The real-time setup

Michael Lührs

Overview

1. General real-time fMRI setup
2. Potential pitfalls
3. Important considerations

1.

General real-time fMRI setup

Individual real-time fMRI components

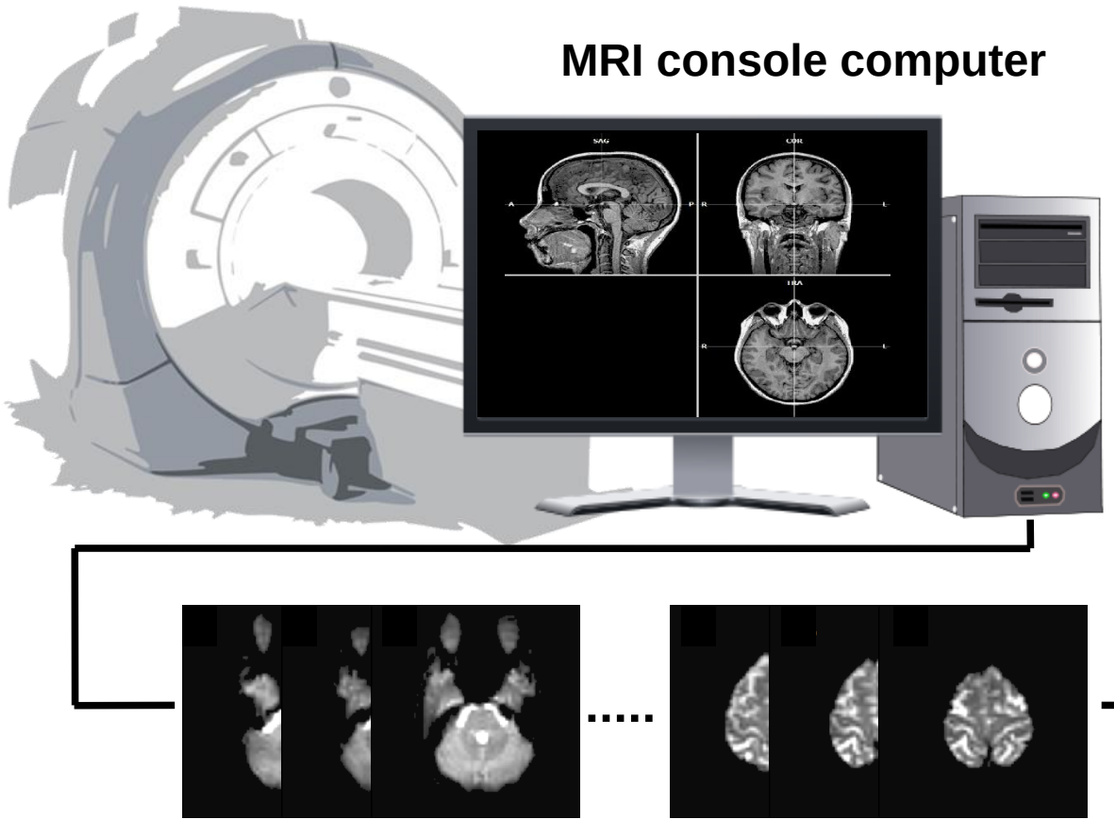
- MRI
  - Siemens
  - Phillips
  - GE
  - United Imaging

- Real-time fMRI processing computer
  - Windows, Linux, Mac

- Stimulus/Neurofeedback presentation computer
  - Windows, Linux, Mac

- Peripherals
  - Physiological recordings, Motion, Eye Tracking, Response box, …

Real-Time fMRI setup



real-time data export of the images

Real-time fMRI computer

Real-Time fMRI setup

MRI console computer

IP: 192.168.1.1

Real-time fMRI computer

IP: 192.168.1.2

Both computers have to be in the same network to access the shared folder provided by the Turbo-BrainVoyager computer. The folder can be reached on the defined location.

