VISUALIS PHYSICS

ELECTROMAGNETISM

EXAMPLES

1. Global display of an electric field
2. Using graphs and CSV export function to Excel
3. Helmholtz configuration
4. Plane capacitor
5. Distribution of iron filings around a coil
6. Trajectory of a charge in an electric field
7. Oscilloscop

Notice
If you wish a precise display of pictures, use the «Zoom» function of PDF.

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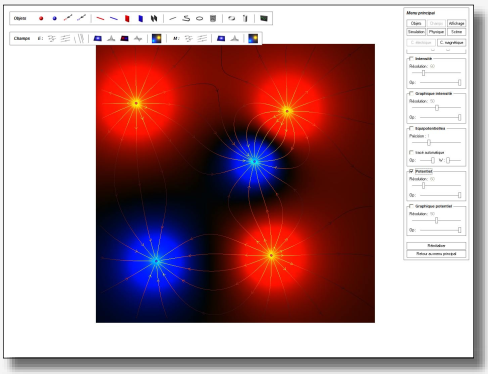
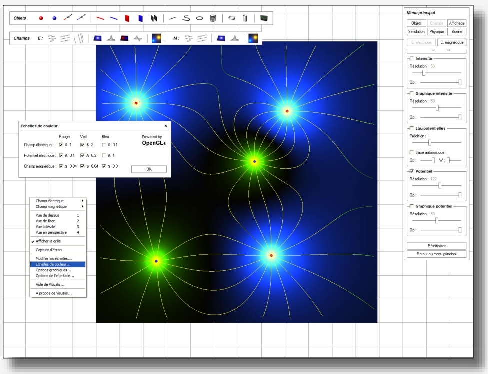
EXAMPLE 1

Global display of an electric field generated by several charges

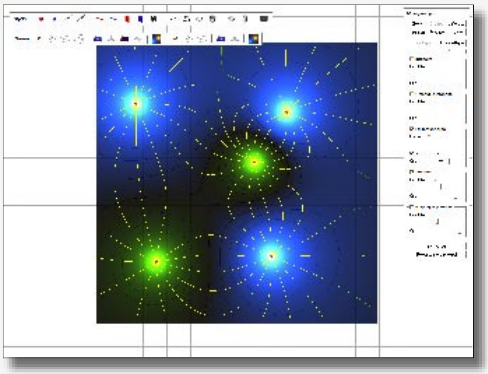


1 Place into the scene several charges (negative and positive), then open the **Field** menu and choose the automatic design of field lines . Scroll down the menu and choose **Potential** .

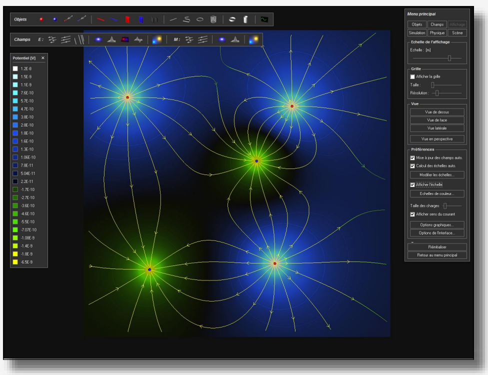


2 For better readability, it is suggested to change the standard colours. Open **Edit colour scales** dialog box (in the **Display** menu or directly through contextual menu activated by right button of mouse) and change values as follows :

Electric field	Red |v| s 1	Green |v| s 2	Blue | | s 0.1
Electric potential	Red |v| A 0.1	Green |v| A 0.3	Blue. | | A 1.



3 Thus, rendering of field looks much better now. For still greater readability, it is possible to display equipotential lines (but it requires more computing power !). To do so, select **Equipotentials** in the **Fields** menu and enable **Automatic**. Then increase precision to maximum. You cannot yet see the equipotential lines, because they are hidden by potential rendering. Choose **Potential** (always in the **Fields** menu) and slightly diminish the opacity in order to bring out the lines



4 To wrap it up, you may intensify the resolution of potential and choose a black background as interface setting (select **Black** as **Interface settings** in the **Display** menu or directly through contextual menu).

