# STRABOEXPERIMENTAL

## USER GUIDE

December 4, 2024

# Contents

# 1 Introduction

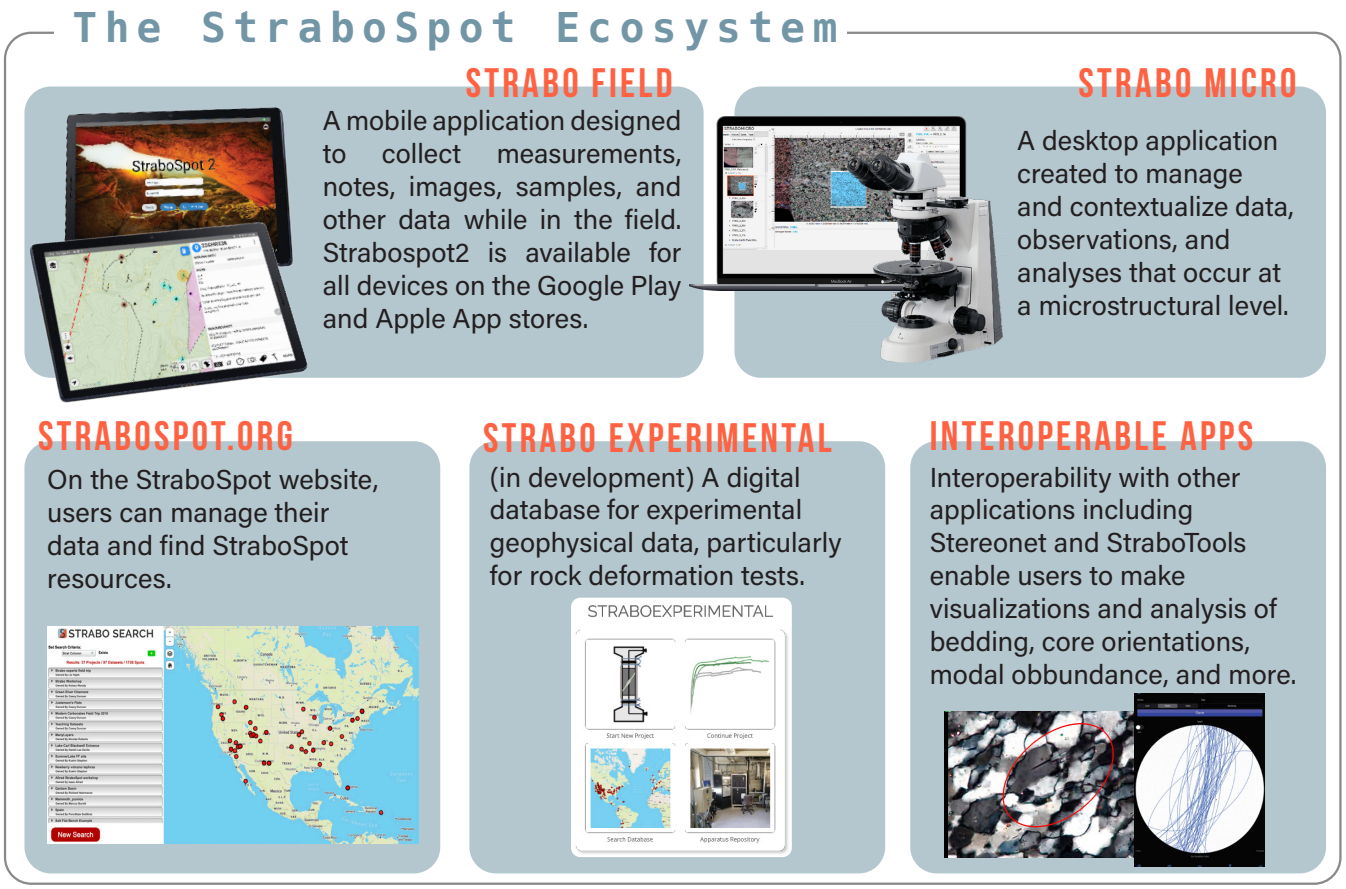
## 1.1 What is StraboSpot

The StraboSpot ecosystem is a network of interconnected applications and software designed to facilitate the collection, management, integration, and sharing of field and laboratory data in the Geologic Sciences. The goal of StraboSpot is to make these data consistent with FAIR (Findable, Accessible, Interoperable, and Reusable) principles and to integrate multidisciplinary field and laboratory geologic data types into one shared data system. Through community input and development, StraboSpot now incorporates structural geology, petrology, sedimentology, and tephra volcanology workflows. The use of controlled vocabularies developed by these communities promotes the standardization of data collection and increases the findability of data.

StraboSpot not only provides a shared data repository, but also the tools to collect and manage data and images. The data system uses the concept of spots, observations that apply over a specified spatial dimension, to nests observations from the regional to microscopic scale and to group data and images as chosen by the user (see below). This approach allows users to connect geologically complex relationships throughout their workflow.

## 1.2 How StraboSpot is Organized

A Spot is the basic element of data collection. It is an observation, relation, analysis, age, or anything that the geologist determines. Spots are fully hierarchical in that a Spots can contain Spots that contain Spots....



Datasets are the next organizational unit. Datasets contain Spots, and for most workers, will correspond to a map area, restricted location, outcrop, or thin section.

A Project in Strabo contains Datasets and Spots. A Project holds Datasets and is made up of a single, or multiple Datasets. The Project contains all the Datasets, vocabulary and custom features associated with the Datasets.

The User Account is the largest element. It allows the User to manage all Projects and Datasets. This management is somewhat limited on the Mobile app, but is fully supported on the Online version (strabospot.org).

## 1.3 About This Manual

This manual describes the basic functionality and features of StraboExperimental. It is based on the prototype version as published and initially presented at AGU 2023. The manual will be continuously updated to accommodate future changes in the site repository. LAPS/StraboExperimental is a project partly funded by NSF (Award 1948453) and is supported by the Experimental Geophysics Community.

## 1.4 StraboExperimental Introduction

StraboExperimental is a digital database for experimental geophysical data, particularly for rock deformation tests. In its envisioned, final form, StraboExperimental is going to be an essential part of the Strabo System (references). Projects entered via StraboExperimental can be linked to other data stored in the Strabo database, including data from the StraboMicro application for microstructure-related images as well as geologic field data imported through StraboMobile. Its aim is to provide experimentalists with a comprehensive and easy-to-use tool to manage, store and share experimental results.

Some major benefits of StraboExperimental are:

- Publicly founded, open-source, and free
- Capability to add all relevant data to an experiment; including apparatus, operating procedures, sensor, sample information etc.
- Public apparatus repository
- User has complete access control over datasets
- Search and presentation features
- Import and export all metadata as JSON files
- Use of reusable templates for quick data entry
- Public rest API

## 1.5 The StraboExperimental Philosophy

The goal of this project is to create a practical standard to describe experimental geophysical data, to implement the findings in an online digital repository and to provide tools for researchers to utilize these standards in the laboratory. While the complexity and the amount of information

related to experimental data can be daunting, StraboExperimental is also useful for very simple tests and applications.

