

Basic conventions for the CAD-modelling of the Micro-Vertex-Detector

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Abstract

The implementation of complete CAD models for the PANDA Micro-Vertex-Detector (MVD) is a very important tool for the development of the detector. It provides the input for detailed detector simulations as well as it gives a starting point for mechanical solutions concerning e.g. the global and local support structure and the cooling system. Based on these studies the final design for the MVD can be fixed. This *modus operandi* assures both the optimization with respect to the physical requirements and the technical reliability of the detector concept.

Due to the parallel development of different detector parts - in particular for the pixel and the strip part of the detector - and the interaction between different hardware and software groups it is essential to define basic conventions. This starts with the fixation of a modular concept for the MVD and furthermore includes geometrical and naming conventions. Moreover, it regulates the global management of different detector versions and their documentation.

In this detector note all the definitions are summarized. Hence, it provides a guideline for all upcoming CAD models of the MVD. Defining a very general framework for the MVD, it should be applicable on a very general scale as well. However, some modifications or more detailed definitions will likely become necessary in the future. Due to this fact it is emphatically recommended to always check the up-to-date status given in [1] before starting a new CAD project for the MVD.

1 Introduction

Basic conventions concerning the CAD modeling must provide a clear structure which helps to manage the communication and interaction of different developer groups. Furthermore, the compatibility with the software for detector simulations must be ensured. Moreover, based on intuitive and simple definitions a high flexibility is desired so that these conventions can be applied easily to all future models. The conventions introduced in this MVD note imply the description of the modular concept for the MVD as well as the definition of the main geometry and the regulation of a nomenclature for all components used in a CAD model. Finally, a general idea of the data management for the design development is presented.

2 Hierarchy

The design of the MVD features a modular concept. On the lowest level there is the sensor with its active and passive volume. The active sensor volume gives the most important input for physics simulation because here the physically valuable data is generated.

Charged particles crossing this volume produce electron-hole pairs. A collection of the generated charge leads to the detector signals which have to be processed in the frontend electronics and consecutively analyzed in the software.

The smallest composed object is a detector module. It defines the smallest unit which is electronically independent. Therefore it consists of a sensor together with the frontend electronics needed for its readout, a local support and, depending on the special kind of module, some other components - e.g. a module controller in case of a pixel frontend.

Level	Components
1 (lowest): Sensor	- Active and passive volume
2: Module	<ul style="list-style-type: none"> - Sensor - Frontend-electronics (FEE) - Local cooling and support - Flex or bus cable - <i>Pixel part</i>: Module controller - <i>Strip part</i>: Pitch adapter - ...
3: Super-module	<ul style="list-style-type: none"> - Module - Cooling and support structure - ...
4: Layer	<ul style="list-style-type: none"> - Super module - Support structure - ...
5: MVD part Halfshell / Forward	<ul style="list-style-type: none"> - Layer - MVD support - ...

