# Real-time beam profiles using SIMION and gnuplot

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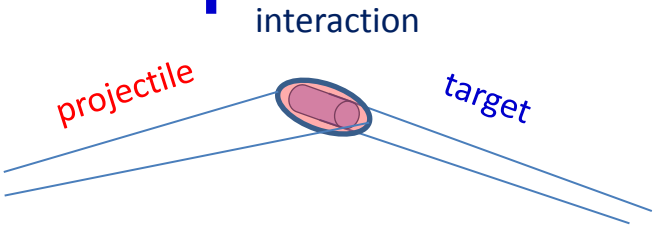
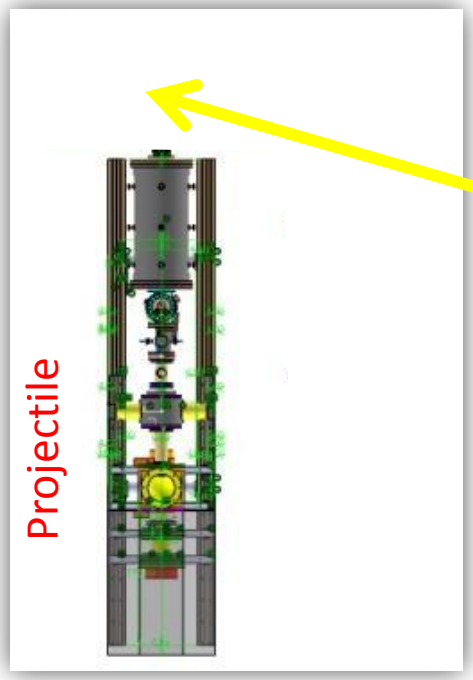
# Introduction

- Ion beam - optical element design and characterization
- Singly charged ions : $Ar^+$ and $He^+$ (and all rare gas)
- Energy range :  up to 20 keV