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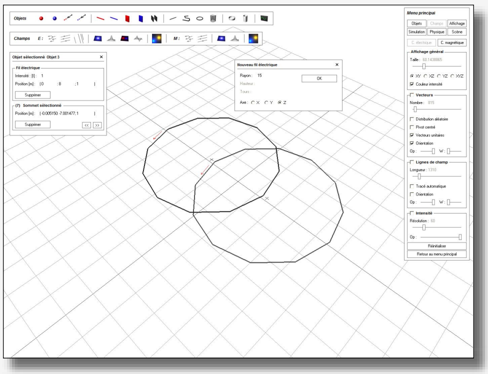
EXAMPLE 2

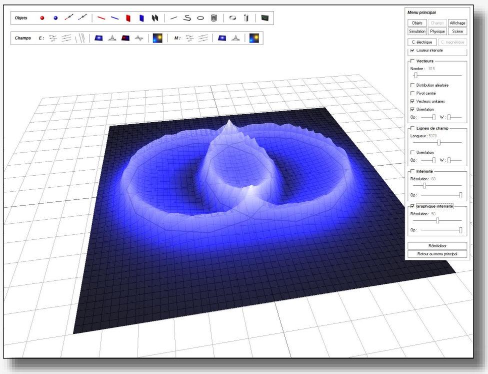
Using graphs and CSV export function to Microsoft Excel



1 Suppose that you wish to view the superimposition of magnetic fields produced by two overlapping circular currents.

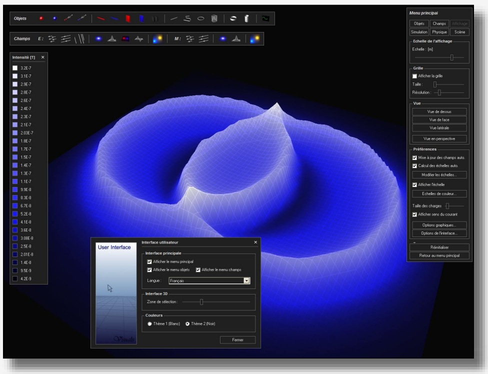
Start with placing two coils, which you create by clicking on the corresponding icon in the **Objects** toolbar. Choose a rather wide radius (~ 15) and place them so that they overlap and do not touch the ground (otherwise the picture would be unreadable due to excessive intensity of the magnetic field on the edge of coil).
For example:

Axis	Z
Position	(0 ; 8 ; 1) et (0 ; -8 ; 1)

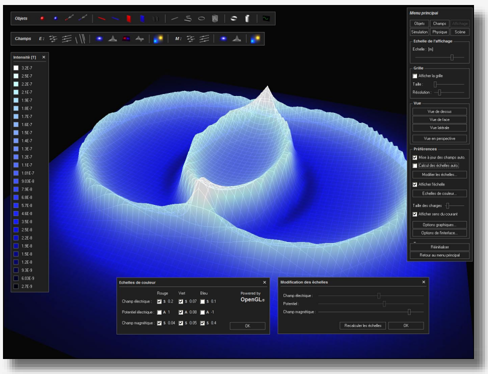


2 Choose then **Fields** and select **Magnetic F.**. Scroll down the menu and enable **Graph intensity**. The desired graph will show on the XY plane.

Increase resolution of graph to maximum and disable the display of grid (in the grid function of the **Display** menu or directly through the contextual menu)



3 You may now display the colour scale of graph, in selecting **Show colour scale** in the **Display** menu. The colours can be highlighted by choosing the black background option in the interface settings function of the **Display** menu



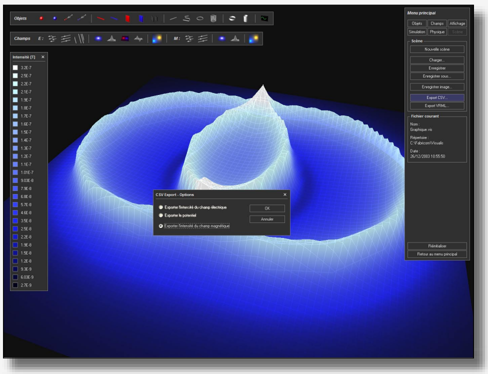
4 To get better shades in colour settings, open the dialog box **Edit colour scales** in the **Display** menu and change the values for magnetic field as follows :

Red |v| s 0.04   Green |v| s 0.05   Blue |v| s 0.4.

