

# Student Robotics 2019 Rulebook

1<sup>st</sup> Revision

March 2, 2019

The following defines the rules and regulations of the Student Robotics 2019 competition. The latest version of this document can be found at <https://www.studentrobotics.org/docs/rules>.

## 1. Game Rules

1.1 The game, called **Caldera**, will be played in the arena defined in section 3.3. The objective of this game is to capture the most zones – especially tricky, hard-to-reach ones – and keep your opponents from doing the same.

1.2 Before a match begins, participating teams must:

- a) Present their robot in the staging area, adjacent to the arena, at least 2 minutes before the scheduled start time. The staging area will be clearly marked on the day.
- b) Attach a robot flag. Robot flags will be provided by Student Robotics officials in the staging area. Section 3.2 provides more information about these flags, as well as their dimensions and mounting requirements.
- c) Place their robot in the starting area that they are assigned. The robot must be placed such that it is entirely within this starting area, with no parts overhanging its boundary.
- d) Vacate the arena 40 seconds before the scheduled start time. During the 40 second period prior to the start of the match there must be no interaction with the robot.

Teams that fail to comply with this rule—such as by arriving late—may forfeit the match, at the discretion of the judge.

1.3 A match lasts 150 seconds.

1.4 There will be a maximum of 4 robots in a match.

1.5 Robots will be started by teams leaning into the arena to press the start button on their robot<sup>1</sup> when instructed to do so.

1.6 A match may be terminated prematurely if all teams participating in that match state to the match officials that they are happy for the game to end.

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<sup>1</sup>A wireless match-starting solution may be provided by Student Robotics.

- 1.7 There are 25 scoring zones in the arena, arranged in a  $5 \times 5$  grid. The outer 16 are known as the “base”, the inner 8 are known as the “volcano”, and the most central zone is known as the “caldera”. The volcano (and, notably, *not* the caldera) is elevated from the floor by  $75\text{mm} \pm 5\text{mm}$ .
- 1.8 There are 40 tokens in the arena: 10 per team. These tokens are marked for the starting area with which they are associated. These are initially placed in 5 stacks of 2 high, along the wall to the right of the robot’s starting area, as defined in section 3.3.
- 1.9 A scoring zone is deemed “captured” by a team if and only if that team has the single<sup>2</sup> most tokens “in” the zone at the end of the game.
- 1.10 A token is considered to be ‘in’ a zone if either:
- at least three vertices of the token are in contact with the floor area inside the zone. The floor area inside the zone is bounded by the edges of the raised volcano, and the inside edge of the coloured tape marking the zone.
  - the token is in contact only with other tokens which are ‘in’ the zone. In the case where several such tokens are in mutual contact (and not in contact with anything else), all those tokens are ‘in’ the zone.
- 1.11 Captured zones in the base are worth **2 game points** each. Captured zones on the volcano are worth **7 game points** each. The caldera, if captured, is worth **30 game points**.
- 1.12 If, at the end of the game, a robot is “in” a zone<sup>3</sup>, the value of that zone and the four zones immediately adjacent in the cardinal directions are tripled. This effect compounds with multiple robots, meaning that it is possible for the value of a zone to be increased 81-fold in one theoretical case.
- 1.13 At the end of a game, league points will be awarded as follows. The team with the *most* game points will be awarded 8 points towards the competition league. The team with the second most will be awarded 6. The team with the third most will be awarded 4 points, and the team with the fewest game points will be awarded 2 points. Teams whose robot was not entered into the round, or who were disqualified from the round, will be awarded no points.
- Tied robots will be awarded the average of the points that their combined positions would be awarded. Thus, three robots tied for first place would receive 6 points each (since this is  $(8 + 6 + 4)/3$ ).
- 1.14 Once the league has completed, a knockout competition will begin. The positions of the teams in the league will seed the positions of teams in the knockout matches. The top teams from the league advance to the knockout. The number of teams progressing to the knockout will be announced before the start of the league matches. In the event of tied league positions, the team with the greatest cumulative game points in the league will go through.
- Each match in the knockout competition involves up to 4 teams. The teams that come 1<sup>st</sup> and 2<sup>nd</sup> in each knockout match will continue to the next round of the knockout. In
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- <sup>2</sup>Were two teams to have the same number of tokens in a scoring zone, the zone would not be considered captured by any team.
- <sup>3</sup>A robot is “in” a zone if and only if the projection of the centroid of its flag mounting cylinder (see 3.2) onto the floor of the arena is within the zone.

