
BOLDQC

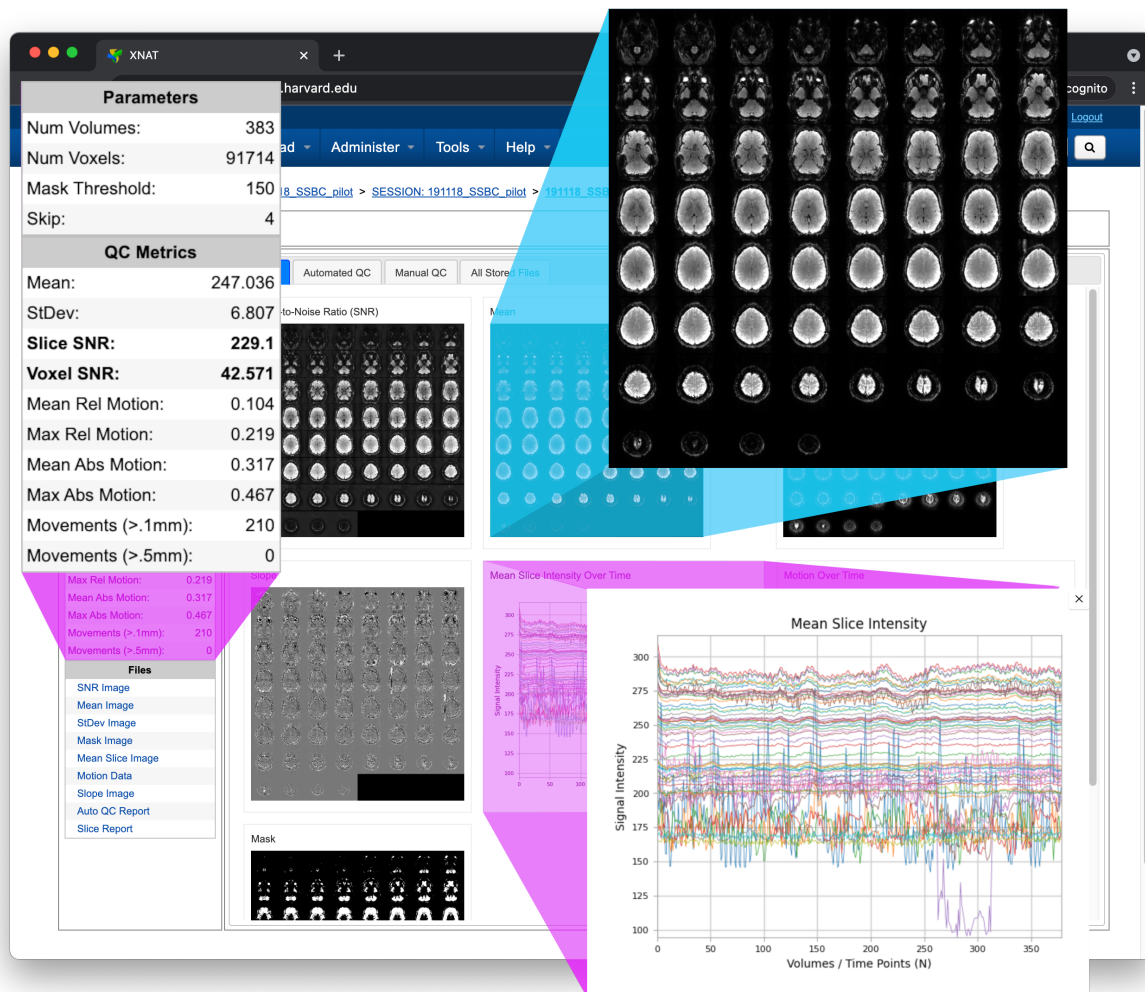
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BOLDQC is a fMRI quality control pipeline. Working closely with neuroimaging experts, we designed a simple ergonomic user interface for the [XNAT](#) informatics and data management platform that allows users to quickly assess image quality and use those insights to address issues within the data acquisition workflow.



XNAT USER DOCUMENTATION

1.1 Tagging your scans

For BOLDQC to discover **BOLD** scans to process, you need to set the scan *type* in **XNAT**

Type	Example series
BOLD	ABCD_fmRI_rest_noPMU

The image below displays an MR Session report page with populated types

MR Session: 191118_SSBC_pilot

Details | **Projects**

Accession #: XNAT_E00004
Date Added: 2021-06-22 14:28:57 (admin)
Date: 2019-11-18
Time: 15:34:09
Operator: Mair
Scanner Name: AWP67056
Scanner Type: SIEMENS Prisma_fit
Acquisition Site: CBS Neuroimaging

Subject: 191118_SSBC_pilot

Actions:
Edit
View
Download
Email
Manage Files
Delete
Run Containers

Scans

Bulk Actions: Download

Scan	Type	Files	Note
<input type="checkbox"/> 12	ABCD_T1w_MPR_vNav_setter	27.9 MB in 144 files	MOVE_001
<input type="checkbox"/> 14	ABCD_T1w_MPR_vNav	42.9 MB in 176 files	ANAT_001
<input type="checkbox"/> 17	BOLD	441.6 MB in 383 files	
<input type="checkbox"/> 19	ABCD_dMRI_Distortion_Map_PA	18.2 MB in 81 files	

Total: 530.6 MB in 784 files

1.2 Running the pipeline

To run the BOLDQC pipeline, use the Run Containers > boldqc-session button located within the Actions box on the MR Session report page

Note: If you don't see the Run Containers menu, please refer to [Setting up the container](#).

