

Siemens/GE/Bruker raw data conversion to MRD through XML style sheets, and working with HDF5 files

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Outline

- Structure of MRD
- Role of stylesheets in MRD
- Accessing components of MRD/HDF5 interactively
- Modification of Stylesheets to alter reconstruction

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Structure of MRD

- From Maxime's presentation:
 - ISMRMRD = 'Experimental Header' + ('Acquisition Header' + Data) * # of Acquisitions
+ Trajectories + Waveforms.

Structure of MRD

ISMRRMRD Dataset

XML Header

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<ismrmrdHeader xmlns="http://www.ismrm.org/ISMRMRD"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.ismrm.org/ISMRMRD ismrmrd.xsd">

  <encoding>
    <encodedSpace>
      <matrixSize>
        <x>512</x><y>256</y><z>1</z>
      </matrixSize>
      <fieldOfView_mm>
        <x>600</x><y>300</y><z>6</z>
      </fieldOfView_mm>
    </encodedSpace>
    <reconSpace>
      <matrixSize>
        <x>256</x><y>256</y><z>1</z>
      </matrixSize>
      <fieldOfView_mm>
        <x>300</x><y>300</y><z>6</z>
      </fieldOfView_mm>
    </reconSpace>
    <encodingLimits>
      <kspace_encoding_step_1>
        <minimum>0</minimum>
        <maximum>255</maximum>
        <center>128</center>
      </kspace_encoding_step_1>
      <repetition>
        <minimum>0</minimum>
        <maximum>1</maximum>
        <center>0</center>
      </repetition>
    </encodingLimits>
    <trajectory>cartesian</trajectory>
  </encoding>