### 1.6 A Metadata Standard for Experimental Data

Experimental data are not per se self-evident and explanatory. As experiments and models are increasingly intricate and complex, contextual information, or metadata, gains in importance to describe results in detail.

A comprehensive set of metadata is useful in many respects. It may be used to estimate the quality and reliability of experiments or its relevance to a theoretical model. It also may provide explanations for unexpected results and is essential to be able to find, reproduce and compile other researchers' discoveries. Direct public access to data and metadata allows to compare results between different laboratories, hence improving data quality. It also creates accountability and facilitates further data processing and long-term storage.

Unfortunately, up to now, in experimental geophysics, no standards exist for the ways data and metadata are to be stored. Most laboratories have their own proprietary workflows and means of data gathering and storage. During publication, it is the researcher's responsibility to add experimental data and metadata in arbitrary digital form to a publicly accessible repository. Without a structured approach, this is frequently a tedious and cumbersome task.

## 2 The StraboExperimental Prototype

During the last years the Strabo Team compiled the most important aspects of various experimental workflows and parameters and created a schema to formulize data entry and storage. We particularly focused on aspects of 'ease of use' and compatibility with existing public repositories to draw on experiences and the needs of the experimental community.

The underlying schema of the StraboExperimental database is based on a perceived workflow for a single experimental test. Following a protocol from choice of equipment, sample selection and preparation to experimental procedure and data collection, StraboExperimental will make sure that most relevant experimental parameters are recorded and stored in an organized way. While only a small fraction of metadata fields is mandatory, the user may optionally add as much information as desired.

Fragmentation of data related to a project is a major concern. While it might appear cumbersome and repetitive to use a form to enter information for each experiment, the underlying premise is that metadata and data needs to be stored and archived together to ensure the usefulness for users as well as for machine learning applications. Adding all metadata information to a dataset does not add significant storage load (<1MB) compared to most other experimental data (e.g., images or data files).

Recognizing that within a project, a series of experiments often use similar or identical conditions and settings, the web application makes extensive use of templates as well as the possibility to import and export information from previous datasets. We hope that this approach saves significant time for data entry. By being able to import and export readable JSON files, lab managers can also incorporate the metadata structure into existing workflows. It is also possible to share these templates with different laboratories.

## 2.1 Description of Data

The data structure of StraboExperimental and LAPS defines a set of experimental metadata necessary to describe geophysical rock deformation experiments. All information (or experiments) are being contained within **projects**, with a project name and description. There can be one or more **experiments** within any given project. A single experiment contains all information for external users to interpret the laboratory results, including equipment and procedures used.

Thematically, experiments are grouped into several sections (schemata):

1. Facility and Experimental Apparatus
2. Digital Data Acquisition (DAQ)
3. Sample Information
4. Experimental Setup
5. Data

## 2.2 StraboExperimental and LAPS Interoperability

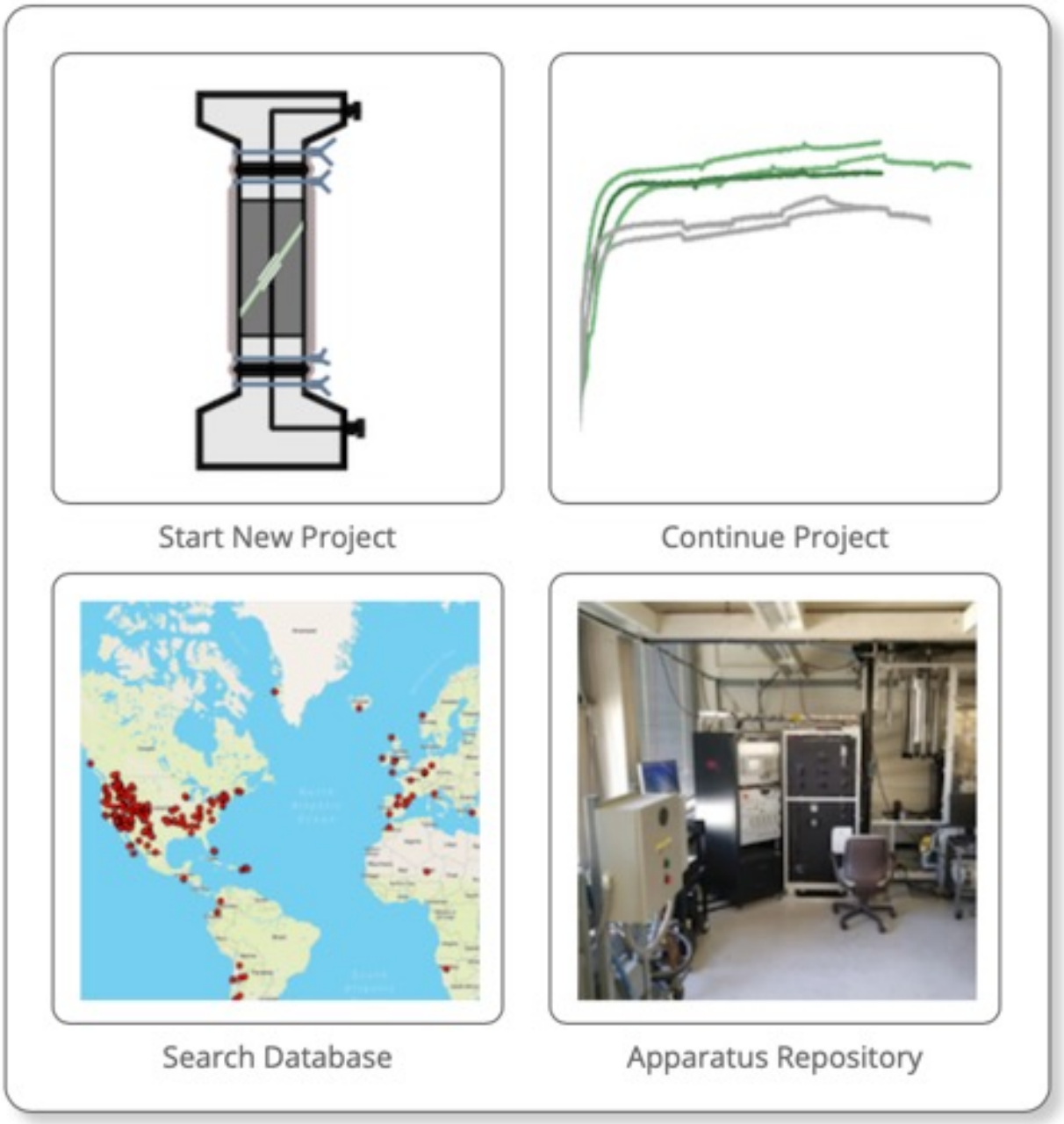
Recognizing the need to manage and store data locally, LAPS tools allow for offline data preparation. It presents a simple and exemplary workflow that may be employed to guarantee that data and metadata can later be seamlessly published to StraboExperimental. LAPS makes use of the JupyterLab environment and Python.

# 3 The Landing Page

StraboExperimental is accessible at https://strabospot.org/experimental/. Before being able to use StraboExperimental, you will have to sign up with your name, address and affiliation. Please contact the Strabo site administrator for more information. After login with your user credentials, you get to the main Projects landing page.

