Fast 3D Optical Mammography using ICG Dynamics for Reader-Independent Lesion Differentiation

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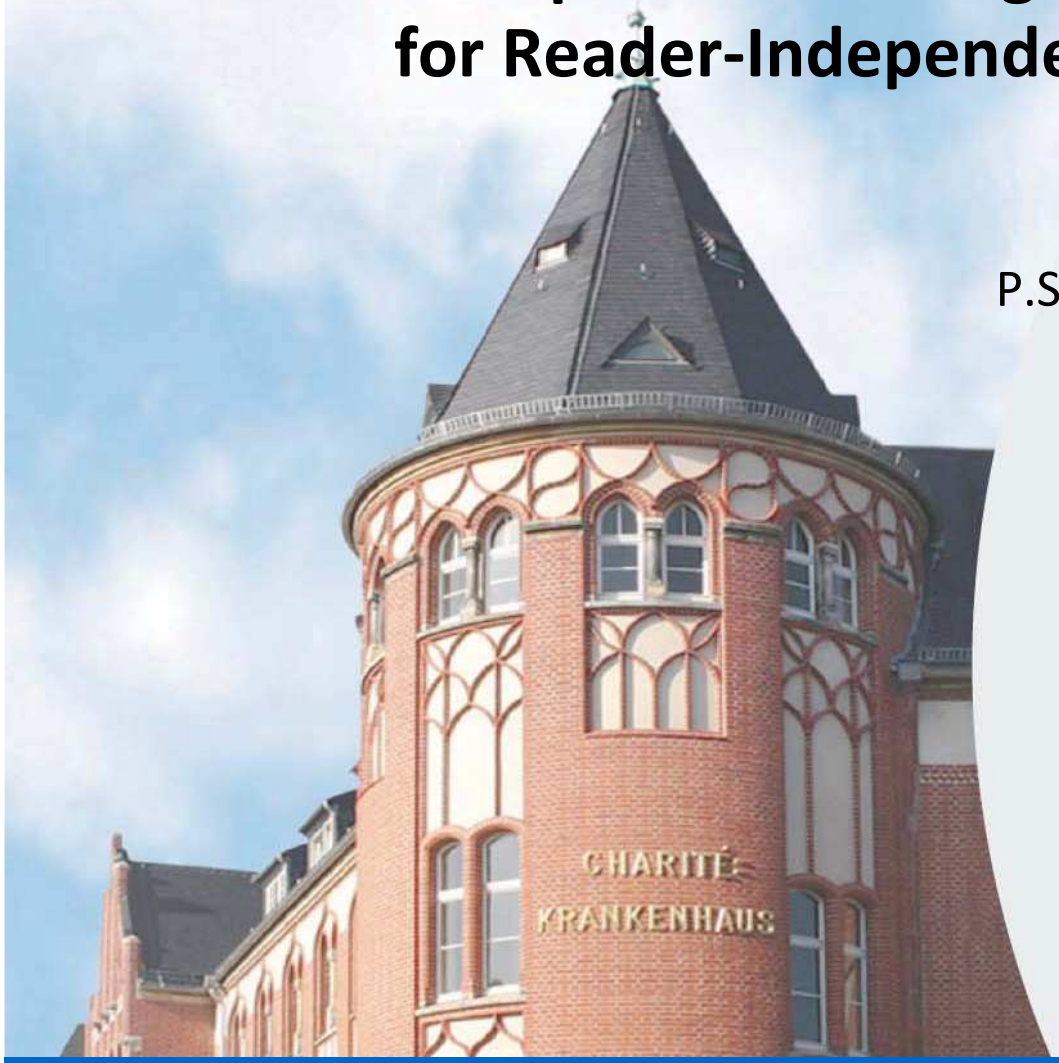