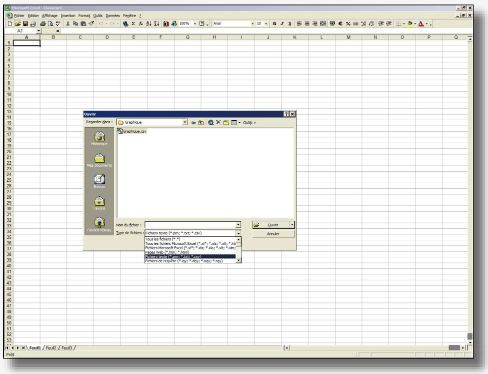
To vary the graph scale on the Z axis, select **Modify scales** in the **Display** menu and move the cursor of magnetic field.

EXAMPLE 2

Using graphs and CSV export function to Microsoft Excel

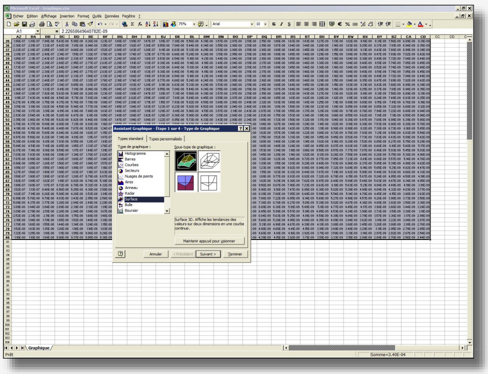


5 If you wish to analyse the graph more precisely, export the value table into any software. For Microsoft Excel, proceed as follows : choose **Export CSV** in the **Scene** menu, then select **Export magnetic field intensity** and then **OK**.

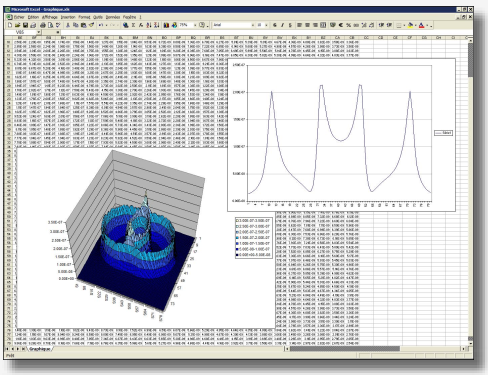


6 Choose the name and place of file under which you will save these values.

Open file with Microsoft Excel by choosing **Text files (*prn, *txt, *csv)** in the **Type of files** menu.



7 The table of value is displayed. Select it and select **Area** in the **Graph** menu.



8 You get the same graph as in Visualis. If you need only a cross-section of the graph, do not select the entire table of values.

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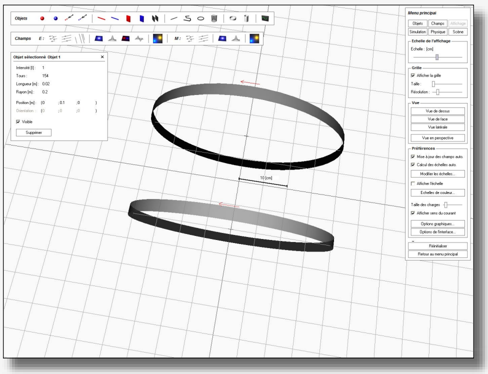
EXAMPLE 3

Helmholtz configuration



1

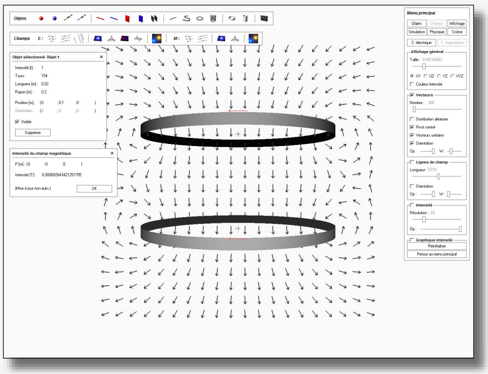
This is a classic lab experiment in magnetism.