</ismrmrdHeader>
```

Raw Data

Data Header

Data Samples

[illegible]

Structure of MRD

- From Maxime's presentation:
 - ISMRMRD = 'Experimental Header' + ('Acquisition Header' + Data) * # of Acquisitions
+ Trajectories + Waveforms.
- **ALL** vendors' data are like this! (no extra trajectory nor waveform meta-data)
 - Problems are with custom (proprietary) layouts, variables, and interpretation.
- ISMRMRD provides fully-documented file structure
 - Stylesheets facilitate “translation” of vendors' variables to ISMRMRD's.

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Role of stylesheets in MRD

- Translate / Map vendor variables to variables in ISMRMRD.

Role of stylesheets in MRD

- Siemens converter (at https://github.com/ismrmrd/siemens_to_ismrmrd)

ismrmrd / siemens_to_ismrmrd

Watch 7 Star 11 Fork 27

<> Code Issues 12 Pull requests 2 Actions Projects 0 Wiki Security 0 Insights

Siemens ISMRMRD converter

446 commits 24 branches 0 packages 2 releases 11 contributors View license

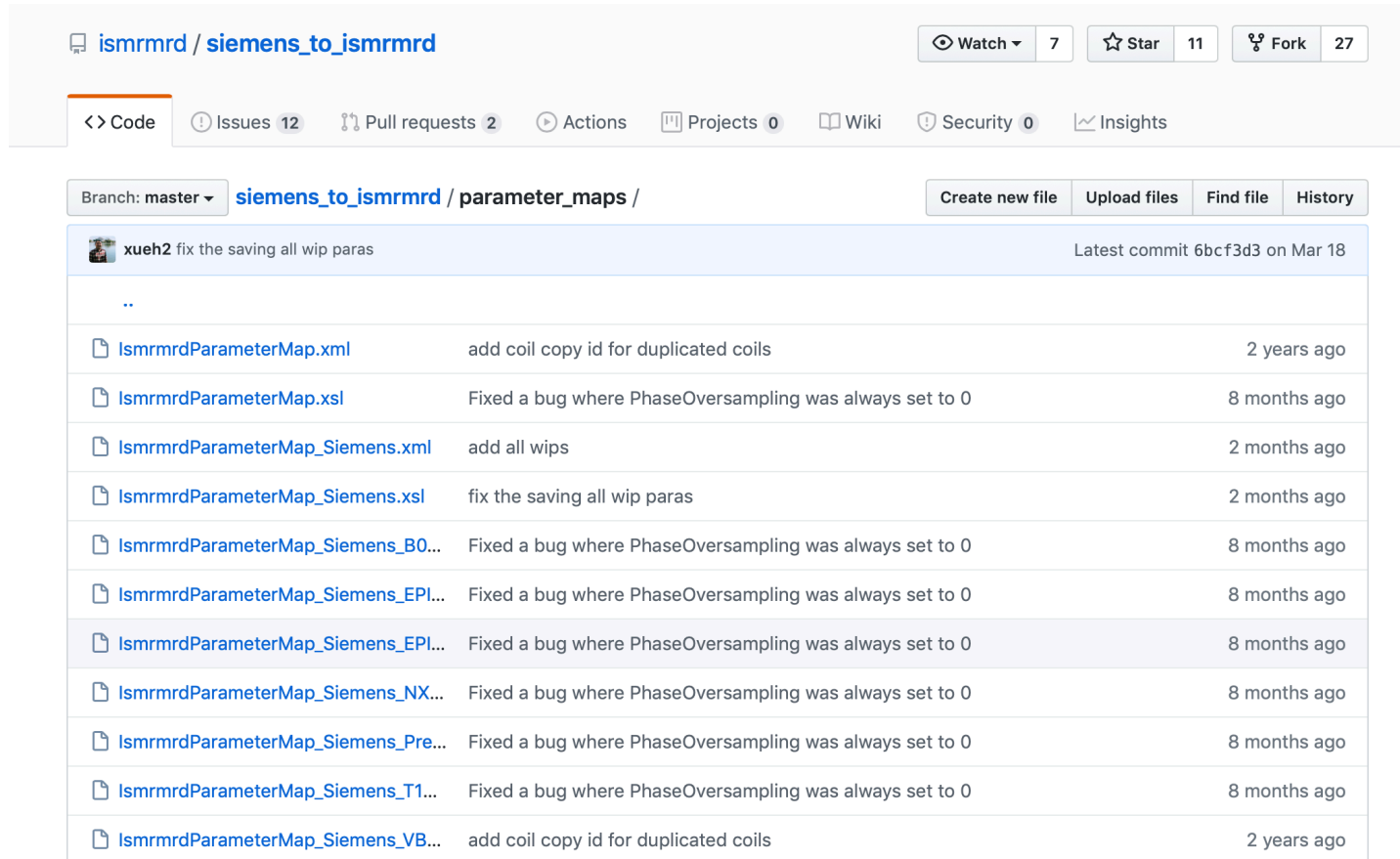
Branch: master New pull request Create new file Upload files Find file Clone or download

Latest commit 6bcf3d3 on Mar 18

cmake	packaging: cpack used, no components	5 years ago
parameter_maps	fix the saving all wip paras	2 months ago
.gitignore	cleaning up some basic issues	5 years ago
CMakeLists.txt	Fixed REMOVE_DUPLICATES bug	7 months ago
ConverterXml.h	Reverted last case change.	6 years ago
LICENSE	Added license file	6 years ago
README.mkd	Added zenodo badge to the readme file.	5 years ago
XNode.cpp	Fix truncating strings containing spaces	2 years ago
XNode.h	Allowed <Line> specifiers in generic parameter blocks. Gave a sane er...	17 months ago
XNodeParser.cpp	update for NX to check software version	8 months ago
base64.cpp	cleaning up some basic issues	5 years ago
base64.h	-Converter does not require Siemens file in order to run	6 years ago

