# I-Prop

*User's Guide*

*version 1.3* r.104

USER'S GUIDE

# I - Prop


info @ i-prop.cz
http://www.i-prop.cz

# Contents

# 1 Introduction

I-Prop is a software tool for an interactive planning of 3D picocellular wireless systems inside multi-floored buildings. Using indoor propagation models I-Prop provides various types of signal coverage analysis. The straightforward concept of the software tool assures an efficient design of indoor wireless systems for wide range of users.

# 2 Installation

*Brief description of I-Prop software installation.*

Copy the I-Prop directory (or extract it from a ZIP archive) to a desired place on your HDD. To uninstall it just simply delete it. I-Prop does not use any files outside its directory, nor the Registry.

#### System requirements

MS Windows 9x/NT/2000/XP/Vista/7, RAM and HDD according to a project extent

#### Demo version

- run *I-Prop.exe*

#### Full version with hardware key

- insert a hardware key into an USB port
- run *hdd32.exe* to install a driver for the hardware key and follow instructions (use the same procedure for uninstall)
- run *I-Prop.exe*

**WARNING!**

**The hardware key must be properly inserted into the port while running I-Prop software! Otherwise, undefined errors can occur.**

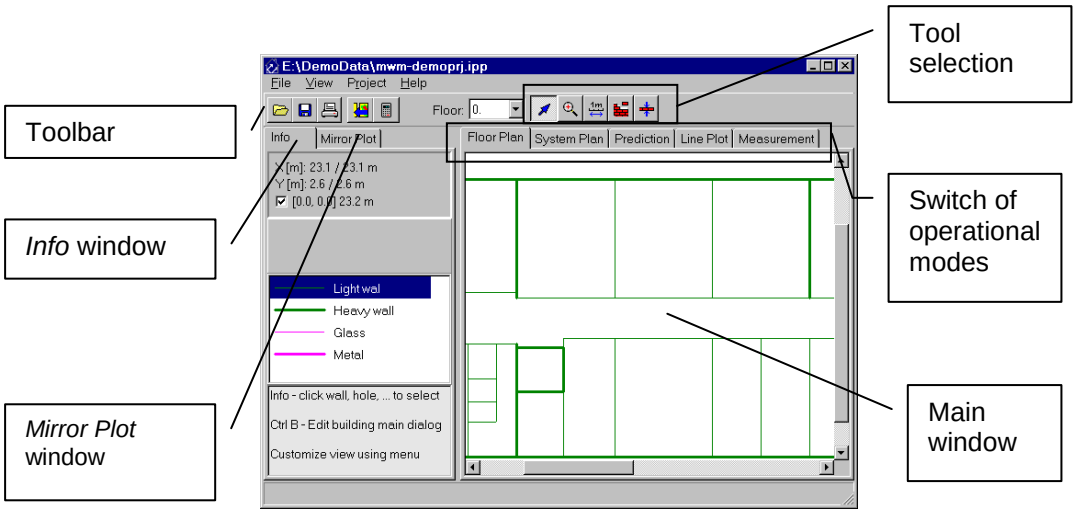
#### Subdirectories of installation

- Doc - documentation in PDF format
- Models - parameter files for propagation models
- Examples - sample project files
- Scales - alternative color scales.

# 3 I-Prop User Interface

*Introduction to user interface, main window, menu, etc.*

For effective and transparent work the I-Prop user interface is divided into five operational modes. In each mode various tools can be selected for a specific action. Together with the change of the mode other controls (menu, toolbar) and information in current windows are changed accordingly.

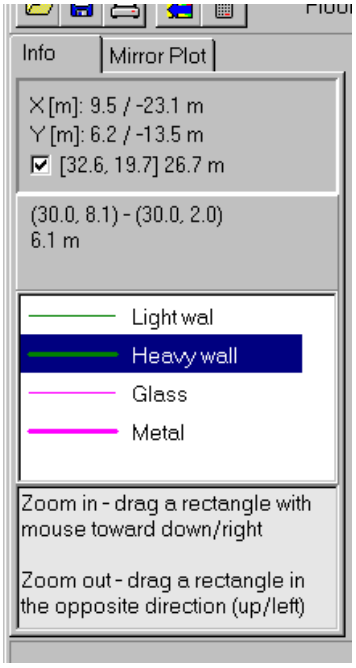



## 3.1 Structure of Program Window

The window of I-Prop can be divided into three parts (except title bar, menu and bottom status bar):

- Left part - optionally *Info* or *Mirror Plot* window (see below).
- Right part - Main window - with switch of operational modes at the top. Graphical information of the main window is different for each mode (see below).
- Toolbar - some menu commands, current floor selector and tool switch (see below).

## 3.2 Info Window




*Info* window contains text information connected to a picture in the main window. There are four sections:

**Cursor coordinates**
The current cursor position coordinates in meters are in the first two lines. X,Y position is given both absolutely and relatively to auxiliary coordinate origin (separated by '/').

The position of auxiliary coordinate origin together with its distance to cursor position is on the third line. Using check box a view of the auxiliary origin in the main window can be switched on/off (as in the menu *View - Auxiliary [X,Y] Origin*).

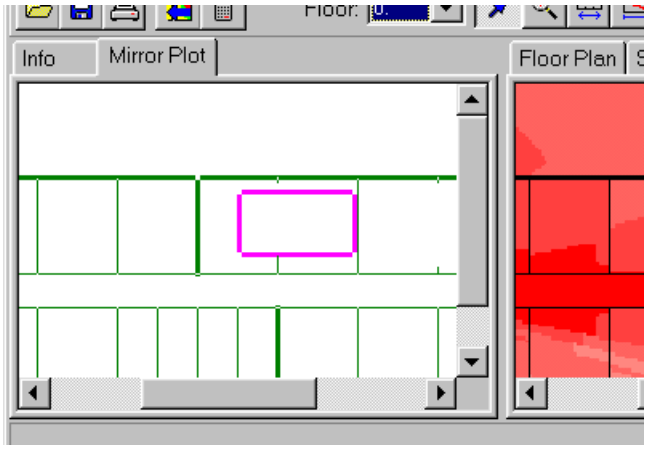
**Text description**
Information connected to the current mode and selected tool - see below the modes descriptions.

**Legend**
Information connected to the current mode - see below the modes descriptions.

**Quick Tips**
Brief help/tips, which is automatically changed according to the selected mode and tool.

## 3.3 Mirror Plot Window

Using the menu command *View - Set Mirror Plot* the picture from the main window is copied to the *Mirror Plot* window. The picture doesn't change with a mode and cannot be edited. Using the *Mirror Plot* window two different pictures can be viewed and compared in parallel according to user needs.



## 3.4 Menu

**File**

- New - creates a new empty project
- Open… - opens an existing project
- Save… - saves a current project
- Save As… - saves a current project with a new file path
- Print - prints the picture from the main window
- Print Setup… - sets the printer options
- Export Bitmap… - saves the picture from the main window as a bitmap
- Exit - ends the I-Prop

**View**

- Background Bitmaps - switches on/off background bitmaps in the main window picture
- Walls - switches on/off the walls in the main window picture
- Grid - switches on/off the grid in the main window
- Auxiliary [X,Y] origin - switches on/off the Auxiliary origin in the main window
- Set Mirror Plot - copies a current picture from the main window to the *Mirror Plot* window
- Set Grid - sets the grid density
- Scales… - starts the *Scales* dialog (see below)
- Zoom out - sets to zoom so that a floor plant fits to the main window

**Project**

- Building… - starts the *Edit Building* dialog (see Ch. 4.2)
- Model Parameters… - starts the *Model Parameters* dialog (see Ch. 4.3)
- Device List… - starts the *Device List* dialog (see Ch. 4.4)
- Antennas… - starts *Antennas* dialog (see Ch. 4.5)

**About**

- author and version information

## 3.5 Toolbar


There are three groups of controls on the toolbar:

- buttons equivalent to menu commands:
    - open project, *File -Open*…
    - save project, *File - Save*…
    - print main window, *File - Print*…
    - copy main window picture to *Mirror Plot* window, *View - Set Mirror Plot*
    - run the whole building prediction calculation, *Prediction - Run Building* in *Prediction* mode
- list of all floors in the building - fast floor navigation
- tool selection buttons, which are different for each mode (see below).