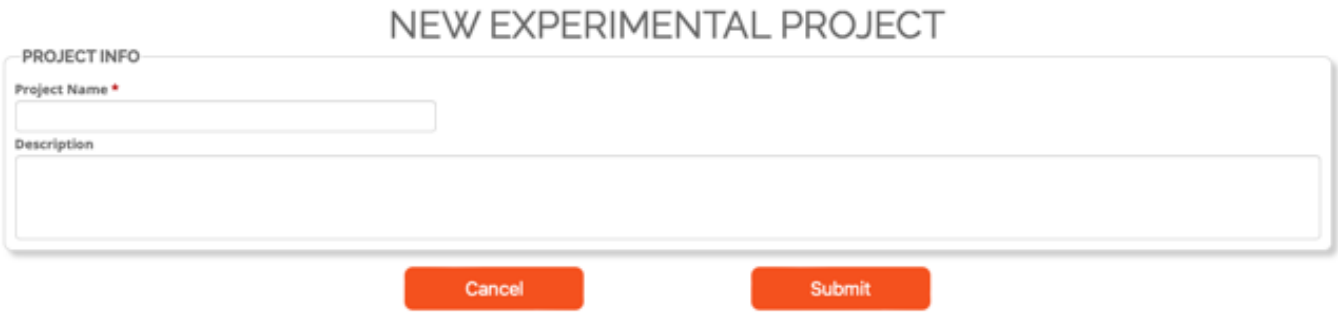
The Landing Page consists of four section:

- Start a New Project
- Continue Project
- Search Database
- Apparatus Repository




## 3.1 Start a New Project

The basic workflow for StraboExperimental users starts by creating an experimental project. This term is used to group individual experimental datasets. A new project may be started from the initial landing page or by adding a new project from within the Project Management page.




The simple form requires only a project name. Once you save a project it will be added to the project list. You can add as many projects as needed.

## 3.2 Continue Project

This page contains all experiments grouped by experimental projects. Differing from the Public Apparatus repository this information is only accessible by the registered user unless the Public option is selected. For ease of use a new project may be added directly from this page. The list of experiments contains the Experiment Id, Apparatus Type and Test Features. In addition, data entered, shows the sections of the workflow that are already completed.

Options for each project are:

- **New Experiment** – creates a new experiment with experimental data and metadata
- **Delete** - deletes the current project **including** all experiments contained within the project
- **JSON** - View/Save JSON file of the entire project
- **Plot Data** - Filter and plot time series data
- **Public** - Toggle switch for private and public access to projects and experiments

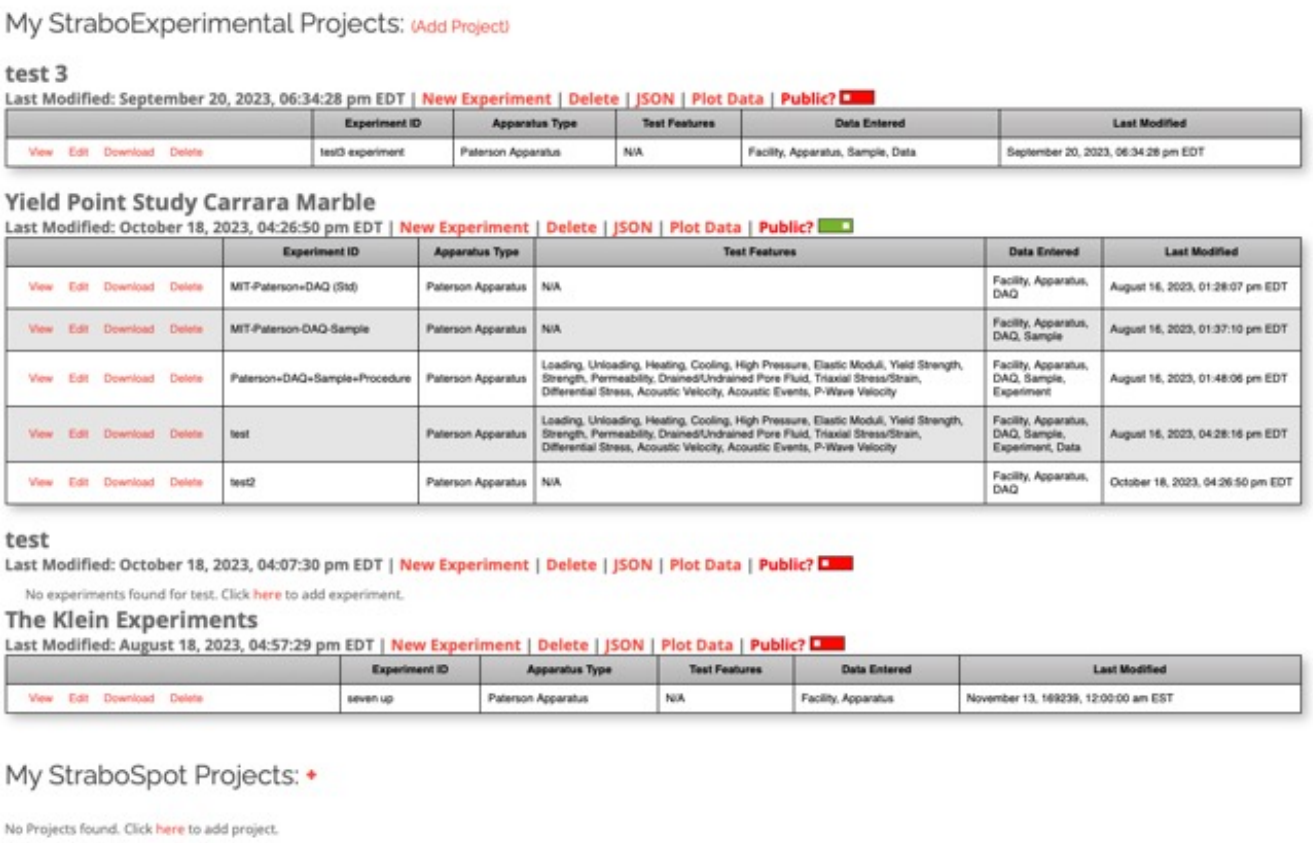
Once a Project contains an experiment, the information can be Viewed, Edited, Deleted or Downloaded to your device. Please not that if you choose to download an experiment currently only the metadata will be saved to your computer. Any documents uploaded to the repository will be referenced by its server id. The functionality to download all information including data files will be added at a later stage.

## 3.3 Search Database

## 3.4 Apparatus Repository

The apparatus repository contains a publicly accessible list of Equipment used in Experimental Rock Physics. It is maintained and updated by the community and facilities and laboratory managers can add to and edit their respective equipment at any time.

Today, many laboratories are also service centers available to external users. Researchers without access to experimental facilities can use this repository to find and utilize appropriate equipment to conduct their experiments. This will benefit the laboratories as well as widen the scope




for potential research. More detailed apparatus information might also serve as a valuable source of information when designing new equipment.

For convenience, the list of apparatuses is grouped by facility and shows name and type of the apparatus. Lab Managers may add, edit and delete apparatuses at any time. Users can only view and browse the directory for specific equipment. Search functionality based on apparatus specifics will be added at a later stage.