# PIBALE Experimental setup



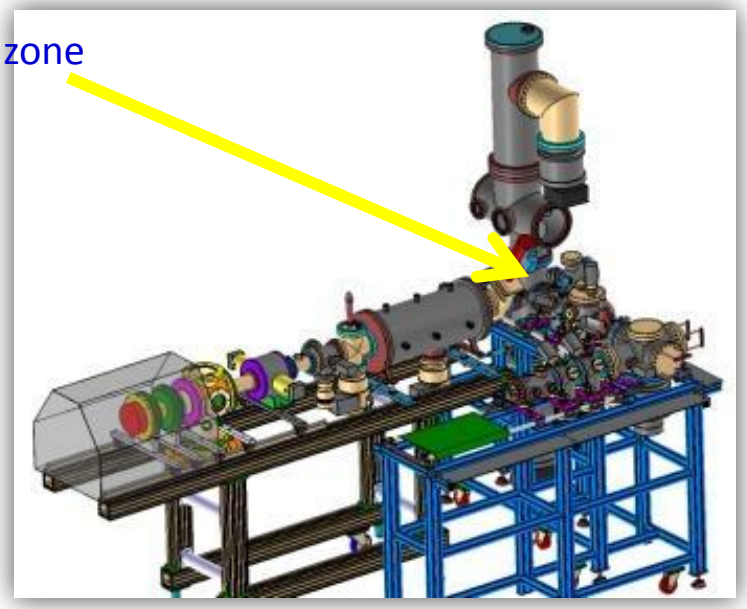

## Top view



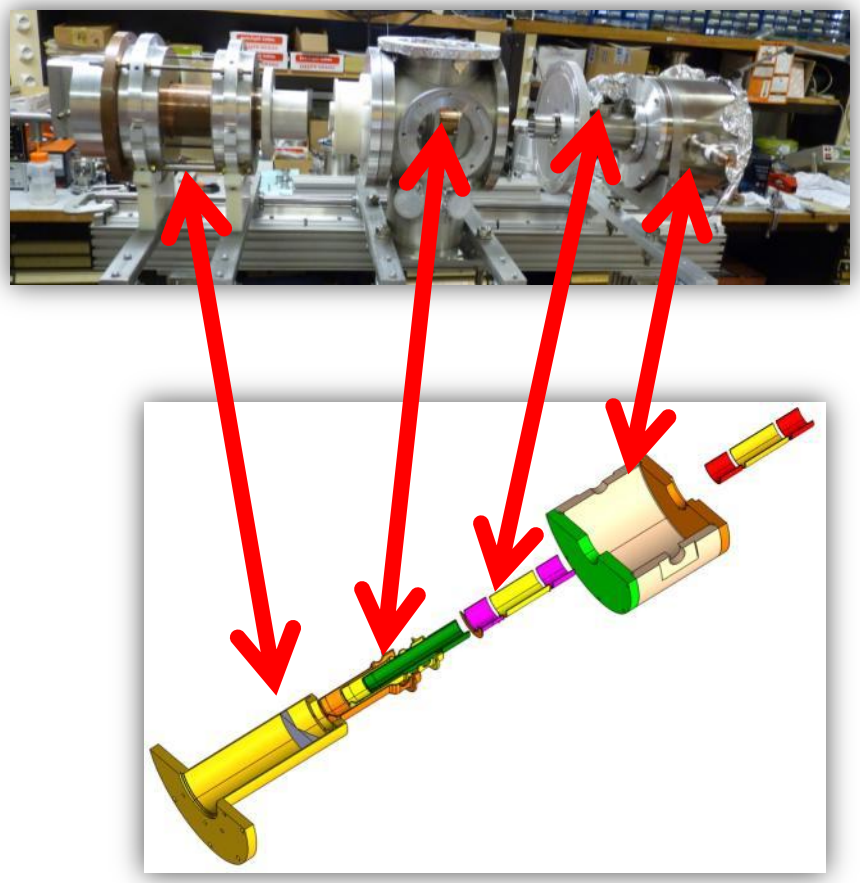

MONO1000

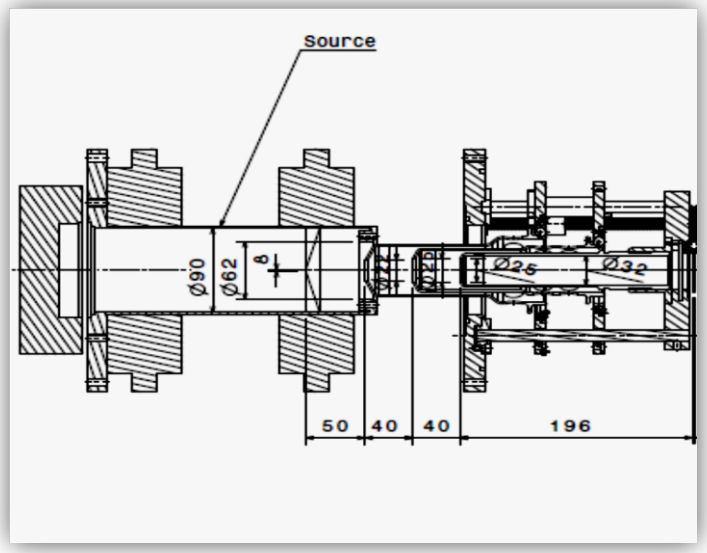
Interaction zone

## 3D side view



# Source and beamline

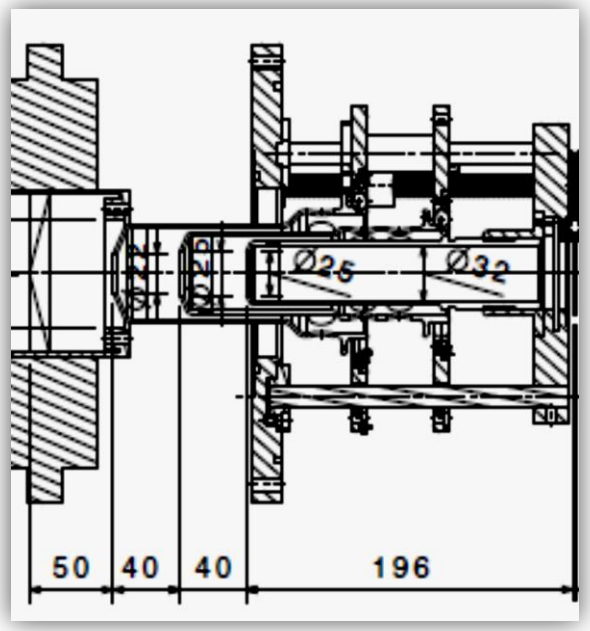


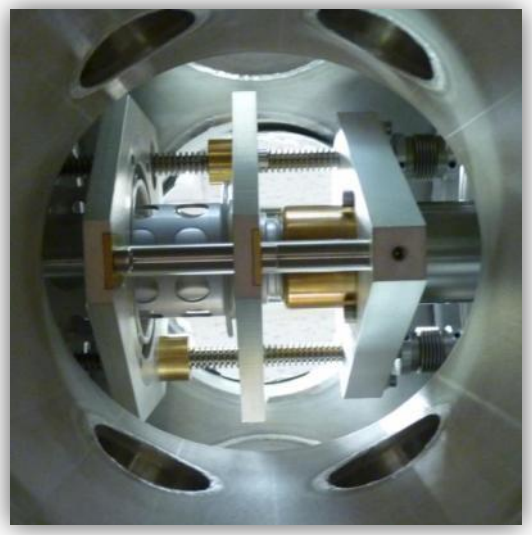


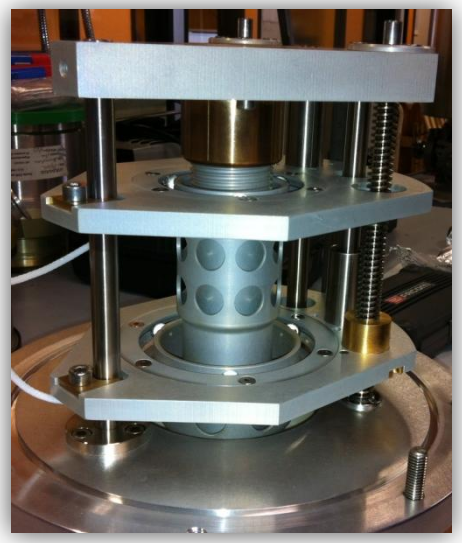

Rémi Maisonny, PhD thesis (2011)

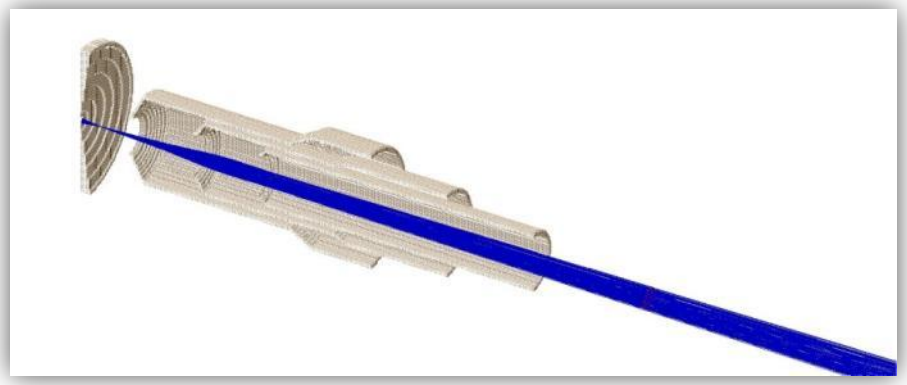
Jardin *et al.*, Rev. Sci. Instrum. 73, 789 (2002)

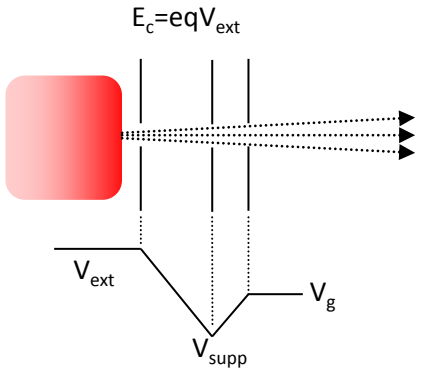
# Extraction lens



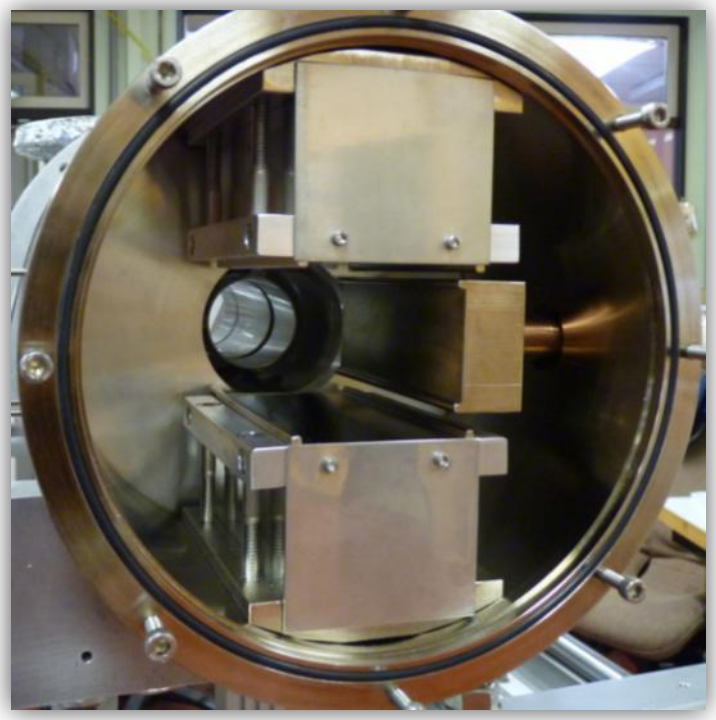




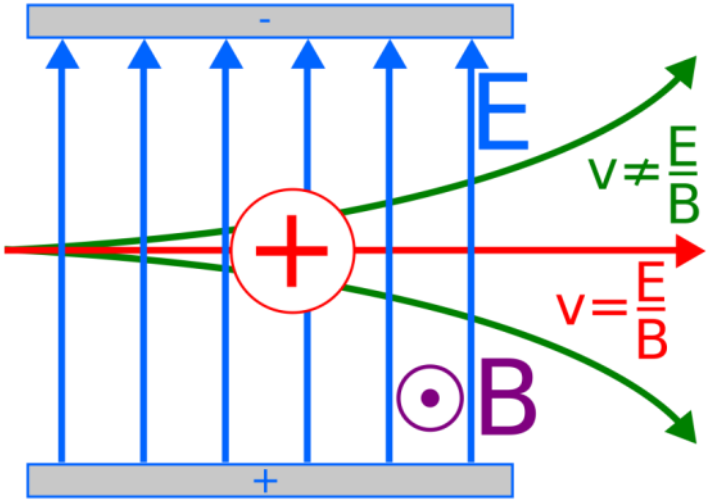



Rémi Maisonny, PhD thesis (2011)

