

SeaTag-TT Manual

V1.1

Desert Star Systems



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Introduction

The SeaTag-TT is a versatile and capable tag for diving animals with a low-drag, lightweight and cost compatible design for Sea-Turtles, Penguins and other Sea-birds. Extremely easy to use, with long transmission times and a cheap price, the SeaTag-TT is built around the systematic tagging model for penguins and is priced to be affordable in high quantities with extremely long endurance.

Worth mentioning are the questions which may be answered by using the SeaTag-TT. With location and temperature data, information about migratory tracks, colony cohesion, time spent at mating sites versus feeding sites and more may be provided through the SeaTag-TT among other questions answered by the low-cost and robust time series data.

Benefits of the SeaTag-TT

Built to be Simple

When using the SeaTag-TT, you may notice the lack of buttons, switches etc... This is by design, as the use of SeaTag-TT's are extraordinarily simple. Upon receiving your SeaTag-TT simply place it in the sun for several hours and let the supercapacitor charge. Once the

supercapacitor reaches the needed energy requirement, it will send a transmission to the ARGOS satellite constellation. One way to verify this is to check your ARGOS account for the corresponding transmission. We recommend you keep the SeaTag-TT in this testing phase/location for at least 24 hours before deploying. Please also be aware that transmission times may vary based on the model you have purchased and the light conditions. For instance, a four panel SeaTag-TT in direct afternoon sunlight will transmit more often than a two panel SeaTag-TT in a cloudy environment. In optimal settings the larger four panel (25g) model will transmit approximately every 60 seconds, while the smaller two solar panel model (18 and 17g) will transmit approximately every 90 seconds under ideal conditions. We also recommend the SeaTag-TT be kept in more “field study” like conditions. These includes areas which have little to no direct overhead infrastructure in the way of possible transmissions between the tag and passing satellites. This also includes, major interference infrastructure such as, but not limited to wires, antenna, radio towers and other obstructions. Please note, this is not a problem (usually) during deployment since field conditions in the ocean do not pose these obstructions.