# 4 Projects

*Project structure, dialogs to work with a project.*

## 4.1 Project Files

All necessary information for the design of 3D picocellular network is stored in a form of a project. The are four data files composing the project which must be in the same directory. The have a same file name but different extension:

***.ipp*** - main project file

***.mp*** - parameters for prediction calculation

***.bws*** - floor plans

***.dev*** - database of antennas and base stations.

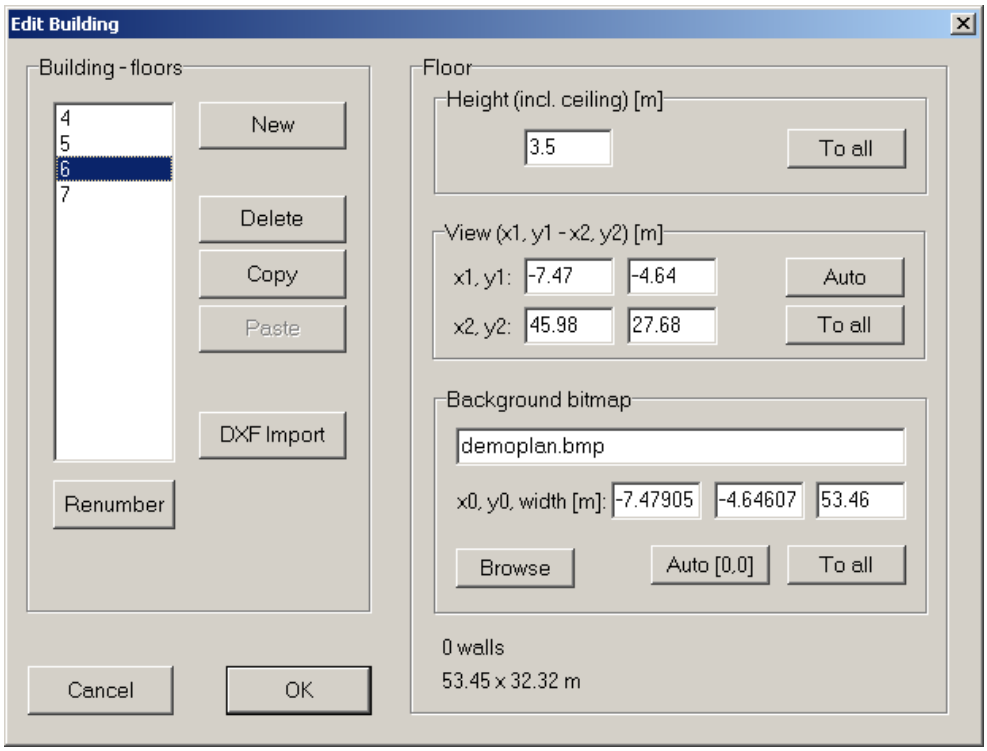
When saving the project backup copies of previous version files are created adding '*bak'* to the file extensions.

When background bitmaps are used the bitmap files are also part of the project, but they are not stored using *Save* or *Save As* commands. When moving the project files the bitmap files must be moved manually and appropriate paths in the *Edit Building* dialog must be updated (see Ch. 4.2).

Files with measured data in **.md?* format are not part of the project.

## 4.2 Edit Building Dialog

The *Edit Building* dialog for a basic editing of building floors is in the beginning of all new projects. The dialog can be divided into several sections:




**Building - floors**

- Floor list - list of all defined floors of the building. Editable parameters of selected floor are available in the *Floor* section (on the right-hand side).
- New - inserts a new floor. The floor list is always continuous, so, e.g., if new floors numbered 5 and 10 are inserted, floors numbered 6, 7, 8 and 9 are added automatically. Maximum number of floors is limited to 64.
- Delete - removes selected floor.
- Copy - copies selected floor settings to clipboard.
- Paste - inserts a floor from clipboard (stored by *Copy* command).
- DXF Import - imports a new floor from a DXF file (AutoCAD format) - see next chapter.
- Renumber - changes a floor numbers.

### Floor

Parameters of selected floor can be edited in subsections. Number of walls defined within the floor and X, Y dimensions are indicated at the section bottom.

### Height

- height of the floor in meters including ceiling thickness
- To All - copies the height to all floors.

### View

- sets the viewport of the floor for the main window and all the predictions
- x1, y1 - coordinates of the left bottom corner in meters
- x2, y2 - coordinates of the right top corner in meters
- Auto - automatic viewport calculation so that the background bitmap and all defined walls are inside it.
- To All - copies the view subsection parameters to all floors.

### Background Bitmap

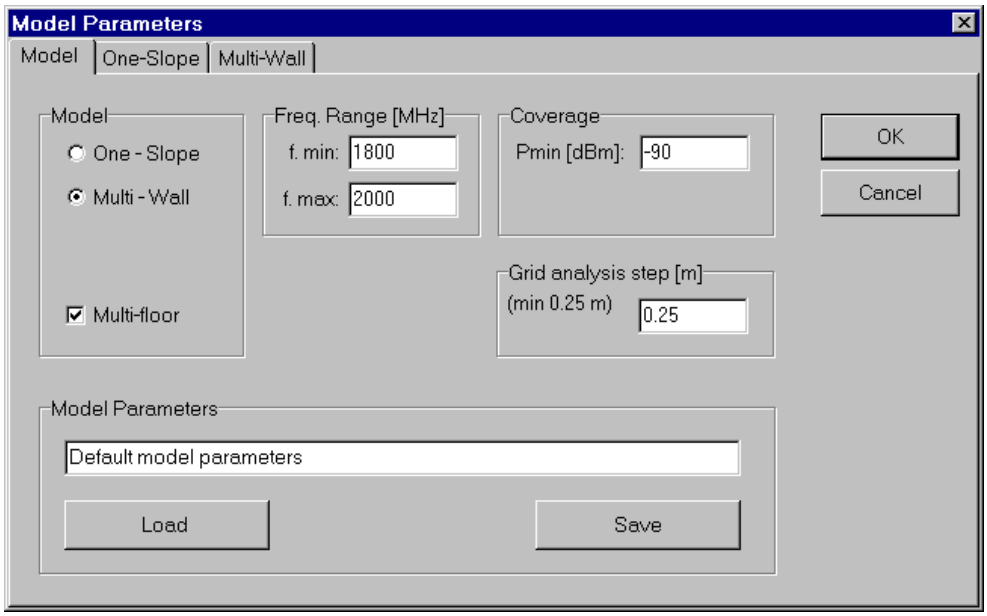
- file path to background bitmap (Windows BMP file)
- Browse - sets the bitmap file path
- x0, y0 - position of left bottom corner of the bitmap in X, Y coordinate system (in meters)
- width - real width of the bitmap in meters (defines the scale of the bitmap)
- Auto [0,0] - automatic calculation of x0, y0 - the bitmap will be moved in X, Y systems so that the bitmap point indicated by auxiliary origin placement becomes a [0,0] X, Y coordinate origin. (The usage is demonstrated in the Chapter 11.)
- To All - copies the background bitmap parameters to all floors.

**WARNING!**

When moving project files the background bitmap files and the file path to them are not automatically updated.

## 4.3 Model Parameters Dialog

A multiple page dialog to set the prediction calculations parameters. The *Model* page contains common parameters, which are described in this chapter. Other pages are attached to specific prediction models, which are described in Ch. 10.




**Model**

- The prediction model selection.

- Multi-floor propagation - when not checked the propagation of the signal through the floor/ceiling is not considered.

**Freq. Range**

- Frequency range of the model parameters validity (lower *f min* and upper *f max* limits in MHz). When the frequency of a base station is out of the range a warning message is shown before every prediction calculation.

**Coverage**

- Pmin - power level limit required for system coverage in dBm (receiver sensitivity).

