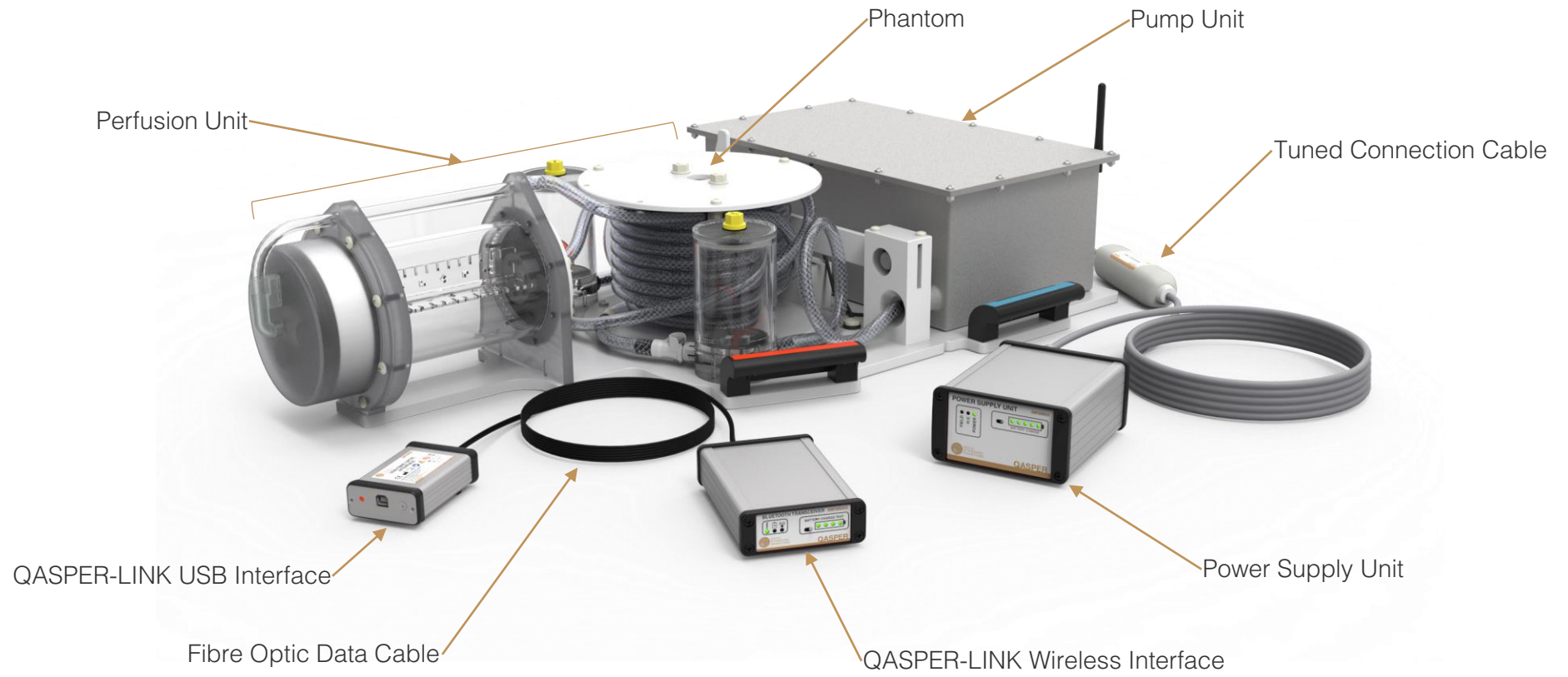
QASPER System Overview

- Constituent Parts
- How the phantom works
- Control and Monitoring

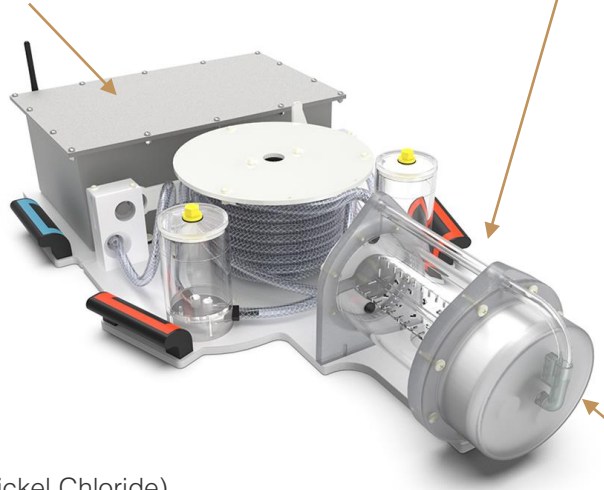
QASPER System Components

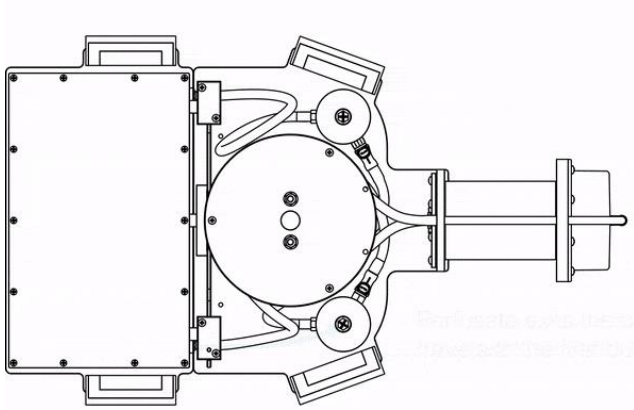


How QASPER Works

MRI Compatible Piezoelectric pump
Delivers perfusate at a controlled known flow rate round the system. Automatic flow control using a ARM microcontroller and calibrated flow meter. Wireless communications for