Low-cost biomedical instrumentation: possibilities and applications

Carleton University Life Science Day,
5 May 2017

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Instrumentation = “Smart . . . ”

Smart Objects?

- Smart . . . Home / Office / Building
- Smart . . . Watches
- Smart . . . Shirt
- Smart . . . Lights

[1] https://en.wikipedia.org/wiki/Smart_objects

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- Representation
- Interaction

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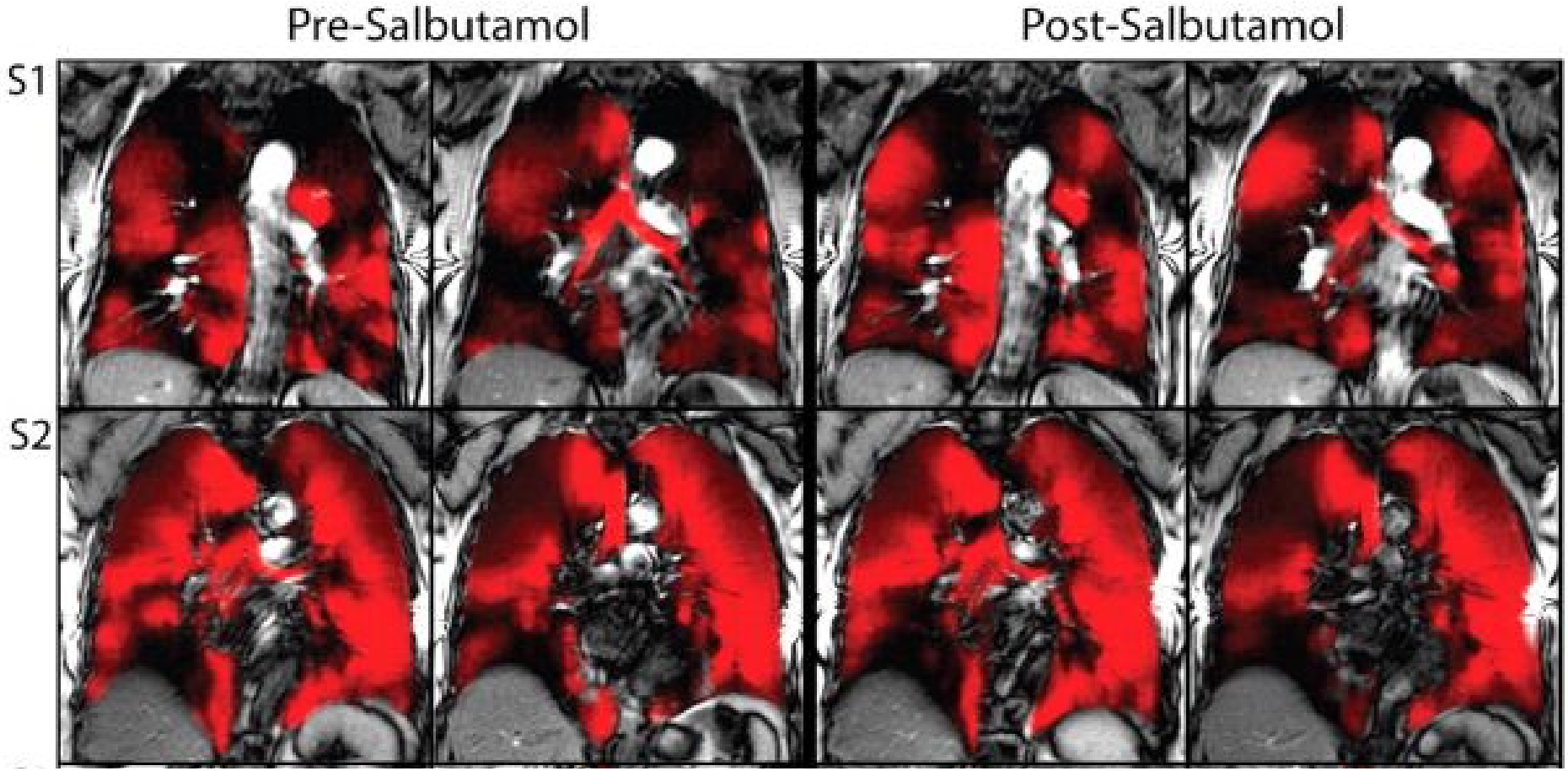
Why instrumentation?