Figure 1: Hierarchy for the CAD models of the MVD

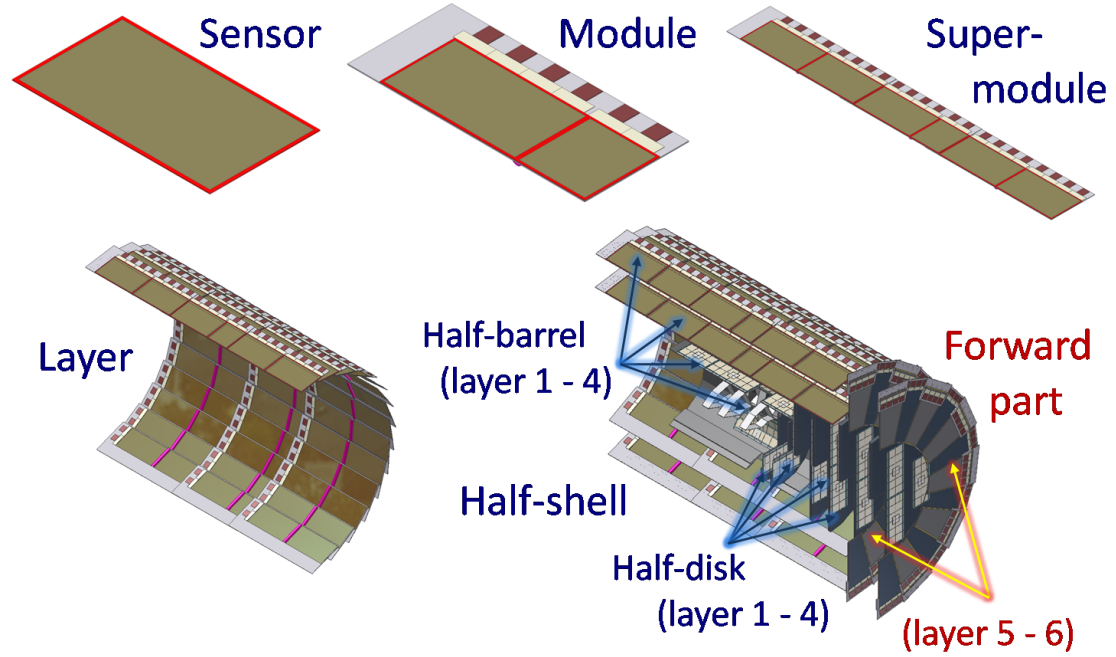


Figure 2: Illustration of the modular concept for the MVD

Single detector modules are integrated within a super-module. A super-module is a mechanically independent unit. Therefore, a local cooling and support structure in addition to the modules is needed on this level. Eventually, supplement components are necessary in some of the super-module types.

The detector layers are formed by an arrangement of super-modules. They are subdivided into barrel layers and disk layers which all are attached to the MVD support structure.

Due to the crossing of the target pipe through the MVD volume, a half-detector concept must be applied. The full detector consists of a forward part and a structure made from two half-shells. The forward part is formed by the outer half-disks of the detector. A half-shell includes all half-barrel layers and the inner half-disks (see figure 2). The half-shells are mechanically independent from the forward part. Unlike all other layers which are equipped with only one sensor type (pixel or strip sensors), the half-disks in the forward part are composed of pixel sensors in the inner part and strip sensor in the outer region. A summary of the CAD hierarchy for the MVD is shown in figure 1.

3 Geometrical conventions

The definition of the global coordinate system must be in agreement with the choice of coordinates in the detector simulations. This results in the choice of a Cartesian system in which the point of origin is equal to the nominal primary interaction vertex. Moreover, the beam axis coincides with the z-axis. The orientation of the z-axis is pointing in beam direction. The target pipe axis is chosen as y-axis. The direction of the axis is opposite to the direction of motion of the target pellets. Thus, the x-axis is automatically defined.

Due to this definition the MVD volume can be separated into an upstream and a

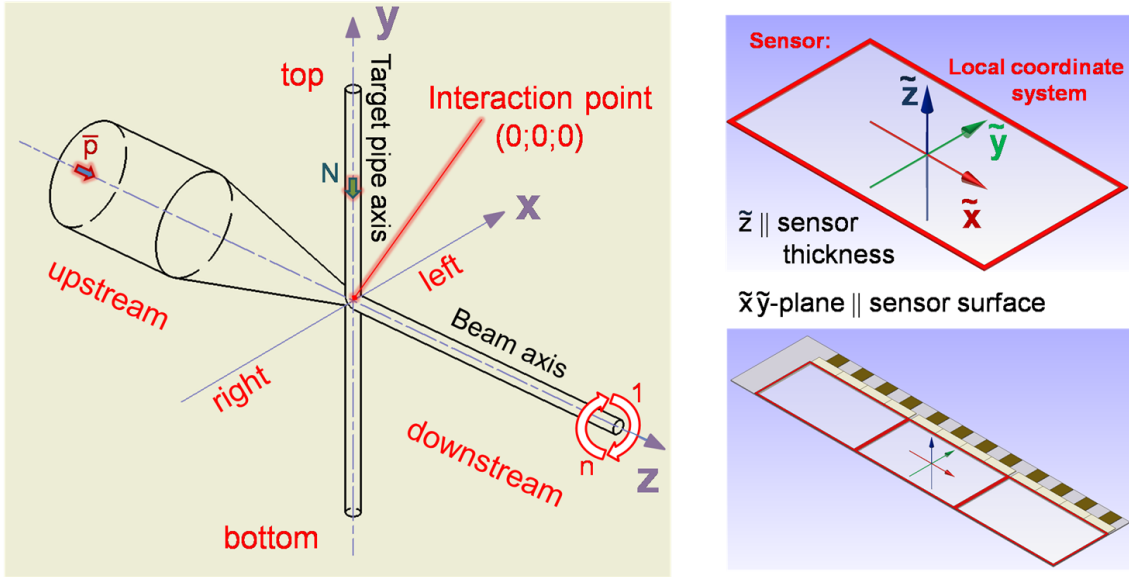


Figure 3: Definition of the global coordinate system (left) and the local coordinate system of a component (right). Besides the same choice of global coordinates, a proper definition of the local coordinate system of the active sensor volume is extremely important for the detector simulations.