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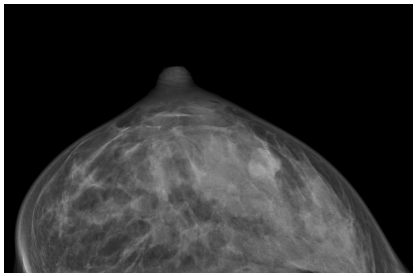
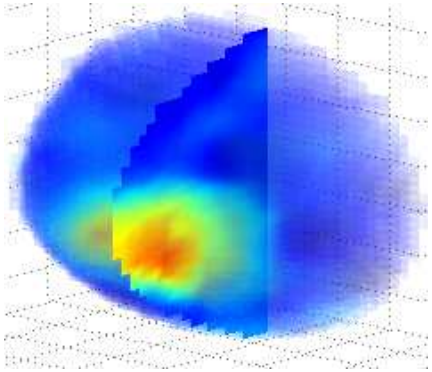
Introduction

Why alternatives to the gold standard of X-ray mammography?



- Very reader- dependent diagnosis
- Need for a better differentiation between malignant and benign lesions
- Non-invasive (radioation free) alternative for breast cancer screening and monitoring preferred

General Benefits of optical mammography:



- Non- invasive, no radiation
- Tomographic imaging
- Functional information
- Dynamic imaging possible

  - Ability to track changes of internal parameters (Hb, HbO etc) or extrinsic contrast agents over time

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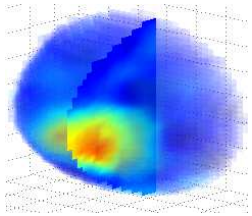
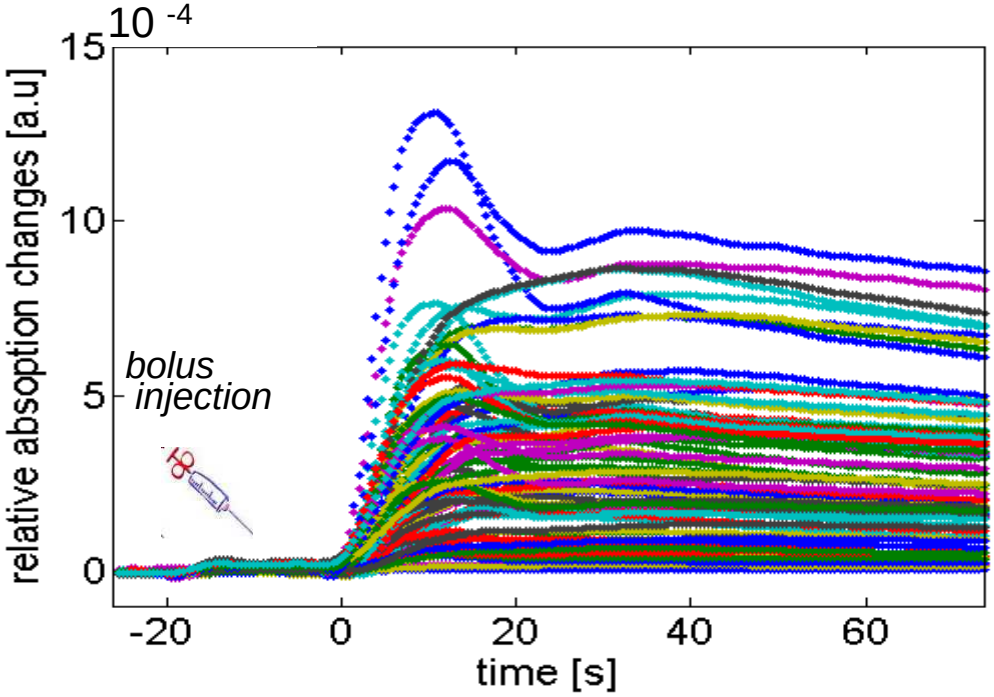
Motivation

Fast 3D Diffuse Optical Imaging (SR >1 Hz):

- Early Bolus kinetics can now be adequately imaged





Measuring early bolus kinetics over the entire breast can help differentiating between malignant and benign or healthy breast tissue

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Fast 3D Diffuse Optical Imaging System

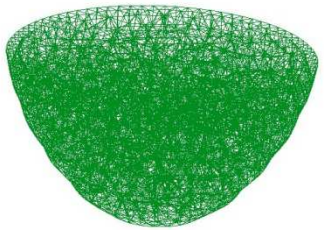
Optical Mammography with 1.9 Hz Temporal Resolution

