



Manual For The Construction Of A Virtual Reality Cave

Institute for Production Management and Logistics
At the University of Applied Sciences Munich
Markus Ehmann

The software for the operation of the Cave is provided by:



The download link for the test version software
of the BS Cave package is at the end of this instruction.

The following pages give an overview of the construction of a Virtual Reality Cave. For more detailed requests and for other information please refer to the contacts at the end of this manual.

1) Measurements Of The Cave

Minimum room size:	7.60 m x 6.90 m x 3.50 m
Diameter:	3.10 m
Height:	2.30 m
Number of projectors:	6
Breadth of projection on the cylinder:	250°
Display width per projector:	1.74 m
Distance projector - screen:	4.43 m
Distance mirror - screen:	1.95 m

2) Three-dimensional View Of The Cave

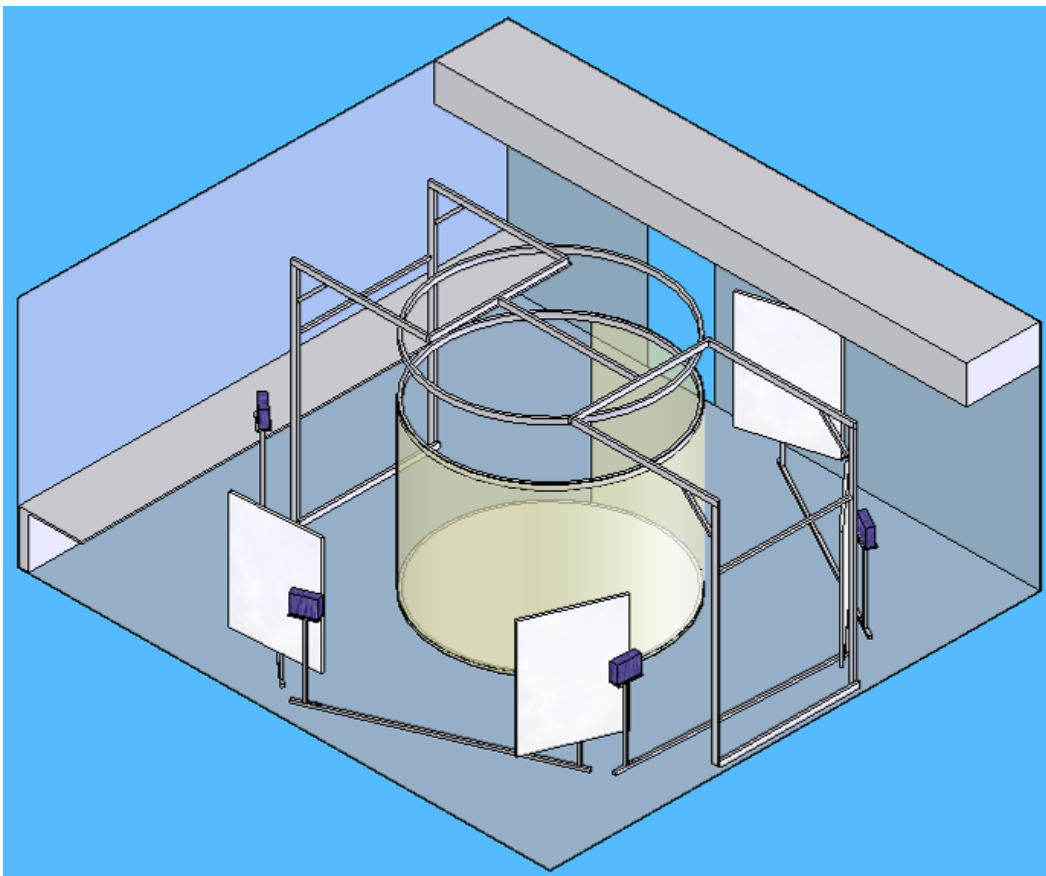


Figure 1) 3D Model of the CAVE

Figure 1) shows the supporting construction, the cylindrical projection area, as well as the four beamers with one mirror each for deflection.

