A futuristic space station interior. A woman with dark hair, wearing an orange tank top and light blue pants, is sitting cross-legged on a blue metal structure, reading a tablet. She is looking towards the right. In the foreground, there is a large, vibrant plant arrangement with several orange daisies, green leaves, and yellow flowers. The background features a large circular window showing a view of Earth and the moon. The station's interior is filled with various equipment, pipes, and glowing blue light effects, creating a high-tech, futuristic atmosphere.

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

## Biological and Physical Sciences

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Blue Marble Space Institute of Science  
NASA Ames Research Center

Sep 4, 2024

# 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


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## Open Science Data Repository Search

Search Datasets  Sort By: **Release Date**


Items per page: 25 1 - 25 of 506 << >>

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

Organisms	Factors	Assay Types	Release Date	Description
 <b>Study</b> OSD-678	Spaceflight Ecotype Treatment Genotype	transcription 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*

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

Organisms	Factors	Assay Types	Release Date	Description
 <b>Study</b> OSD-516	Spaceflight Treatment Sex	transcription 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*

### Characterization and immunoblot analysis of protein levels in cell walls of Arabidopsis thaliana...

### 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**

# OSDR: GeneLab and ALSDA

☰

Search Bar

- 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

- OSD-516
  - Study Metadata Files
  - RNA-Seq
    - Raw sequence data
    - Aligned sequence data
      - GLDS-516\_ma-seq\_367402.accepted\_hits.merged.markeddups.recal.bai 4.25 MB Fri Jul 19 2024
      - GLDS-516\_ma-seq\_367402.accepted\_hits.merged.markeddups.recal.bam 1.07 GB Fri Jul 19 2024
      - GLDS-516\_ma-seq\_367403.accepted\_hits.merged.markeddups.recal.bai 4.41 MB Fri Jul 19 2024
      - GLDS-516\_ma-seq\_367403.accepted\_hits.merged.markeddups.recal.bam 1.28 GB Fri Jul 19 2024
      - 4.40 MB Fri Jul 19 2024

# 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 example 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

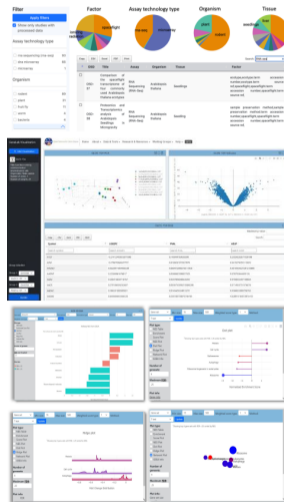
Navigate: (Shift-)click headers to sort. Hover to highlight equal values. Toggle crosshairs.  
 Download: as [csv](#), [tsv](#), [json](#), [gct](#). Switch view level: [assays](#), [samples](#), [data](#).

* *	GLDS-21 gse65943_transcription_profiling_RNA-Sequencing_(RNA-Seq)				GLDS-127 e-geod-84582_transcription_pr
index	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
ENSG00000001036	1250	1315	1239	1534	577.56
ENSG00000001084	961	988	1046	1194	348.96
ENSG00000001167	3102	3102	2909	3149	1342
ENSG00000001460	2	2	4	1	204
ENSG00000001461	141	131	143	121	492
ENSG00000001497	6047	6088	5433	6249	1058
ENSG00000001561	749	848	843	859	95
ENSG00000001617	1	1	1	0	764
ENSG00000001626	0	2	3	0	380
ENSG00000001629	2523	2755	2639	2638	1116.84
ENSG00000001630	7438.87	8272.86	8505.75	9655.86	833.4
ENSG00000001631	2124.14	2269.97	2063.21	2337.41	687.57
ENSG00000002016	863	932	944	846.09	355.05
ENSG00000002079	1	6	4	2	2
ENSG00000002330	325	356	296	419	426.27
ENSG00000002549	2830	3108	2554	3022	679
ENSG00000002586	2451	2523	2227	2349	4079
ENSG00000002587	0	1	0	1	179
ENSG00000002726	35	43	37	34	2

