Co-funded by the
Erasmus+ Programme
of the European Union

D.O.M.E MOUNTING GUIDE

DESIGN YOUR OWN MULTIMEDIA LEARNING ENVIRONMENT (D.O.M.E.)

Project number: **2022-1-PT01-KA220-SCH-000089939**

2023

v.1.0

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Summary

1. Preparation

It is necessary to do a previous calculus and separate the materials to start the project.

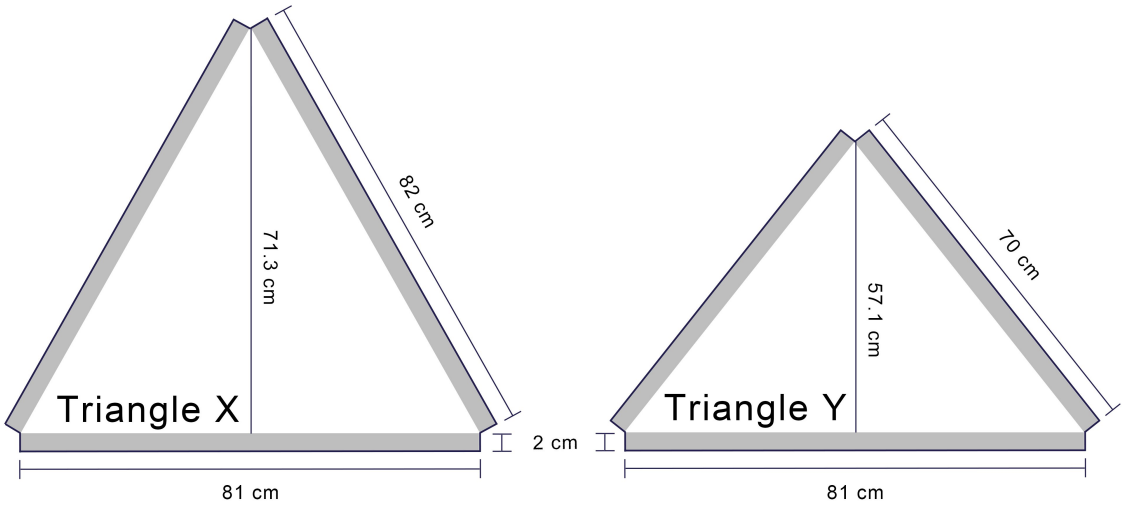
1.1 Calculus about the dome

The starting calculus can be done in: Dome calculation tool, where is possible to choose the diameter in the floor of the geodesic to build the dome, ever in metres.

When we decide to build a dome using triangles it was necessary to do an approximation using a geodesic, where the term frequency is associated with the degree of approximation between a geodesic and a sphere. It is known that the higher the frequency the closer the finished shape is to a sphere, yet is more difficult to build. As a side note, this frequency is proportional to the quantity of triangles needed to create the sensation of a sphere. We chose a 3v frequency because it presents a good relationship between form and mounting difficulty.

So, our planetarium dome was made by a geodesic at frequency 3v with a diameter of 4 metres. Which implies 75 isosceles triangles, as:

- Triangle X, a base of 81 cm and the lateral edge with 82 cm, a total of 45 triangles;
- Triangle Y, a base of 81 cm and the lateral edge with 70 cm, a total of 30 triangles



Remember: it's necessary add a tab, with approximately 2.0 cm beyond the dimensions informed here. This tab can be see in the figure above in grey. This is where we connect the triangles to build the dome.

