Khwarizmi Science Society

Configuration of the LIT-DISCO - A User Manual

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Abstract—LIT DISCO, a setup using advacned technology, is a next step towards science popularization. After the successful implementation and functioning of LIT - LHC Interactive Tunnel, LIT DISCO - LHC Interactive Tunnel Discovery is our next step towards spreading the message of complex science of elementary particles to common man. This report includes all the necessary information and guidance towards implementing and running the setup successfully.

Contents

1. Introduction

One of the major components in scientific pursuits is science communication, which must be addressed for the future of science in humanity. During the last decade, efforts to promote scientific communication have steadily increased. This has been the most effective way to instill an interest in science among the youth.

Research has proven that the public learns and understands concepts better when demonstrated live. For example, since the construction of the first modern planetarium in 1924, which was constructed in Munich, interest in astrophysics has increased significantly, which further goes to show how important live demonstrations are for developing the public's interest in science. Similar is the case with science centers. They purposely include interactive elements for the public to increase interest and boost learning. Other technology-based setups used for science communication include Virtual Reality(VR) and Augmented Reality (AR) as well as hosting science events and festivals, which all are great ways to increase science outreach and create curiosity in the minds of people and leave them in a state of wonder, which is what makes a great scientist.

When one enters the LIT-DISCO setup, they are met by two high-definition projection screens, one in the front and the other on the floor; this is complemented by a high-quality sound system that ensures an immersive experience. When someone from the audience enters the bounds of the system, two Microsoft Azure sensors placed in the setup precisely capture their body movements. From then on, there are endless possibilities as to what can be done and how the movements can be incorporated into the setup.

This setup can be used to display various interactive applications. This application aims at simplifying the complexities of particle collisions and the interactions that occur in the Large Hadron Collider at CERN. This application requires two volunteers, each one standing on opposing sides. The projector which is displayed on the floor shows two spheres, one on each end, which represent protons. Both volunteers kick the protons in the air, because of which the Azure sensors detect movement, causing both protons to collide. After the collision of the protons, the collision is presented on another screen behind them. This interaction shows the specification of the collision and visually displays the particles formed by the collision as well as the background radiation produced during the collision. The energy in the collision increases when the kick is harder, which leads to the production of more particles.

These applications show the potential that the LIT-DISCO has in advancing science, and how new applications are tailored to its specifications and are of great influence.

2. Equipment Details

LIT-DISCO setup is different from the previously built LHC-IT setup, following are the equipment that are required for this setup:

- Two Ultra Short Throw Laser Projectors
- One Gaming Grade Computer
- Two Microsoft Kinect Azure Sensors
- Peripheral System for PC
- Sound System
- Projection Surfaces (floor and ground)
- 9' x 9' Structural Truss for Mounting of Equipment
- Miscellaneous Sensor Mounts
- Extra Dolly for the Mounting of Projector on Horizontal Truss
- Toolbox

2.1. Structure and Mounts

The skeleton of the frame work includes a heavy truss, which includes 3 pillars and 3 dollies. 2 of the dollies are required for the base of the vertical pillars and one of the dollies is required to place the projector along the vertical pillar.

A detailed breakdown of the items included in the structure is as following:

- Three 9 ft Long Pillars
- 2 Base Structures
- 3 Dollies
- One Special Rod (for front projector support)
- One Base Bracket for the Floor Projector
- Customized Support Bracket for Sensors

- Sensors Mount
- Six Iron Clamps to Support the Sensor Support Rod
- Two Pulleys for Elevation of the Horizontal Pillar
- Nuts and Bolts

2.2. Sensors

Two Microsoft Kinect Azure DK sensors are installed along with the truss on both left and right side of the setup. Two active 3.0 Cables are necessary for proper functioning of the setup.

Azure Kinect DK is a developer kit that has advanced AI sensors which provide the computer vision and can track body movements. Kinect contains a depth sensor, spatial microphone array with a video camera, and orientation sensor as an all in-one small device with multiple modes, options, and software development kits (SDKs).

2.3. Computer Requirements

One gaming computer with 32GB RAM, i7 processor and RTX 3080 graphics card installed is ready to go with the setup.

2.4. Projectors

Two ultra short-throw laser projectors Epson EH-LS500B are used. One of the them is used for floor projection and the other is used for front projection on the screen. Configuration and detailed setting guidelines are provided in upcoming sections.

