



# RadLab: A Comprehensive Database and Graphical and Programming Interfaces for Space Radiation Data

## Biological and Physical Sciences

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# NASA Transform to Open Science (TOPS)



"Closed science, hoarding information and resources, silos of knowledge holds science back by limiting who can participate. We need more voices that work together and share knowledge and resources. [...]"

NASA's Transform to Open Science (TOPS) initiative will allow us to create a scientific culture that is ready for 21st century challenges.

Open Science will broaden participation, increase accessibility to knowledge, and embrace new technologies that can respond to these changes at scale."

[science.nasa.gov/open-science/](https://science.nasa.gov/open-science/)  
[nasa.github.io/Transform-to-Open-Science/about/](https://nasa.github.io/Transform-to-Open-Science/about/)

# NASA Open Science Data Repository

## Open Science Projects

Open Science Projects primary goals aim to increase collaborative scientific data sharing, analysis and more rapid scientific advancement.

### GeneLab

GeneLab, an open science multi-omics repository, covering transcriptomics, metagenomics, epigenomics, proteomics, and metabolomics. Studies comprise of data from model organisms including microbes, plants, fruit flies, rodents and humans.

[Learn more GeneLab](#)



### BSP

The NASA Space Biology Biospecimen Sharing Program (BSP) collects biospecimens to maximize the scientific return from biological spaceflight and associated ground investigations and to encourage and broaden participation from the scientific community in space biology-related research.

[Learn more about BSP](#)



### ALSDA

Ames Life Sciences Data Archive (ALSDA) collects, curates, and makes available space-relevant higher-order phenotypic datasets. Datasets that enable scientists to perform retrospective analysis across missions, experiments, life science disciplines, research subjects, and species.

[Learn more about ALSDA](#)



### NBISC

NASA Biological Institutional Scientific Collection (NBISC) is a biorepository of non-human samples collected from NASA-funded spaceflight investigations and correlative ground studies. The purpose of NBISC is to receive, store, document, preserve, and make the collection available to the scientific community.

[Learn more about NBISC](#)



# FAIR Guiding Principles

"[...] all research objects should be  
Findable, Accessible, Interoperable and Reusable (FAIR)  
both for machines and for people."

Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.*

"The FAIR Guiding Principles for scientific data management and stewardship" (2016)

[doi.org/10.1038/sdata.2016.18](https://doi.org/10.1038/sdata.2016.18)



# OSDR: GeneLab and ALSDA

**General Search Filters**

Data Source

☒ GeneLab

☒ ALSDA

☐ NIH GEO

☐ EBI PRIDE

☐ ANL MG-RAST

Data Type

☒ Study

☐ Experiment

☐ Subject

☐ Biospecimen

☐ Payload

Show more ▾

Study Search Filters

Project Type

☐ Ground

☐ Spaceflight

☐ High Altitude

Assay Type

 Open Science for Life in Space

Home

About ▾

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Research & Resources ▾

Working Groups ▾

Help ▾

 ▾

Open Science Data Repository Search

Search Datasets

Q

Sort By: Release Date ▾

Items per page: 25 ▾ 1 - 25 of 506

|< < > >|



Study

OSD-678

### Light has a principal role in the Arabidopsis transcriptomic response to the spaceflight environment

| Organisms            | Factors                                         | Assay Types                | Release Date | Description                                                                                                                                                                                                |
|----------------------|-------------------------------------------------|----------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Arabidopsis thaliana | Spaceflight<br>Ecotype<br>Treatment<br>Genotype | transcription<br>profiling | 20-Dec-2024  | The Characterizing Arabidopsis Root Attractions (CARA) spaceflight experiment provides comparative transcriptome analyses of plants grown in both light and dark conditions within the same spaceflight... |

Highlights: *cgene*



Study

OSD-516

### Modeling cellular responses to serum and vitamin D in microgravity using a human kidney microphysiological system

| Organisms    | Factors                         | Assay Types                | Release Date | Description                                                                                                                                                                                                 |
|--------------|---------------------------------|----------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Homo sapiens | Spaceflight<br>Treatment<br>Sex | transcription<br>profiling | 18-Jul-2024  | The microgravity environment aboard the International Space Station (ISS) provides a unique stressor that can help understand underlying cellular and molecular drivers of pathological changes observed... |

Highlights: *cgene*



Study

OSD-517

### Characterizing cellular responses to spaceflight in Arabidopsis thaliana roots

RadLab: DB, GUI, API for Space Radiation Data  
Kirill Grigorev

NASA OSDR  
NASA ARC, BMSIS

GSU SEP Workshop  
October 2024

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# OSDR: GeneLab and ALSDA

☰

Search Bar

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Description

📅

Experiments

🚀

Payloads

🚀

Missions

📄

Protocols

👤

Samples

📊

Assays

📖

Publications

📁

Files

📅

Version History

📈

Visualization

Modeling cellular responses to serum and vitamin D in microgravity using a human kidney microphysiological system.

**Authors:** Lidberg KA, Jones-Isaac K, Yang J, Bain J, Wang L, MacDonald JW, Bammler TK, Calamia J, Thummel KE, Yeung CK, Countryman S, Koenig P, Himmelfarb J, Kelly EJ.  
**PubMed ID:** 38982119  
**DOI:** 10.1038/s41526-024-00415-2

📁 Files

Study Files

Selected: 0

Search Files

🔍

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📁 OSD-516

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📁 Study Metadata Files

☐

📁 RNA-Seq

☐

📁 Raw sequence data

☐

📁 Aligned sequence data

☐

📄 GLDS-516\_rna-seq\_367402.accepted\_hits.merged.markeddups.recal.bai

4.25 MB

Fri Jul 19 2024

☐

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1.28 GB

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📄 -----

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“RadLab: DB, GUI, API for Space Radiation Data”  
Kirill Grigorev

NASA OSDR  
NASA ARC, BMSIS

GSU SEP Workshop  
October 2024

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# OSDR: GLOpenAPI

Generated URL:

```
https://visualization.genelab.nasa.gov/GLOpenAPI/samples/?id=OSD-37|OSD-48&file.datatype=unnormalized%20counts&format=csv
```

Retrieval of entries with metadata field values

*This interactive widget is temporarily disabled pending performance improvements and backend refactoring.  
Please refer to the examples below.*

Follow generated URL

The search can be constrained to only the samples that are annotated with specific **value(s)** of an ISA field.

