

JLU

NEUE WEGE. SEIT 1607.

JUSTUS-LIEBIG-
UNIVERSITÄT
GIESSEN

BION: A BRAIN IMAGING UNIT

OUTLINE

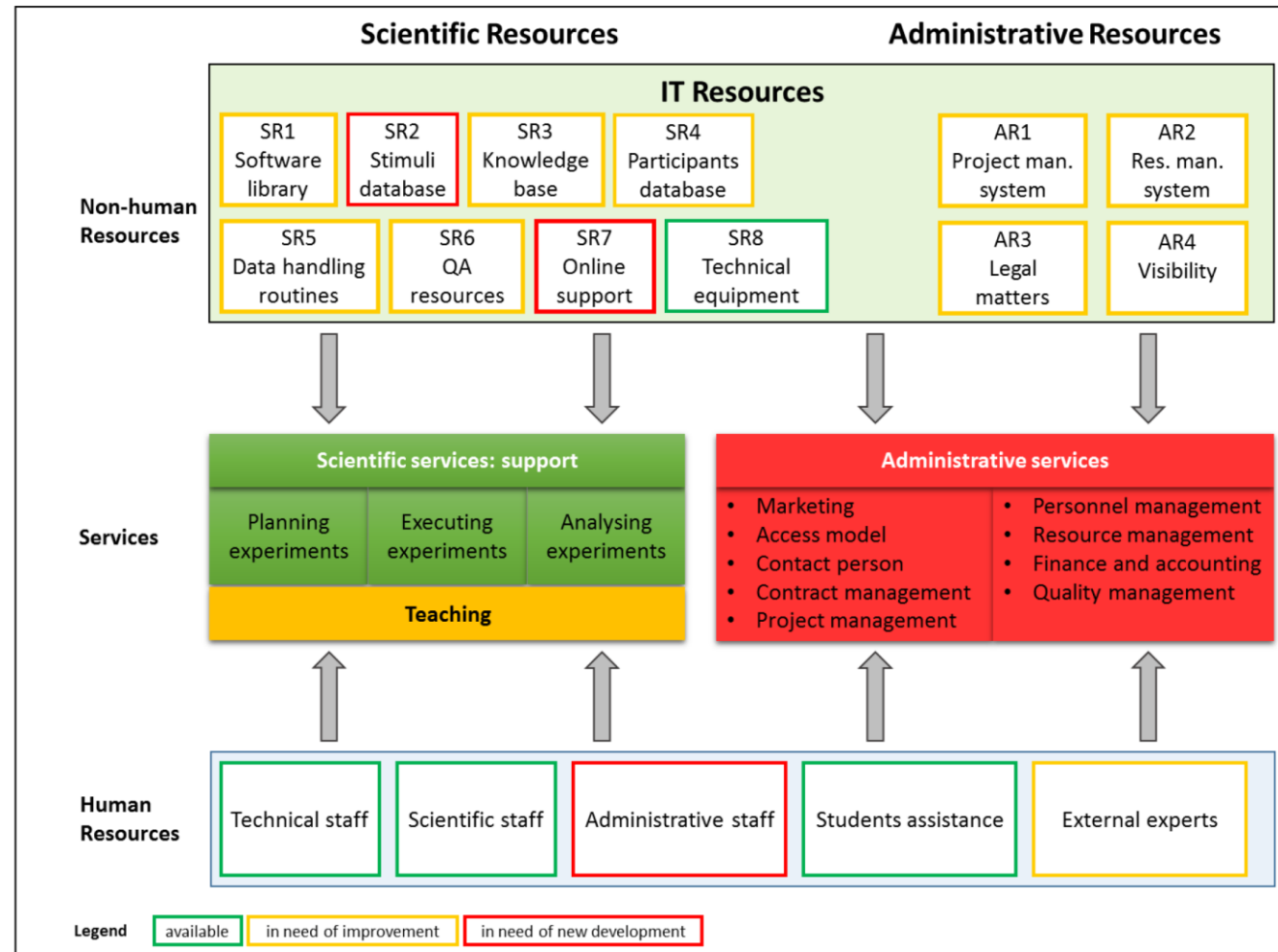
- **Who are we?**
- Management of Brain Imaging Data
- Facility Management

BION: WHO ARE WE?

- Bender Institute of Neuroimaging (BION) founded in 2000 by Prof. Dr. Dieter Vaitl.
- Named after Hans Bender (1907-1991), founder of the “Institut für Grenzgebiete der Psychologie und Psychohygiene (IGPP)”.
- Currently, a unit of the Department of Psychology and Sport Science (FB06)
- 3 T MRI scanner for scientific use (Siemens Prisma)
- Head: Prof. Dr. Rudolf Stark

PLEASURE

PLannning, Experimental, and Analysis SUpport in REsearch (PLEASURE)



SERVICE UNIT IDEALISM

- Data management plan
- Storage + computational resources
- Software (possibly licensed and expensive)
- Introduce and provide currently promoted features
 - Version control (e.g. source code, documentation)
 - Imaging data standardization for easy sharing etc.
- Offer information / knowledge / tutorials to users

SERVICE UNIT IDEALISM (CONT.)

- Possibly generate necessary information on demand
- Be ready for “big data” (e.g. standardize data layout) and other recent developments in the field (e.g. containerized analysis).
- Resource usage monitoring: not only the MRI scanner, but also storage size and CPU time used on hardware, etc.

Do not implicate or enforce any data handling or analysis methods to users.

Users hold all copyright and intellectual property.