MR Session: 191118_SSBC_pilot

Details | Projects

Accession #: XNAT_E00004 Subject: 191118_SSBC_pilot
 Date Added: 2021-06-22 14:28:57 (admin) Gender:
 Date: 2019-11-18 Handedness:
 Time: 15:34:09 Age: --
 Operator: Mair
 Scanner Name: AWP67056
 Scanner Type: SIEMENS Prisma_fit
 Acquisition Site: CBS Neuroimaging

Actions

- Edit
- View
- Download
- Email
- Manage
- Delete
- Run Containers
 - boldqc-session

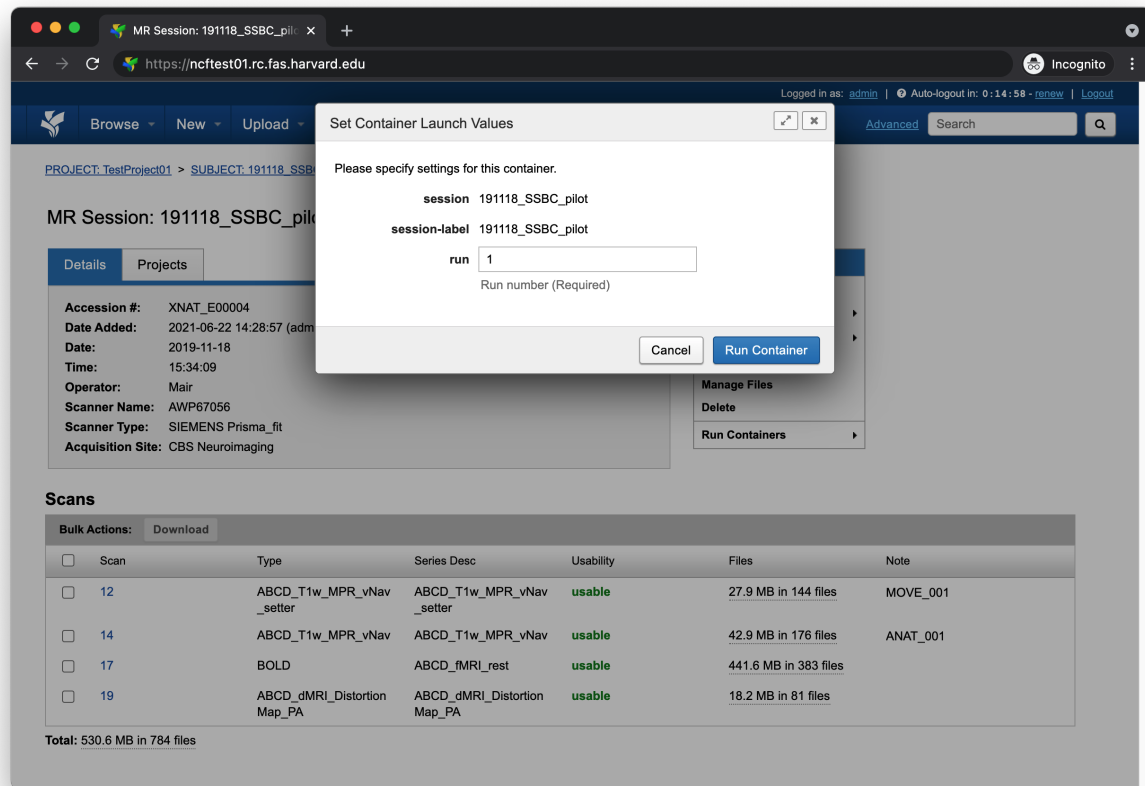
Scans

Bulk Actions: Download

Scan	Type	Series Desc	Usability	Files	Note
<input type="checkbox"/> 12	ABCD_T1w_MPR_vNav _setter	ABCD_T1w_MPR_vNav _setter	usable	27.9 MB in 144 files	MOVE_001
<input type="checkbox"/> 14	ABCD_T1w_MPR_vNav	ABCD_T1w_MPR_vNav	usable	42.9 MB in 176 files	ANAT_001
<input type="checkbox"/> 17	BOLD	ABCD_fMRI_rest	usable	441.6 MB in 383 files	
<input type="checkbox"/> 19	ABCD_dMRI_Distortion Map_PA	ABCD_dMRI_Distortion Map_PA	usable	18.2 MB in 81 files	

Total: 530.6 MB in 784 files

This should bring up a small form with any configurable settings. Continue reading for a description of each setting