Network connection

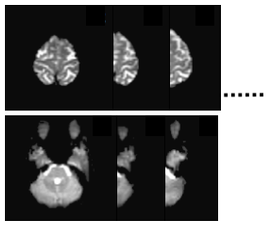
Shared folder “rtfmri”

Location: \\192.168.1.2\rtfmri

Neurofeedback setup

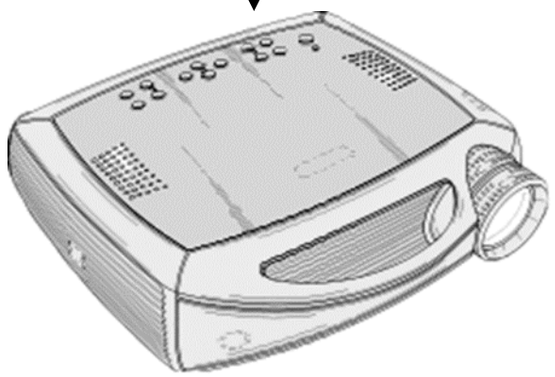
Transfer stimulus files to shared folder

MRI images



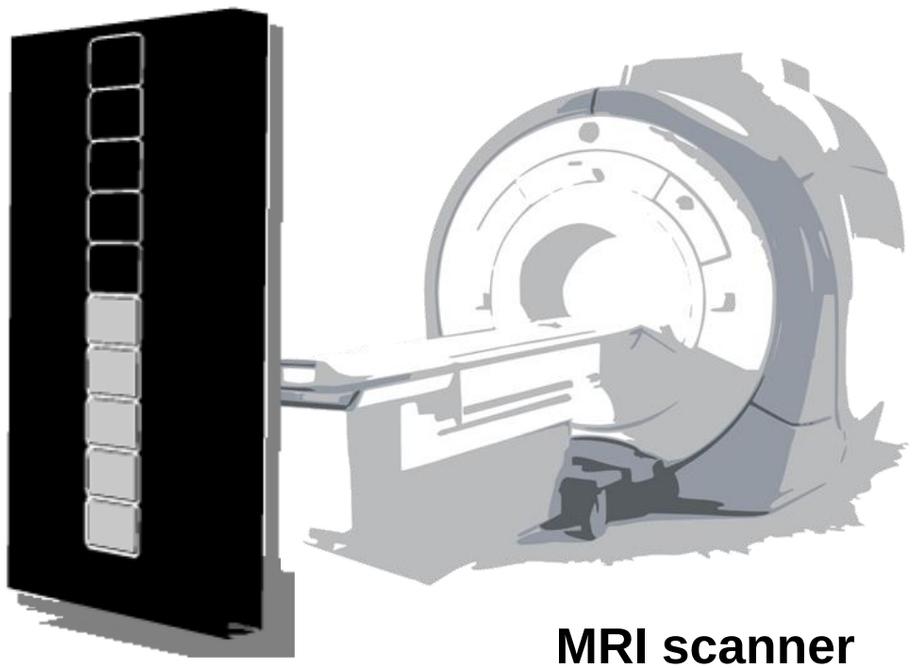
Real-time fMRI computer

Connect video projector as second display



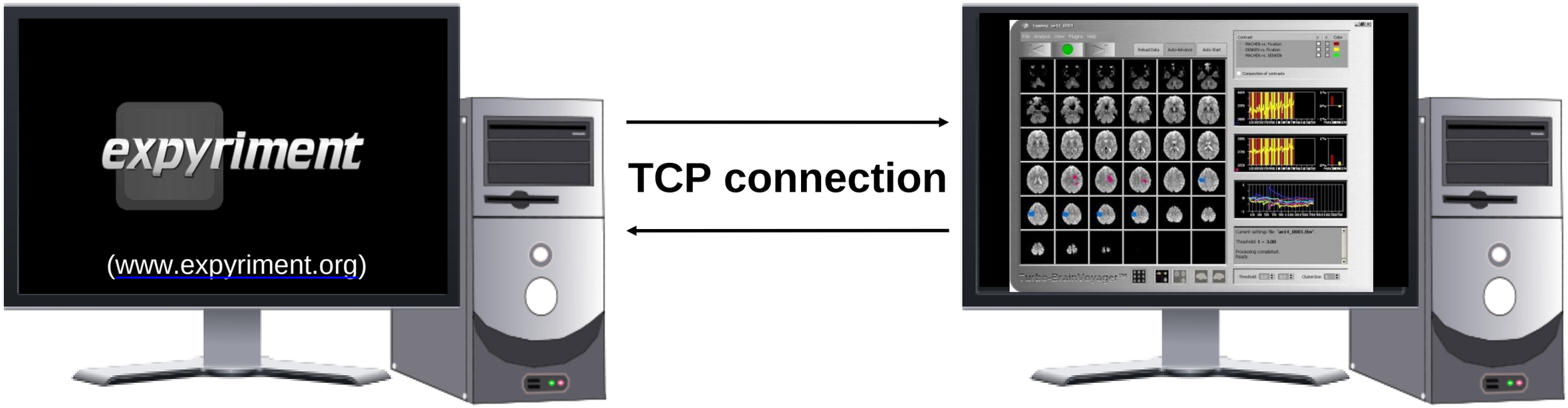
Video projector

Show stimulus to subject



MRI scanner

Providing feedback



- On Stimulation PC:
  - TBV Network Interface

- On Analysis PC:
  - TBV Network Plugin

2.