- DYNOT 232 optical tomography system
  (NIRx Medizintechnik, Berlin, Germany//NY, USA)

NIRx Medizintechnik

Study Design:

830nm



- 22 patients: 14 malignant + 8 benign lesions, 3 controls
- 25mg ICG bolus within 5-10 sec

tion changes

in each of 2243 FEM nodes/ 14000 isometric voxel

P. Schmitz et al. *Rev. Sci. Instrum.* 71(1): 256-63 (2000)

S. H. Schmitz et al. *Radiology* 183(1): 95-99 (2002)

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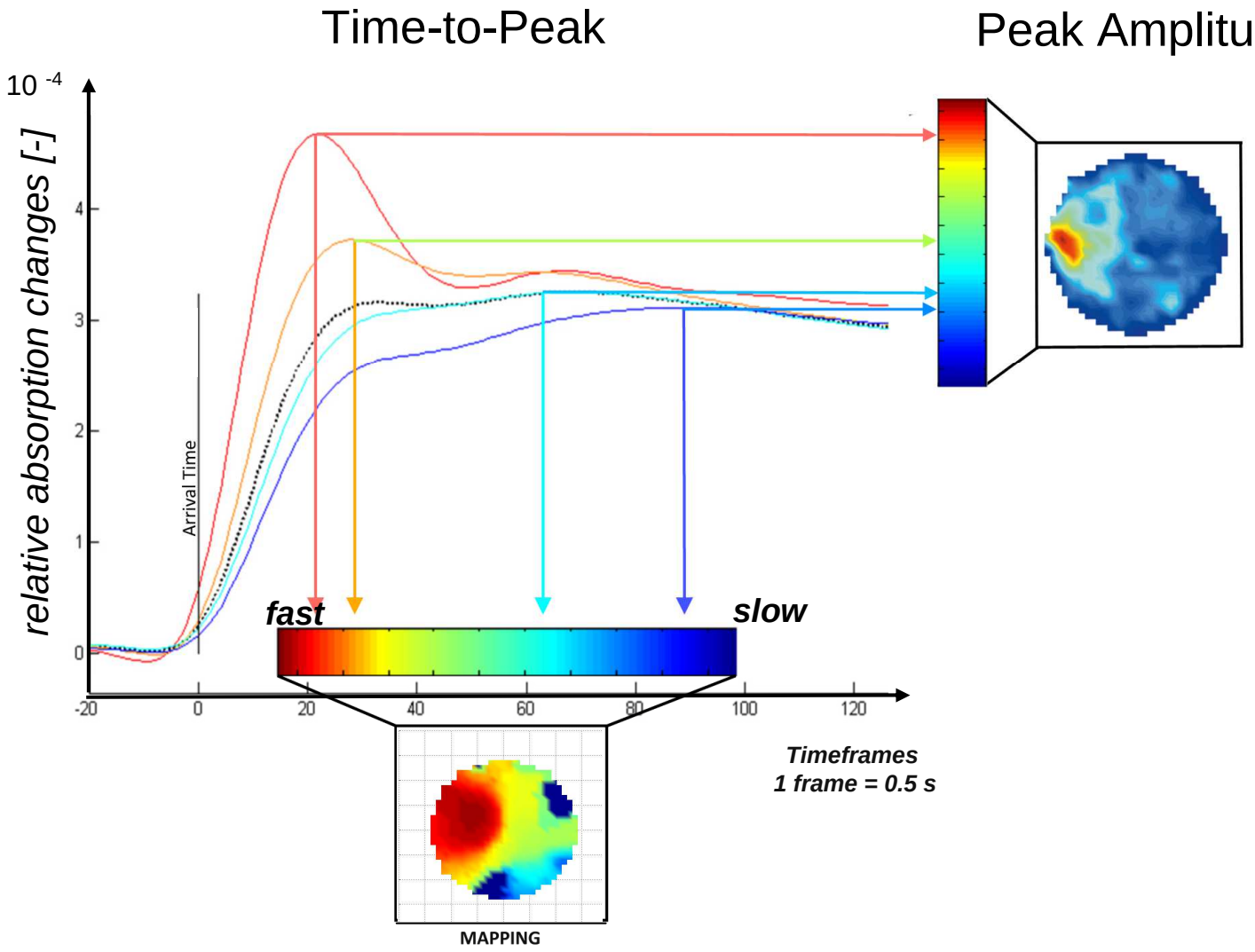
Bolus Peak Mapping