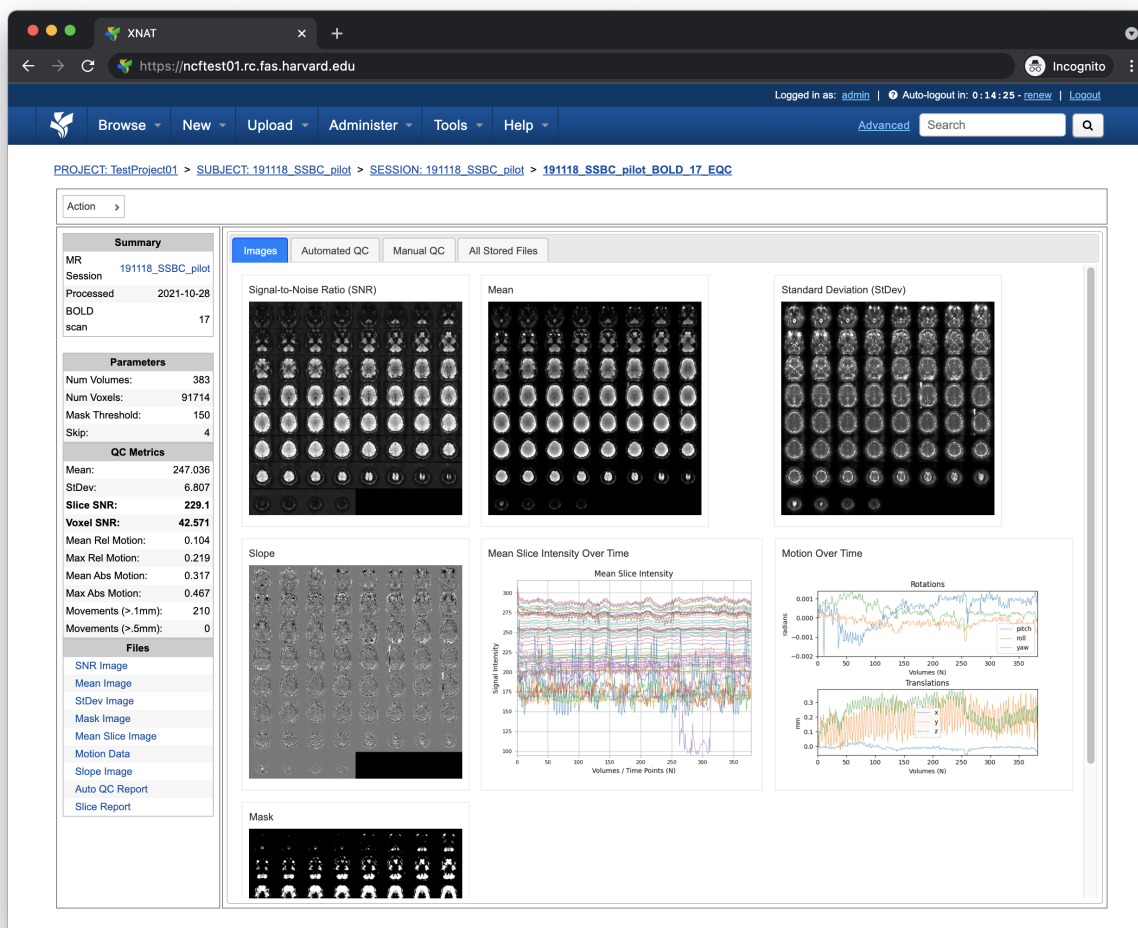
1.2.1 run

Note: The run number is *not* the scan number. If scan 17 was the first BOLD scan within the MR session, the run number would be 1, the second BOLD scan would be run 2, and so on.

This should be set to the integer value of the BOLD scan you want to process.

1.3 Understanding the report page

The following section will break down each section of the BOLDQC report page.

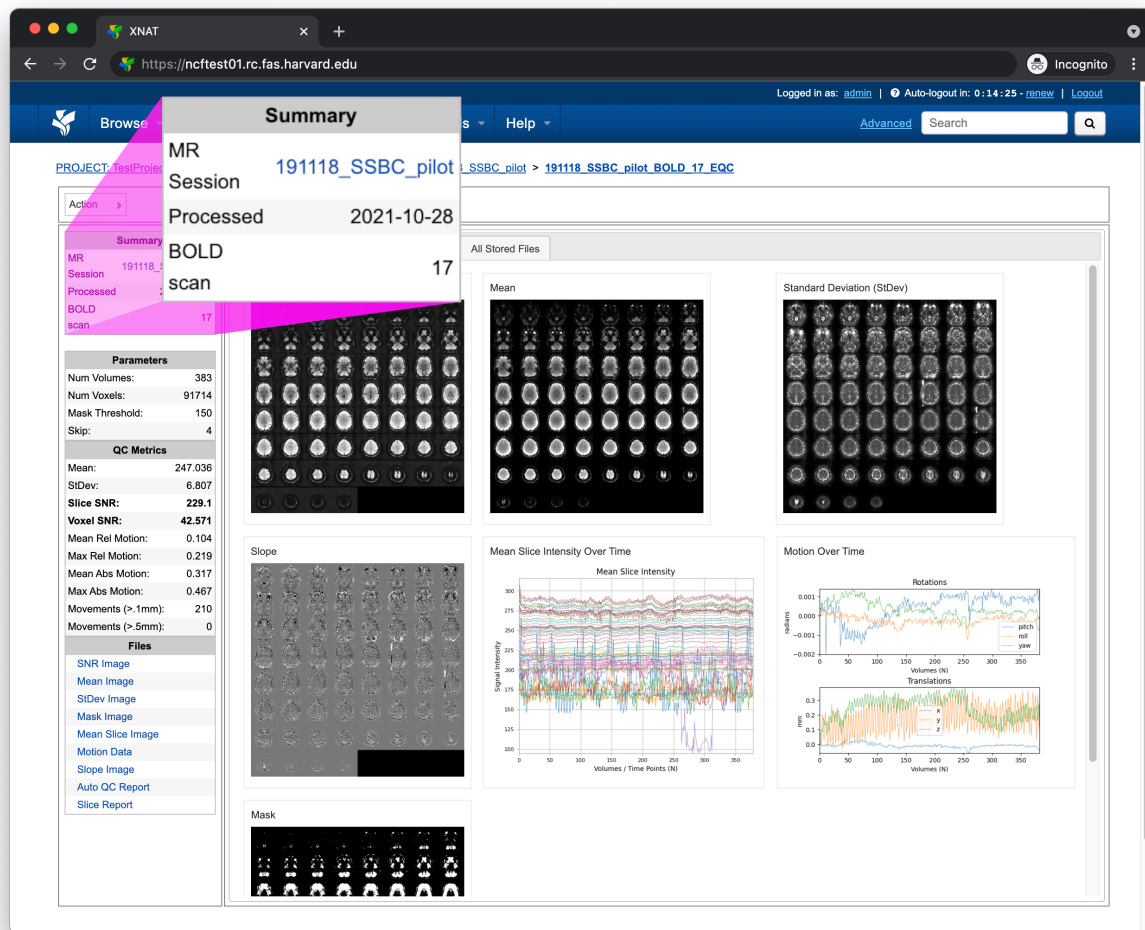


1.3.1 Left pane

The left pane is broken up into several distinct sections. Each section will be described below.