control and real-time telemetry of measured flow rate and temperature

Label Chamber
Represents the 'neck' of the phantom, containing the inflow "carotid" tube.



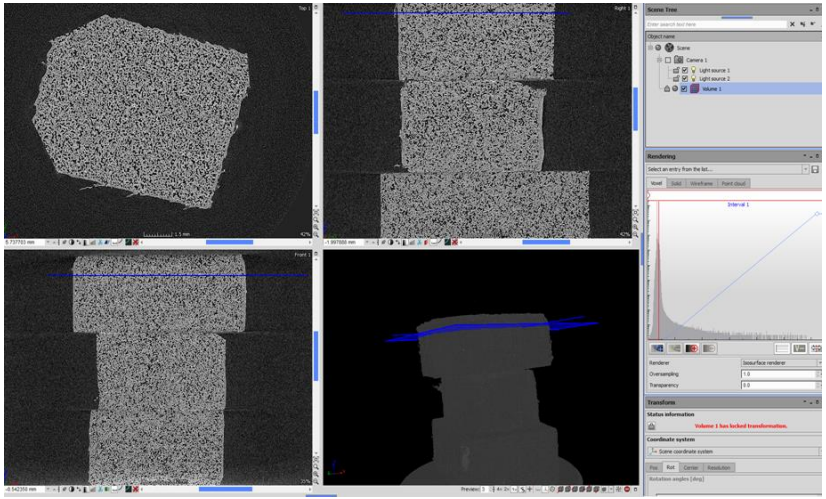


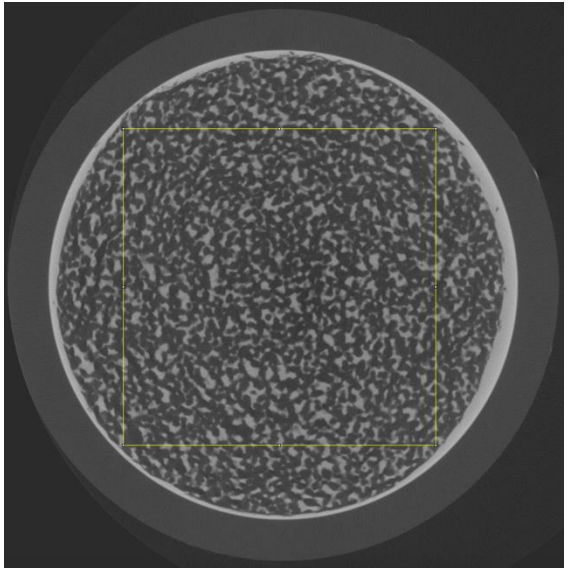
Perfusate
- Water based
- T_1 ~1800ms at 3T (Nickel Chloride)
- Non-ionic surfactant (improved wetting)
- viscosity ~1.65mPA.s @ 20°C (water soluble polymer)
- Non-toxic preservative (isothiazolinone CMIT:MIT 3:1 ratio).