- $\Uparrow$ reliability $\Downarrow$ cost
- New business models
  –rental jet engines, remote coaching
- Customization
  –Taser's "smart-weapon"

Instrumentation drives new insights



^{3}He images of distribution of ventilation in two COPD patients[2].

[2] Kirby et al, Radiology 261.1 (2011): 283–292

Instrumentation used to be expensive

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We used a 3-axis accelerometer for a μgravity application
$\tilde{\$}$10k

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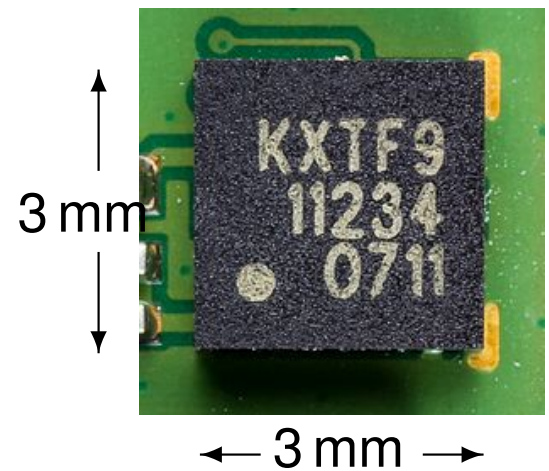

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2017 Most of you are carring at least one

Example #1: Mobility Trainer

Bungee Mobility Trainer (Neurogym Technologies)[3]

