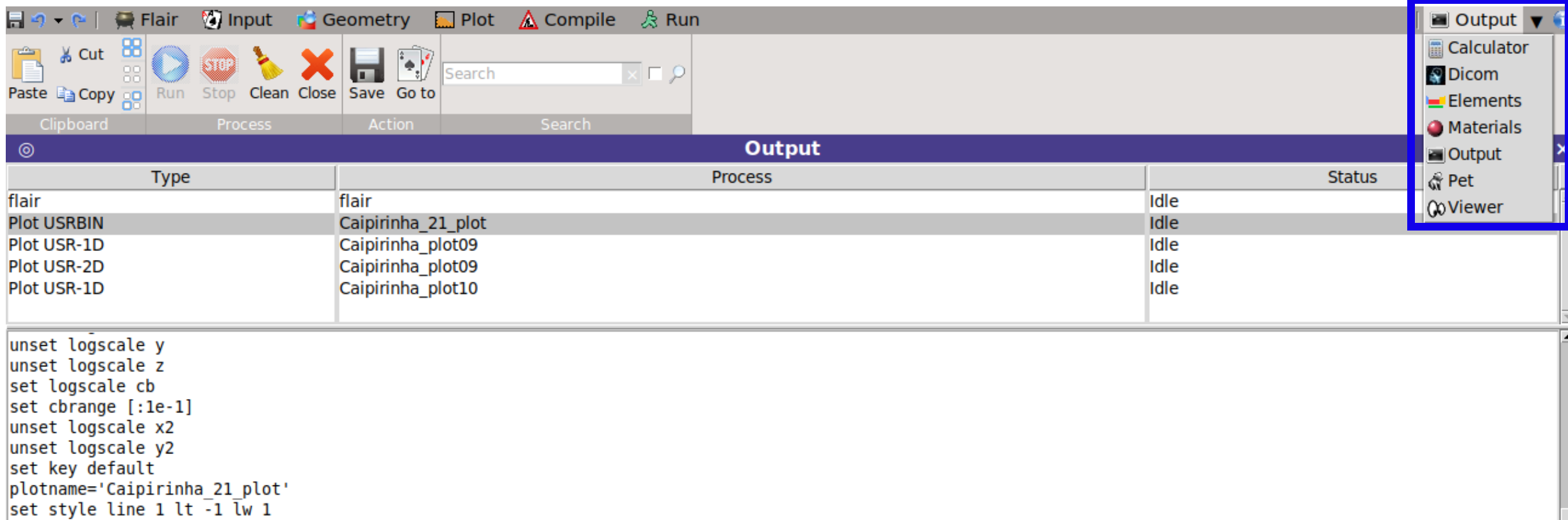
FLUKA



MINISTÉRIO DA
CIÊNCIA, TECNOLOGIA
E INOVAÇÃO



gnuplot no Flair



The screenshot shows the Flair software interface. The top toolbar includes icons for File, Edit, Process, Action, and Search. The main window is titled "Output" and contains a table with the following data:

Type	Process	Status
flair	flair	Idle
Plot USRBIN	Caipirinha_21_plot	Idle
Plot USR-1D	Caipirinha_plot09	Idle
Plot USR-2D	Caipirinha_plot09	Idle
Plot USR-1D	Caipirinha_plot10	Idle

Below the table, a gnuplot script is displayed:

```
unset logscale y
unset logscale z
set logscale cb
set cbrange [:1e-1]
unset logscale x2
unset logscale y2
set key default
plotname='Caipirinha_21_plot'
set style line 1 lt -1 lw 1
```

On the right side, a context menu is open, listing various tools: Output, Calculator, Dicom, Elements, Materials, Output, Pet, and Viewer. The "Output" option is highlighted.



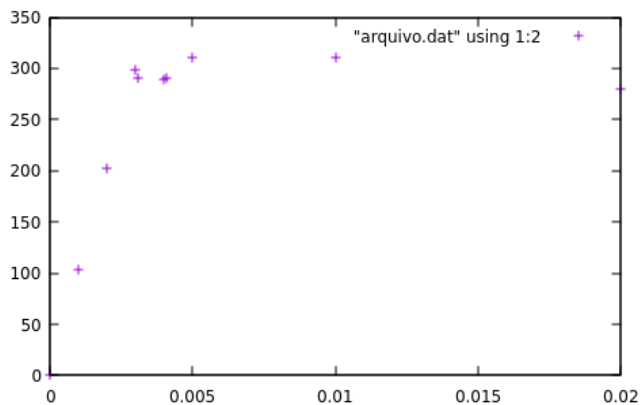
gnuplot – Plot 1D de arquivo

```
# Esse arquivo chama "arquivo.dat"
```