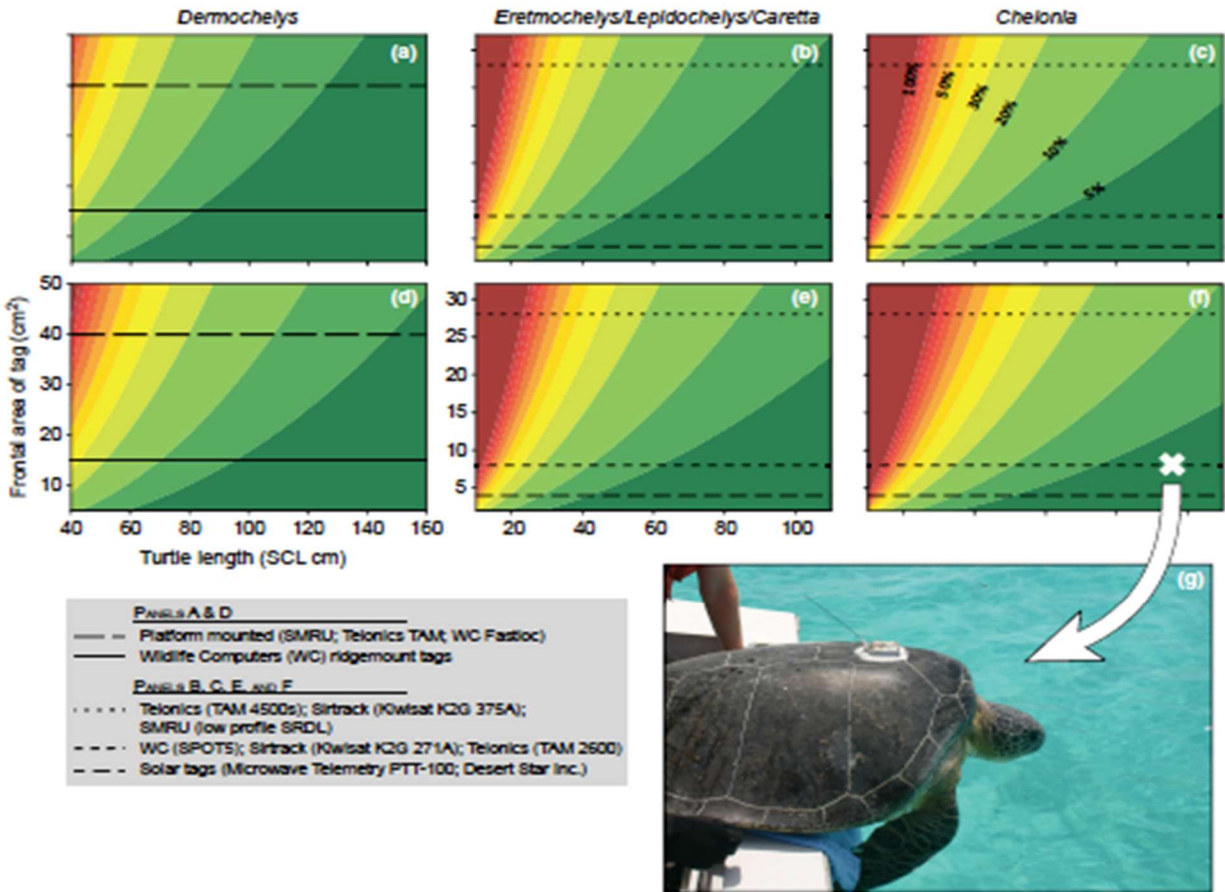
Long-term Transmission Times

Due to the solar panel design of the SeaTag-TT, reporting times may last for several months and possibly beyond. Therefore, the transmission time is not dependent on batteries, but rather environmental conditions, survivability, and drag on the tag. In some cases, especially with Chin Strap Penguins, the tagged animal may be more inclined to try and remove the tag, even if it poses no behavior hindrance. Additionally, tagged animals which dive in caves or ocean environments with a lot of coral reefs, or other biological matter may be more prone to forcing the SeaTag-TT off by means of rubbing, striking, scraping etc. However, with diving species such as Penguins and Sea-Turtles, the SeaTag-TT has often seen several months or more of transmissions.

Low-drag design

It's important to limit the impact our research tools have on animals to the greatest extent possible for the sake of the animal and for the sake of removing bias from research. Therefore, the SeaTag-TT incorporates a low-drag, rounded and tiny design in order to ensure drag is the least of your researches concerns.

Jones, Todd T. et al. (2013)



Note here in a study done on the drag and behavioral effects of certain tag types on Sea-Turtles, the SeaTag-TT provided the lowest drag of any tag type.

Cross-species compatible and flexible between research types

The SeaTag-TT is not limited by species. Given the tiny, low-drag design, the SeaTag-TT is cross-species-compatible from Penguins, to Sea-Turtles and other Sea-Birds. The SeaTag-TT

also includes temperature and location data and is therefore perfect for diving animals and migratory location tracks.

We have now covered the circumstances and reasons for which one would use the SeaTag-TT. The next several section will cover how to set-up and deploy the SeaTag-TT.

Setting up an ARGOS Account

ARGOS (by CLS) is the satellite constellation which the SeaTag-TT will transmit to. Before ordering any SeaTag-TT's you must first have an ARGOS account and unique ID's for each SeaTag-TT you wish to purchase. If you have already purchased your SeaTag-TT(s), make sure you know how to login into and view Track & Lock data through CLS's web portal.

Setting up the SeaTag-TT

This step is simple, remove the SeaTag-TT(s) from the box, set them in a safe and sunny location for 24 hours in order to ensure the tag(s) charge. After the 24-hour period check ARGOS to ensure each tag has transmitted. Please note transmission times vary on number of solar panels in each tag and present sunlight conditions.