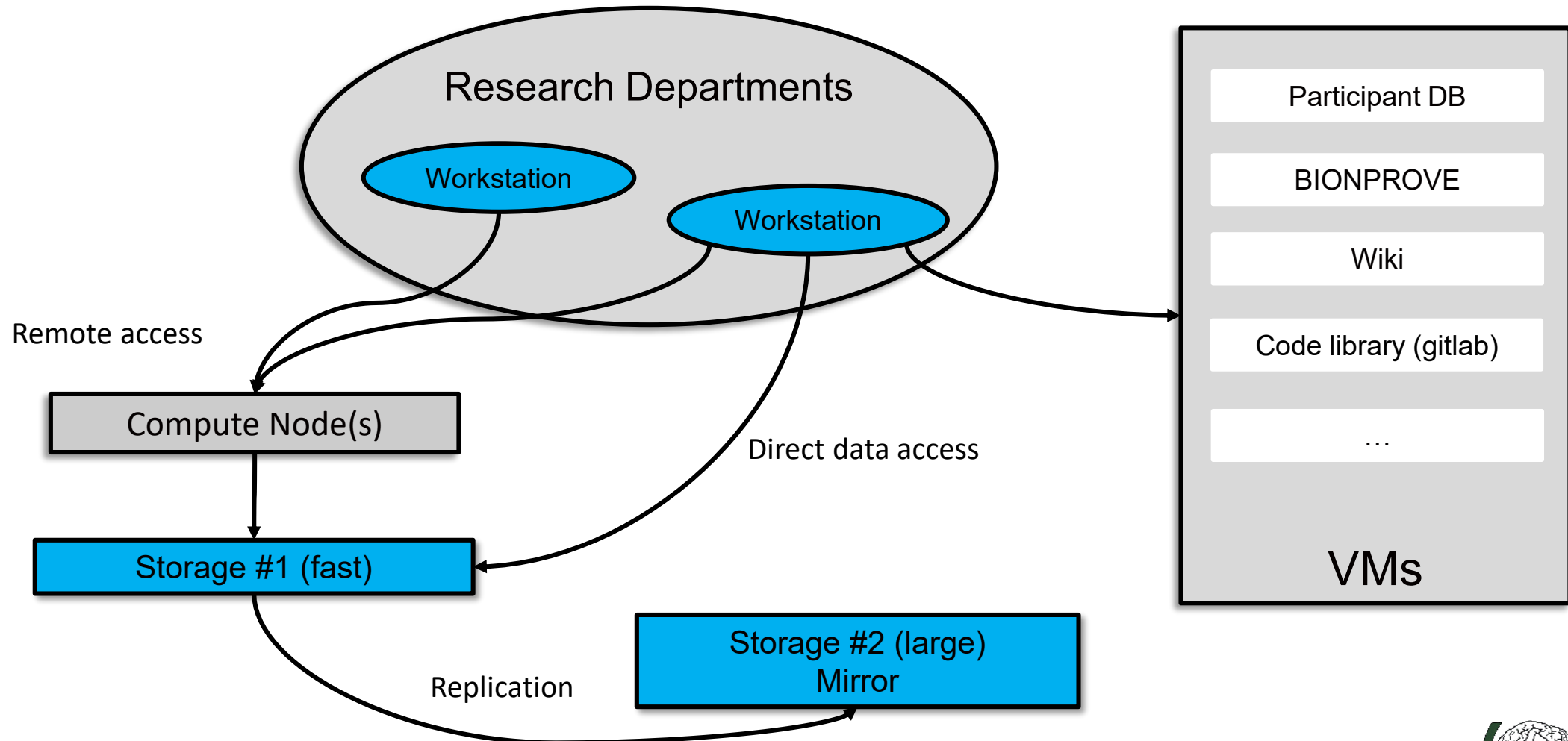
OUTLINE

- Who are we?
- **Management of Brain Imaging Data**
- Facility Management

DATA MANAGEMENT PLAN: KEY POINTS

- Define file formats (e.g. DICOM, NIFTI, JSON) and standardized data layout (BIDS)
- Keep data for 10 years
- Describe data security, backup, and quality control mechanisms
- Includes administrative data as well (e.g. user contacts)
- Define responsibility of the BION

IT INFRASTRUCTURE



STORAGE RESOURCES

- Important features:
 - Transparent data compression (regain disk space)
 - Snapshots (save current state)
 - Full data replication (data exists twice with exactly the same states etc.)
- Replication includes states (every evening)
 - Up to 6 months (current definition, could be longer)
 - Avoid data loss caused by accidental deletion, crypto virus, etc.

COMPUTATIONAL RESOURCES

- Compute node (36 cores, 384 GB main memory)
- Linux (mandatory) including preinstalled software for neuroscientific use
 - Matlab, R, Python
 - Imaging analysis software: SPM (and its sub-releases), FSL (5, 6), FreeSurfer, etc.
- Cluster software (PBS) SGE
 - Analysis parallelization
 - Scheduling of long running analyses

DATA SECURITY CONSIDERATIONS

- Datenschutzgrundverordnung (DSGVO)
 - Defines handling of person related data (includes staff/users as well)
 - Control access, avoid alteration of data, availability, accessibility, etc.
 - Defines information obligations in consent forms etc., e.g. purpose and duration of data usage
- IT-Security (BSI)
 - Defines security setups for IT, e.g. encryption etc.