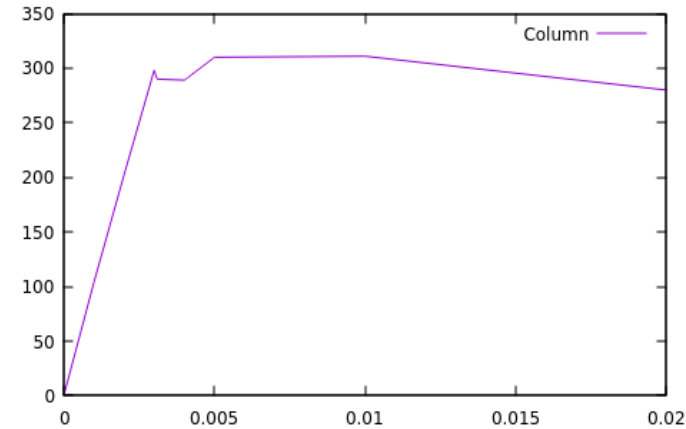
```
# Par1 Par2 Par3
```

```
0.000 0 0  
0.001 104 51  
0.002 202 101  
0.003 298 148  
0.0031 290 149  
0.004 289 201  
0.0041 291 209  
0.005 310 250  
0.010 311 260  
0.020 280 240
```

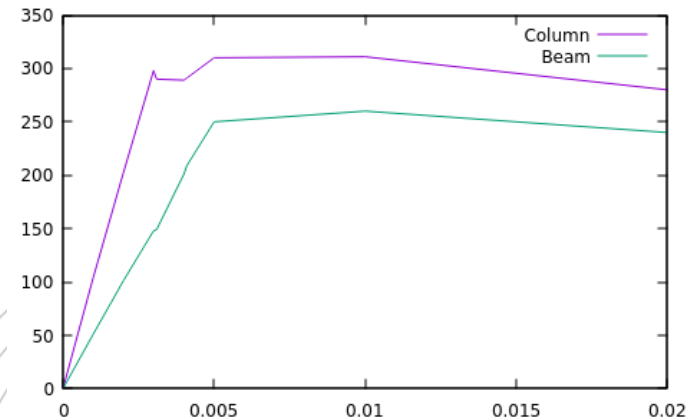
plot "arquivo.dat" using 1:2



plot "arquivo.dat" using 1:2 title 'Column' with lines

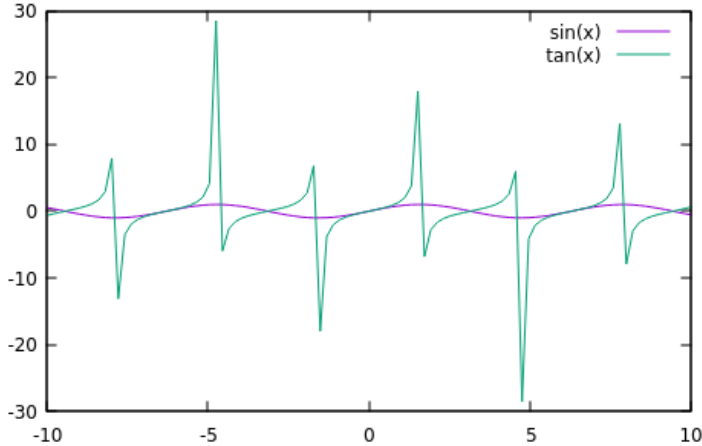


plot "arquivo.dat" using 1:2 title 'Column' with lines, \
"arquivo.dat" using 1:3 title 'Beam' with lines



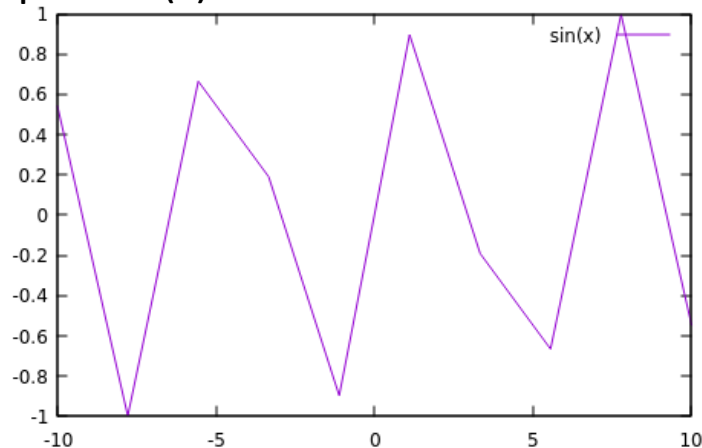
gnuplot – Plot 1D de funções

plot sin(x), tan(x)