Potential pitfalls

Real-Time fMRI setup

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Real-time fMRI computer

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Network connection

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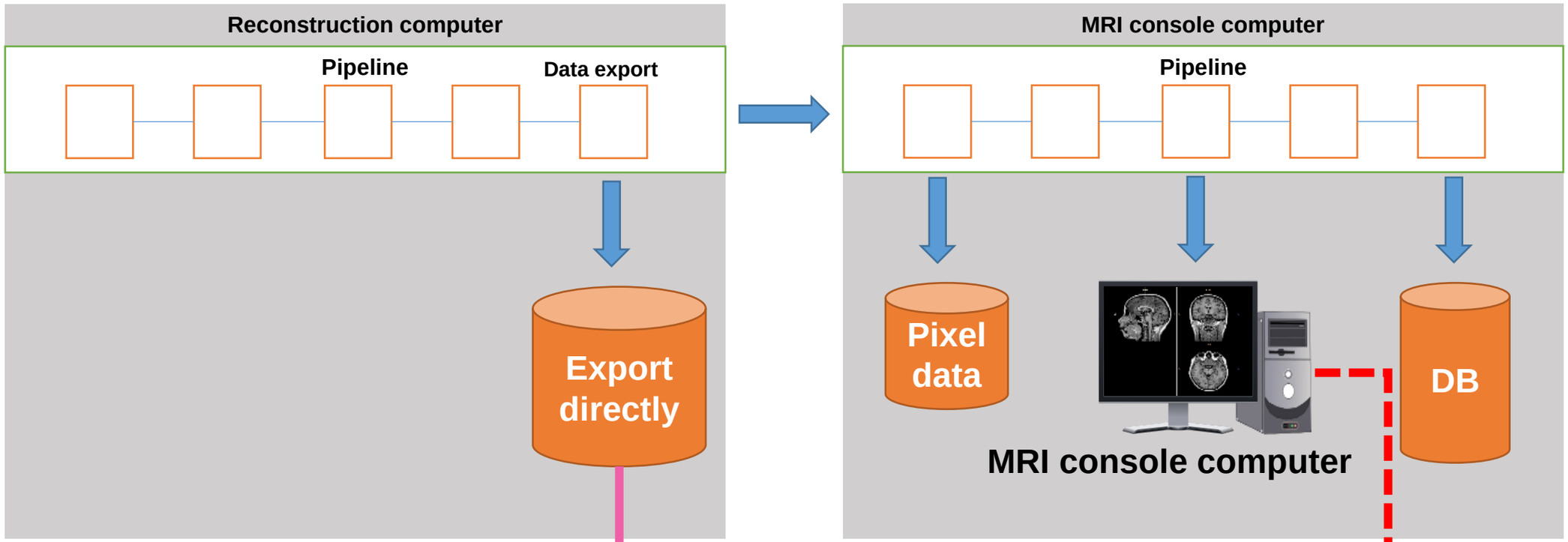
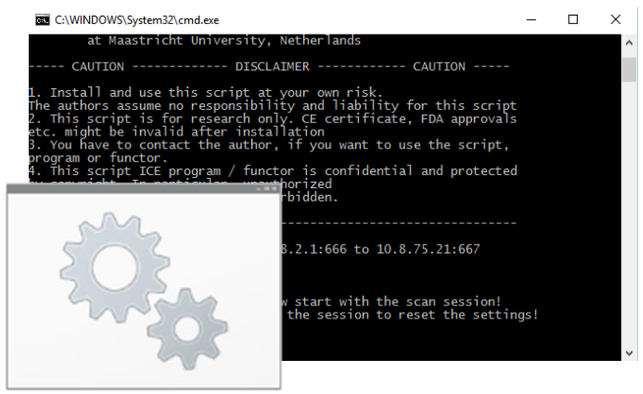
Location: \\192.168.1.2\rtfmri