**Grid analysis step**

- step in meters for coverage analysis - spacing of calculation points. The step and building dimensions determine the number of points where the prediction is calculated. This number also determines the time and memory requirements for calculations. **In all predictions the coverage is calculated for the height of 1.5 m above the floor.**

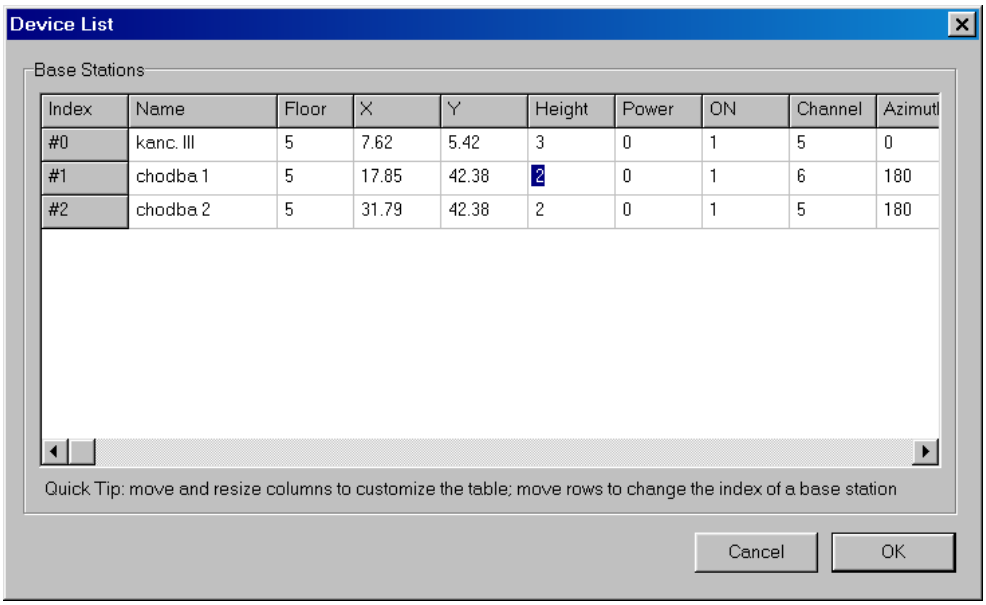
**Model Parameters**

- text description of model parameters file.

- Load/Save - loads/saves the parameters from/to **.mp* file.

## 4.4 Device List Dialog

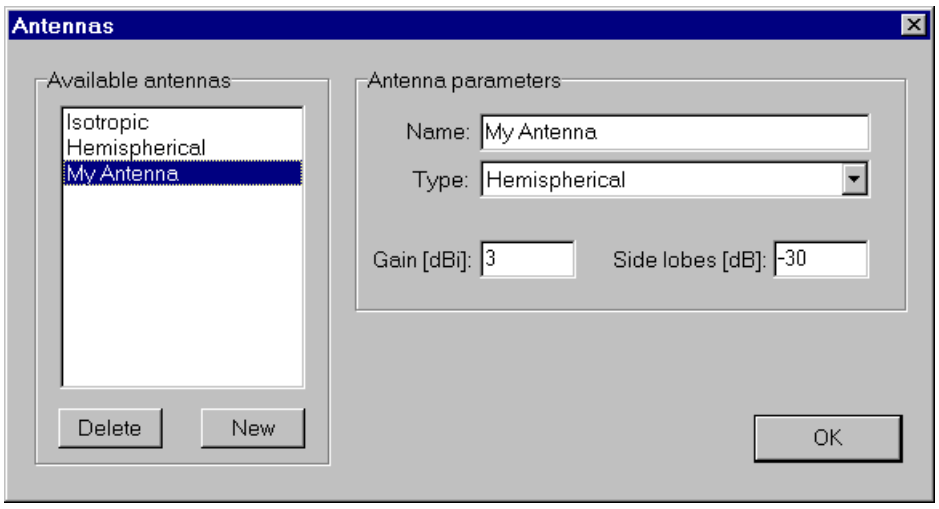
Dialog for tabular list of bas stations.




- Using mouse the columns positions and widths can be changed.
- Using mouse the rows positions together with base station indexes can be changed.
- The base station parameters can be edited in the table. The antenna is set by its name. In the case of nonexistent antenna the isotropic radiator is used instead. The parameters can also be edited in the *Base Station Parameters* dialog, see Ch. 6.3.

## 4.5 Antennas Dialog

The dialog to an edit antenna database which is stored together with base stations in **.dev* project files.




**Available antennas**

- List of all antennas in the project.
- Delete - removes selected antenna. First two fixed antennas (*Isotropic* a *Hemispherical)* cannot be removed.
- New - creates a new antenna.

**Antenna parameters**

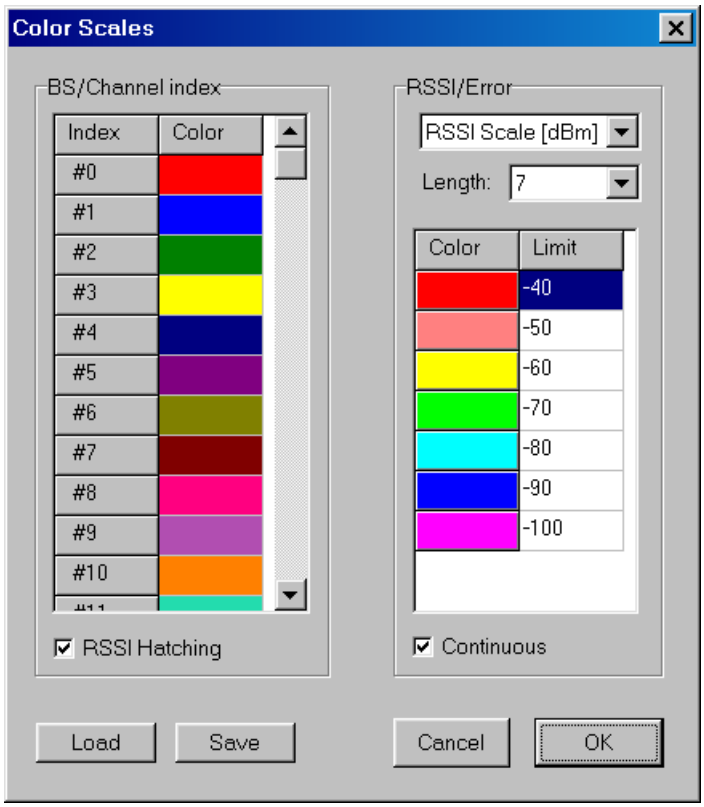
- Selected antenna parameters, which are different for different antenna types. Editing of the first two fixed antennas is limited.
- Name - name of the antenna.
- Type - the antenna type.
- antenna parameters according to the antenna type
- Gain - max. antenna gain in dBi.
- Side lobes - side lobes in dB relatively to the main maximum of the antenna radiation pattern.

There are two antenna types in version 1.0:

- Isotropic - the isotropic radiator with 0 dBi gain.
- Hemispherical - the idealized hemispherical radiator with the gain of *Gain* in the hemisphere of the main maximum direction and the gain of *Gain* - |*Side lobes*| in the opposite hemisphere.

## 4.6 Scales Dialog

The dialog to customize color scales for a coverage analysis (menu *Project - Scales*).




On the left there is a color scale for base station index/freq. channel. On the right there is a power level color scale in dBm (*RSSI Scale*) or an error scale in dB (*Error Scale*). For these scales their lengths (number of colors) and appropriate limits (numbers in descending order) can be edited. Last limit for *Error Scale* is always -999 dB. The colors can be changed when clicking on the color field.

- Continuous - a continuous scale for the *RSS Study* (see Ch. 7).

- RSSI Hatching - an indication of the signal strengths in the *Best Server* and *Freq. Channel* studies (see Ch. 7). The color indicating appropriate BS index or a channel number is graded according to the signal strength down to white color. The signal strength maximum (selected color in the dialog) and the minimum (white color) are set by the first and last limits of the *RSSI Scale*.

The scales can be saved or loaded as a file (buttons *Load* and *Save*). On the I-Prop startup scales from *default.clr* file in the program directory are automatically loaded. Current scales are automatically saved to this file when closing the program.

## 4.7 DXF Import Dialog

The *DXF Import* dialog is launched from *Edit Building* dialog to import a floor from a DXF AutoCAD file, which has to be selected first. Professional building plans are quite intricate and correct building plan divides floors into different drawing layers. That is why the import is executed only for single floor at a time. For multi-floored buildings the procedure has to be repeated for each floor.

The procedure using the dialog (described bellow) can be divided into 4 steps:

- Drawing layers and corresponding wall type are selected.
- The number and height for the new floor is selected.
- The transformation is run.
- If successful, the new floor is inserted into a building plan.