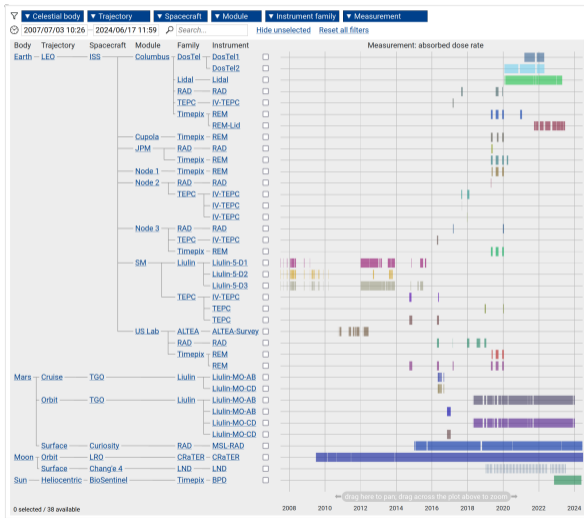


# OSDR: Impact

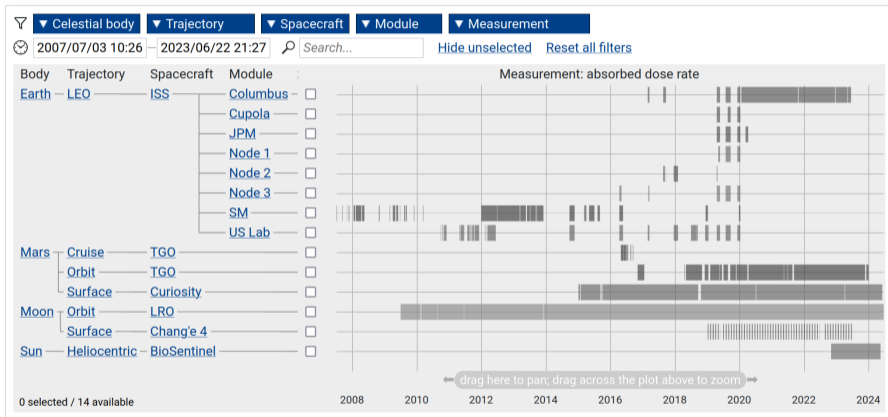
- ▶ Analysis Working Groups (AWGs)
- ▶ GeneLab-derived publications
- ▶ Educational initiatives (GL4U, GL4HS)



# RadLab: Current State



# RadLab: Current State



# RadLab: GUI (Bells and Whistles)

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▼ Module ▼ Instrument family ▼ Measurement

2007/07/03 10:26 -- 2023/06/14 08:10 Search... Hide unselected Reset all filters

Module	Family	Instrument	
Columbus	DosTel	DosTel1	<input type="checkbox"/>
		DosTel2	<input type="checkbox"/>
	LidAl	LidAl	<input type="checkbox"/>
		Timepix	REM
		REM-Lid	<input type="checkbox"/>
Cupola	Timepix	REM	<input type="checkbox"/>
JPM	Timepix	REM	<input type="checkbox"/>
Node 1	Timepix	REM	<input type="checkbox"/>
Node 3	Timepix	REM	<input type="checkbox"/>
SM	Liulin	Liulin-5-D1	<input type="checkbox"/>
		Liulin-5-D2	<input type="checkbox"/>
		Liulin-5-D3	<input type="checkbox"/>
			<input type="checkbox"/>
US Lab	ALTEA	ALTEA-Survey	<input type="checkbox"/>
	Timepix	REM	<input type="checkbox"/>
		REM	<input type="checkbox"/>