the event of a tie in a knockout match, the team that ranked highest in the league will go through. If there is a tie in the final, then a rematch will be played. The number of league and knockout matches will be announced on the morning of the competition.

## 2. Regulations

2.1 All robots must be safe.

- a) It must not be possible to directly or indirectly injure oneself on the robot. Exposed sharp edges and fast moving parts, for example, will be tested using a Frankfurter sausage to simulate a finger. Teams are encouraged to discuss any safety concerns about their robot on the Student Robotics forums.
- b) The robot's power switch must be on the outside top of the robot and easily accessible at all times – including throughout the game. This is for everyone's safety, especially your robot's.
- c) The lithium-ion polymer batteries provided in the kit must be shielded from mechanical and thermal harm. This includes mechanical protection from accidental impact with other robots. Teams found to be in violation of this rule will have their batteries confiscated until they have demonstrably rectified the identified issues.
- d) Only the power board may be connected directly to the battery.

2.2 The Judge's decision is final.

2.3 Any assistance from Student Robotics volunteers is provided without guarantees.

2.4 Student Robotics reserves the right to examine your robot software and hardware at any time.

2.5 No remote control systems may be used.

2.6 This is a non-contact sport, but accidental bumps and scrapes are inevitable.

2.7 Robots must not intentionally damage anything – including tokens, zone barriers, the arena or other robots. At the discretion of the judge, teams who deliberately engage in collisions or take insufficient precautions against collisions may be penalised, including disqualification from rounds and deduction of league points.

2.8 All kit deployed by Student Robotics remains the property of Student Robotics. All electronic kit **must** be returned to Student Robotics after the competition. [Appendix A](#) details the parts of the kit that must be returned. After the competition, the kit that is not specified in [Appendix A](#) becomes the property of the team.

2.9 Robots must pass an inspection by a Student Robotics Inspector before competing in a match. This inspector will check that the robot complies with the rules and regulations of this game, and is safe to compete (see [Appendix B](#)). **Robots that have not passed inspection will not be permitted to compete.**

2.10 At the beginning of each match, robots must fit within a cube with 500mm internal sides. *During the match*, the robot may extend beyond this size.

2.11 During a match robots may deploy supporting equipment into the arena, as long as that equipment is clearly designed to be of direct benefit to the robot. Such equipment must not deliberately impede other robots and reasonable care must be taken to ensure that it does not become merely an obstacle to other robots.

- 2.12 All wires connected to the robot's ground (0V line) must be black. Black wires *must not* be used for anything else. It is *strongly recommended* that all wiring is neat and easily removable, as this will reduce the time required to debug problems on robots (teams may be asked to tidy their wiring before a Student Robotics volunteer will approach any issues with their robot).
- 2.13 All electronics must be securely fixed to the robot, and should also be easily removable.
- 2.14 All robots must have mountings for the removable robot flags provided by Student Robotics, as described in section 3.2. A mounting must firmly hold a flag in an upright position. Flags must be mounted on the top of the robot.
- 2.15 If teams wish to use batteries other than the lithium-ion polymer batteries provided, then they must seek approval from Student Robotics through the Student Robotics forums first. Additionally, if teams wish to add systems powered by separate batteries then they must seek approval through the same channel first.
- In general, teams are encouraged to power everything off the Student Robotics supplied battery through the power board.
- 2.16 Robots may not include radio transmitters or receivers. In exceptional circumstances, teams may request an exemption from this rule.
- 2.17 Robots must not have any devices designed for the sole purpose of producing audible noise, with the exception of the piezoelectric buzzer on the power board.