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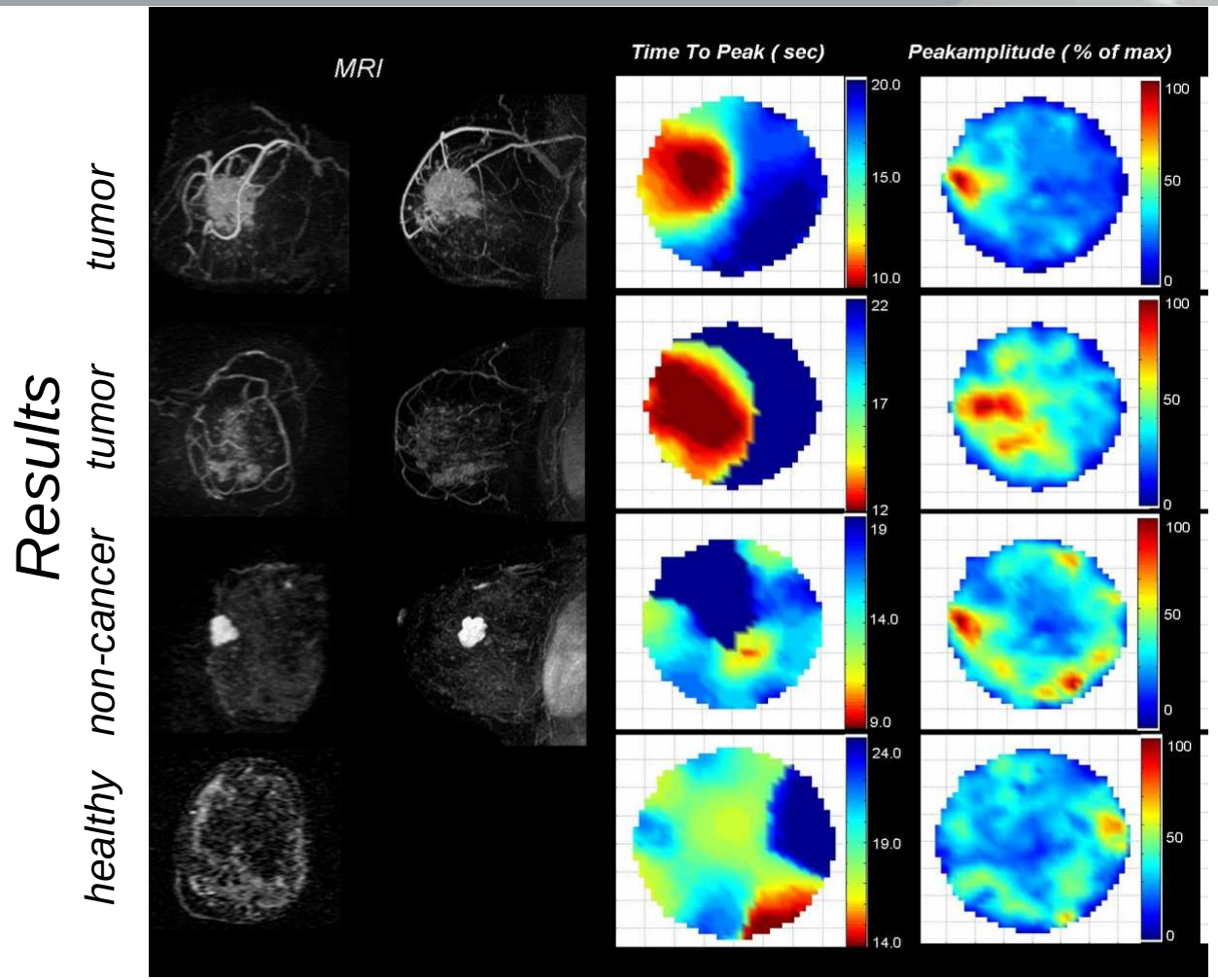
Reader- dependent visual inspection



In general: A priori information about the localization of the lesion and an experience reader is necessary.