# Wien filter



$$F = qE = qvB$$

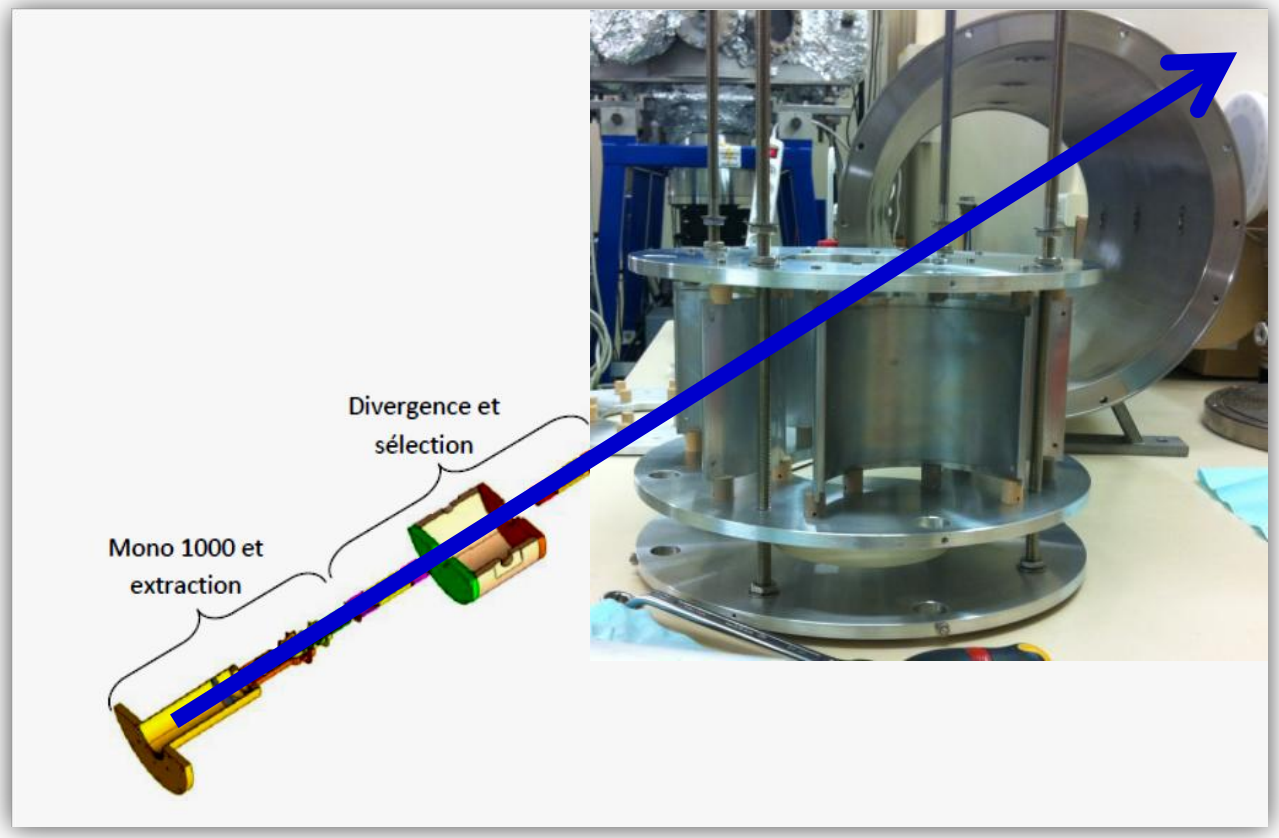



http://en.wikipedia.org/wiki/Wien_filter

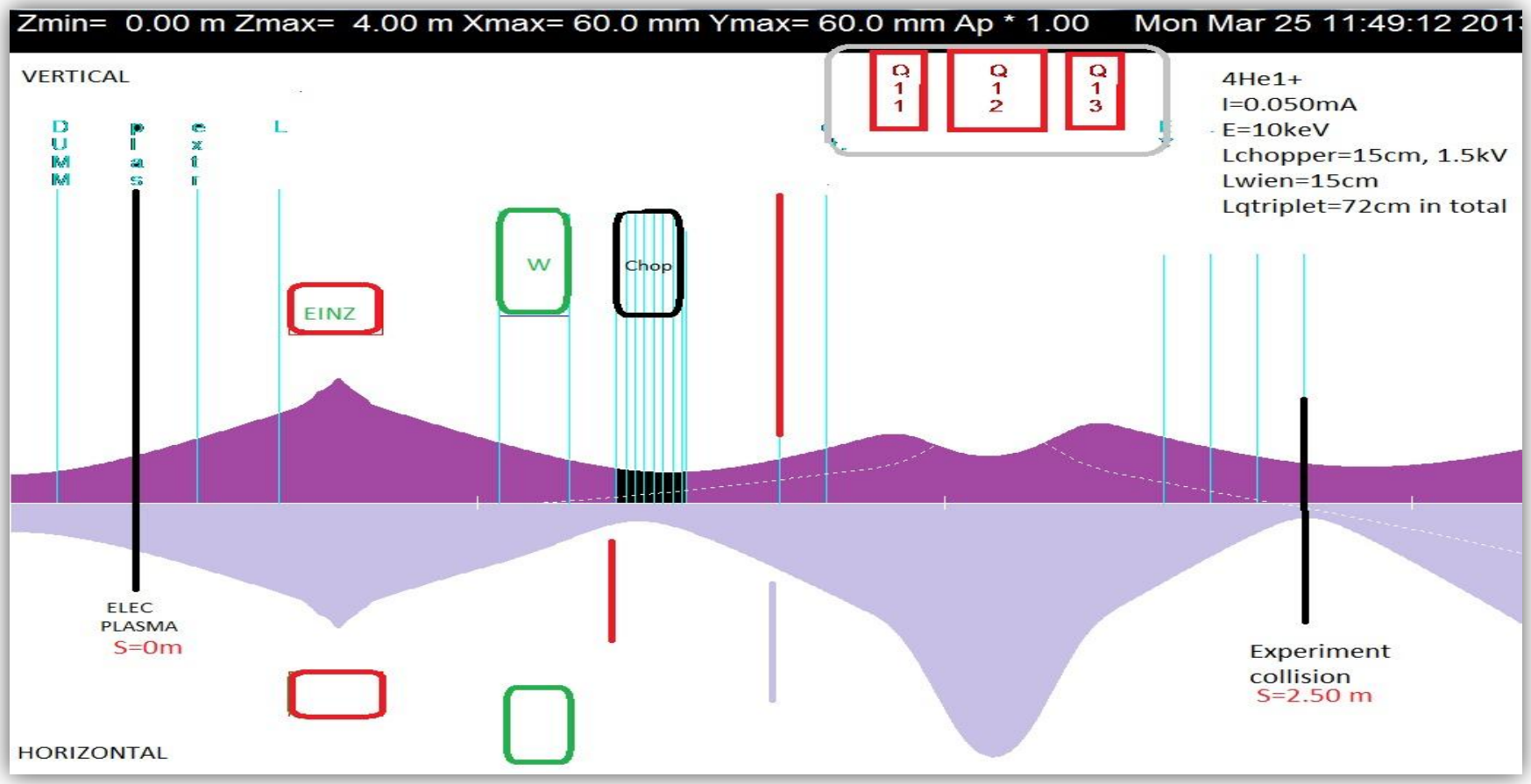
# Beam shaping

CF

ZI



# Simulations by TRANSPORT code

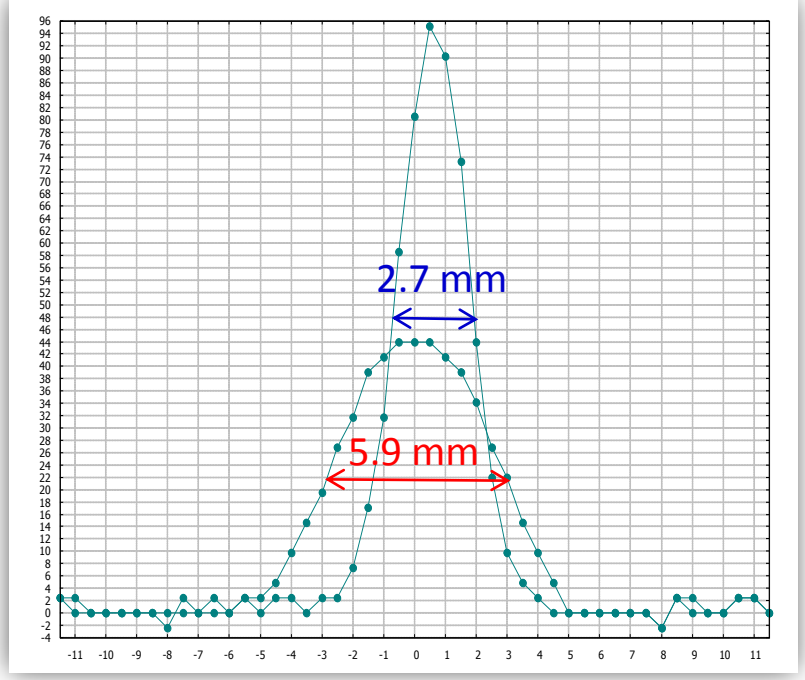


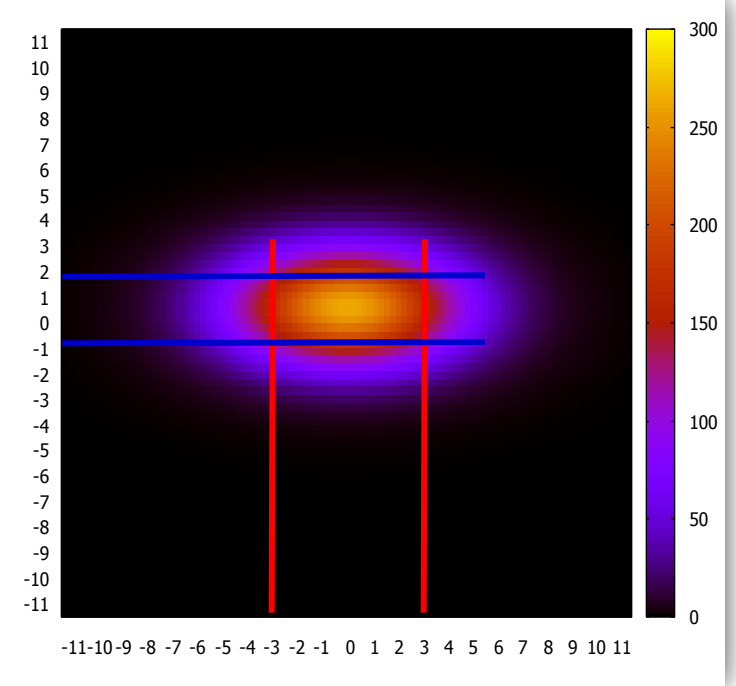

http://aea.web.psi.ch/Urs_Rohrer/MyWeb/trans.htm

*PSI Graphic Transport Framework by U. Rohrer based on a CERN-SLAC-FERMILAB version by K.L. Brown et al.*