set samples 10

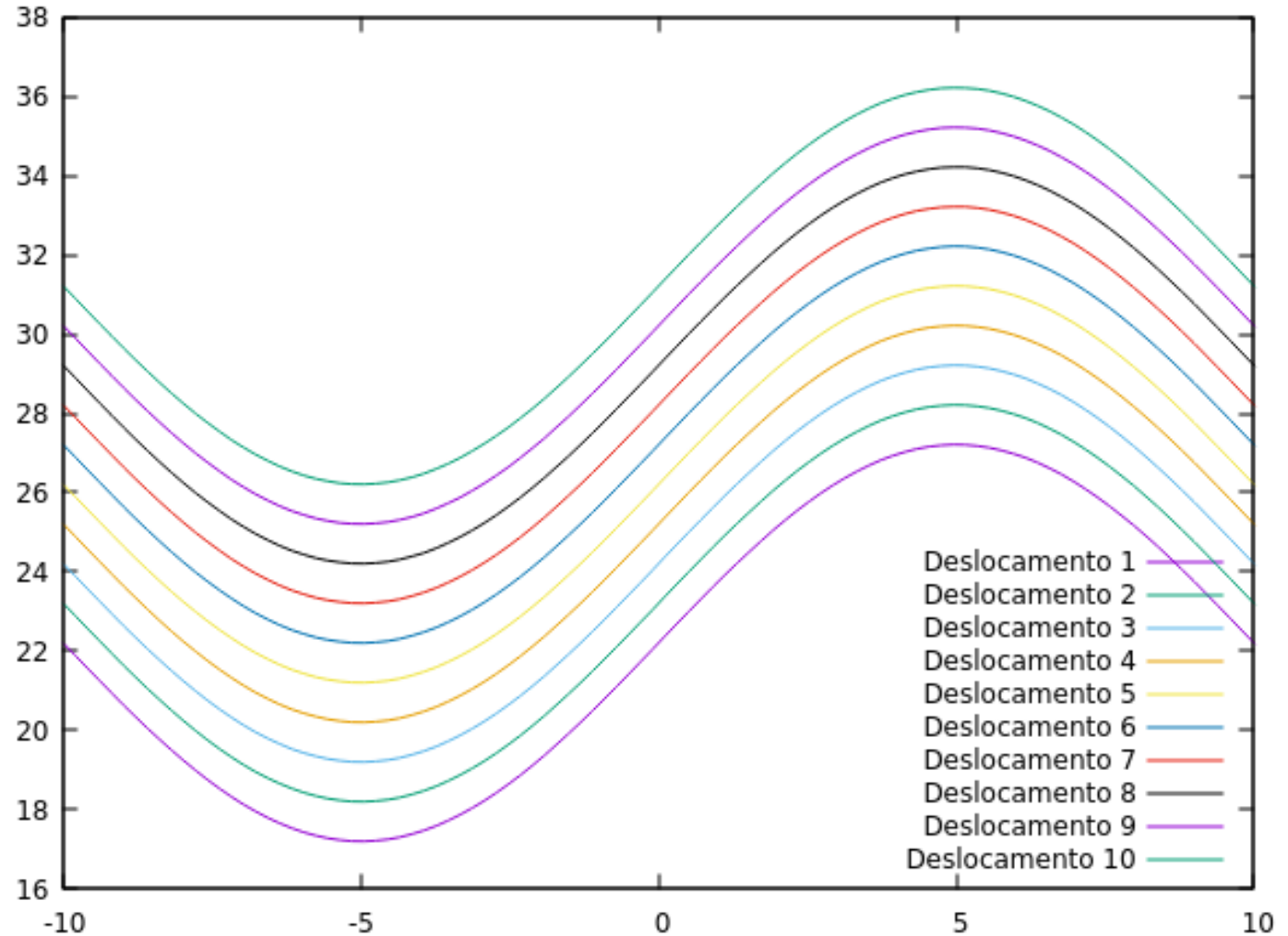
plot sin(x)



abs(x) absolute value of x, $|x|$
acos(x) arc-cosine of x
asin(x) arc-sine of x
atan(x) arc-tangent of x
cos(x) cosine of x, x is in radians.
cosh(x) hyperbolic cosine of x, x is in radians
erf(x) error function of x
exp(x) exponential function of x, base e
inverf(x) inverse error function of x
invnorm(x) inverse normal distribution of x
log(x) log of x, base e
log10(x) log of x, base 10
norm(x) normal Gaussian distribution function
rand(x) pseudo-random number generator
sgn(x) 1 if $x > 0$, -1 if $x < 0$, 0 if $x = 0$
sin(x) sine of x, x is in radians
sinh(x) hyperbolic sine of x, x is in radians
sqrt(x) the square root of x
tan(x) tangent of x, x is in radians
tanh(x) hyperbolic tangent of x, x is in radians

gnuplot – Variáveis e cálculos

```
per = 10  
amp = 5  
desloc = log(100)**2  
f(x) = amp * sin(pi*x/per) + (desloc + t)  
  
plot for [t=1:10] f(x) title 'Deslocamento 't
```