### 3.4.1 Facility

For new lab managers to get started, you initially need to add a Facility and a Facility Name, i.e., the name of your lab or group. Also required entries are Facility Type and the name of your Institution (e.g., University). All other entries are voluntary, but we do recommend adding at least a contact name and email. You may add several facilities within your institution if needed.

### 3.4.2 Apparatus

Each Facility contains a list of Apparatuses the Lab manager or responsible party is willing to share with the community. Equipment details should be concise and not contain proprietary information. To add new equipment, click on 'Add Apparatus' in the Facility section of the Repository.

Required information are Name*, Type* of the Apparatus. Additional fields are shown to add specific details about the apparatus and its capabilities. Frequently, generic equipment is being

modified over the years to add new features and capabilities. Such changes may be outlined to reflect the most recent upgrades.

The Parameters section lists machine limits with respect to Pressure, Temperature, Stress, Load, Dimensions, etc. capabilities. They are included to help users find equipment that covers a certain range of experimental conditions. Supporting documents such as manuals, diagram, photos or schematics may be uploaded as desired. If in public domain, specific design drawings may be included.

# 4 Add Experiment

The second step in the StraboExperimental Workflow is to Add an Experiment to a Project.

This page contains the main functionality and information for a specific experiment. The user has several options to enter the required data:


**Load All Data from Previous Experiment:** It is the fastest way to replicate a dataset for quick entry. Selecting this option opens a list of all projects and Experiments in the User database and will create a copy of the selected data and metadata under the current project. Please note that the data section contains a reference to the original data files. Make sure you update these accordingly.

**Load All Data from JSON File:** Recognizing that users would like more control over the type of metadata templates, you can choose to upload data from a JSON file on your computer. If you edit the JSON file to accommodate your needs, make sure you adhere to the original metadata structure outlined in the schema. If unsure, you can download an existing dataset as a template and modify it.

This feature will only upload the metadata and not the actual data files. Please note that if your template contains references to existing files on the server, these links will only work if you have

permission to view these. It is possible, and intended, to exchange templates between different laboratories, but existing data references in the JSON files will have to be updated.

The StraboExperimental metadata is organized into the following sections:

- Facility Information
- Apparatus Information
- DAQ (Digital Data Acquisition)
- Sample Information
- Experimental Set Up and Procedure
- Data

Individual sections (e.g., Sample Info) may be populated Manually, from Previous Experiment or From a JSON File. The Facility and Apparatus section also allows the selection of equipment from the public Apparatus Repository as described previously. The added Apparatus will contain references to all files uploaded to the original repository. All registered users have permission to view these documents. If there are any changes to the Apparatus for a specific experiment (e.g., newly added capabilities), you can add them here. Any modifications made here will not update the information in the Apparatus Repository.

Please note that you can populate each section from its corresponding part from a Previous Experiment in your Project Page. For example, you can choose to load the Sample Information from one of the previous experiments and the Apparatus from another experiment. This gives you full flexibility in prepopulating StraboExperimental within the application. The JSON Import/Export capability will allow you to manipulate experimental metadata on your local computer as well.

## 4.1 DAQ - Digital Data Aquisition

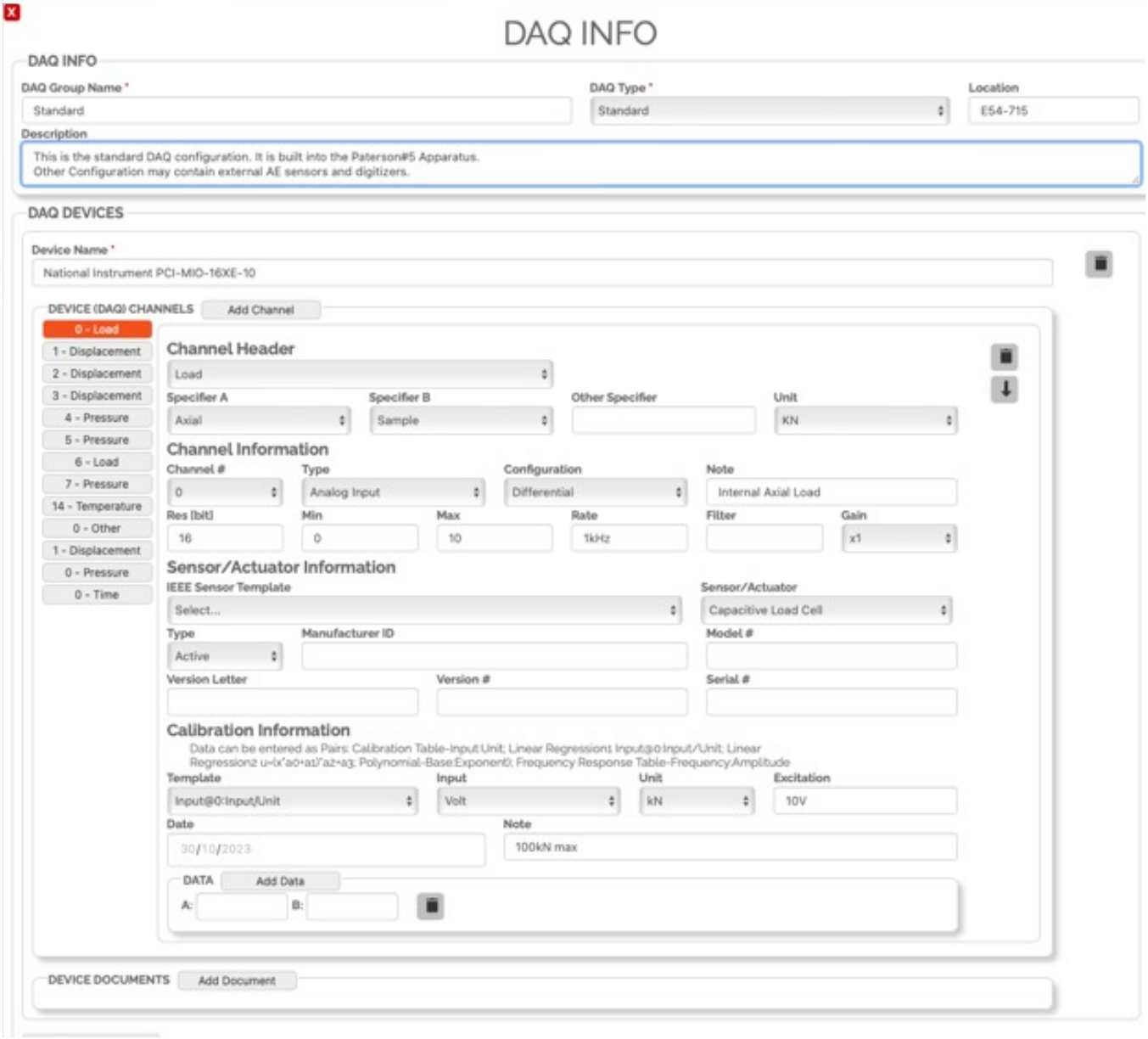
The Digital data Acquisition Part is specifically designed for Laboratory Managers and users who would like to know more about the system details and how the data was acquired. Adding information into this section is not required.