downstream region with respect to the beam axis, a left and a right side with respect to the x -axis and a top and a bottom part with respect to the y -axis (see figure 3). For the local coordinate system of single components, modules and super-modules there are the following restrictions:

- The centre point of the volume coincides with the geometrical centre.
- The horizontal projection corresponding to the local $(\tilde{x}\tilde{y})$ -plane is parallel to the sensor surface.
- The sensor thickness expands along the local z -axis (\tilde{z}).

It should be noted that the definitions given above are very important for the integration of the CAD models in the software simulation. This in particular applies to the sensor volume. For higher levels - i.e. different layers and MVD parts - the local coordinate system is the same as the global one.

The indexing for an arrangement of a number of copied components is carried out from upstream to downstream along the beam pipe and clockwise within the xy -plane (see figure 4).

4 Naming conventions

Each component in the CAD model is expected to have a unique and self-explanatory name which is kept as short as possible. The first letter of a name is written in capital while the rest is left in lower case. Different parts of a composed name are separated by an underscore. Generally, there are four criteria to classify a component:

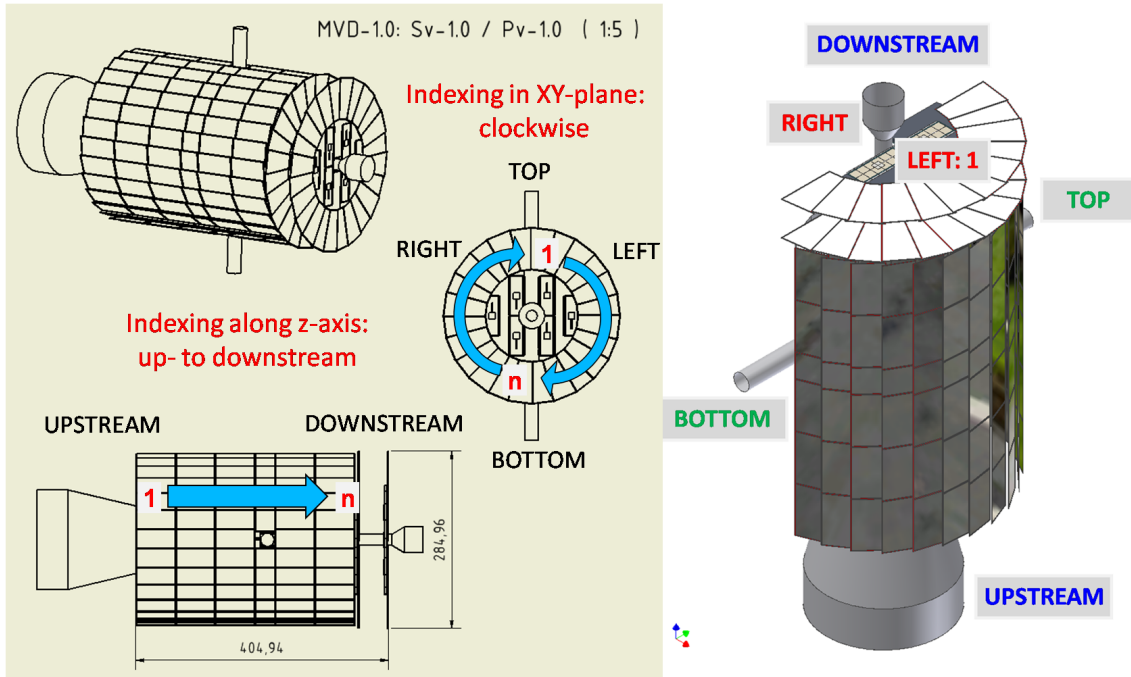


Figure 4: Indexing of copied components. Right: Isometric view of first half-detector

1. The sensor type which is used in the component.
2. The geometrical shape of the component.
3. The size of the component.
4. The layer type in which the component is used.

