The History of the Solar System Scale Model in Lethbridge

by
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In the Beginning

It all began with one building and one person. The building was the John D. Higinbotham Building on the corner of 4th Avenue and 7th Street in downtown Lethbridge, also known as the Federal Building or Post Office. It was built in 1912–1913 and is a good example of pre-World War I monumental federal architecture. The building is a fine example of Second Empire/Beaux-Arts principles of design. The building has four floors with a distinctive five-story clock tower in the northwest corner capped with a copper dome roof. The Federal Building is also a heritage building. The person is Klaus Jericho, who is a long-time member of the Lethbridge Astronomy Society, becoming a member in the early 2000's.

On his way home after a meeting of the Astronomy Society in 2004, Klaus contemplated on what if the dome on top of the Federal Building was used to represent the Sun, then how big would the solar system be in terms of the relative sizes and orbital distances of the main planets. Klaus thought this was a good idea to pursue. He contacted his good friend, Don Fergason, at the University of Lethbridge, who was a mathematician, and asked him to do the calculations for a scale model using the Federal Building's dome as the Sun. Klaus gave Don the diameter of the dome, which is 5.478 metres (obtained from city drawings), and the actual sizes of the Sun and the eight main planets and the average distances of the planets from the Sun. These data were obtained from the textbook *Universe*, 6th edition by W.J. Kaufmann and R.A. Freedman (2002). In due course, Don presented a sheet of numbers for a scale model to Klaus (Columns 2 and 3 below).

With the model Sun at 5.478 metres in diameter, the scale factor of the model is 1:254,107,338 based on the Sun's diameter of 1,392,000 km (Kaufmann and Freedman 2002).

	Calculated model diameter of spheres (cm)[z]	**Calculated model distance from the Sun (km)[z]**	**Actual distance used for the model (km)[y]**
Mercury	1.92	0.228	0.257
Venus	4.76	0.426	0.399
Earth	5.02	0.589	0.475
Mars	2.67	0.897	0.784
Jupiter	56.26	3.063	2.370
Saturn	47.43	5.635	5.680
Uranus	20.12	11.324	8.970
Neptune	19.49	17.700	14.290

[z] Based on 5.478-m diameter of the model Sun, i.e., the diameter of the Federal Building's dome.
[y] Measured using Google Map.

In addition to the above calculated results, it turned out that a moderately-slow walking pace would represent the speed of light at this scale. For example, to walk from the Federal Building (Sun) to the Earth monument takes about 8 minutes, the time it takes light to travel from the real Sun to Earth. Also of interest, is that when the above values were calculated, Pluto was included, because in 2004, Pluto was still classified as a planet; it was reclassified as a dwarf planet in 2006. Therefore, Pluto was not included in the scale model when the project was finalized about 13 years later. The Moon was added much later once the idea of a scale model became a viable project.

Klaus took the calculated results to Dan McGee, a spatial planner with the City of Lethbridge, to determine how the model would superimpose on the city's layout. To Klaus's great excitement, the orbits of the four inner terrestrial planets were within the downtown area, the two gas giants were within the city limits, and the two ice giants were at reasonable distances outside of the city limits but within the County of Lethbridge. Klaus thought it was serendipity that the 5.478-metre scale size for the Sun worked out so well for the orbital distances of the planets (and their sizes) to lay mainly within the city limits.

With great excitement that he had a doable model, Klaus then approached the City Planning Department to get their take on it, and hopefully some advice on how to proceed. They were not interested. No doubt a setback.

Several years passed by and the solar-system-model idea faded and was half forgotten. Then during one of Klaus's visits to the Lethbridge Public Library in 2012, he decided to visit the Library's CEO Tony Vander Heuvel and pitched the model idea to him. Klaus did so by bouncing a small rubber ball in Tony's office and explained that if the Sun was the size of the Federal Building's dome, then this small ball would be the size of Earth. After further discussion, Tony apparently got very excited by the concept and felt the project should be pursued. Tony had been watching the *Cosmos* TV series and was aware of the educational value of the project. Tony also allocated funds, which were never used for this purpose, and assigned a person to the project. As it turned out, the assigned person was not really interested in the project and not much happened. A couple more years passed by.