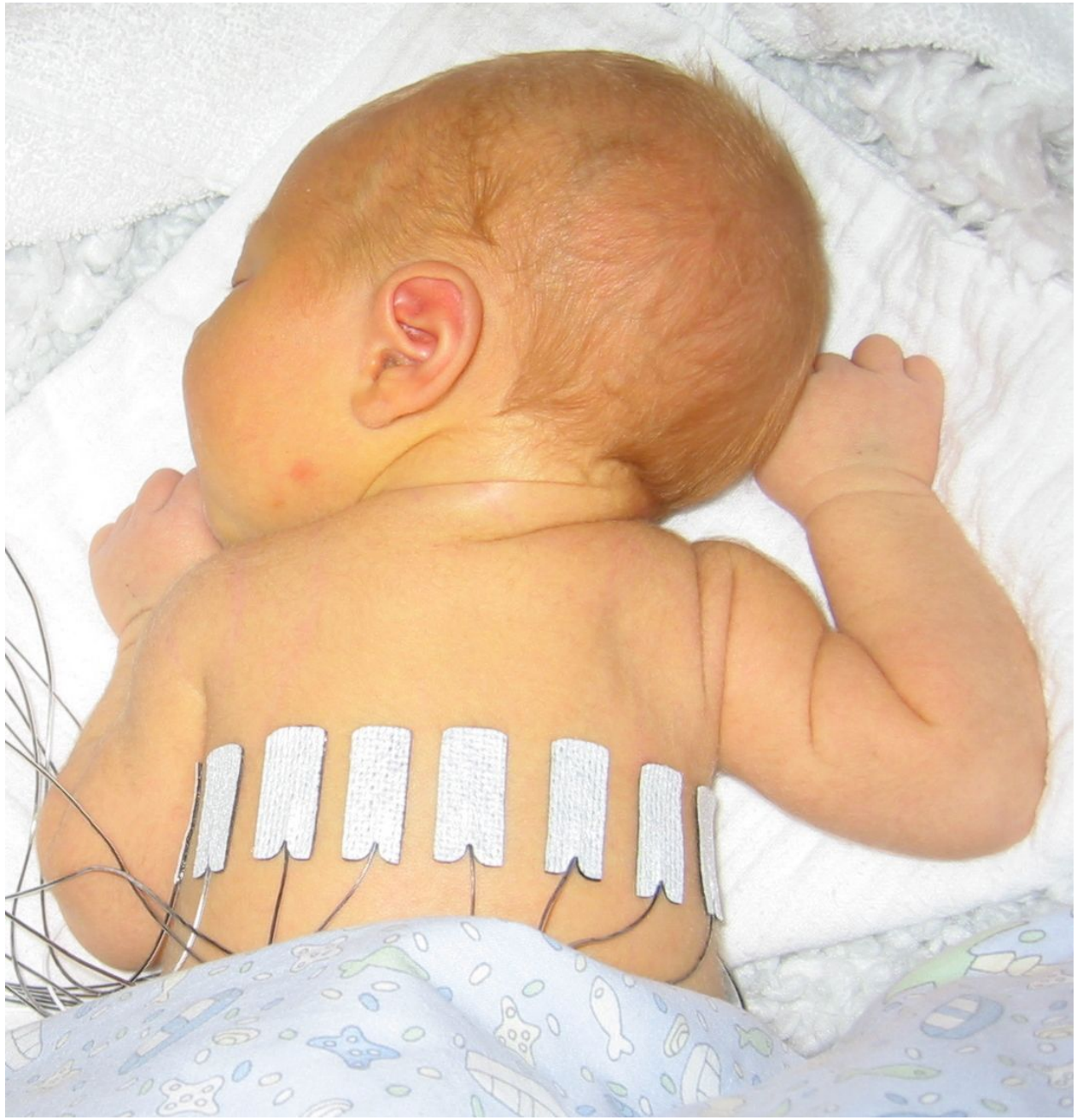
[3] http://neurogymtech.com/wp-content/uploads/BungeeMobilityTrainer_ProductSheet_UpdatedAddress_WEB.pdf

Example #2: Electrical Imaging

Electrical Impedance Tomography

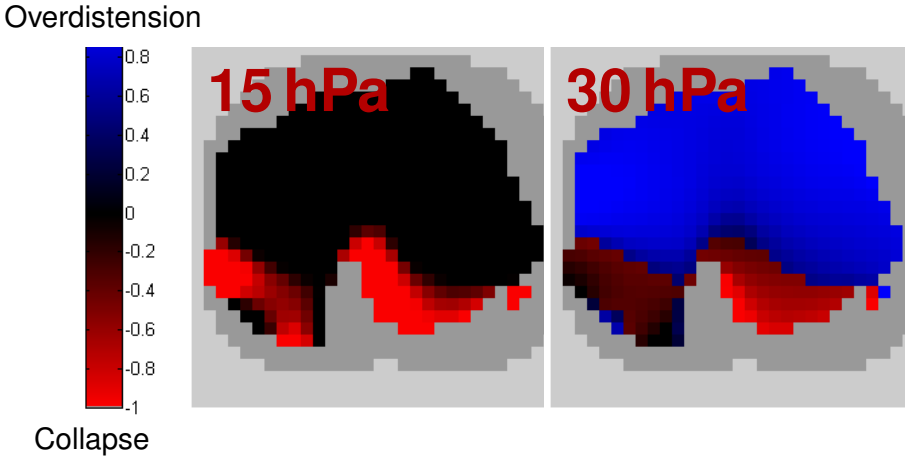
10-day old healthy baby with EIT electrodes

Source: eidors3d.sf.net/data_contrib/if-neonate-spontaneous



Medical Applications of EIT

- Monitoring Mechanical Ventilation:



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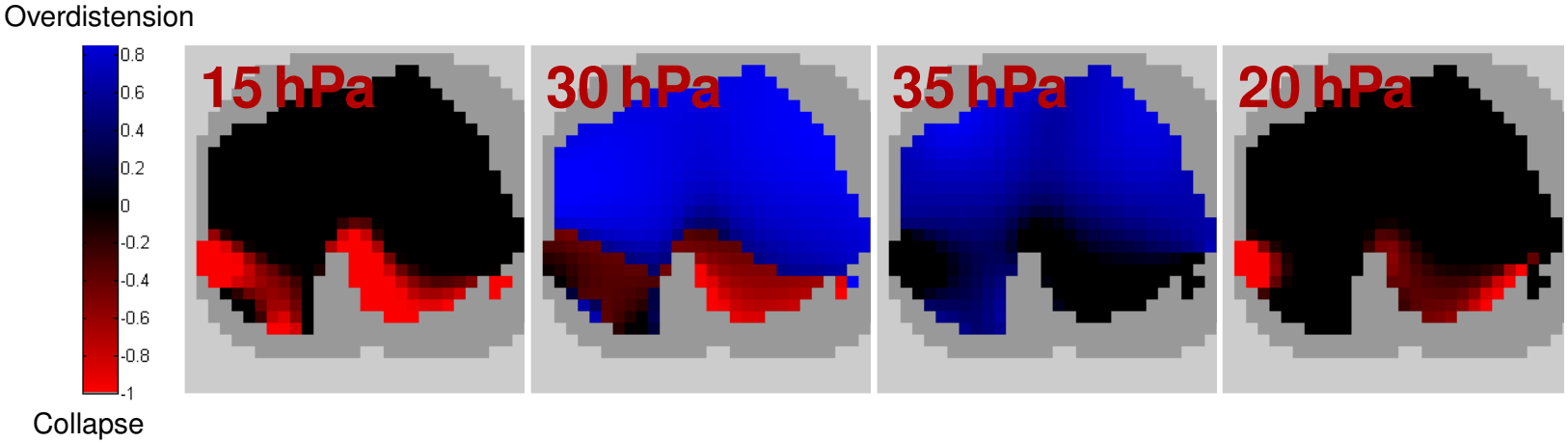