For most cases, DAQ is an integral part of the apparatus, but some tests use additional measurement devices or configurations. In addition, sensors and sensor calibrations might change from experiment to experiment. It is therefore important to have a means to add this information.

We chose the terminology of a DAQ Group that describes the complete set of physical measurements, sensors and actuators. If you choose to enter DAQ information, a DAQ Group Name and the DAQ type is mandatory.

A DAQ Group might consist of one or more DAQ Devices (required). Each device consists of an array of sensors and possibly actuators for measuring and controlling a range of physical properties and parameters (Channels).

You may select from a large selection of physical measurements (Channel Header) and a set of property dependent Specifiers. Please note that the list of options offered is a compromise for structuring the information. It therefore may not be exhaustive and is a work in progress. The Header section also contains fields for Units and additional information the user can add (Other Specifiers).




Channel Information lists general parameters for the chosen property to measure, such as index, and details for the type of electrical connection, range, frequency, sample resolution and amplifier settings (filter, gain). Options not listed can be added in the Notes field.

For Sensor and Actuator Information, we follow a shortened IEEE template but also added commonly used Sensors for Geophysical laboratory tests, recognizing the fluidity of the field.

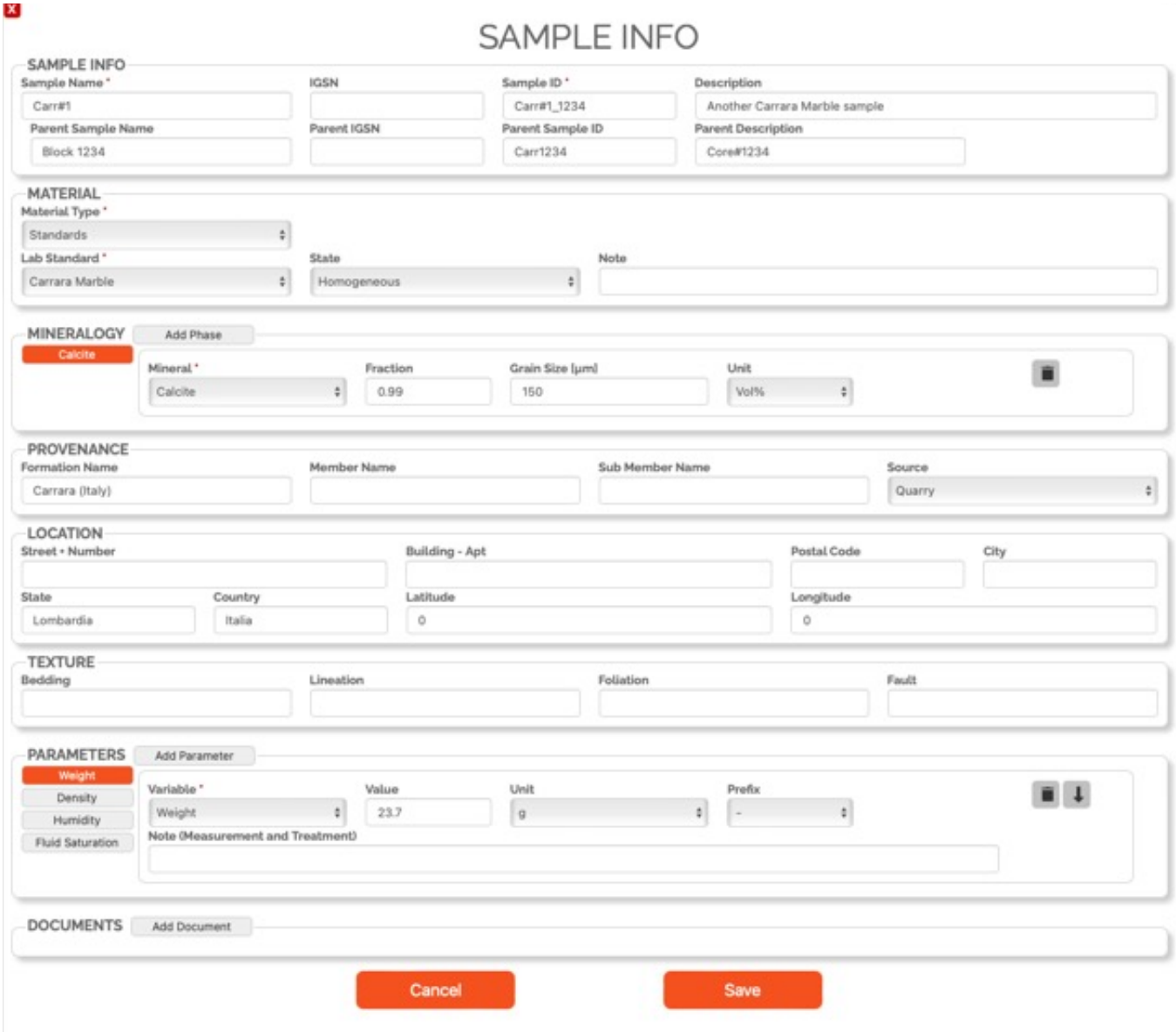
A Calibration Section allows users to store sensor calibrations in a variety of ways. After choosing a suitable calibration template and units, a table of input/output values may be used to the calibration data with the current calibration date.

Each DAQ device also allows the upload of documents describing its function and configuration in more details.

## 4.2 Sample

All sample related properties may be added in the Sample Form. Combination of Sample Name*, IGSN, ID*, and Description should be unique for each dataset. We also provide the option to add

parent sample ids to allow for experiments on successive samples.




The Material Section entails all Sample material information, except for geometry and specific preparation for the test. This is covered in the Experimental form.

The material section is currently still the development stage. Common Material Types (e.g., Rock Types, Minerals or Commodities) are added for convenience but the list is not comprehensive. A menu lists different material types such as common minerals and rock types. In the prototype version the selections are unique. In subsequent versions we plan to link the choices to standard mineral and rock databases as well as to the Strabo rock repository. Material state depicts the general condition of the sample (e.g., solid, powder, composite) together with a note field for more details. Description of more complex materials will have to be added as a separate document.

**Mineralogy** lets you add the sample mineralogy or the composition of a powder, mixed sample or gauge layer. Adding phases to the mineralogy allows to add the Mineral name, the Fractional Composition and Grain Size if needed.