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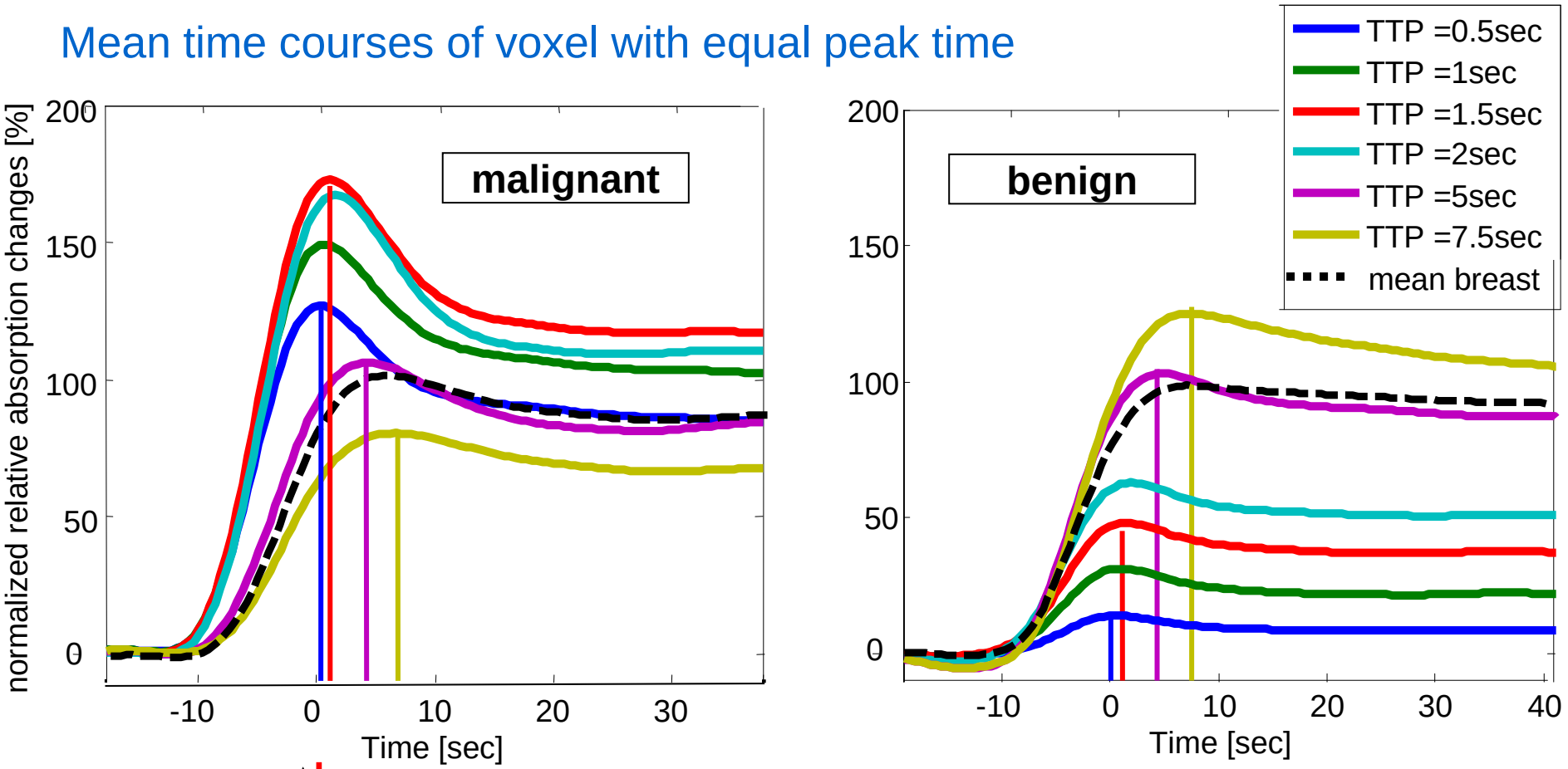
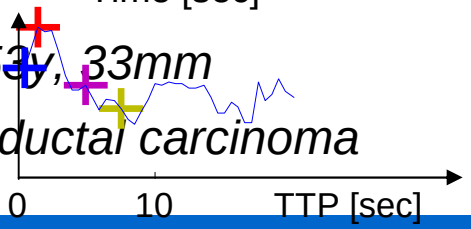
Peak-Time grouped Amplitude (PTA)