Summary

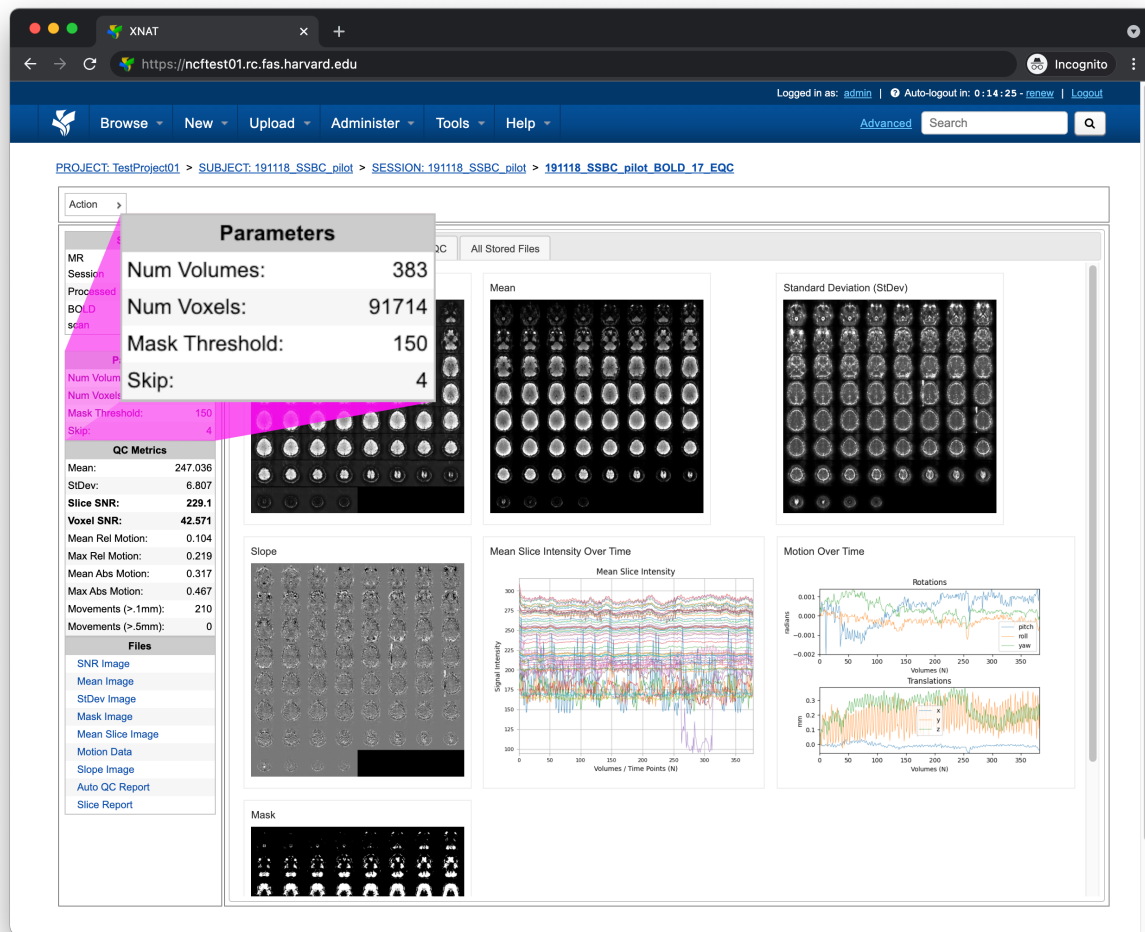
The Summary pane orients the user to what MR Session they're currently looking at and various processing details



Key	Description
MR Session	MR Session label
Processed	Processing date
BOLD scan	Processed BOLD scan

Parameters

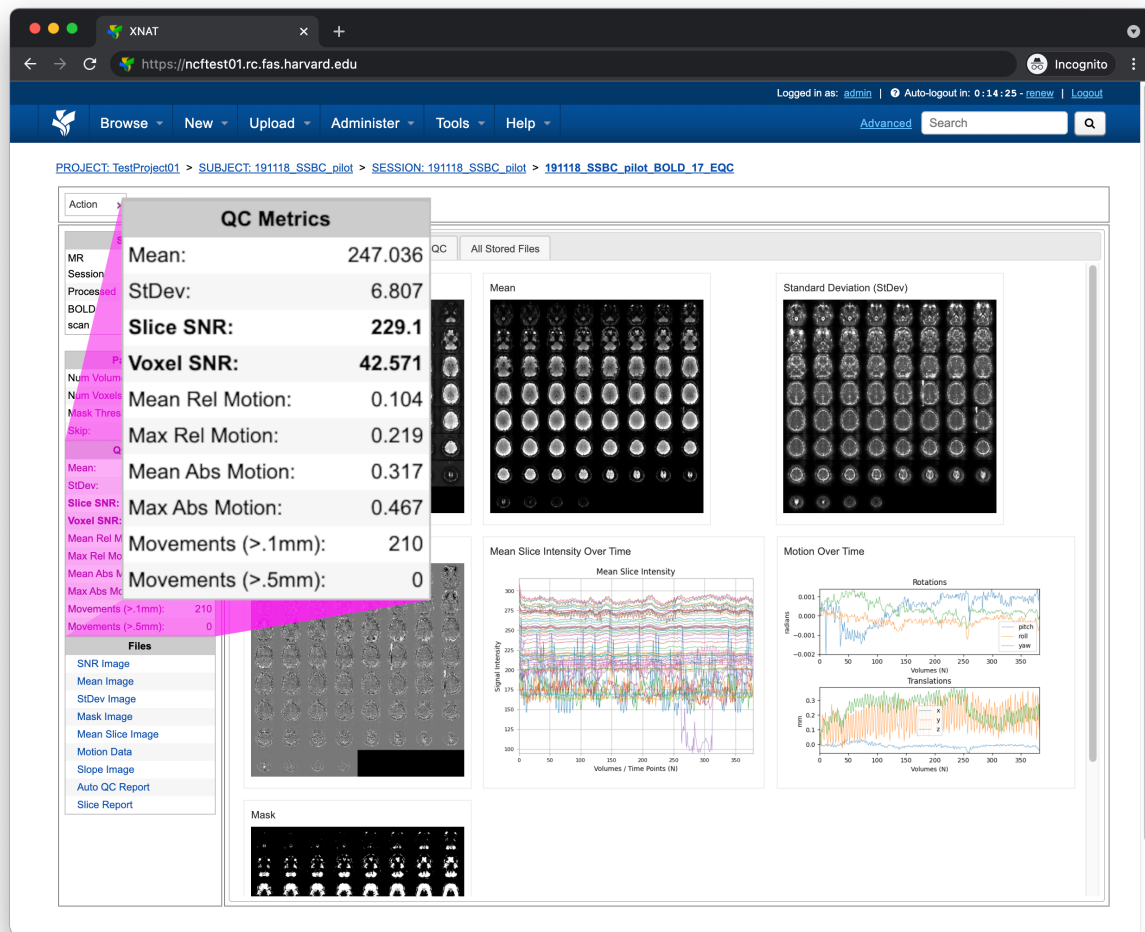
The Parameters pane displays fine-grained scan information