With courtesy of B. Jacquot

# Experimental profile

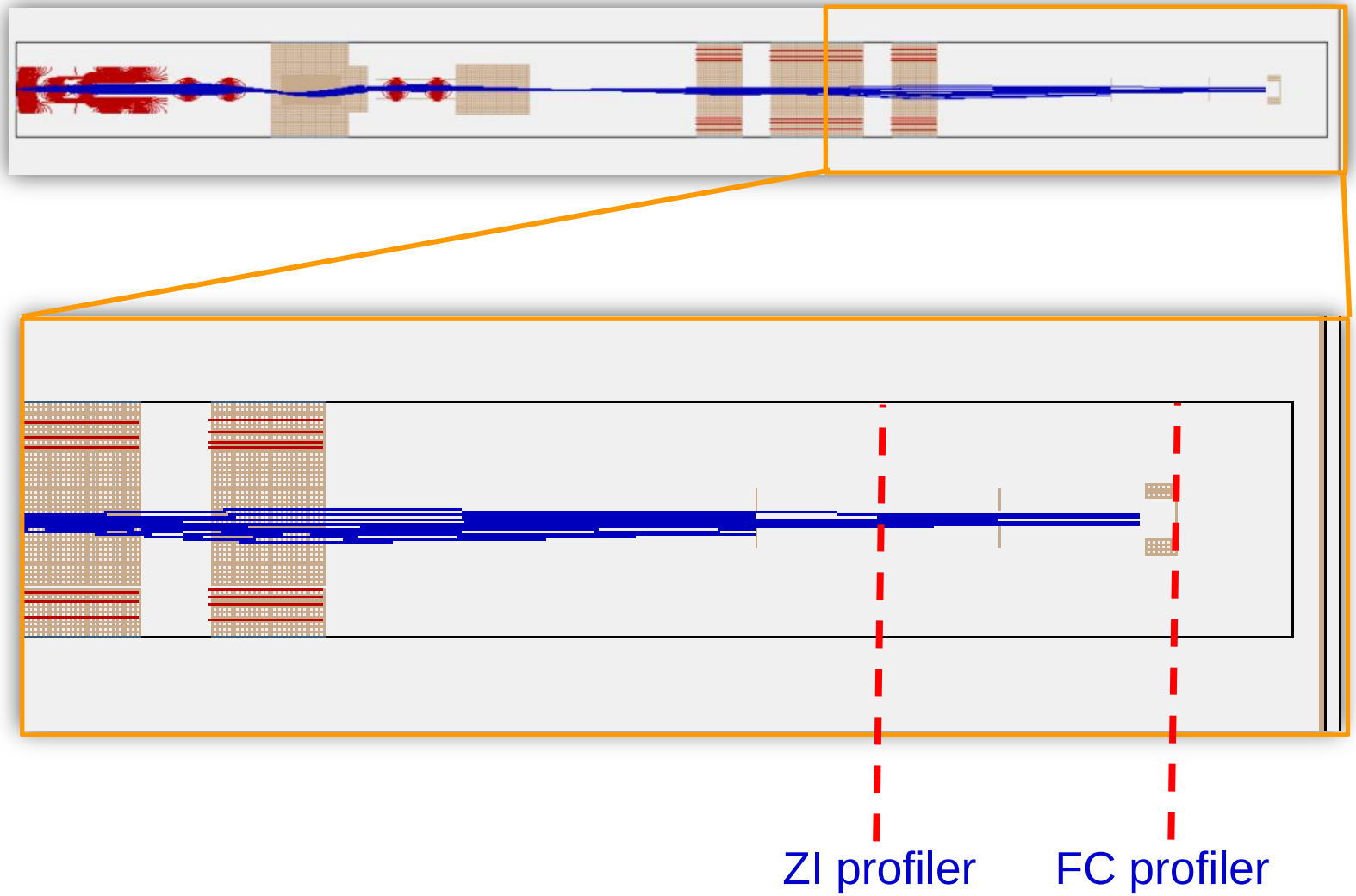


Good agreement with TRANSPORT


# Is it possible to do this with SIMION ?

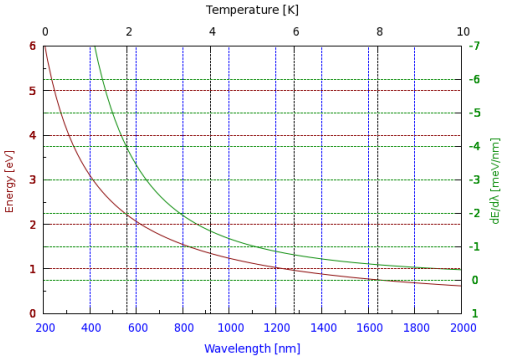
# Localization of the virtual profilers

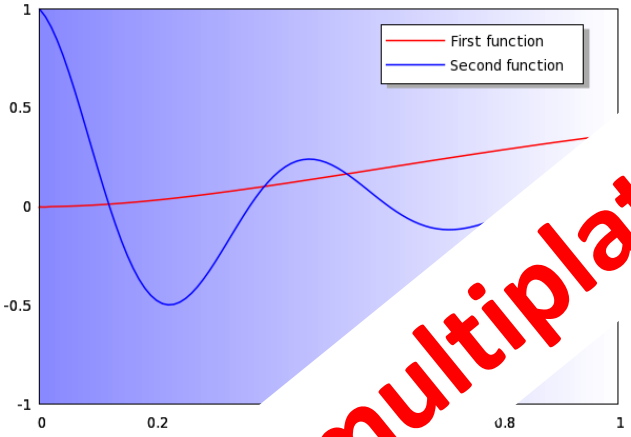


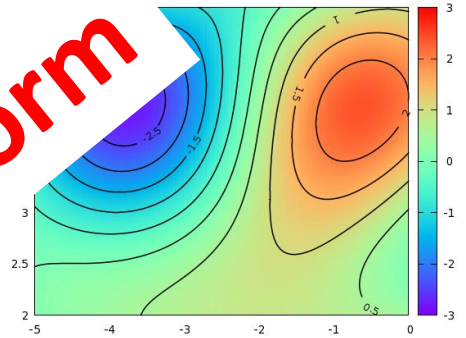
# LUA Code

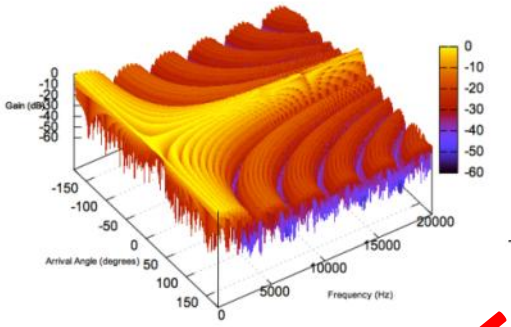
```
simion.workbench_program()

adjustable extract_plasma = 7000
function segment.init_p_values()
            if ion_instance == 1 then
                        adj_elect01 = extract_plasma
                        adj_elect02 = extract_e1
                        …
end

local fileZI = assert(io.open("resultsZI.dat", "w")) -- write mode

function segment.other_actions()
num_particles = ion_number


            if ion_px_mm > 2435 then