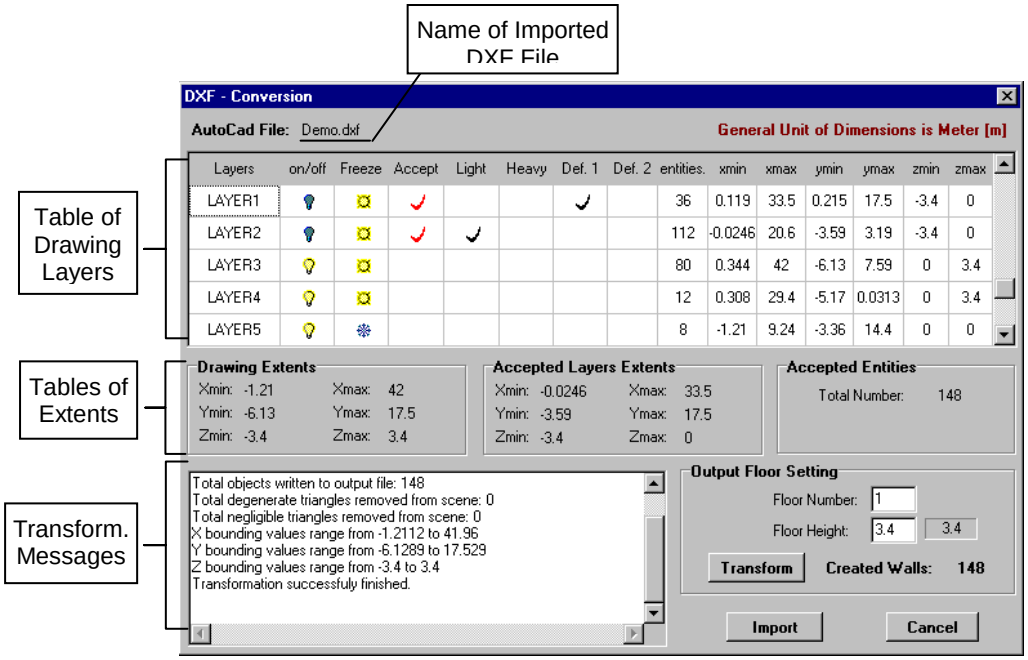



**Table of DXF Drawing Layers**

- Layers - list of layer names included in the selected DXF file.
- on/off - AutoCAD flag (no influence on the import).
- Freeze - AutoCAD flag (no influence on the import).
- Accept - indicates whether the layer is selected for the import.
- Light, Heavy, Def. 1, Def. 2 - wall types used in the I-Prop Multi-Wall Model. Double-click a grid element to accept a layer as the desired wall type.

- Entities - Number of entities within the layer.

- Xmin, Xmax, Ymin, Ymax, Zmin, Zmax: - Extents of the layer.

**Tables of Extents**

- Drawing Extents - overall extents of the drawing (original from AutoCAD)

- Accepted Layers Extents - overall extents of all layers accepted for the import.

- Accepted Entities - Total number of all entities within the accepted layers.

**Transform. Messages**

- Information generated by import procedure run by *Transform* button. Also indicates the total number of degenerated and negligible (smaller then 10mm in XY plain) entities.

**Output Floor Settings**

- Floor Number - floor number of the imported floor.

- Floor Height - indicates the height for the imported floor. The number in gray box is calculated from Z extents of accepted layers as a hint (double-click it to accept this value as a floor height).

- Transform - The button is enabled only if the total number of accepted entities is nonzero.

- Created Walls - information about a total number of created walls within the new imported floor plan.

**Import**

- Inserts the new floor plan to the building. If a floor with the same floor number already exists, all the existing floors are shifted up. The *Transform* must be pressed first.

**Useful Tips**

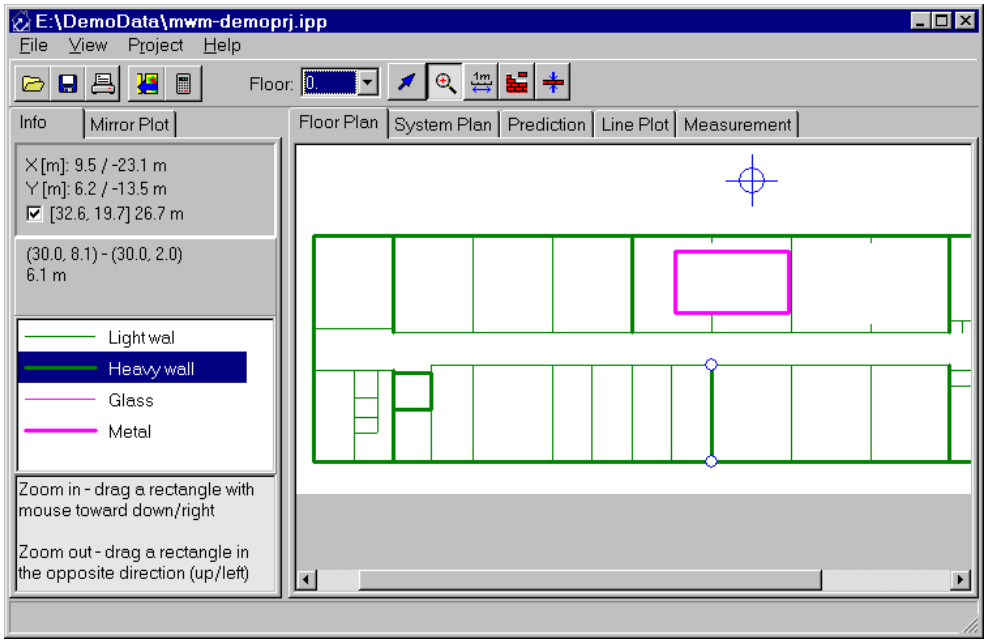
- Select only layers, which you want to import and assign each of them one of the wall types.

- The import procedure accepts only DXF entities of the type "LINE". Almost all the important entities for walls description can be simply converted to LINE type by AutoCAD function "Explode".

- The extent of a floor plan in I-Prop is than same as it was in AutoCAD. A scale of DXF drawing is expected in millimeters. If not, use *Rescale* in the toolbar to change the scale of the floor plan (see Ch. 5.2).

# 5 Floor Plan Mode

*In this operational mode the floor plan is view and edited.*




In the main window the floor plan of the current floor is showed. First the background bitmap is drawn (if defined in the *Edit Building* dialog for the floor). Then the walls, partitions and holes (if defined) are painted. The thickness and color for the walls is assigned according to wall types (see legend in the *Info* window). For holes, red rectangles with diagonal are used.

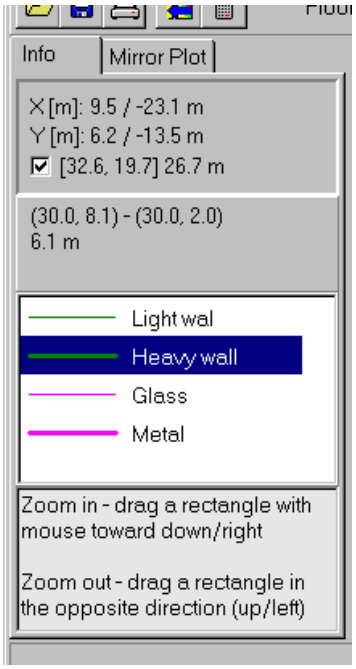
Currently selected wall (hole) has emphasized ends (corners).

In the *View* menu the display of background bitmaps can be switched off. The walls are always visible in this mode.

In the *View* menu the visibility of the grid and auxiliary origin can be switched on/off. The blue color is used.

> White color of a background bitmap is transparent for other displays in the main window (walls, grid, coverage analysis etc.). That is why the background bitmaps should be simple pictures with prevailing white. Otherwise, the final image will be too complicated to comprehend.

## 5.1 Info Window




**Cursor coordinates**
See Ch. 3.2.

**Text description**
Coordinates of the selected wall corners. The wall lengths in meters.

**Legend**
Legend for wall types. The text description is set by the Multi-Wall model parameters (the *Model Parameters*. dialog). The type of the selected wall is emphasized.

**Quick Tips**
See Ch. 3.2.

## 5.2 Tools

**Info**
The wall (hole) is selected by a left mouse click on it (on hole's diagonal).

**Zoom**
Zoom in - dragging a rectangle with a mouse toward down/right (left mouse button pressed). The maximum zoom is limited. Zoom out - fit the image to the window - dragging a rectangle in the opposite direction (up/left). The viewable sector of the floor plan can be set in the *Edit Building* dialog.

**Rescale**
Right click sets the auxiliary coordinate system origin position. The visibility of the origin in the main window can be set in the *View - View auxiliary [X,Y] origin* menu or in the *Info* window.

All floor plans of the building can be rescaled by drawing the line with the left mouse button and assigning real length of the line in meters. The positions of base stations of the project are recalculate as well.

