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

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NIH National Institute of Mental Health

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

ISMRMRD Dataset

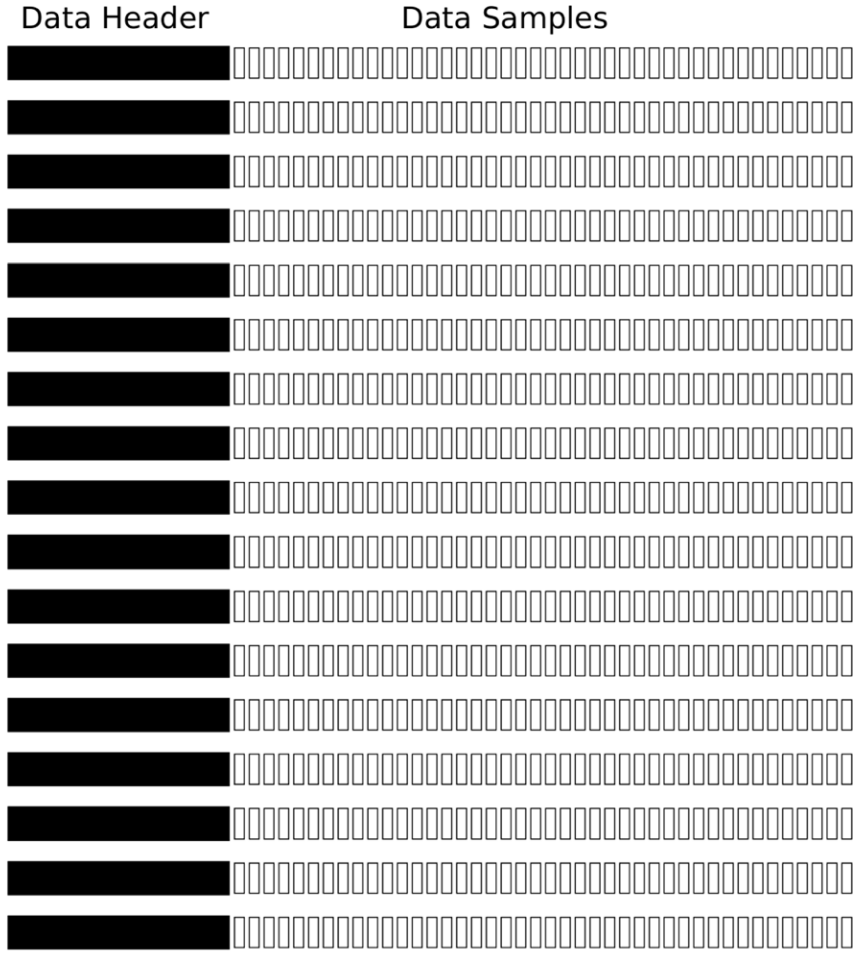
XML Header

```
<?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



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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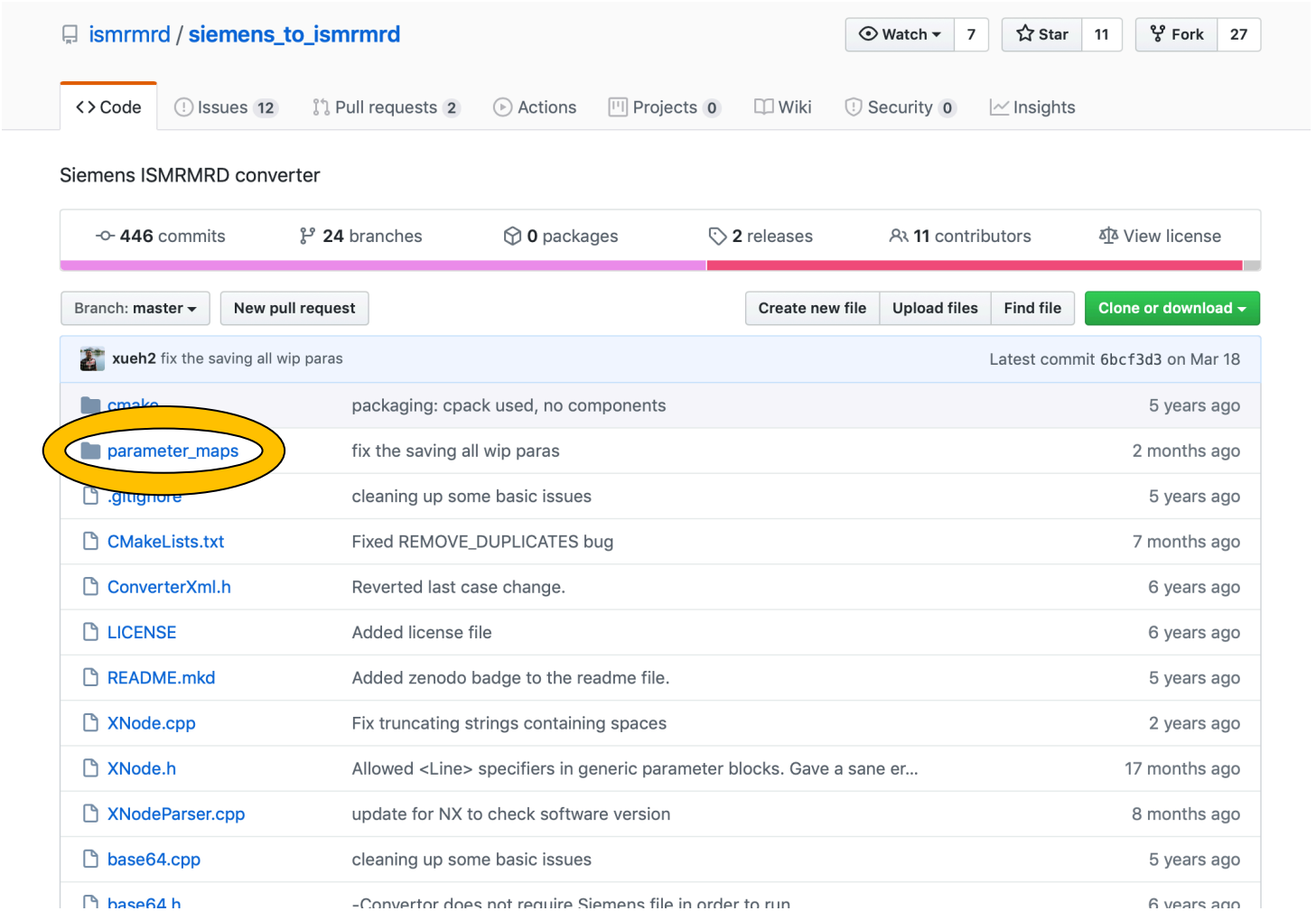
Role of stylesheets in MRD

- Translate / Map vendor variables to variables in ISMRMRD.