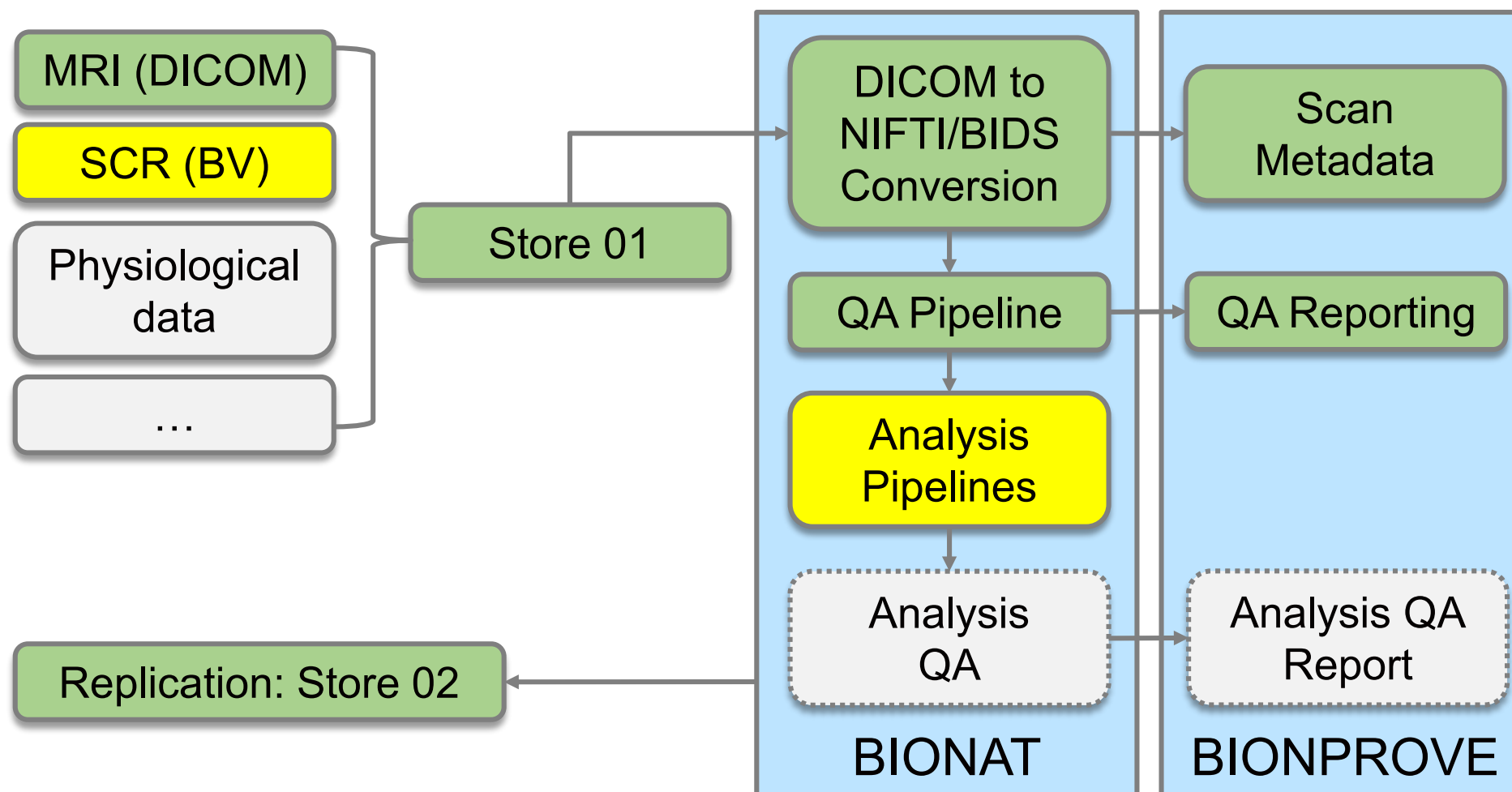
DATA SECURITY CONSIDERATIONS

- Anonymization of brain imaging data possible at all?
- We don't think so!
 - DSGVO applies
 - Control access
 - Secure IT setups
 - Make sure that data is always available and backed up
 - Make sure that data isn't altered without permission

DATA SECURITY CONSIDERATIONS

- User database (in our case: Active Directory (AD))
 - User uniquely identified via his/her account
 - General access via global user group
 - Project access via special project groups (e.g. bion-project-xxxxxx)
- Users can only access data they need to or own
 - includes all services: storage, computation, scheduling, etc.

DATA FLOW



BRAIN IMAGING DATA STRUCTURE (BIDS)

- BIDS defines
 - Naming and layout of data
 - Metadata
- BIDS advantages:
 - Same layout for all projects
 - Easy sharing of data
 - Support from major analysis packages
 - BIDS apps with common command line interface

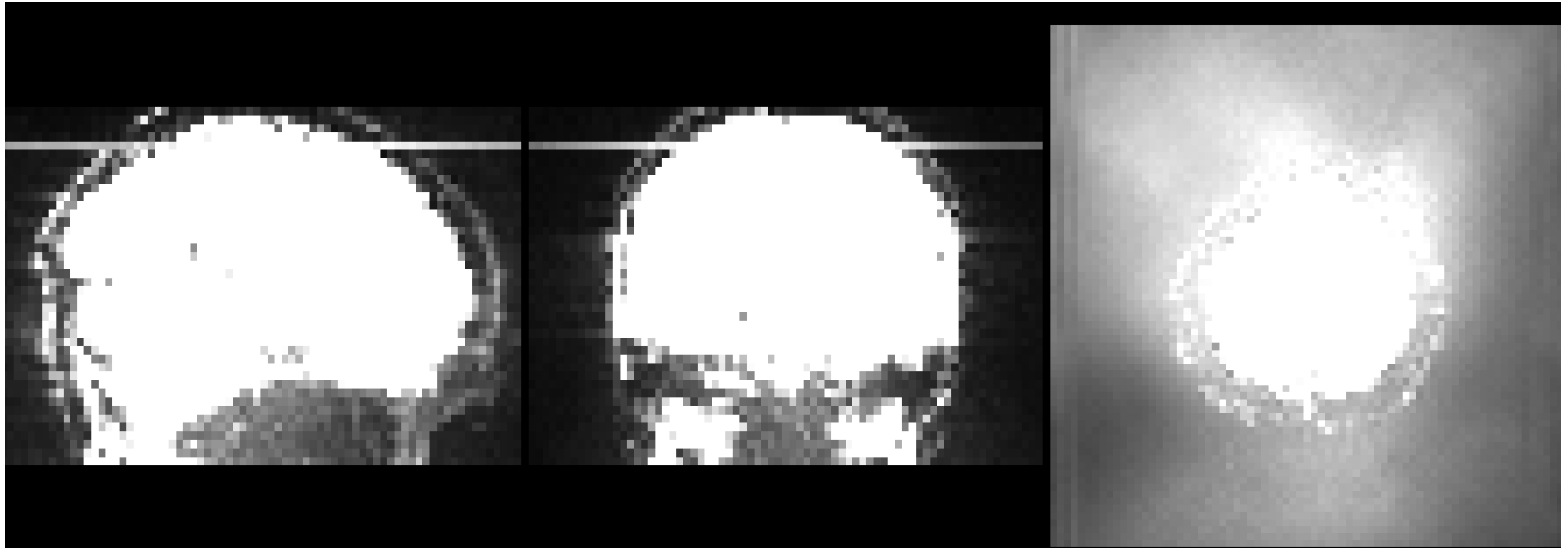
```

../bids/sub-155mann/
├── anat
│   ├── sub-155mann_T1w.json
│   └── sub-155mann_T1w.nii
├── dwi
│   ├── sub-155mann_acq-dir64_dwi.bval
│   ├── sub-155mann_acq-dir64_dwi.bvec
│   ├── sub-155mann_acq-dir64_dwi.json
│   ├── sub-155mann_acq-dir64_dwi.nii
│   ├── sub-155mann_acq-dir6_dwi.bval
│   ├── sub-155mann_acq-dir6_dwi.bvec
│   ├── sub-155mann_acq-dir6_dwi.json
│   └── sub-155mann_acq-dir6_dwi.nii
├── fmap
│   ├── sub-155mann_run-1_magnitude1.json
│   ├── sub-155mann_run-1_magnitude1.nii
│   ├── sub-155mann_run-1_magnitude2.json
│   ├── sub-155mann_run-1_magnitude2.nii
│   ├── sub-155mann_run-1_phasediff.json
│   ├── sub-155mann_run-1_phasediff.nii
│   ├── sub-155mann_run-2_magnitude1.json
│   ├── sub-155mann_run-2_magnitude1.nii
│   ├── sub-155mann_run-2_magnitude2.json
│   ├── sub-155mann_run-2_magnitude2.nii
│   ├── sub-155mann_run-2_phasediff.json
│   └── sub-155mann_run-2_phasediff.nii
└── func
    ├── sub-155mann_task-mid_bold.json
    ├── sub-155mann_task-mid_bold.nii
    ├── sub-155mann_task-rest_bold.json
    ├── sub-155mann_task-rest_bold.nii
    ├── sub-155mann_task-sid_bold.json
    └── sub-155mann_task-sid_bold.nii
  
