

Data formats for EIT

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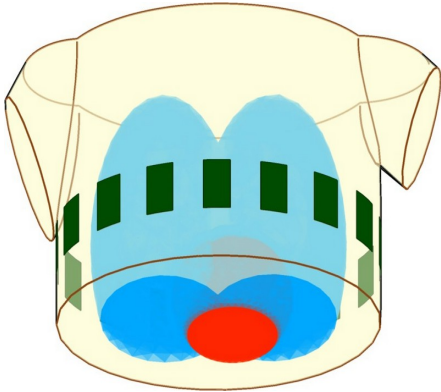
Electrical Impedance Tomography: Non-invasive

[1]

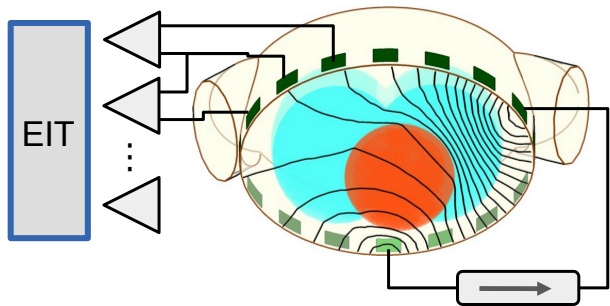


¹Heinrich *et al* (2006) **Body and head position effects on regional lung ventilation in infants ...** Int Care Med 32:1392–1398

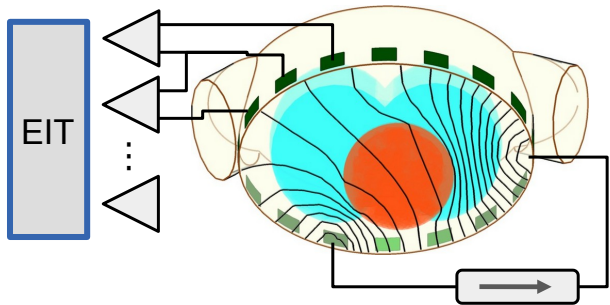
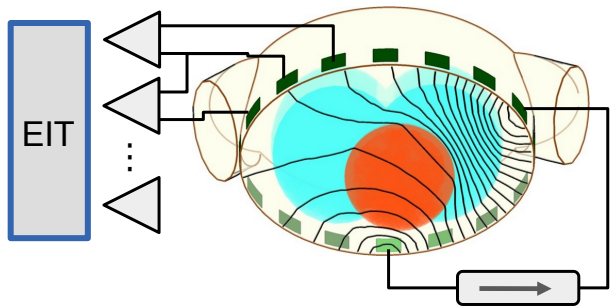
EIT and Computational Model