[Attribute]	Abbreviation	Explication
[sensor type]	Pixel	Used sensor type: pixel sensors
[sensor type]	Strip	Used sensor type: strip sensors
[sensor type]	Mixed	Used sensor type: pixel and strip sensors
[shape]	Rect	Rectangular shape of component
[shape]	Trap	Trapezoidal shape of component
[shape]	Circ	Round shape of component
[size]	Xs	Very small size
[size]	S	Small size
[size]	M	Medium size
[size]	L	Large size
[size]	Xl	Very large size
[layer type]	Bl	Barrel layer
[layer type]	Dk	Disk layer
[layer type]	Co	Compound layer out of barrel and disk part

Table 1: List of abbreviations for the classification of a component

Hierarchical allocation	
<i>Abbreviation</i>	<i>Explication</i>
Mvd	<i>Micro-Vertex-Detector</i>
Pv	<i>Pixel version</i>
Sv	<i>Strip version</i>
Sup	<i>Support</i>
Hshell	<i>Half-shell</i>
Fwd	<i>Forward part</i>

Table 2: List of abbreviations for the main MVD structure illustrated in figure 7.

Hence, the name of a component can be formed by its individual abbreviation extended by chosen classifying attributes. The additional information in the component name must ensure naming unambiguity. A list of abbreviations can be found in table 1 and 2. The composition of main component names is shown in table 3. The implementation of the naming conventions is illustrated exemplarily in figure 5 and figure 6. The lists are not complete and can be extended according to the special demands of a model.

With these conventions it is assured that after integrating the CAD files into the detector simulation the active detector volume can easily be identified by searching components including the string 'Active'. In the same manner special detector components - e.g. the pixel or the strip part, the detector support structure or the cooling system - can be switched on or off in the simulations to study their influence on physics performance.

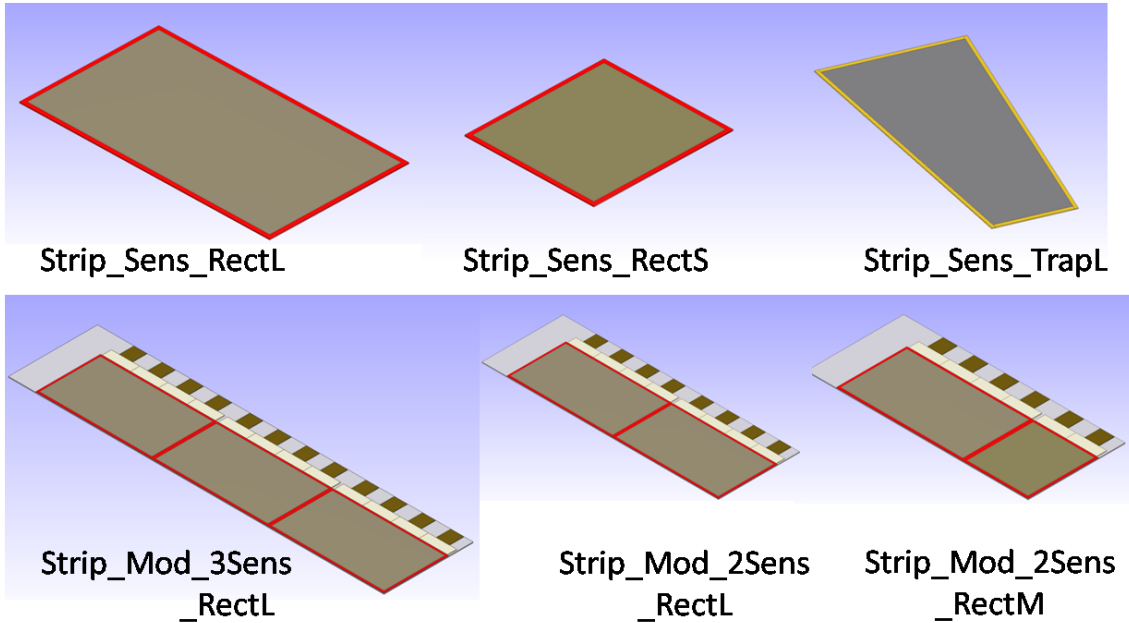


Figure 5: Exemplary illustration of the naming for different strip sensors and appropriate modules used in a MVD strip subversion.

