BrAPI4PSI FAIRagro

Integration of BrAPI into a proprietary software solution for FAIRification of high-throughput phenotyping based on the MIAPPE standard

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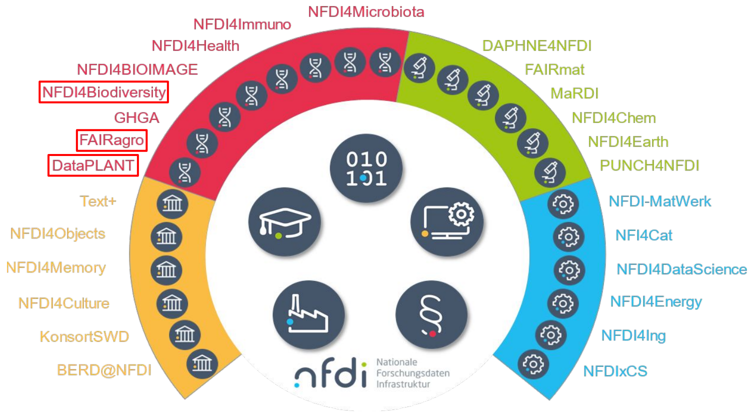
Images: www.capitalise.eu, https://www.ipk-gatersleben.de

What is the NFDI? - National Research Data Infrastructure

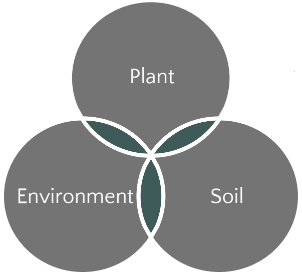
- Supported with ~900m € over 10 years by federal and state governments
- Addresses all research domains: **A**rchaeology to **Z**oology
- Consolidation with continuous funding
- Aim is to
  - systematically manage scientific data
  - provide long-term storage and accessibility
  - network the data on (inter-)national level

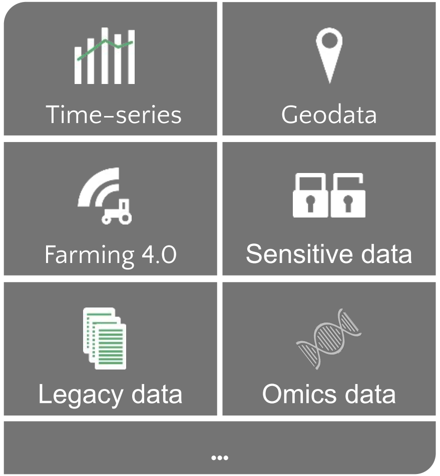


- Plant sciences represented in 3 consortia

What is FAIRagro?

- FAIRagro consortium (>30 partners) is building a FAIR research data management system
- focuses on agrosystems science
  - crop production
  - ecosystems & landscapes
  - plant-soil-environment interactions



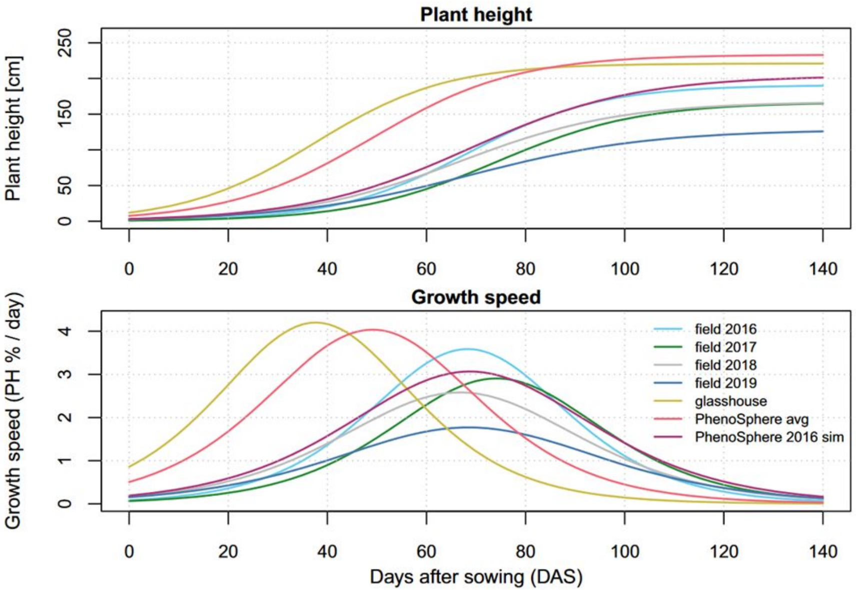


FAIRagro

https://fairagro.net/

Incentive - IPK PhenoSphere (Container System)