The project file eventually landed on the desk of Barbara Longair at the Lethbridge Public Library. In 2014, Barbara called Klaus and asked him about a file concerning a model solar system project and she was wondering what it was all about. Likely with anticipation, Klaus eagerly met with Barbara and Lisa Weeks (also with the Public Library) to discuss the model concept. They decided to form a small committee to decide on how to proceed. They eventually decided to start with the Jupiter monument, which was hoped to be located at the University of Lethbridge. Their idea was if Jupiter could be built at the university, then perhaps the other planets would come along with donations and other support, as Klaus phrased it. In the meantime, Klaus asked his nephew, Neil Jericho, a commercial artist living in Halifax, to develop ideas on the design of the planet monuments. According to Klaus, about 10 to 15 ideas were prepared, and the "prettiest" was selected. The selected design was referred to as the semi-circular design. It was determined that it would cost about $80,000 to $90,000 to build the eight monuments. But there was no money, not a penny. Several meetings were held with the university, in the office of John Claassen, Director, Campus Planning, to determine where to

locate the Jupiter site on campus. The university was also willing to provide $12,000 for the Jupiter monument. The original site selected in 2015 was about 10 metres east of the steps to the Students Union Building on the grass surface. This site is about 500 metres less than the calculated scale orbit of Jupiter (a different site on campus was later selected).

In spring 2016, quotes for the manufacture of this design were obtained, and Charlton and Hill (Trevor Tabish) manufactured the first and only stainless steel semi-circular structure. Charlton and Hill also agreed to donate $1,000 to the project. The structure was found to be too weak to hold a 15-kilogram Jupiter globe. Support ribs were designed but never added to the structure.

From Idea to Final Project

Apparently, Tony Vander Heuvel moved from the Public Library to City Hall where Tony talked about the solar system project and led to more discussion about the idea at City Hall unbeknownst to Klaus. On 8 August 2016, Klaus introduces City Council to the project, and he requested $5,000 for the purchase of stainless-steel globes. Even though the City Council viewed the project favourably, the request was denied, and instead, requested letters of support for the project. Eleven letters of support were received from 16 November 2016 to 15 March 2019.

On 23 May 2017, The Lethbridge Astronomy Society agrees to serve as steward of the project without financial commitments. The city did not want to take this on as a city project. Even though the city provided extensive support, they requested that this endeavour be a Lethbridge Astronomy Society project.

In summer 2018, Lori Harasem, Recreation and Culture Development Manager, City Hall embraced the project and provided advice about the ways of City Hall and led the grant application process. Money was needed and Lori knew how and where to apply for funds, and through her guidance, the efforts were successful. The Astronomy Society applied for funding from various organizations. These applications were under the name of the Lethbridge Astronomy Society with the participation of former society president Bob Orth.

In June 2019, Klaus received an e-mail from another Astronomy Society member, Brian Tedder, whose son, Andrew Tedder, was in Prague, Czech Republic where he saw a scale model of the solar system. Andrew sent a link to a webpage describing the model in Prague. The simpler design included a post with a small plaque attached, and a globe of appropriate size on top of the post. It was determined that this design would do very well, and it was adopted. Plus, the new design was much cheaper at about $30,000 and easier to construct. The original semi-circular model, which had been stored at Charlton and Hill for about one year, was demolished (and the donation of $1000 from Charlton and Hill was therefore not collected).

The first major funding was awarded by the Community Foundation of Lethbridge and Southwestern Alberta receiving $15,000. TELUS and Richardson Oilseed had programs for funding community projects and successful applications brought in $5,000 and $10,000, respectively, for a total of $30,000 base funding. The University of Lethbridge's Faculty of Arts and Science paid for the Jupiter monument on campus, estimated at about $3,000.

After funding was secured, Bob and Klaus identified tentative locations for each model. Shortly afterward, Bob Orth moved to Vancouver and was no longer society president. Tom Anderson became the new president in 2019 and was very committed to the solar system project. Tom essentially became the project lead from that point forward. Perry Sabey (society member) assisted with design of the monuments, plaque wording, and model installation.

The Lethbridge School Division 51 covered most of the cost of the Saturn monument, except for the hollow sphere and the plaque. Because of the different design of the Saturn monument, which included rings around the sphere, the Lethbridge School Division's contribution was critical as the design requirement for this site was beyond the available budget. Kevin Wood, former principal of the school, was a keen early supporter of the project.

Finally, Ward Bros. Construction in Lethbridge was hired to install all the monuments. The cost of installation was about $1,600 per site (about $12,800 total). However, the budget could only cover about half this amount, but Ward Bros. Construction agreed to cover the difference, estimated at about $7,000. Therefore, the amount of funding made available was about $45,000 of which the Astronomy Society administered $30,000 from grants.

After the funding was in place, the Lethbridge Astronomy Society gave a presentation to City Council on 8 December 2019, and City Council supported the project by giving approval to locate the four inner planets within the downtown area. The City of Lethbridge was very supportive of the project and provided much in-kind support through expertise on funding advice, engineering, and graphic design. The city's assistance for siting the four inner planet monuments in the downtown area was critical for setback requirements and to avoid issues with other infrastructure such as buried lines and pipes. Dean Romeril of the city was particularly helpful in determining precise locations after the technical drawings of the monuments were available.