```


QUALITY CONTROL/ASSESSMENT: WHY?

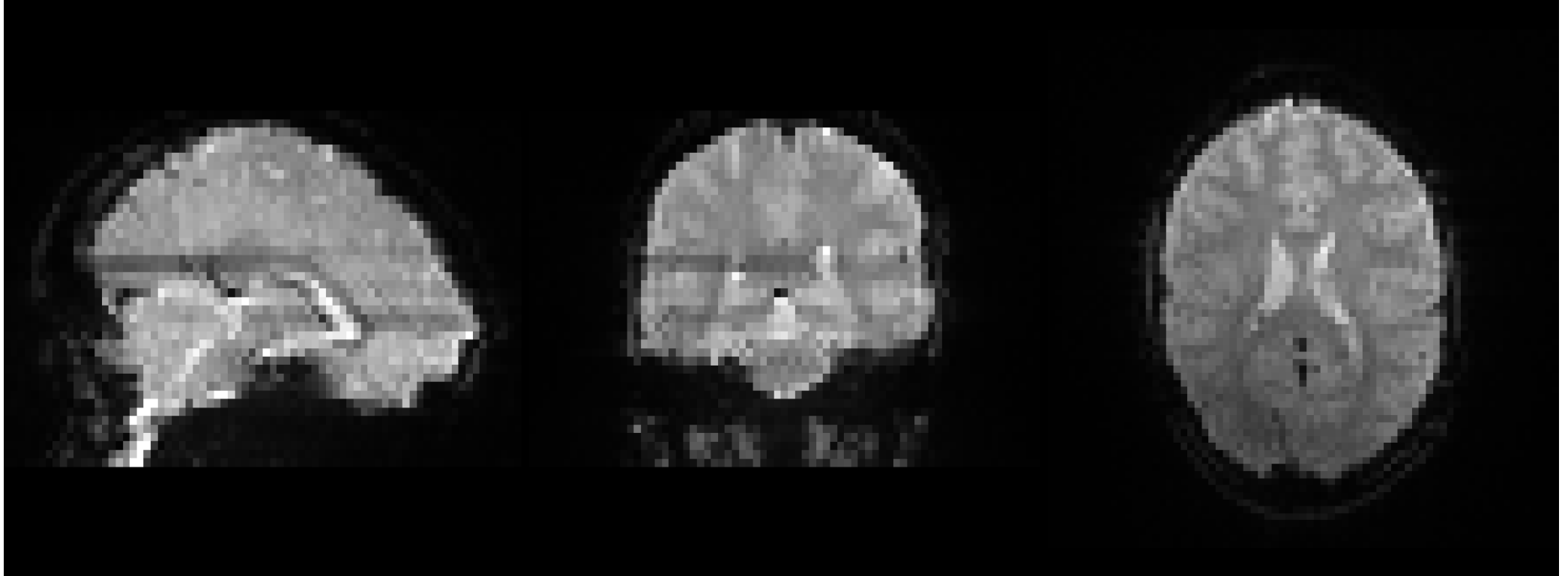
- Common issues
 - QA with imaging data is particular hard (software packages don't support us well).
 - Sometimes data sets are very large (i.e. looking into everything is not feasible)
 - Indicators vary, criteria unclear or depend on analysis chosen.
 - Not everything can be automatic
- Problems with quality of scans often detected very late
 - Exclusion of data even if avoidable

QUALITY CONTROL/ASSESSMENT: WHY?