Proper Tagging Procedure

In this section you will learn about procedures for tagging Penguins and Sea-Turtles with the SeaTag-TT. Before tagging any animal make sure you have tested your SeaTag-TT. Next, properly wash and prepare the SeaTag-TT for deployment by doing the following:

1. Gently scrub your SeaTag-TT(s) in lukewarm soapy water, we recommend a dish soap such as Dawn to remove any grease and oils.

2. Dry each tag by hand towel and then let to air dry until completely dry
3. Place inside some form of moisture resistant bag such as a zip-lock bag or plastic container.

These steps are more so necessary to ensure a limited chance of transmitting bacteria and virus's to the animals in which you may be tagging. It is also recommended you wear non-latex gloves while handling any animal.

Penguins

Tissue Attachment method by Klemens Putz, Antarctic Research Trust



1. A paper template defines the intended location of the tag.



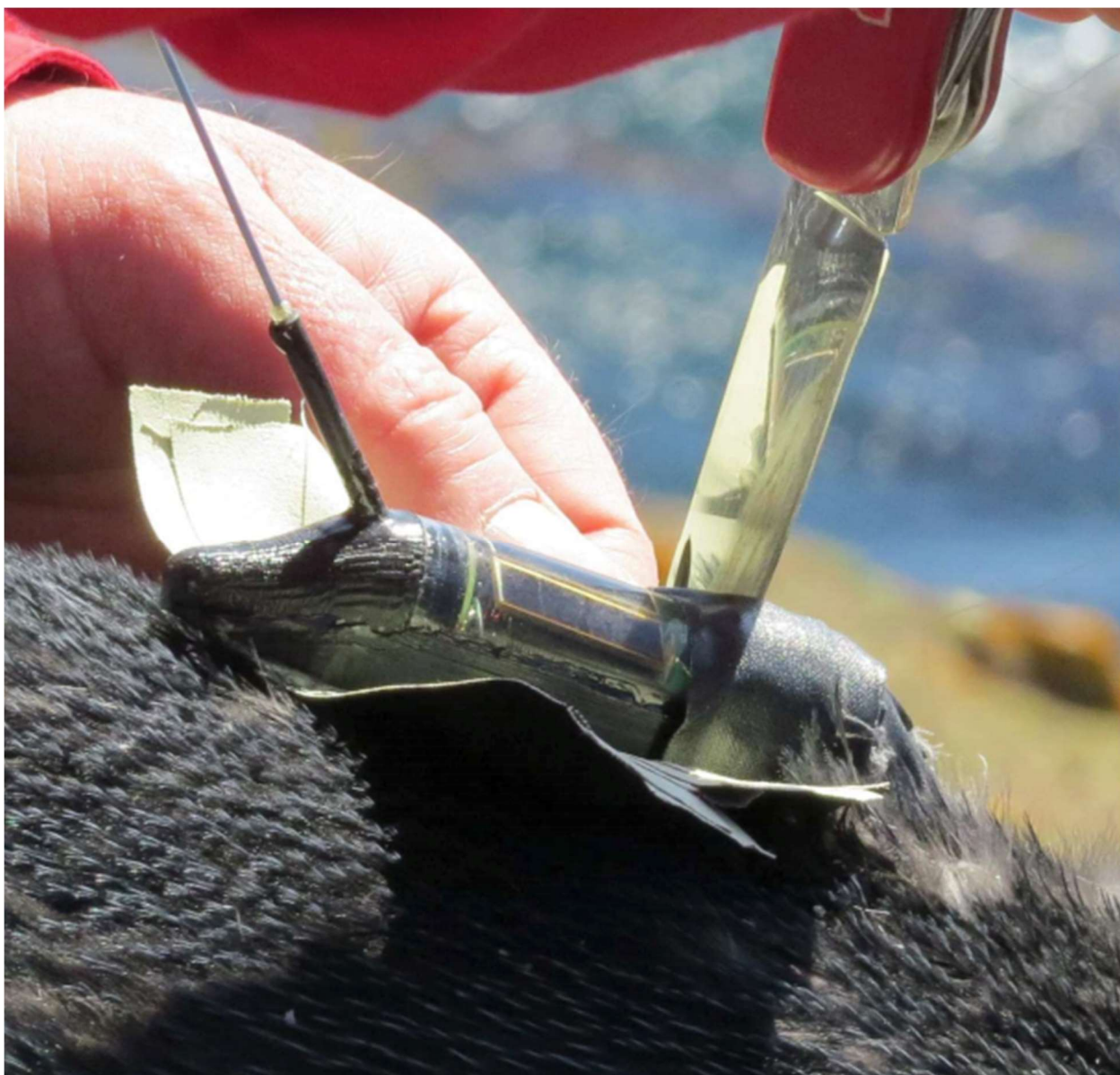
2. Overlapping strips of fabric with re-enforced adhesive tape are slide under layers of feathers. Fast curing epoxy is applied to the feathers, forming a base for the tag.