Measurement: absorbed dose rate

0 selected / 15 available

2008 2010 2012 2014 2016 2018 2020 2022

— drag here to pan, drag across the plot above to zoom —

The ISS

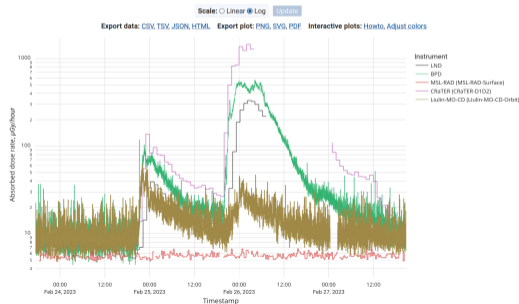
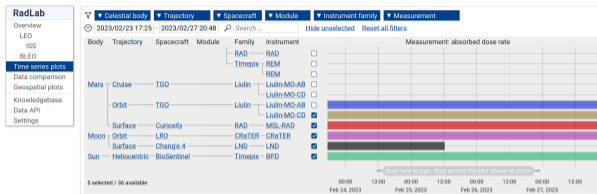
The RadLab database contains readings from multiple instruments that are/were located throughout the ISS. The table on this page organizes these instruments by module (e.g., US Lab) and instrument family (e.g. Timepix).

Users can filter the list of instruments by these criteria: the dropdowns above the table provide selections of modules and instrument families of interest, as well as target measurement types. The modules on the diagram of the ISS can also be selected and unselected with a mouse click. The visualized time spans of available readings are [interactive](#), and regions of interest can be selected by panning and zooming the plot.

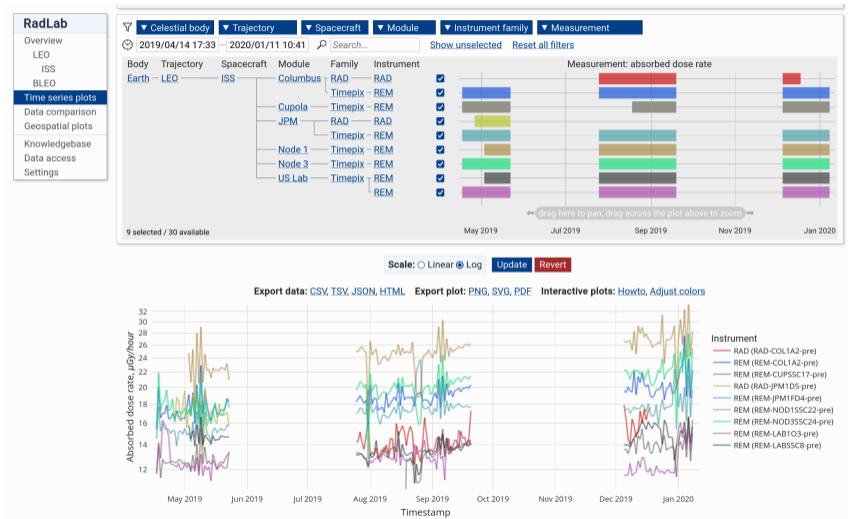
Click on the names of modules, families, and instruments for more info, or tick the checkboxes next to the instruments of interest in order to proceed with more in-depth visualizations.

Instrument dataset colors can be adjusted in [Settings](#).

# RadLab: GUI (Time Series Plots)



# RadLab: GUI (Time Series Plots)



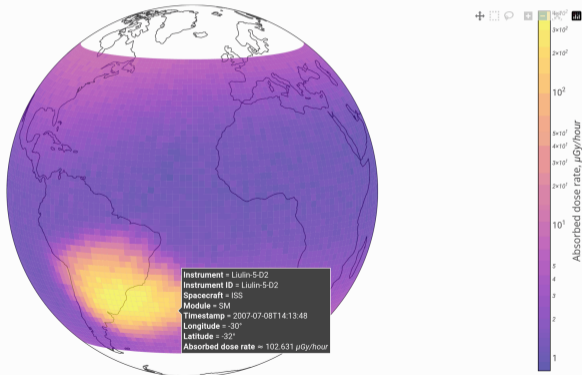
# RadLab: GUI (Geospatial Plots)

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Scale:  Linear  Log    Projection:    

- At large time scales, the *altitude* of the spacecraft (ISS) may vary appreciably; interpolation obscures this property of the data.
- Certain instruments may sample readings more often while over the [South Atlantic Anomaly](#); interpolation obscures this property of the data.
- More than 5000 points were set to be visualized ( $n=333157$ ); the data on the plot was resampled to reduce the computational load. Please refer to the raw data ([CSV](#), [TSV](#), [JSON](#)) for the original non-resampled values.