This is a scale model, and with any scale model, trade offs and compromises regarding accuracy and details are made. This project was no exception, particularly for the distances from the Sun (Federal Building dome) to the planet monuments. For the scale-model calculations, the average distance from the Sun to the planets were used (Table on Page 15). However, all the orbits are elliptical shaped with distances that vary from perihelion (closest distance to the Sun) to aphelion (furthest distance from the Sun). For example, at perihelion and aphelion orbital positions, Venus is 107.5 million and 108.9 million kilometres from the Sun, respectively. For the scale model, this calculates to about 423 and 429 metres from the dome (Sun), respectively. If a given planet monument falls within its perihelion and aphelion distances, the model is considered accurate. However, this was not always the case for the solar system model. Again, for example, the Venus monument is about 399 m from the dome in the model, and this distance is about 6% short of perihelion, i.e., it is too close to the model Sun. Only the Mercury and Saturn monuments fall with there respective perihelion and aphelion distances. The other six planet monuments are less than their respective perihelion distances to varying degrees (Columns 13–14 in the table below on Page 15).

There were many reasons why several of the monuments were located at less accurate distances. Some of the reasons included infrastructure avoidance, practical access points, traffic parking

and flow, targeting familiar sites, sites with easy access by foot or car, reasonable security for the monuments, setback requirements, and clearance for pedestrian traffic in the downtown area. In the end, accessibility and safety were priorities over accuracy. As a model, it approximates reality, and these variations do not take away the effectiveness of the overall purpose of the model to relay a concept and an appreciation about the solar system to the public.

Apparently, in May 2021, Gene Lublinkhof, Director of Campus Planning, asked the Astronomy Society to explain its choice of site selection for Jupiter. The Astronomy Society decided to comply with the wishes of Dr. David Naylor to locate Jupiter on the patio of the new Science Commons Building, which was officially opened in September 2019.

After the city's approval, MPE Engineering (Jeremy Greenway) was selected to prepare technical drawings of the monument design. This process took time, and the drawings were not available until fall 2020. Then fabrication began in the latter part of 2020 and into 2021.

Charlton & Hill in Lethbridge was contracted to fabricate the metal monuments including the posts, plaque mounting brackets, base plates, and the model planets. Trevor Tabish with Charlton & Hill's metal works was very helpful during the fabrication process. Solid, high-speed-steel ball bearings of different sizes (from Motion Canada) were used for the inner planets. AMS Industries in Vancouver was subcontracted to fabricate the four outer planets as stainless-steel hollow spheres. Note that most of Charlton & Hill, including its metal works, were sold to Borne Industries Ltd. However, this sale occurred shortly after the fabrication of the monuments was completed.

Outlaw Metal Polishing in Lethbridge polished the four hollow spheres to a high reflective finish. Full Proof Coatings (also called Draggn' Design) in Fort Macleod applied the finish to the stainless-steel posts and plaque brackets. At this stage, because the spheres were attached to the posts, the spheres were covered for protection during the finishing process. The posts have a top cap to which the planet models were first welded to and then the caps were welded to the posts.

Lori Harasem from the city directed the Astronomy Society to Keaton Bosch who was also with the city and who designed signs. Keaton designed the information plaques for each of the monuments with help from Perry Sabey, a member of the Astronomy Society, as content supervisor. Outdoor Museum in Calgary was approached to manage the fabrication of the plaques. Outdoor Museum used D2 Design to carry out a pre-printing consultation of the plaque content. The plaques were fabricated by a company in Texas, United States. During this phase, Outdoor Museum managed the custom brokerage, import tariffs, etc., which saved the Astronomy Society a lot of headaches. The plaques (28 by 45.5 centimetres, 1.2-centimetres thick) were made from a type of Arborite material.

The images used for the plaques came from a few sources. Astronomy Society member Perry Sabey provided an image of the Moon. Most of the remaining images were obtained from the National Aeronautics and Space Administration (NASA), which freely allows the use of their images for non-monetary purposes. However, a quality image of Venus in full phase could not be found in NASA sources. Other sources, such as the Japan Aerospace Exploration Agency (JAXA) and the European Space Agency (ESA) were searched; however, the use of images from

these agencies were highly restrictive. Fortunately, an individual named Mattias Malmer had processed images taken by the Mariner 10 spacecraft (February 1974). One image was of good quality and the planet nearly in full phase. The society contacted Malmer and obtained permission to use the image.