- The logical AND of several conditions is achieved by passing them at the same time ( $x=a\&y=b$ ).
- The logical OR for a *single* condition is achieved by passing the target values joined by a vertical pipe ( $x=a|b$ ).
- Under view levels "assays" and "samples", the values of target field(s) will be reported in table columns.

Example: `/samples/?study.characteristics.genotype=WT`

Example: `/samples/?study.characteristics.genotype=WT|TK6`

Retrieval of files or data

- ☐ & file.filename=
- ☐ & file.datatype
- ☒ & file.datatype=  OR

For the resultant queried datasets, assays, and samples, there may be files associated.

- All files with recognized datatypes can be queried by passing `file.datatype`.
- The query can be constrained to files of particular datatypes by specifying these datatypes in the query (`file.datatype=pca`).

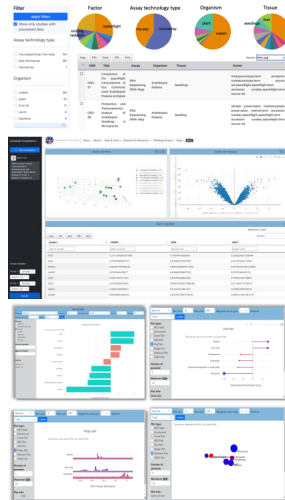
# OSDR: GLOpenAPI

Navigate: (Shift-)click headers to sort. Hover to highlight equal values. [Toggle crosshairs](#).  
Download: as [csv](#), [tsv](#), [json](#), [gct](#). Switch view level: [assays](#), [samples](#), [data](#).

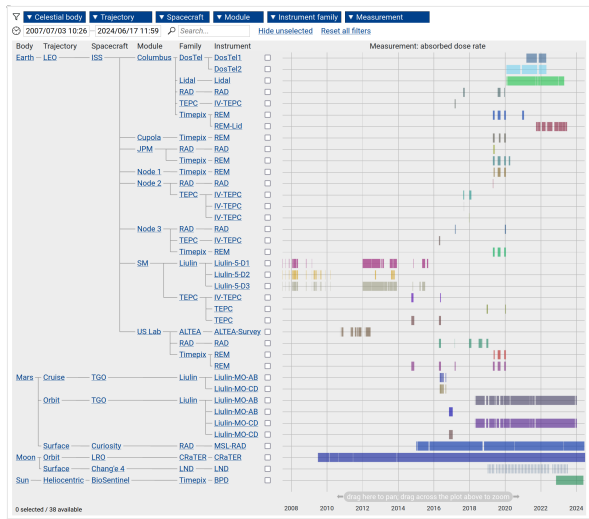
| *<br>index       | GLDS-81<br>gse65943_transcription_profiling_RNA-Sequencing_(RNA-Seq) |                           |                            |                            | GLDS-127<br>e-geod-84582_transcription_pr |
|------------------|----------------------------------------------------------------------|---------------------------|----------------------------|----------------------------|-------------------------------------------|
|                  | Hsap_TK6cells_LCL_1G_Rep1                                            | Hsap_TK6cells_LCL_1G_Rep2 | Hsap_TK6cells_LCL_suG_Rep1 | Hsap_TK6cells_LCL_suG_Rep2 | Hsap_IMR90iPSCs_CPCs_1G_f                 |
| ENSG00000000003  | 0                                                                    | 0                         | 0                          | 0                          | 2626                                      |
| ENSG00000000005  | 0                                                                    | 0                         | 0                          | 0                          | 1                                         |
| ENSG000000000419 | 8626                                                                 | 8795                      | 7877                       | 10306                      | 543                                       |
| ENSG000000000457 | 949                                                                  | 972                       | 1041                       | 1095                       | 358.29                                    |
| ENSG000000000460 | 1519                                                                 | 1583                      | 1387                       | 1620                       | 327.71                                    |
| ENSG000000000938 | 2048                                                                 | 1881                      | 1675                       | 1745                       | 0                                         |
| ENSG000000000971 | 2                                                                    | 3                         | 1                          | 0                          | 0                                         |
| ENSG000000001036 | 1250                                                                 | 1315                      | 1239                       | 1534                       | 577.56                                    |
| ENSG000000001084 | 961                                                                  | 988                       | 1046                       | 1194                       | 348.96                                    |
| ENSG000000001167 | 3102                                                                 | 3102                      | 2909                       | 3149                       | 1342                                      |
| ENSG000000001460 | 2                                                                    | 2                         | 4                          | 1                          | 204                                       |
| ENSG000000001461 | 141                                                                  | 131                       | 143                        | 121                        | 492                                       |
| ENSG000000001497 | 6047                                                                 | 6088                      | 5433                       | 6249                       | 1058                                      |
| ENSG000000001561 | 749                                                                  | 848                       | 843                        | 859                        | 95                                        |
| ENSG000000001617 | 1                                                                    | 1                         | 1                          | 0                          | 764                                       |
| ENSG000000001626 | 0                                                                    | 2                         | 3                          | 0                          | 380                                       |
| ENSG000000001629 | 2523                                                                 | 2755                      | 2639                       | 2638                       | 1116.84                                   |
| ENSG000000001630 | 7438.87                                                              | 8272.86                   | 8505.75                    | 9655.86                    | 833.4                                     |
| ENSG000000001631 | 2124.14                                                              | 2269.97                   | 2063.21                    | 2337.41                    | 687.57                                    |
| ENSG000000002016 | 863                                                                  | 932                       | 944                        | 846.09                     | 355.05                                    |
| ENSG000000002079 | 1                                                                    | 6                         | 4                          | 2                          | 2                                         |
| ENSG000000002330 | 325                                                                  | 356                       | 296                        | 419                        | 426.27                                    |
| ENSG000000002549 | 2830                                                                 | 3108                      | 2554                       | 3022                       | 679                                       |
| ENSG000000002586 | 2451                                                                 | 2523                      | 2227                       | 2349                       | 4079                                      |
| ENSG000000002587 | 0                                                                    | 1                         | 0                          | 1                          | 179                                       |
| ENSG000000002726 | 35                                                                   | 43                        | 37                         | 34                         | 2                                         |