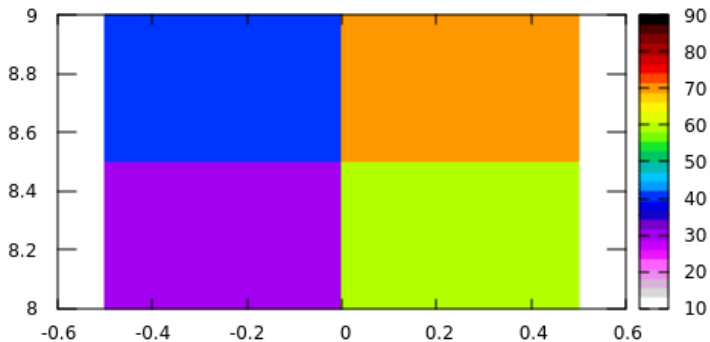
gnuplot – Plot 2D de arquivo

```
# Esse arquivo chama "arquivo.dat"
```

```
# x y cb  
-0.5 8.0 10.0  
-0.5 8.5 20.0  
-0.5 9.0 30.0  
  
0.0 8.0 40.0  
0.0 8.5 50.0  
0.0 9.0 60.0  
  
0.5 8.0 70.0  
0.5 8.5 80.0  
0.5 9.0 90.0
```

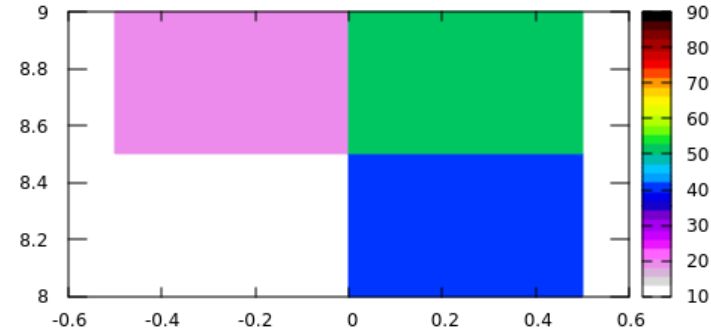
set pm3d map

plot "arquivo.dat" using 1:2:3 notitle



set pm3d map corners2color c1

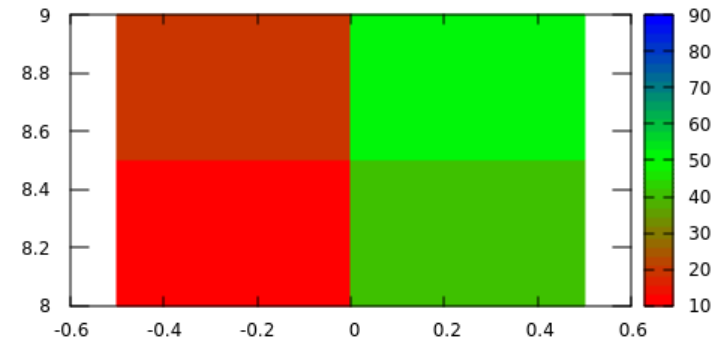
plot "arquivo.dat" using 1:2:3 notitle



set pm3d map corners2color c1

set palette defined (1. 1 0 0, 2. 0 1 0, 3. 0 0 1)

plot "arquivo.dat" using 1:2:3 notitle



gnuplot – Plot 2D "soma" de 2 arquivos

```
# Esse arquivo chama "arquivo1.dat"
```

```
# x1 y1 cb1
-0.5 8.0 10.0
-0.5 8.5 10.0
-0.5 9.0 10.0
```

```
0.0 8.0 10.0
0.0 8.5 10.0
0.0 9.0 10.0
```

```
0.5 8.0 10.0
0.5 8.5 10.0
0.5 9.0 10.0
```

```
# Esse arquivo chama "arquivo2.dat"
```

```
# x2 y2 cb2
-0.5 8.0 20.0
-0.5 8.5 20.0
-0.5 9.0 20.0
```

```
0.0 8.0 20.0
0.0 8.5 20.0
0.0 9.0 20.0
```