- Right heart (pulmonary arterial) Pressure

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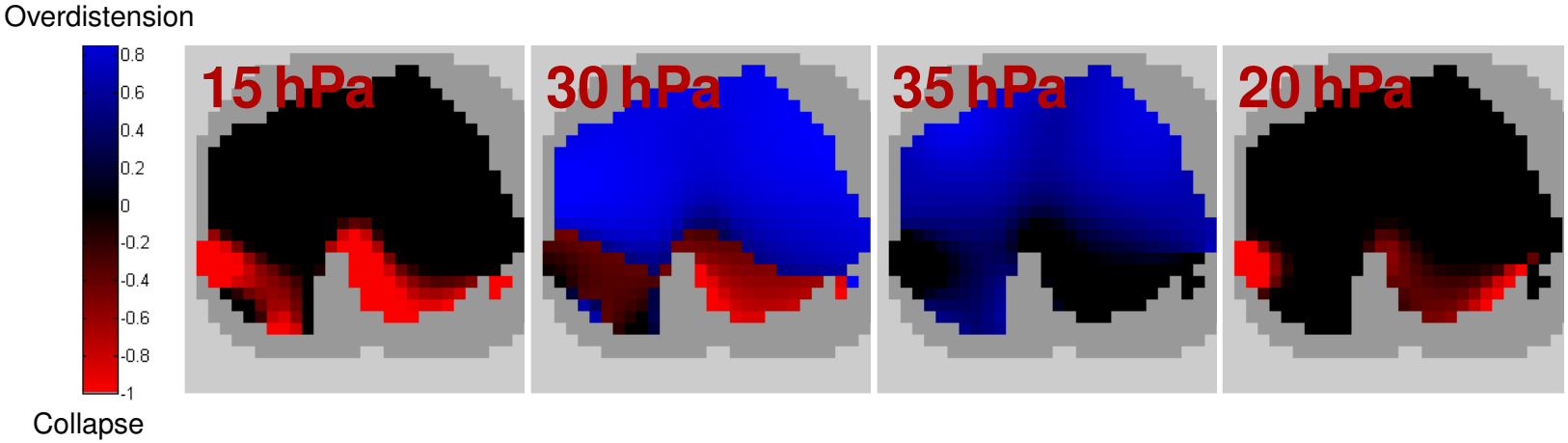
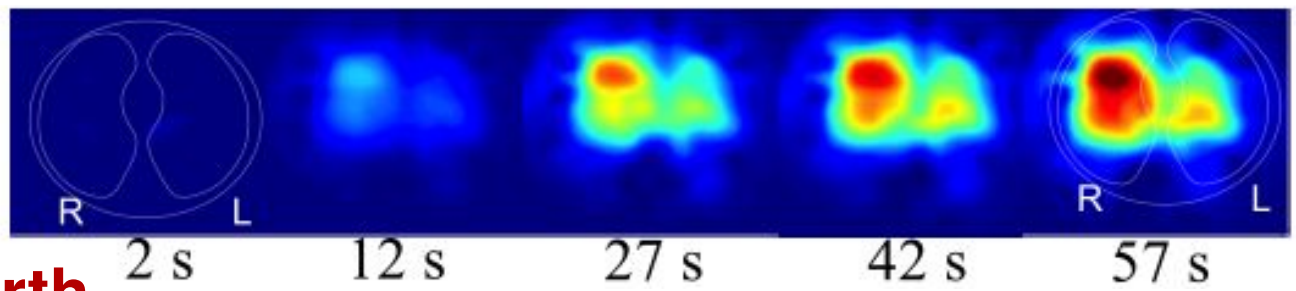


- Right heart (pulmonary arterial) Pressure
- Breathing in newborns



Instrumentation's challenge . . . analysis

- Information = Data + Interpretation
- Real world challenges:
  - Isolate relevant features
  - Reject "other stuff" which we're not interested in
  - Data errors
  - Permanence – are features stable over time?
  - Active deception