2.5. Cables

Following are the sets of cables that are necessary for the setup:

- Two HDMI cables
- One HDMI to DVI convertor
- One PC power cable
- Two Projector power cables
- Two Kinect power cables and bricks
- One Kinect USB C to USB cables (included in box)
- One Active 3.0 USB extender 10m (Ugreen)

2.6. Sound System

A good sound system enhances the atmosphere of the setup as brilliant sound effects are included in the software. It can be installed with the PC.

3. Implementation of the Framework

The first step towards configuration of the setup is building the skeleton of the framework on which all the necessary, projectors and sensors, equipment can be installed. A heavy skeleton for the system enhances the atmosphere of the setup.

Fig. 1 shows complete setup after installation.

Figure 1. Setup after final installations. [1].

3.1. Building the Skeleton

Follow these steps to build the setup:

1. Take the base of the pillar and place it upside down, so that the tyres under the base face the roof. (important for stability and it avoids unnecessary movements)
2. Place both the bases approximately 9ft apart so that the horizontal pillar can fit in between the vertical pillars.
3. Place the dollies in the centre of the base.
   Note: Do not place the special dolly, that has markings for support of the front screen projector.
4. Now place the vertical pillars inside the dolly and tighten the screws that bind the pillar with base.
5. Now place the horizontal pillar inside the dolly and put it in between both of the vertical pillars.
   Note: Make sure the orientation of the dolly is correct; the markings for projector placement must be in front of you.
6. Tighten the screws to bind the horizontal pillars with the dollies of the vertical pillars.
7. Screw up the rod for projector placement on horizontal dolly.
8. Make sure the horizontal dolly is in middle of the horizontal pillar.
9. Now place the support base for the floor projector about 0.5 m (50 cm) to the left side of the central horizontal dolly.
10. Now place the pulleys on top of the vertical pillars and use them to elevate the horizontal pillar after installation of the projectors as mentioned in upcoming sections.

Fig. 9 & Fig. 13 helps in the distances schematics for skeleton.

3.2. Projectors Adjustment

Place the projectors according the guidelines mentioned in above section.

Place the front screen projector on the dolly and floor projector on the stand with horizontal pillar. Height of the projectors from floor should be 2.3 m (230 cm).

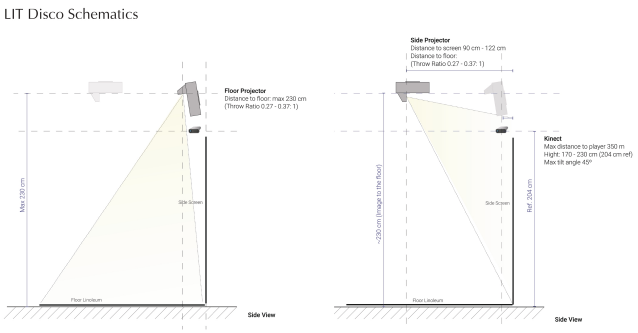

Figure 2. Side View Schematics for Projections.

Let's have a detailed look at projector adjustments.

3.2.1. Screen Projector Adjustment

Follow these instructions to set the Front Screen Projector.

- The screen projector is mounted on the dolly while still being attached to the vertical support of the projector stand. Demonstrated in fig 2.
- The dolly is 1.53 m (5 feet) away from the left most pillar.
- The whole assembly is fastened to the dolly using two bolts. Demonstrated in Fig. 3 & Fig. 4.
- Screen Projector after installation can be seen in Fig. 6 & Fig. 5.

Figure 3. Fastening of the Screen Projector with the Horizontal Dolly.

Figure 4. Another View of the Screen Projector Attached with Dolly.

Figure 5. Side View of the Screen Projector Attached to Horizontal Dolly.

Figure 6. Another View of the Screen Projector Attached.

3.2.2. Floor Projector Adjustment

Follow these steps to set the Floor Projector:

- The floor projector is mounted on to the custom-built bracket with 3 bolts. Demonstrated in Fig 7.
- The bracket is 61 cm (2 feet) away from the left most pillar.
- The bracket needs to be removed and placed again in order to move it over the horizontal truss
- Angle of the tilt can be controlled by tilting the bracket itself.
- We can unscrew the screw above the projector to tilt the projector downwards. Demonstrated in Fig 8.

Figure 7. Front View of the Floor Projector After Final Installation.

Figure 8. Side View of the Floor Projector.