Start with producing the Helmholtz configuration needed for generating a uniform magnetic field.

Place two similar coils in front of each other, at a distance equal to their radius (Helmholtz coils). Change display scale to centimetre level in order to have realistic conditions (choose Display scale" in the “Display” menu). The following data should be picked :

Turns per coil	154
Radius	20 cm
Length	2 cm.
Locations	(0 ; 0.1 ; 0) and (0 ; -0.1 ; 0) (fig. 2)

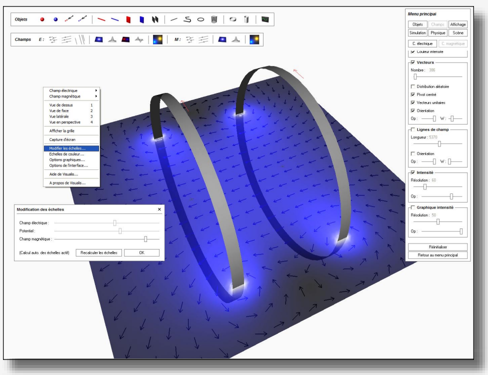
Caution ! Even though display scale has been changed to centimetres, positions and other data are still indicated in meters.



2

You may now visualize the magnetic field inside and around the coils in selecting **Magnetic field** in the **Fields** menu and then enabling **Vectors.** A better readability is obtained by selecting **Pivot centered,** slightly increasing the width of vectors (**W cursor**) and disabling **Colour intensity** under **General display** (still in the **Magnetic field** menu).

One can thus observe that the magnetic field is almost uniform between the coils. To get the exact value of intensity in the centre of system, click on origin with right button of mouse. Select **Intensity** in the **Electric field** function.

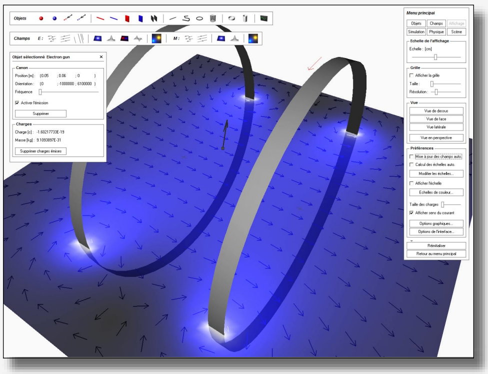


3

If you then wish to view the field intensity on a global level, simply click on **Intensity** and colour will show again. Slightly diminish opacity of intensity to bring out vectors.

EXAMPLE 3

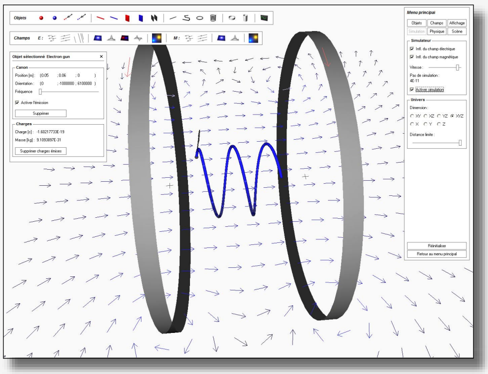
Helmholtz configuration



4 Now add to the scene an electron emitter and assign it the following properties:

Position [m] (0.05 ; 0.06 ; 0)
Orientation [m/s] (0 ; -1000000 ; 6100000)
Frequency cursor to minimum.

Some settings are also necessary in the **Display** menu : disable **Automatic update fields** and **Automatic recalc. scales** in order to speed up simulation.