Export data: [CSV](#), [TSV](#), [JSON](#), [HTML](#)    Export plot: [PNG](#), [SVG](#), [PDF](#)    Interactive plots: [Howto](#), [Adjust colors](#)



# RadLab: API

## RadLab

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## 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 parentheticals).

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 ([, ], %, spaces) may need to be URL-encoded (see <a href="#">notes</a> and <a href="#">examples</a> below).</p>	<code>celestial_body</code> <code>celestial_body=Earth</code> <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> <code>trajectory=Orbit</code> <code>trajectory=LEO Heliocentric</code>
<a href="#">spacecraft</a>	string	Name of spacecraft			<code>spacecraft</code> <code>spacecraft=ISS</code>
<a href="#">module</a>	string <small>(Note: may become <a href="#">resolved string</a> in the future)</small>	Module within the spacecraft; currently only applicable for the ISS and is blank (NA) for others			<code>module</code> <code>module=US%20Lab</code> <code>module=Cupola JPM</code>
<a href="#">instrument_family</a>	string	Instrument family, which is a loosely defined			<code>instrument_family</code> <code>instrument_family=TEPC</code>



# RadLab: API

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<a href="#">instrument_id</a>	string	<b>Note: case-sensitive.</b> 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="#">DORELI</a> project; or <a href="#">Liulin-5-D2</a> , the second detector of the <a href="#">Liulin-5</a> instrument. <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> .			<pre>instrument_id instrument_id=ALTEA-Survey instrument_id=DosTel1 DosTel2</pre>
<a href="#">timestamp</a>	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> <p>Note: can be used more than once in a single query</p>	<pre>timestamp timestamp=2021-01-01T15:25 timestamp&gt;=2022-01-01&amp;timestamp&lt;2023-01-01 timestamp&gt;1683786900</pre>
<a href="#">absorbed_dose_rate</a>	number	Absorbed radiation dose rate	μGy/hour		<pre>absorbed_dose_rate absorbed_dose_rate&gt;=2</pre>
<a href="#">dose_equivalent_rate</a>	number	Dose equivalent rate	μSv/hour		<pre>dose_equivalent_rate dose_equivalent_rate&lt;=20</pre>
<a href="#">flux</a>	number	Particle flux	cm <sup>-2</sup> sr <sup>-1</sup> s <sup>-1</sup>		<pre>flux flux&lt;1</pre>
<a href="#">latitude</a>	number	Latitude of a spacecraft at given timestamp, where available. This and the values below are currently only tracked for the ISS and are blank (NA) for others.	deg		<pre>latitude latitude&lt;-10</pre>

# RadLab: API

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## 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
2022-04-01T00:10:00	Lidal	2.42490397146081	416.22943	28879	0.1122379...	1.15888	21.89461	-174.5494...	Columbus	ISS
2022-04-01T00:15:00	REM-Lid	3.86292	419.150222	34088	0.2971092...	1.52678	35.576278	-160.0008...	Columbus	ISS
2022-04-01T00:15:00	DosTel2	3.78154447435897	419.150222	34088	0.2223902...	1.52678	35.576278	-160.0008...	Columbus	ISS
2022-04-01T00:15:00	DosTel1	4.11190379487179	419.150222	34088	0.2051074...	1.52678	35.576278	-160.0008...	Columbus	ISS
2022-04-01T00:15:00	Lidal	3.94472706410343	419.150222	34088	0.1846939...	1.52678	35.576278	-160.0008...	Columbus	ISS
2022-04-01T00:20:00	REM-Lid	10.904088	422.420509	40921.5	0.4180964...	2.36792	46.397315	-139.8094...	Columbus	ISS
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
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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
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2022-04-01T00:35:00	DosTel1	6.70294814102564	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.