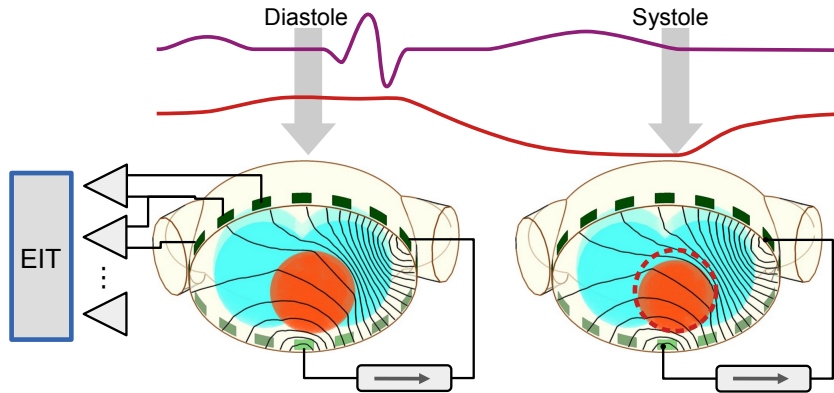
EIT: apply current
and measure voltages



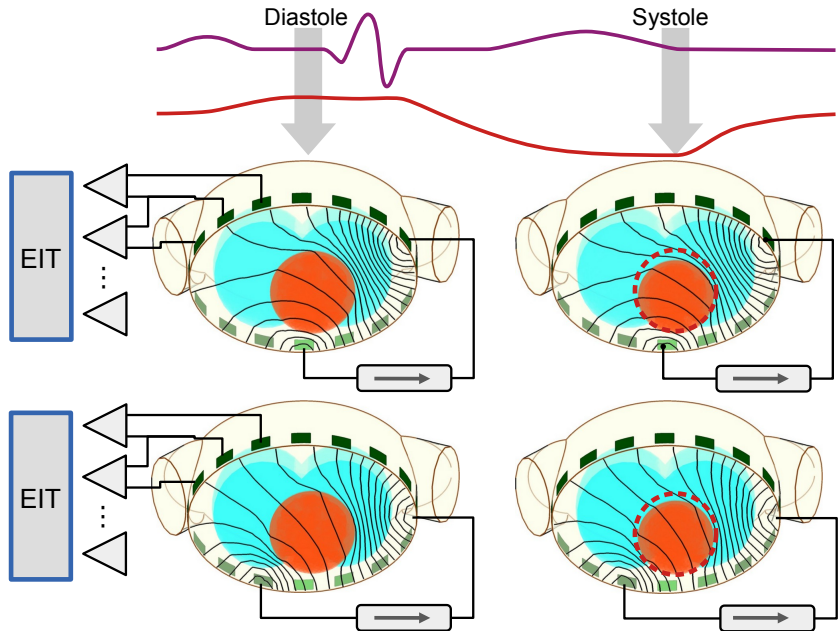
EIT: apply current
and measure *new* voltages