5 In **Simulation** menu, change the simulation step to 4E-11. Finally, activate simulation and electron emitter and press **T** key or select **Show path** in the path function of the **Display menu**. You will the see the trajectory of the electron beam !

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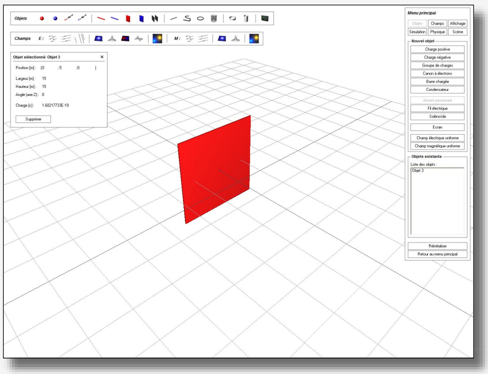
EXAMPLE 4
Plane capacitor



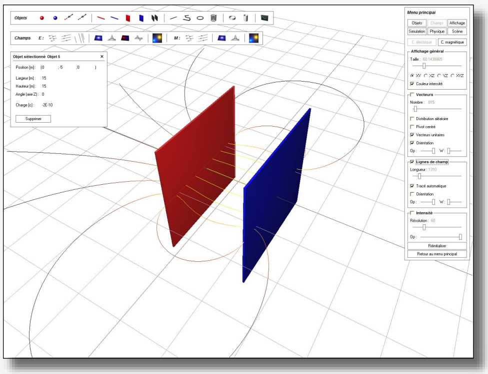
1

Place
1 positively charged plate with the following properties

Width	15
Length	15
Position	(0;5;0)

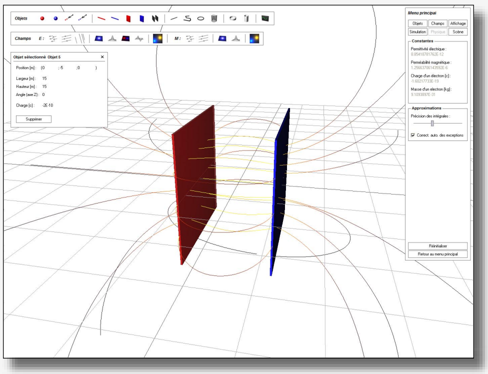
1 negatively charged plate with the following properties

Width	15
Length	15
Position	(0;-5;0)



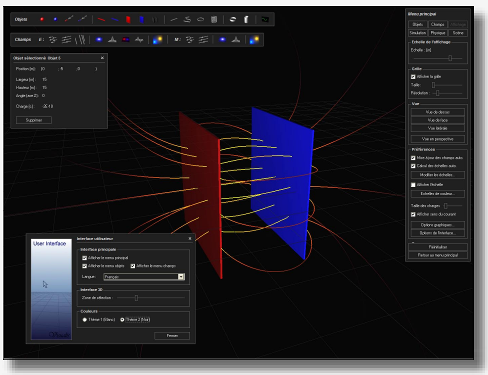
2

Choose the **Fields** menu, select **Field lines** and enable **Automatic** Increase the length of the lines to maximum and in the **General Display** function, choose the **XYZ dimensions.**



3

The present simulation is rather inaccurate, because the software runs on numerical approximations with charged plates. You should therefore adapt their accuracy. Open the **Physics** menu and move the Integral precision cursor to the first third of scale (in **Approximations** dialog box). Calculation of the field is longer, but the result is much better.

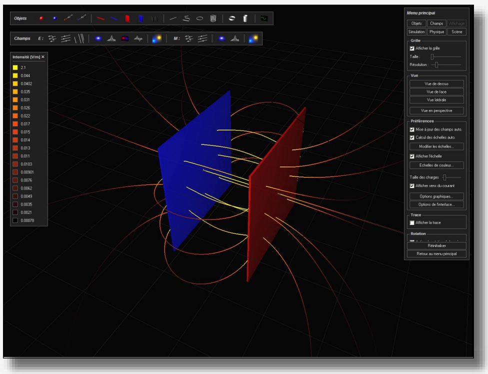


4

To obtain more legible field lines, open the **Interface settings** box in the **Display** menu and choose the black background setting.