Holding keys when drawing: Ctrl - snap to corners, Shift - horizontal/vertical lines only, Alt - snap to grid. The grid can be set in the *View* menu.

**New Wall**
Using a mouse a new walls can be added to the floor plan. The function of *Alt*, *Shift* and *Ctrl* keys while drawing is described above. The wall type is determined by a selection in the legend in the *Info* window.

**Edit Wall**

In the legend of the *Info* window the wall type of selected wall can be changed. The wall corners can be repositioned using a mouse. The function of *Alt*, *Shift* and *Ctrl* keys while drawing is described above.

Similarly a hole can be selected and edited using its diagonal.

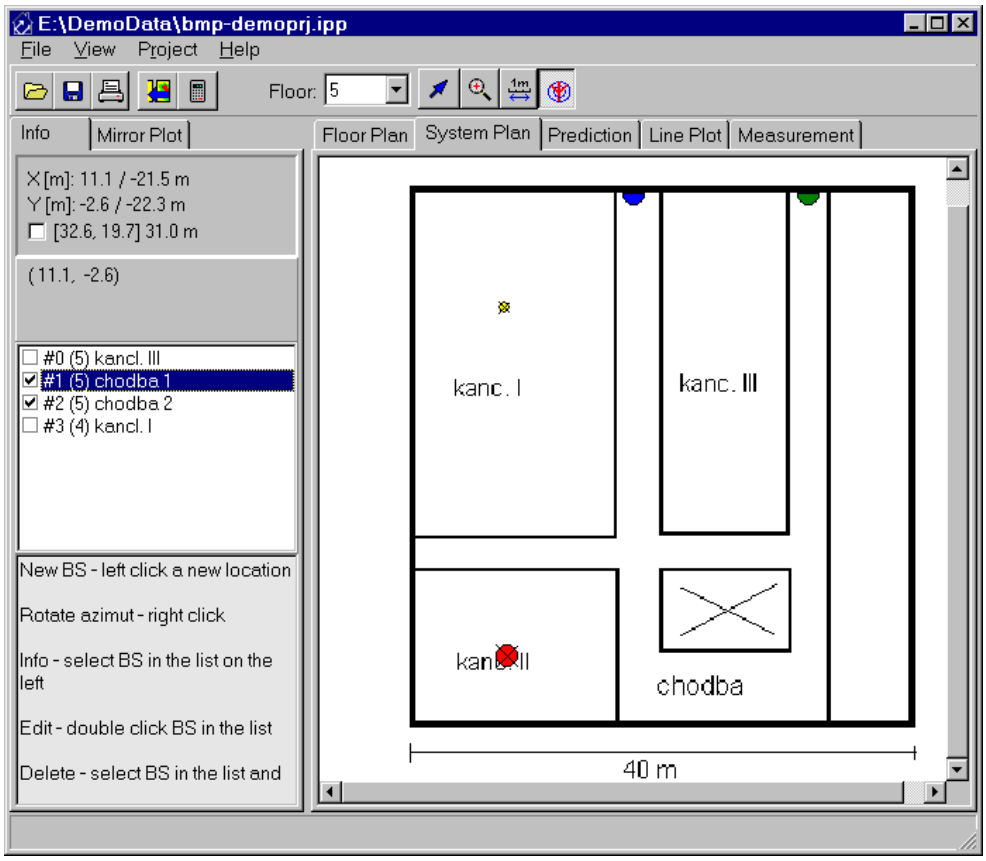
*Delete* key removes the currently selected wall (hole).

**New Hole**

New rectangular holes can be added to the floor plan using a mouse. The function of *Alt*, *Shift* and *Ctrl* keys while drawing is described above.

# 6 System Plan Mode

*The base station picocellular system can be viewed and edited in this operational mode.*




In the main window the base stations are shown with a floor plan in the background. Visibility of the floor plan background bitmaps and walls can be set in the *View* menu as well as the grid and auxiliary coordinate system origin. All the walls are drawn in black color.

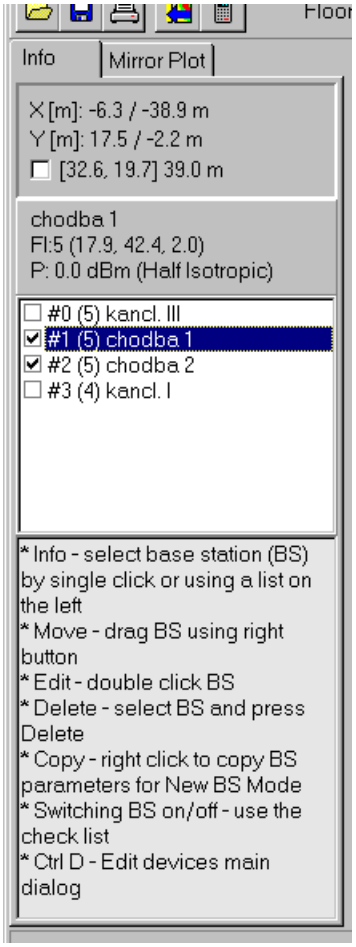
A base station is shown as a circle for an omnidirectional antenna and as a half-circle for directional antenna.

The color is defined by the base station index and can be edited in *Scales* dialog (see Ch. 4.6).

Base stations from other than the currently displayed floor are shown in a reduced size.

Base stations, which are switched off, are crossed.

## 6.1 Info Window




**Cursor coordinates**
See Ch. 3.2.

**Text description**
Currently selected base station information: name, floor number, location (X, Y, height), power in dBm, antenna.

**Legend**
List of all base stations in the project: switched on/of, index, floor number, name. Base stations can be directly switched on/off from the list. The selected base station is emphasized.

**Quick Tips**
See Ch. 3.2.

## 6.2 Tools

 **Info**
Mouse left click selects the base station.

Using the right mouse button the base station can be repositioned.

Right click on a base station copies its parameters into the memory. These parameters are then used as a default values for new base stations.

Double click on a base station runs the *Base Station Parameters* dialog (see below).

 **Zoom**
See Ch. 5.2.

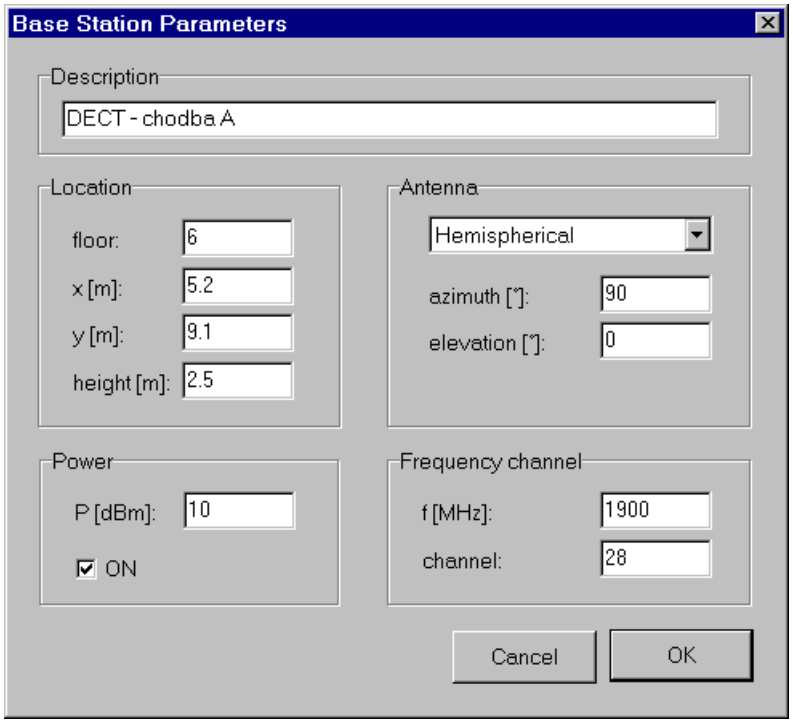
 **Rescale**
See Ch. 5.2.

 **New BS**
Left click adds a new base station at the mouse position. The *Base Station Parameters* dialog (see below) for the new base station is launched.

Right click changes the azimuth of a directional antenna (Hemispherical) for a new base station to all quarters and downwards (antenna mounted on a ceiling). The direction is indicated by a cursor shape.

*Delete* key removes the selected base station (in all tools).