                        if ion_px_mm < (2435+ion_time_step*ion_vx_mm)  then
                                    TOF_ZI = ion_time_of_flight
                                    print('TOF_ZI', ion_time_of_flight)
                                    print('diffTOF(ZI-CHOPPER)', TOF_ZI-TOF_CHOPPER)
                                                fileZI:write(ion_px_mm.. " "..ion_py_mm.. "  "..ion_pz_mm.."\n" )
                        end
            end
end

function segment.terminate_run()


 fileZI:close()

end
```

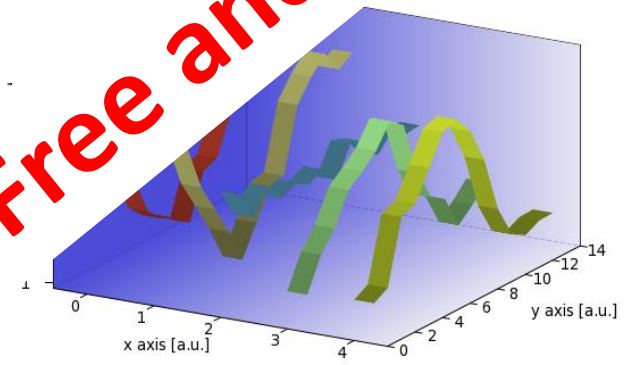
# Introduction of gnuplot

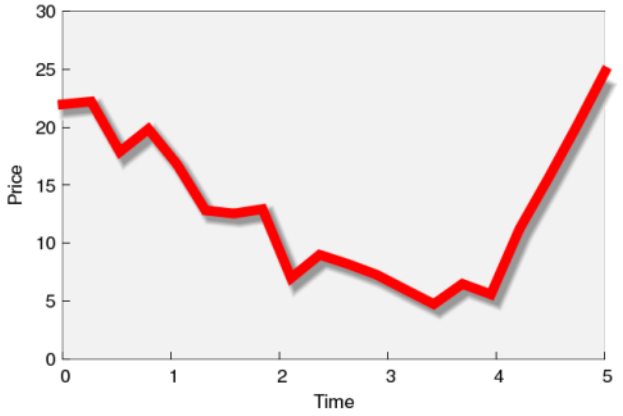




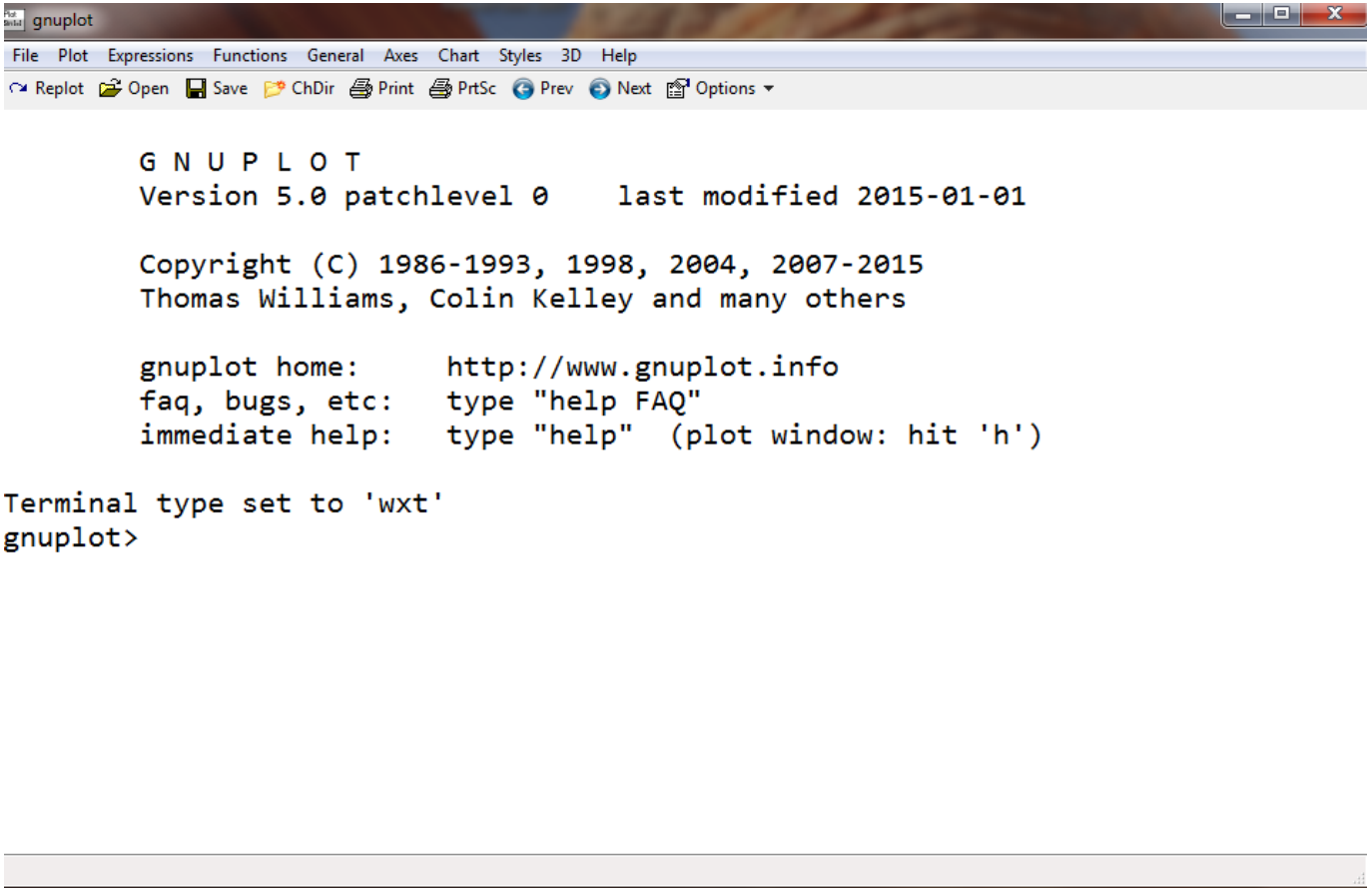




Free and multiplatform

http://www.gnuplot.info/
http://www.gnuplotting.org/
http://www.phyast.pitt.edu/~zov1/gnuplot/html/intro.html