# OSDR: Impact

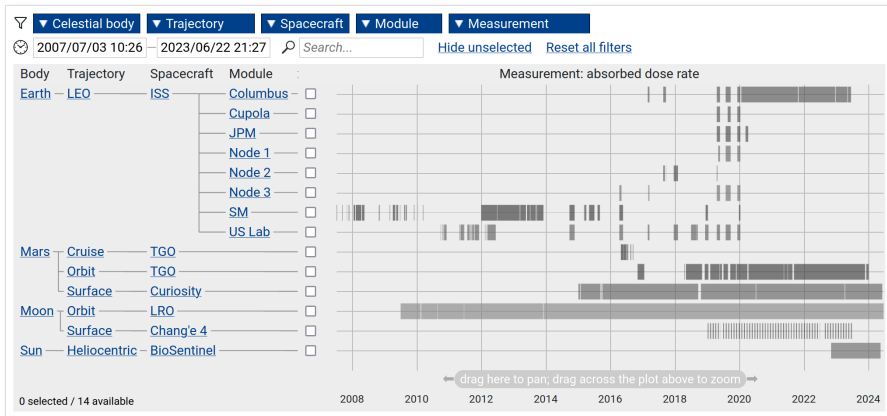
- ▶ Analysis Working Groups (AWGs)
- ▶ GeneLab-derived publications
- ▶ Educational initiatives (GL4U, GL4HS)



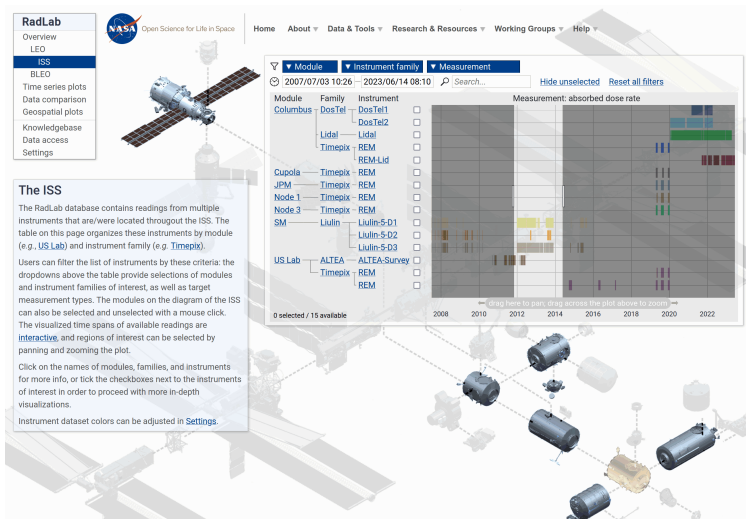
# RadLab: Current State



# RadLab: Current State

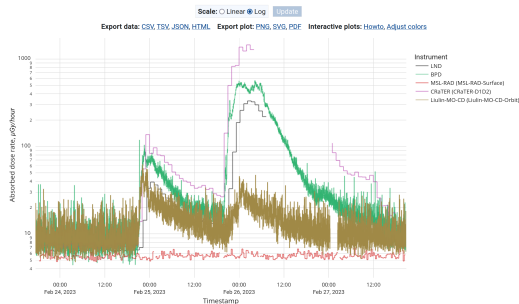
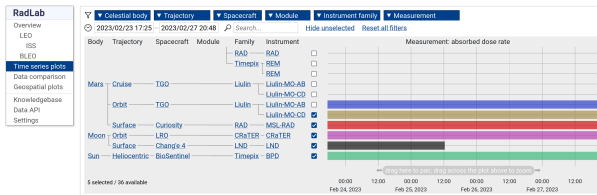