3.2.3. Projection Screens

Projection screens must have following dimensions:

Table 1. Projection Screens Dimensions

Screen	Length (m)	Width (m)
Front Screen	3.32	1.87
Floor Screen	3.32	1.87

A detailed schematics of the all the dimensions of the setup can be seen in the following figures.

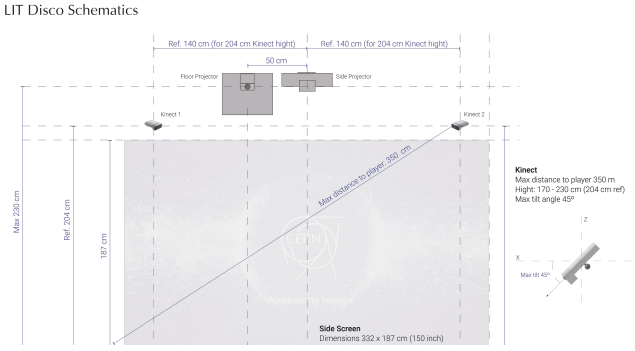

Figure 9. Front Screen Projection Details.

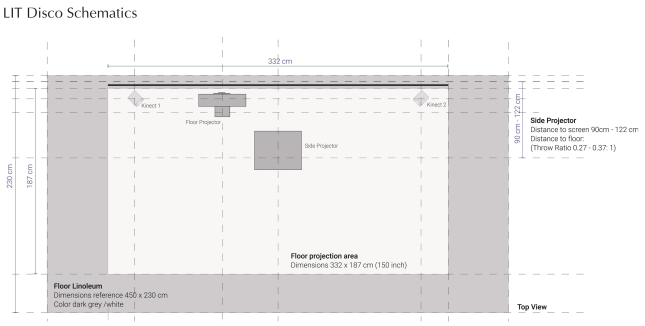

Figure 10. Floor Screen Projection Details.

3.3. Sensors Adjustment

Follow these steps to adjust the sensors:

- The sensors are to be mounted on the custom brackets fit on the pillar at the height of 1.90m.
- Connect the left most sensor to a USB 3.0 port using the included USB C – USB cable and provide power using included power brick.
- Connect the right most sensor to a USB 3.0 port using the included USB C – USB cable extended by the Active 3.0 USB extender and provide power using included power brick.
- Check the sensors using the Kinect application in the PC.

Figure 11. Left Sensor after Installation.

Figure 12. Right Sensor after Installation.

4. Setting the Machine

After successful implementation of the skeleton, we move towards set up of the machine. Follow these steps:

- Gather all the required cables, as mentioned in Section 2.5.
- Place the PC near to the left pillar of structure.
- Connect both of the projectors using HDMI cables with the PC.
- PC has only one HDMI port, you will need to have a D Port to HDMI adaptor.
- Connect the Left Sensor using the shorter 3.0 USB to C type data cable.
- Connect the Right Sensor using the 10 m long active data cable. You may need to provide power to the active data cable using its power points.
- Connect the sound system with PC.
- Fig 13 & Fig 14 shows the schematics of all the connections required.

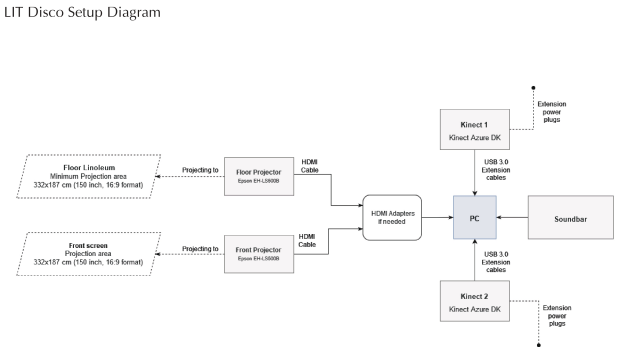

Figure 13. Flow Diagram for the Setup Schematics.

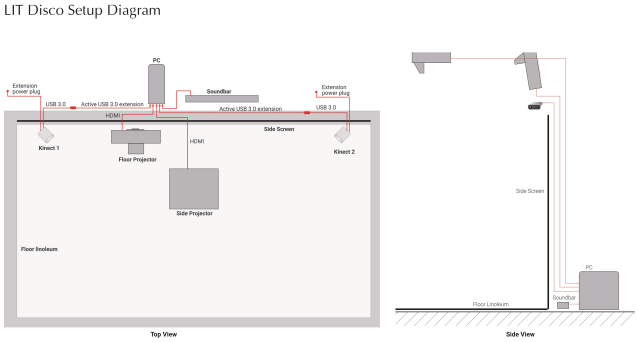

Figure 14. Side View of the Setup Schematics.