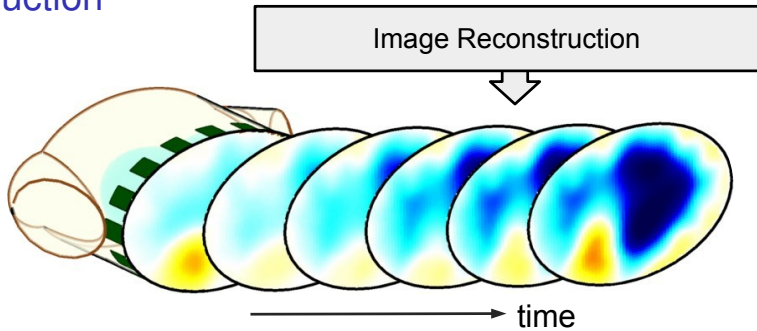
EIT: Physiology



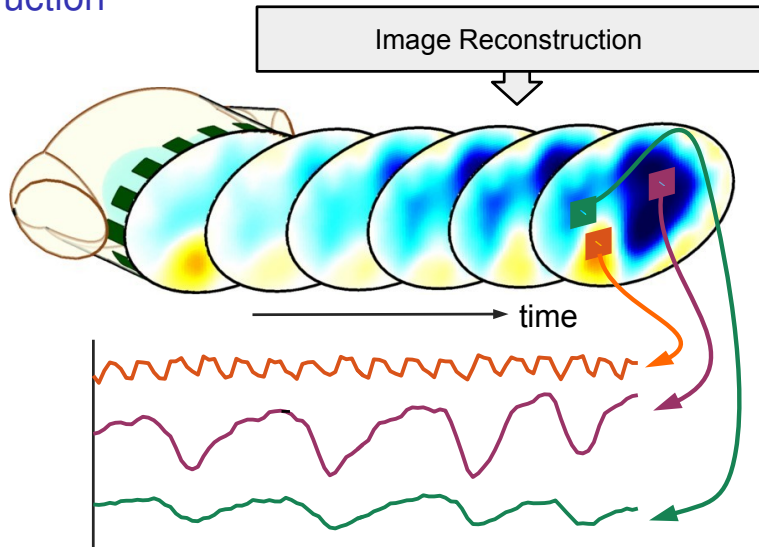
EIT: Physiology



EIT: Image Reconstruction

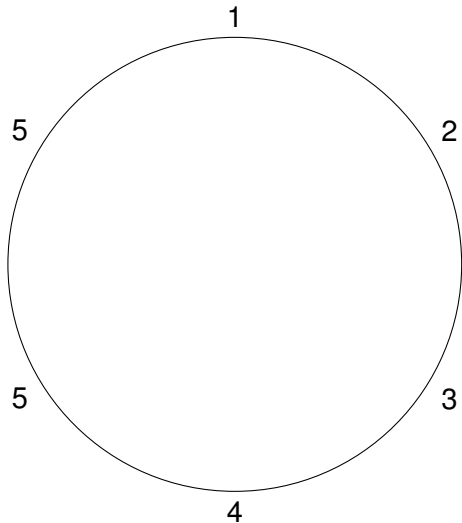


EIT: Image Reconstruction



Stimulation & Measurement patterns – 6 electrodes

- EIDORS: `mk_stim_patterns()`



Adjacent Stimulation – no_rotate_meas

Stim	Meas	Meas	Meas	Meas	Meas	Meas
1→2	1→2	2→3	3→4	4→5	5→6	6→1
2→3	1→2	2→3	3→4	4→5	5→6	6→1
3→4	1→2	2→3	3→4	4→5	5→6	6→1
4→5	1→2	2→3	3→4	4→5	5→6	6→1
5→6	1→2	2→3	3→4	4→5	5→6	6→1
6→1	1→2	2→3	3→4	4→5	5→6	6→1

Adjacent Stimulation – no_rotate_meas, no_meas_current

Stim	Meas	Meas	Meas	Meas	Meas	Meas
1→2	1→2	2→3	3→4	4→5	5→6	6→1
2→3	1→2	2→3	3→4	4→5	5→6	6→1
3→4	1→2	2→3	3→4	4→5	5→6	6→1
4→5	1→2	2→3	3→4	4→5	5→6	6→1
5→6	1→2	2→3	3→4	4→5	5→6	6→1
6→1	1→2	2→3	3→4	4→5	5→6	6→1

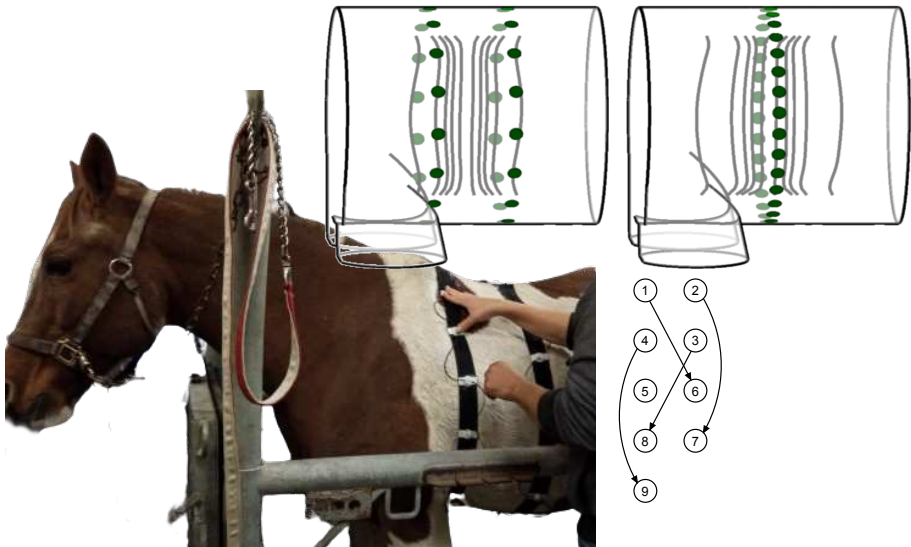
Adjacent Stimulation – rotate_meas

Stim	Meas	Meas	Meas	Meas	Meas	Meas
1→2	1→2	2→3	3→4	4→5	5→6	6→1
2→3	2→3	3→4	4→5	5→6	6→1	1→2
3→4	3→4	4→5	5→6	6→1	1→2	2→3
4→5	4→5	5→6	6→1	1→2	2→3	3→4
5→6	5→6	6→1	1→2	2→3	3→4	4→5
6→1	6→1	1→2	2→3	3→4	4→5	5→6