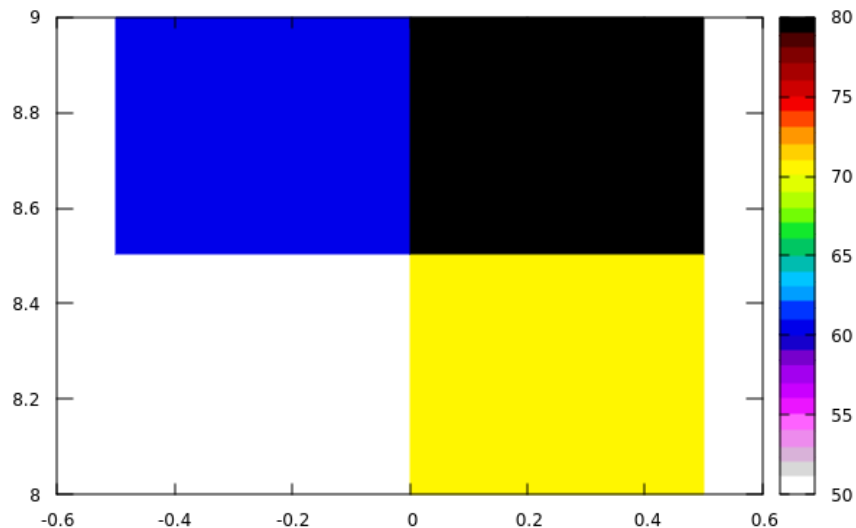
```
0.5 8.0 20.0
0.5 8.5 20.0
0.5 9.0 20.0
```

```
# Resultado do <paste
```

```
# x1 y1 cb1 x2 y2 cb2
-0.5 8.0 10.0 -0.5 8.0 20.0
-0.5 8.5 10.0 -0.5 8.5 20.0
-0.5 9.0 10.0 -0.5 9.0 20.0
```

```
0.0 8.0 10.0 0.0 8.0 20.0
0.0 8.5 10.0 0.0 8.5 20.0
0.0 9.0 10.0 0.0 9.0 20.0
```

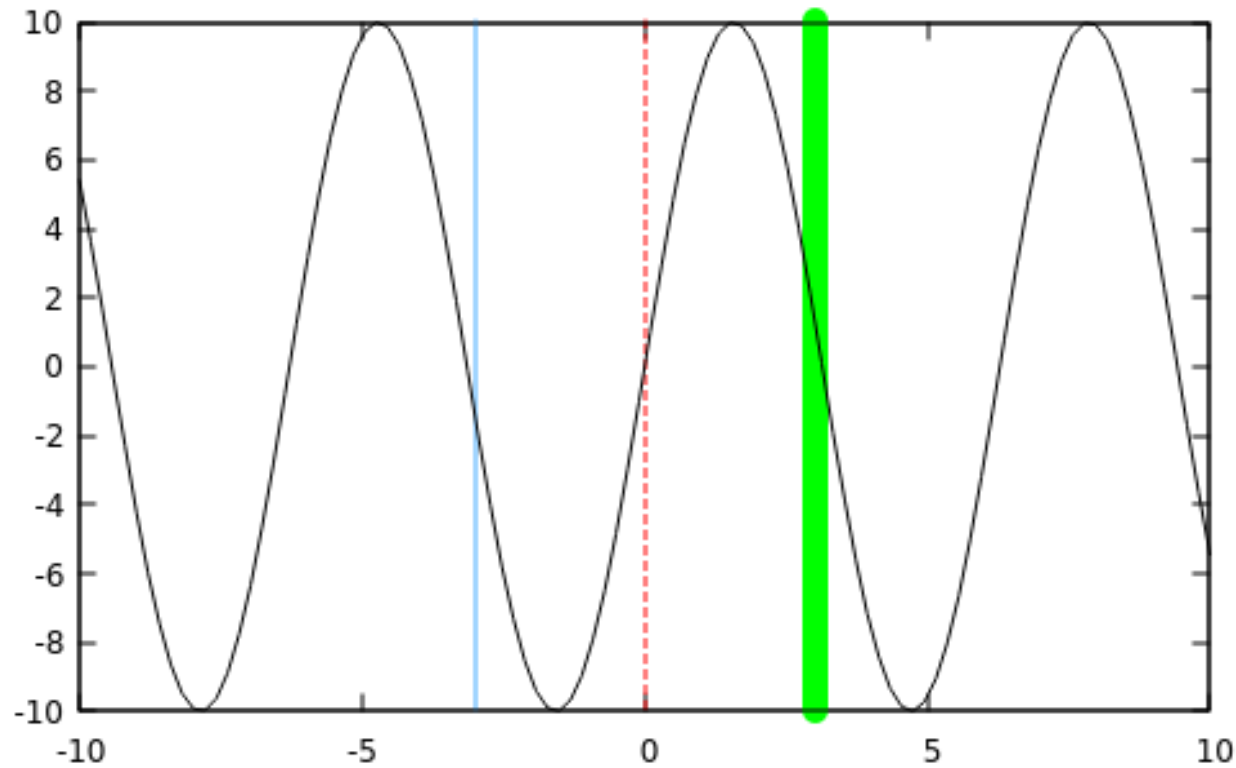
```
0.5 8.0 10.0 0.5 8.0 20.0
0.5 8.5 10.0 0.5 8.5 20.0
0.5 9.0 10.0 0.5 9.0 20.0
```



```
plot '<paste arquivo1.dat arquivo2.dat' us 1:2:($3+$6) notitle front
```