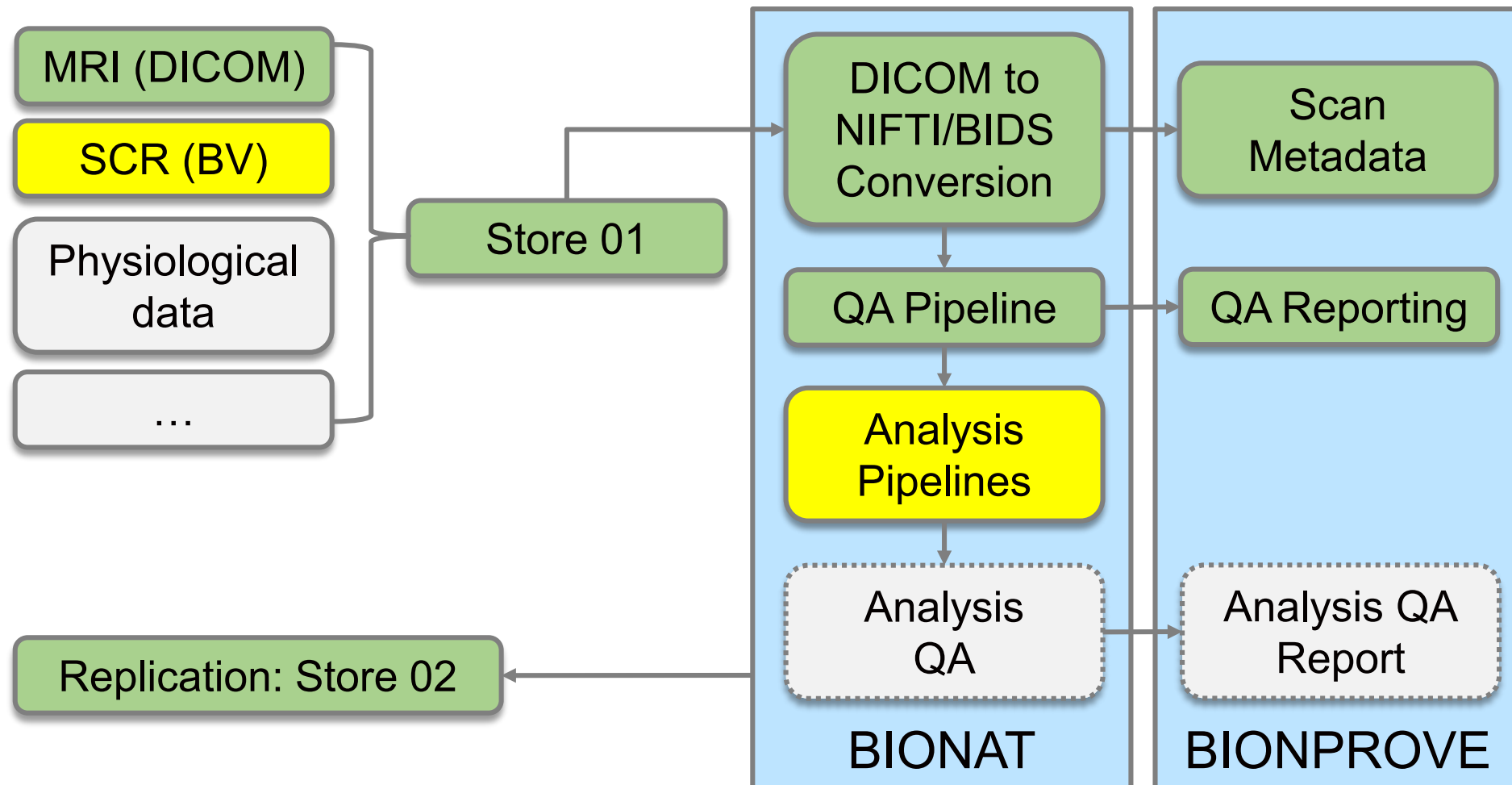
Spiking (technical artifact): rare but dangerous. Might indicate equipment defects. Users can't do anything about it.

QUALITY CONTROL/ASSESSMENT: WHY?



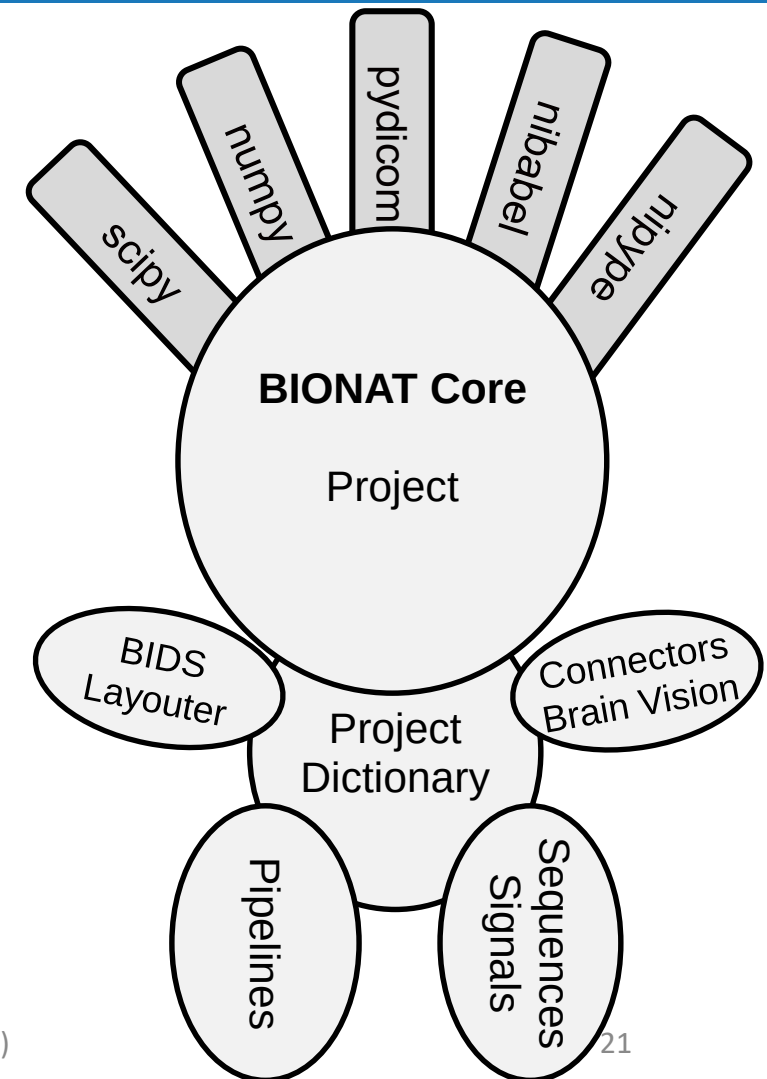
Motion related artifact (spin history). Users can do something