Component	Naming	Comments
Barrel layer	[type] + '_Bl' + [N _{Bl}]	[N _{Bl}] = 1,...,4: barrel layer
Disk layer	[type] + '_[size]dk' + ':{N _{Copy} }'	{N _{Copy} } = copy number
Super-module	[type] + '_Smod_N' + [N _{Mod}] + _[shape][size] + ':{N _{Copy} }'	[N _{Mod}] = number or array [a] × [b] of used modules
Pixel module	'Pixel_Mod_' + [N _{Fe}]... ... + _[shape][size] + ':{N _{Copy} }'	[N _{Fe}] = number or array [a] × [b] of used frontends
Strip module	'Strip_Mod_' + '[N _{Sens}]Sens_' + _[shape][size] + ':{N _{Copy} }'	[N _{Sens}] = number of used sensors
Frontend	[type] + '_Fe' + ':{N _{Copy} }'	
Pixel sensor	'Pixel_Sens_' + [N _{Fe}]	
Strip sensor	'Strip_Sens_' + [shape][size] + ':{N _{Copy} }'	
Active sensor	'[type]Active_' + [shape][size]	Pixel sensor:
Sensor edge	'[type]Passive_' + [shape][size]	[shape][size] = [N _{Fe}]

Table 3: Naming conventions for main components. Depending on the further CAD development it is possible to introduce additional suffixes in order to maintain exclusivity for each name of individual components.

Component name	Component path	(Strip subversion: Sv-1.0)
Fwd	Sv-1.0/ Fwd	
Strip_Ldk	Sv-1.0/ Fwd/ Strip_Ldk	
Strip_Smod_N2_TrapL	Sv-1.0/ Fwd/ Strip_Ldk/ Strip_Smod_N2_TrapL	
Strip_Mod_1Sens_TrapL	Sv-1.0/ Fwd/ Strip_Ldk/ Strip_Smod_N2_TrapL/ Strip_Mod_1Sens_TrapL	
Strip_Sens_TrapL	Sv-1.0/ Fwd/ Strip_Ldk/ Strip_Smod_N2_TrapL/ Strip_Mod_1Sens_TrapL/ Strip_Sens_TrapL	
StripActive_TrapL	Sv-1.0/ Fwd/ Strip_Ldk/ Strip_Smod_N2_TrapL/ Strip_Mod_1Sens_TrapL/ Strip_Sens_TrapL/ StripActive_TrapL	
StripPassive_TrapL	Sv-1.0/ Fwd/ Strip_Ldk/ Strip_Smod_N2_TrapL/ Strip_Mod_1Sens_TrapL/ Strip_Sens_TrapL/ StripPassive_TrapL	
Hshell	Sv-1.0/ Hshell	
Strip_BI3	Sv-1.0/ Hshell/ Strip_BI3	
Strip_Smod_N5_RectL	Sv-1.0/ Hshell/ Strip_BI3/ Strip_Smod_N5_RectL	
Strip_Mod_3Sens_RectL	Sv-1.0/ Hshell/ Strip_BI3/ Strip_Smod_N5_RectL/ Strip_Mod_3Sens_RectL	
Strip_Sens_TrapL	Sv-1.0/ Hshell/ Strip_BI3/ Strip_Smod_N5_RectL/ Strip_Mod_3Sens_RectL/ Strip_Sens_TrapL	
StripActive_RectL	Sv-1.0/ Hshell/ Strip_BI3/ Strip_Smod_N5_RectL/ Strip_Mod_3Sens_RectL/ Strip_Sens_TrapL/ StripActive_RectL	
StripPassive_RectL	Sv-1.0/ Hshell/ Strip_BI3/ Strip_Smod_N5_RectL/ Strip_Mod_3Sens_RectL/ Strip_Sens_TrapL/ StripPassive_RectL	
...	...	

Figure 6: Example for the implementation of the naming conventions. To find the active sensor volume only the search string 'Active' has to be applied in the component paths.