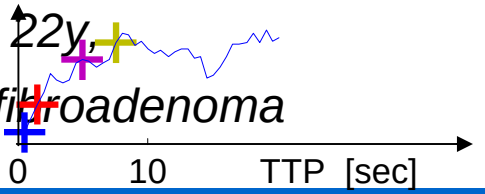
Mean time courses of voxel with equal peak time



Case1: 53y, 33mm
invasive ductal carcinoma



Case2: 22y,
22mm fibroadenoma



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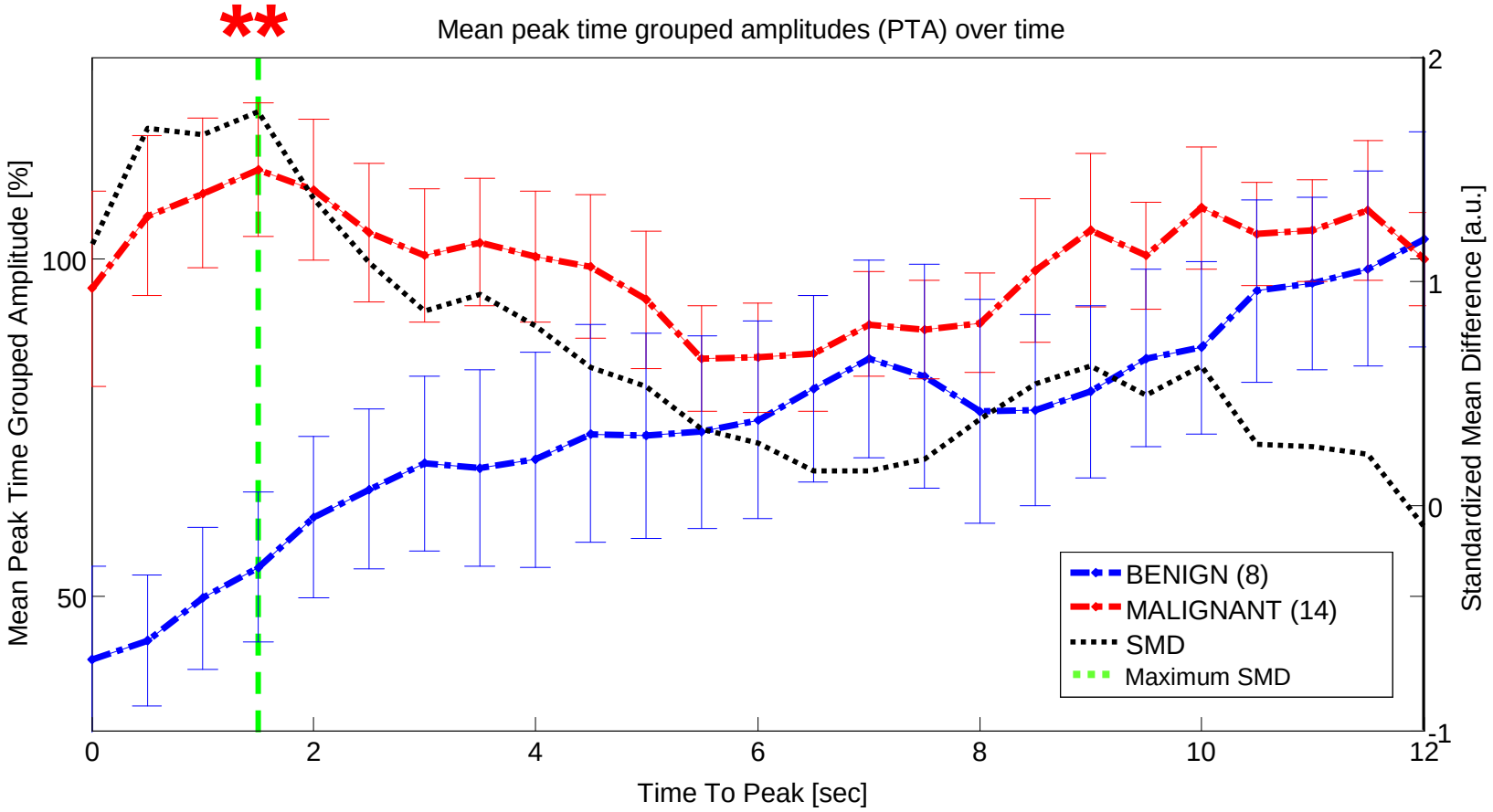
Mean PTA-curves over all patients