DATA FLOW



DATA MANAGEMENT: BIONAT

- Convert DICOM into NIFTI, sort into BIDS, and do initial checks
- Extract additional information from DICOM data
- Quality assessment
- Run analysis pipelines (in parallel where necessary/possible)
- Send metadata to BIONPROVE (see later)



BIONAT: OTHER FEATURES

- Python3 package
- Read and convert typical file formats (that we came across so far)
 - BrainVision Analyzer®
 - Presentation® logfiles

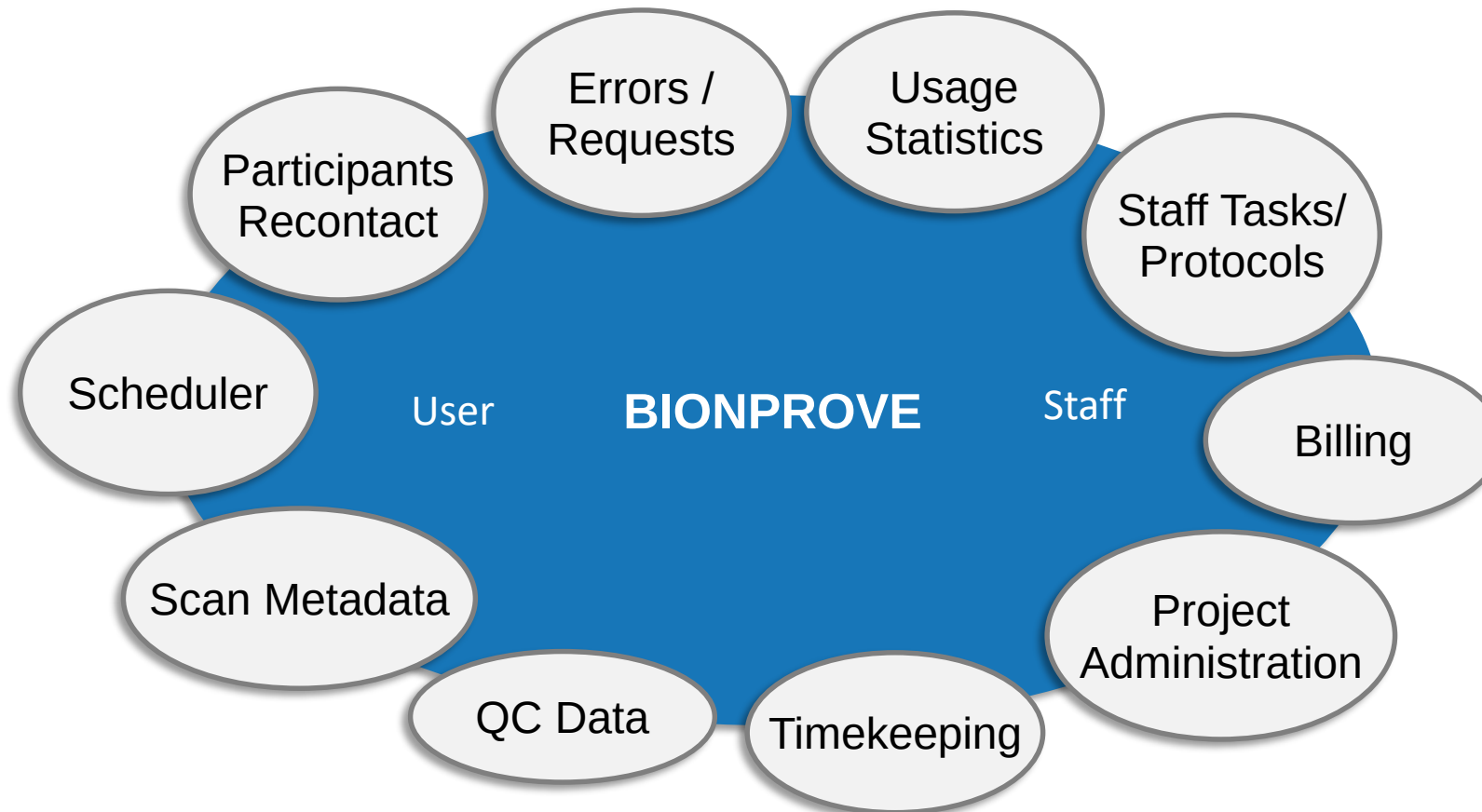
OUTLINE

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- Management of Brain Imaging Data
- **Facility Management**

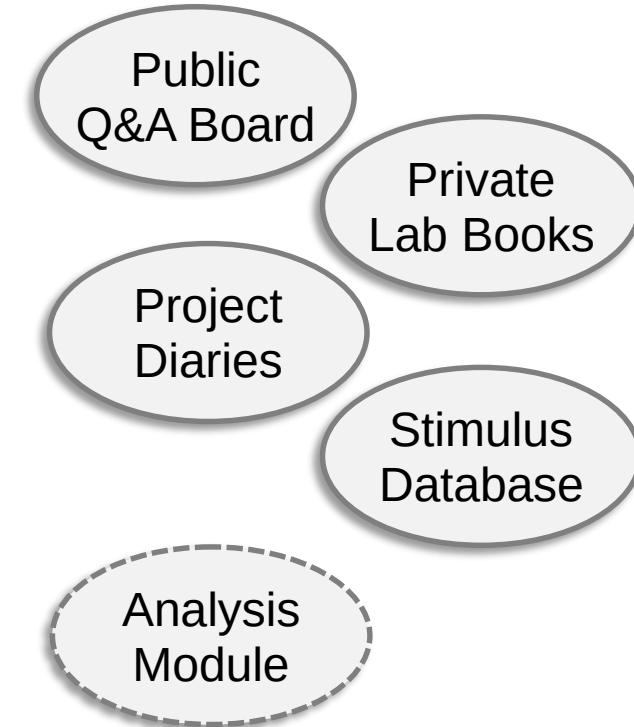
FACILITY MANAGEMENT

- Tasks of a brain imaging unit:
 - Scheduling scan times for projects
 - Representation of quality control data
 - Resource usage statistics
 - Handle errors and keep solutions (quality management)
 - Schedule regular tasks/protocols and keep records of it (quality management)
 - Bill projects
 - Record work hours (timekeeping)
 - ...