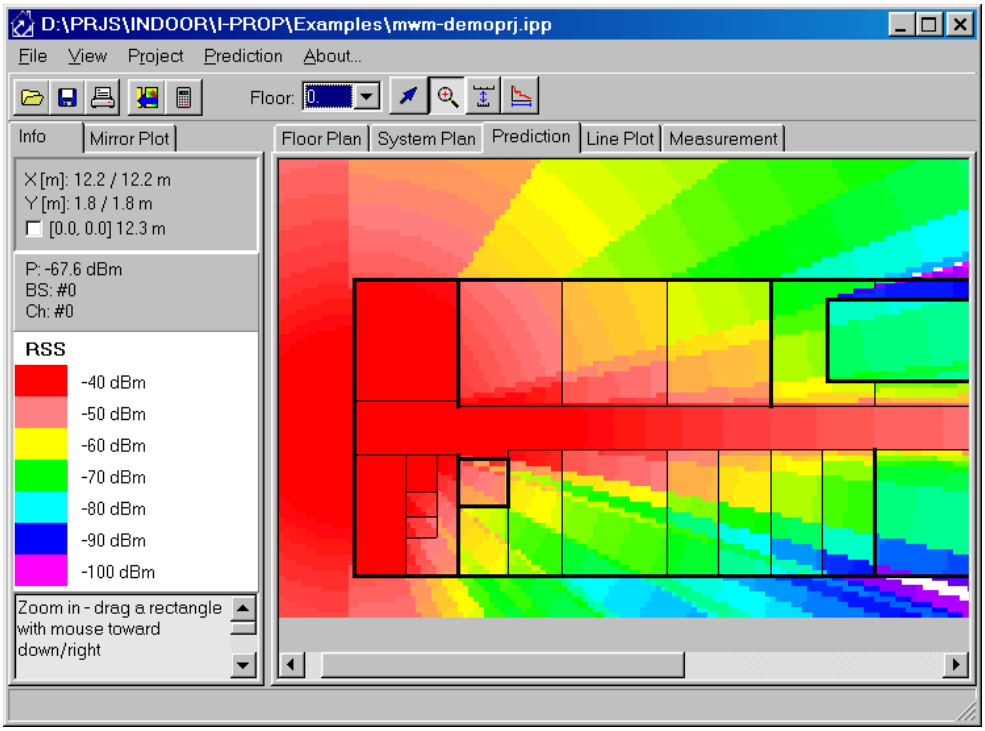
## 6.3 Base Station Parameters Dialog




- Description - text description - name - of the base station.
- Location - floor number, X, Y coordinates and a height above the floor.
- Power - transmitter power in dBm (at the antenna input).
- Antenna - name, azimuth and elevation of the used antenna.
- Frequency channel – frequency in MHz and the frequency channel number.

# 7 Prediction Mode

*The coverage studies are calculated and viewed in this operational mode.*




In the main window a selected coverage study is shown with a floor plan in the background. Visibility of the floor plan background bitmaps and walls can be set in the *View* menu as well as the grid and auxiliary coordinate system origin. All the walls are drawn in black color.

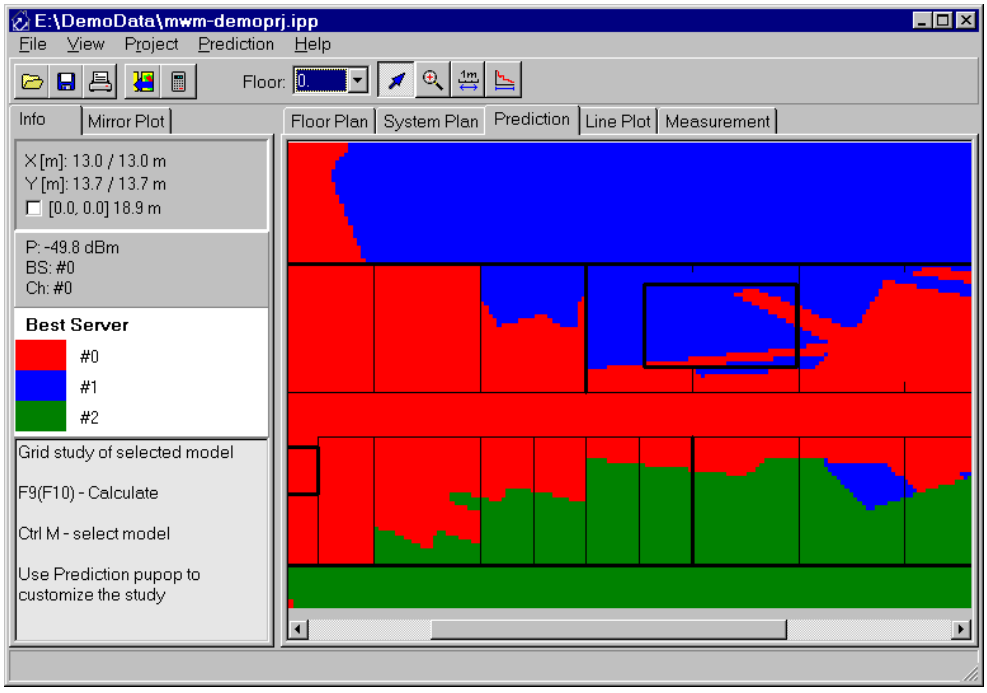
Color scale for the study is displayed in the *Info* window. All the scales can be edited in the *Scales* Dialog (see Ch. 4.6).

The analysis step (editable in the *Model Parameters* dialog) determines the square size in a grid for analysis calculations. The computed value (color) corresponds to the center point of the square.

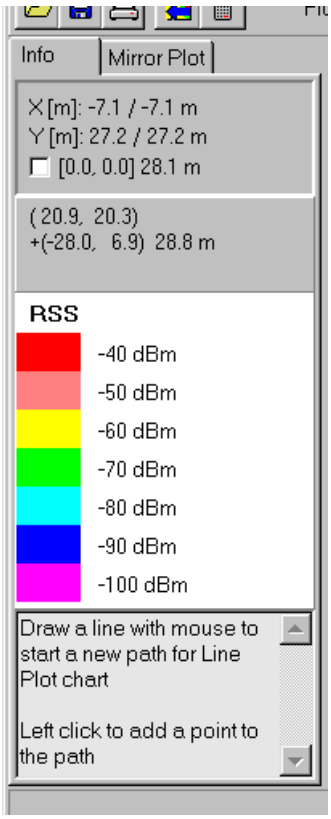
> The analysis step determines the number of points for prediction calculations and study picture drawing. That is why this parameter has an essential influence on the calculation and drawing time and on the memory requirements.

## 7.1 Prediction Menu

- Run building (F9) - runs the prediction for all floors of the building.
- Run floor (Ctrl F9) - runs the prediction calculation only for the current floor.
- RSS (F4) - the received signal strength (by isotropic antenna) study - displays the maximum signal strength.
- Best Server (F5) - the best server base station study - using the index color the base station with the strongest signal in the point is indicated.
- Freq. Channel (F6) - the best server frequency channel study - using the index color the frequency channel number with the strongest signal in the point is indicated.
- Coverage (F8) - if checked the locations with signal strengths lower than the limit defined in the *Model Parameters* dialog (no coverage) are filled white.
- Export - export of the RSS coverage study in the 'measured data' file format - see Ch. 9.1.



## 7.2 Info Window




**Cursor coordinates**
See Ch. 3.2.

**Text description**
Analysis information for the cursor position (RSS, best server index, and best server frequency channel) or an information on a last segment of a polyline path when the *Set line plot* tool is selected (see below).

**Legend**
Color scale for the selected coverage analysis (e.g. received power in dBm, base station index or frequency channel number).