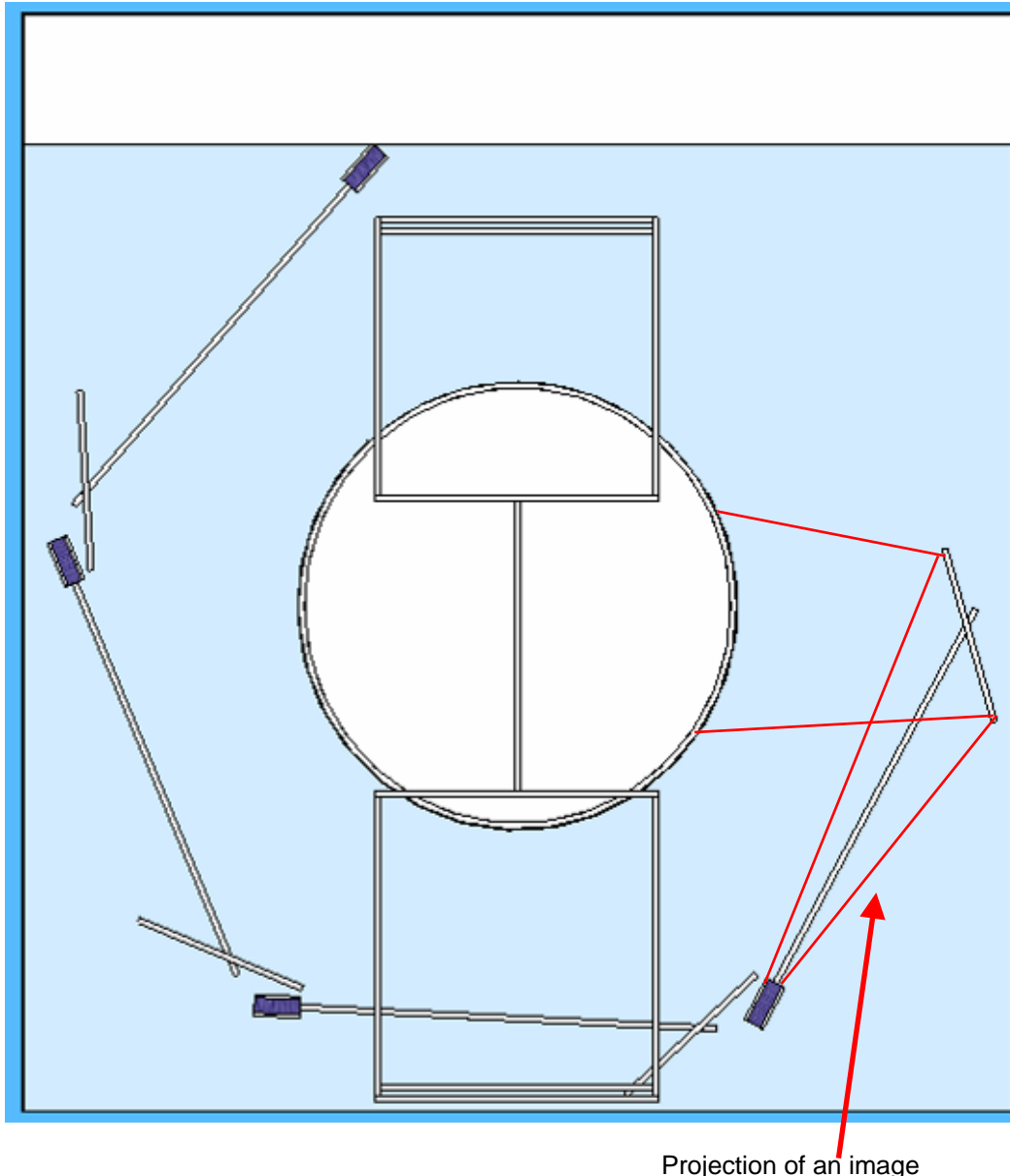


Bild 2) Topview of the Model

Projection of an image

3) Preparation The Room

With the assistance of the 3D-Model the arrangement can be marked on the floor. These marks can serve as a guideline during the assembly.