BIONPROVE: COMPONENTS



Possible Future Developments:



BIONPROVE

Welcome to BIONPROVE

Recent Messages

[Report Error / Request Support](#)[My Requests / Error reports](#)

Warning

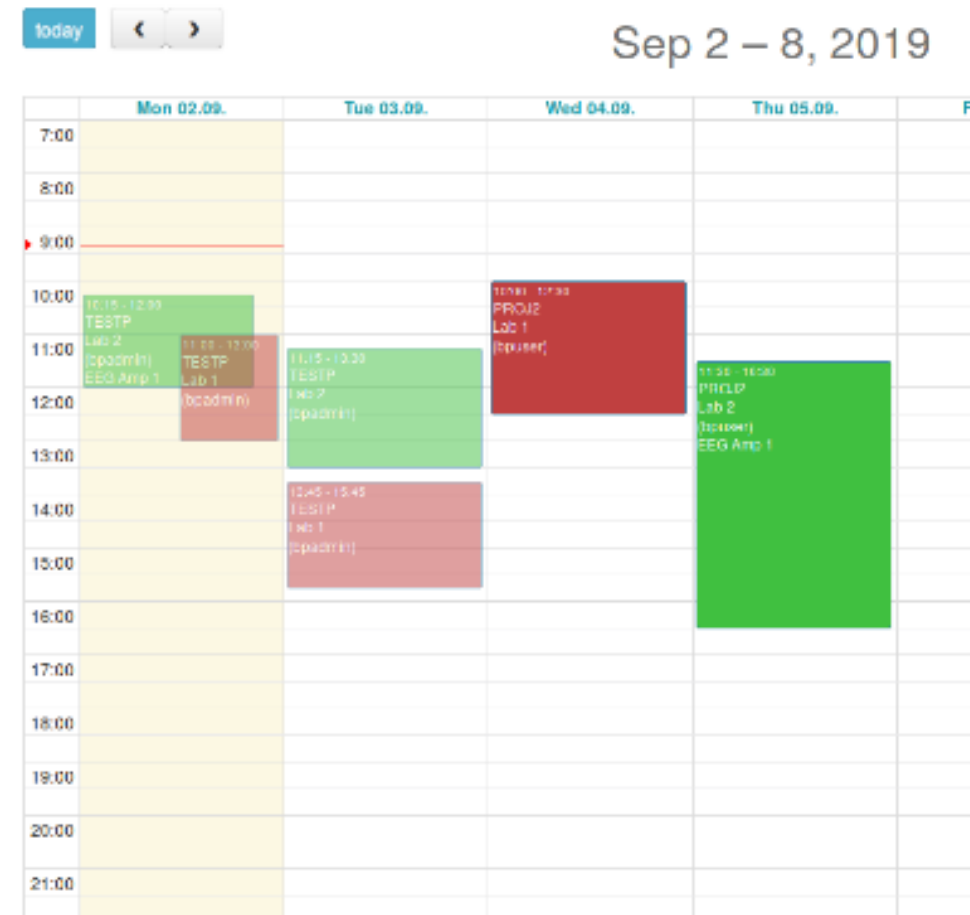
badmin (01.09.19, 08:05)

Lab 1 is currently not usable

Stimulus presentation computer is broken.

USER ENDPOINTS: SCHEDULING

- Schedule MRI for projects (if accepted) + resources
- Features
 - Check resource conflicts
 - Personalized project events
- Basis for other modules
 - Billing
 - Resource statistics



USER ENDPOINTS: QA WITHIN STUDY

Modality	Type	N	Average	MIN	MAX	STD		
bold	max_fd	494	0,958	0,078	24,702	1,471	Plot	Table
bold	num_spikes	498	0,002	0	1	0,045	Plot	Table
bold	percent_motion_affected_fd	494	2,071	0	80	5,161	Plot	Table
bold	sgr	498	37,736	23,507	61,739	2,999	Plot	Table
bold	snr	498	140,063	82,044	197,107	15,842	Plot	Table
T1w	snr	93	74,427	39,035	102,538	13,856	Plot	Table
T1w	vcsf2tiv	93	1,666	1,006	3,213	0,443	Plot	Table



Each user sees QA data of his/her project(s).

Ease QA diagnostics for user

STAFF ENDPOINTS: TASKS / PROTOCOLS

Protocols / Staff Tasks

[Add Protocol / Staff Task](#)

Name	Resource	Check Interval	Due Limit	Created	Last Check	Next Check	State
Check equipment	Lab1	7	7	28.08.19, 11:20	28.08.19	04.09.19	
General		7	7	28.08.19, 11:27		30.08.19	

General Description

Check all equipment (amplifiers, computers) In Lab1

Regular task for staff, e.g.

- Visible damages to equipment
- Maintenance tasks (updates etc.)
- ...

Items

[Add Item](#) [PDF Sheet](#)

Order	Type	Description	Actions
1	Technical Test	Check contacts of all cables.	Disable
2	IT administration	Update OS on computers.	Disable



Protocol / Staff Task Actions

Date	Result	Comment	Created	Actions
28.08.19, 11:23	ok	All ok	28.08.19, 11:23	View Edit Delete

STAFF/USER ENDPOINTS: TICKETS

Tickets

Types:

	Description	Created	Creator	Type
	EEG amp broken in Lab1?	28.08.19, 10:54	badmin	Miscell
	Only noisy recordings recently. Maybe broken?	28.08.19, 10:53	badmin	Resou

< previous

Ticket #1

[Edit Description](#)
[Change Ownership](#)
[Close](#)
[Change Type](#)
[Notify owner](#)
[Notify users](#)
[Make Message](#)
[Comment](#)
[Delete Ticket](#)

Creator	Type	Resource	Assignee	Current State	Severity	Public	Created
badmin	Resource	EEG Amplifier 1	badmin	Solved	medium	No	28.08.19, 10:53

Description

badmin (28.08.19, 10:53, modified: 28.08.19, 11:58)

Only noisy recordings recently. Maybe broken?