**Quick Tips**
See Ch. 3.2.

## 7.3 Tools

**Info**
In the *Info* window the analysis information for the cursor position is displayed.

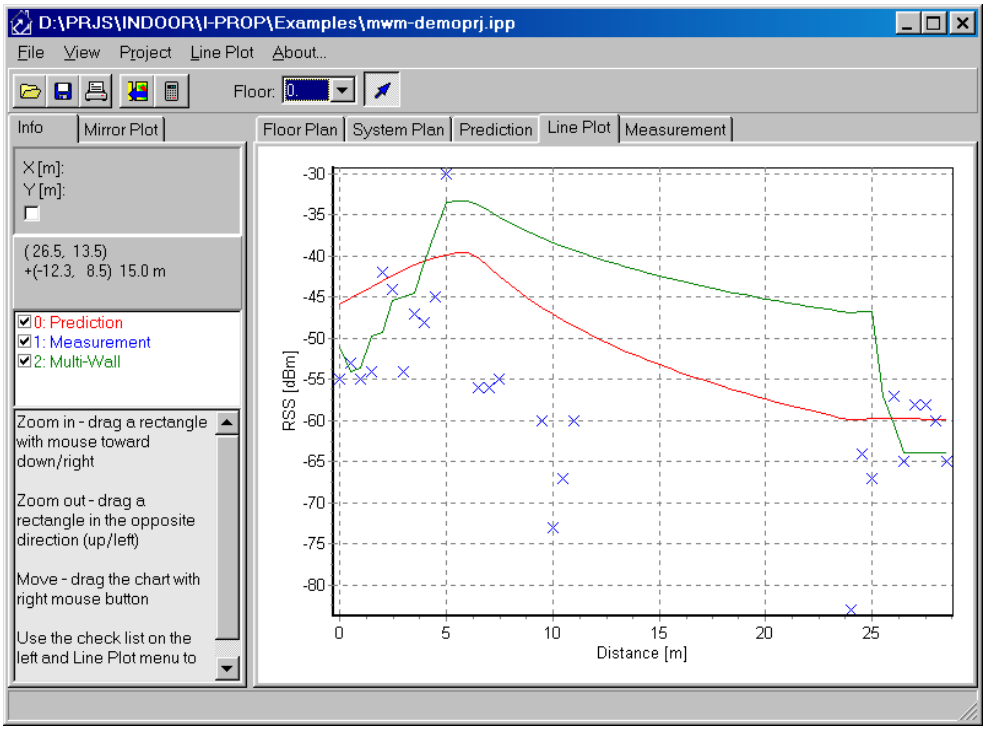
**Zoom**
See Ch. 5.2.

**Rescale**
See Ch. 5.2.

**Set line plot**
Dragging a line using left mouse button, a new polyline path for the *Line Plot* mode is created. Left click adds a point to the polyline path. Maximum number of points is 16. Information for the last section is displayed in the *Info* window.

# 8 Line Plot Mode

*Signal strength along polyline paths can be view and compared in this operational mode.*




A chart in the main window represents the received signal strength in dBm along a polyline path. Primarily first two graphs *Prediction* a *Measurement* (red and blue color) representing the current polyline path in Prediction and Measurement modes (if available) are fixed. The paths can be set using the *Set line plot* tool in these modes (see Ch.7.3). The *Measurement* graph is not continuos because discrete measurement points are considered.

The first two fixed graphs are automatically updated when the polyline path or the current floor is changed. Other stored graphs do not change.

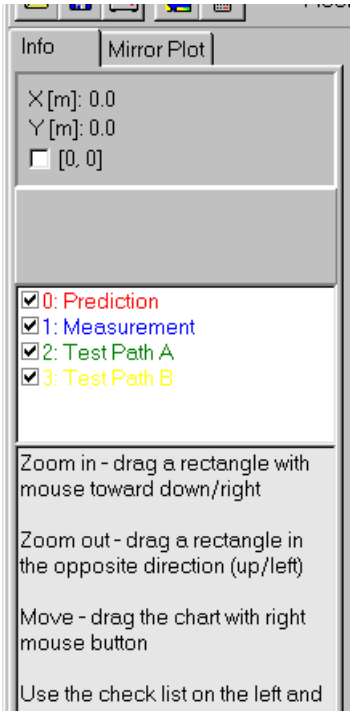
Arbitrary number of graphs can be viewed and compared in the chart. The graphs can represent various paths within the same or different floors, different prediction models etc.

Zooming in the graph is available similarly as in other modes. Using the right mouse button the graphs can be moved.

## 8.1 Line Plot Menu

- Store prediction plot - copies the *Prediction* graph (first fixed) at the end of the list. A text description can be defined.
- Store measurement plot - copies the *Measurement* graph (second fixed) at the end of the list. A text description can be defined.
- Reset graph - removes all stored graphs.
- Export - exports all the graphs into a text file for further processing (e.g. using MS Excel).

## 8.2 Info Window




**Cursor coordinates**
No information.

**Text description**
No information.

**Legend**
List of the graphs. Visibility of each graph in the chart can be switched on/off in the list.

**Quick Tips**
See Ch. 3.2.

# 9 Propagation Prediction Models

*Implemented indoor propagation prediction models are based on the ITU-R P.1238-1 recommendation, final report of COST 231 project and results of research conducted by the I-Prop authors team. In this chapter, only the user interface for model parameters settings is described.*

Propagation of electromagnetic waves inside buildings is a very complicated issue. There are various models based on various principles with various requirements for input data complexity. In real situation any piece of furniture, open doors and windows, moving people, reflections from outside the building and other effects influence the signal propagation. It is obvious that the results of any model is just a prediction which can failed in some cases.

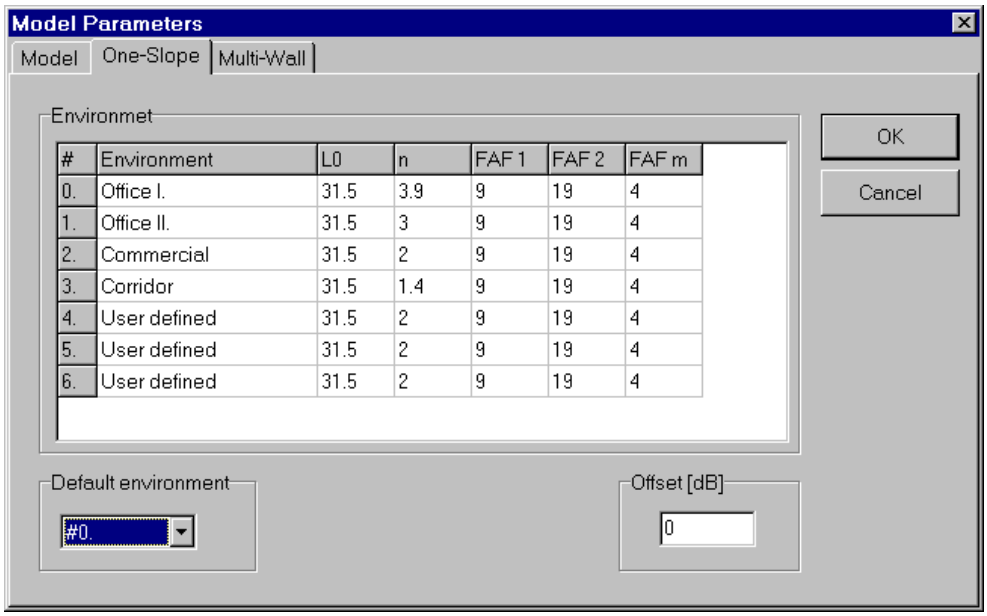
(Semi-)empirical models used in I-Prop with only minimum requirements on input data can very effectively predict an indoor coverage with the standard deviation typically up to around 10 dB. After an optimization of model parameters using test measurement data from an analyzed site the deviation can be dramatically reduced. The prediction accuracy is reduced for extremely irregular building interiors or when improper model parameters are used. When interpreting the prediction results these effects should be taken into account.

Default recommended model parameters for various frequency bands and common indoor environments are place in the *Models* subdirectory (how to load the parameters see Ch. 4.3).

Stand-alone software tool is available for automatic model parameters optimization based on test measurements.

## 9.1 One Slope Model

Empirical model that does not require the walls and partitions definition but only the environment type. The model is suitable for very fast coverage studies on simple bitmaps or drawings




| # | Environment | L0 | n | FAF 1 | FAF 2 | FAF m |
|---|---|---|---|---|---|---|
| 0. | Office I. | 31.5 | 3.9 | 9 | 19 | 4 |
| 1. | Office II. | 31.5 | 3 | 9 | 19 | 4 |
| 2. | Commercial | 31.5 | 2 | 9 | 19 | 4 |
| 3. | Corridor | 31.5 | 1.4 | 9 | 19 | 4 |
| 4. | User defined | 31.5 | 2 | 9 | 19 | 4 |
| 5. | User defined | 31.5 | 2 | 9 | 19 | 4 |
| 6. | User defined | 31.5 | 2 | 9 | 19 | 4 |

**Environment**

- Environment - environment type description. In default recommended parameters:
    - Office I. - strong signal attenuation - administration buildings, a lot of furniture or hard partitions/walls
    - Office II. - medium signal attenuation - common offices
    - Commercial - slight signal attenuation - large interiors with a lot of space (halls, large empty rooms, large offices with soft partitions etc.)
    - Corridor - for users in corridors with line of sight to the base station.
- L0 1 - path loss in dB at 1 m distance (intercept).
- n - power decay index (slope).
- FAF 1 - Floor Attenuation Factor in dB for signal propagation through a single floor.
- FAF 2 - Floor Attenuation Factor in dB for signal propagation through two floors.