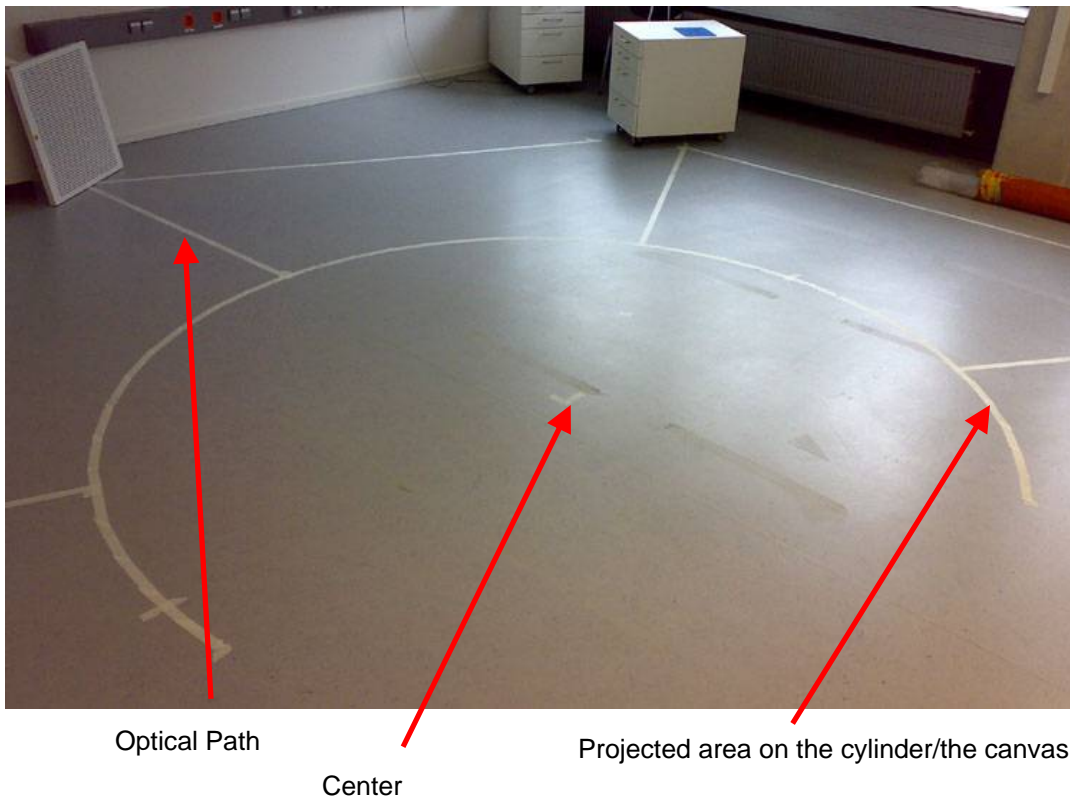


Fig. 3) Markings on the floor

Figure 3) shows the drawn markings. The circle was pasted only within the range of the later projection. In the rear part of the illustration a complete path of rays with direction change over the mirror (represented by a lattice) can be seen.

For the proper set-up of the Cave it was made certain that there are the necessary power and network connections on both sides of the room.

The window areas outwards, as well as to other areas were covered with a commercial, self adhesive foil.

The lighting necessary for working on the Cave system was reduced to a row of lamps at the face-side of the room. Thus there are no complications with the arrangement of the projection at the ceiling.

4) Installation & Tuning Of The Components

On the basis of the floor markings the lowest ring can be aligned and finally fixed on the floor. It is important that all the center points of the three rings have to be coordinated accurately otherwise the changes will be difficult to manage later. The middle ring, to which the upper end of the projection foil is fastened, is strutted by means of loops, linking up hooks and a steel cable with the upper ring (see figure. 4).

This way it is ensured that the foil can be pulled tight again later, in case it is becoming too loose.



Fig. 4) Suspension of the upper cylinder ring at the carrier ring

The back projection foil is connected by means of Velcro tape to the rings and foil. This leaves the possibility of shifting the openings of the Cave if necessary. Subsequently, the projectors and mirrors are aligned and fixed at the upper stretcher ring for the path of rays from the ceiling to the floor. The projector is fastened to the rack with adjustable aluminum poles and the mirrors with proper hooks. Before inserting the ground plates for bottom projection, the interior of the bottom cylinder ring is elevated to a height of 40 mm using wooden and square bars, in order to lock with the floor concisely. The lattice structure, for better distribution of load when entering, can be seen in figure 5:



Fig. 5) Lattice structure from square timbers under the base plates

After inserting the base plates, the carrier racks for mirrors and projectors assembled (see figure 6 and figure 7) can be positioned. If the desired breadth of the projection screen is covered can be easily examined by the running the projectors in the native screen resolution. Also, these units must be finally fixed to the ground, so that the detailed correction of the projection can be adapted concerning curvature, overlap and subsequent slipping is no more threatened.