# RadLab: GUI (Bells and Whistles)

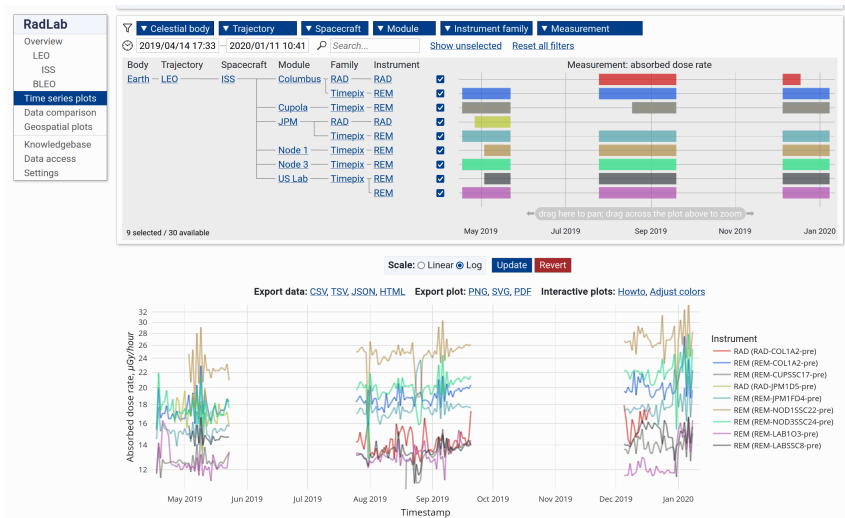




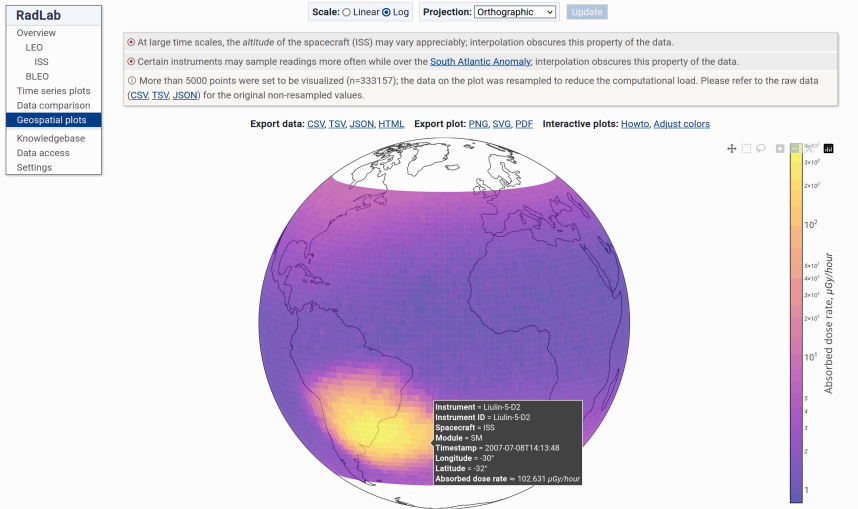
# RadLab: GUI (Time Series Plots)



# RadLab: GUI (Time Series Plots)



# RadLab: GUI (Geospatial Plots)



# RadLab: API

## RadLab

Overview

LEO

ISS

BLEO

Time series plots

Data comparison

Geospatial plots

Knowledgebase

Data API

Settings

## API syntax

The data can be retrieved programmatically with queries sent as a GET request to <https://visualization.osdr.nasa.gov/radlab/api>.

Queries can be constructed using one of two approaches: either as **key-value pairs** (a simple approach, but with limited complexity with regard to nesting logical expressions), or as **boolean expressions** (which allow combining AND, OR, NOT, and comparison operators with optional parentheses).

These two approaches are mutually exclusive: see [notes](#).

Click on the field names in the table below for more information.

Several [example requests](#) are provided at the bottom of this guide.

### Key-value pair syntax; data fields

| Key                               | Type                                                                           | Description                                                                                                                                                                                                                       | Unit | Value format                                                                                                                                                                                                                                                                                                                                                                                | Examples                                                                                                 |
|-----------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <a href="#">celestial_body</a>    | string                                                                         | A celestial body that an instrument of interest is associated with, or another identifier (e.g. "deep space") if none                                                                                                             |      | <ul style="list-style-type: none"><li><code>empty</code>: Request the field without applying filters to its values</li><li><code>=value</code>: Match value</li><li><code>=value1 value2</code>: Match value1 or value2</li></ul> <p>Note: special characters (<code>[ ] . %</code>, spaces) may need to be URL-encoded (see <a href="#">notes</a> and <a href="#">examples</a> below).</p> | <code>celestial_body</code><br><code>celestial_body=Earth</code><br><code>celestial_body=Moon Sun</code> |
| <a href="#">trajectory</a>        | <a href="#">resolved string</a>                                                | Name or type of trajectory; can be an exact identifier (e.g. "LEO") or one of "Orbit", "Surface", "BLEO", etc. For example, "BLEO" will resolve to "Moon surface", "Heliocentric orbit at 1 AU" and anything else outside of LEO. |      |                                                                                                                                                                                                                                                                                                                                                                                             | <code>trajectory</code><br><code>trajectory=Orbit</code><br><code>trajectory=LEO Heliocentric</code>     |
| <a href="#">spacecraft</a>        | string                                                                         | Name of spacecraft                                                                                                                                                                                                                |      |                                                                                                                                                                                                                                                                                                                                                                                             | <code>spacecraft</code><br><code>spacecraft=ISS</code>                                                   |
| <a href="#">module</a>            | string<br><br>(Note: may become <a href="#">resolved string</a> in the future) | Module within the spacecraft; currently only applicable for the <a href="#">ISS</a> and is blank ( <code>NA</code> ) for others                                                                                                   |      |                                                                                                                                                                                                                                                                                                                                                                                             | <code>module</code><br><code>module=US%20Lab</code><br><code>module=Cupola JPM</code>                    |
| <a href="#">instrument_family</a> | string                                                                         | Instrument family, which is a loosely defined                                                                                                                                                                                     |      |                                                                                                                                                                                                                                                                                                                                                                                             | <code>instrument_family</code><br><code>instrument_family=TEPC</code>                                    |

# RadLab: API

|                                                                                                                                                             |                                   |                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>RadLab</b><br>Overview<br>LEO<br>ISS<br>BLEO<br>Time series plots<br>Data comparison<br>Geospatial plots<br>Knowledgebase<br><b>Data API</b><br>Settings | <code>instrument_id</code>        | string                                   | <b>Note: case-sensitive.</b><br>A specific ID of an instrument, detector, or configuration; this is guaranteed to be unique in the database. E.g.: <a href="#">REM-Lid</a> , the REM instrument affixed to the lid of <a href="#">Lidaj</a> and included in the <a href="#">DORELL</a> project; or <a href="#">Liulin-5-D2</a> , the second detector of the <a href="#">Liulin-5</a> instrument.<br><b>Note:</b> is always returned, even when not explicitly requested. The ID can be used to look up the specifics of the instrument and the dataset in the <a href="#">knowledgebase</a> . |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <code>instrument_id</code><br><code>instrument_id=ALTEA-Survey</code><br><code>instrument_id=DosTel1 DosTel2</code>                                                            |
|                                                                                                                                                             | <code>timestamp</code>            | ISO-formatted string (or Unix timestamp) | Timestamp of recorded value(s). <b>Note: case-sensitive</b> if passed as an ISO-formatted string.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li><code>empty</code>: Request the field without applying filters to its values</li> <li><code>&lt;value</code>: Match any less than value</li> <li><code>&lt;=value</code>: Match any less or equal to value</li> <li><code>=value</code>: Match value</li> <li><code>&gt;=value</code>: Match any greater or equal to value</li> <li><code>&gt;value</code>: Match any greater than value</li> </ul> Note: can be used more than once in a single query | <code>timestamp</code><br><code>timestamp=2021-01-01T15:25</code><br><code>timestamp&gt;=2022-01-01&amp;timestamp&lt;2023-01-01</code><br><code>timestamp&gt;1683786900</code> |
|                                                                                                                                                             | <code>absorbed_dose_rate</code>   | number                                   | Absorbed radiation dose rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $\mu\text{Gy}/\text{hour}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <code>absorbed_dose_rate</code><br><code>absorbed_dose_rate&gt;=2</code>                                                                                                       |
|                                                                                                                                                             | <code>dose_equivalent_rate</code> | number                                   | Dose equivalent rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $\mu\text{Sv}/\text{hour}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <code>dose_equivalent_rate</code><br><code>dose_equivalent_rate&lt;=20</code>                                                                                                  |
|                                                                                                                                                             | <code>flux</code>                 | number                                   | Particle flux                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <code>flux</code><br><code>flux&lt;1</code>                                                                                                                                    |
|                                                                                                                                                             | <code>latitude</code>             | number                                   | Latitude of a spacecraft at given timestamp, where available. This and the values below are currently only tracked for the <a href="#">ISS</a> and are blank (NA) for others.                                                                                                                                                                                                                                                                                                                                                                                                                 | deg                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <code>latitude</code><br><code>latitude&lt;-10</code>                                                                                                                          |