All the monuments were installed by Ward Bros. Construction in 2021. The monuments were installed before the plaques were ready. During the interim, temporary paper adhesives were attached to the plaque brackets providing information about the project. The plaques were ready about 4 to 6 weeks after the monuments were installed. Members of the Astronomy Society attached the plaques to the monuments, and to the exterior wall of Chinook High School at the Saturn site.

The Sites

The Sun (dome of the Federal Building) is at the corner of 7th Street and 4th Avenue (Figure 1). Across the street from the Federal Building (west of the building) and next to the Royal Bank was a kiosk used for posting notices, i.e., a doubled-sided poster board with a roof. Andrew Malcolm of Lethbridge Business Revitalization Zone was able to secure the kiosk as a permanent display for the solar system model. Keaton Bosch designed an information poster (83 by 129.5 centimetres), and the city printed and installed the poster on both sides of the kiosk (Figure 2). The poster includes information about the project, details about the Sun, and a map showing the location of the monuments (Figure 3). The two posters were installed during the latter half of 2022.

The Mercury site is in front of the main, north entrance to the Lethbridge Public Library on 5th Avenue (Figure 4). Venus is in front (north side, beside the walkway) of the Old Courthouse on 4th Avenue, just east of City Hall (Figure 5). Earth and the Moon are east of the Fire Headquarters Station 1 on 3rd Street and a few metres north of the corner of 3rd Street and 4th Avenue (Figures 6 to 8). At this scale, Earth and the Moon should be about 1.5 metres apart. However, the distance used between the two monuments was nearly 3 metres, because they were located on a sidewalk adjacent to angle parking, and placing the monuments closer may have blocked the walkway to enter or exit vehicles. Mars is near the main entrance of the Galt Museum and Archives (Figure 9). The Jupiter monument was located on the outdoor patio of the Science Commons Building at the University of Lethbridge (Figure 10). One interesting point is there is a direct line of sight to the Federal Building's dome from the Mercury, Venus, Mars, and Jupiter sites.

The Saturn monument is different, as it was placed on a much taller metal post (about 3.75 metres tall) and rings were represented by a flat, circular metal disk about 1.5 metres in diameter (Figure 11). The information plaque for Saturn was attached to the nearby exterior wall of Chinook High School. The original idea for the Saturn monument was to have the planet and rings attached to the outside of the building, perhaps with half the sphere and rings protruding from the wall. Daniel Heaton, Director of Facility Services for the Lethbridge School Division, who was an architect, suggested a different design, which was adopted. Daniel obtained assistance from Dan Chronik, an engineer with MPE. The model of Saturn was placed on a higher post so the rings could be protected and for safety concerns (i.e., prevent people from

climbing on the rings). The engineering challenges were formidable, given the 1.5-metre diameter rings and the high winds that regularly blow through Lethbridge. The cost of the new design was well beyond the Astronomy Society's budget envelope, so the Lethbridge School Division covered these additional costs. The Astronomy Society covered the cost of the planet sphere and the plaque with grant money.

The entire ring system of Saturn extends about 417,356 kilometres above the surface of Saturn. Most of this distance is occupied by the very faint E Ring (301,340 kilometres). The diameter of the planet and rings is about 955,248 kilometres. For the scale model, the rings should be 3.76 metres in diameter, but instead, the diameter used in the model was 1.5 metres. However, the model rings represent the bright A, B, and C rings reasonably well as they appear in a small telescope. At 1.5 metre in diameter, the model rings extend beyond the outer edge of the A ring past the F and G rings and about 3% into the E ring. The thickness of the rings varies but most of the rings are less than 100 metres to as thin as about 10 metres. In the scale model, this would mean a thickness of less than 1 millimetre. This thickness was not practical, and a much thicker value (about 8 mm) was used so the metal plate could support itself and withstand windy conditions.

The Uranus and Neptune monuments were located outside of the city limits. With permission from Paul and Hilda de Jonge of Broxburn Vegetables and Café, Uranus was placed in front of the café (Figure 12). The monument is about 9 kilometres east of the model Sun. Apparently, Coalhurst had some interest in hosting this planet monument, but once it was learned the planet was Uranus, they declined because the town was uncomfortable with the planet's name. An unfortunate but humours reaction, but no more needs to be said.

With permission from Alberta Parks, Neptune was located at Park Lake Provincial Park, which is about 14 km from the Sun (Figure 13). Tom Anderson, of the Astronomy Society, pointed out that it seemed very appropriate that Neptune was placed next to Park Lake, for Neptune was the god of fresh water and of the sea in Roman religion. Park Lake was built as an irrigation reservoir in 1929 and is in the Lethbridge Northern Irrigation District. The lake is also the setting for one of Alberta's oldest provincial parks.