Role of stylesheets in MRD

- Siemens converter (at https://github.com/ismrmrd/siemens_to_ismrmrd)



The screenshot displays the GitHub interface for the repository `ismrmrd / siemens_to_ismrmrd`. The repository has 7 watchers, 11 stars, and 27 forks. The navigation bar includes links for Code, Issues (12), Pull requests (2), Actions, Projects (0), Wiki, Security (0), and Insights. The current view is the `parameter_maps` directory on the `master` branch. A commit by `xueh2` titled "fix the saving all wip paras" is shown at the top, with the latest commit hash `6bcf3d3` dated Mar 18. Below the commit, a list of files is displayed, each with a file icon, name, description, and commit time.

File Name	Description	Commit Time
..		
<code>IsrmrdParameterMap.xml</code>	add coil copy id for duplicated coils	2 years ago
<code>IsrmrdParameterMap.xsl</code>	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
<code>IsrmrdParameterMap_Siemens.xml</code>	add all wips	2 months ago
<code>IsrmrdParameterMap_Siemens.xsl</code>	fix the saving all wip paras	2 months ago
<code>IsrmrdParameterMap_Siemens_B0...</code>	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
<code>IsrmrdParameterMap_Siemens_EPI...</code>	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
<code>IsrmrdParameterMap_Siemens_EPI...</code>	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
<code>IsrmrdParameterMap_Siemens_NX...</code>	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
<code>IsrmrdParameterMap_Siemens_Pre...</code>	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
<code>IsrmrdParameterMap_Siemens_T1...</code>	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
<code>IsrmrdParameterMap_Siemens_VB...</code>	add coil copy id for duplicated coils	2 years ago

Role of stylesheets in MRD

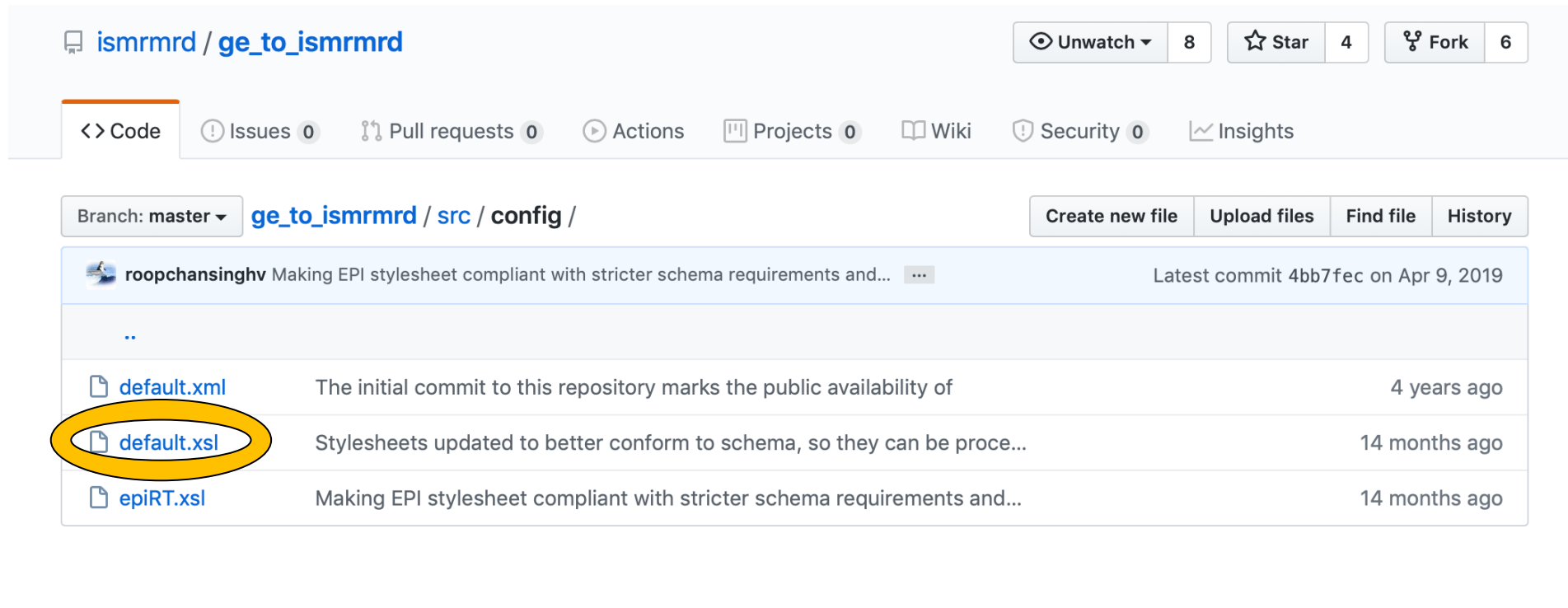
- Siemens converter (at https://github.com/ismrmrd/siemens_to_ismrmrd)