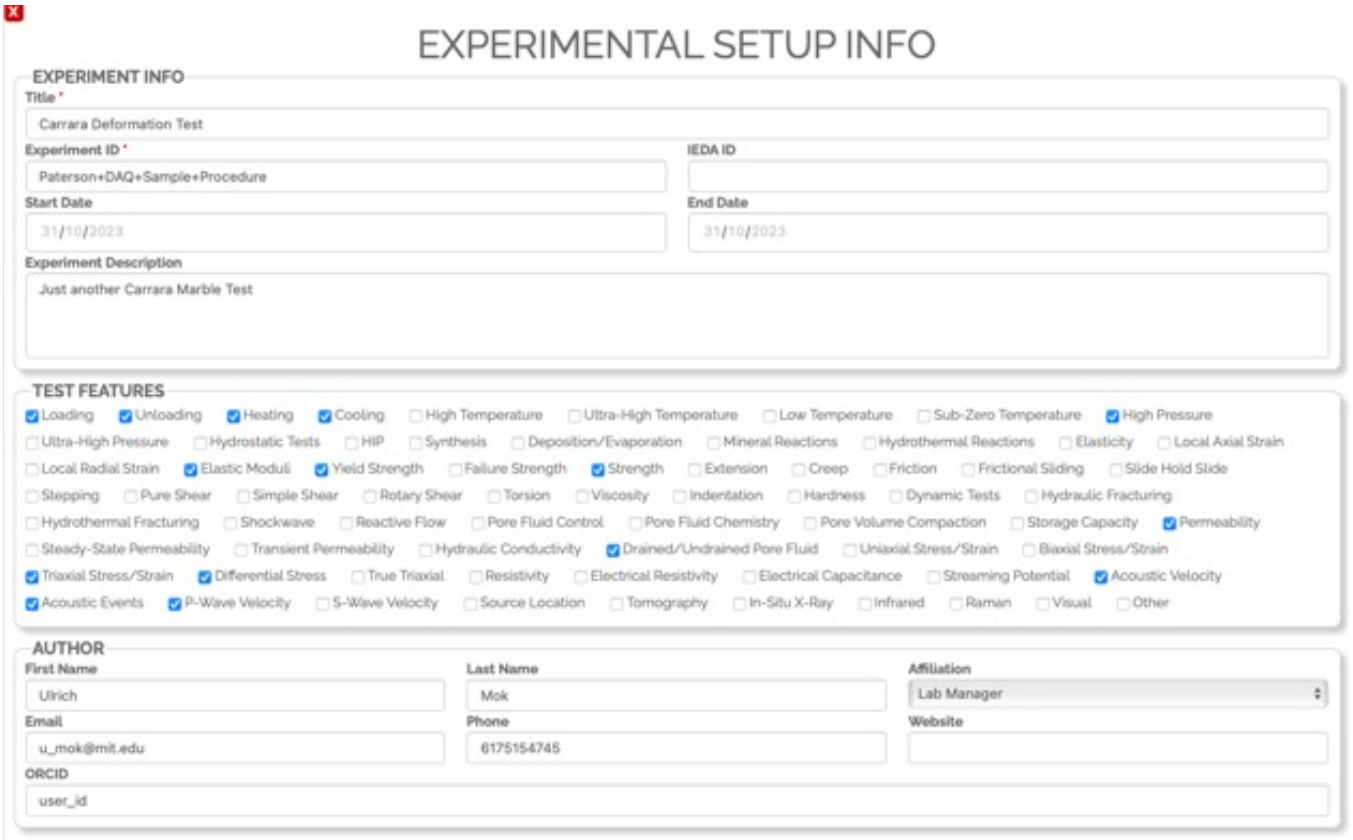
**Provenance** describes the general source and location of natural samples and rocks as well as their geological formation and member names.

**Texture** adds optional fields to describe macroscopic features, such as bedding, lineation, foliation and faults. For detailed descriptions and information, it is recommended to upload supporting documents (e.g., pictures and/or data).

**Sample Parameters** lists sample weight as well material specific properties, such as density, permeability, porosity and/or prestress conditions, as well as specific sample treatment (e.g., humidity, fluid saturation, etc.). This is not a comprehensive list, and it may be extended added in future. Sample and assembly geometry will be covered in the experimental section.

## 4.3 Experimental Set Up and Protocol

Experimental title, ID, start and end date as well as a basic description are entered in the information section. The API also contains the Project Name.

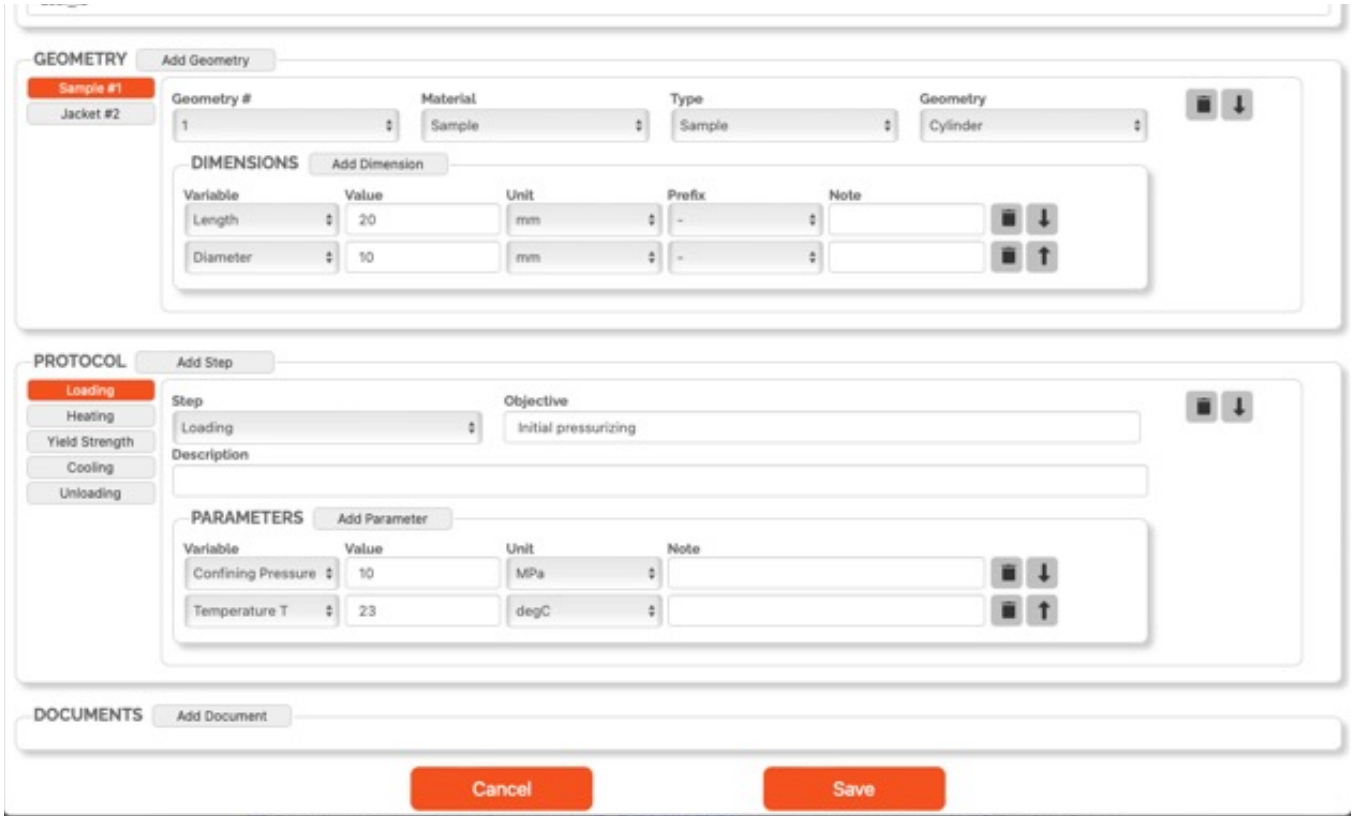



**Test Features** allow to add commonly applied test procedures. They are distinct from Apparatus features because they will indicate the purpose of the test and the applied methods. Make sure that all procedures are checked.