2 compartments: 2 x 116 m² (2 x 54 Container)

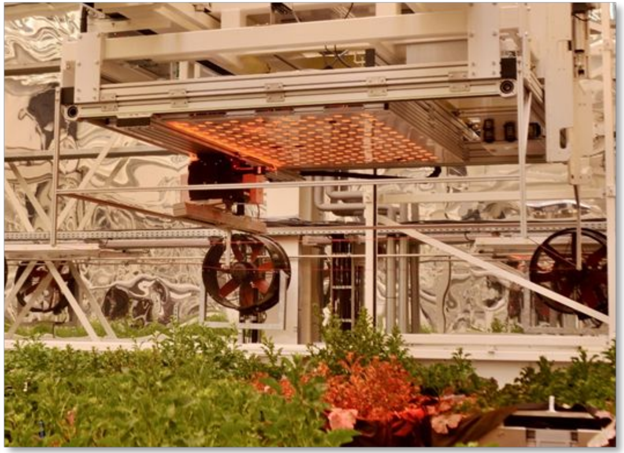


- **illumination**
  - up to 1500 µmol/m²*s PAR
  - discharge lamps + UV-A + different LEDs
- air/soil **temperature**
  5-25 – 40°C ± 1°C
- relative air **humidity**
  20 – 70% (90%) r.h. ± 5%
- **wind** simulation ≤ 4 Bft
- **CO_2**: 400 – 1200 ppm
- automated **watering**
  (drip irrigation)
- **aerial** and **soil** sensors

The PhenoSphere can recreate a single field season with similar plant growth and development progression.

Heuermann *et al.*, 2023; *Nat. Comm.* **14**:5783

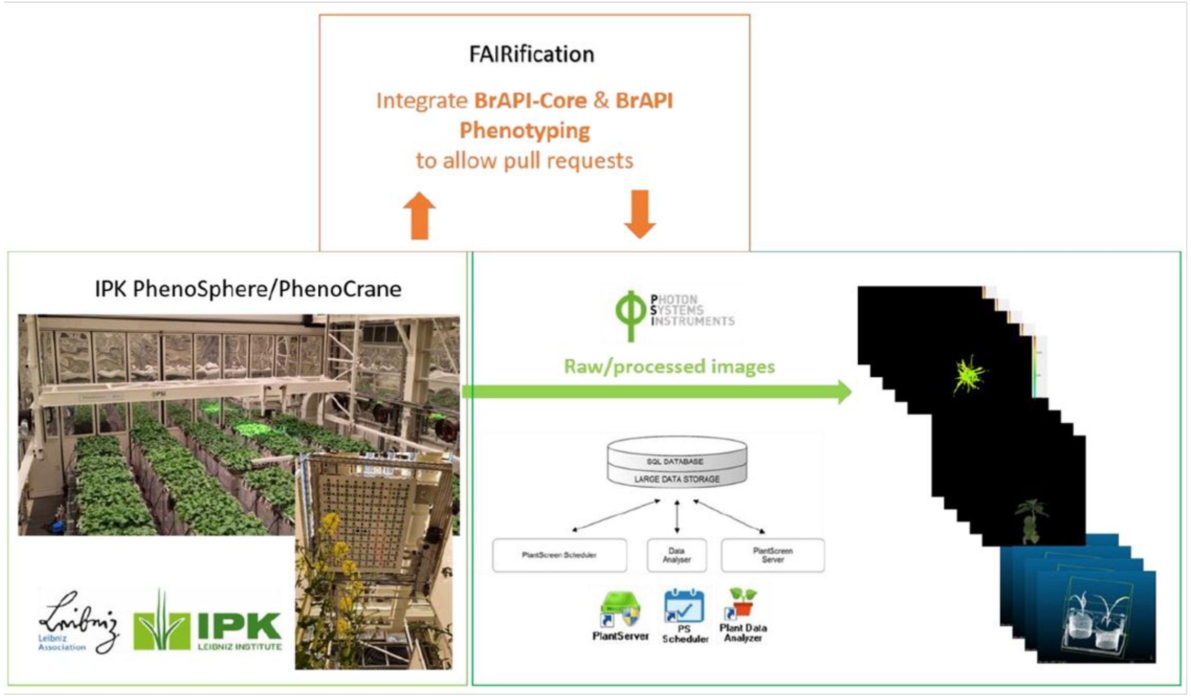
IPK PhenoCrane



1. high-resolution RGB imaging (architectural & color-related traits)
2. 3D laser scanner (precise canopy height)
3. FluorCam (Chlorophyll fluorescence)
4. Visible-NIR hyperspectral camera (e.g. score abiotic/biotic stresses)

The PhenoCrane generates images daily for high-throughput phenotyping using multiple camera modalities.