5. Software Configuration

Once everything is in place it is time to start the setup and run the software. Start the computer and click on the DISCO Software Icon. It will start the whole setup. Important Step included in the settings are:

- Game Interface Setting
- Calibration of the sensors
- Special Modes in the game

Once the game has started, press the F1 key and the Reference Help Menu will appear as shown in Frg 15. It includes all the shortcuts required to adjust the game settings. You can press F1 button again to close this window.

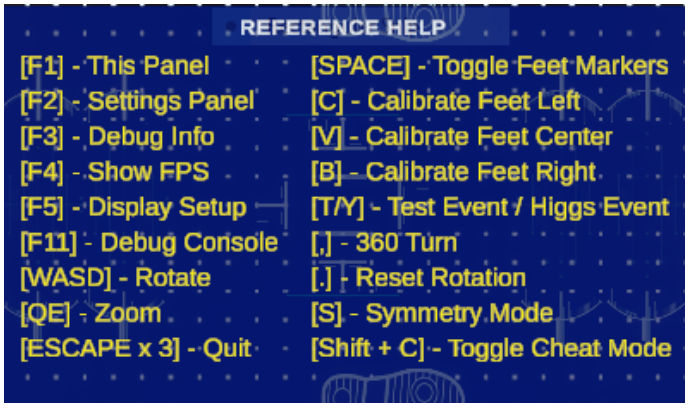

Figure 15. Reference Menu Preview.

5.1. Game Interface Setting

When the Reference Help Window is opened press F2 to open the setting panel as shown in Fig. 16.

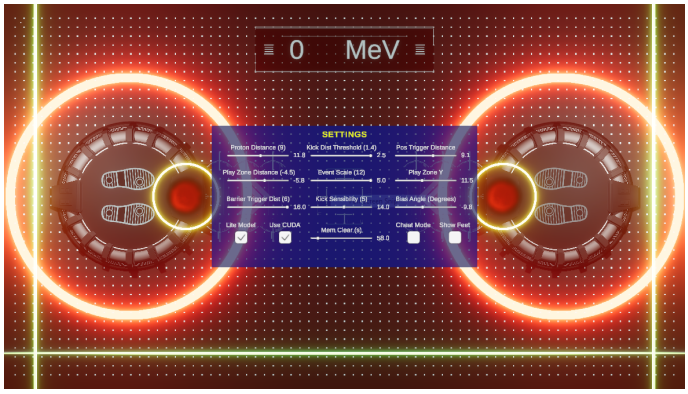

Figure 16. Settings Panel Preview.

Let's explore everything separately in detail.

5.1.1. Proton Distance

Proton Distance parameter controls the distance between the proton balls displayed on the floor. It also increases the distance between the players standing on the floor. Increasing the value of Proton Distance will increase the distance between the Proton balls. Fig 17, Fig 18 & Fig 19 shows the results of the settings for different values.

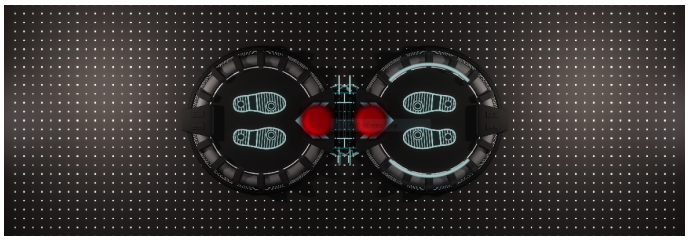

Figure 17. Proton Distance Set to the value 2.0.

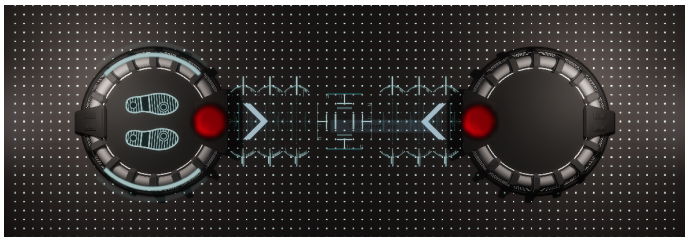

Figure 18. Proton Distance Set to the value 10.0.