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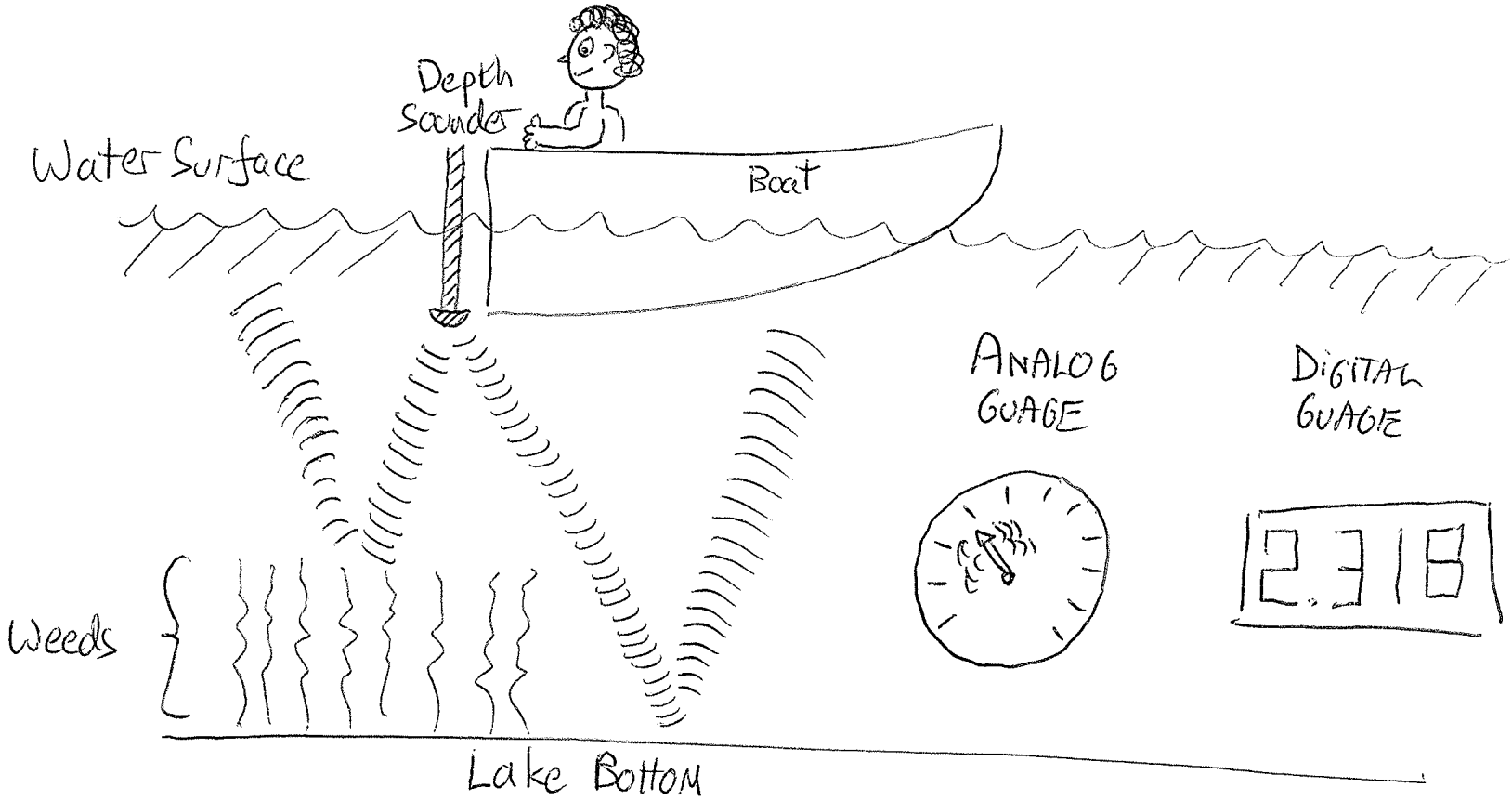
