Perfusion Neuroimaging:

Cerebral Blood Flow through Brain Tissue Matter

Recap: *MR Angiography-MRA* **BLOOD FLOW VELOCITY in Artery**

Time-of-Flight(TOF) MRA: "Bright Blood Imaging"

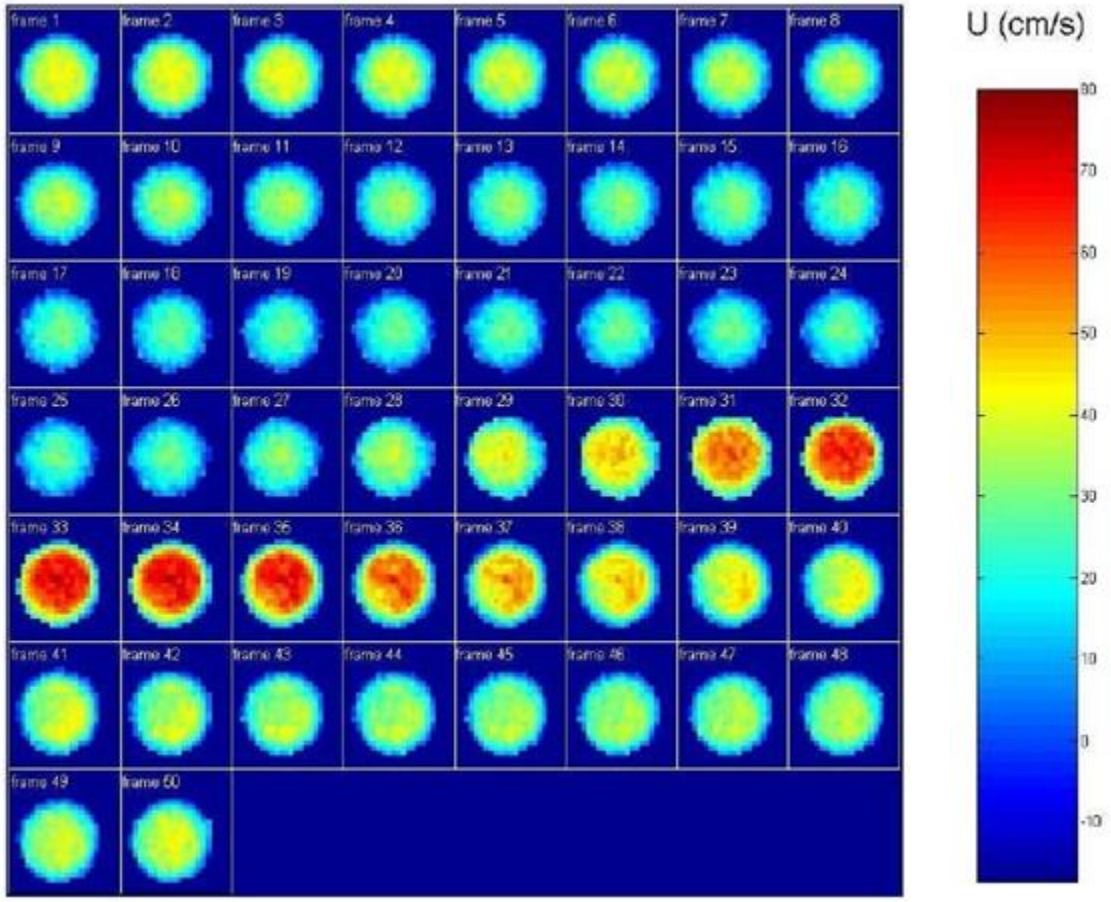
- Magnetic resonance angiography is a group of techniques based on magnetic resonance imaging to image blood vessel.
- MRA is often used to evaluate the arteries of the neck and brain, the thoracic and abdominal aorta, the renal arteries, and the legs.
- Time of Flight(TOF) MRA was the dominant non-contrast bright-blood method for imaging the human vascular system.