3. Epoxy is applied to the underside of the tag & the tag is applied to the feather and tape base.



4. Tape is wrapped tightly over the end-caps of the tag. Start with the end of the tag away from the antenna and work towards the antenna.



5. Cut excess tape to prevent covering the solar panels. All solar panels must stay unobscured for best tag performance.



6. Tape is now cut into narrow strips and wrapped around the tag on both sides of the antenna.



7. Epoxy is applied to the tape to seal it. A flat rock is used as a convenient base to mix the fast curing epoxy.



8. The penguin is released after the tag is secured. Notice the position of the tag in the middle of back, antenna facing down. Ideally, the tag will be placed such that the antenna does not touch the ground. Penguins may also occasionally pick at the tag. Thus the tag needs to be well secured to maximize retention on the animal.

Sea-Turtles

Direct Adhesive Method – Kate L. Mansfield, Ph.D., Florida Atlantic University

Attaching Satellite Tags—Hard-Shell Turtles:

Turtles restrained
in box, barnacles
removed



Cleaning/sanding carapace (2nd
vertebral scute)



Apply tag: marine
epoxy base layer

Mark placement of
tag on carapace



- Sand bottom and sides of tag
- Place tape over saltwater switches

Photos by UM/RSMAS, VMSM, K. Mansfield

Attaching Satellite Tags—Hard Shell Turtles:



Buffering tag: Sonic Weld



Let base epoxy set



Let Sonic Weld set; keep turtle cool/wet



Remove tape over switches, release turtle...

Photos by UM/RSMAS, K. Mansfield

Getting Location Tracks from Argos

Once your target species has been tagged, information should begin appearing in your Argos account in the form of location markers/tracks. There are two methods of retrieving that data. However, before retrieving that data, it may be advantageous to only use/select “good” satellite passes. The term “good” is defined by the angle the satellite passes the tag at, which in most cases will yield certain thresholds of passing time which affects accuracy, transmission count and more.

We’ll walk you through getting the location information from Argos, then determining which information is “good” and “bad”. This is especially important for publishing data in a journal later on.

First, log into your Argos account. Navigate to “Satellite Pass Predictions”. The first method allows to selection of specific data in terms of time, location and satellite selection (please see below).

ARGOS Data System Support and help SEATAGTEST - Local

Satellite pass prediction

Simulation period

Start date: 2018-11-15

☐ End date
 ☒ Simulation duration (in hour(s))
 ☐ Number of pass(es)

24

Select the date you wish to see the satellite passes. The "simulation duration" set to 24 hours gives you the full day of passes. Also can set an "end date" a get a view of passes for a full week or longer.