Significant Difference of PTA at TTP= 1.5sec between the malignant and benign lesions (Wilcoxen test, p=0.0015)

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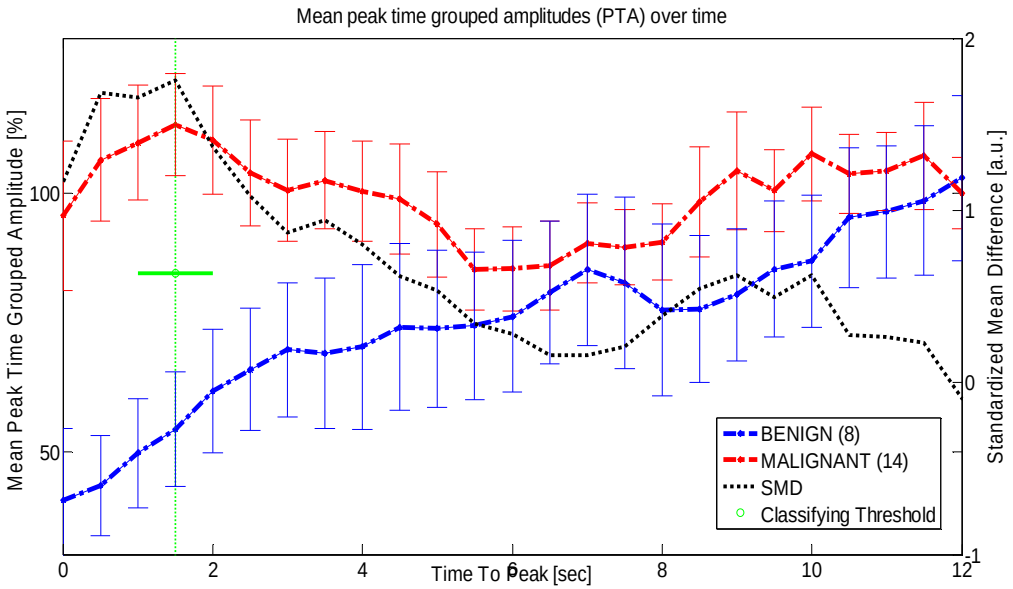
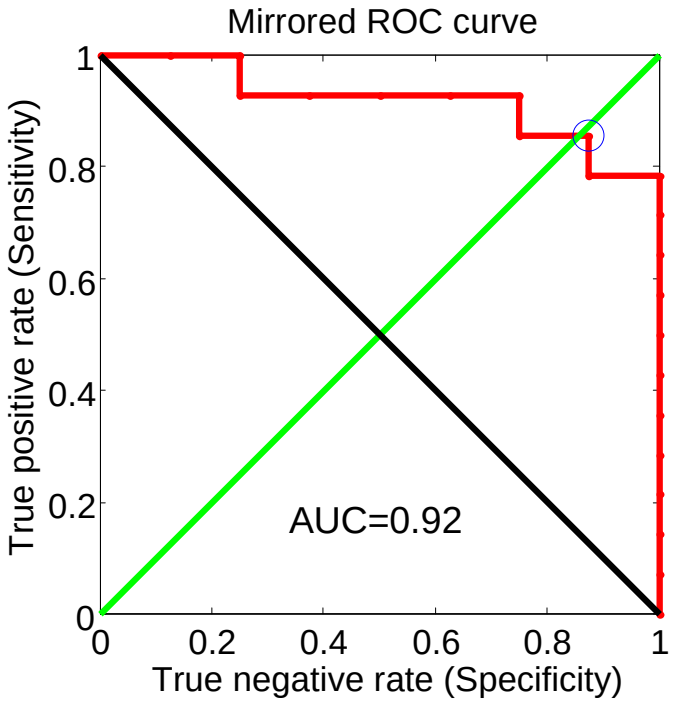
Reader independent Classification Approach