Key	Description
Num Volumes	Number of time points
Num Voxels	Number of voxels included in the analysis
Mask Threshold	Masking threshold
Skip	Number of initial time points discarded

QC Metrics

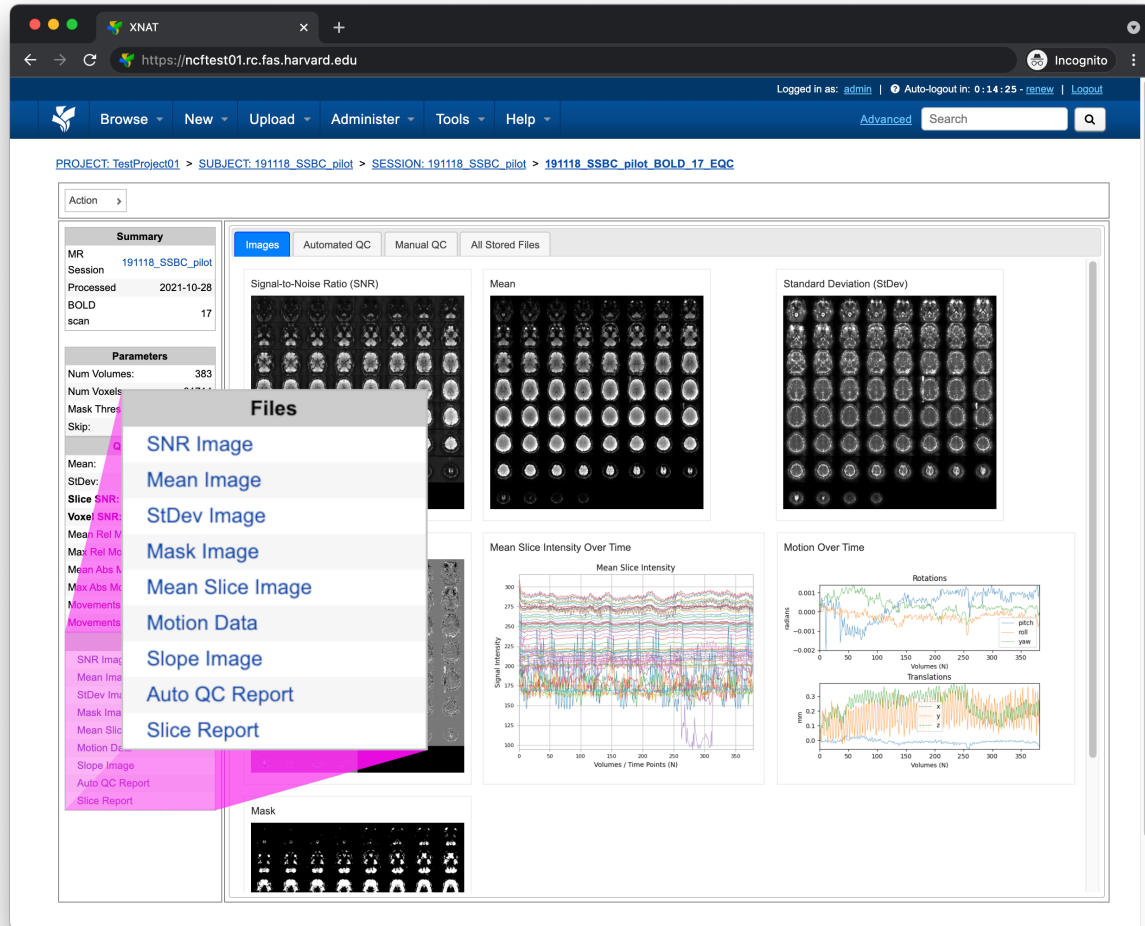
The QC Metrics pane displays quality control metrics computed *over the entire volume*



Metric	Description
Mean	Mean signal intensity
StDev	Mean voxel Standard deviation
Slice SNR	Mean slice-based SNR (sensitive to motion)
Voxel SNR	Mean voxel SNR
Mean Rel Motion	Mean relative translations in 3D (mm)
Max Rel Motion	Maximum relative motion (mm)
Mean Abs Motion	Mean absolute motion in 3D (mm)
Max Abs Motion	Maximum absolute motion in 3D (mm)
Movements (>.1mm)	Number of relative translations in 3D > .1mm
Movements (>.5mm)	Number of relative translations in 3D > .5mm

Files

The Files pane contains the most commonly requested files. Clicking on any of these files will display that file in the browser