1.2 The materials

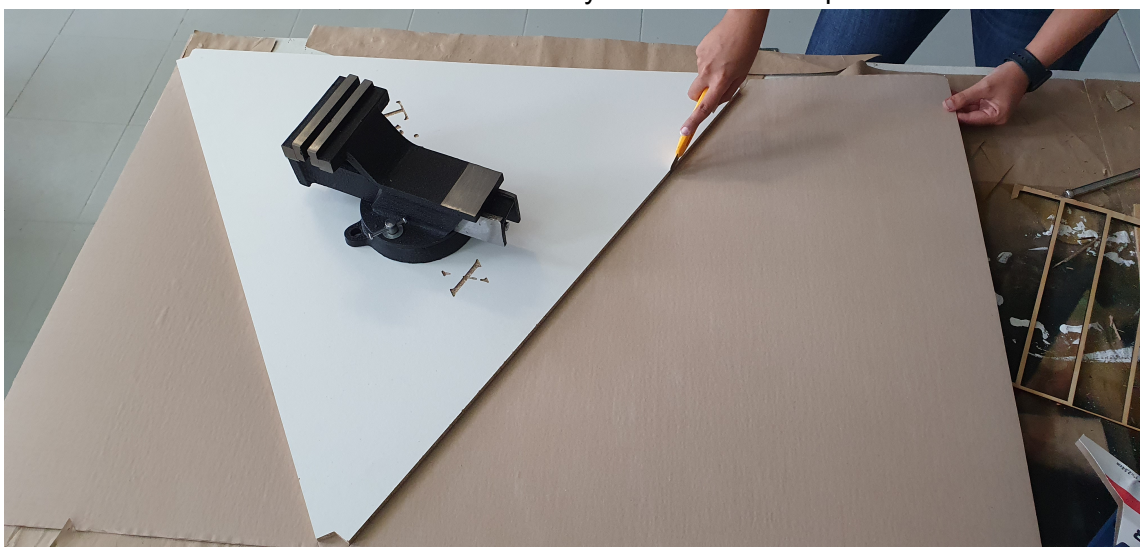
Here is a list of the materials we need, and the minimum quantity for one complete cardboard planetarium.

Material	Specification	Quantity
Cardboard	3 mm thick, for the dome	75 boards
Cardboard	5 mm thick, for the base	14 boards
Blender Clips	32 mm, packs with 12 units	33 packs
Ink	4 L, white colour	1 gallon
Paint roller	5 cm size	1 unit
Ink tray	to mix the ink	1 unit
Fisheye lens	f3.5 and 8 mm focal length	1 unit
50 mm lens	lens with f1.8 and adapted for CANON and large aperture cameras	1 unit
Flat mirror	4 x 4 cm, inner the structure of the optical system	1 unit
LED projector	4,000 Lumens Full HD 1080p LED projector	1 unit
Threaded rod	6 mm thick and 2 m length	1 unit
Nuts	nuts for the threaded rod	12 unit
Rapsberry Pi 400	computer to use the software	1 unit
Speakers 5 W	It's necessary for the audience understand the videos	1 pair
Small fan	to make the air circulation inside the planetarium	1 unit

The only mandatory software is one to do the planetarium presentation, we used Stellarium[1], however you can use others also available. A good idea is to have a video player installed, too. We recommend the VLC[2], because it is multiplatform and it has many codecs to show almost any existing video.

The optical structure should be printed in a 3D printer, using a model provide by us, based in the project 'Planet in a Room'. The figure beside show this structure used working in a session of the project Planet in the Room.

To make easy the cut of the triangles, a template for the triangle X and another for the Y can be used. That way, it is possible to guarantee that each triangle will be the same dimensions planned before. Figure below shows the use of a model to cut a triangle X in cardboard. Note that the side bar is already added in the template.

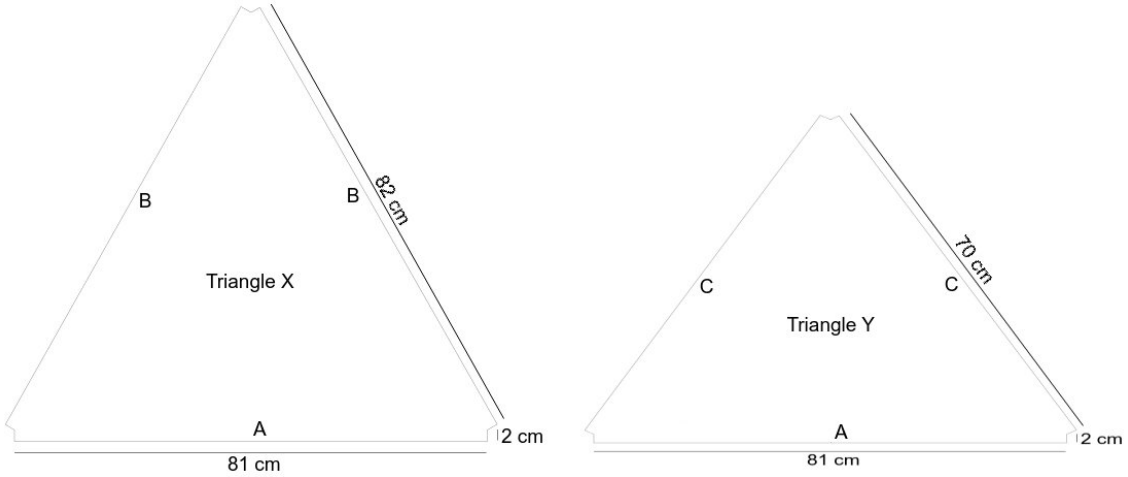


We had the access to a CNC, so we did the model in wood. However, you can use any material you have access, as the own cardboard, the most important is maintain the dimensions for all the triangles as planned.