Satellites choice

☒ Select all

☒ MA (METOP-A)
 ☒ MB (METOP-B)
 ☒ NK (NOAA-15)

☒ NN (NOAA-18)
 ☒ NP (NOAA-19)
 ☒ SR (SARAL)

Download satellite AOP

Location

☒ Latitude / Longitude / Altitude
 ☐ Argos Id

There are 2 options here that can be used. If your Latitude/Longitude is known, or where your tags will be on the animals, input the coordinates for the location.

Latitude: 36.718 Longitude: 238.339 Altitude: 0

Minimum elevation site: 5

When settings are inputted, click simulate in the lower corner to see results

Simulate

However, in some cases you may wish to see all data transmitted by a tag according to its Argos ID. In order to do so, reference the Argos ID that CLS provided upon making your account. If you have trouble obtaining this ID, please contact Desert Star Systems for assistance.

The screenshot shows the ARGOS CLS web interface. At the top, there is a navigation bar with the ARGOS CLS logo, a home icon, and links for Data, System, and Support and help. The user is logged in as SEATAGTEST - Local. Below the navigation bar, there are checkboxes for various satellite systems: MA (METOP-A), MB (METOP-B), NK (NOAA-15), NN (NOAA-18), NP (NOAA-19), and SR (SARAL). A green button labeled "Download satellite AOP" is on the right. The "Location" section has two radio buttons: "Latitude / Longitude / Altitude" and "Argos Id". The "Argos Id" option is selected and highlighted with a red box. Below this, there is a dropdown menu showing a list of Argos IDs: 67617, 67616, 67615, 67614, 67613, 67612, 67611, 67610, and 67609. A tooltip is visible next to the "Argos Id" radio button, stating: "The other option for getting location is selecting the 'Argos ID' this will autofill the coordinates so long as the tag has transmitted and has successfully reached the satellite. Select an ID from the dropdown list and click simulate in the lower right hand corner to see results."

Good versus Bad Passes

Now that you have a collection of your location data, it's time to determine which data is worth using. Here we only use three categories, "good" "fair", and "bad".

- **Good** passes are defined as any pass at or above a 45° angle and should be included in research datasets.
- **Fair** passes are those which reside within 25° to 44°. These passes in most cases, are okay to use in your paper(s).
- **Bad** passes are any which reside at 25° or less and should most likely not be included in research datasets.

In order to determine good, fair, and bad passes navigate to your results table. Next, view the "Middle Elevation" column, and compare the angle with the three categories discussed above.