## 3. Specifications

### 3.1. Markers

The arena, tokens and robots involved in the game are labelled with *libkoki* markers. Each marker pattern encodes a number. Each marker number is associated with a particular feature within the arena, and also has an associated size. The marker numbers and sizes are as follows:

Item	Marker Numbers	Marker Size (mm)
Arena boundary	0 – 27	250
Tokens	28 – 31	115

Two sets of marker codes will be used: one for development purposes, and one for the competition itself. The competition set is only to be used inside the Student Robotics arena at the Student Robotics competition. This is so that people carrying markers past the arena do not confuse robots. The competition codes are 100 above the development codes. When run in competition mode, the software provided by Student Robotics will subtract 100 from the detected marker codes, as well as ignore the development codes.

The markers can be printed on a black-and-white printer. Marker designs can be downloaded from the documentation section of the Student Robotics website.

Unless specified otherwise, all markers described in this document are oriented vertically such that the principle corner of the marker (which is indicated by a dark grey dot in the black marker border) is on the higher edge.

### 3.2. Robot Flag

3.2.1 A “robot flag” is a removable identifier that will be attached to a robot throughout a match. It features identifying areas to allow spectators to easily associate a robot with its starting area. An example of one of these flags is shown in figure 1. The markings in the identifying areas are intentionally not specified.

3.2.2 Robot flags will be mounted on cylinders with a diameter of  $15\text{mm} \pm 1\text{mm}$ , and a length of  $200\text{mm} \pm 10\text{mm}$ .

3.2.3 The identifying area will be attached to the top  $100\text{mm} \pm 10\text{mm}$  of the mounting cylinder, with a width of  $150\text{mm} \pm 10\text{mm}$ , as described in figure 1.

3.2.4 The mounting cylinder must be permanently affixed to the main chassis of a robot, and vertical when the robot is in its typical stopped position.

3.2.5 The identifying part of the robot flag must be visible when attached to the mount.

3.2.6 Flags are not counted when considering the starting size of the robot.

### 3.3. Arena

3.3.1 The match arena floor, overall, is an  $8\text{m} \times 8\text{m}$  square, as shown in figure 2. The tolerance of these two dimensions is  $\pm 0.2\text{m}$ .

3.3.2 The floor of the arena is covered with a closed-loop, short pile carpet.

- 3.3.3 The perimeter of the arena floor is delimited by the arena wall, which has a minimum height of  $100mm$ .
- 3.3.4 Each wall of the arena features seven  $250mm$  libkoki markers. Figure 3 shows the positioning of these markers, whilst figure 4 shows the numbering of these markers.
- 3.3.5 Each robot will be assigned a corner at the start of every match to indicate its starting area. Corner starting areas are  $1000 \pm 20mm$  square and will be marked by tape. The mapping of these corner numbers in the arena is shown in figure 4.
- 3.3.6 Student Robotics reserves the right to have match officials in the arena during games.

### 3.4. Scoring Zones

- 3.4.1 There are 25 zones in the arena, in a 5 by 5 grid centred within the arena and aligned with its axes. Each zone is  $1175mm \pm 50mm$  by  $1175mm \pm 50mm$ . The arrangement and dimensions of these zones can be seen in figure 2.
- 3.4.2 Where the boundary of a scoring zone is not formed by the edge of the volcano it will be marked by  $48mm$  coloured tape. The tape will be placed along the outside of the edge of the zone, excluding it from the zone for scoring purposes.

### 3.5. Tokens

- 3.5.1 Tokens are cubic cardboard boxes with a side length of  $130 \pm 10mm$ .
- 3.5.2 There will be 40 tokens in the arena: 10 associated with each starting area. These will be arranged as shown in figure 2 at the start of a match.
- 3.5.3 The mapping between a token's starting corner and the libkoki marker on that token is as follows:

Corner	Marker Number
0	28
1	29
2	30
3	31

## 4. Awards

### 4.1. Main Competition Awards

Prizes will be awarded to the teams that are placed highest at the end of the competition. The teams in 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> place will receive awards.