gnuplot – Alterando linhas

```
set arrow from -3, graph 0 to -3, graph 1 nohead linecolor "#0044ABFF"  
set arrow from 0, graph 0 to 0, graph 1 nohead linecolor "#00FF0000" dashtype 2  
set arrow from 3, graph 0 to 3, graph 1 nohead linecolor "green" linewidth 10  
plot 10*sin(x) notitle lc "#00000000"
```



linetype		lt	Tipo de linha
linecolor		lc	Cor da linha
linewidth		lw	Tamanho da linha
pointtype		pt	Tamanho do ponto
pointsize		ps	Tipo do ponto

gnuplot – Alterando linhas

Gnuplot line and point types

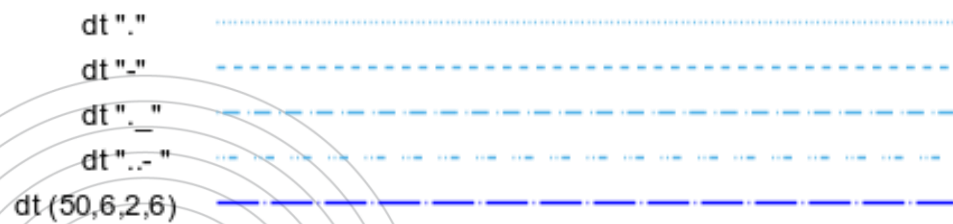
-1	—				
0	---				
1	— +	41	---	81	121
2	— x	42	---	82	122
3	— *	43	---	83	123
4	— □	44	---	84	124
5	— ■	45	---	85	125
6	— ○	46	---	86	126
7	— ●	47	---	87	127
8	— ▲	48	---	88	128
9	— △	49	---	89	129
10	— ▽	50	---	90	130
11	— ▾	51	---	91	131
12	— ◆	52	---	92	132
13	— ◇	53	---	93	133
14	— ○	54	---	94	134
15	— ●	55	---	95	135
16	— ○	56	---	96	136
17	— ○	57	---	97	137
18	— ○	58	---	98	138
19	— ○	59	---	99	139
20	— ○	60	---	100	140
21	— ○	61	---	101	141
22	— ○	62	---	102	142
23	— ○	63	---	103	143
24	— ○	64	---	104	144
25	— ○	65	---	105	145
26	— ○	66	---	106	146
27	— ○	67	---	107	147
28	— ○	68	---	108	148
29	— ○	69	---	109	149
30	— ○	70	---	110	150
31	— ○	71	---	111	151
32	— ○	72	---	112	152
33	— ○	73	---	113	153
34	— ○	74	---	114	154
35	— ○	75	---	115	155
36	— ○	76	---	116	156
37	— ○	77	---	117	157
38	— ○	78	---	118	158
39	— ○	79	---	119	159
40	— ○	80	---	120	160

linetype | lt Tipo de linha
 linecolor | lc Cor da linha
 linewidth | lw Tamanho da linha
 pointtype | pt Tamanho do ponto
 pointsize | ps Tipo do ponto

Terminal's native dashtypes



Custom dashtypes



gnuplot – Caixas de texto

```
set label "Texto 1" at 0,5
```

```
# Fontes, Estilos e Âncora dos textos
```

```
set label "Texto 2" at -5,-1 left textcolor "red" font ',14'
```

```
set label "Texto 3" at -5,-3 center tc "red" font 'Symbol,14'
```

```
set label "Texto 4" at -5,-5 right tc "red" font 'Times,14'
```

```
# Rotação
```

```
set label "Texto 5" at 0,-1 center rotate by 30
```

```
set label "Texto 6" at 0,-3 rotate by 180
```