	Location	**Address**	**Coordinates**
Sun	Federal Building dome	704 – 4 Ave. S.	49°41'39.7"N; 112°50'13.5"W
Mercury	Public Library	810 – 5 Ave. S.	49°41'34.5"N; 112°50'03.0"W
Venus	Old Courthouse	1003 – 4 Ave. S.	49°41'40.5"N; 112°49'53.1"W
Earth/Moon	Fire Station 1 (east of)	322 – 3 St. S.	49°41'39.9"N; 112°50'36.7"W
Mars	Galt Museum and Archives	502 – 1 St. S.	49°41'33.6"N; 112°50'51.3"W
Jupiter	Science Commons patio (U of L)	4401 University Dr. W.	49°40'48.4"N; 112°51'40.7"W
Saturn	Chinook High School	259 Britannia Blvd. W.	49°40'26.0"N; 112°54'33.1"W
Uranus	Broxburn Vegetables and Café	5-90008 Range Road 210	49°41'58.4"N; 112°42'44.7"W
Neptune	Park Lake Province Park	101052 Range Road 223	49°48'45.4"N; 112°54'52.6"W

Official Launch

On 1 June 2022, the official launch of the model solar system was held outdoors on a sunny day next to the Saturn monument at the Chinook High School (Figure 14). The ceremony was hosted by Bill Forester, principal of Chinook High School. Speakers included Klaus Jericho, Tom Anderson, and Mayor Blaine Hyggen. In addition, Reid DeCillia, a student at Chinook High School, talked about and showed a 3.85-minute video, which he had prepared of the solar system model. The official launch was recorded as a 41-minute video.

The maintenance of the monuments will be the responsibility of the Lethbridge Astronomy Society. As of this writing, the society has a small fund of $5,000 set aside for repairs and maintenance. After 3 years following installation, the monuments have remained intact. Periodic cleaning is required, and the ball bearings used to represent the four inner planets and the Moon are showing signs of rust. Apparently, Tom Anderson periodically visits these four sites and give the spheres a quick polish.

No formal process is in place to assess the use of the solar system model by the community. The society receives some feedback from people visiting the Oldman River Observatory indicating they had seen one or more monuments. Some have even carried out bike tours of the monuments. Several school groups have told us they have toured the inner planets. Information pamphlets about the model are available at the city's visitor centre. Tourism Lethbridge's webpage provides ideas for pre-plan tours of the city, and the solar system model is listed among the suggested tours on an app called Drfitscape. In addition, the Astronomy Society's website has extensive support detailing the project and providing in-depth information about the planets. Additional information is accessible via a QR code on each of the plaques. Most of the web support was developed by society members Tom Anderson and Perry Sabey.

In the acknowledgements below, only a few individuals are listed. However, this project was a long time in the making and required the support and efforts of many people. Even if a project has broad support, the right decision makers need be in the right place at the right time. A successful project such this requires the right people, funding, and a bit of luck along the way. It was estimated that at least 64 people were directly involved with the project in one form or another, and the Astronomy Society was involved in 60 or more meetings to develop and manage the project.

Acknowledgements

Funding and installation

Community Foundation of Lethbridge and Southwestern Alberta ($15,000 grant)
TELUS ($5,000 grant)
Richardson Oilseed ($10,000 grant)
University of Lethbridge (about $3,000)
Lethbridge School Division (funded Saturn model, except for the globe and plaque)
Ward Bros. Construction (about $7,000)

Operational support

Lethbridge Astronomy Society (LAS):
- Klaus Jericho (project designer)
- Tom Anderson (project lead)
- Perry Sabey
- Bob Orth

City of Lethbridge:
- Lori Harasem (Manager, Culture Development)

Site support

City of Lethbridge (Mercury, Venus, Earth/Moon, Mars)
University of Lethbridge (Jupiter)
Lethbridge School Division (Saturn)
Daniel Heaton, Dan Chronik (Saturn design)
Alberta Parks (Park Lake Provincial Park site, Neptune)
Broxburn Vegetables and Café (Uranus)
Sumus Property Group (Federal Building, Sun)

Construction and fabrication

AMS Industries, Vancouver (built the hollow spheres for Jupiter, Saturn, Uranus, Neptune)
Charlton & Hill (carried out the metal work for the monuments, including rings for Saturn)
Outlaw Metal Polishing (polished the hollow spheres)
Draggin' Design (also called Full Proof Coatings; applied the finish to the monuments)
MPE Engineering (technical drawings of monuments)
Ward Bros. Construction Ltd. (installed the monuments)

Plaques and website content

Keaton Bosch (City of Lethbridge, plaque design)
Perry Sabey (LAS, content supervisor, Moon image)
Tom Anderson (LAS, web content)
M2 Designs (pre-print consultation)
Outdoor Museum (management of plaque fabrication)
Mattias Malmer (Venus image)
NASA and its affiliates (planetary images and information)

Finally, we like to thank Tom Anderson for reviewing this document.