Attention: It is not possible to visualise a shuttered image using standard projectors. We therefore used the CAVE-DepthQ from Lightspeed. You may find the contact and a keyword for a bundle price at the end of this paper.



Fig. 6) Projector/mirror connection for the cylinder projection. You can see the mounting rack for the aluminum mirror and the projector turned around the longitudinal axis. In order to fix the projection distance, a further bar from the aluminum profile is used.



Fig. 7) Attachment of the ceiling projectors and mirrors

As last step of preparation before the software adjustments, the cables for display, electricity and the display frame synchronization network are laid.

Before execution of the software the workstations get the current driver combinations for the graphic cards as updates. Here it is to be noted that for the stereoscopic representation a separate driver add-on is necessary, which is not always compatible with the latest basic drivers. A suitable combination must be therefore verified before using tests drives.

Now it's time to set up the BS Cave package. It consists of the BS Collaborate Server ("server"), the number of the BS Contact Stereo Clients ("Clients"), necessary for the Cave, and the BS SDK ("documentation for round Cave and model adjustment").

For the transmission of the synchronization signal as well as to load the 3D scenes and objects the BS Collaborate system is used. The synchronization signal is needed to distribute an animation of the 3D scene on all computers as well as for the control of the camera in 3D at the client computers. Each client computer possesses one „display frame (Gen-lock)“ graphics card, so that the picture signal is transferred to the respective beamer at the same time as the other computers. Thus it is guaranteed that the buffer flip of the graphics cards takes place at the same time. That computer is selected as framelock master, at which the IR-emitter is connected to. That way it is ensured that the shutter glasses are synchronized with the stereo image switching.

On each computer a configuration file is present for adjustment of the specific camera misalignments as well as for the settings of the server client system. More exact parameters and their handling are explained in the BS SDK on the web page of Bitmanagement Software GmbH. Each computer can be individually configured further on. With the BS Cave software it is not only possible to control 6 views

through 3 computers, but many different views and projections other than the described round Cave in size and form.

For the installation of the BS Cave software only the BS Cave package is needed. On a selected master computer the BS Collaborate („server“) is installed and the concerned IP address and Port is configured. On this computer also the master for the control of the slaves and navigation can be installed with the 3D scene. With this master the configuration file must be adapted for communication between the servers. Subsequently, the remaining computers can be equipped with the BS Cave software. For the slave computers, an installation of the BS Collaborate („server“) is not necessary. For the slave computers then the configuration files for communication to the server as well as the individual camera calibration must be adapted likewise. Further a mask must be provided through which the cross fades of the other projectors to the canvas is reduced. These masks can be prepared with any program for imaging.

Enclosed is an excerpt from the configuration file and their parameter description are in English.

```
#Here are the blending maps defined. With these maps you can reduce the edge over blending effect of projectors.
```

```
#Create your own gray scale transparency mask with any image creation tool. It must have the resolution of 1024 x 1024
```

```
#Please use absolute pathes to the image files.
```

```
DEF Blendingmap_0 ImageTexture {  
    url "C:\gitterlinien1.png"  
    repeatSFALSE  
    repeatTFALSE  
}
```

```
DEF Blendingmap_1 ImageTexture {  
    url "C:\gitterlinien1.png"  
    repeatSFALSE  
    repeatTFALSE  
}
```

```
DEF Blendingmap_2 ImageTexture {  
    url "C:\gitterlinien1.png"  
}
```

```
DEF Blendingmap_3 ImageTexture {  
    url "C:\gitterlinien1.png"  
}
```

```
# Here you can define the ip adress of the server
```

```
DEF ServerAddress MetadataString {name "ServerAdress" value "192.168.1.2"}
```

```
# This is the server port number
```

```
DEF ServerPort MetadataInteger {name "ServerPort" value 12538}
```

```
# If this client ist the master Client for the navigation, then set the value to 'isMaster' else set it to 'isNotMaster'.
```

```
# Is the value setted to 'isNotMaster' no navigation is posible.
```

```
DEF Master MetadataString {name "MasterFlag" value "isMaster"}
```

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#This value describes the folder to the location of the scene files for loading. Please use Windows Shared Folder system.

```
DEF MasterFilePath MetadataString {name "FilePath" value "Bitmanagement"}
```

#Everything below this line is projector specific.