ARGOS CLS Home Data System Support and help SEATAGTEST - Local Settings Power

Result table Table of synthesis Time blocks display

Pass predictions list

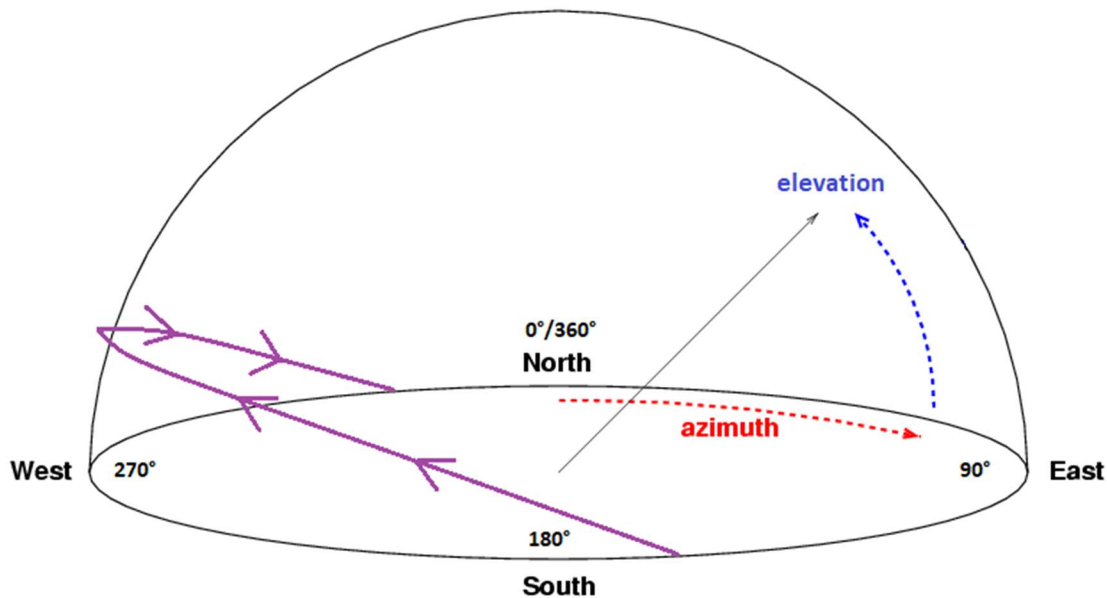
Export

What determines the quality of the pass is generally the "Middle Elevation". A 45° and higher middle elevation pass has a significantly better chance of catching a transmission of a tag. A 25°-44° pass has a fair chance of receiving a transmission. Below 25° is considered poor due to being low on the horizon and the duration of the pass is usually very short. Horizon, "Azimuth" in this case, should be taken into consideration as well. If there are high mountains or buildings in line with the satellite pass, this will affect transmissions reaching the satellite.

Start date/time	Middle date/time	End date/time	Duration	Middle elevation	Start azimuth	Middle azimuth	End azimuth
2018-11-15 07:30:47	2018-11-15 07:36:56	2018-11-15 07:43:05	00:12:18	60.64	7.19	287.03	206.13
2018-11-15 07:50:59	2018-11-15 07:56:56	2018-11-15 08:02:53	00:11:53	29.78	30.96	97.46	163.38
2018-11-15 08:01:20	2018-11-15 08:04:01	2018-11-15 08:06:42	00:05:22	7.5	63.3	89.06	114.48
2018-11-15 09:02:30	2018-11-15 09:08:13	2018-11-15 09:13:55	00:11:25	27.71	31.66	96.6	160.95
2018-11-15 09:14:06	2018-11-15 09:15:40	2018-11-15 09:17:14	00:03:07	5.87	317.69	302.65	287.9
2018-11-15 09:31:36	2018-11-15 09:37:30	2018-11-15 09:43:24	00:11:47	31.48	357.7	291.88	226.28
2018-11-15 09:38:24	2018-11-15 09:44:44	2018-11-15 09:51:04	00:12:40	83.62	14.03	105.56	192.47
2018-11-15 10:42:27	2018-11-15 10:48:13	2018-11-15 10:53:59	00:11:31	31.97	357.53	291.12	224.88
2018-11-15 11:20:15	2018-11-15 11:24:04	2018-11-15 11:27:52	00:07:37	11.26	336.77	298.84	261.32
2018-11-15 15:10:31	2018-11-15 15:16:31	2018-11-15 15:22:32	00:12:00	32.87	135.34	68.34	1.29

Page 1 of 1 Clear filters These are the results. There are a couple good passes, a few moderate passes and a few poor passes for this location. Good examples will be marked green. Moderate will be marked in blue and poor passes will be marked in red. Displaying 1 - 28 of 28 Back

For a visual representation of this passing phenomena please see below



Here is an example of azimuth/elevation. This can give you an idea of the direction the satellite is traveling and its elevation.

The **Purple** line is a satellite traveling from ~175° heading west, middle elevation of ~32° reached at ~280°, then traveling northeast to go below horizon at ~350°

Final Thoughts

The SeaTag-TT is an extremely easy and straight forward tag meant for application on diving animals and sea-birds alike. With no settings to configure, no external toggles or switches, upon receiving your SeaTag-TT(s), simply let the device(s) sit in the sun for several hours and verify transmissions are received through ARGOS. The SeaTag-TT is perfect for migratory studies and long transmission times. If you have further questions please contact us at salesinfo@desertstar.com .