Time-of-flight MRA at the level of Circle of Willis

***Recap*: MRA.**

MRI Velocitometry:

Color Coding of Blood Flow Velocity in cm/s across an arterial cross-section



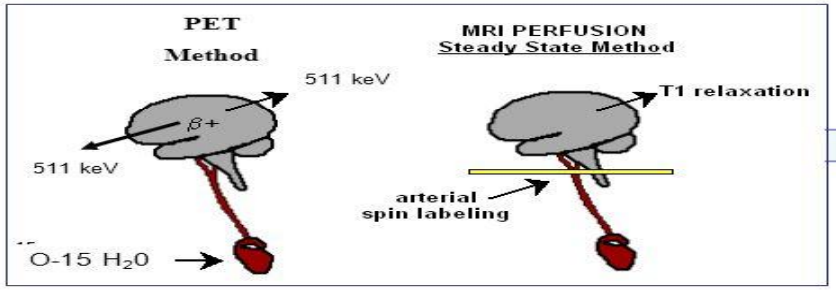
Time Variation with Arterial Pulsing:

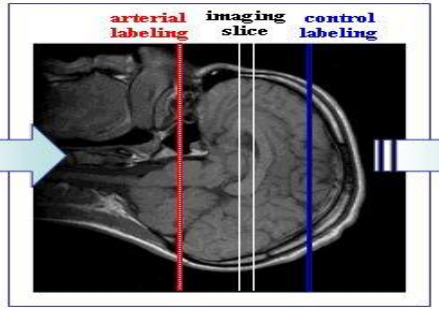
Velocity Profile in Carotid Artery at different time points as Heart Expands & Contracts

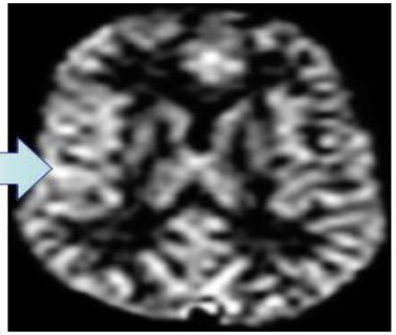
PERFUSION

- Perfusion is the rate of blood flow through capillary circulation of an organ or tissue.
- Measurement of perfusion requires the use of tracer molecules or particles that may be intravascular, extracellular or freely diffusible.

Measurement of Cerebral Blood Flow with PET or MRI (Arterial Spin Labeling - ASL)





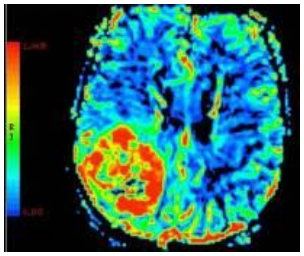


- Uses magnetically labeled arterial blood water as an endogenous flow tracer
- Potentially provide quantifiable CBF in classical units (mL/min per 100 gm of tissue)

Detre et al., 1992

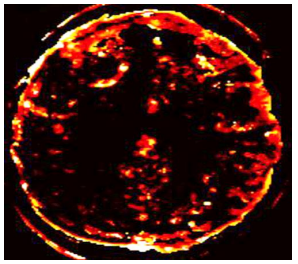
TYPES OF PERFUSION MRI

- There are **3 types** of perfusion using MRI.



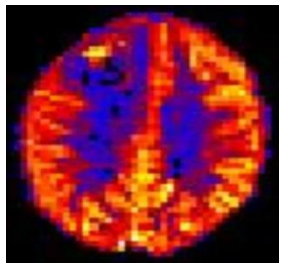
1) **Dynamic Susceptibility Contrast**

Most widely used ,rapid **T2*** imaging after **gadolinium** bolus.



2) **Dynamic Contrast Enhanced**

T1-imaging after **gadolinium** bolus; measure vascular **permeability**.



3) **Arterial Spin Labeling-**

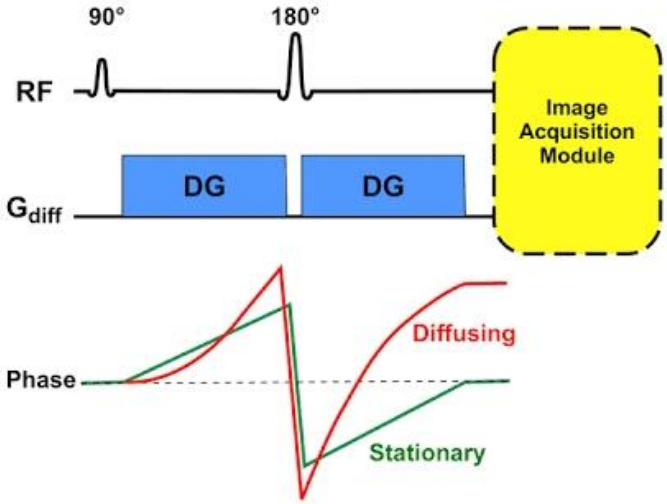
Uses magnetically tagged **water** in blood (not Gadolinium) as tracer.