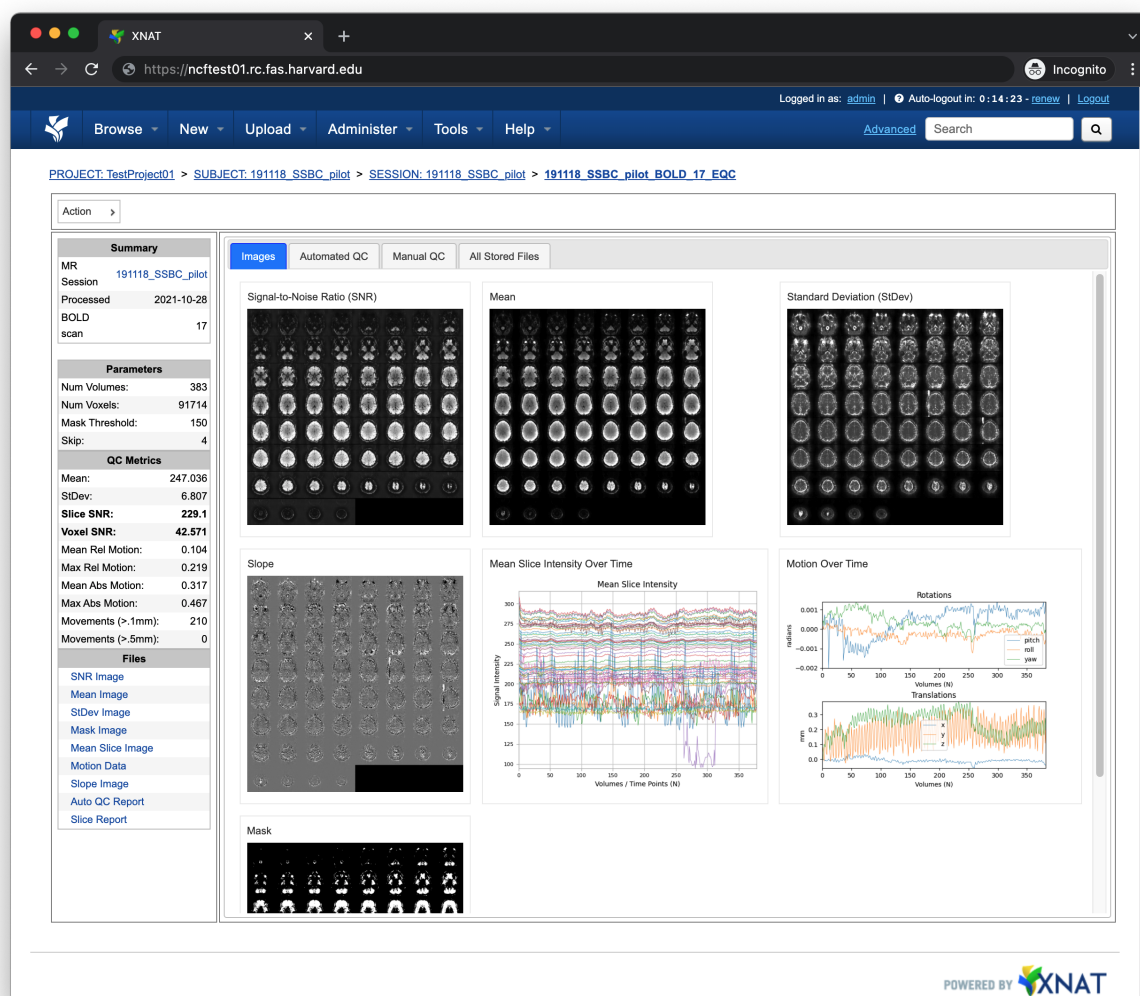
File	Description
SNR Image	BOLD signal SNR image, axiale
Mean Image	BOLD signal mean image, axial
StDev Image	BOLD signal standard deviation image, axial
Mask Image	Masked image
Mean Slice Image	BOLD signal mean slice intensity plot
Motion Data	Motion (translations and rotations) plot
Slope Image	BOLD signal slope image, axial
Auto QC Report	Automated QC report
Slice Report	Individual slice QC report

1.3.2 Tabs

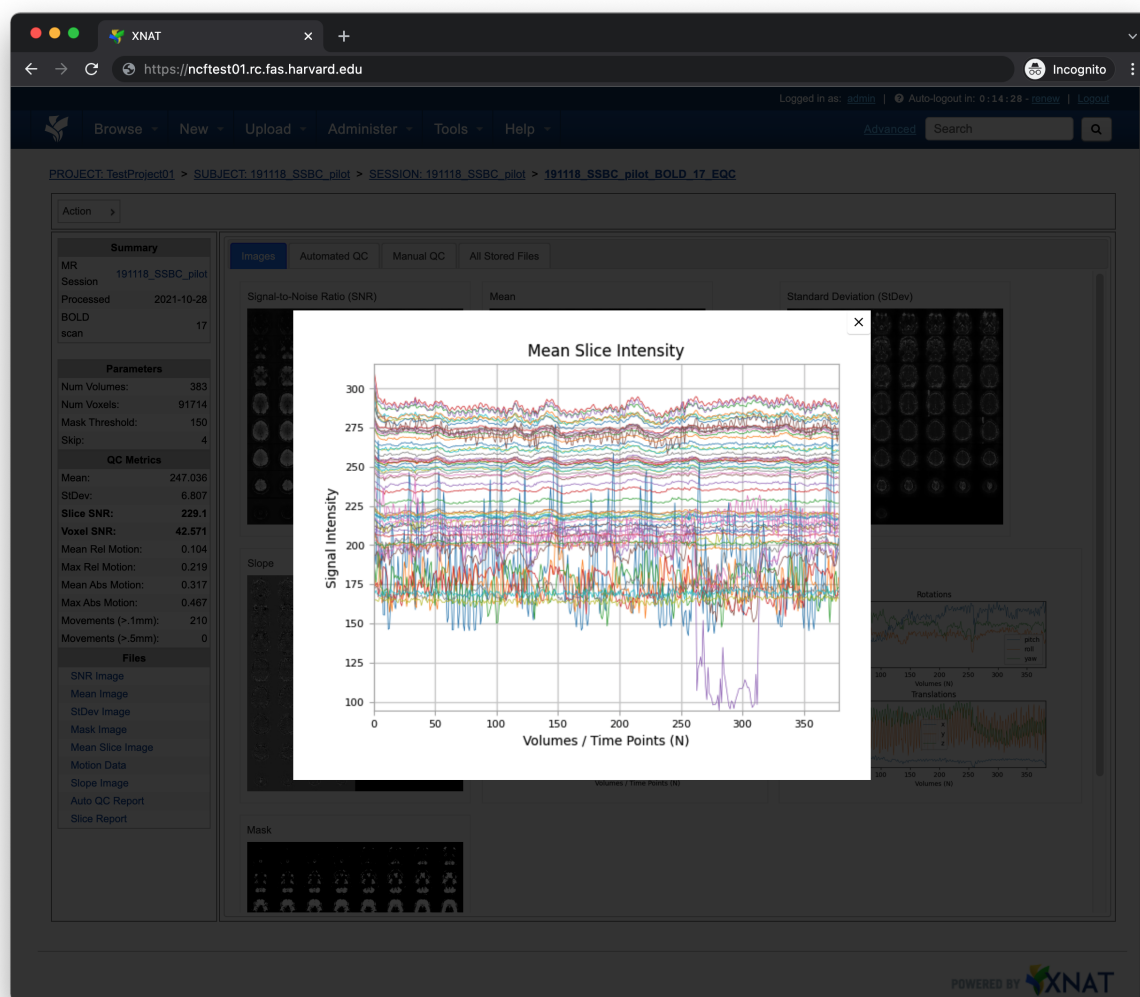
To the right of the *left pane* left pane you'll find a tab container.