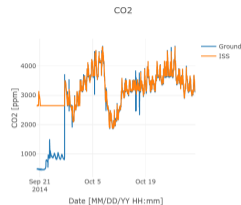
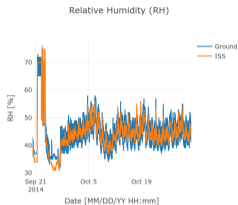
# RadLab: GeneLab/ALSDA Applications

Environmental Data App

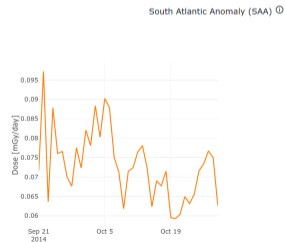
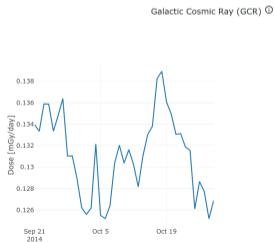
**Mission Dashboard**

RR-1 ▾

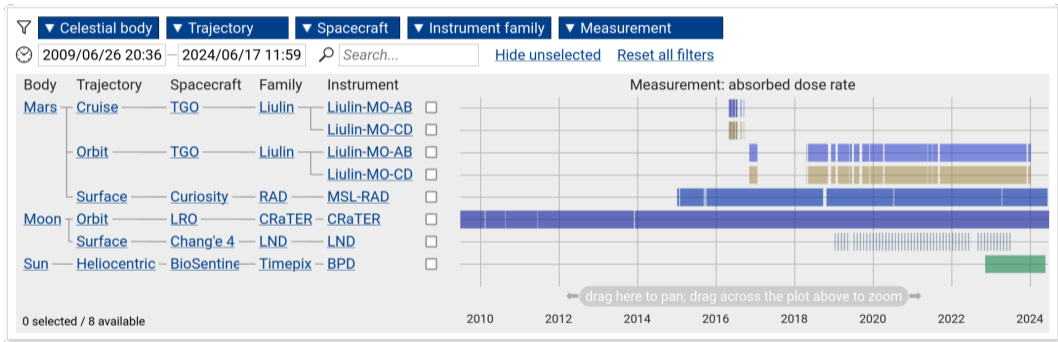
- RR-3
- RR-4
- RR-5
- RR-6
- RR-8
- RR-9
- RR-12
- RR-17
- RR-19



## Radiation data ☺



# 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

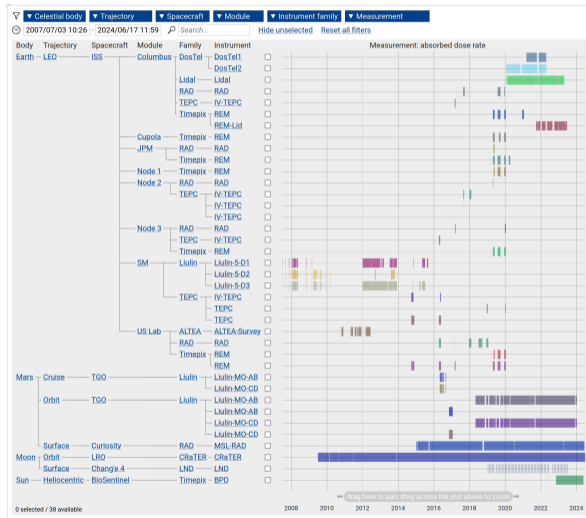
[frontierdevelopmentlab.org/fdl2024](https://frontierdevelopmentlab.org/fdl2024)  
[youtube.com/watch?v=VYe9wpx8PXQ](https://youtube.com/watch?v=VYe9wpx8PXQ)

# RadLab: Modeling Applications

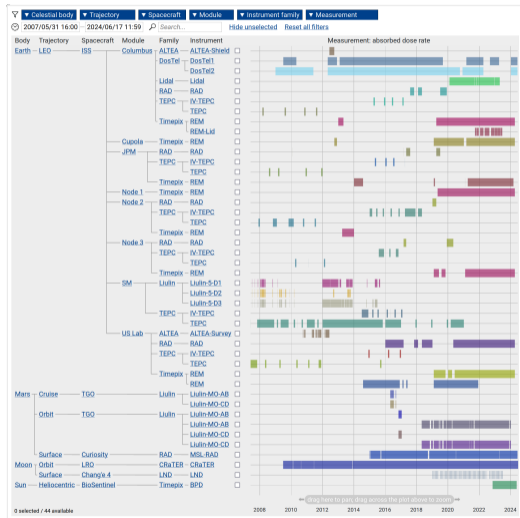
- ▶ Synthetic datasets
  - ▶ For payloads
  - ▶ For arbitrary locations / timespans
  - ▶ Combining data from multiple sources