The Wisdom or Folly of a Solar Powered Argos Tag for Penguins

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Klemens Pütz, Antarctic Research Trust (ART)
Claudia Godoy Reyes, Parque Pinguino Rey (PPR)

Desert Star
Systems LLC

INTRODUCTION

Satellite reporting tags for penguin are generally powered by batteries for an obvious reason. Sunlight is minimal in the (sub) Antarctic regions during winter. Even in summer, the sun is low above the horizon. Yet, battery power imposes a hard choice. A long endurance tag will by necessity be big, while a tag with minimal batteries will also have limited endurance. Solar power provides a potential solution. As power reserves may be replenished, small tags with unlimited endurance and full re-usability might be possible. But, given the limited sunlight, is such a tag practical?

Tag Design Objectives:

- A small tag, suitable for juveniles and small penguin species
- Hydrodynamic and a tough design with 800m diving depth rating
- Solar powered (for small size), yet capable of year round operation
- A reference design, sparking new ideas from researchers and leading to further innovations



TAG DESIGN & VALIDATION STRATEGY

Our tag development and validation strategy has three fundamental elements:

- **Science & Technology Collaboration:** A joint project between research organization ART and tag manufacturer DSS. ART expertise in penguin tagging informs the tag design. DSS's modular tagging technology data base and manufacturing expertise enables rapid 'plug and play' style tag implementation and inherent reliability of the tag design. The tag is named SeaTag-pt.
- **Spiral development:** Recognizing that an 'ideal tag' is an unlikely outcome of any single-push effort, the project uses spiral development with progressive year-over-year improvements.
- **Reference Tags:** A static reference tag was deployed at PPR for year 1 and Isla de los Estados for year 2. The references provide a baseline performance independent of the animal to distinguish tag from animal factors. A second group of animals was tagged with SeaTag-pt performance relative to a conventional, battery powered tag design.

YEAR 1 (2015): TAG DESIGN & INITIAL TAGGING RESULTS

Design

The original SeaTag-pt weighed 25g, with a 800m diving depth rating. A cylindrical design to minimize drag (cross sectional area), the tag main body is 5.9 cm L x 1.9 cm D. 3D printed polycarbonate end-caps for adhesive tape attachment, add 2.1 cm on both ends, resulting in a total length of 10.1 cm. The tag is powered by two high-efficiency (22%) solar panels providing 7.6 mA at 8.4V in full sunlight. The photovoltaic charge is stored in an ultra capacitor. An Argos transmission is emitted once the capacitor is charged, and the process repeats.



SeaTag-pt 'penguin tag' is glued onto a base layer of feathers using adhesive fabric tape weaved through the feathers and sealed with epoxy



Tag 146577 shed after 265 days of reporting during molting season (pictured here after cleaning). The tag remains functional and will be re-deployed.

• Tags Approximately to Scale on Puffer



The first king penguin tagged with SeaTag-pt seconds after release at Parque Pinguino Rey, Tierra del Fuego, Chile, March 2015

Year 1 Results

- **Tag Retention and Survival:** Five tags were deployed on king penguin at PPR, Tierra del Fuego in March 2015. Two tags reported until molting season in December, with one animal staying local and the other migrating through the Pacific and Atlantic, reaching South Georgia island (see track). Three tags were removed after tag antenna broke at the base (see reporting distribution). No tag shed early, other than being removed.
- **Position Reporting:** Position reports were available on most days, near the winter solstice. The reference tag 67609 at PPR exhibited a maximum gap of 8 days, penguin tag 146577 residing at PPR 74 days, and penguin tag 146579 migrating in the southern ocean 88 days. From March 16 to December 26 2015, 3284 Argos position fixes were obtained from the static reference tag, 1741 position fixes from the PPR resident penguin tag and 816 position fixes from the migrating penguin tag. Argos position fixes are divided into quality classes. Classes 0-3 provide an associated error estimate, while for classes A and B the tag reporting is too sparse (< 4 messages received in a satellite pass) to estimate the error. The static tag yielded 69% of fixes in classes 0-3, the PPR resident penguin tag yielded 58% and the migrating penguin tag (146579) yielded 15% of fixes in classes 0-3.
- **Ref. Tag Transmit Interval (sustained for 5 messages):** Min. observed 16 sec, 10% at 45 sec, median at 2m 33s.