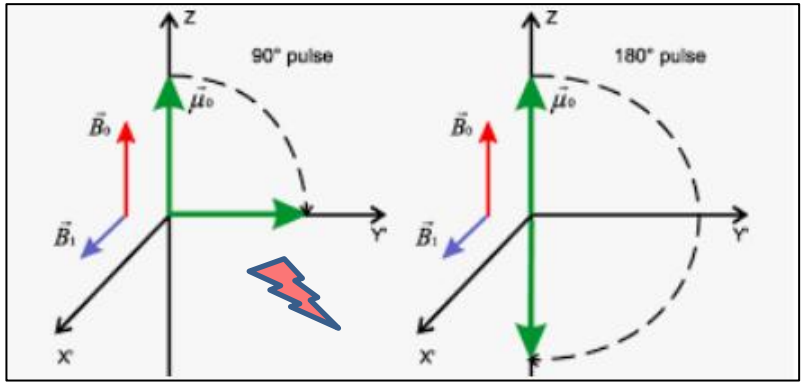
ARTERIAL SPIN LABELING

- Arterial spin labeling (ASL) is an Magnetic Resonance Imaging method for measuring perfusion using the patient's own water molecules as tracers.
- ASL is a non-invasive , no exogenous contrast injection required.
- ASL is reliable and reproducible, repeated measurements possible.
- Absolute quantification for blood flow.
- **Note:**

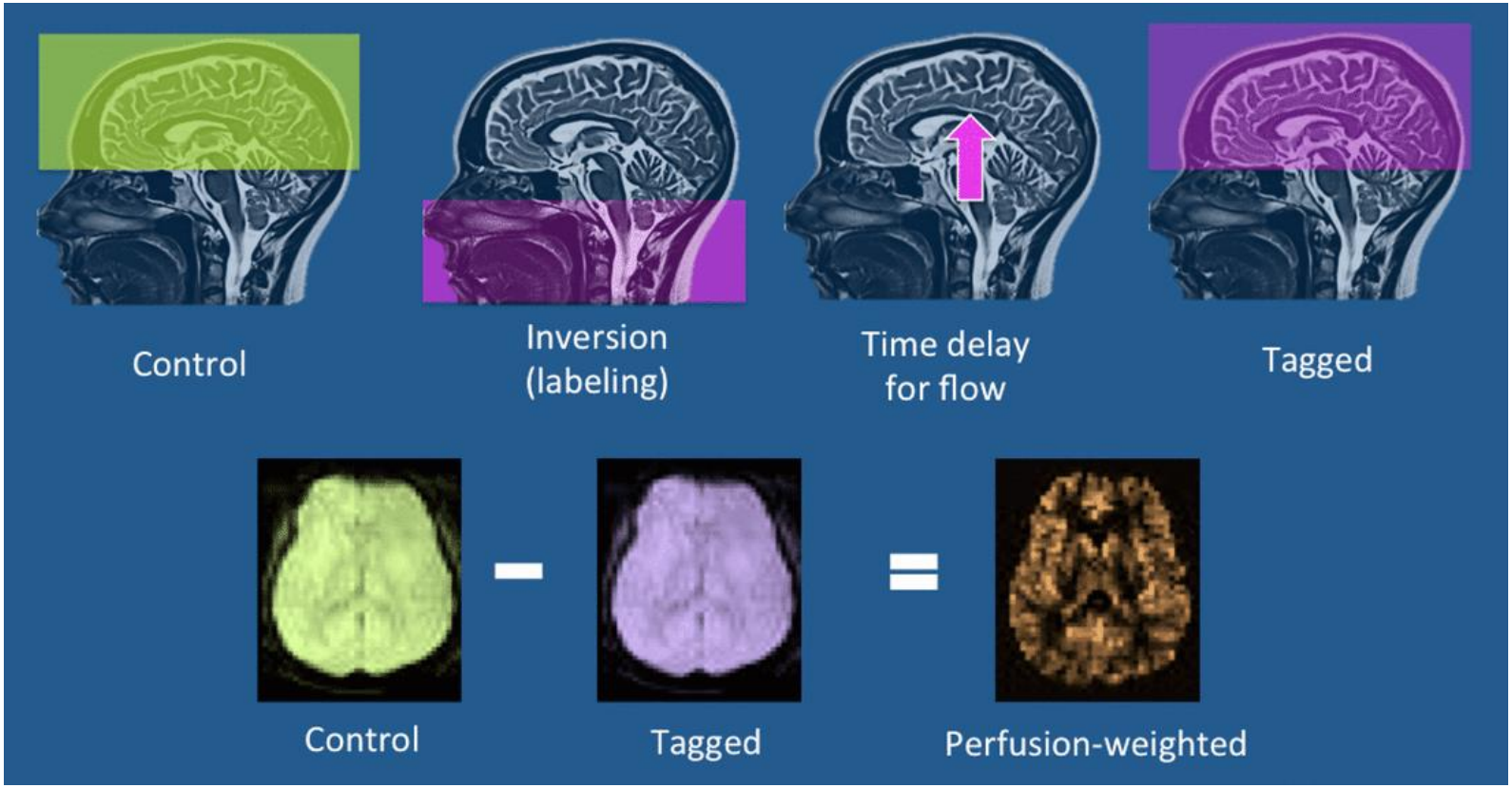
  Unit of Perfusion or Cerebral Blood Flow is say **X ml. of Blood** flowing **through 100 gram** of Brain Tissue **per minute.**