Figure 1

Figure 2

Figure 3

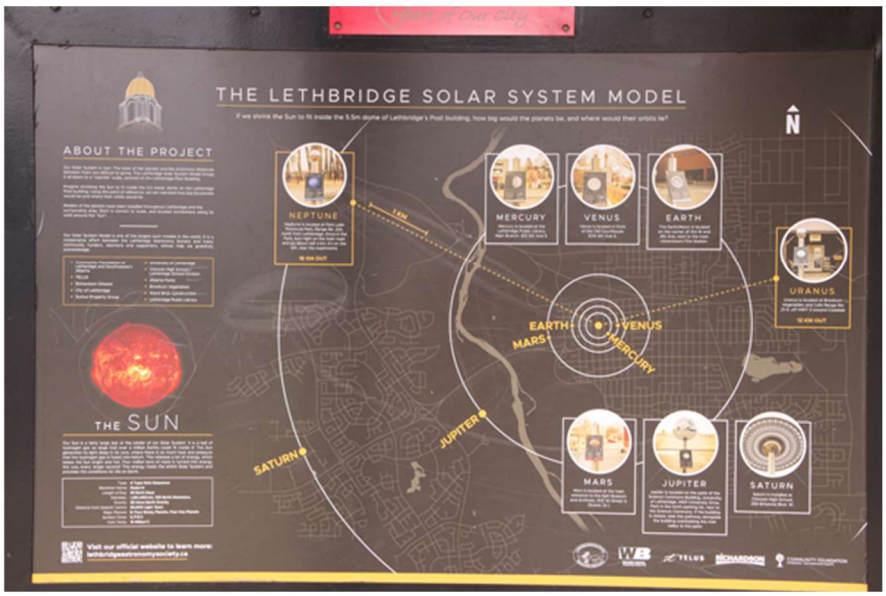


Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

Figure 10

Figure 11

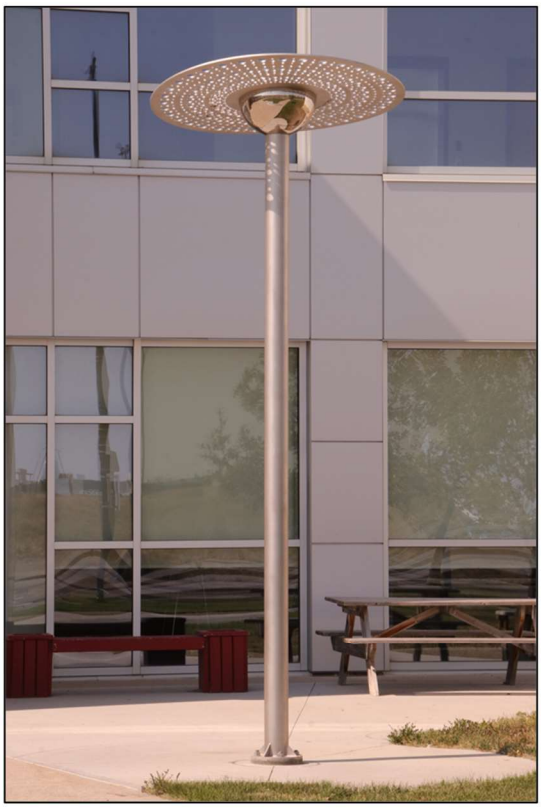


Figure 12

Figure 13

Figure 14

Scale-model Calculations

Below are the calculations for the scale model. Two diameter values in Column 4 differ slightly in the last decimal place compared to values in the table on Page 1. These slight differences are likely due to rounding. Columns 8 to 14 compare the actual distances used in the model to the perihelion and aphelion distances. This provides the accuracy of the final model as installed.

Federal Building dome diameter: 5.478 m
Diameter of the Sun (km): 1,392,000 km (Kaufmann, W.J. and Freedman, R.A. 2002. Universe. 6th Edn.)