Images

The Images tab displays a zoomed out view of the SNR, Mean, Standard Deviation, Slope, MEan Slice Intensity, Motion, and Mask images.



Clicking on any of these images will display a larger version of the image



Automated QC

The Automated QC tab displays a complete list of BOLDQC metrics.

The screenshot shows the XNAT BOLDQC web interface. The browser address bar displays <https://ncfctest01.rc.fas.harvard.edu>. The user is logged in as **admin** with an auto-logout timer of 0:14:18. The navigation menu includes **Browse**, **New**, **Upload**, **Administer**, **Tools**, and **Help**. The breadcrumb trail indicates the current location: **PROJECT: TestProject01 > SUBJECT: 191118_SSBC_pilot > SESSION: 191118_SSBC_pilot > 191118_SSBC_pilot_BOLD_17_EQC**.

The interface is divided into two main sections. On the left is a sidebar with a **Summary** tab and a **Files** tab. The **Summary** tab displays the following information:

- MR Session:** 191118_SSBC_pilot
- Processed:** 2021-10-28
- BOLD scan:** 17
- Parameters:**
 - Num Volumes: 383
 - Num Voxels: 91714
 - Mask Threshold: 150
 - Skip: 4
- QC Metrics:**
 - Mean: 247.036
 - StDev: 6.807
 - Slice SNR: 229.1**
 - Voxel SNR: 42.571**
 - Mean Rel Motion: 0.104
 - Max Rel Motion: 0.219
 - Mean Abs Motion: 0.317
 - Max Abs Motion: 0.467
 - Movements (>.1mm): 210
 - Movements (>.5mm): 0
- Files:**
 - SNR Image
 - Mean Image
 - StDev Image
 - Mask Image
 - Mean Slice Image
 - Motion Data
 - Slope Image
 - Auto QC Report
 - Slice Report

On the right is a table with tabs for **Images**, **Automated QC** (selected), **Manual QC**, and **All Stored Files**. The table lists 25 metrics with their corresponding values:

#	Metric	Value
1	N_Vols	383
2	Skip	4
3	qc_N_Tps	379
4	qc_thresh	150.000000
5	qc_nVox	91714
6	qc_Mean	247.035605
7	qc_Max	315.690000
8	qc_Min	94.540000
9	qc_Stdev	6.806792
10	qc_sSNR	229.100000
11	qc_vSNR	42.570848
12	qc_slope	0.000476
13	mot_N_Tps	379
14	mot_rel_x_mean	0.005368
15	mot_rel_x_sd	0.004458
16	mot_rel_x_max	0.026579
17	mot_rel_x_1mm	0
18	mot_rel_x_5mm	0
19	mot_rel_y_mean	0.092484
20	mot_rel_y_sd	0.049973
21	mot_rel_y_max	0.212603
22	mot_rel_y_1mm	176
23	mot_rel_y_5mm	0
24	mot_rel_z_mean	0.036497
25	mot_rel_z_sd	0.024515

The bottom right corner of the interface features the text **POWERED BY XNAT**.

Manual QC

The **Manual QC** tab contains a form allowing a quality control technician to record additional observations, comments, and assign a final **PASS**, **WARN**, or **FAIL** grade to the scan

The screenshot displays the BOLDQC web application interface. The browser address bar shows the URL <https://ncftest01.rc.fas.harvard.edu>. The user is logged in as 'admin' with an auto-logout timer of 0:14:15. The navigation menu includes 'Browse', 'New', 'Upload', 'Administer', 'Tools', and 'Help'. A search bar is located on the right.

The breadcrumb trail indicates the current report is for: PROJECT: TestProject01 > SUBJECT: 191118_SSBC_pilot > SESSION: 191118_SSBC_pilot > 191118_SSBC_pilot_BOLD_17_EQC.

The main content area is divided into two columns. The left column contains a 'Summary' section with the following data:

Summary	
MR Session	191118_SSBC_pilot
Processed	2021-10-28
BOLD scan	17

Below the summary is a 'Parameters' section:

Parameters	
Num Volumes:	383
Num Voxels:	91714
Mask Threshold:	150
Skip:	4

Next is the 'QC Metrics' section:

QC Metrics	
Mean:	247.036
StDev:	6.807
Slice SNR:	229.1
Voxel SNR:	42.571
Mean Rel Motion:	0.104
Max Rel Motion:	0.219
Mean Abs Motion:	0.317
Max Abs Motion:	0.467
Movements (> 1mm):	210
Movements (> 5mm):	0

At the bottom of the left column is a 'Files' section with a list of downloadable files: SNR Image, Mean Image, StDev Image, Mask Image, Mean Slice Image, Motion Data, Slope Image, Auto QC Report, and Slice Report.