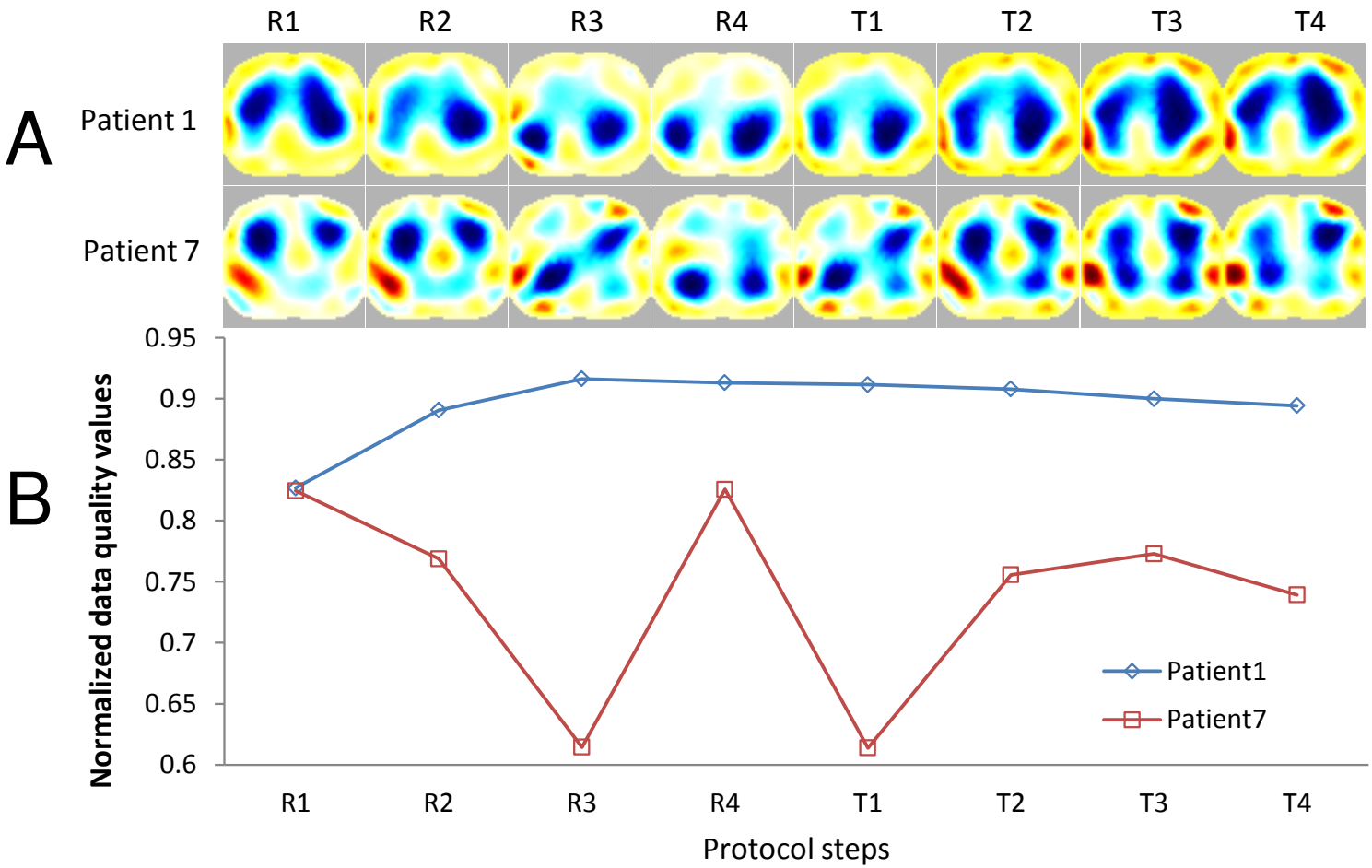
Data Quality