UC Pilot concept and objective

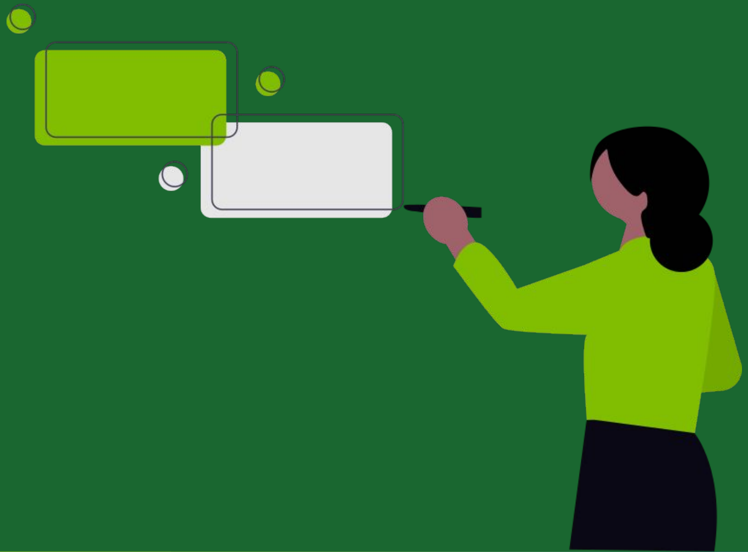


Integrate BrAPI into PSI phenotyping software (PSI SQL database)

FAIRify exemplary PhenoCrane images

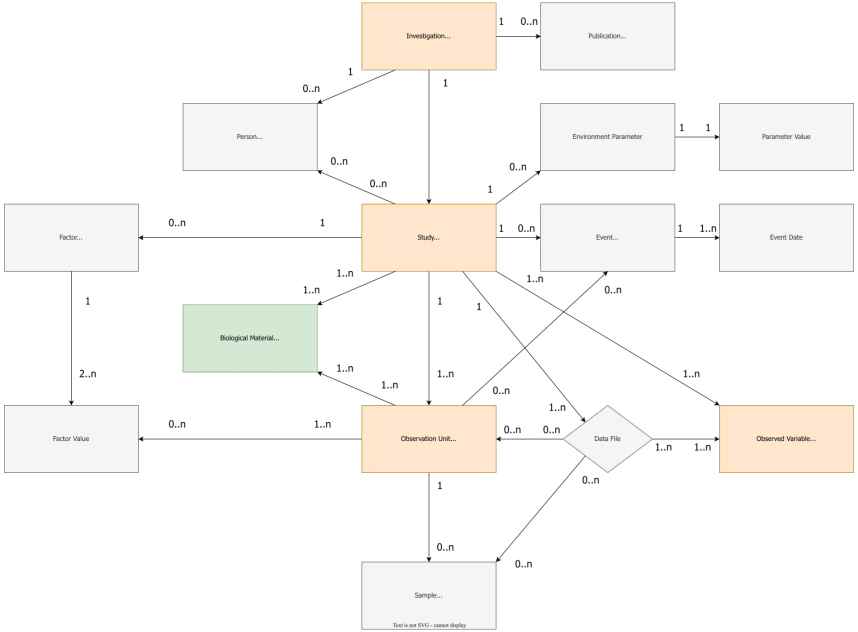
Build on the MIAPPE standard to connect ISA-JSON with BrAPI