EXAMPLE 4

Plane capacitator



5 To wrap it up, display the colour scale to have a global view of field intensity .

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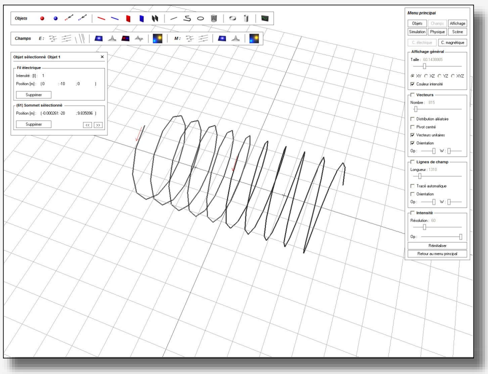
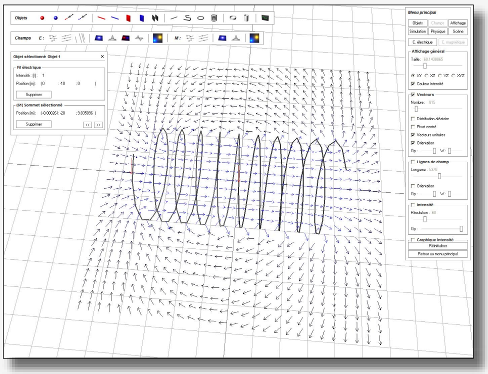
EXAMPLE 5

Distribution of iron filings around a coil

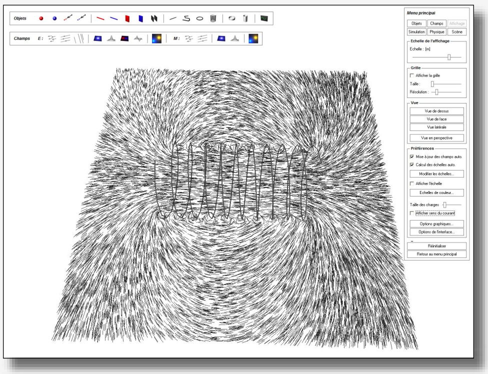


1 Let us suppose that you wish to obtain a “realistic” (and not a schematic) picture of a magnetic field generated by a solenoidal current.
For such a simulation, you should use the **Current** object, and not the **Coil**. Select the icon **Solenoidal current** and validate the dialog box.
Choose the following properties :

Radius	10
Length	40
Turns	12



2 In the **Fields** menu, choose **Magnetic field** and select **Vectors.**



3 To produce the picture of iron filings, enable **Random distribution** (in **Vectors**) and disable **Orientation** as well as **Colour intensity** in the **General display** box. Then increase the number of vectors to maximum .

To wrap it up, choose the **Display** menu to disable the grid as well as the direction of the electric c. in the **Preferences** box.

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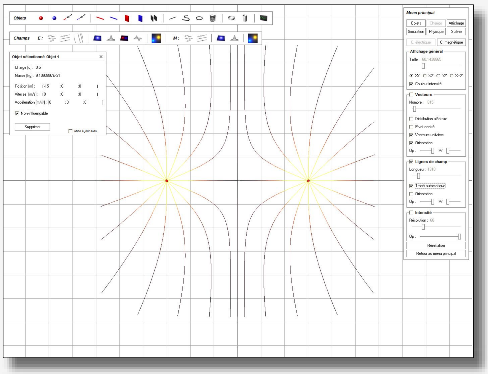
EXAMPLE 6