1	2	3	4	5	6
	Diameter[z] (km)	**Average distance[z,y] (km)**	**Model diameter (cm)**	**Model distance (m)**	**Scale factor**
Mercury	4,880	57,910,000	1.92	228	254,107,338
Venus	12,104	108,200,000	4.76	426	254,107,338
Earth	12,756	149,600,000	5.02	589	254,107,338
Mars	6,794	227,930,000	2.67	897	254,107,338
Jupiter	142,984	778,300,000	56.27	3,063	254,107,338
Saturn	120,536	1,431,900,000	47.44	5,635	254,107,338
Uranus	51,118	2,877,400,000	20.12	11,324	254,107,338
Neptune	49,528	4,497,800,000	19.49	17,700	254,107,338
Moon	3,476	384,400	1.37	1.51	254,107,338

[z] Source of data: Kaufmann, W.J. and Freedman, R.A. 2002. Universe. 6th Edn.
[y] The Moon's distance is from Earth.

7	8	9	10	11	12	13	14
	Perihelion distance (km)[x,w]	**Aphelion distance (km)[x,w]**	**Model perihelion distance (m)**	**Model aphelion distance (m)**	**Actual model distance (m)[v]**	**Error (%)**	
Mercury	46,000,000	69,800,000	181	275	257		Good
Venus	107,500,000	108,900,000	423	429	399	6	Short of perihelion
Earth	147,100,000	152,100,000	579	599	475	18	Short of perihelion
Mars	206,700,000	249,300,000	813	981	784	4	Short of perihelion
Jupiter	740,600,000	816,400,000	2,915	3,213	2,370	19	Short of perihelion
Saturn	1,357,600,000	1,506,500,000	5,343	5,929	5,680		Good
Uranus	2,732,700,000	3,001,400,000	10,754	11,812	8,970	17	Short of perihelion
Neptune	4,471,100,000	4,558,900,000	17,595	17,941	14,290	19	Short of perihelion
Moon	363,000	406,000	1.43	1.60	2.99	87	Long of apogee

[x] NASA data https://nssdc.gsfc.nasa.gov/planetary/factsheet/
[w] For the Moon: perigee and apogee, respectively.
[v] Determined using Google Map, except for the Earth-Moon distance, which was measured at the site.

Saturn's Rings

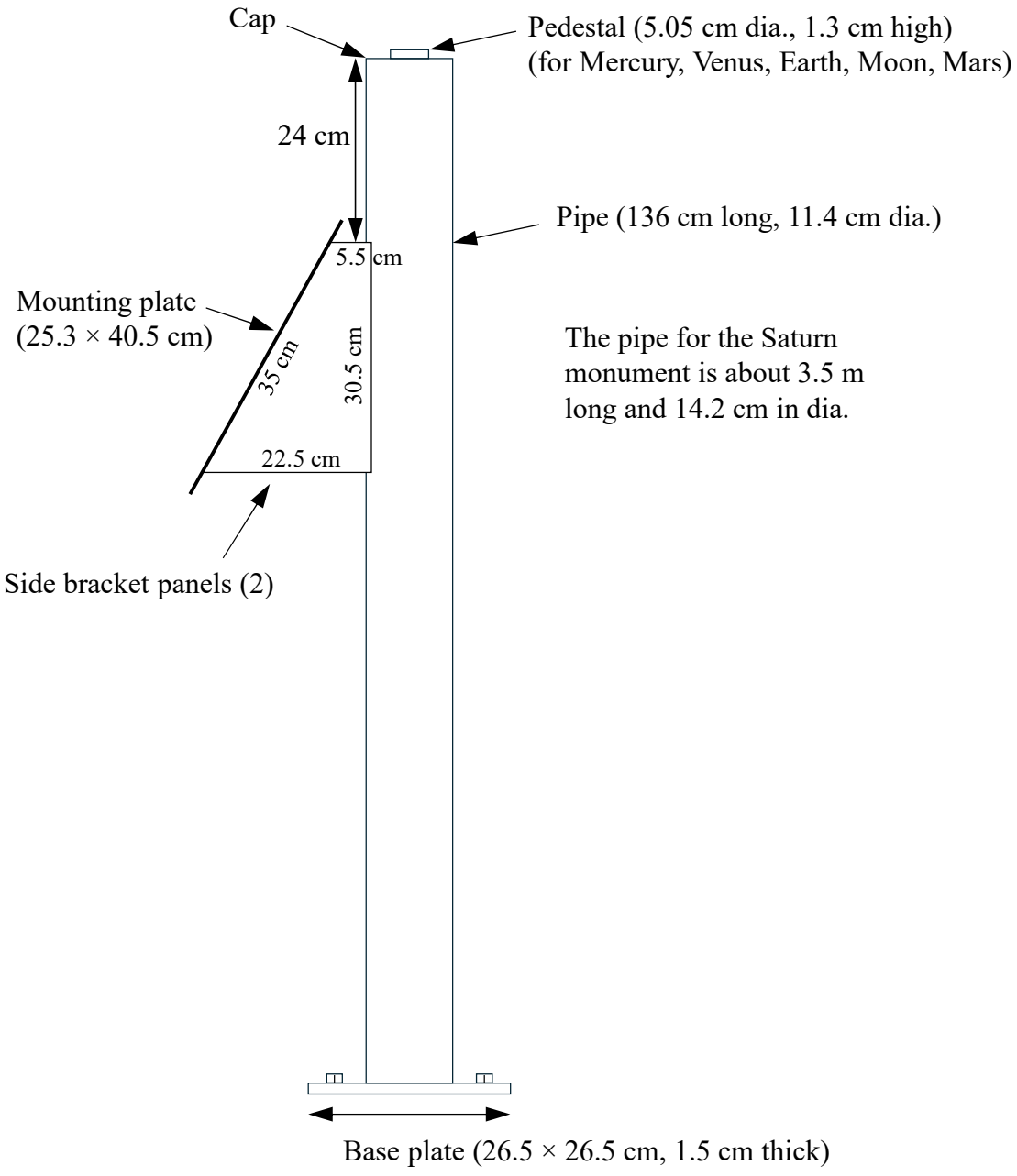
Saturn's radius: 60,268 km
Model scale: 1:254,107,338
Model radius of planet: 23.72 cm