- FAF m - Floor Attenuation Factor in dB for signal propagation through more than two floors. The final attenuation factor is calculated as FAF = „FAF 2“ + (*n* - 2) “FAF m“, where *n* is a number of floor between the base station and the user (*n* > 2).

**Default environment**

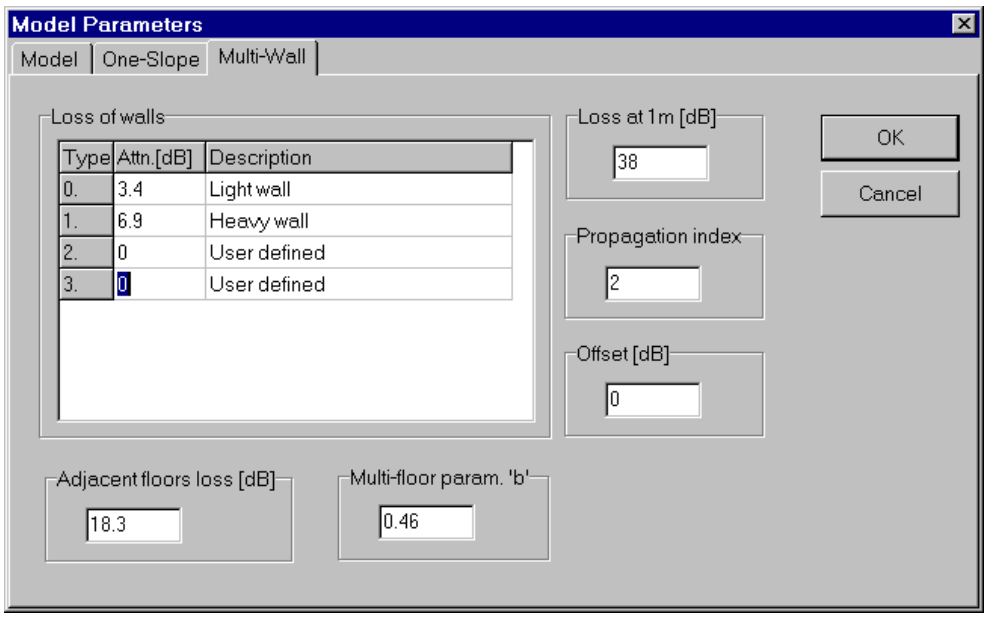
- selected environment (index from the table) for the prediction calculation.

**Offset**

- attenuation offset - the value in dB is added to the prediction in each point.

## 9.2 Multi - Wall Model

Site specific semi-empirical model, which needs walls definition. The accuracy is much better comparing to One-Slope Model.




**Loss of walls**

- attenuation factor in dB and a text description for basic wall types.

**Loss at 1m**

- path loss in dB at 1 m distance (intercept).

**Propagation index**

- power decay index (slope).

**Offset**

- attenuation offset - the value in dB is added to the prediction in each point.

**Adjacent floor loss**

- signal propagation loss between adjacent floors.

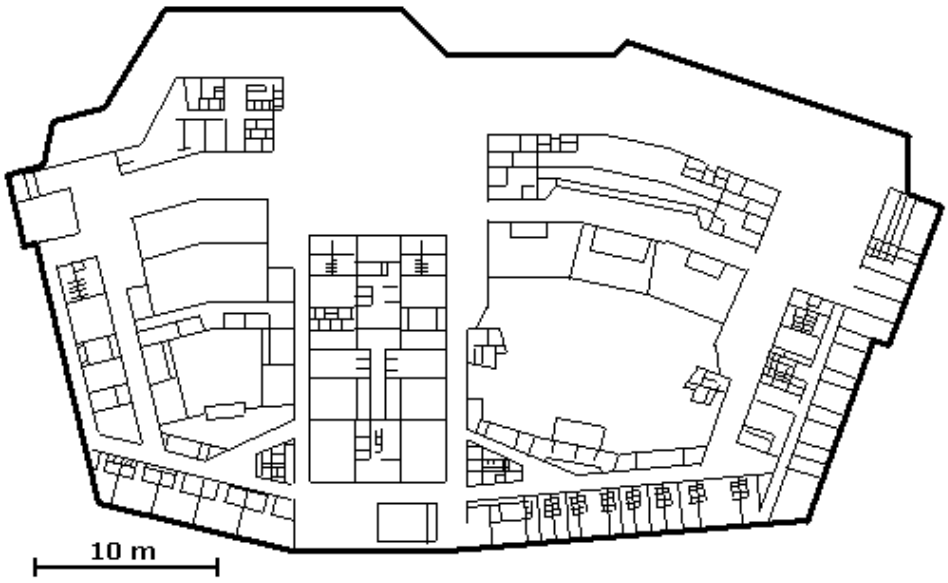
**Multi-floor param. 'b'**

- empirical parameter representing multi-floor attenuation linearity.

# 10 How to Create a New Project

*An example of how to create a new project in few steps is described in this chapter.*
*A simple project with only the background bitmap and the One-Slope Model is used.*

Let us assume that a brief study of design possibilities of a picocellular wireless system deployment in 5th floor of an office building is needed. Only a simple sketch of the 5th floor plan is available. In few minutes simple bitmap of the plan can be generated or scanned as a background picture and scale for the coverage analysis:




**Creating the floor plan**

- Run I-Prop, choose *New* from *File* menu.
- Select *Building…* from *Project* menu (Ctrl-B). The dialog for the basic building editing is opened.
- Press *New* (left part of the dialog) and input the desired floor number - 5. In the floor list a new 5th floor is added.
- In the right part of the dialog the parameters for the new floor are shown. Press *Browse* in *Background bitmap* section to load the prepared background bitmap.
- Because the coverage in adjacent floors is interesting for interference issues as well, add floors number 4 and 6 using the same *New* button as above. Do not edit their parameters yet.

**Rescaling the floor plan**

- Press *OK* to return to the main window into a *Floor Plan* mode. Select the 5th floor in the floor selector.

- Pick the *Rescale* tool. Using a mouse with the left button pressed draw a line over the scale on the background bitmap (when holding *Shift* only horizontal or vertical line is drawn). Than input a real length of the distance, e.g. 10 meters. The floor plan is automatically rescaled.

- Using a right mouse button put the auxiliary coordinate system origin on the required point on the bitmap, e.g. on the lower left corner of the floor plan. The visibility of the auxiliary origin can be set by *View auxiliary [X,Y] origin* in the *View* menu.

- Start again the *Edit Building* dialog (*Project - Building*…menu) and select the 5th floor in the floor list.

- In the *Background bitmap* subsection press the *Auto [0,0]* button to move the background bitmap to the desired position in the coordinate system. Press *To all* in this subsection to copy the bitmap settings to all other floors.

- In the *View* subsection press the *Auto* button to set the viewport for the coverage studies (viewport is defined to include the whole bitmap). Press *To all* button in this subsection to copy the settings to all other floors.

- In the *Height* subsection set the floor height (including the ceiling thickness) to e.g. 4,5 meters. Again use the *To all* button to copy the information to other floors.

**Base stations**

- Return to the main window and select the *System Plan* mode and the *New BS* tool.

- Using a mouse put a required base stations on the floor plan and set their parameters.

**Coverage analysis**

- In the *Model parameters* dialog (menu *Project - Model parameters*…, Ctrl-M) choose the One-Slope model, check the *Multi-floor propagation* and set the environment for the One-Slope Model.

- Return to the main window and switch to the *Prediction* mode. Run the prediction calculation (menu *Prediction - Run Building*). Then you can switch to a desired coverage study (*Prediction* menu) for all floors. Polyline path can be chosen to see the results in the *Line Plot* mode as well (see Ch. 8).

**For more precise design**

- If a design that is more precise is required, the floor plan should be defined in details by its walls. Multi-Wall model can be used then.

- If test measurements are available for the site, parameters of the models could be optimized for the specific case.

Examples of projects are placed in the *Examples* subdirectory.