```
<xsl:variable name="partialFourierPhase">
  <xsl:choose>
    <xsl:when test="siemens/MEAS/sKSpace/ucPhasePartialFourier = 1">0.5</xsl:when>
    <xsl:when test="siemens/MEAS/sKSpace/ucPhasePartialFourier = 2">0.75</xsl:when>
    <xsl:when test="siemens/MEAS/sKSpace/ucPhasePartialFourier = 4">0.875</xsl:when>
    <xsl:otherwise>1.0</xsl:otherwise>
  </xsl:choose>
</xsl:variable>

<xsl:variable name="numberOfContrasts">
  <xsl:value-of select="siemens/MEAS/lContrasts"/>
</xsl:variable>
```

Role of stylesheets in MRD

- GE converter (at https://github.com/ismrmrd/ge_to_ismrmrd)



The screenshot displays the GitHub repository page for `ismrmrd / ge_to_ismrmrd`. The repository has 8 Unwatch, 4 Star, and 6 Fork. The navigation tabs include Code, Issues (0), Pull requests (0), Actions, Projects (0), Wiki, Security (0), and Insights. The current branch is `master`, and the file path is `ge_to_ismrmrd / src / config /`. The latest commit is by `roopchansinghv` with the message "Making EPI stylesheet compliant with stricter schema requirements and..." on April 9, 2019. The file list shows three files: `default.xml` (4 years ago), `default.xml` (14 months ago), and `epiRT.xml` (14 months ago). The `default.xml` file is highlighted with a yellow circle.

File	Description	Commit Date
<code>default.xml</code>	The initial commit to this repository marks the public availability of	4 years ago
<code>default.xml</code>	Stylesheets updated to better conform to schema, so they can be proce...	14 months ago
<code>epiRT.xml</code>	Making EPI stylesheet compliant with stricter schema requirements and...	14 months ago



Role of stylesheets in MRD

- GE converter (at https://github.com/ismrmrd/ge_to_ismrmrd)

```
<experimentalConditions>
  <H1resonanceFrequency_Hz><xsl:value-of select="Header/Image/ImagingFrequency * 1000000"/></H1resonanceFrequency_Hz>
</experimentalConditions>

<encoding>
  <trajectory>cartesian</trajectory>
  <encodedSpace>
    <matrixSize>
      <x><xsl:value-of select="Header/AcquiredXRes"/></x>
      <y><xsl:value-of select="Header/AcquiredYRes"/></y>
      <xsl:choose>
        <xsl:when test="(Header/Is3DAcquisition)='true'">
          <z><xsl:value-of select="Header/AcquiredZRes"/></z>
        </xsl:when>
        <xsl:otherwise>
          <z><xsl:value-of select="1"/></z>
        </xsl:otherwise>
      </xsl:choose>
    </matrixSize>
    <fieldOfView_mm>
      <x><xsl:value-of select="Header/TransformXRes * Header/Image/PixelSizeX"/></x>
      <y><xsl:value-of select="Header/TransformYRes * Header/Image/PixelSizeY"/></y>
      <!-- <z><xsl:value-of select="Header/Image/SliceThickness + Header/Image/SliceSpacing"/></z> -->
      <z><xsl:value-of select="Header/Image/SliceThickness"/></z>
    </fieldOfView_mm>
  </encodedSpace>
  <reconSpace>
```

Logic Checks

Basic Math

Role of stylesheets in MRD

- **Basic** example of vendor inconsistency, and how it is handled by ISMRMRD:

```
<experimentalConditions>  
  <H1resonanceFrequency_Hz><xsl:value-of select="Header/Image/ImagingFrequency * 1000000"/></H1resonanceFrequency_Hz>  
</experimentalConditions>
```

ismrmrd-ge/src/config/default.xsl

```
<experimentalConditions>  
  <H1resonanceFrequency_Hz><xsl:value-of select="siemens/DICOM/lFrequency"/></H1resonanceFrequency_Hz>  
</experimentalConditions>  
<encoding>
```

ismrmrd-siemens/parameter_maps/IsmrmrdParameterMap.xsl

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Accessing components of MRD/HDF5 interactively

- Interactive session using Jupyter notebooks. The notebooks can be found at:

https://github.com/roopchansinghv/ge_to_ismrmrd/tree/master/sampleData/notebooks

The notebooks used will be “[h5FileManipulationDemo.ipynb](#)” for the first portion of the demonstration, and “[basicISMRMRDPythonImportAndRecon.ipynb](#)” for the latter part.

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Modification of Stylesheets to alter reconstruction

- Interactive session using the terminal, with MRD converter and Gadgetron running in multiple Docker containers.

...