	Width[z] (Saturn radii)	Width (km)	Model width (cm)	Cumulative radius[y] (cm)
gap	0.126	7,594	2.99	26.7
D	0.125	7,534	2.96	29.7
gap	0.003	181	0.07	29.7
C	0.288	17,357	6.83	36.6
B	0.424	25,554	10.06	46.6
Cassini Div.	0.076	4,580	1.80	48.4
A	0.242	14,585	5.74	54.2
gap with F	0.551	33,208	13.07	67.2
G	0.080	4,821	1.90	69.1
gap	0.010	603	0.24	69.4
E	5	301,340	118.59	188.0
Width of rings:		417,356	164.2	
Total radius of plant and rings:		477,624	188.0	
Total diameter of planet and rings:		955,248	375.9	

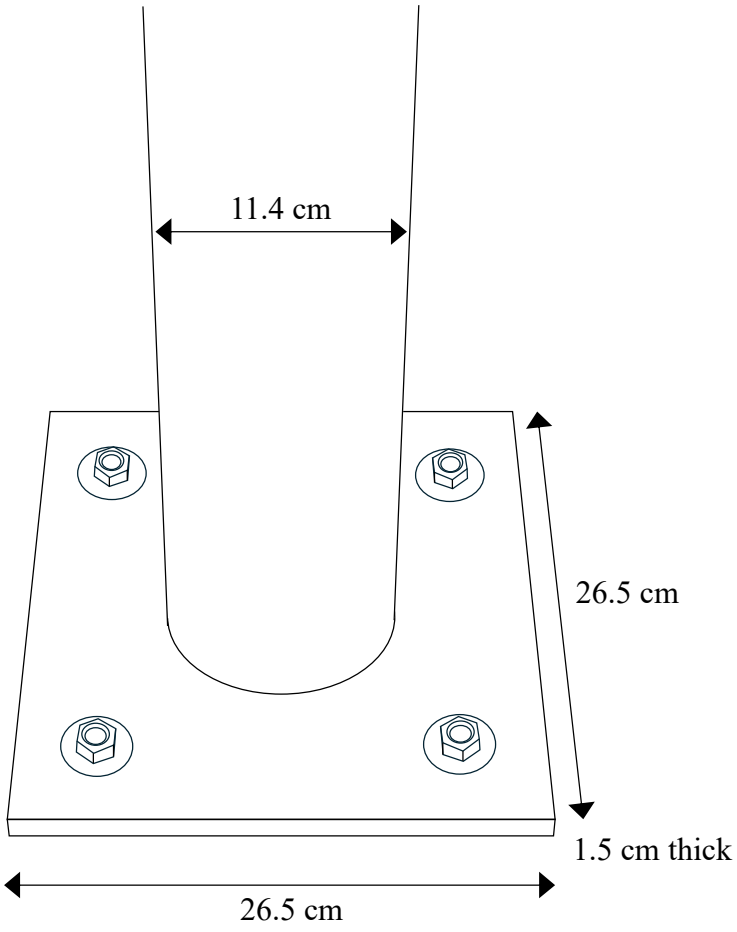
[z] Based on NASA data (https://caps.gsfc.nasa.gov/simpson/kingswood/rings/).
[y] From the centre of the planet (23.7 + 2.99 = 26.7 cm).

Ring thickness (m):	10	100	1000
Model ring thickness (mm):	0.039	0.394	3.935

Monuments configuration (side view) except for Saturn



Base plate for monuments except for Saturn



Base plate for Saturn monument