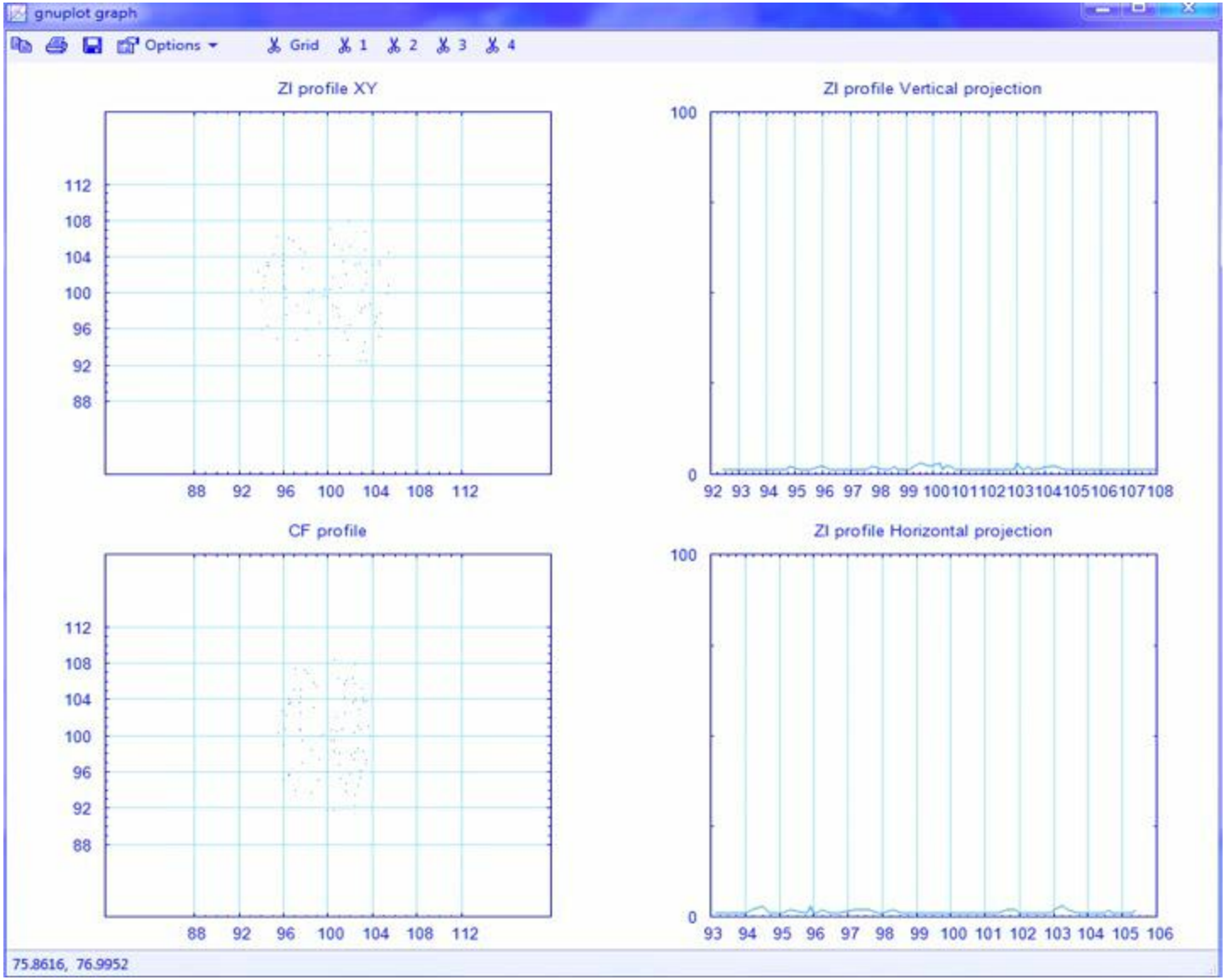
# Introduction of gnuplot

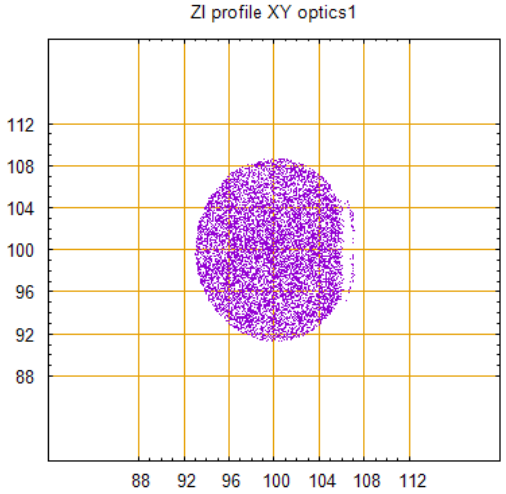


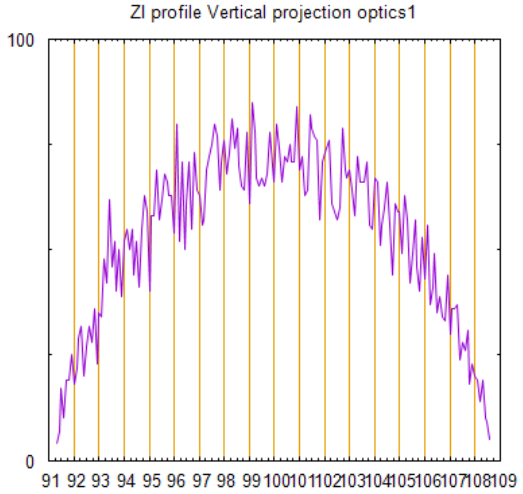
# Liveplot.plt

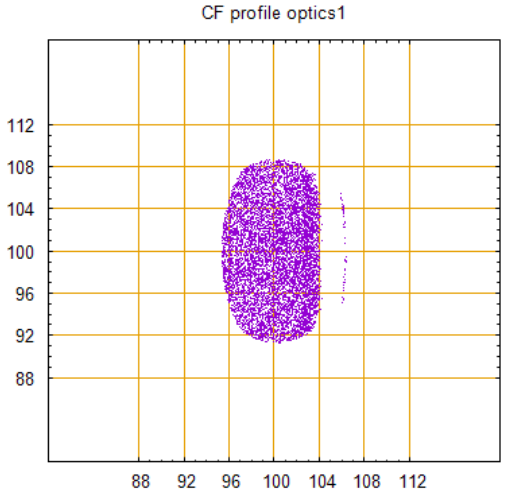
```
reset

set multiplot layout 2,2
set xrange [80:120]
set yrange [80:120]
set size square
set xtics 88,4,112
set ytics 88,4,112
set mxtics 4
set mytics 4
set grid xtics lt 0 ls 100
set grid ytics lt 0 ls 100

unset key
bin(x,width)=width*floor(x/width)
set title "ZI profile XY"
plot 'E:\rangama\aSimion\MONO 1000 FULL SIM\resultsZI.dat' u 3:2 w d #points pointtype 7 pointsize .1

unset key
set grid
#set xrange [80:120]
#set yrange [80:120]
set autoscale
set ytics 100
set xtics 1
set title "ZI profile Vertical projection"
plot 'E:\rangama\aSimion\MONO 1000 FULL SIM\resultsZI.dat' u (bin($2,0.1)):(1.0) smooth freq w l
pause 1
reread
```