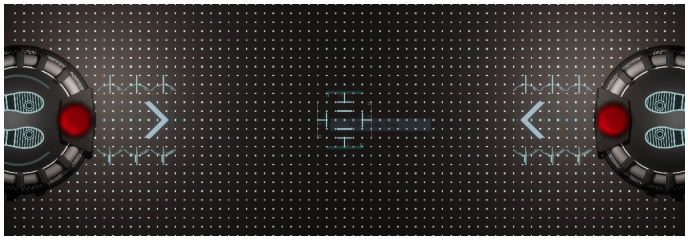

Figure 19. Proton Distance Set to the value 20.0.

5.1.2. Kick Distance Threshold

Kick Distance Threshold controls the threshold area around the proton that will detect the kick over the proton. If this value is increased, the system will take more area under consideration for detection of the kick and this trigger decreases with the decrease in this value. Fig 20, Fig **??** & **??** show the results for different values.

Figure 20. Kick Distance Threshold Set to the value 0.2.

Figure 21. Kick Distance Threshold Set to the value 1.2.

Figure 22. Kick Distance Threshold Set to the value 2.5.

5.1.3. Pos. Trigger Distance

Position Trigger Distance controls the detection of the area in which the players will stand. Increased value of this parameter controls more area for detection of the player standing on the floor. Fig 23, Fig 24 & Fig 25 shows the results for different values of this parameter.

Figure 23. Position Trigger Distance Set to the value 1.0.

Figure 24. Position Trigger Distance Set to the value 4.9.

Figure 25. Position Trigger Distance Set to the value 14.0.

5.1.4. Play Zone Distance

This parameter controls the Play Zone area that how much of the area away from the screen will be included in the play zone. A vertical green line shows the area covered. The part of the floor between the screen and this green line is included in the Play Zone. This value increases while moving towards the screen and it decreases while moving away from the screen. It is a negative value. Fig 26, Fig 27 & Fig 28 shows the result for different values of this paramter.

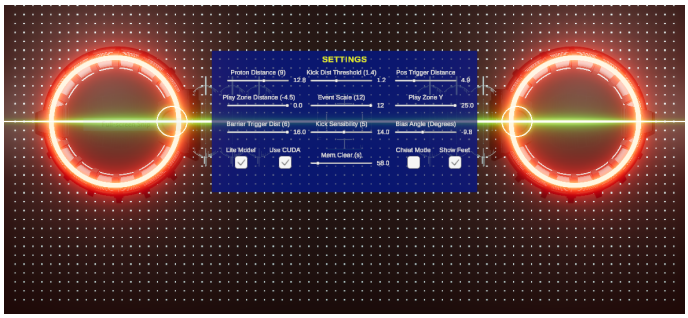

Figure 26. Play Zone Distance Set to the value 0.0.

Figure 27. Play Zone Distance Set to the value -3.0.

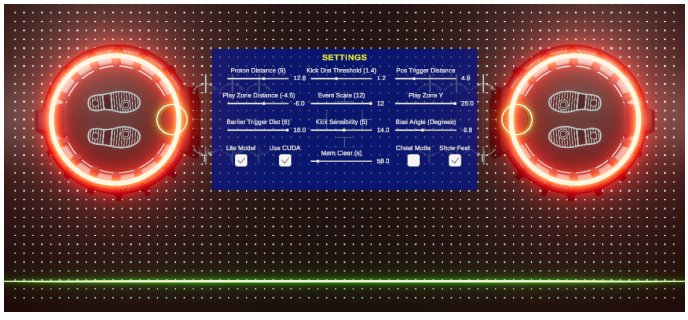

Figure 28. Play Zone Distance Set to the value -6.0.

5.1.5. Event Scale

Event Scale parameter controls the size of the result shown in front of you after collision. Smaller value of this parameter shows a tiny picture of the particles scattered as result of the collision. And increased value shows a huge picture of the event happened on the screen.

5.1.6. Play Zone Y

Play Zone Y parameter controls the area of the play zone while moving from left to right along the setup. Two vertical green lines appear in this setting and area between these two lines is detected as the Play Zone. Play Zone Y combined with Play Zone parameter controls the total area that will be detected as the Play Zone. Fig 29, Fig 30 & Fig 31 shows the result for different values of this parameter.