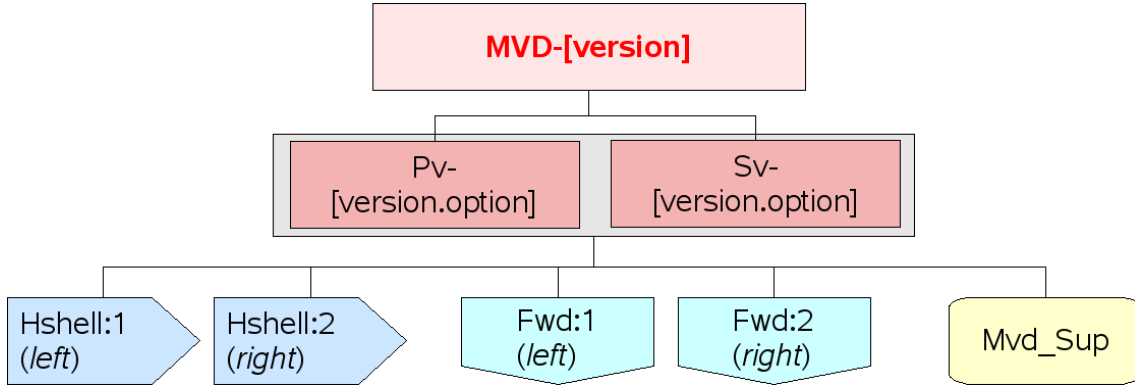


Figure 7: Main structure of the MVD-CAD models

5 Data management and documentation

The main branches of the detector development are the strip and the pixel part of the detector. In principle, these developments are independent from each other. Therefore a main CAD version of the MVD consists of a strip version and a pixel part. This will become an important issue when thinking about the different demands with respect to their cooling and support.

With this strategy it is possible to check the compatibility of different pixel and strip solutions with each other. Furthermore it is possible to put the same pixel or strip version into different main versions. To define a clear structure each version - i.e. the MVD as well as the pixel and strip version - has a main version number and an option number both separated by a point. The indexing starts from '1' for the main version number and from '0' for the option number where the zero option means the default or the simplest option. The number of options for one main version should be kept small and not grow beyond nine.

As a first solution for the data management it is foreseen to use the PANDA wiki pages of the MVD web. Once a version is completed it will be uploaded on a central page (file dump) in the web. The fixed format for the CAD files is a STEP-file format. All the uploaded versions are considered to be final. They are available for other developer groups. Due to this fact it is strongly recommended to restrain from updates for these files but rather upload a new option which includes all necessary modifications. This procedure should be sufficient as long as the number of versions and subversions remain within reasonable limits.

Parallel to the file upload it is obligatory to add documentation for the different versions. Therefore another central page (model revision history) in the web is set up. On this page a short summary for the main versions can be found. For a more detailed documentation each main version has its own topic in the MVD web. This page can be reached by a link given on the central page as well.

An adequate documentation for the MVD main versions is fulfilled by describing the main geometry of the model, i.e. radii and lengths of barrel layers as well as size and position of disk layers. Aside from this, general remarks and comments can be added. For each individual pixel or strip version some basic parameters about the sensor dimensions, the radial symmetry and - if included - the support and cooling structure should be given explicitly. For all consecutive options it may be sufficient to note all modifications with respect to precedent subversions.

The described structure is completely set up in the MVD web [1]. All pages are located in the developer's area which is restricted for MVD subgroup members only. All other users are referred to the contacts given on the public pages [2].

6 Summary

This detector note contains a summary of the CAD conventions for the MVD subgroup. They were fixed during an internal meeting in November 2007. Based on these conventions the first models have been developed already. The very basic definitions allow an adaption for all future models. Therefore they should be followed strictly. For actual informations and updates see reference [1].

Finally, the effort of setting up the conventions is done within this note. According to experience its application and continuation demands a lot of discipline. However, the more complex the project will become the more these conventions will help to organize further developments easily. Thus, they will accelerate progress by not wasting time on technical details when engineering solutions and physical optimization have to be discussed.

7 References

- [1] PANDA wiki: MVD web, Developer's area
<http://panda-wiki.gsi.de/cgi-bin/view/Mvd/MvdDevelop>
(Main page)
<http://panda-wiki.gsi.de/cgi-bin/view/Mvd/CadGeomConv>
(Geometrical conventions)
<http://panda-wiki.gsi.de/cgi-bin/view/Mvd/CadConvention>
(Hierarchy and naming conventions)
<http://panda-wiki.gsi.de/cgi-bin/view/Mvd/CadFileDump>
(CAD file dump)
<http://panda-wiki.gsi.de/cgi-bin/view/Mvd/CadDocu>
(Model revision history)

- [2] PANDA wiki: MVD web, Public pages
<http://panda-wiki.gsi.de/cgi-bin/view/Mvd/WebHome>
(Home Page)
<http://panda-wiki.gsi.de/cgi-bin/view/Mvd/MvdPublic>