After the cut, it is necessary to paint a face of each triangle, this is useful to reflect more light from the projector during the planetarium session. We suggest paint based in water in low proportion, because like this we reduce the undesirable reflection.

[1] available in https://stellarium.org/
[2] available in https://www.videolan.org/vlc/

After all this process each triangle has three tabs named with a letter based on its size. In this way, the mounting of the dome will be easier, as you will have to join the sides with the same name, see figure below.



Summarizing, for triangle X the side with 81 cm has the name A and the side with 82 cm the name B, it results in a triangle with sides ABB. For triangle Y, we have again the side A (81 cm) and the side with 70 cm the name is C, it results in a triangle with sides ACC.

1.2.1 Time estimate

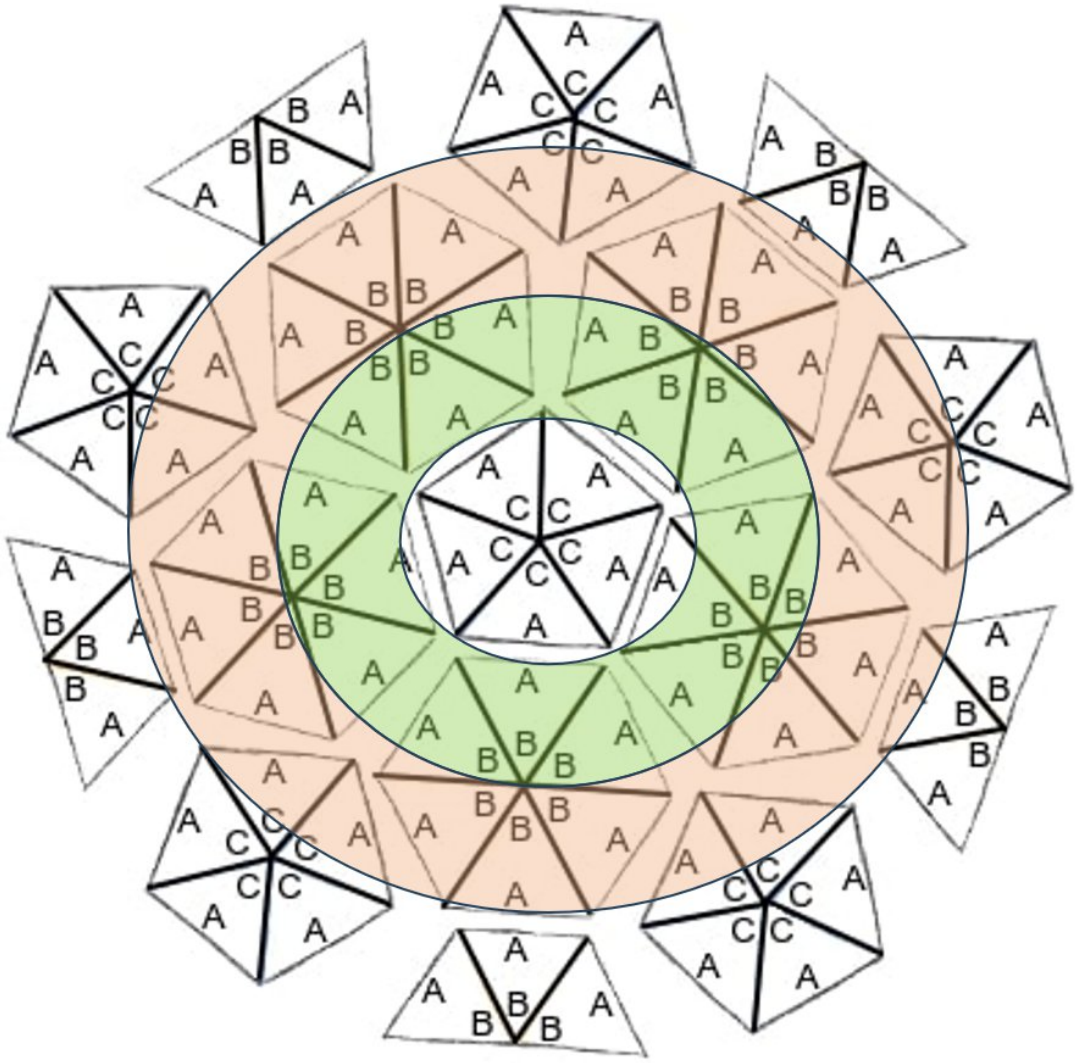
A possible time estimate, considering only one person working and without consider the time to ink drying, can be express by:

Procedure	Duration
Cut the triangles (2 min each)	150 min = 2h30m
Paint the triangles (5 min each)	375 min = 6h15m
Cut the rectangles (2 min each)	28 min
Fold the sides (30 seg each side)	134 min = 2h14m

2. Mounting

2.1 The dome

The mounting scheme for the dome starts with the central pentagon, this geometrical figure is made by 5 triangles Y linked by the sides with the same length (side C). The next layer, similar to a ring made by triangles put together by the side with the same letter, is connected in this pentagon. Another layer is connected in this first one, and so on. We can note that the geometrical figure create are form ever by the same triangles, X for hexagons and Y for pentagons. All the scheme can be see in the figure bellow:



Following the mounting scheme of rings, in each side A of the central pentagon we connect half hexagon (3 triangles X linked by the side B) represented by the green ring. After this one, the light pink ring will be composed by 5 half hexagon to complete the previous and 5 top of pentagons (2 triangles Y linked by the side C). The last ring has 5 half hexagon and 5 parts to complete the pentagons.

In this link you can see the mounting of this planetarium made by three person: https://youtu.be/iDMfMsSlO24. The time spend for this video was 2h20.

2.2 The base

After mount the dome the next step is linked the rectangles in the base, for each one it is necessary to have tabs. These rectangles should be linked to the bottom of the dome and each other, ever using the tabs and the clips.

Considering that the base must be stronger to support all the structure, the use of cardboard cylinder as a pillar between two adjunct rectangles (see figure above)

It is important to leave one space in the base to work like the door, it means, we use 14 rectangles in the base and leave a gap without rectangle. For this door, we can use an agrotextil to close the the door and guarantee the darkness inside the planetarium. An agrotextil is a non-woven fabric use in gardens.

To protect the structure the use of an attention tape (red and white band) on the floor, inside the planetarium, to indicate a safe distance to stay from the walls (cardboard rectangles in the base) for the audience. Because if someone leans against the wall, it is possible that the planetarium will break down. This situation is not potentially

dangerous, however it will be necessary remounting the planetarium and, maybe, change some parts damaged.

2.3 Inside the planetarium

The optical system must be in the centre of the dome, it means, aligned with the centre of the first pentagon mounted. The adjust of the system needs calm and attention because it is sensitive, the first idea is put the 50 mm lens really close to the projector, with focus on infinity. The fisheye lens must be moved laterally to improve visualization in the dome, the focus on infinity too. The correct position is found by try-and-error method.

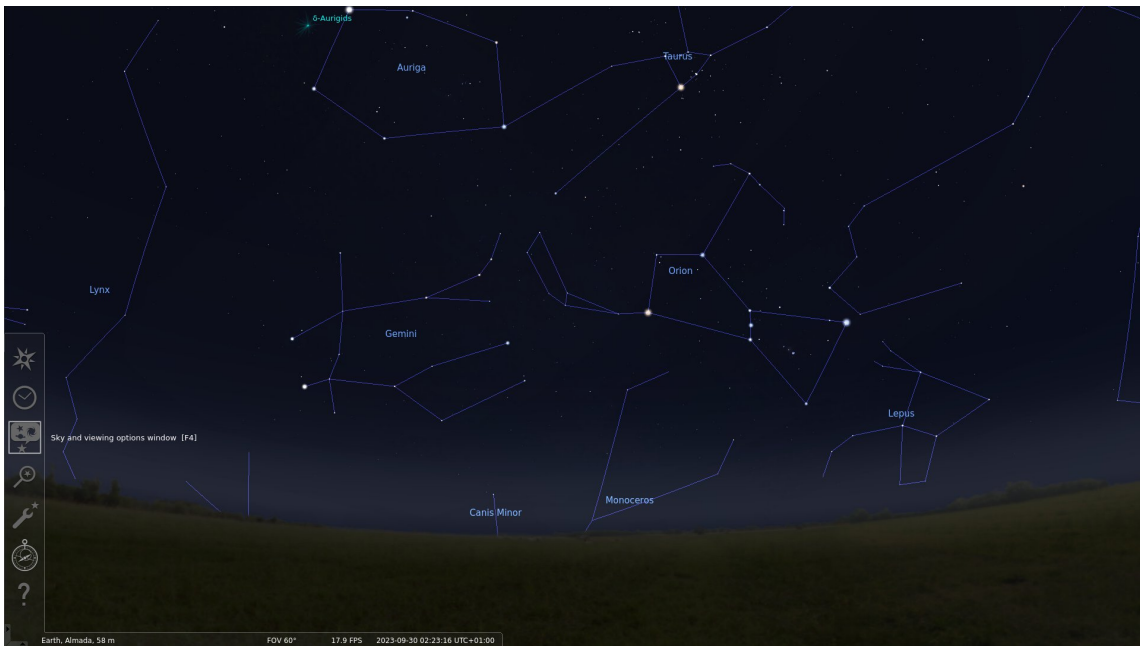
Note it is a good idea to have a fan inside the planetarium for circulation of the air, and some place to the operator seat more comfortable. The audience will seat on the floor because they stay inside only for a few minutes, the operator stay long time.