#Every definition on index 0 is for the projector on index 0 in ConnectedProjectorID and every definition on index 1 is for the projector on index 1 in ConnectedProjectorID.

#This field is to define which projector view should be used for rendering.

#You have to copy the DEF name of the projector view. There must be two projector views defined.

```
DEF ConnectedProjectorID MetadataString {name "ProjectorID" value ["Projector_0"  
"Projector_1"]}
```

```
DEF CaveModel MetadataString {name "ModelName" value ["wall" "wall"]}
```

#In this field you can define the offset in RAD for the navigation camera for every projector.

#With this field you are able to determine what the projector is displaying from your scene.

```
DEF PhysicalCamX MetadataDouble {name "PhysicalCamX" value [0 0]}
```

#This field is for looking up or down

```
DEF PhysicalCamY MetadataDouble {name "PhysicalCamY" value [-  
1.5707963267948966192 -1.5707963267948966192]}
```

#This field is for lrolling the camera around the z axis

```
DEF PhysicalCamZ MetadataDouble {name "PhysicalCamZ" value [0 1]}
```

#This field is for flipping the projected view around the xy axis Camera [x1,y1,x2,y2] as bool variable 1=true, 0 =false

```
DEF PhysicalCamFlip MetadataInteger {name "PhysicalCamFlip" value [0,0,0,0]}
```

#This field is the offset to the navigation (user) camera. Each point consists of 3 values (x,y,z).

#For two cameras you need 6 values. x1,y1,z1 and x2,y2,z2

```
DEF PhysicalCamPosOffset MetadataFloat {name "PhysicalCamPosOffset" value [0 0 0  
0 0 0]}
```

#Here you have to define which blending map is for the projector.

#Please use the DEF name from the definition of the blending map.

```
DEF BlendingMap MetadataString {name "Blendingmap" value ["Blendingmap_2"  
"Blendingmap_2"]}
```

A detailed guidance for the use of the parameters is offered in the BS Cave package for download.

Accordingly after configuration three computers take over the diagram computation and allocation for two projectors each as soon as the adjustment has been completed, while the fourth workstation represents the master computer. From it the programs are started and the movements and changes of the models are processed. Thus it can be switched simply between the model production on a normal monitor and the presentation in the Cave.



The fig. 8) An impression of a finished Cave

5) Parts Lists

a) Parts List In Alphabetical Order

Name	Description	Size	Number
aluminium mirror		900x700	2
aluminium mirror		1700x1250	4
aluminium pole	40x40	500	4
aluminium pole	40x40	550	4
aluminium pole	40x40	1600	2
aluminium pole	40x40	1700	1
aluminium pole	40x40	1800	1
aluminium pole	40x40	1920	2
aluminium pole	40x40	3280	4
aluminium pole	40x40	1920 + connector	4
aluminium pole	40x40, 45° chamfer, 2 connectors	1800	4
aluminium pole	80x40	250	8
aluminium pole	80x40	500	6
aluminium pole	80x40	1930	2
aluminium pole	80x40	2000	3
aluminium pole	80x40	2080	2
aluminium pole	80x40	3000	1
aluminium pole	80x40	3240	4
aluminium pole	80x80	1500	4
aluminium ring	40x40, curved	d _a =3100	1
aluminium ring	80x40, curved	d _a =3100	2
boulter		10m	1
bracket	40x40		27
bracket	80x40		84
brad		10	19
bush		10x15	18
connector screw		70	4
female screw		SW 13	234
female screw		5	18
Genlock card	Quadro-Sync II		4
graphics cable	VGA	5m	2
graphics cable	VGA	2m	4



Name	Description	Size	Number
ground plate	Dibond	d _a =3104, semicircle	2
hammerhead screw		M8	234
loop screw		M8x50	24
mounting rack (projector)	3mm	250x250	6
network cable		10m	1
network cable		7m	1
network cable		0,5m	2
power cable		7m	2
power cable		4m	6
projector			6
rear projection canvas	High-Gain	2,40m x 8m	1
rope clamp			4
screen		20"	2
screw		M8	19
screw		M5x35	18
self-adhesive loop			16
sponge		80x40	12
steel cable		4mm, 15m	11
switch	Gigabit		1
t-nut		8E, M8	24
Velcro tape	self-adhesive	9m	2
working station	R650		4