Methods



MIAPPE
Minimal Information About a Plant Phenotyping Experiment

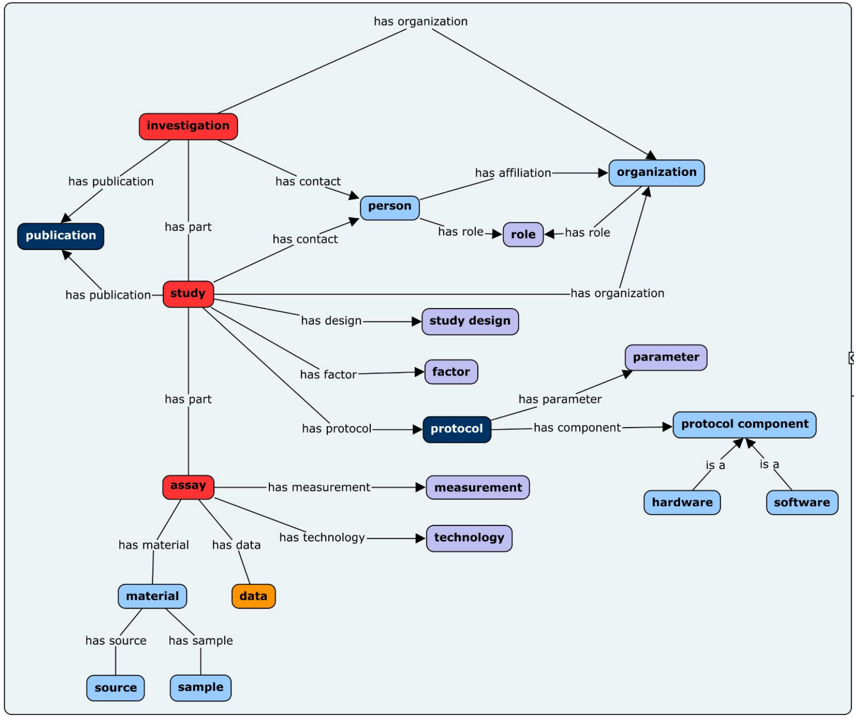
- Harmonizes description of
    - Experimental design
    - Plant materials and traits
    - Data annotation and file references
- Enables sharing and reuse of phenotyping datasets
- Provides mapping to open standards
    - Breeding API
    - ISA standard



ISA

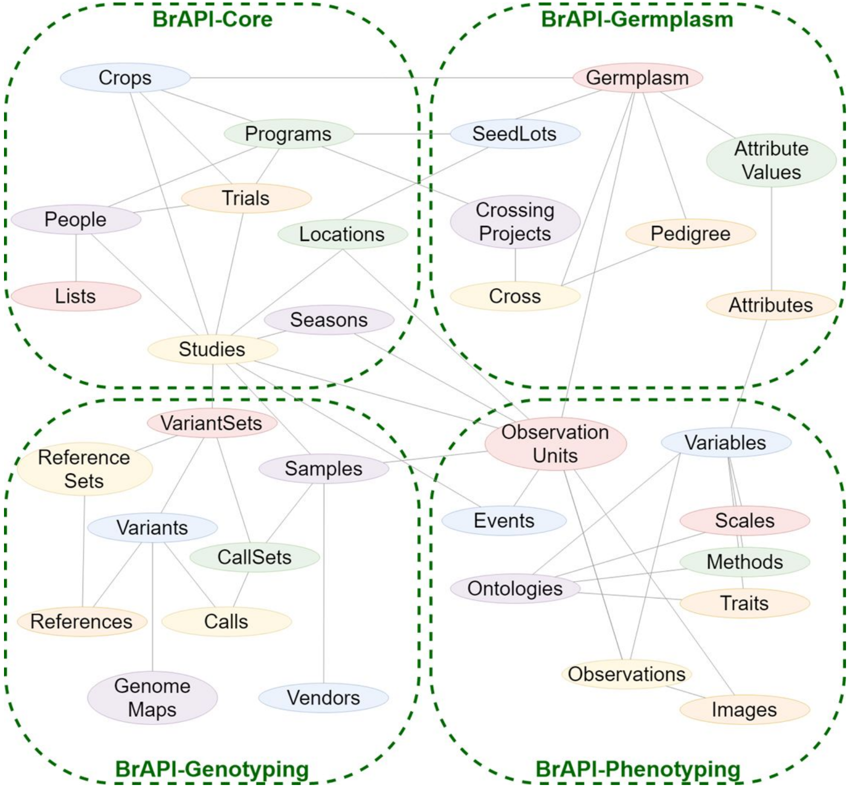
Investigation / Study / Assay

- Structured metadata model for life sciences and beyond
- Supports metadata capture and integration across domains
- Provides
    - A **conceptual model**
    - **Serialization formats** (`ISA Tab`, `ISA JSON`)
    - **Tools** for authoring and validation