### 4.2. Rookie Award

The Rookie Award will be awarded to the rookie team<sup>4</sup> that places highest in the league.

### 4.3. Committee Award

The Committee Award will be given to the team that displays the most extraordinary ingenuity in the design of their robot. It will not be awarded for complexity of design, rather the implementation of a simple and elegant solution to a problem.

### 4.4. Robot and Team Image

The team that presents their robot and themselves in what is judged to be the most outstanding way will receive this award.

### 4.5. First Robot Movement

The first rookie team<sup>4</sup> that demonstrates a moving robot to the community will be awarded with an edible prize at the final competition.

4.5.1 The robot movement must be controlled by software running on the Student Robotics kit.

4.5.2 The robot must move 2 metres, pause for 2 seconds, turn 180° ( $\pm 20^\circ$ ), return to its starting area ( $\pm 0.5m$ ), and come to a halt without interference.

4.5.3 This must be demonstrated by a video on the web (e.g. on YouTube, flickr, etc.) and linking to this video from a post on the Student Robotics forum.

### 4.6. Online Presence

The team that is judged to have the best online presence will be awarded with an edible prize at the final competition.

4.6.1 The hashtag for this competition is #srob019.

4.6.2 Teams are encouraged to post their activity and online presence in the Student Robotics forums.

4.6.3 When detailing activities online do not post any private information concerning yourself or others.

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<sup>4</sup>A rookie team is one from a school, college or independent group that hasn't competed in a Student Robotics competition before, nor certain similar competitions: Robocon 2018 and SourceBots 2018.



## 5. Amendments

From time to time Student Robotics may amend the rulebook. When this happens, this document will be updated.

- **2019-03-02:** Clarify the wording of the grid of scoring zones; clarify rules for whether a robot is considered to be in a zone; correct hashtag; clarify regulation of supporting equipment.

# Appendices

## A. Return of Kit

Each team is responsible for ensuring that they return these items from their kit.

### A.1. Items to be Returned

Item	Quantity
18l Really Useful Box	1
Power Board	1
Brain Board (Odroid U3)	1
Motor Board	2
Servo Board	1
Ruggeduino	1
Screw Shield	2
USB Hub	2
USB Memory Stick	1
USB WiFi Adapter	2
Webcam (C500 or C270)	1
USB A to USB B lead	3
USB A to USB Micro-B lead	5
Lithium Polymer Battery	2
Battery Charger (IMAX B6 or HobbyKing E4)	1
Charger Power Supply and Mains Cable	1
Battery charging bag	1
7.5mm Green Camcon plugs	10
5mm Green Camcon plugs	7
3.81mm Green Camcon plug	1
ODROID Power Cable	1
Screwdriver	1

### A.2. When and How to Return Kit

The kit should be returned at the competition. If you wish to keep the kit beyond the competition, then this **must** be arranged with us, before the 22<sup>nd</sup> of March 2019, via email to [info@studentrobotics.org](mailto:info@studentrobotics.org).

## B. Safety regulations

To maintain safety at the competition, all robots at the event are required to pass the safety regulations that are listed below. Robots that do not comply to these rules will not be permitted to compete.

These regulations are intended to identify a base level of safety — the inspector will use their own judgement and common sense when assessing your robot, and your robot may be judged to be unsafe for reasons or features not listed here.

We recommend that you bear these regulations in mind during development too, although it's not always possible to meet them while building and testing your robot.

## **B.1. Regulations**

The following procedure will be used when testing a robot:

- Check that there is a battery installed in the robot.
- Check that any additional power sources have already been authorised.
- Check that the battery cable originally provided by Student Robotics is being used to connect the power board to the battery. If not, check that the replacement has suitable rating and quality.
- Leaving the battery physically installed, unplug the deans connector.
- Check the battery's mounting holds the battery securely, and does not expose the battery to sharp edges.
- Check that the battery's casing is rigid, and strong – i.e. bubble wrap is not suitable.
- Locate the large green power connector that connects the battery to the power board. In turn, give each of the wires that enter it a gentle tug. The cables must not move.
- Check that there is not an excessive amount of unshielded wire protruding from the large green power connector.
- Check that the cable between the large green power connector and the deans connector is not damaged. The sheath must not have any holes in etc.
- Check that the cables between the power board and body of the battery do not pass through areas of the robot that could cause them to be damaged by moving mechanical parts.
- Check that only the power board is connected to the battery (if the deans connector were currently connected).
- Check that the power switch on the power board is easily accessible.
- Check that all electronics are securely fixed to the robot.
- Check for unreasonably sharp edges and dangerous moving parts.