Recap: *180^{O} Inversion Pulse:* **DTI b-value**



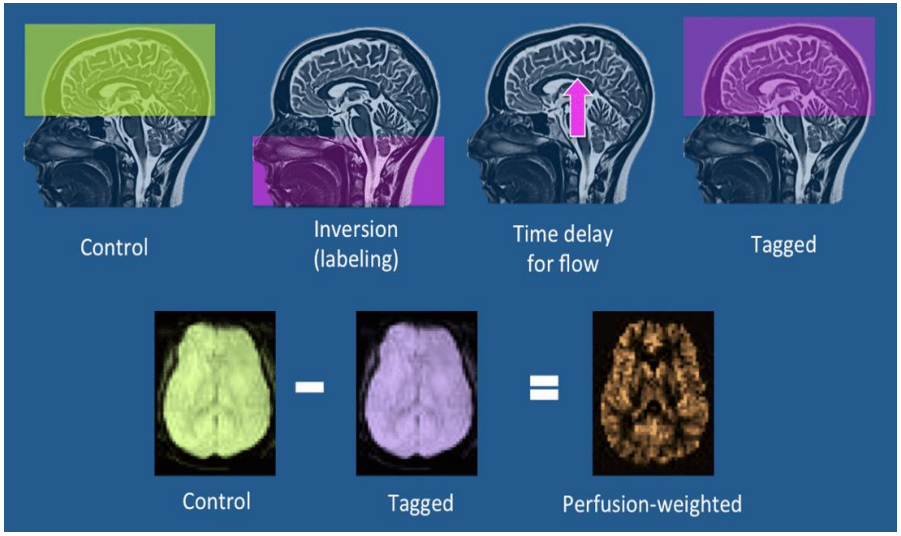


ARTERIAL SPIN LABELING PRINCIPLES



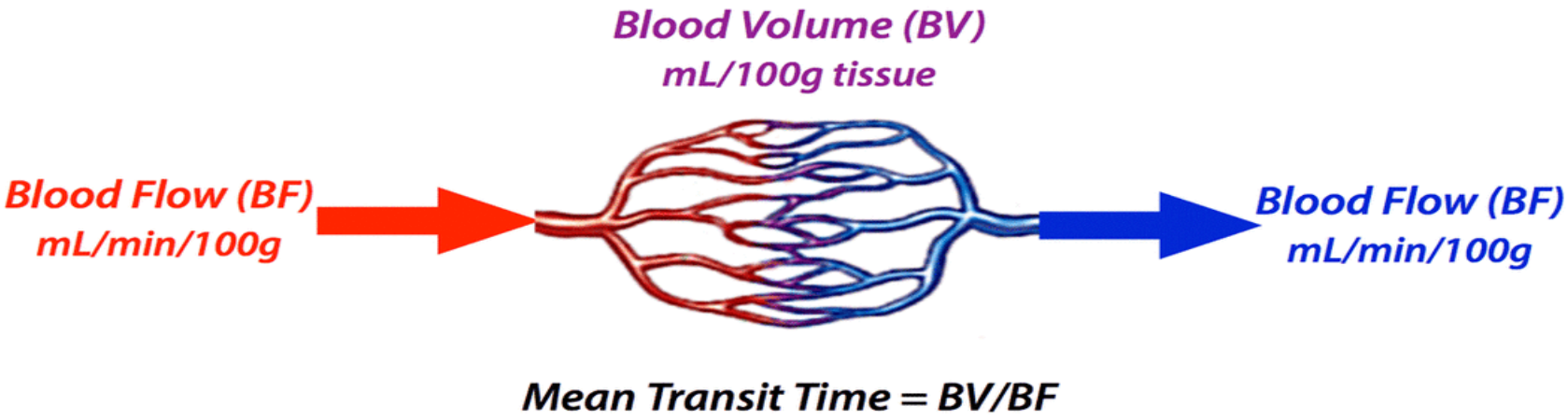
ARTERIAL SPIN LABELING PRINCIPLES

- First "control " images are acquired through area of interest (cerebral hemispheres).
- Next, "tagged" pulse are applied to a slab of tissue proximally from the imaging volume that **inverts the magnetization** of water molecules in this slab
- In next couple of seconds, most of these "magnetically labeled" molecules lying within the vessels will flow into imaging volume.
- **These tagged water molecules exchange their magnetization with those in the static tissue.** The area of interest is re-imaged
- Tagged images are subtracted from control image and the **result of this subtraction is perfusion-weighted image.**