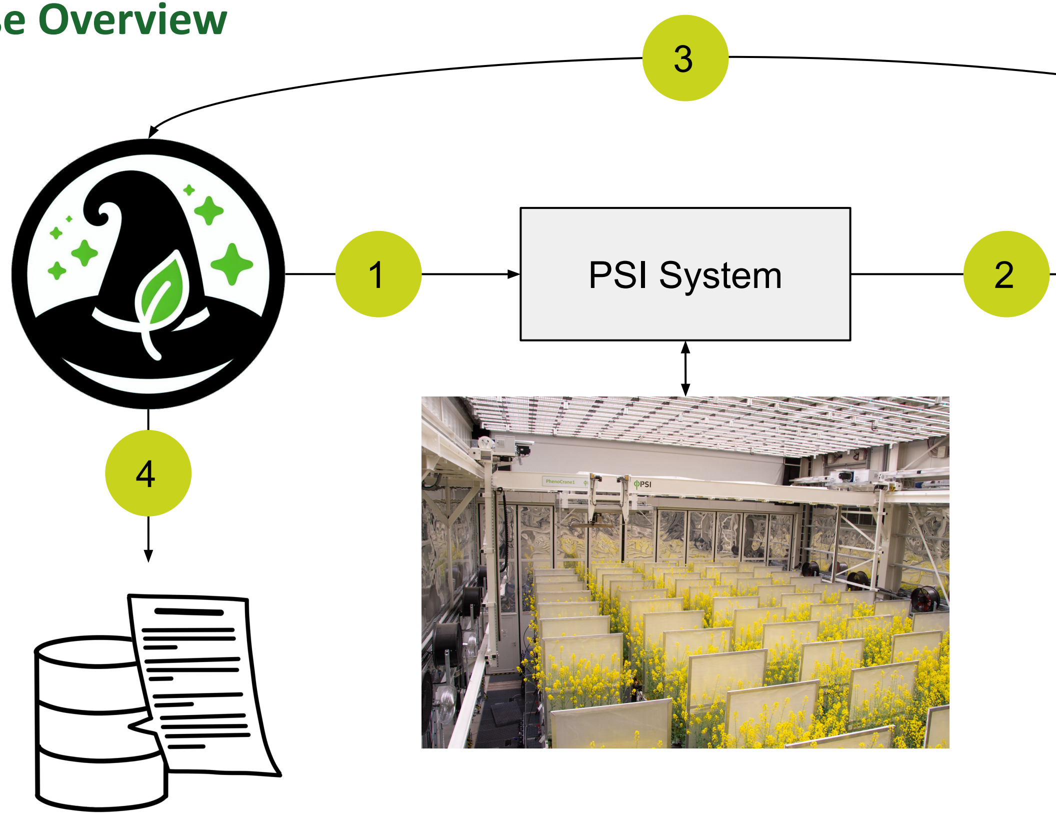
BrAPI
Breeding Application Programming Interface

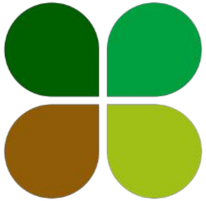
- Community driven standard to enable interoperability among agricultural databases and tools
- Standardized RESTful web service API specification
- Modular design
  - Core
  - Phenotyping
  - Germplasm
  - Genotyping



Results

Use Case Overview





Example data set: 2236DK

AVATARS experiment (benign conditions) during flowering.
54 containers in compartment 1, equipped with 48 WOSR varieties. Photo taken during the daily PhenoCrane RGB imaging.