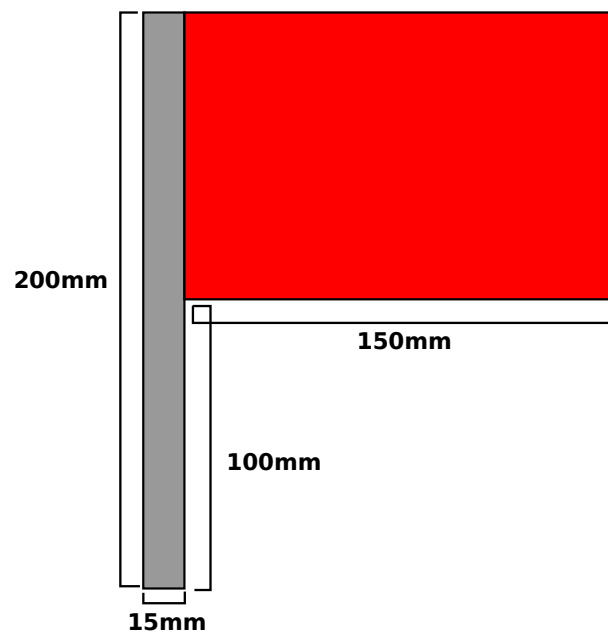


Figure 1: An example robot flag.