**Author** is the experimentalist who is responsible for running the test. At least a name and email address is recommended to ensure the proper authorship of the experimental results.

**Geometry** is for sample as well as assembly geometry. You can add as many assembly elements as you like, including sample, jacket, spacer and forcing blocks. It allows for most used geometries for rock physics and petrology (e.g., cylindrical, rectangular, dog bone). Even complex assemblies can be described using the indexed order of geometries.

**Protocol** lets the users add a step-by-step procedure for a test. Listed steps are all features checked under Test Features (e.g., Heating, Loading, Permeability, etc). Each step contains a




field for Objective and description as well as Step Parameters. Parameters are values for specific test variables, such as Pressure, Temperature and Load. The protocol order can be rearranged according to the test sequence.

**Documents:** supporting information to the test protocol and objective.

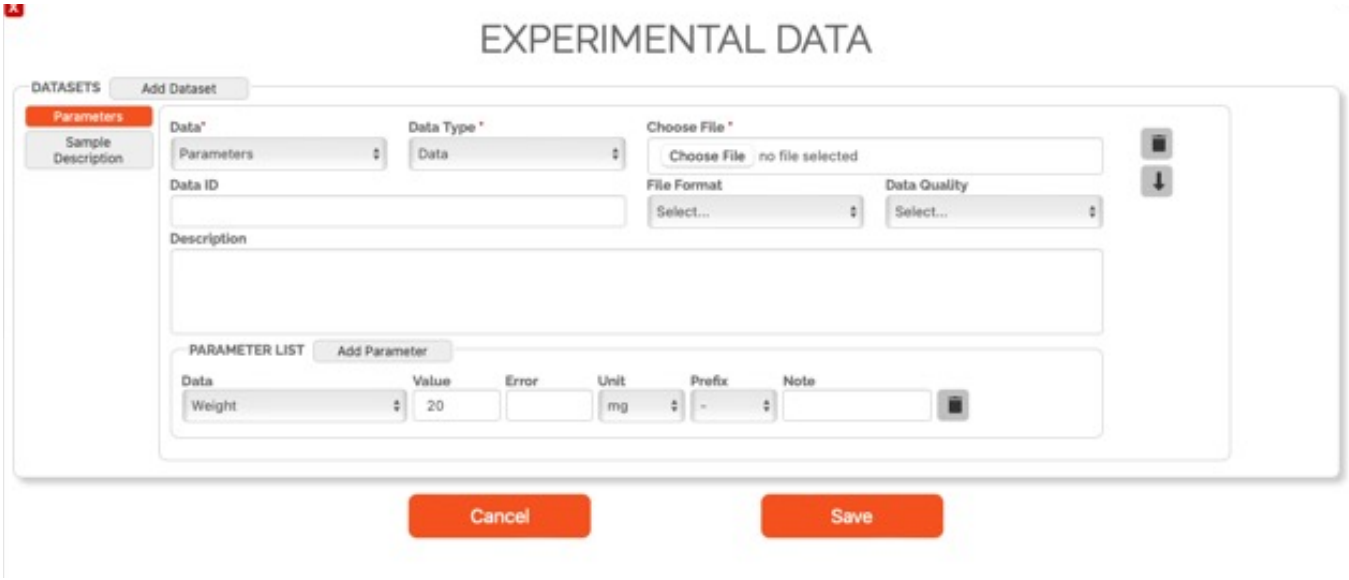
## 4.4 Experimental Data

This section is to upload pre- and post-experimental results and data, such as Pictures, SEM, micrographs, Data files, software, etc. We recommend organizing the data into datasets. Each dataset contains a specific type of data type (shown via pulldown menu are a list of common types for experimental results.) Most data types are unstructured images, videos or experimental results and require a Data Type, ID, File Format, Description and an estimate of the Data Quality. A file upload option is available for each data type. Please refer to the API for the upload of a series of images or pictures. However, there are some exceptions where data may be entered in a more structured way. Please note that this is an attempt make the data more useful for external users and the public.

### 4.4.1 Specific structured Data Types

**Parameters:** Here the user can manually add a list of pre- and post-experimental measurements. They can include sample length or diameter or any other single measurement (e.g., permeability) that applies to the test.

**Pore Fluid:** Users can add multiple pore fluid phases with their respective fraction/fugacity or activity values. For each phase the pore fluid chemistry can be added with the most common anion/cation composition.




**Time Series:** Most commonly, a deformation experiment will contain some form of time dependent measurement (time series). These are mostly used to analyze elastic and inelastic rock properties and may contain time, stress, strain, pressure, load, temperature or any other low frequency measurements. High frequency data such as acoustic emissions will be treated separately.

The time series dataset should contain details about file content and format. The data header section is an attempt to allow digestion of the data files in a more structured way. Like the Headers in the DAQ section, they contain additional descriptors to make each header unique.

It is assumed that the data is contained in a text file and a tabular format with individual measurements listed as columns. Only the number and standardized names of data headers entered with their respective format are considered. Additional headers or columns contained in the data file will be ignored.

### 4.4.2 Nomenclature of Data Headers

The main Header categorizes the type of measurement taken. These include common basic and derived Variables such as: Time, Temperature, Pressure, Load, Stress, Displacement, etc.

Secondary Header Information (Specifier A) depend on the initial header choice. For example, if Temperature is chosen as main header, there are the following options available: Room, Sample, Furnace, Vessel, Pore, Fluid.

Lastly, Specifier B depicts more detailed information about measurement location (e.g., Sample Top, Average, Bottom, Internal, External, etc). An additional descriptor field is added for more measurement details but is not mandatory. For non-conventional data headers, a list of SI and derived units is available as well.