b) Structured Parts List

Level 1	Level 2	Level 3	Description	Size	Number	Total
projection screen					1	
	rear projection canvas		High-Gain	2,40m x 8m	1	1
	ground plate		Dibond	d _a =3104, semicircle	2	2
	projector				2	2
	graphics cable		VGA	5m	2	2
	power cable			7m	2	2
	aluminium mirror			900x700	2	2
	selh-adhesive loop				16	16
	boulter			10m	1	1
	cylinder construction				1	
		aluminium ring	40x40, curved	d _a =3100	1	1
		aluminium ring	80x40, curved	d _a =3100	2	2
		Velcro tape	self-adhesive	9m	2	2
		t-nut		8E, M8	24	24
		loop screw		M8x50	24	24
		steel cable		4mm, 15m	11	11
		rope clamp			4	4
		bracket	80x40		12	12
		bracket	40x40		7	7
		hammerhead screw		M8	48	48
		female screw		SW 13	48	48
		brad		10	3	3
		screw		M8	3	3
		aluminium pole	40x40	1800	1	1
		aluminium pole	40x40	1700	1	1
		aluminium pole	80x40	500	2	2
		mounting rack (projector)	3mm	250x250	2	2
		screw		M5x35	3	6
		bush		10x15	3	6
		female screw		5	3	6
supporting construction					1	
	aluminium pole		40x40	1600	2	2
	aluminium pole		40x40	1920	2	2
	aluminium pole		40x40, 45° chamfer, 2 connectors	1800	4	4
	aluminium pole		80x40	3240	4	4
	aluminium pole		80x40	3000	1	1
	aluminium pole		80x40	1930	2	2
	aluminium pole		80x40	2000	3	3
	aluminium pole		80x40	2080	2	2
	connector screw			70	4	4
	brad			10	8	8
	screw			M8	8	8
	bracket		80x40		28	28
	hammerhead screw			M8	90	90
	female screw			SW 13	90	90



Level 1	Level 2	Level 3	Description	Size	Number	Total
projection unit					4	
	rack				1	4
		aluminium pole	40x40	3280	1	4
		aluminium pole	40x40	500	1	4
		aluminium pole	40x40	1920 + connector	1	4
		aluminium pole	40x40	550	1	4
		aluminium pole	80x40	500	1	4
		aluminium pole	80x40	250	2	8
		aluminium pole	80x80	1500	1	4
		bracket	80x40		11	44
		bracket	40x40		5	20
		hammerhead screw		M8	24	96
		female scrwe		SW 13	24	96
		sponge		80x40	3	12
		mounting rack (projector)	3mm	250x250	1	4
		screw		M5x35	3	12
		bush		10x15	3	12
		female screw		5	3	12
		brad		10	2	8
		screw		M8	2	8
	aluminium mirror			1700x1250	1	4
	projector				1	4
	graphics cable		VGA	2m	1	4
	power cable			4m	1	6
working station					1	
	computer		R650		4	4
	Genlock card		Quadro-Sync II		4	4
	switch		Gigabit		1	1
	network cable			10m	1	1
	network cable			7m	1	1
	network cable			0,5m	2	2
	screen			20"	2	2



6) Contact Information:

Construction, Details and Supplier Information:

Markus Ehmann
Institut für Produktionsmanagement und Logistik
an der Hochschule München
Fakultät für Wirtschaftsingenieurwesen
Lothstr. 64
80335 Munich
Germany

Tel.: +49 (89) 12 65 39 67

Mail: markus.ehmann@i-p-l.de

Download link for the „BS-Cave“- Software package:

www.bitmanagement.de/download/playerdownload.de.html#BS_Contact_Cave

The clearing of the test version upon autonomous set up of this Cave is handled in case of licensing according the pricelist of Bitmanagement by license keys for BS Collaborate and BS Contact Stereo.

Contact:

Peter Schickel
Bitmanagement Software GmbH
Oberlandstr. 26
82335 Berg
Germany

Tel: +49 (8151) 97 17 08

Mail: peter.schickel@bitmanagement.de

3D-Stereo-Projector from Lightspeed:

Keyword: CAVE-Projector

Jeff Rische
Lightspeed Design Group
1611 116th Ave NE, Suite 112
Bellevue, WA 98004

Mail: jeff.rische@lightspeeddesign.com

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