# RadLab: API

| RadLab            |
|-------------------|
| Overview          |
| LEO               |
| ISS               |
| BLEO              |
| Time series plots |
| Data comparison   |
| Geospatial plots  |
| Knowledgebase     |
| Data API          |
| Settings          |

## Examples

### • Key-value pair syntax

- Dose rate and flux readings from DosTel-type instruments on the ISS between 11 PM on 01 Apr 2022, inclusive, and 1:05 AM on 02 Apr 2022, non-inclusive, only where the dose rate is above 2  $\mu\text{Gy}/\text{hour}$ , together with the spatial and magnetic coordinates of the ISS, formatted as HTML:

- Conceptually:

```
https://visualization.osdr.nasa.gov/radlab/api/  
?spacecraft=ISS  
&instrument=DosTel  
&timestamp=>2022-04-01T23:00  
&timestamp<2022-04-02T01:05  
&absorbed_dose_rate>2  
&flux  
&latitude  
&longitude  
&altitude  
&b  
&l  
&format=html
```

- URL-encoded (may not be necessary):

```
https://visualization.osdr.nasa.gov/radlab/api/  
?spacecraft=ISS  
&instrument=DosTel  
&timestamp%3E=2022-04-01T23%3A00  
&timestamp%3C2022-04-02T01%3A05  
&absorbed_dose_rate%3E2  
&flux  
&latitude  
&longitude  
&altitude  
&b  
&l  
&format=html
```

- Full URL: [https://visualization.osdr.nasa.gov/radlab/api/?spacecraft=ISS&instrument=DosTel&timestamp%3E=2022-04-01T23%3A00&timestamp%3C2022-04-02T01%3A05&absorbed\\_dose\\_rate%3E2&flux&latitude&longitude&altitude&b&l&format=html](https://visualization.osdr.nasa.gov/radlab/api/?spacecraft=ISS&instrument=DosTel&timestamp%3E=2022-04-01T23%3A00&timestamp%3C2022-04-02T01%3A05&absorbed_dose_rate%3E2&flux&latitude&longitude&altitude&b&l&format=html)

- Full URL without encoding (should work in most browsers, Python, ...): [https://visualization.osdr.nasa.gov/radlab/api/?spacecraft=ISS&instrument=DosTel&timestamp=>2022-04-01T23:00&timestamp<2022-04-02T01:05&absorbed\\_dose\\_rate>2&flux&latitude&longitude&altitude&b&l&format=html](https://visualization.osdr.nasa.gov/radlab/api/?spacecraft=ISS&instrument=DosTel&timestamp=>2022-04-01T23:00&timestamp<2022-04-02T01:05&absorbed_dose_rate>2&flux&latitude&longitude&altitude&b&l&format=html)

### • Boolean expression syntax

- Dose rate readings from all detectors in either the Cupola or JPM modules, between 5 Dec 2019 inclusive and 25 Dec 2019, non-inclusive; also retrieve the value of "Instrument\_family" for each reading and format the output as TSV:

# RadLab: API

| timestamp           | instrument_id | absorbed_dose_rate | altitude   | b       | flux         | l       | latitude  | longitude    | module   | spacecraft |
|---------------------|---------------|--------------------|------------|---------|--------------|---------|-----------|--------------|----------|------------|
| 2022-04-01T00:00:00 | REM-Lid       | 0.9107814          | 416.851987 | 32511.1 | 0.0731268... | 1.09344 | -8.324694 | 162.94325    | Columbus | ISS        |
| 2022-04-01T00:00:00 | DosTel2       | 2.368557           | 416.851987 | 32511.1 | 0.1394459... | 1.09344 | -8.324694 | 162.94325    | Columbus | ISS        |
| 2022-04-01T00:00:00 | DosTel1       | 1.99686266666667   | 416.851987 | 32511.1 | 0.1160901... | 1.09344 | -8.324694 | 162.94325    | Columbus | ISS        |
| 2022-04-01T00:00:00 | LidAl         | 2.2391858088147    | 416.851987 | 32511.1 | 0.0982921... | 1.09344 | -8.324694 | 162.94325    | Columbus | ISS        |
| 2022-04-01T00:05:00 | REM-Lid       | 2.0818824          | 415.176415 | 27547.8 | 0.1663191... | 1.02651 | 6.951546  | 173.790418   | Columbus | ISS        |
| 2022-04-01T00:05:00 | DosTel2       | 2.08211030188679   | 415.176415 | 27547.8 | 0.1343182... | 1.02651 | 6.951546  | 173.790418   | Columbus | ISS        |
| 2022-04-01T00:05:00 | DosTel1       | 1.87163492307692   | 415.176415 | 27547.8 | 0.1053458... | 1.02651 | 6.951546  | 173.790418   | Columbus | ISS        |
| 2022-04-01T00:05:00 | LidAl         | 2.0517677736311    | 415.176415 | 27547.8 | 0.0981521... | 1.02651 | 6.951546  | 173.790418   | Columbus | ISS        |
| 2022-04-01T00:10:00 | REM-Lid       | 2.291432           | 416.22943  | 28879   | 0.1320885... | 1.15888 | 21.89461  | -174.5494... | Columbus | ISS        |
| 2022-04-01T00:10:00 | DosTel2       | 2.46097266666667   | 416.22943  | 28879   | 0.1473333... | 1.15888 | 21.89461  | -174.5494... | Columbus | ISS        |
| 2022-04-01T00:10:00 | DosTel1       | 2.18748766666667   | 416.22943  | 28879   | 0.1266577... | 1.15888 | 21.89461  | -174.5494... | Columbus | ISS        |
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| 2022-04-01T00:15:00 | REM-Lid       | 3.86292            | 419.150222 | 34088   | 0.2971092... | 1.52678 | 35.576278 | -160.0008... | Columbus | ISS        |
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| 2022-04-01T00:15:00 | DosTel1       | 4.11190379487179   | 419.150222 | 34088   | 0.2051074... | 1.52678 | 35.576278 | -160.0008... | Columbus | ISS        |
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| 2022-04-01T00:20:00 | DosTel2       | 7.48317466666667   | 422.420509 | 40921.5 | 0.4153514... | 2.36792 | 46.397315 | -139.8094... | Columbus | ISS        |
| 2022-04-01T00:20:00 | DosTel1       | 7.80761766666667   | 422.420509 | 40921.5 | 0.3730812... | 2.36792 | 46.397315 | -139.8094... | Columbus | ISS        |
| 2022-04-01T00:20:00 | LidAl         | 6.11440798239105   | 422.420509 | 40921.5 | 0.2980769... | 2.36792 | 46.397315 | -139.8094... | Columbus | ISS        |
| 2022-04-01T00:25:00 | REM-Lid       | 11.048988          | 424.567687 | 45611.9 | 0.5415207... | 3.89651 | 51.663254 | -112.4683... | Columbus | ISS        |
| 2022-04-01T00:25:00 | DosTel2       | 10.6957077435897   | 424.567687 | 45611.9 | 0.5561581... | 3.89651 | 51.663254 | -112.4683... | Columbus | ISS        |
| 2022-04-01T00:25:00 | DosTel1       | 11.0199630897436   | 424.567687 | 45611.9 | 0.5182704... | 3.89651 | 51.663254 | -112.4683... | Columbus | ISS        |
| 2022-04-01T00:25:00 | LidAl         | 6.96877643785163   | 424.567687 | 45611.9 | 0.3478796... | 3.89651 | 51.663254 | -112.4683... | Columbus | ISS        |
| 2022-04-01T00:30:00 | REM-Lid       | 11.574072          | 424.812496 | 45307.7 | 0.5625323... | 3.85842 | 49.120498 | -83.450832   | Columbus | ISS        |
| 2022-04-01T00:30:00 | DosTel2       | 10.61511933333333  | 424.812496 | 45307.7 | 0.5378740... | 3.85842 | 49.120498 | -83.450832   | Columbus | ISS        |
| 2022-04-01T00:30:00 | DosTel1       | 10.82385166666667  | 424.812496 | 45307.7 | 0.5084686... | 3.85842 | 49.120498 | -83.450832   | Columbus | ISS        |
| 2022-04-01T00:30:00 | LidAl         | 6.38013989877022   | 424.812496 | 45307.7 | 0.3076296... | 3.85842 | 49.120498 | -83.450832   | Columbus | ISS        |
| 2022-04-01T00:35:00 | REM-Lid       | 7.364856           | 423.385667 | 39608.2 | 0.3250669... | 2.25814 | 39.968035 | -60.605414   | Columbus | ISS        |
| 2022-04-01T00:35:00 | DosTel2       | 7.15227441025641   | 423.385667 | 39608.2 | 0.3641040... | 2.25814 | 39.968035 | -60.605414   | Columbus | ISS        |
| 2022-04-01T00:35:00 | DosTel1       | 6.70494814102564   | 423.385667 | 39608.2 | 0.3208913... | 2.25814 | 39.968035 | -60.605414   | Columbus | ISS        |

# RadLab: GeneLab/ALSDA Applications

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 **RR-1**  
Rodent Research 1

Payload



Description

↑

Description

NASA's Rodent Research Hardware System provides a research platform aboard the International Space Station (ISS) for long-duration rodent experiments in space. Scientists and engineers at Ames Research Center (ARC) developed the new system for the space station based on the Animal Enclosure Module (AEM) that flew aboard 27 space shuttle missions between 1983 and 2011 and supported studies ranging from four to 18 days. Rodent spaceflight experiments have contributed significantly to our understanding of the effects of microgravity on biological processes that are directly relevant to humans in space.

The maiden voyage of the system, Rodent Research-1 (RR-1), launched on SpaceX-4 CRS-4 on September 21, 2014, and returned October 25, 2014, during ISS expeditions 41/42. Lasting 37 days, RR1 was the longest duration spaceflight rodent study to date conducted in a NASA facility. RR1 was the first mission to transport rodents aboard an unmanned commercial vehicle. The primary goal is for NASA to validate hardware and demonstrate critical research operations, while supporting the Center for the Advancement of Science in Space (CASIS) in sponsoring the first commercial research study. Ten mice were flown to the ISS and transferred into habitat. Five mice were wild type (WT) and identified by an ear notch and the remaining mice, called "Knockouts" had no ear notches. Ten mice were used as ground controls.