Network structure



Direct TCP/IP based real-time export

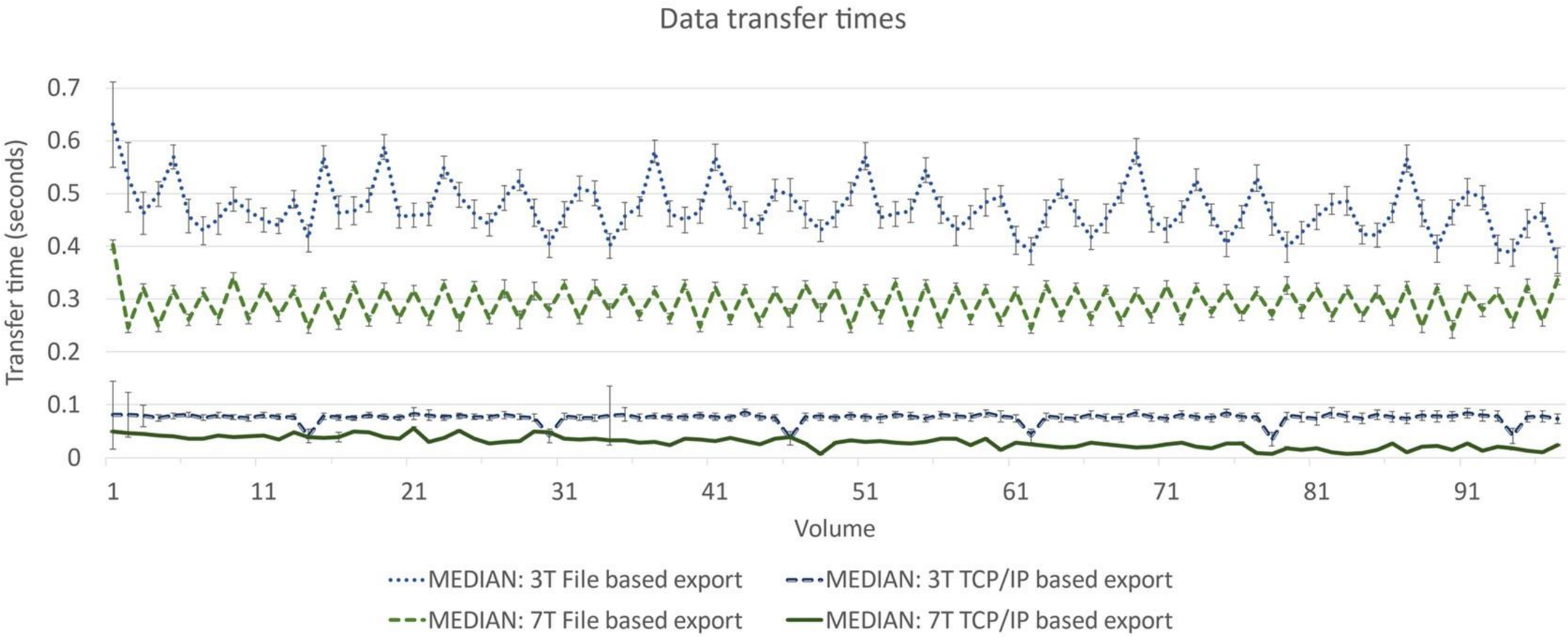
Default data transfer using SMB protocol