Perfusion Chamber
Simulates the capillary bed by using six 4.75x116mm discs of sintered UHMW Polyethylene (mean pore size 7um, porosity 32%)

Porous Material

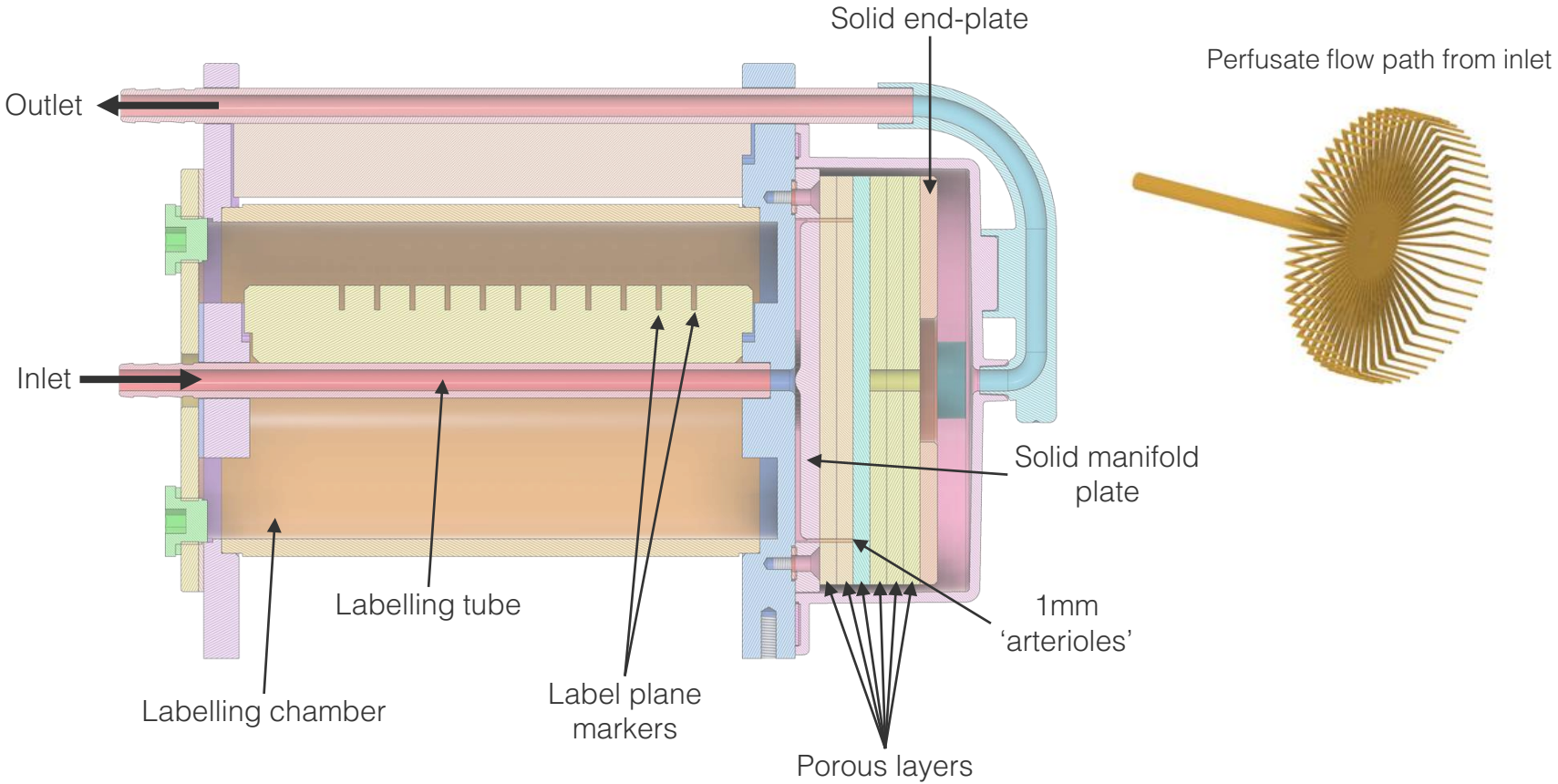
XCT measurements made by the National Physical Laboratory