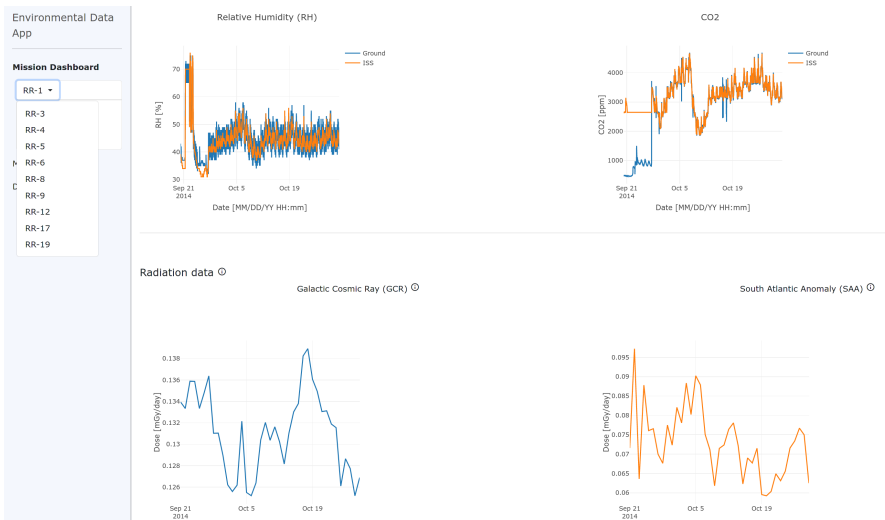
PI: Novartis Pharmaceuticals

The mission objectives of the validation flight:

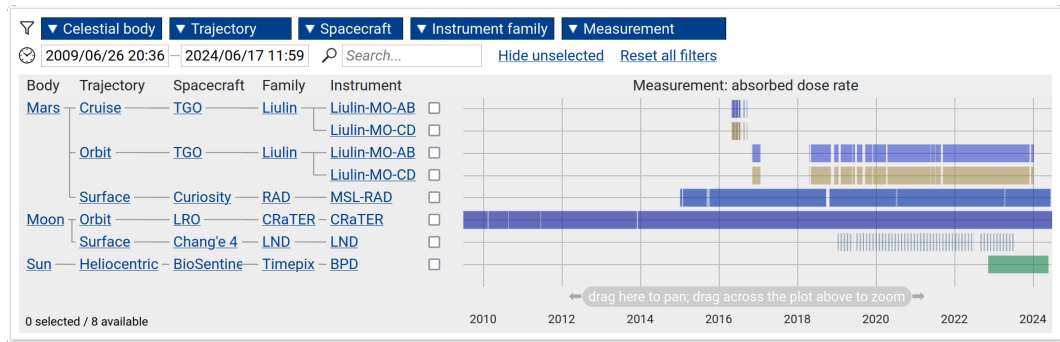
- The addition of the rodent research system expands the utilization of ISS for research on the effects of microgravity on rodents.
- The demonstration of the hardware capability to support rodent research for long-duration missions on ISS is accomplished.
- A validation of the operational capabilities of the hardware to support rodent research provides valuable information applicable to future long-term space missions.
- Validate that the Rodent Research Hardware can deliver and maintain healthy animals.
- Validate that on-orbit activities to support hardware operations can be performed.



# RadLab: GeneLab/ALSDA Applications



# RadLab: Modeling Applications



# RadLab: Modeling Applications

Frontier Development Labs: FDL-X Heliolab 2024 Challenge

## **"Forecasting Radiation Exposure for Human Space Flight"**

Team: Elena Massara, Xiaomei Song, Rutuja Gurav, Kimberly Sinclair

Faculty: Matt Kusner, Atılım Güneş Baydin, Bala Poduval

Advisors: Sylvain Costes, Jack Miller, Kirill Grigorev

Resources used: GOES, SDO, RadLab (BioSentinel + CRaTER)

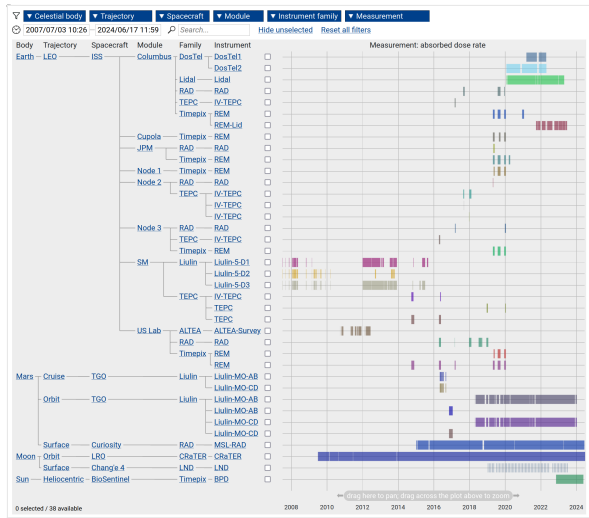
Training an early warning model

[frontierdevelopmentlab.org/fdl2024](https://frontierdevelopmentlab.org/fdl2024)  
[youtube.com/watch?v=VYe9wpX8PXQ](https://youtube.com/watch?v=VYe9wpX8PXQ)

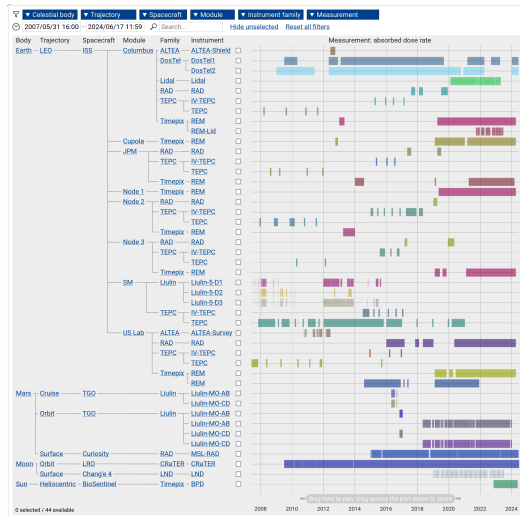
# RadLab: Modeling Applications

- ▶ Synthetic datasets
  - ▶ For payloads
  - ▶ For arbitrary locations / timespans
  - ▶ Combining data from multiple sources