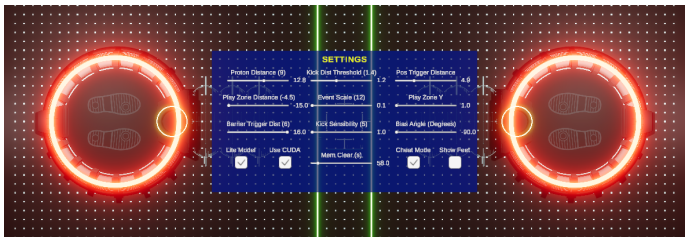

Figure 29. Play Zone Y Set to the value 1.0.

Figure 30. Play Zone Y Set to the value 8.4.

Figure 31. Play Zone Y Set to the value 12.2.

5.1.7. Kick Sensitivity

Kick Sensitivity controls the sensitivity of the kick. Increased value detects kicks abruptly and decreased value detects it slowly which results in particles moving towards each other fast and slow respectively.

5.2. Calibration of the sensors

Another important part of the software setup is the calibration of the sensors. Sometimes sensors are unable to detect the players and kicks which means that calibration of the sensors is disturbed and we need to realign or calibrate the sensors for them work properly.

If we press SPACEBAR while settings opened it toggles the camera view of the sensors along with the thermal detections and it also shows some feet on the floor as shown in Fig 32.

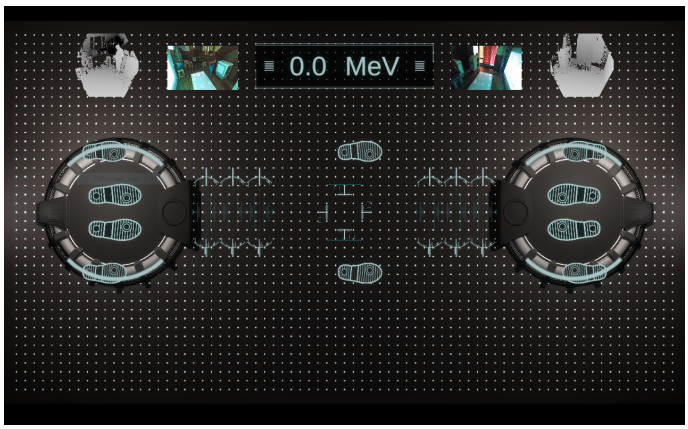

Figure 32. Play Zone Y Set to the value 12.2.

Follow these instructions to calibrate the sensors properly:

- Use the camera view and adjust the sensors so that players on the floor appears to be in the centre of the camera view.
- Now place the feet on the sign that shows feet on the left side of the floor and press the "C" key on the keyboard.
- Now place the feet on the sign that shows feet in centre of the floor and press the "V" key on the keyboard.
- This time place the feet on the sign that shows feet on the right side of the floor and press the "B" key on the keyboard.
- The sensors will be properly calibrated after following these steps, close the setting panels and start the game.

5.3. Special Modes in the game

5.3.1. Cheat Mode

Cheat Mode always makes the collision happens. Sometimes kicks are missed because of tilted kick angle. But will the cheat mode on collision will always happen irrespective of the kick angle. It can be activated by pressing the "SHIFT + C" key on the keyboard. Small dots on the bottom left corner of the floor lights up as sign of activated cheat mode.

5.3.2. Symmetry Mode

Symmetry Mode reduces the chances of missed kicks. When this mode is on the angles of the kicks are symmetric and avoids the chances of kicks without collisions.

6. Educational Concept and Purpose

This whole setup is aimed at teaching the basics of Particle Physics and how laboratories at CERN operates. Basic concepts that are covered in this setup described in upcoming sections.

6.1. Converting Energy into Particles at CERN

6.2. Production of Higgs Particles

7. Summary

Summary of the whole report is as following:

- Build the structure.
- Install the machines.
- Do settings and calibration.
- Start the demonstrations

A complete list of all the material used and important dimensions is as follows:

7.1. List of Materials

Table 2. Projection Screens Dimensions

Item	Quantity
Short Throw Laser Projectors	2
Gaming Grade Computer	1
Microsoft Kinect Azure Sensors	2
Keyboard for PC	1
Sound System	1
Projection Surfaces	2
9’ x 9’ Structural Truss	1
Sensor Mounts	2
Extra Dolly for Projector	1
Toolbox	1
Bracket for Floor Projector	1
HDMI to DVI Convertor	1
PC Power Cable	1
Projector Power Cables	2
Kinect power cables and bricks	2
Kinect USB C to USB cables	1
Active 3.0 USB extender 10m	1

7.2. Important Dimensions and Numbers