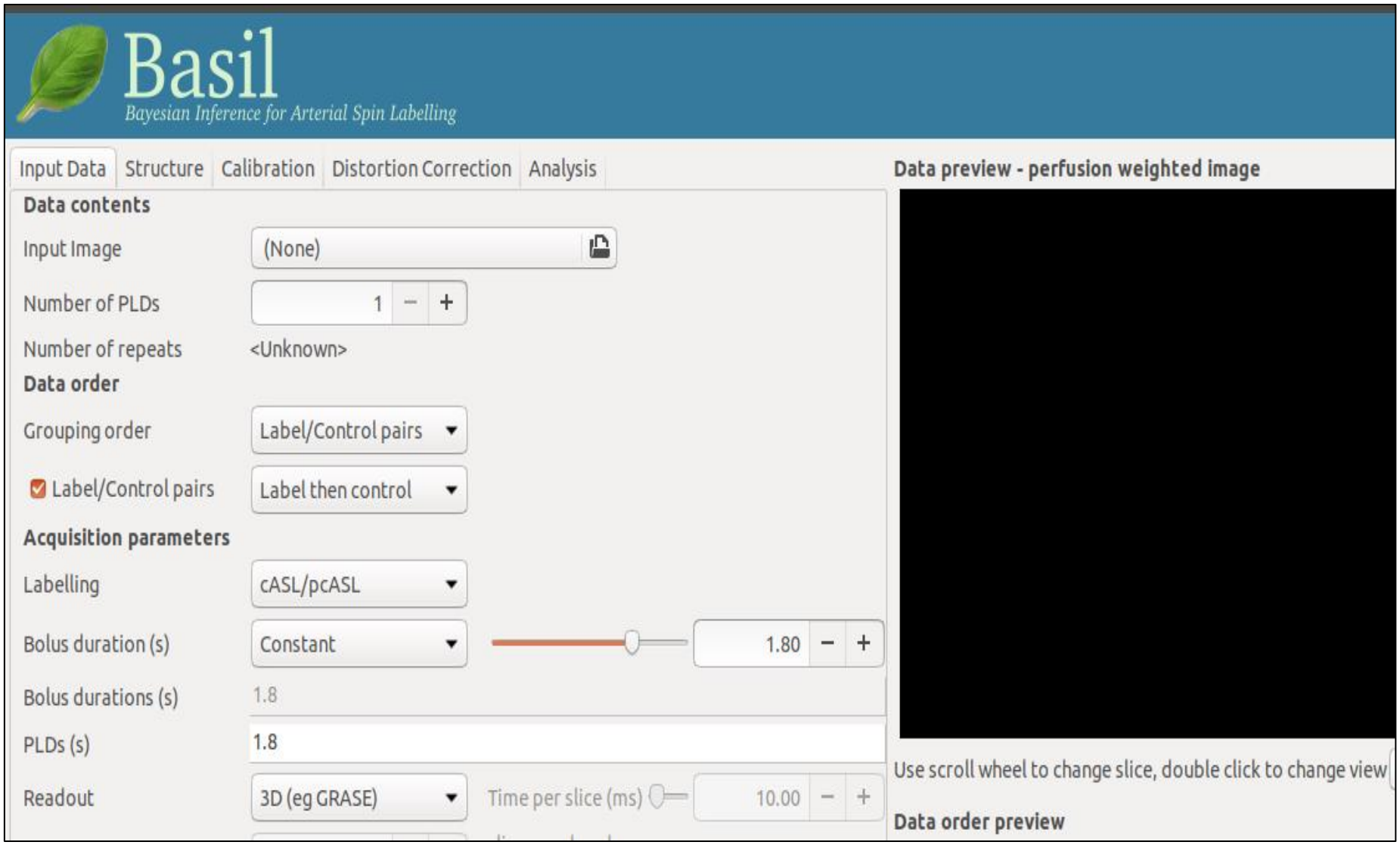
PARAMETERS OF ASL

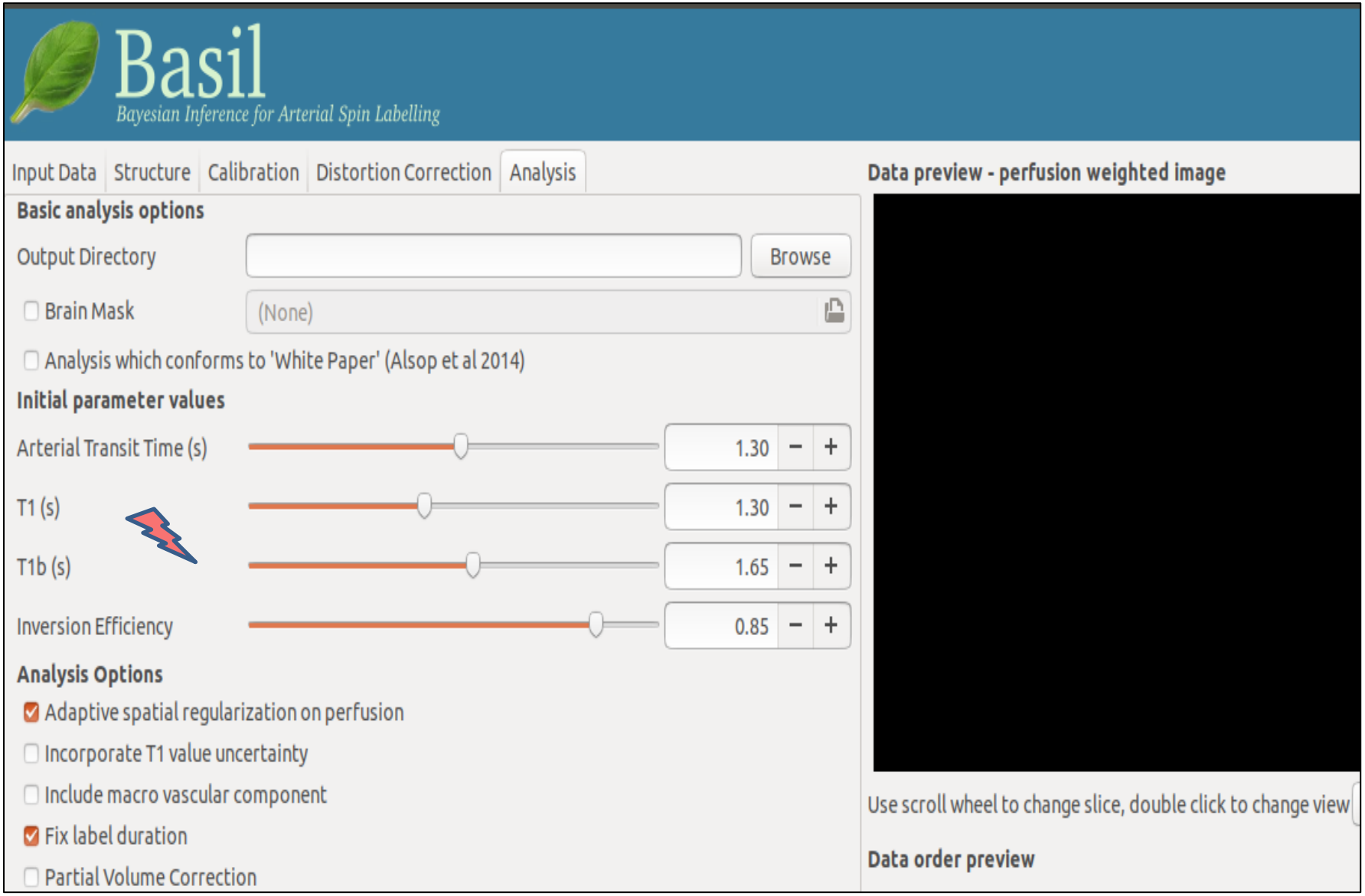
- Blood flow(BF), Blood Volume(BV) and Mean transit time are basic parameters.