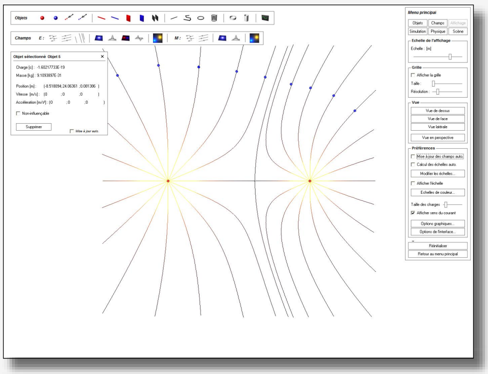
Trajectory of a charge in an electric field



1 Start with creating a system with several charges (two large positive ones and several small negative ones). It could be compared to the Earth-Moon system, with a few small asteroids, since the physical law that rules attraction between charges is similar to the one governing attraction between bodies. It will thus be possible to observe the trajectories of negatives charges inside the system.

So, add to positive charges (0.5 [c]) into scene. Select **Fixed** in the property box of these charges and place them as follows : (-15 ; 0 ; 0) and (15 ; 0 ; 0).

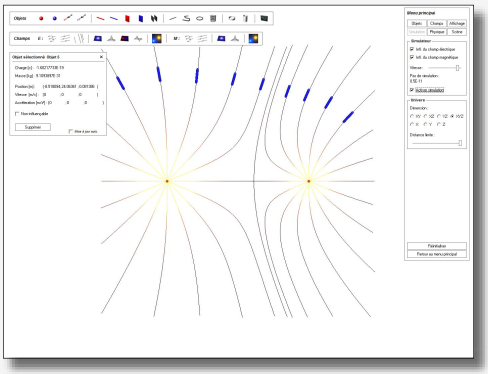
In the **Fields** menu, select **Fields lines** and enable **Automatic**



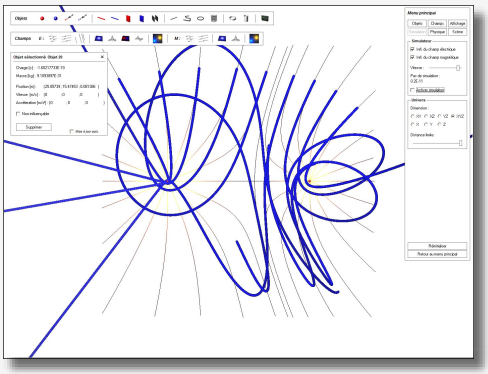
2 To get a more interesting system, you may diminish one of the charges to 0.2 [c].

Then set the simulation step to **0.5E-11** in the **Simulation** menu

Introduce several negative charges into the scene that you will place on the field lines. In the **Display** menu, disable **Automatic update fields** and **Automatic recalc. scales** in the Preferences box and enable **Show path** in the same box.



3 Finally, in the **Simulation** menu, select **Activate real time simulation**.



4 It is very interesting to see the negative charges move exactly along the field lines and then deviate from them due to increased speed

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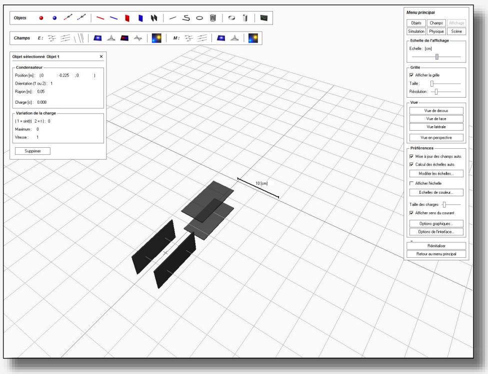
EXAMPLE 7

Oscilloscop

Visualis gives the opportunity to visualise the basic functioning of an oscilloscop, thanks to **capacitors** (whose charge may change all along the simulation) and to a **screen** which can stop the electron beam and display its trace.