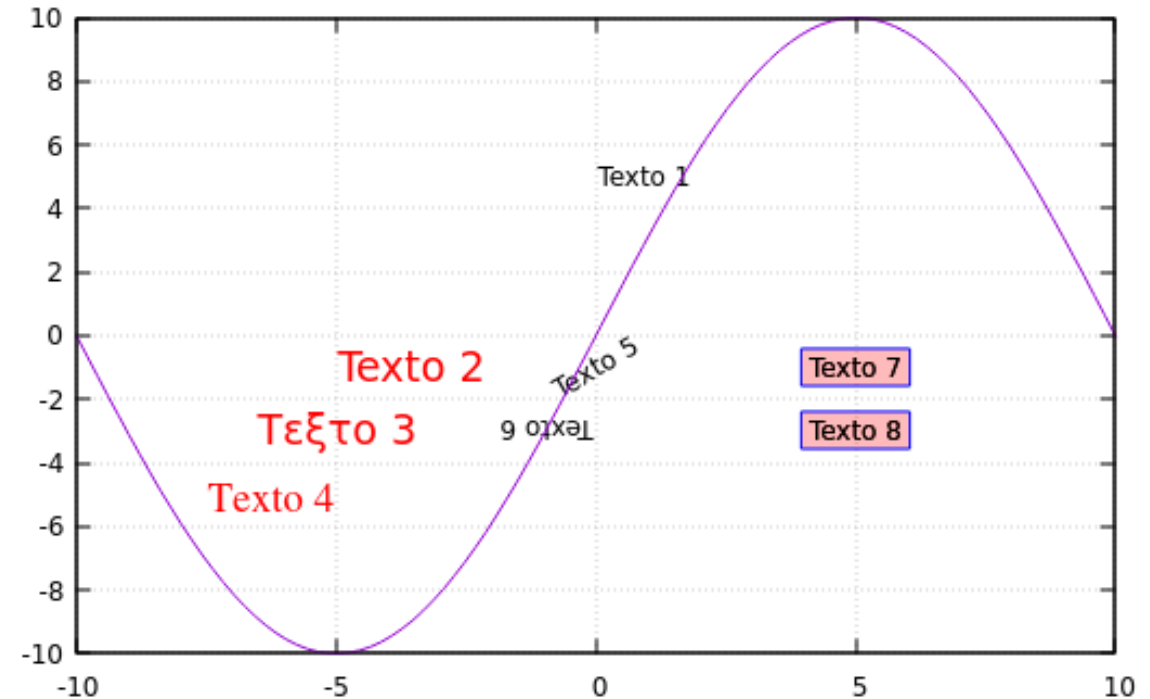
```
# Texto dentro de caixa
```

```
set style textbox opaque fillcolor "#bbff0000" border linecolor "blue"
```

```
set label "Texto 7" at 5, -1 center boxed front
```

```
set label "Texto 8" at 5, -3 center boxed front
```

```
plot 10*sin(pi*x/10) notitle
```



gnuplot – Objetos

```
set object rect from -1,-1 to 2,3  
set object rect from -4,2 to 0,5 fillcolor "#bb0000FF" fillstyle noborder  
set object rect from 3,-4 to 7,3 fc "#bbFF00FF" fs pattern 5 border lc "green"
```

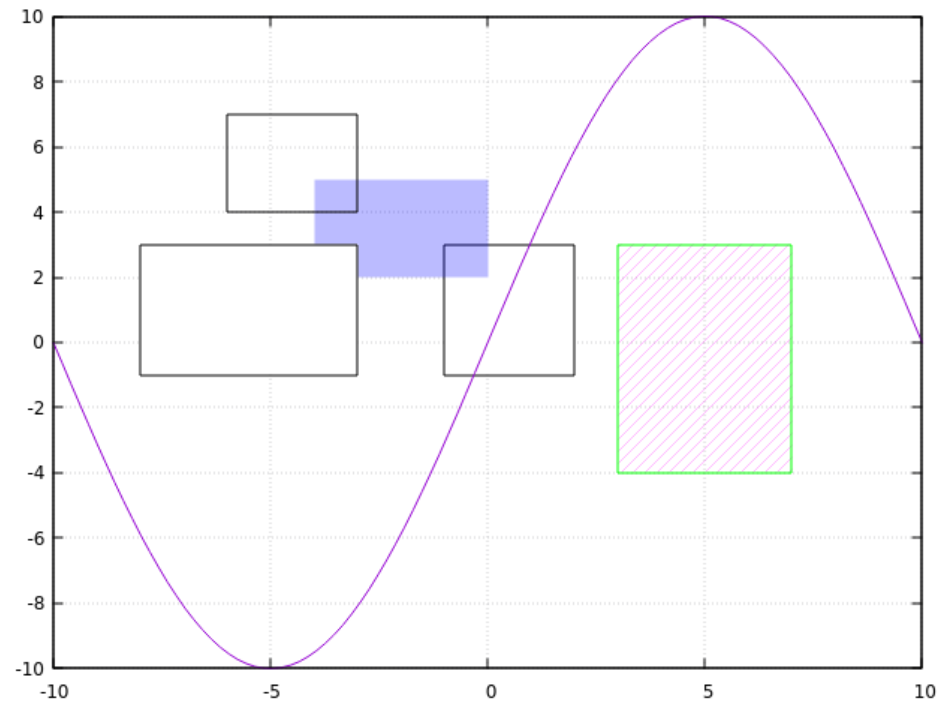
Sobreposto cheio

```
set object rect from -8,-1 to -3,3
```