Of course, to support all these systems we need a energy source, so the place where we decide to mount the planetarium must provide this source. In the photo above we have a power strip close to a speaker.

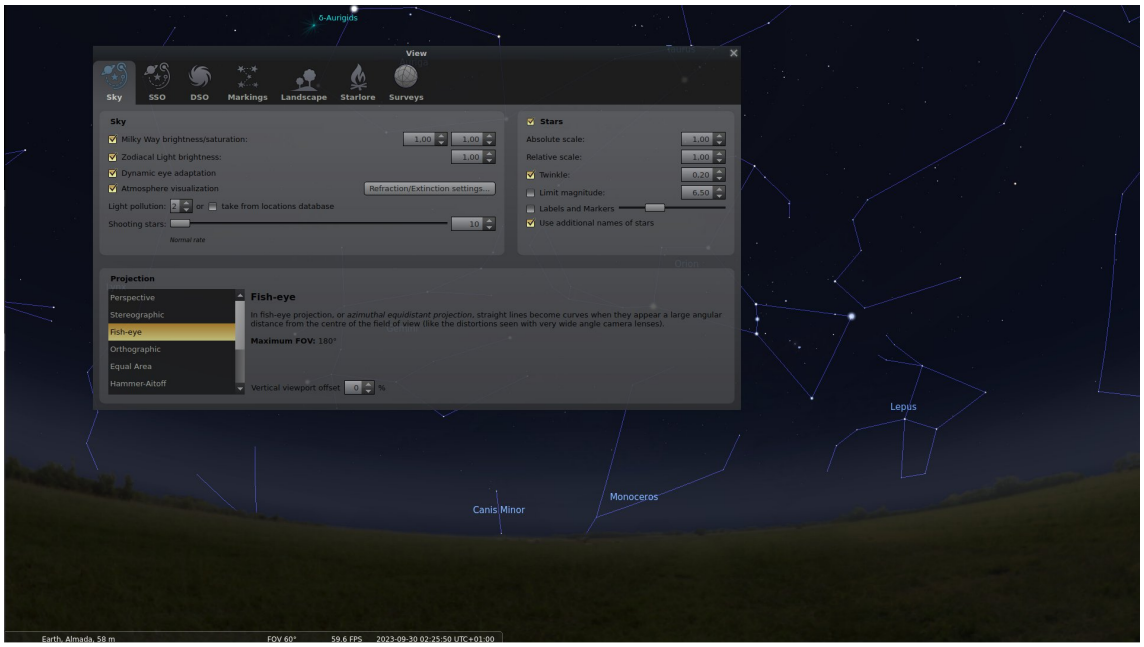
2.3.1 Setting the Stellarium

The setting should be every time you turn on the laptop, however it is only few steps:

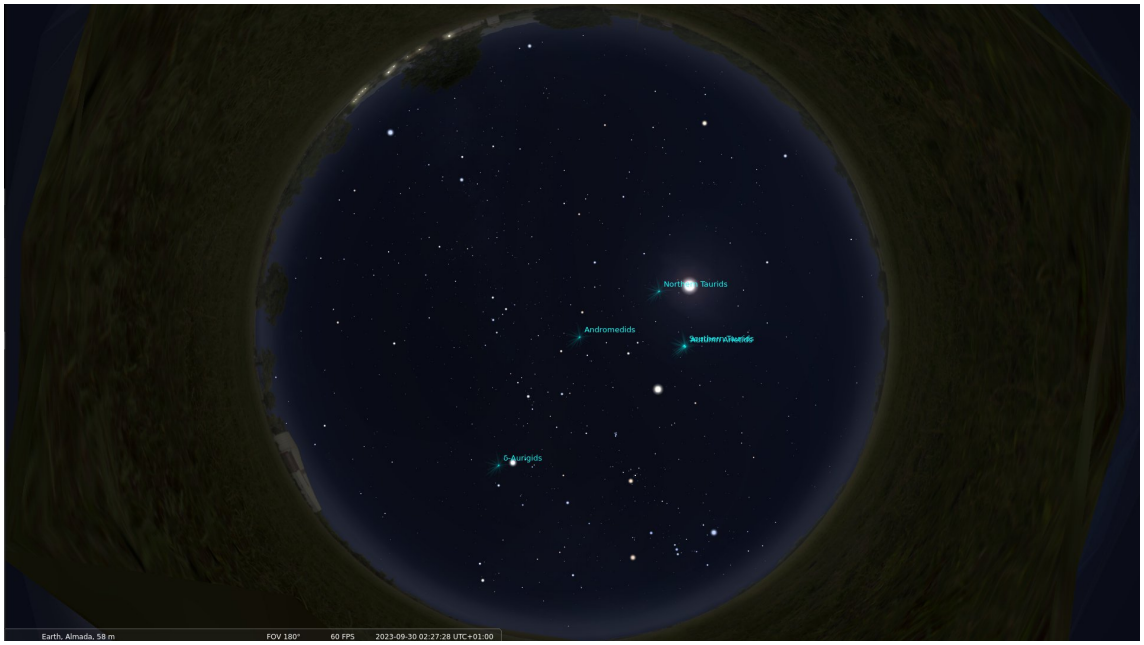
1. Open the *Sky and see options* menu (at the side of the screen or press F4)



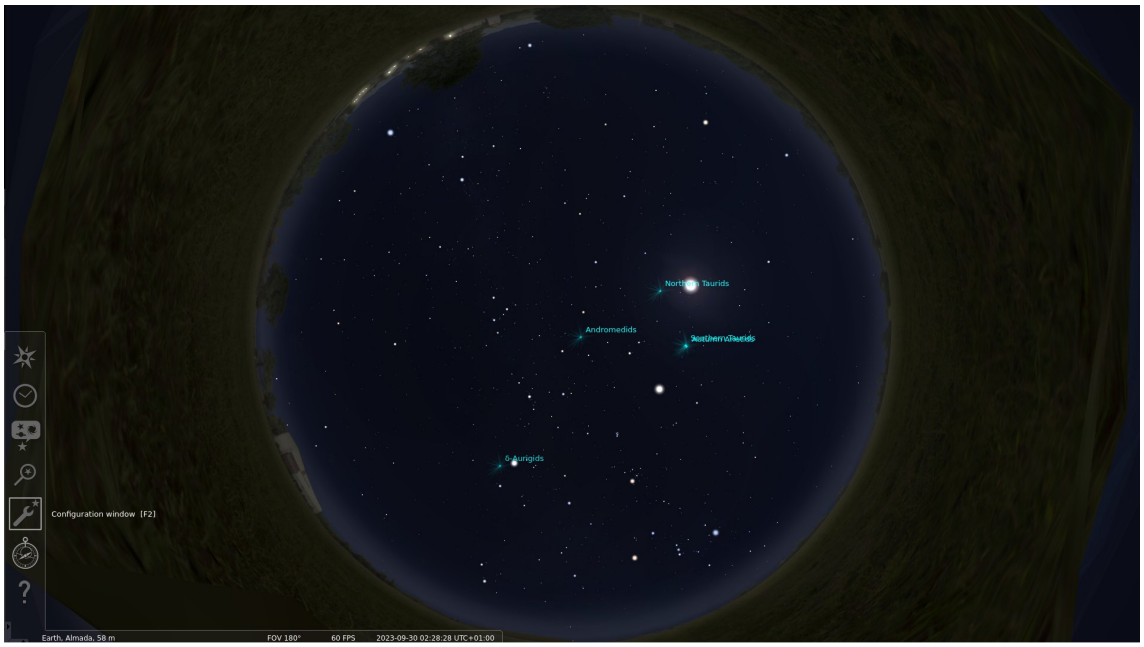
2. At the window *Sky*, mark ‘fisheye’ in projection item



3. Adjust the zoom to put the projected floor in the horizon of the dome, the sky projected in the middle



4. Open the *Settings* menu (in the side of the screen or press F2)



5. At the window *Tools*, mark the option ‘disc viewport’ in Position of the planetarium