- Blood flow and Blood volume are assumed to be constant.

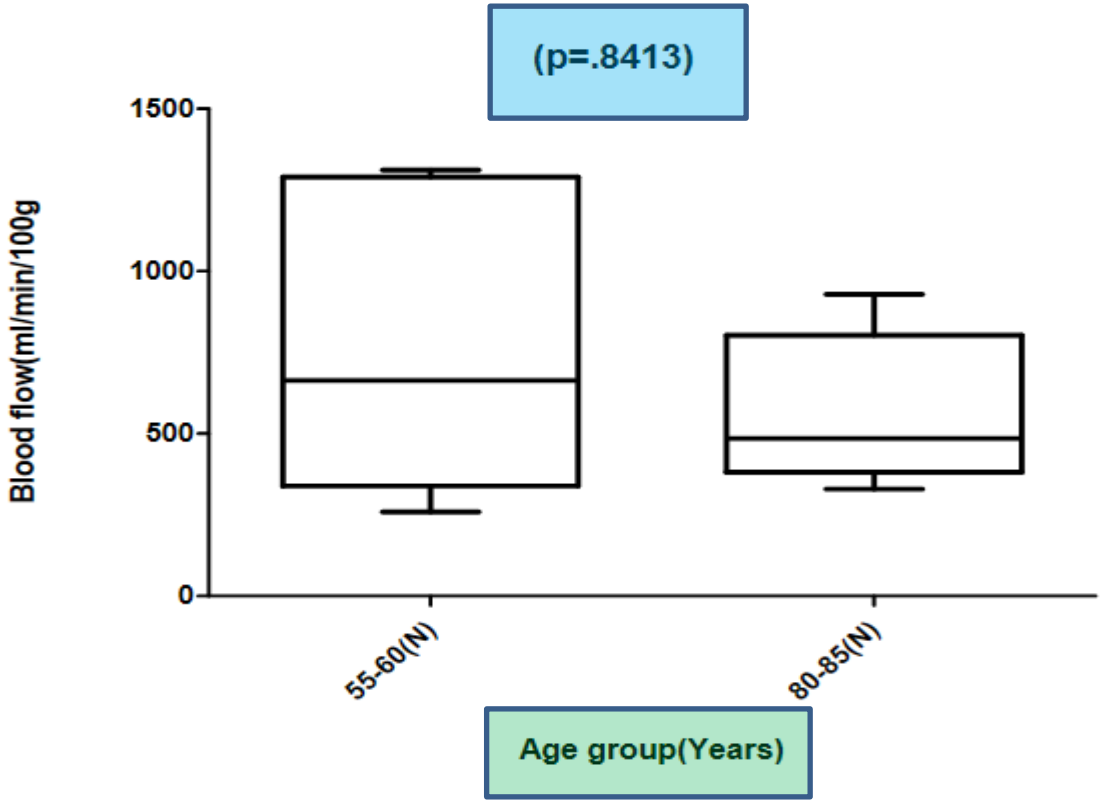
BASIL TOOL BOX FOR PERFUSION MAPPING




Basil
Bayesian Inference for Arterial Spin Labelling
Input Data
Structure
Calibration
Distortion Correction
Analysis
Basic analysis options
Output Directory
Browse
Brain Mask
(None)
Analysis which conforms to 'White Paper' (Alsop et al 2014)
Initial parameter values
Arterial Transit Time (s)
1.30
T1 (s)
1.30
T1b (s)
1.65
Inversion Efficiency
0.85
Analysis Options
Adaptive spatial regularization on perfusion
Incorporate T1 value uncertainty
Include macro vascular component
Fix label duration
Partial Volume Correction
Data preview - perfusion weighted image
Use scroll wheel to change slice, double click to change view
Data order preview