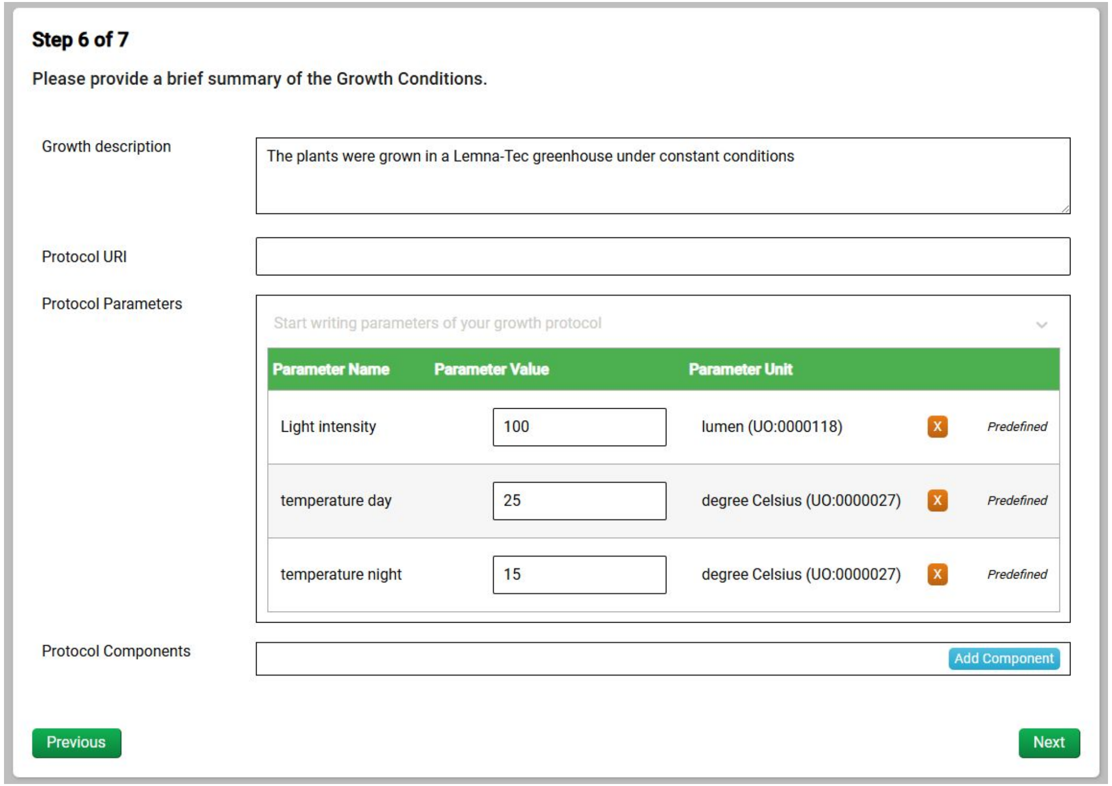
https://www.avatars-project.de/

ISA Wizard

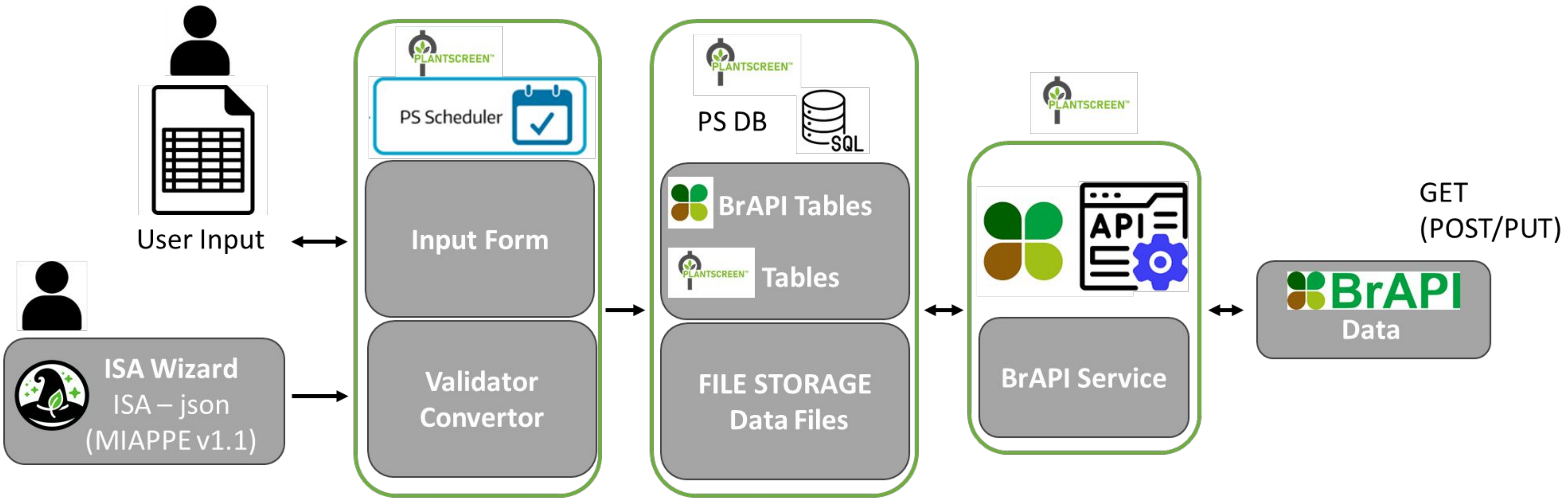
https://brapi4psi.ipk-gatersleben.de/

- Web application for the annotation of metadata of ISA compliant dataset
- Configurable questionnaire to complete annotation checklists like MIAPPE

1. Configuration of a ISA Wizard instance tailored to typical automated plant phenotyping experiments at IPK
2. Extension of the ISA Wizard to cater for requirements (e.g. optional explanations of the steps)

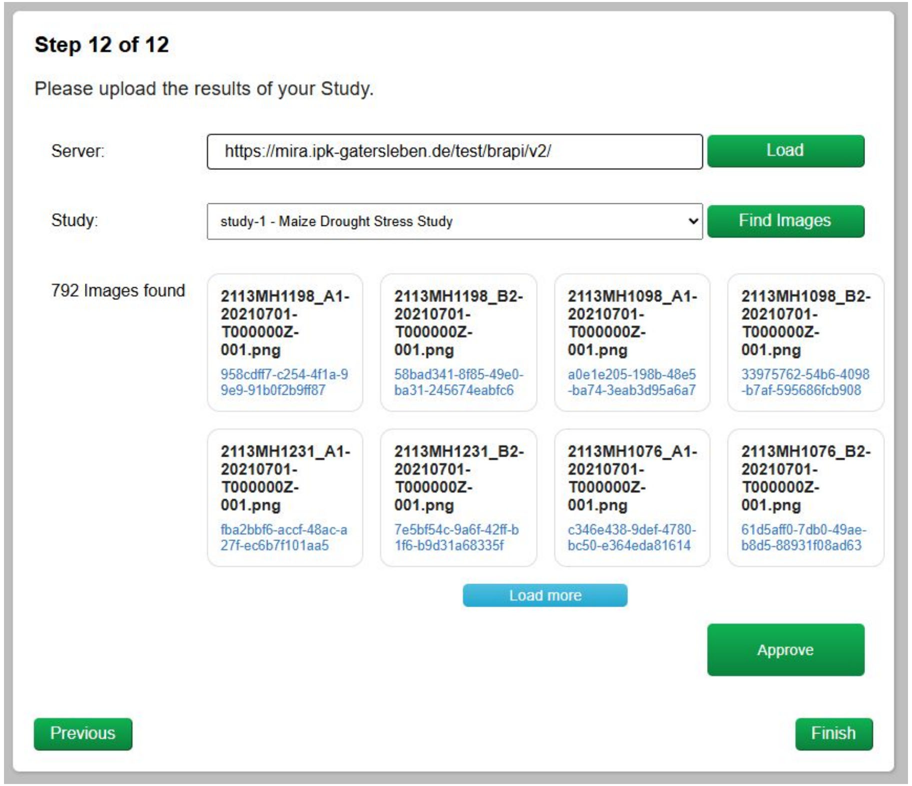


PSI BrAPI Server



BrAPI Integration

- Implementation of a BrAPI-based component for the ISA Wizard
- Query the BrAPI Server by
  - Studies
  - Images
- Import the BrAPI images into the ISA JSON as outputs of an imaging process
- Creation of FAIR Digital Object using the Annotated Research Context (ARC) framework



Conclusion

Summary

- Foundation for FAIRification of IPK’s phenosphere
    - BrAPI server and client will be implemented in the PSI software
    - Implementations can be reused and adopted by other phenotyping facilities using PSI hardware (e.g. IPK’s controlled environment HTP systems, NPEC HTP Wageningen University & Research and Utrecht University)
- ISA Wizard extends the original scope of the use case, but promises a more intuitive metadata annotation

Outlook

- Open Questions:
  - Where to deposit the images?
  - How to model continuous weather conditions in ISA?
  - Extension of the BrAPI specification (e.g. `GET /images?studyDbId=study1`)
  - How to continue work on this topic when the use case ends?

Thank you for your kind attention

Project Number: 501899475

PSI BrAPI Server