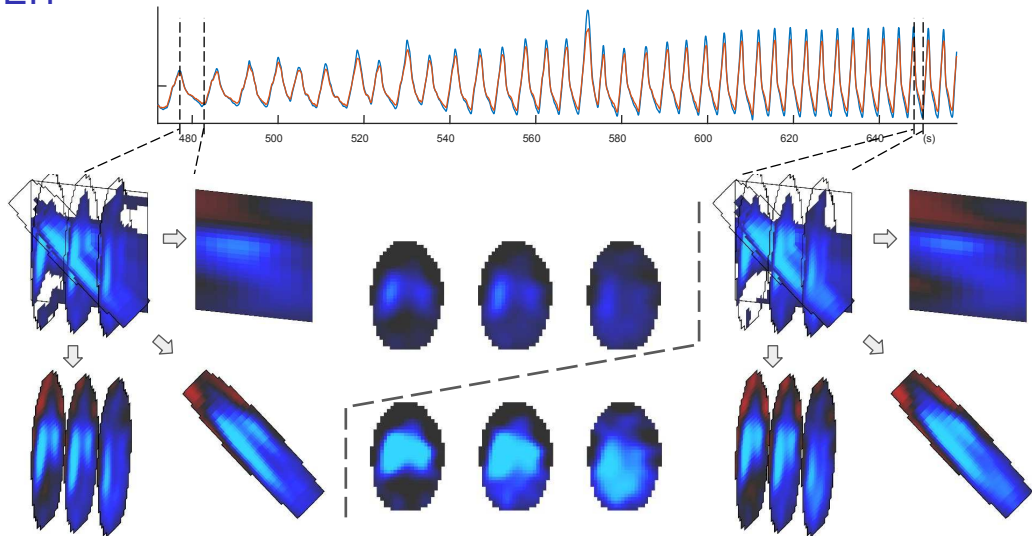
Adjacent Stimulation – rotate_meas, no_meas_current

Stim	Meas	Meas	Meas	Meas	Meas	Meas
1→2	1→2	2→3	3→4	4→5	5→6	6→1
2→3	2→3	3→4	4→5	5→6	6→1	1→2
3→4	3→4	4→5	5→6	6→1	1→2	2→3
4→5	4→5	5→6	6→1	1→2	2→3	3→4
5→6	5→6	6→1	1→2	2→3	3→4	4→5
6→1	6→1	1→2	2→3	3→4	4→5	5→6

Skip stimulation, measurements patterns



3D EIT



Skip-1 Stimulation – no_rotate_meas

Stim	Meas	Meas	Meas	Meas	Meas	Meas
1→3	1→3	2→4	3→5	4→6	5→1	6→2
2→4	1→3	2→4	3→5	4→6	5→1	6→2
3→5	1→3	2→4	3→5	4→6	5→1	6→2
4→6	1→3	2→4	3→5	4→6	5→1	6→2
5→1	1→3	2→4	3→5	4→6	5→1	6→2
6→2	1→3	2→4	3→5	4→6	5→1	6→2

Skip-1 Stimulation – no_rotate_meas, no_meas_current

Stim	Meas	Meas	Meas	Meas	Meas	Meas
1→3	1→3	2→4	3→5	4→6	5→1	6→2
2→4	1→3	2→4	3→5	4→6	5→1	6→2
3→5	1→3	2→4	3→5	4→6	5→1	6→2
4→6	1→3	2→4	3→5	4→6	5→1	6→2
5→1	1→3	2→4	3→5	4→6	5→1	6→2
6→2	1→3	2→4	3→5	4→6	5→1	6→2

Uses and abuses of EIDORS: an extensible software base for EIT

Andy Adler and William R B Lionheart

Published 18 April 2006 • 2006 IOP Publishing Ltd

[Physiological Measurement](#), [Volume 27](#), [Number 5](#)

Citation Andy Adler and William R B Lionheart 2006 *Physiol. Meas.* **27** S25

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[Article information](#) ▼

Abstract

EIDORS is an open source software suite for image reconstruction in electrical impedance tomography and diffuse optical tomography, designed to facilitate collaboration, testing and new research in these fields. This paper describes recent work to redesign the software structure in order to simplify its use and provide a uniform interface, permitting easier modification and customization. We describe the key features of this software, followed by examples of its use.

EIDORS: eidors_readdata.m

sourceforge.net/p/eidors3d/code/HEAD/tree/trunk/eidors/interface/eidors_readdata.m

[r7174]: ↗ /trunk / eidors / interface / eidors_readdata.m

[Download this file](#)