Decision Boundary for Reader Independent Classification: PTA = 84.4% of the mean bolus signal

P. Schneider et al. *Rofo*,183(10):956-63 (2011).

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Classification Rates for 22 patients

Malignant, mean lesion size (range)	***Detection Rate***	***Benign, mean lesion size (range)***	***Detection Rate***
Invasive ductal carcinoma , 29mm (8-51mm)	*8 / 9*	*Fibro-cystic mastopathy, 11mm*	*1 / 1*
Invasive lobular carcinoma, 25mm	*1 / 1*	*Fibroadenoma, 24mm (10-51mm)*	*5/ 6*
Invasive lobular ductal carcinoma, 17mm	*0/1*	*Pseudoangiomatous stromalhyperplasia (PASH), (44mm)*	*1/ 1*
Metaplastic carcinoma, 28mm (19-37mm)	*2 / 2*		
Ductal carcinoma in situ, 80mm	*1 / 1*		
Sum	***12 / 14***	***Sum***	***7/8***

P. Schneider et al. *Rofo*,183(10):956-63 (2011).

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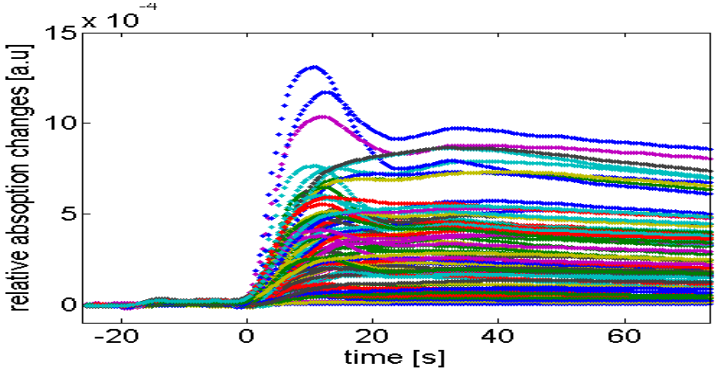
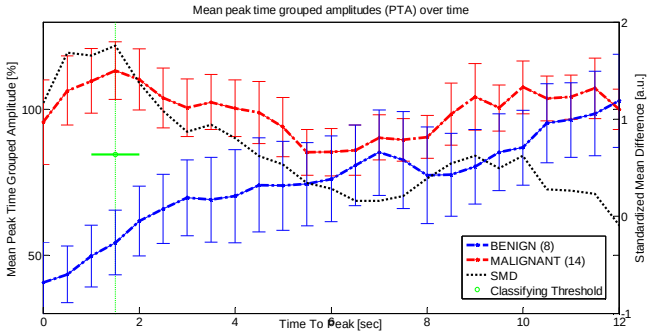
Summary

- High-frame rate DOT allows to adequately image early bolus kinetics.
- Extracting “Peak time grouped amplitudes” out of those kinetic curves can be used for an automatic differentiation between malignant and benign breast lesions.





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Outlook

- To further investigate the robustness of the suggested approach more patient data are needed.

- Cooperation with the Machine Learning Group of the Technical University Berlin
  - Classifying PTA –values at TTP=1.5 sec : mean loss: 0.19±0.02
  - Classifying PTA curves (TTP: 0 – 40sec) : mean loss: 0.10±0.03

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Thank you for your attention!

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