Ticket History

Assigned to badmin on 28.08.19, 10:54

badmin (28.08.19, 11:58, modified: 28.08.19, 11:58)

Checked all cables. One was broken and substituted.

[Edit](#)

badmin solved this ticket on 28.08.19, 11:58

Errors/Requests handled via “Tickets”
(issue tracking)

- Keep solutions (if useful)
- Detect frequent errors
- Possibly statistics

USER ENDPOINTS: PARTICIPANTS DB

Participants

[Search](#)[Saved Searches](#)[New Participant](#)

Last name	First/Given name	Birthdate	Sex	
Mustermann	Max	01.09.09	male	Edit
Musterfrau	Melanie	01.09.09	female	Edit +Contact +Project

Volunteer database for easy acquisition.

ADDITIONAL RESOURCES + CONTROVERSIES

- Stimulus Database (provide material to users)
 - Any copyright issues?
- Offer Wiki for documentation: tutorials, teaching materials, etc.
 - Can this cover all needs and who checks quality of entries?
- Offer Gitlab server for version controlled code repositories
 - For us and the users (could be used for papers and other documents as well)
 - For code library “BION Code Repository” (can we simply merge user code?)

CONTROVERSIES: IS DOCUMENTATION A MYTH?

Possible problems of documentation:

Someone needs to write it.

- Who is the recipient?
- Which knowledge state can be assumed?

Someone else needs to read it and

- Report errors etc. (or its usability is unknown) and
- Note missing parts (or its usability is restricted).

Someone needs to maintain it (or it will outdate).

Edit

bpadmin (28.08.19, 09:28)

How can I list all subjects in a BIDS directory?

In an Ideal case in *Matlab*.

0 Accept DownVote Comment

bpuser (28.08.19, 09:32)

Try this with Matlab and SPM:

```
1. BIDS = spm_BIDS('/path/to/bidsdata');
2.
3. subjects = spm_BIDS(BIDS, 'subjects');
```

Edit

If you are using *Python*, you can use our **BIONAT** package like so:

```
1. from bionat.Layout import BIDS
2.
3. bids = BIDS('/path/to/data')
4. bids.listSubjects()
```

Seems that the *Matlab* solution requires *SPM* in a more recent version.

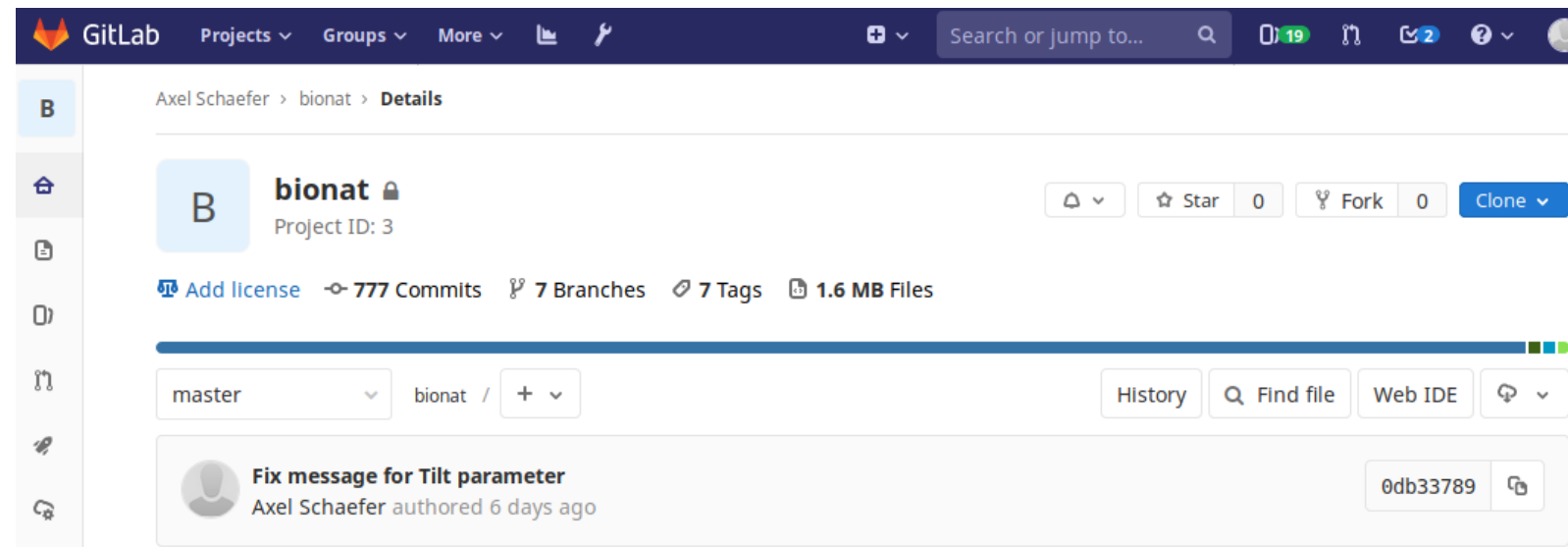
bpadmin Edit

CONTROVERSIES: SEND ME YOUR CODE!

- Code repository for users with code from users
- Code often handles special cases and possibly
 - lacks sufficient testing,
 - has insufficient documentation (if it's not a myth at all), and
 - cannot be reused easily.

CONTROVERSIES: SEND ME YOUR CODE!

- Code needs
 - Modularization
 - Refactoring
 - Review
 - Error/issue tracking
 - Version control
 - Maintenance



Thank you for your attention!