1

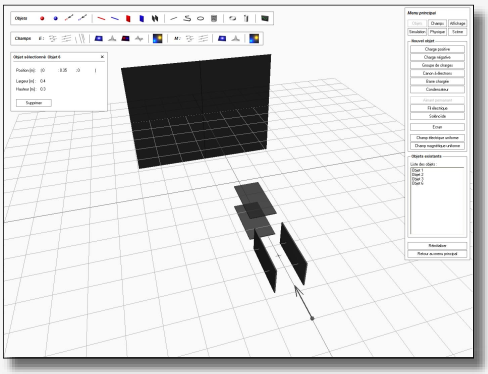
Settings :
Scale (in the **Display** menu) : down to cm

2 capacitors with the following properties :

Position	(0 ; -0.225 ; 0) and (0 ; -0.1 ; 0)
Orientation	1 for one and 2 for second, so that electrons are deflected horizontally, then vertically
Radius [m]	0.05

Both are supposed to be connected to alternate current

Charge variation	1
Maximum	3.5E-5
Velocity	1



2

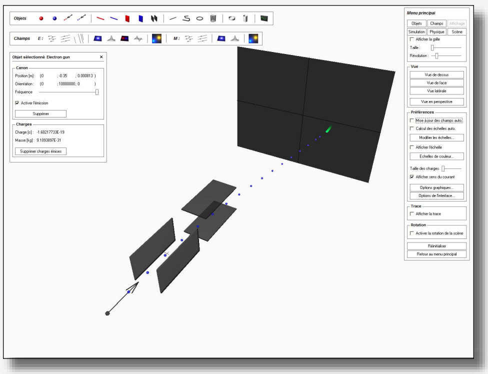
1 electron emitter with the following properties :

Position	(0 ; -0.35 ; 0)
Orientation	(0 ; 1E10, 0)

Do not forget to enable **Activate emission** !

1 screen with the following properties :

Position	(0 ; 0.35 ; 0)



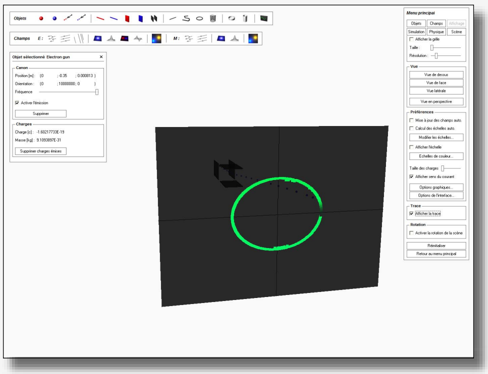
3

Then, in the **Simulation** menu, choose 2E-12 as Simulation step and enable **Activate real-time simulation**.

To speed up simulation, in the **Display** menu disable **Automatic update fields** and **Automatic recalc. scales** in the **Preferences** box.

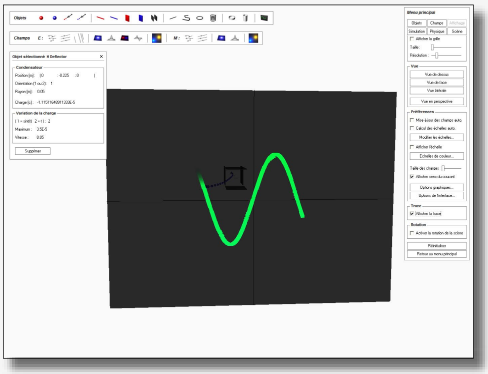
EXAMPLE 7

Oscilloscop

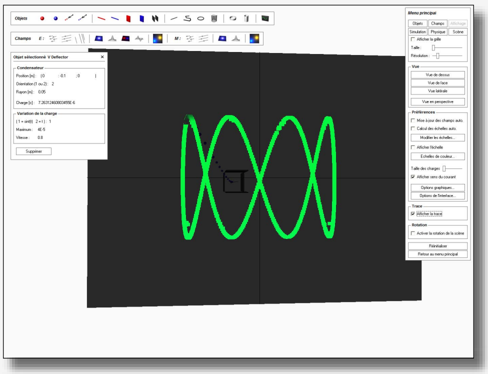


4 You may now change the charge variation of capacitors to draw various functions on the screen, in enabling **Show the path** or pressing the **T** key. Change your point of view and place yourself in front of the screen (right button of mouse).

For example :2x sinus



5 1x linear and 1x sinus



6 or two sinuses of different phases.