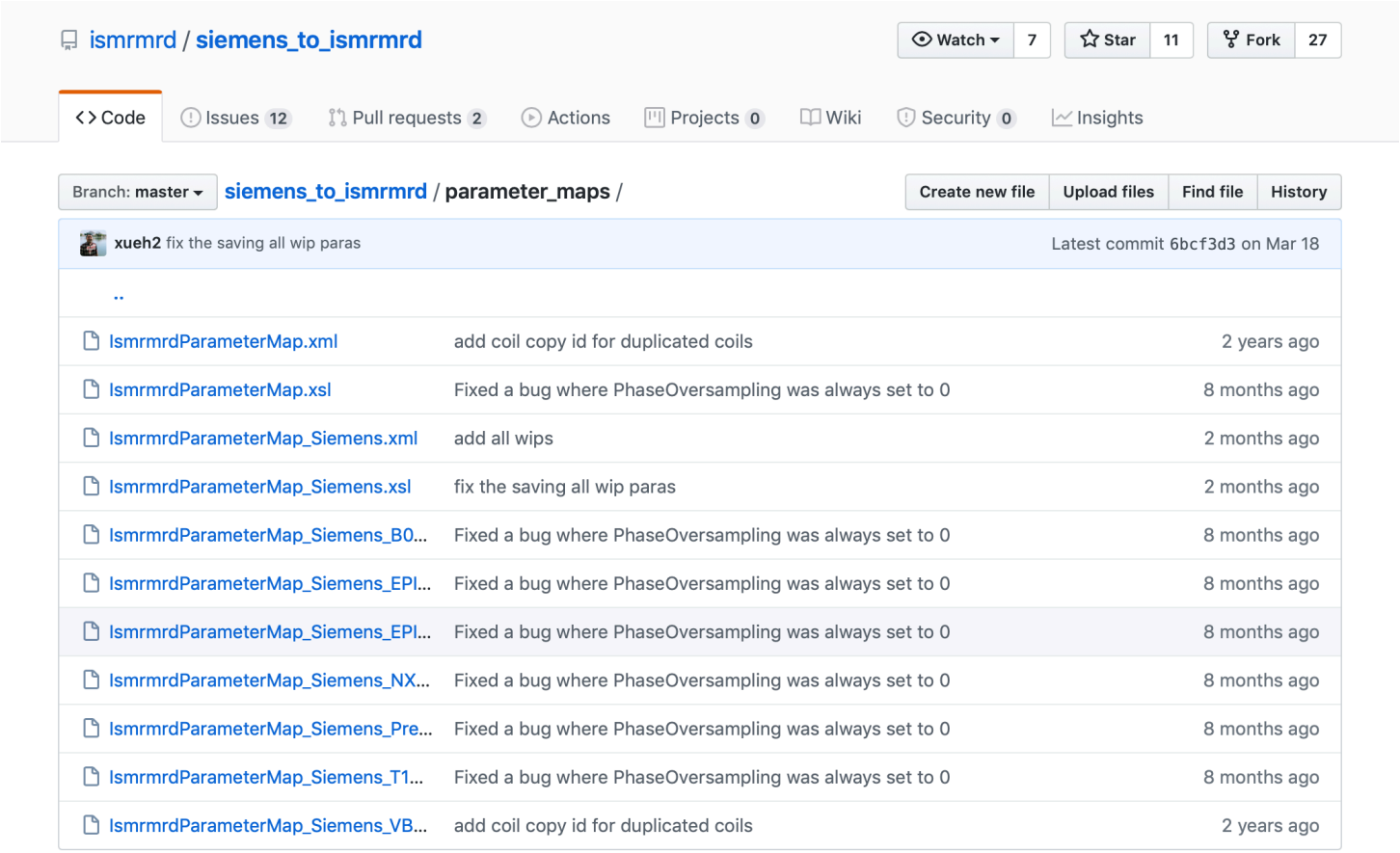
Role of stylesheets in MRD

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



Role of stylesheets in MRD

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



ismrmrd / siemens_to_ismrmrd

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

Branch: master ▾ siemens_to_ismrmrd / parameter_maps / | Create new file | Upload files | Find file | History

xueh2 fix the saving all wip paras — Latest commit 6bcf3d3 on Mar 18

..		
IsmrmrdParameterMap.xml	add coil copy id for duplicated coils	2 years ago