Enable_Realtime_Export_VD13.bat

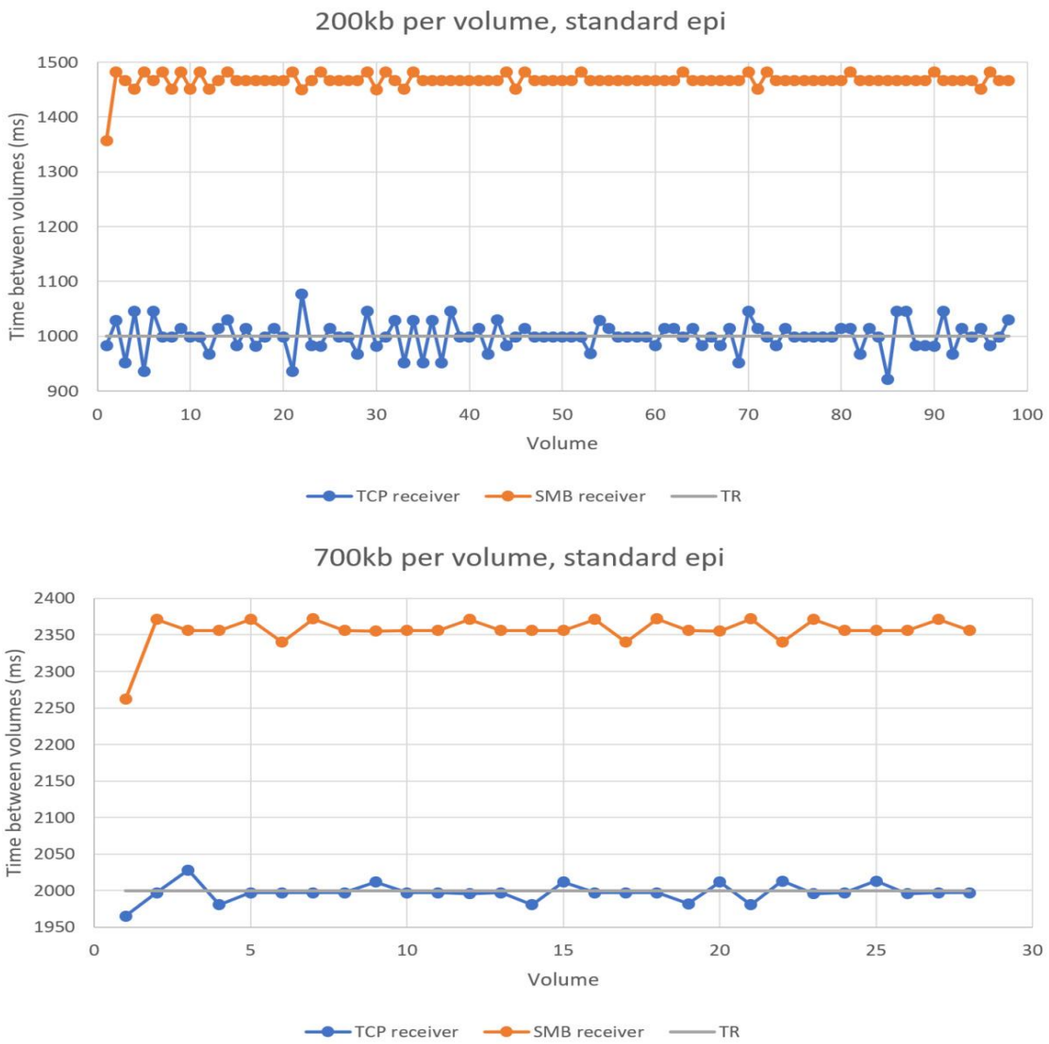
Real-time fMRI computer

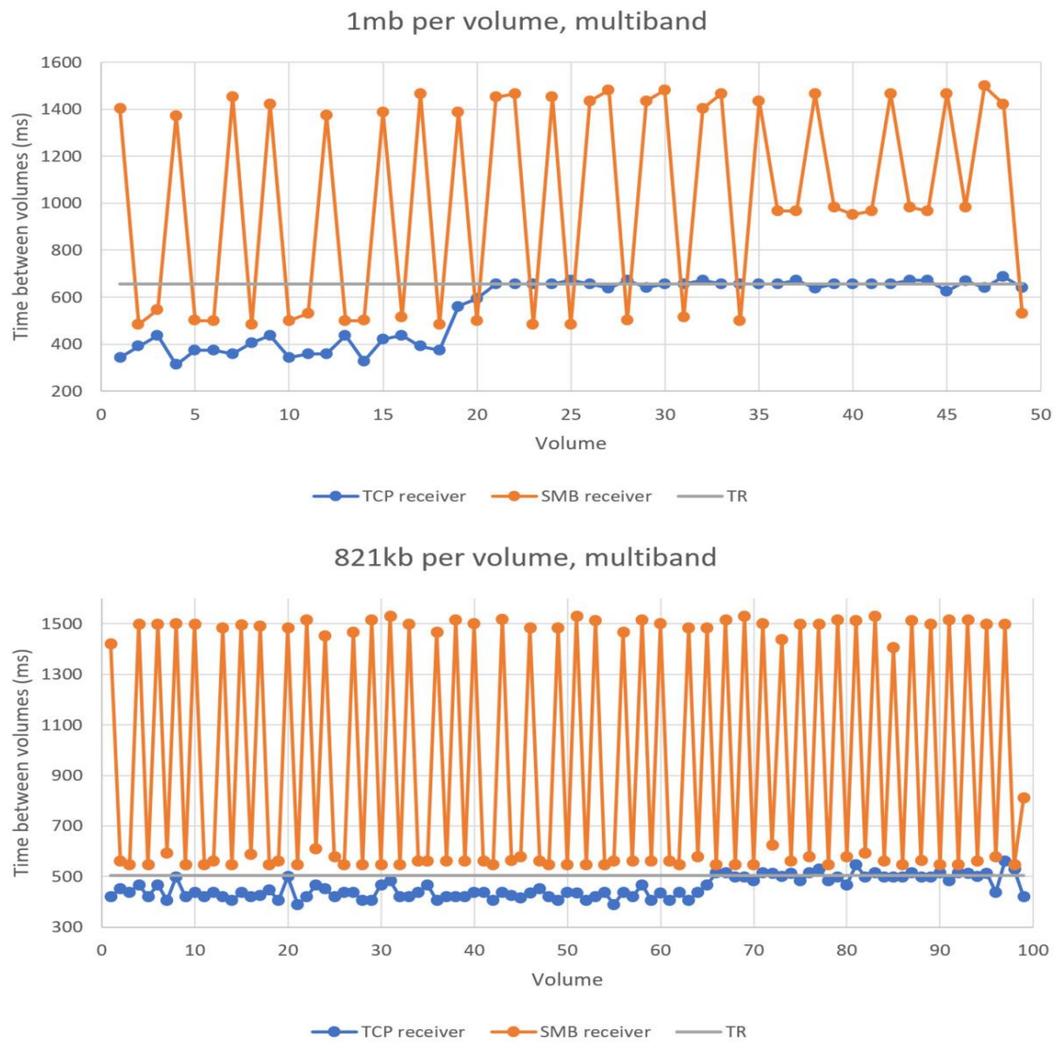
Data transfer times



Lührs, Michael, et al. "Fast Retrieval of fMRI Data for Real-Time Applications: Improving the Transfer Time through Direct Connection." *Aperture Neuro*, vol. 3, Aug. 2023, https://doi.org/10.52294/001c.77768.

Data transfer times





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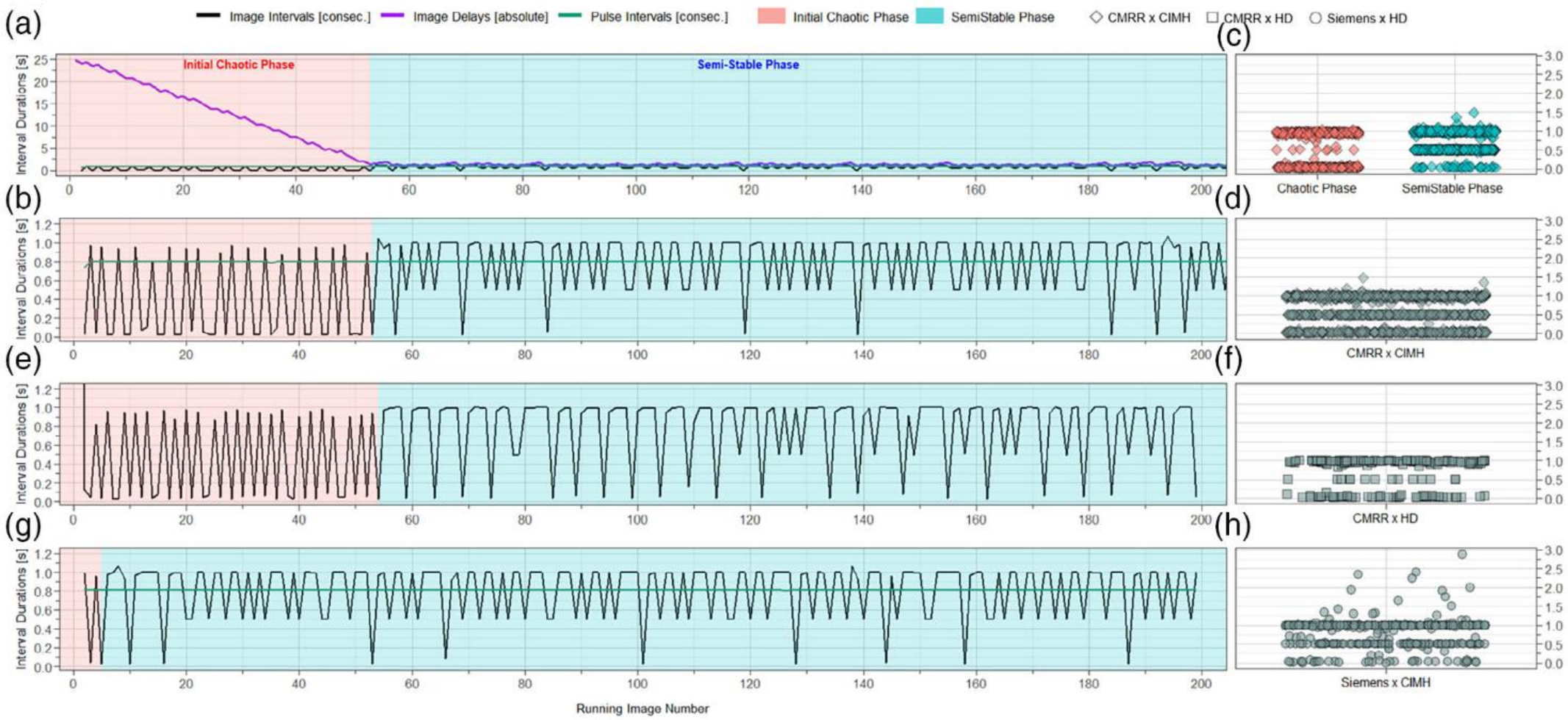