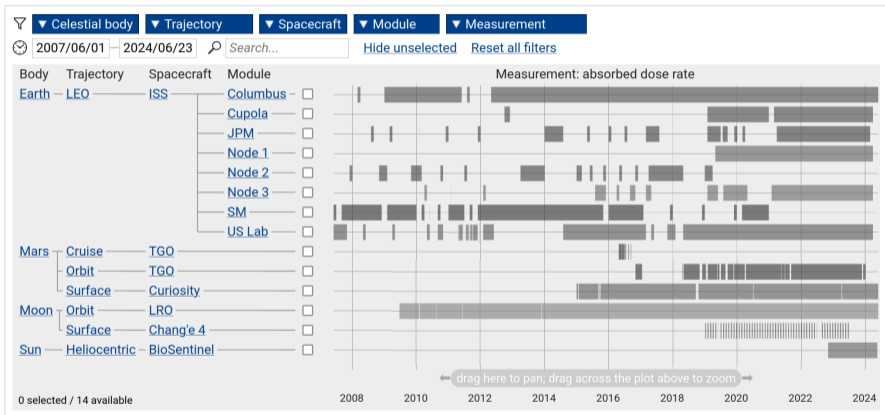
# RadLab: Current State



# RadLab: Goals



# RadLab: Goals



# RadLab: Knowledgebase

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- ALTEA-Flat
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- ALTEA Survey
- Absorbed dose rate
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- BioSentinel
- COLER3
- Celestial body
- Chang'e 4
- Columbus
- Cupola
- DORELI
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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 \(ALTEA-Fix\)](#) configuration.

### Attributes

Trajectory: LEO

Spacecraft: ISS

Modules: US Lab, Columbus

Time resolution of the currently available data: 60 seconds

### References

1. Narioli, L., Casolino, M., Di Fiino, 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. Narioli, L., Berger, T., Bumeister, S., Di Fiino, L., Rizzo, A., Matthäi, 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. Zewin, C., Narioli, L., Ros, 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(2), 396-418. <https://doi.org/10.1029/2018SW002150>

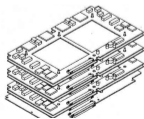
### Overview

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 ( $Z > 1$  He). 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 data](#) 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 8x4 cm<sup>2</sup> silicon wafers, 380 µm thick, placed side by side on an aluminum support and spaced 5.5 mm apart, for a total surface of 8x16.55 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

- ▶ Datasets
  - ▶ Wider DosTel timespan
  - ▶ TriTel
  - ▶ Additional TEPCs
  - ▶ Various passives
  - ▶ (Farther future) SPACEDOS, ...
  - ▶ Ultimately, "all radiation data" <sup>TM</sup>
- ▶ Expansion of the knowledgebase
- ▶ Other Working Group business (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

# 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. [...]"

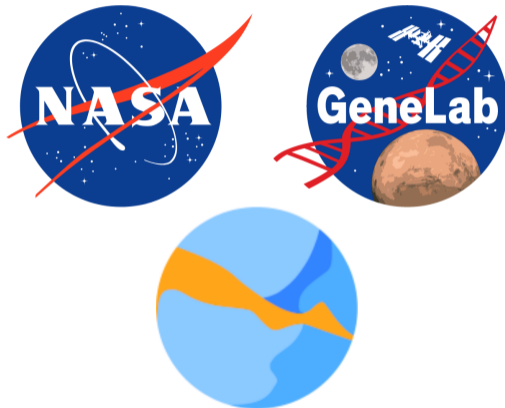
NASA's Transform to Open Science (TOPS) initiative will allow us to create a scientific culture that is ready for 21st century challenges.

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/)



Thank you!



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

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