Sobreposto com fundo transparente

```
set object rect from -6,7 to -3,4 fc "#FF000000"
```

```
plot 10*sin(pi*x/10) notitle
```

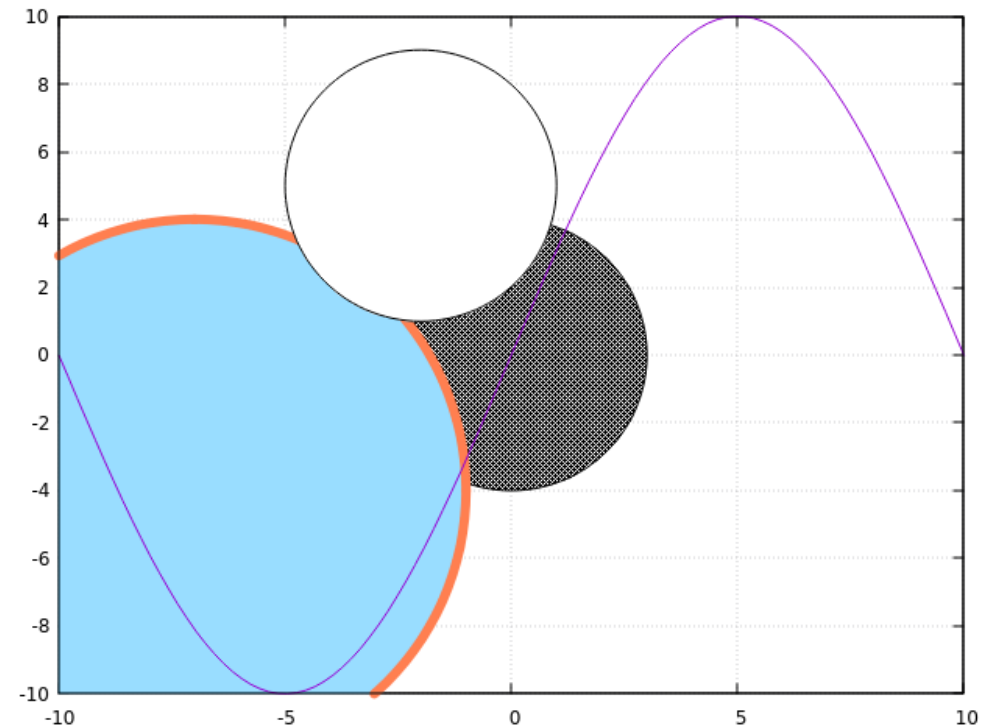


```
set object circle at -2,5 size 3 front
```

```
set object circle at graph 0.5, 0.5 size 4.5 fc "black" fs pattern 2
```

```
set object circle at -7,-4 size 6 fc "#9900ABFF" fs pattern 3 border lc "coral" lw 6
```

```
plot 10*sin(pi*x/10) notitle
```



gnuplot – Outros comandos

Título do gráfico:	<code>set title "Force-Deflection Data"</code>
Título do eixo x:	<code>set xlabel "Deflection (meters)"</code>
Título do eixo y:	<code>set ylabel "Force (kN)"</code>
Tirar todos os títulos:	<code>unset label</code>
Mover a legenda:	<code>set key 0.01,100</code>
Mover a legenda pra esquerda	<code>set key left</code>
Tirar a legenda:	<code>unset key</code>
Colocar caixa na legenda	<code>set key box</code>
Mudar o alcance do eixo x:	<code>set xrange [0.001:0.005]</code>
Mudar o alcance do eixo y:	<code>set yrange [20:500]</code>
Alcances automáticos:	<code>set autoscale</code>
Plotar em escala logarítmica:	<code>set logscale</code>
Plotar em escala log em y:	<code>unset logscale; set logscale y</code>
Mudar o "tics" do eixo x:	<code>set xtics (0.002,0.004,0.006,0.008)</code>
Voltar para o tics padrão:	<code>unset xtics; set xtics auto</code>
Salvar o gráfico em png:	<code>set term png; set output "plot.png"</code>

CURSO INTRODUTÓRIO



23 DE JANEIRO
A 8 DE MARÇO
DE 2023

AULA 08

Detectores – USRBIN (parte II)

Obrigado pela participação!

Código Monte Carlo de interação e transporte de partículas