Depth Sounder – with analog and digital guages



Problem: With complex algorithms we can get pretty pictures, even when they are irrelevant.

Idea #1: Data quality measures using consistency



Images and data quality metric for each stage of the protocol
A: EIT images *B*: Calculated data quality.

Idea #2: Community

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$\Rightarrow$

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We need

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- Open Data

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We need

- Open Data
- Open source analysis

For EIT . . .

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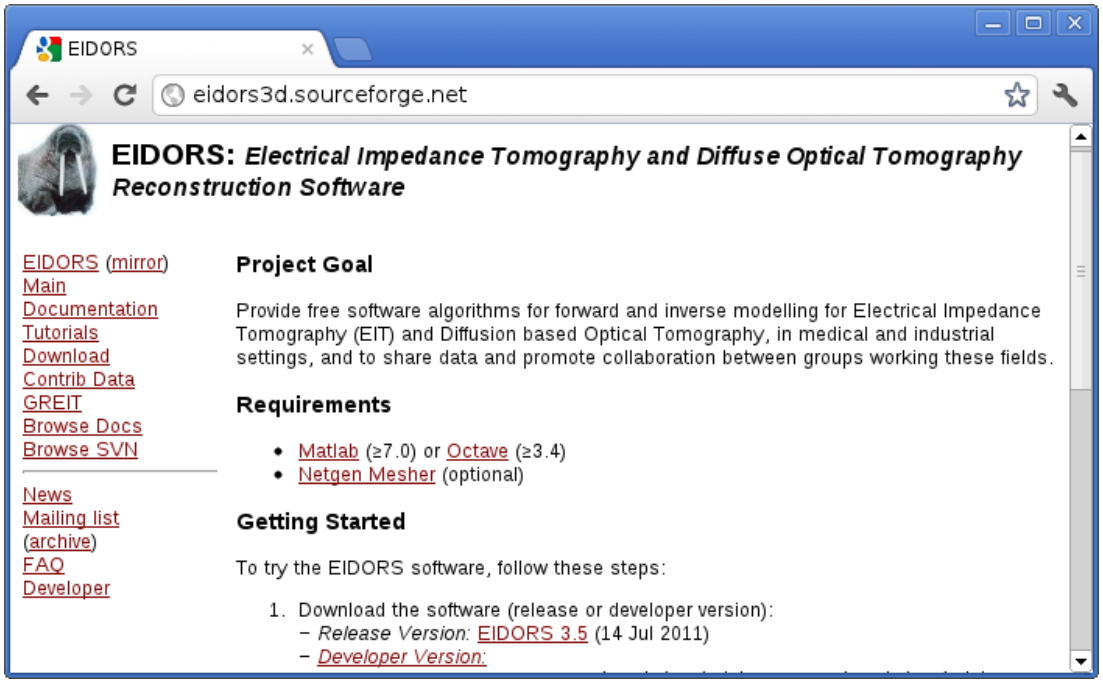
EIDORS
eidors3d.sourceforge.net
EIDORS: Electrical Impedance Tomography and Diffuse Optical Tomography Reconstruction Software
EIDORS (mirror)
Main
Documentation
Tutorials
Download
Contrib Data
GREIT
Browse Docs
Browse SVN
News
Mailing list
(archive)
FAQ
Developer
Project Goal
Provide free software algorithms for forward and inverse modelling for Electrical Impedance Tomography (EIT) and Diffusion based Optical Tomography, in medical and industrial settings, and to share data and promote collaboration between groups working these fields.
Requirements
Matlab (≥7.0) or Octave (≥3.4)
Netgen Mesher (optional)
Getting Started
To try the EIDORS software, follow these steps:
1. Download the software (release or developer version):
– Release Version: EIDORS 3.5 (14 Jul 2011)
– Developer Version:

For EIT . . .

EIDORS

eidors3d.sourceforge.net

EIDORS: ***Electrical Impedance Tomography and Diffuse Optical Tomography Reconstruction Software***

EIDORS (mirror)
Main
Documentation
Tutorials
Download
Contrib Data
GREIT
Browse Docs
Browse SVN

News
Mailing list (archive)
FAQ
Developer

Project Goal

Provide free software algorithms for forward Tomography (EIT) and Diffusion based Opt settings, and to share data and promote c

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EIDORS

eidors3d.sourceforge.net/data_contrib/if-neonate-spontaneous/index.

Contributed EIT Data:

Authors:	S. Heinrich, H. Schiffmann, A. Frerichs, A. Klockgether-Radke, I. Frerichs
Date:	2006
Brief Description:	10-day old spontaneously breathing neonate lying in the prone position with the head turned to left. Data were published in S. Heinrich, H. Schiffmann, A. Frerichs, A. Klockgether-Radke, I. Frerichs, Body and head position effects on regional lung ventilation in infants: an electrical impedance tomography study. Intensive Care Med., 32:1392-1398, 2006.
License:	Creative Commons Artistic License (with Attribution)
Attribution Requirement:	Use or presentation of these data must acknowledge Inéz Frerichs, and reference this publicat S. Heinrich, H. Schiffmann, A. Frerichs, A. Klockgether-Radke, I. Frerichs, Body and h position effects on regional lung ventilation in infants: an electrical impedance tomograp study. Intensive Care Med., 32:1392-1398, 2006.
Format:	EIT data were acquired with the Göttingen Goe-MF II device, 220 frames, 13 frames/s. Data ar .GET file format.
Methods:	Neonate in prone position, with electrode #1 at the front of the chest, electrode #5 on the left s the chest, electrode #9 on the back and electrode #13 on the right side of the chest
Data:	Data (zip format)
Image of Experimental Configuration:	

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