Renz, Malika P et al. "Practical challenges of continuous real-time functional magnetic resonance imaging neurofeedback with multiband accelerated echo-planar imaging and short repetition times." Human brain mapping vol. 44,3 (2023): 1278-1282. doi:10.1002/hbm.26154

Continuous vs. intermittent feedback

- Continuous:
  - Give feedback as soon as it is available
  - During regulation attempts

- Intermittent:
  - Give feedback only after regulation attempts

Real-time pre-processing and analysis

- Delays in data processing/analysis
  - Variability due to:
    - Motion parameters
    - GLM statistics
    - MVPA
    - Connectivity
  - Real-time processing computer is not made for real real-time
    - Delays can occur more in later runs compared to initial

3.

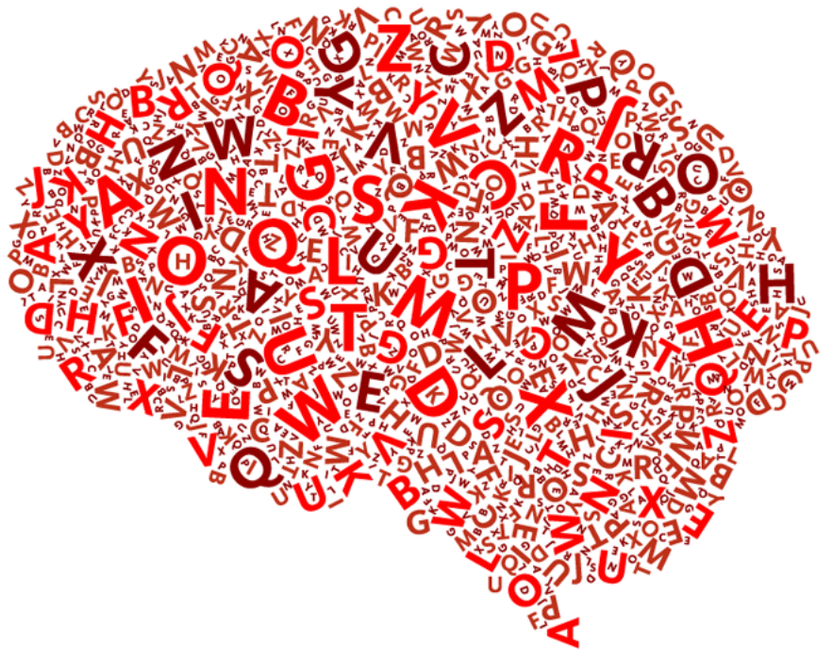
Important considerations

Verify real-time export parameters of your study

- Acquire phantom scans at least 20% longer than your planne
  - Use the same sequence parameters as for the final study
  - Record export times and repeat this teste on different days and times

- Include longer baseline phase in the beginning of each run
  - Accounting for stable data reconstruction (Multi-band)
  - More stable statistics for real-time GLM

- Log transfer time during experiment
  - Important to be able to trace potential delays also month after the study



Questions?