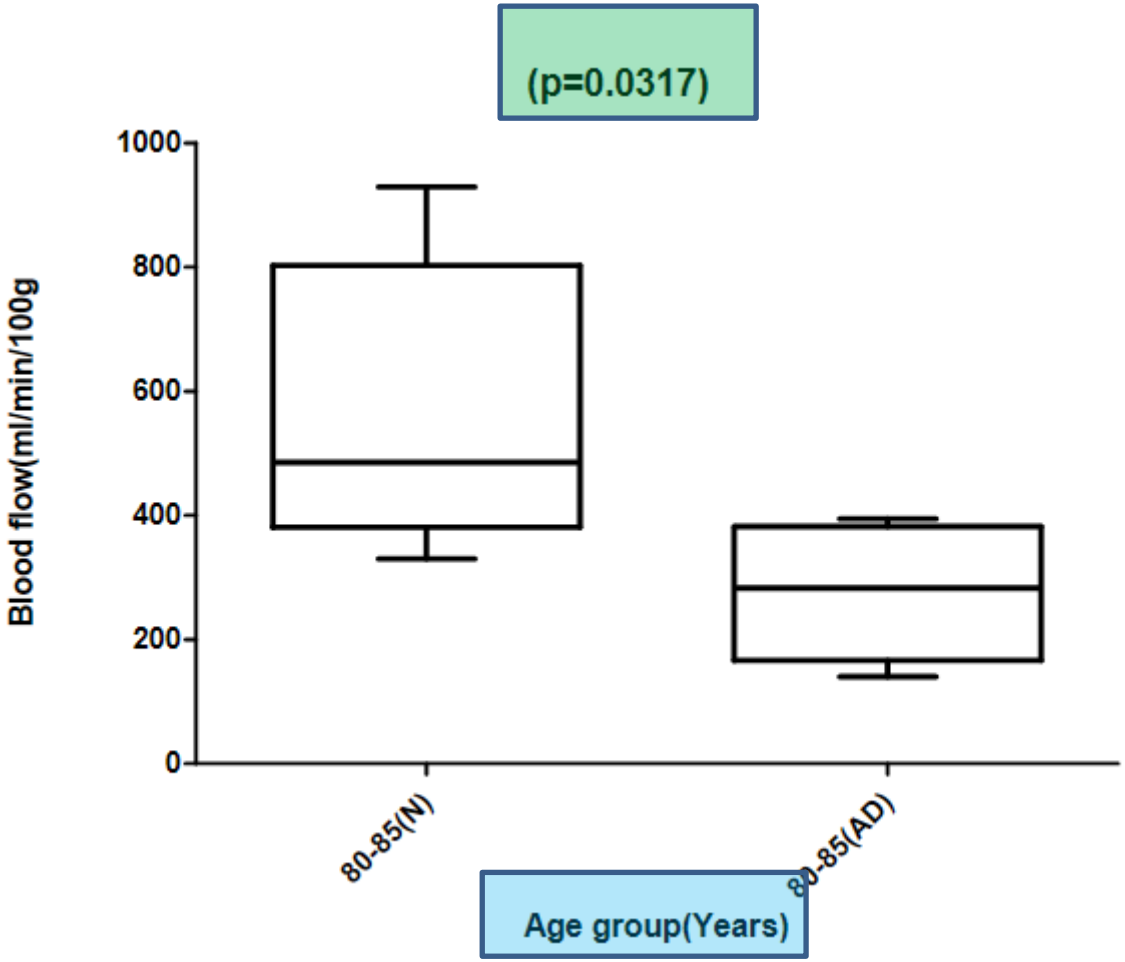
Illustrative Example - 1

GRAPHICAL ANALYSIS OF CEREBRAL BLOOD FLOW AND DIFFERENT AGE GROUP



Analysis of CBF with ageing (Normal Subjects):
There is no statically significant change

Illustrative Example - 2



Analysis of CBF between Normal subjects and Alzheimer's patients of the Same Age Groups:

There is statistically significant decrease.

CONCLUSION OF THE STUDY

- From observations we have concluded that value of cerebral blood flow in normal patients is more than the Alzheimer disease patients.