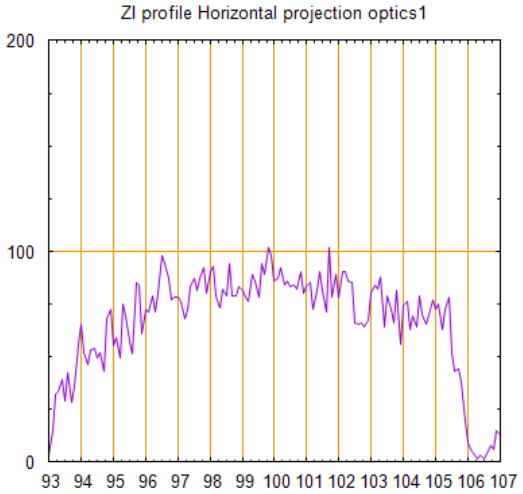
Time in second

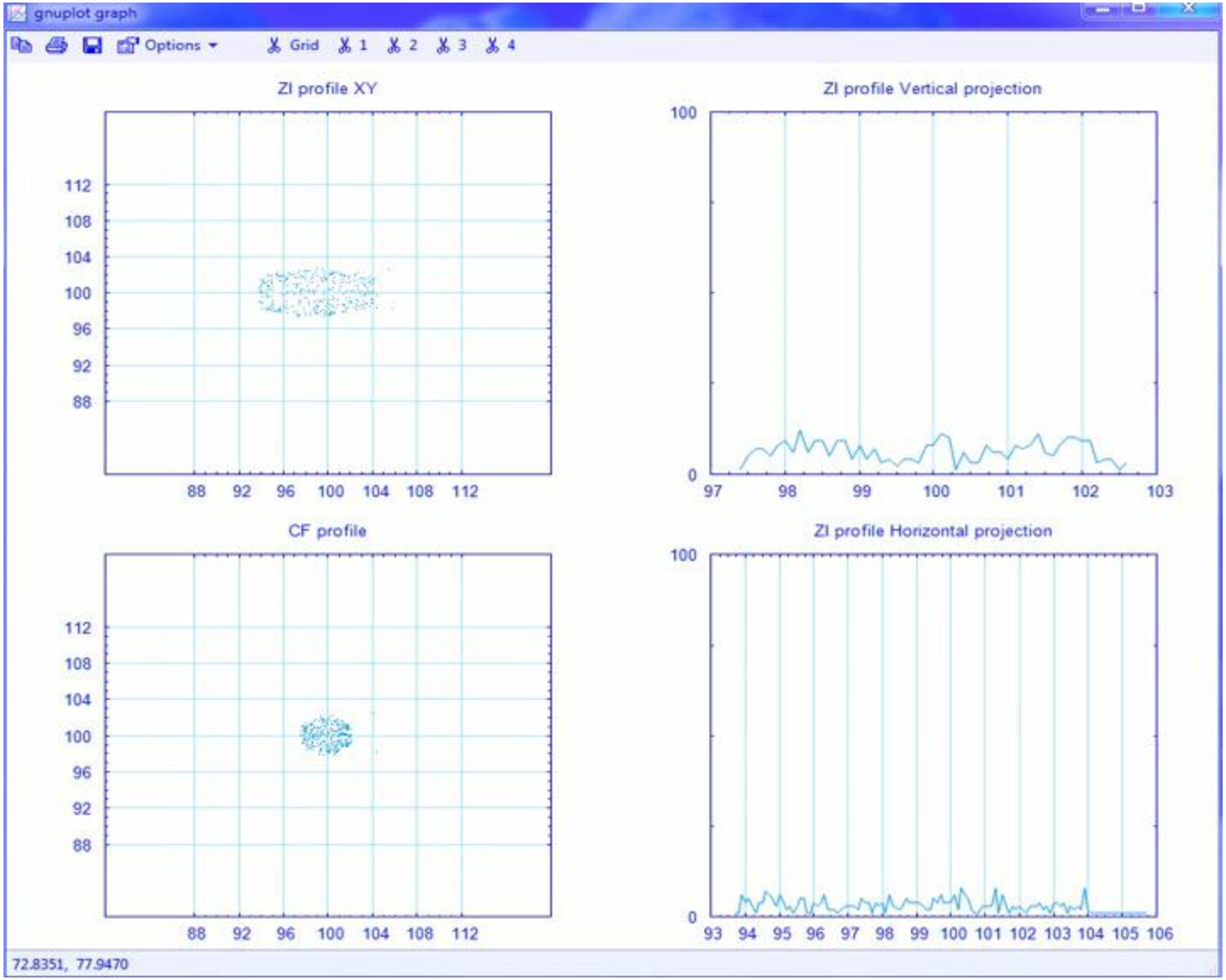

gnuplot graph
Options
Grid
1
2
3
4
ZI profile XY
112
108
104
100
96
92
88
88 92 96 100 104 108 112
ZI profile Vertical projection
100
0
92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108
CF profile
112
108
104
100
96
92
88
88 92 96 100 104 108 112
ZI profile Horizontal projection
100
0
93 94 95 96 97 98 99 100 101 102 103 104 105 106
75.8616, 76.9952

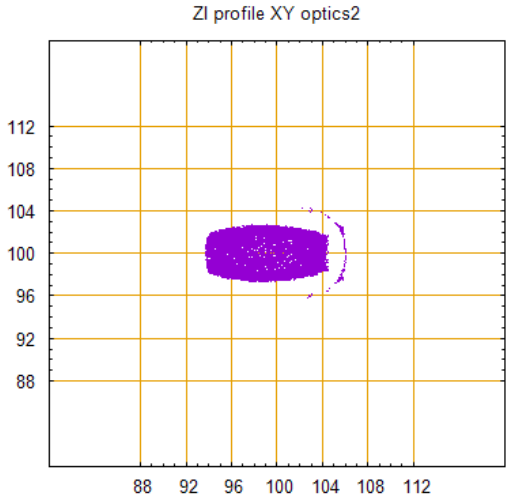

ZI profile XY optics1
112
108
104
100
96
92
88
88 92 96 100 104 108 112

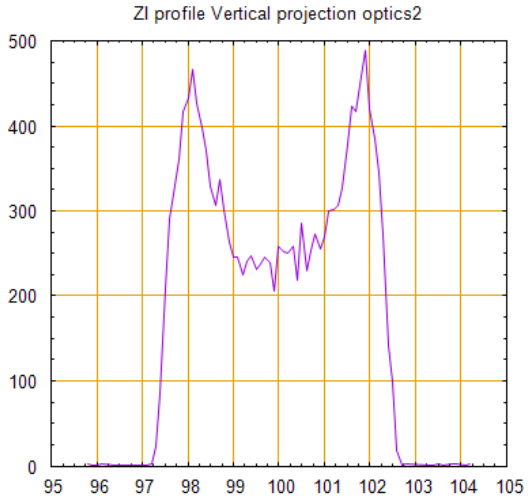

ZI profile Vertical projection optics1
100
0
91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109

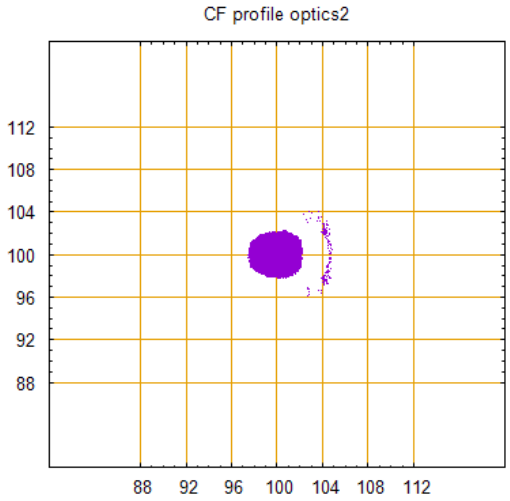

CF profile optics1
112
108
104
100
96
92
88
88 92 96 100 104 108 112

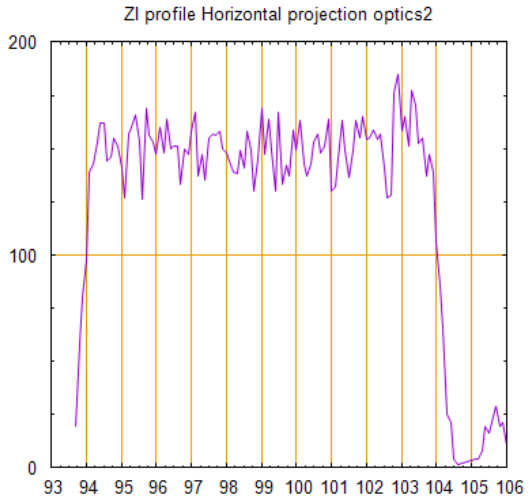

ZI profile Horizontal projection optics1
200
100
0
93 94 95 96 97 98 99 100 101 102 103 104 105 106 107