The right column contains a 'Manual QC' tab with four sections for quality assessment, each with radio button options:

- Motion**
 - ☐ Good
 - ☐ Questionable
 - ☐ Bad
- Head Coverage**
 - ☐ Good - full brain coverage with ≥ 1 slice buffer
 - ☐ Questionable - slight clipping or necessary clipping
 - ☐ Bad - brain clipped unnecessarily or severely
- Unexpected Inhomogeneity**
 - ☐ None
 - ☐ Expected
 - ☐ Unexpected - moderate
 - ☐ Unexpected - severe
- Ghosting/Blurring - Affects Brain**
 - ☐ None
 - ☐ Mild
 - ☐ Moderate

The bottom right corner of the interface features the text 'POWERED BY XNAT' with the XNAT logo.

All Stored Files

The All Stored Files tab contains a list of *every file* stored by BOLDQC

PROJECT: TestProject01 > SUBJECT: 191118_SSBC_pilot > SESSION: 191118_SSBC_pilot > 191118_SSBC_pilot_BOLD_17_EQC

Logged in as: admin | Auto-logout in: 0:14:12 - renew | Logout

Advanced Search

Action

Summary	
MR Session	191118_SSBC_pilot
Processed	2021-10-28
BOLD scan	17

Parameters	
Num Volumes:	383
Num Voxels:	91714
Mask Threshold:	150
Skip:	4

QC Metrics	
Mean:	247.036
StDev:	6.807
Slice SNR:	229.1
Voxel SNR:	42.571
Mean Rel Motion:	0.104
Max Rel Motion:	0.219
Mean Abs Motion:	0.317
Max Abs Motion:	0.467
Movements (>.1mm):	210
Movements (>.5mm):	0

Files	
SNR Image	
Mean Image	
StDev Image	
Mask Image	
Mean Slice Image	
Motion Data	
Slope Image	
Auto QC Report	
Slice Report	

All Stored Files			
#	File	Description	Type
1	191118_SSBC_pilot_BOLD_17_EQC_auto_report.txt	Automated QC Report	text/plain
2	191118_SSBC_pilot_BOLD_17_EQC_mask_thumbnail.png	Mask Image	image/png
3	191118_SSBC_pilot_BOLD_17_EQC_mask.nii.gz	Mask NIFTI	image/nifti1
4	191118_SSBC_pilot_BOLD_17_EQC_mean_thumbnail.png	Mean Image	image/png
5	191118_SSBC_pilot_BOLD_17_EQC_mean.nii.gz	Mean NIFTI	image/nifti1
6	191118_SSBC_pilot_BOLD_17_EQC_mean_slice.txt	Mean Slice Intensity Data	text/plain
7	191118_SSBC_pilot_BOLD_17_EQC_mean_slice.png	Mean Slice Intensity Image	image/png
8	191118_SSBC_pilot_BOLD_17_EQC_motion.png	Motion Image	image/png
9	191118_SSBC_pilot_BOLD_17_EQC_slice_report.txt	Slice Report	text/plain
10	191118_SSBC_pilot_BOLD_17_EQC_slope_thumbnail.png	Slope Image	image/png
11	191118_SSBC_pilot_BOLD_17_EQC_slope.nii.gz	Slope NIFTI	image/nifti1
12	191118_SSBC_pilot_BOLD_17_EQC_snr_thumbnail.png	SNR Image	image/png
13	191118_SSBC_pilot_BOLD_17_EQC_snr.nii.gz	SNR NIFTI	image/nifti1
14	191118_SSBC_pilot_BOLD_17_EQC_stddev_thumbnail.png	StDev Image	image/png
15	191118_SSBC_pilot_BOLD_17_EQC_stddev.nii.gz	StDev NIFTI	image/nifti1

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Note: Clicking on a file within the All Stored Files tab will download the file.

File	Description
*_EQC_auto_report.txt	Automated QC report
*_EQC_mask_thumbnail.png	Mask snapshot image
*_EQC_mask.nii.gz	Mask NIFTI
*_EQC_mean_thumbnail.png	Mean snapshot image
*_EQC_mean.nii.gz	Mean NIFTI
*_EQC_mean_slice.txt	Mean slice intensity data
*_EQC_mean_slice.png	Mean slice intensity plot
*_EQC_motion.png	Motion plot
*_EQC_slice_report.txt	Slice report
*_EQC_slope_thumbnail.png	Slope snapshot image
*_EQC_slope.nii.gz	Slope NIFTI
*_EQC_snr_thumbnail.png	SNR snapshot image
*_EQC_snr.nii.gz	SNR NIFTI
*_EQC_stdev_thumbnail.png	Standard deviation snapshot image
*_EQC_stdev.nii.gz	Standard deviation image

DEVELOPER DOCUMENTATION

2.1 Installation

At the moment, the only supported way to install BOLDQC is *within a container*.

2.1.1 downloading a container

There are prebuilt versions of BOLDQC on [Docker Hub](#). You can pull the latest version by running

```
docker pull neuroinformatics/boldqc
```

or you can pull a specific version e.g., `0.1.0` by running

```
docker pull neuroinformatics/boldqc:0.1.0
```

2.1.2 building a container

To build BOLDQC as a container, grab the latest [Dockerfile](#) from the repository and run

```
docker build -t boldqc:latest - < Dockerfile
```

Now you can run `boldQC.py`—which is the default ENTRYPOINT—using `docker run`

```
docker run boldqc:latest --help
```

Note: You can also convert the BOLDQC Docker image into a Singularity image, however to run `boldQC.py` you'll need to supply `--pwd /sw/apps/boldqc`

```
singularity run --pwd /sw/apps/boldqc boldqc.sif --help
```

2.2 XNAT Installation

The following section will describe how to build and configure BOLDQC as a [XNAT](#) plugin.

2.2.1 building the plugin

Clone the `xnat-1.8` branch from the `github.com/harvard-nrg/boldqc` repository

```
git clone -b xnat-1.8 --single-branch https://github.com/harvard-nrg/boldqc
```

Change into the repository directory and compile the plugin using [Gradle](#)

```
./gradlew jar
```

Once the plugin has been compiled, move the resulting `.jar` into your XNAT plugins directory

```
mv ./build/libs/boldqc-plugin-1.0.0.jar ${XNAT_HOME}/plugins/
```

INDICES AND TABLES

- `genindex`
- `modindex`
- `search`