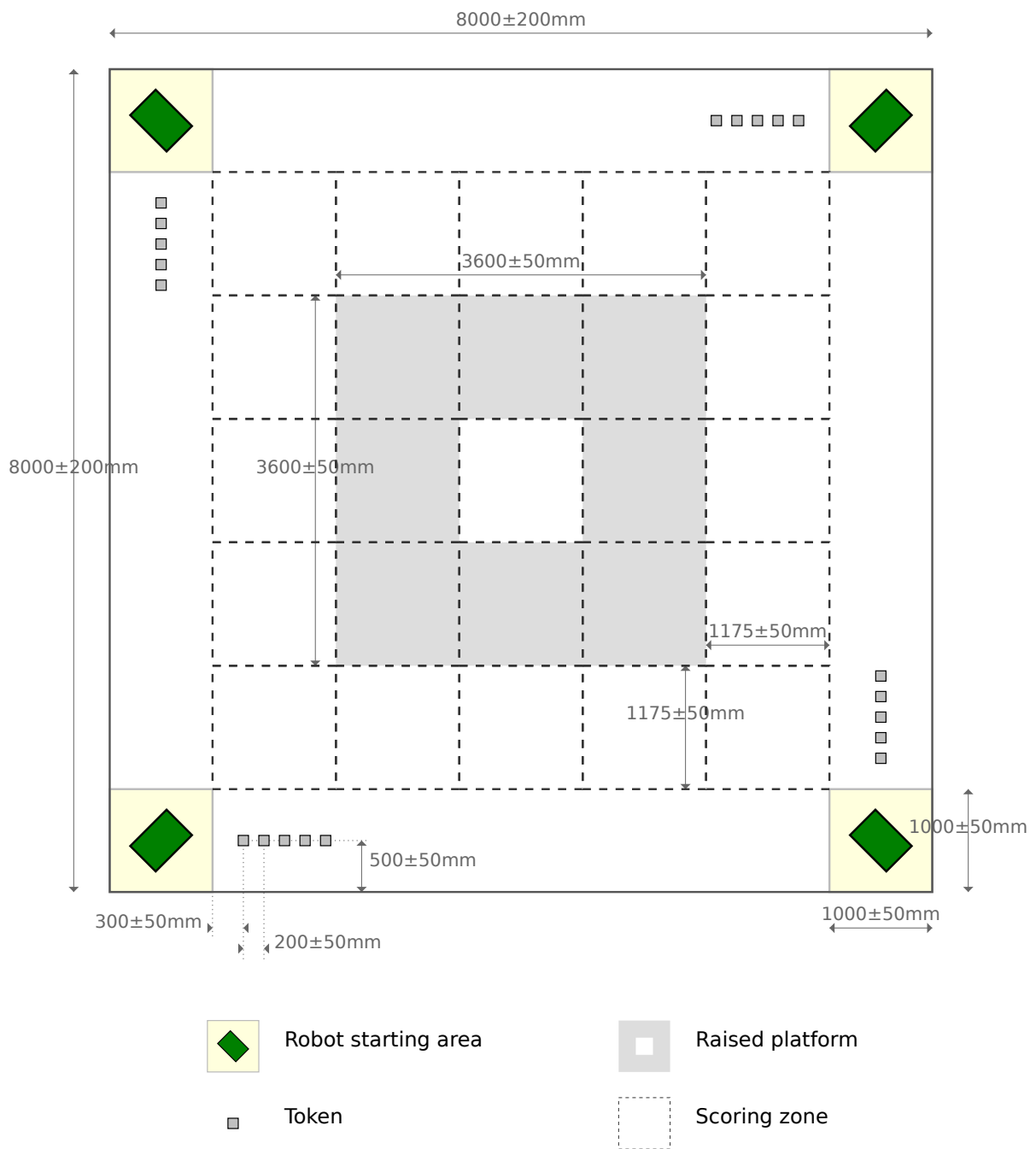


Figure 2: A bird's-eye view of the arena. All dimensions are in millimetres.

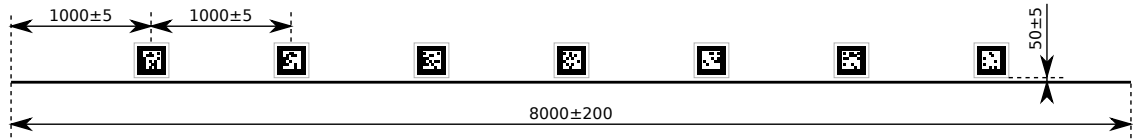


Figure 3: Seven  $250\text{mm}$  wide markers are spaced evenly along each  $8\text{m}$  arena wall. The markers are placed  $50\text{mm}$  above the floor. All dimensions are in millimetres.

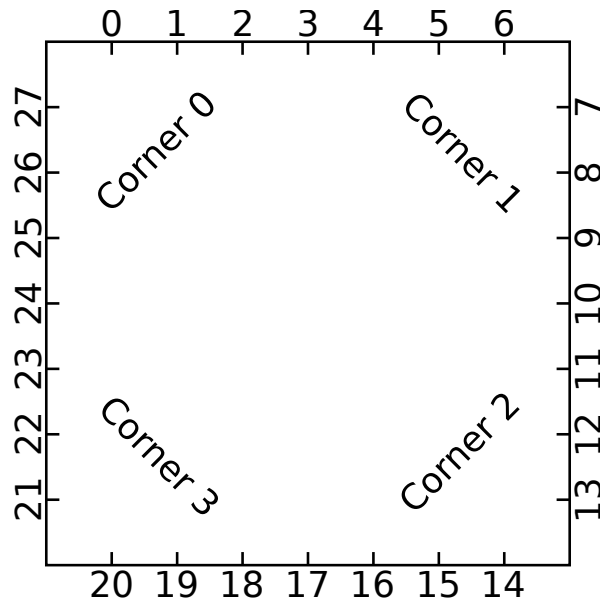


Figure 4: Twenty eight arena wall markers are positioned around the perimeter of the arena with the marker codes incrementing in a clockwise fashion. The corners are counted in a clockwise fashion, with corner 0 being the corner closest to arena marker 0.