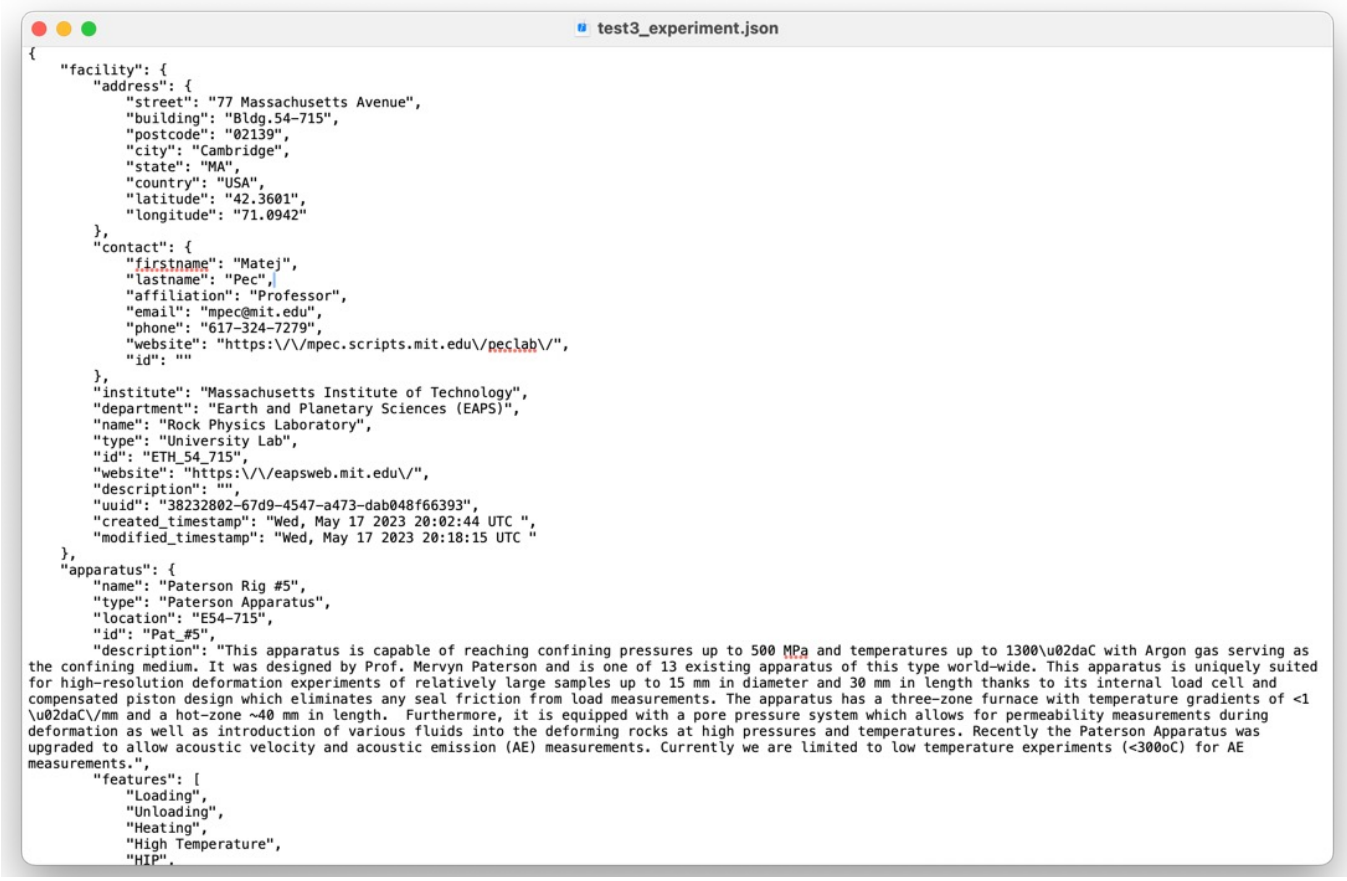
# 5 JSON Import and Export

This section describes the (optional) capabilities for using readable JSON files as experimental templates. They are using the same schema as the API but are more easily accessible for the end

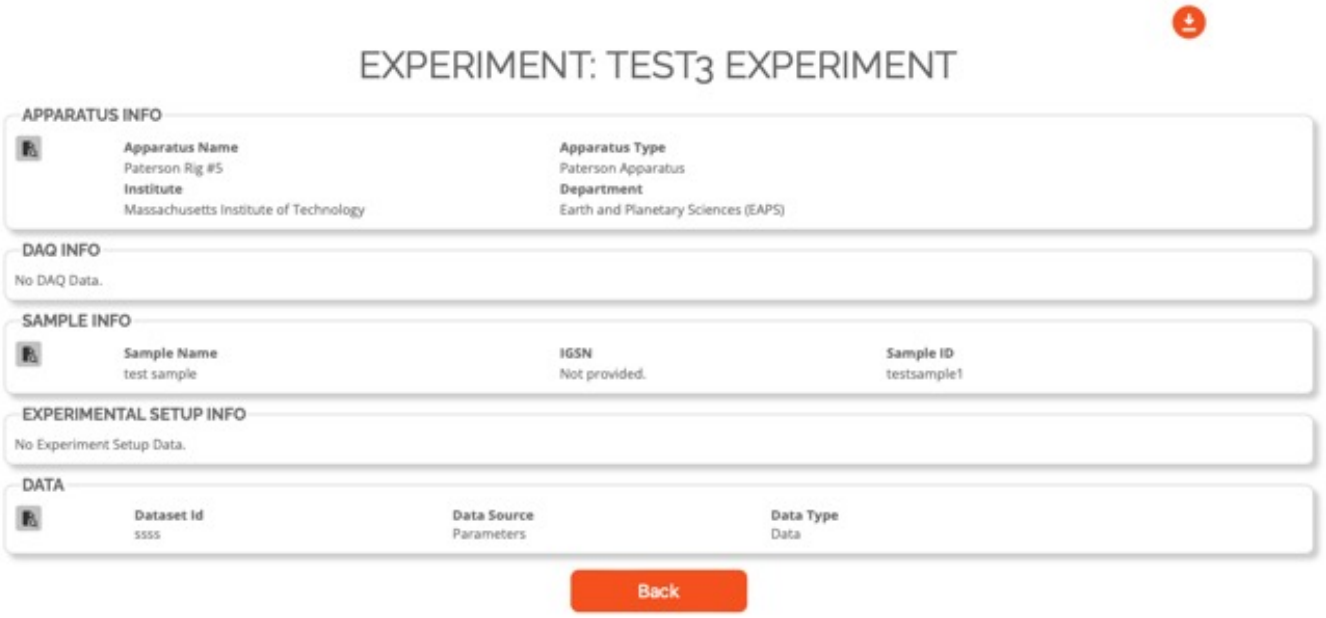
users. We briefly summarize the various options to make use of the Import/Export capabilities of StraboExperimental.

The exported JSON file lists all data entered in the web form (values) as well as their corresponding properties in a hierarchical structure that follow a predefined schema. Only files that adhere to this schema and are valid JSON may be used as templates and can be later uploaded to StraboExperimental. If you follow the schema guidelines, you are free to modify the files in a text editor. We will also offer offline editing tools with LAPS later.

**Option 1:** In your Project Page, choose an Experiment and select Download. This will download your entire experiment. You can download a JSON file at various stages in your workflow and save them as backup or template containing a combination of Apparatus, DAQ, Sample and Testing Information. For a series of experiments using similar settings, you may simply upload the template and modify experiment specifics (i.e., Sample Name or Specific Sensor Calibrations). This will speed up your data entry significantly.




**Option 2:** In the Project Page, choose an experiment and click View. The download button for Download Project JSON on the top right corner of the page will let you download or copy the JSON data for the experiment.


EXPERIMENT: TEST3 EXPERIMENT
APPARATUS INFO
Apparatus Name
Paterson Rig #5
Apparatus Type
Paterson Apparatus
Institute
Massachusetts Institute of Technology
Department
Earth and Planetary Sciences (EAPS)
DAQ INFO
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SAMPLE INFO
Sample Name
test sample
IGSN
Not provided.
Sample ID
testsample1
EXPERIMENTAL SETUP INFO
No Experiment Setup Data.
DATA
Dataset Id
ssss
Data Source
Parameters
Data Type
Data
Back


DOWNLOAD PROJECT
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Cancel
Copy
Save