1803 lines (1552 with data), 64.4 kB

```
1 function [vv, auxdata, stim]= eidors_readdata( fname, format, frame_range, extra )
2 % EIDORS readdata - read data files from various EIT equipment
3 % manufacturers
4 %
5 % [vv, auxdata, stim ]= eidors_readdata( fname, format, frame_range, extra )
6 % frame_range is the list of frames to load from the file (ie. 1:100).
7 % if the frames are beyond the number in the file, no data is returned
8 % to get all frames, use frame_range= []
9 %
10 % Currently the list of supported file formats is:
11 % - "EIT" Files, may be one of
12 %   - Draeger Pulmovista (2008+)
13 %   - GoeIIMF/Carefusion (2010+)
14 %   - Swisstom BB2/Pioneer (2010+)
15 %   The function will attempt to autodetect the format
16 %
17 % - MCEIT (GoeIIMF / Viasys) "get" file format
18 %   format = "GET" or "MCEIT"
19 %   Note that the data is "untwisted" to correspond to a "no_rotate_meas" stim pattern
20 % - MCEIT (GoeIIMF) "get" file format
21 %   format = "GET-RAW"
22 %   Data in original order, corresponds to "rotate_meas" stim pattern
23 %
24 % - Draeger (Pulmovista) "EIT" file format (2008+)
25 %   format = "DRAEGER-EIT"
26 %
27 % - Draeger "get" file format (- 2007 - format for Draeger equipment)
28 %   format = "DRAEGER-GET"
29 %
30 % - Sentec (Swisstom) EIT equipment "EIT" (Pioneer set and BB2):
31 %   'LQ1' (2010 - 2011)
32 %   'LQ2' (2013 - 2014)
33 %   'LQ4' (2015+)
34 %   'LQ5' (2023+)
```

EIDORS: eidors_readdata.m

Main formats:

- Sheffield MKI/MKII
- Goettingen MFII (“get”)
- Dräger Pulmovista (“eit”)
- Sentec BB2 / PioneerSet (“eit”, LQ1 ... LQ5)

Newer formats

- HDF5

Minor / older formats

- Dixtal, Midas Medical, Sciospec, ITS, IIRC

Looking for formats for other EIT vendors, *please*

- Timpel
- Infivision
- ...

File format issues

- Flexibility with Stim/Meas patterns
- Measurement time: serial / parallel / frame rate variations
- Synchronization with other data streams
- Metadata: Hardware settings
- Electrode positions
- Patient data & privacy issues

HDF5-based format

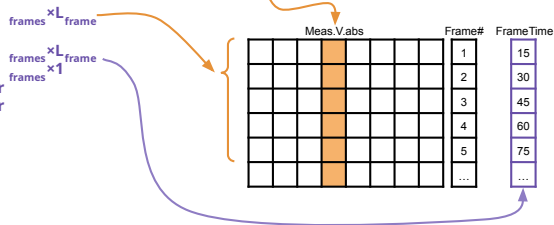
/data # folder for data
/dataset1 # this dataset (of several)
/protocol

Stim.I.01(A) Curr elec#01
Stim.I.02(A) Curr elec#02
Stim.I.freq(Hz) Injection Freq
Meas.V.01(V) Meas gain elec#01
Meas.V.02(V) Meas gain elec#02
Meas.V.03(V) Meas gain elec#03
Meas.V.04(V) Meas gain elec#04
Meas.V.freq(Hz) Demodulation Freq
Meas.Dtime(s) Δtime after meas

-0.01	-0.01	-0.01	-0.01	...	0	...	-0.01
+0.01	+0.01	+0.01	+0.01	...	-0.01	...	0
13000	13000	13000	13000	...	13000	...	13000
-10	0	0	0	...	-10	...	-10
+10	-10	0	0	...	+10	...	-10
0	+10	-10	0	...	0	...	0
0	0	+10	-10	...	0	...	0
13000	13000	13000	13000	...	13000	...	13000
0.001	0.001	0.001	0.001	...	0.001	...	0.001

Meas.V.Abs # data files N
Meas.V.Real/.Imag # if available
Time.Meas(s) # if available N
Time.Frame(s) # if available N
Time.Start(s) # if available scalar
Time.Stop(s) # if available scalar

/initialize # optional folder
/finalize # optional folder
/dataset2 # more datasets
/patient # optional folder
/instrument # optional folder



HDF5-based format

- Allow additional synchronized data
- Allow different stim/meas pattern data
- Allow multifrequency data
- Simplicity: writing data in < 50 code lines.
- Self-documenting: core data element is the “frame”.
- Streaming: suitable for large and online data sets.
- Extensibility: easy to add additional data and elements.

Discussion

- Need more vendor file formats
- Need Repository of data for classic EIT studies
- EIT image formats & DICOM
- File format converters