IsmrmrdParameterMap.xsl	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
IsmrmrdParameterMap_Siemens.xml	add all wips	2 months ago
IsmrmrdParameterMap_Siemens.xsl	fix the saving all wip paras	2 months ago
IsmrmrdParameterMap_Siemens_B0...	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
IsmrmrdParameterMap_Siemens_EPI...	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
IsmrmrdParameterMap_Siemens_EPI...	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
IsmrmrdParameterMap_Siemens_NX...	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
IsmrmrdParameterMap_Siemens_Pre...	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
IsmrmrdParameterMap_Siemens_T1...	Fixed a bug where PhaseOversampling was always set to 0	8 months ago
IsmrmrdParameterMap_Siemens_VB...	add coil copy id for duplicated coils	2 years ago

Role of stylesheets in MRD

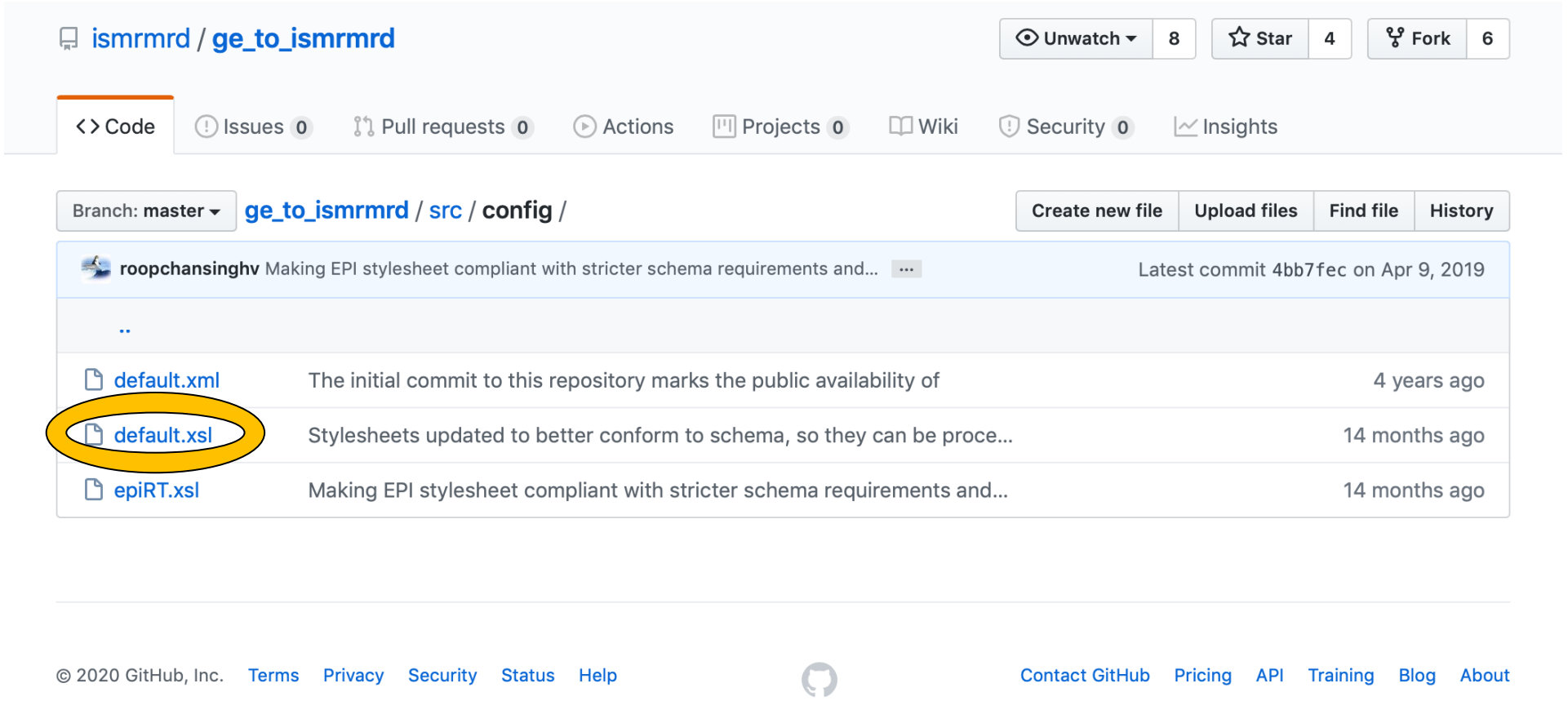
- Siemens converter (at https://github.com/ismrmrd/siemens_to_ismrmrd)

```
<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)



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.

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