The reason for the winter track loss (top) is apparent in the graph (left). During a period centered on the winter solstice, tag reporting is sparse (PPR reference tag red, average of all reporting penguin tags blue), failing to meet the min. Argos fix requirement of two messages per satellite pass. The number of penguin tags still reporting is indicated by the dashed black line.

YEAR 2 (2016): IMPROVEMENTS & SECOND TAGGING CAMPAIGN



Twelve rock hopper penguin were equipped with 2nd generation tags, seven to the Falkland Islands (Islas Malvinas) and five at Isla de los Estados (Argentina)

Attempted Improvements

- **Minor Mechanical Changes:** We strengthened the antenna base to avoid the breakage seen on three tags in year one, and added a flat mounting base to ease attachment. We reduced the tag length slightly by removing the unneeded end-cap tip on the antenna side.
- **Concentrating Transmissions for Improved Argos Position Classes:** By adding a tiny rechargeable lithium-ion battery, we designed the second year tag to slowly collect enough solar energy to support 200-600 transmissions. Once charged, the tag would transmit quickly to yield class 0-3 messages even during periods of limited light.
- **GLS observation & heartbeat transmissions to fill the winter track data hole:** In this change, we modified the tag to observe sunrise and sunset each day. Even if charging its battery slowly in winter over several days, the tag was instructed to transmit a single 'heartbeat' message once an hour. With the previous year's GLS observations encoded in the heartbeat, an occasional single message receipt by an Argos satellite should reveal the animal's approximate position, shortening or closing the winter track data hole.

Year 2 Preliminary Results (data collection still in progress)

- **Lithium-ion battery:** Inclusion appears to have led to a strong winter reduction in overall transmit activity. The penguin tag heartbeats indicate that their batteries are 'stuck' in charging mode. An intermittent pattern of sunlight might explain. Brief opportunities of intense light when the clouds clear and a penguin at the surface happens creates the tag to send the sun can yield a message in the quick responding capacitor design after hours of darkness. Yet, such brief periods of good light contribute little to battery charging as the charge might be lost again if opportunities are infrequent or during the long nights.



- **The GLS observation and reporting method is working:** Despite reduced transmit activity, tags are yielding position fixes decoded from their heartbeat transmission.

After Argos position fixes (red) cease in the fall, tag 153458 continues to transmit heartbeats yielding GLS fixes (yellow arrows), and revealing a migration to the Antarctic peninsula. The scatter plot from the reference tag at Isla de los Estados (yellow dots) indicates the accuracy of the GLS fixes. Typical of the method, longitude precision is better than latitude.

CONCLUSION & WAY FORWARD

To-date, the solar powered penguin tag proved to be neither wisdom nor folly, but rather an alternate design approach leading to different tag characteristics. In year 1, two out of five of the satellite and the battery powered tags reported until molting season. The battery powered tags provided more and higher quality position fixes. Yet, while battery tag shedding loss was visually observed, all five solar tags remained firmly on the animals until molting season or removal. This and solar tag documentation of a migration between TDF and South Georgia Island may by first principles result from the advantages of a smaller, lighter tag.

Forward looking, the path for SeaTag-pt is now splitting. On one track is miniaturization. A low profile 17g device is available, and an approx. 12g device is in the planning phase. These use the quick-response capacitor design and GLS reporting to improve winter performance. On the other track, the 25g form factor is receiving new features. An array of four solar panels improves solar energy collection from more directions. GPS and depth sensors will be available. And for Antarctic species such as Adlie, a small primary battery and GPS will support track observation and archiving in winter, with satellite reporting when the sun returns in spring.