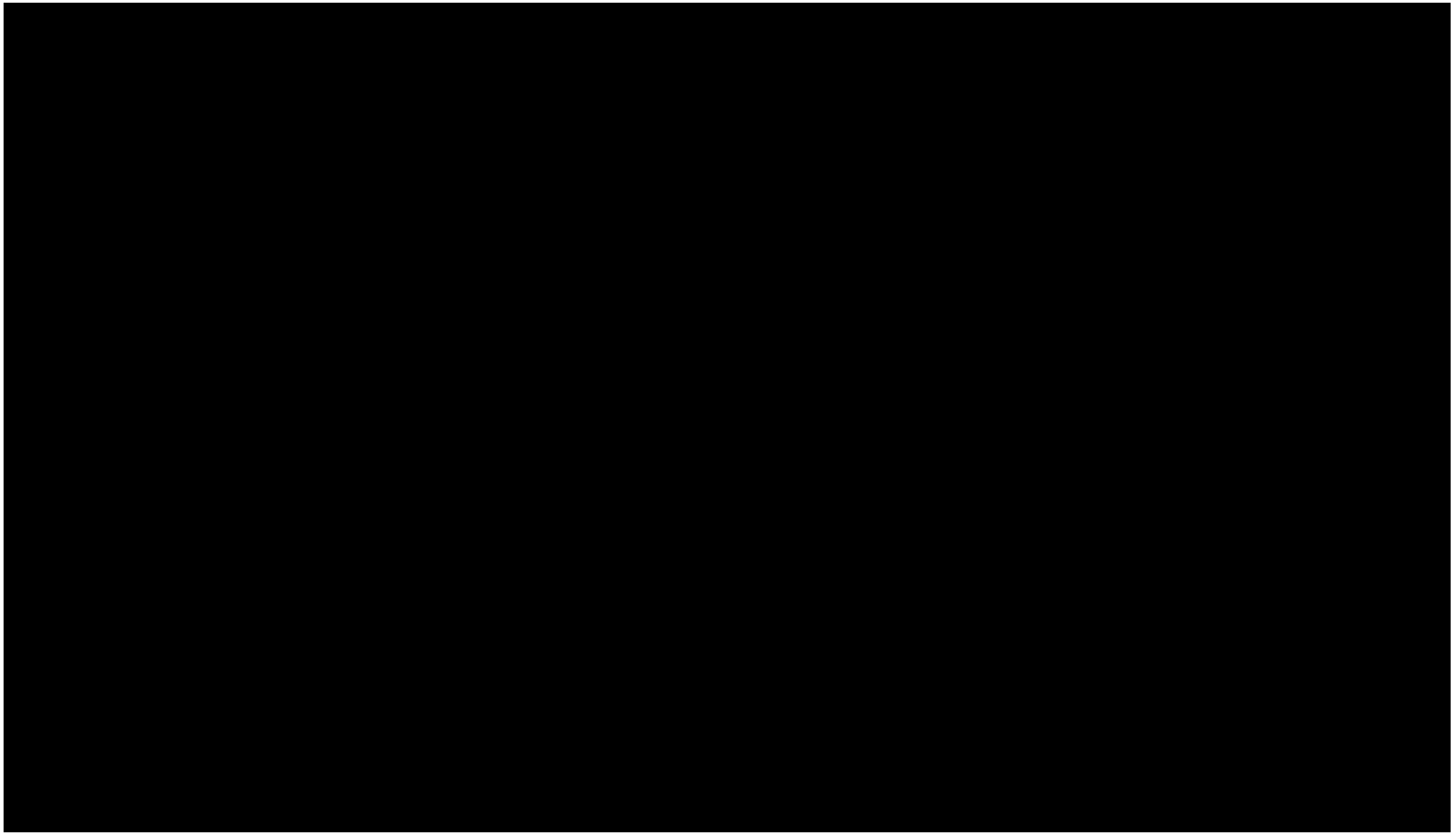

gnuplot graph
Options
Grid
1
2
3
4
ZI profile XY
112
108
104
100
96
92
88
88 92 96 100 104 108 112
ZI profile Vertical projection
100
0
97 98 99 100 101 102 103
CF profile
112
108
104
100
96
92
88
88 92 96 100 104 108 112
ZI profile Horizontal projection
100
0
93 94 95 96 97 98 99 100 101 102 103 104 105 106
72.8351, 77.9470

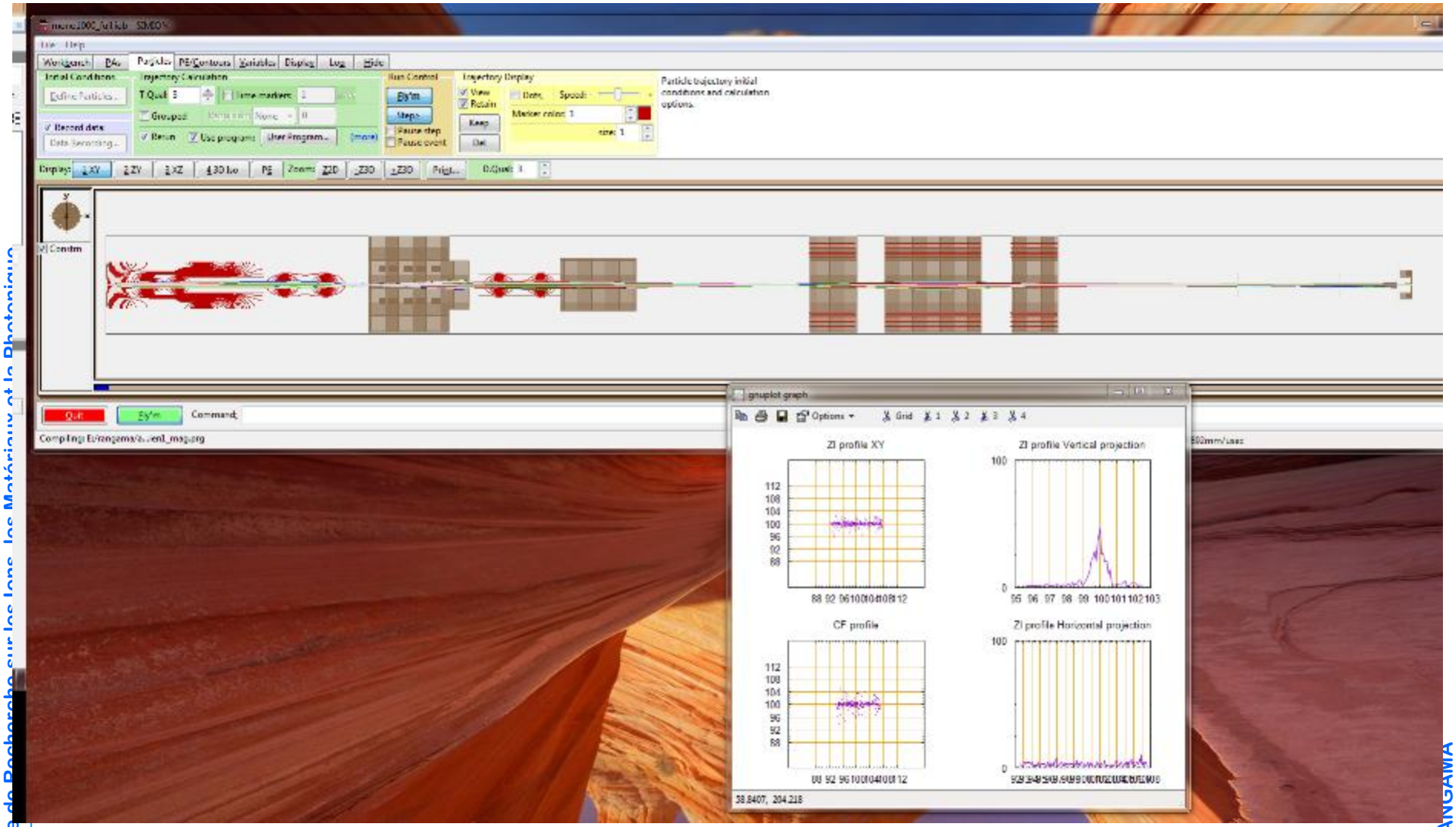

ZI profile XY optics2
112
108
104
100
96
92
88
88 92 96 100 104 108 112


ZI profile Vertical projection optics2
500
400
300
200
100
0
95 96 97 98 99 100 101 102 103 104 105


CF profile optics2
112
108
104
100
96
92
88
88 92 96 100 104 108 112


ZI profile Horizontal projection optics2
200
100
0
93 94 95 96 97 98 99 100 101 102 103 104 105 106




gnuplot graph
ZI profile XY
ZI profile Vertical projection
CF profile
ZI profile Horizontal projection
Command:

# How to stop it ?

```
pause 1
reread
```

 Infinite loop

a) Close the gnuplot program…

b) Add a mistake in the gnuplot script and save it

c) Instead of using « `pause 1` », use « `pause -1` »

# Conclusions

- Gnuplot can read data files provided by SIMION in real-time

- Gnuplot does not need a lot resources (whatever the OS)

- We can have access to all recordable variables in real-time

# Thank you for your attention