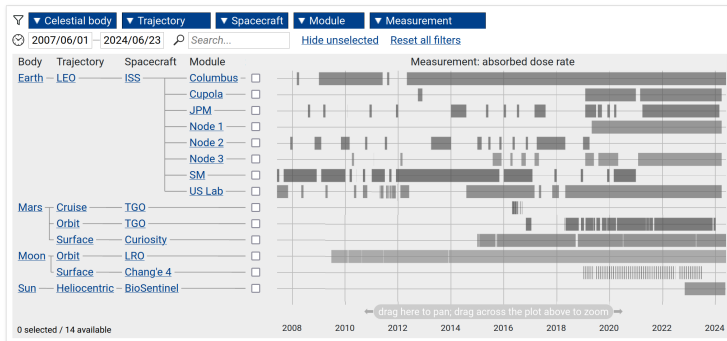
# RadLab: Current State



# RadLab: Goals



# RadLab: Goals



- + **Known historical SPE annotations** (in both the API and the GUI)
- + Federated GOES and POES data
- + Integration with other resources (e.g. *Space Radiation Intelligence System a.k.a. SPRINTS*)

# RadLab: Knowledgebase

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# RadLab: Knowledgebase

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## ALTEA

ALTEA is a detector on the [ISS](#) which has been deployed in the [US Lab](#) in the [ALTEA-Survey \(ALTEA-30\)](#) configuration, and in the [Columbus](#) module in the [ALTEA-Shield \(ALTEA-Fig\)](#) configuration.

### Attributes

Trajectory: [LEO](#)  
Spacecraft: [ISS](#)  
Modules: [US Lab](#), [Columbus](#)

Time resolution of the currently available data: 60 seconds

### References

1. Nariel, L., Casolino, M., Di Fino, L., Larosa, M., Picozza, P., & Zaccante, V. (2015). **Radiation survey in the international space station**. *Journal of Space Weather and Space Climate*, 5, A37. <https://doi.org/10.1002/swsc.2015037>
2. Nariel, L., Berger, T., Burmeister, S., Di Fino, L., Rizzo, A., Matthä, D., & Reitz, G. (2017). **Exploiting different active silicon detectors in the International Space Station: ALTEA and DOSTEL galactic cosmic radiation (GCR) measurements**. *Journal of Space Weather and Space Climate*, 7, A18. <https://doi.org/10.1002/swsc.2017018>
3. Zeffin, C., Nariel, L., Rios, R. R., Rizzo, A., Stoffle, N., Hessler, D. M., ... & Spence, H. E. (2019). **Comparisons of high-linear energy transfer spectra on the ISS and in deep space**. *Space Weather*, 17(3), 396-418. <https://doi.org/10.1029/2018SW002193>

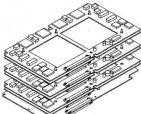
### Overview

ALTEA is a detector system composed of six identical silicon strip telescopes, each able to measure the energy loss of all ions most relevant for radiation protection in space ( $Z > 1$ –26). For protons and helium ions, respectively, the energy ranges are 25–45 MeV and 25–250 MeV/n. ALTEA also measures the trajectory of each ion, while using a statistical method to estimate the incident ion charge and energy. Typically [flux](#), LET (Linear Energy Transfer) rate, [absorbed dose rate](#),  $Q$  (quality factor), [dose equivalent rate](#) with a time resolution of better than 1 second can be provided. Particle by particle data is also available, as well as LET spectra. In conjunction with orbital data, separation among the important geographical or magnetic regions can be made.

### Detector configuration

The ALTEA system is composed of 6 identical Silicon Detector Units (SDU), and one electronic Data Acquisition Unit (DAU). Each SDU is a six-plane particle telescope, with each plane composed of two 8×4 cm<sup>2</sup> silicon wafers, 389 µm thick, placed side by side on an aluminum support and spaced 5.5 mm apart, for a total surface of 8×16.55 cm<sup>2</sup>. Each silicon wafer is divided into 32 strips, with a pitch of 2.5 mm. Plane orientation alternates between X and Y directions. The distance between an X plane and the adjacent Y plane is 3.75 mm, while the distance between each XY pair is 37.5 mm. The hits in two consecutive planes provide the position of the particle in the X-Y plane, while hits in pairs of planes provide the Z. The outer box of each SDU is made of 1.3 mm thick aluminum and the whole structure results in a double-ended geometrical factor of 230 cm<sup>2</sup> sr. The field of view reaches 66.8° on the diagonal.

The front-end electronics are located around each double wafer, while at the bottom of the silicon planes, a 7th parallel plane with the same dimensions hosts the Read-Out Electronics board (ROE). (The figure shows the six double wafers plus electronics and—at the bottom—the ROE). The average equivalent thickness of the ROE is estimated to be 0.8 µm of glass + 0.8 µm of copper + 1 µm of silicon.



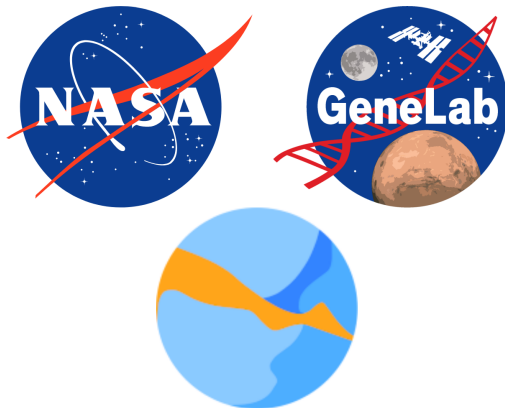
# RadLab: Roadmap

- ▶ Ingest and make public the currently staged datasets (more DosTel, TEPC, TriTel, ...)
- ▶ Integrate known historical SPE annotations
- ▶ Expand the knowledgebase
- ▶ Working Group objectives (next slide)

# The RadLab Working Group (RLWG)

- ▶ Fostering collaboration
- ▶ Integration of new datasets
- ▶ Development of data harmonization standards
- ▶ Guiding the development of the platform
- ▶ Establishing the use of RadLab in radiation and biology research

Thank you!



**[visualization.osdr.nasa.gov/radlab](https://visualization.osdr.nasa.gov/radlab)**

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