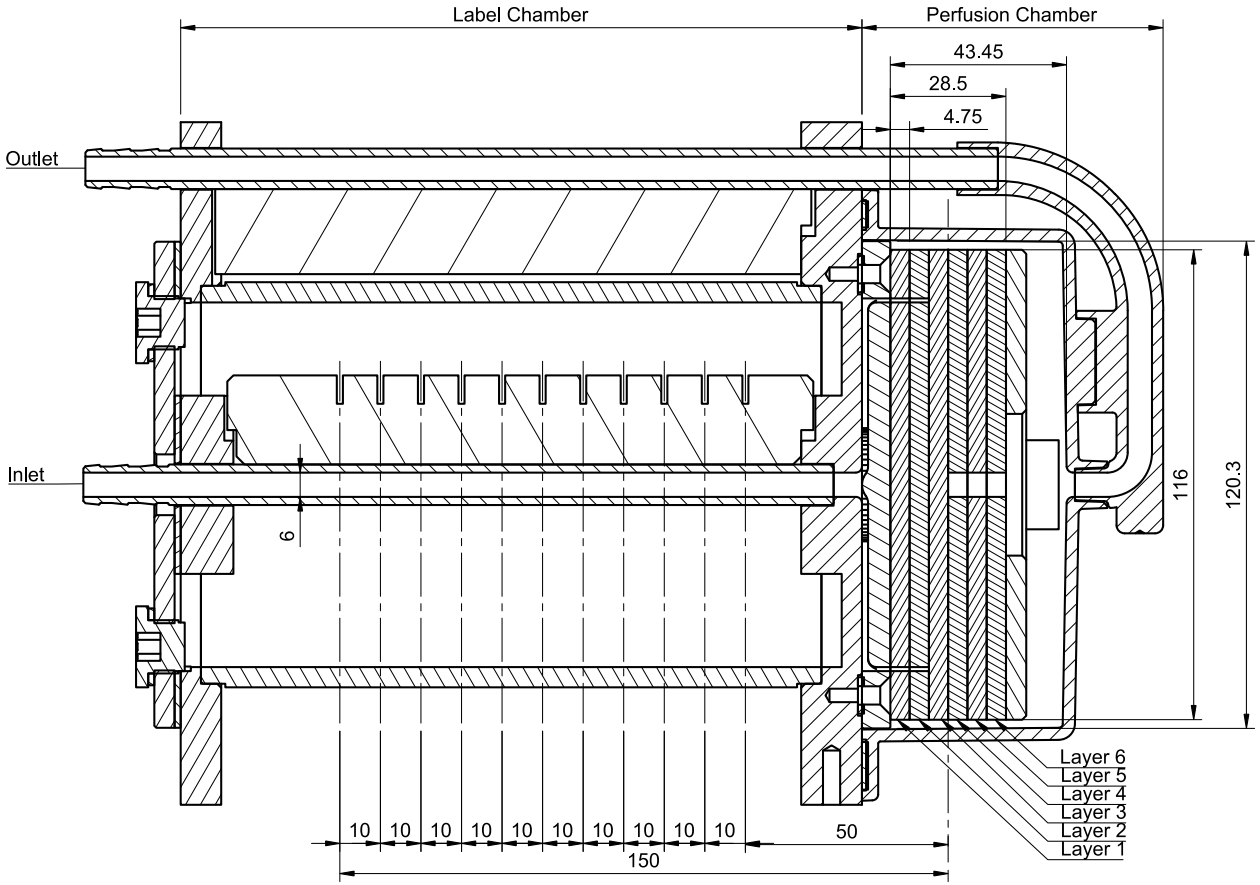


With contrast agent in voids (light regions)

Perfusion and Labelling Chambers

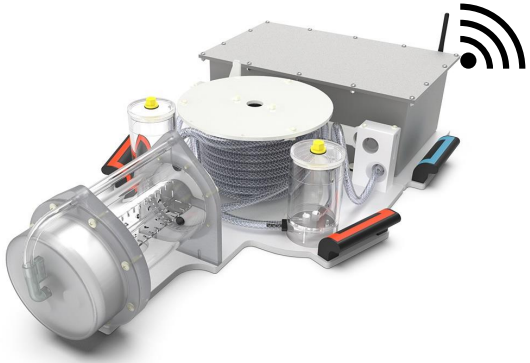


PLC Dimensions



QASPER Control and Monitoring

Config 1: inside magnet room



Config 2: inside magnet room

QASPER-LINK Wireless Interface

Fibre Optic Data Link

QASPER-LINK USB Interface

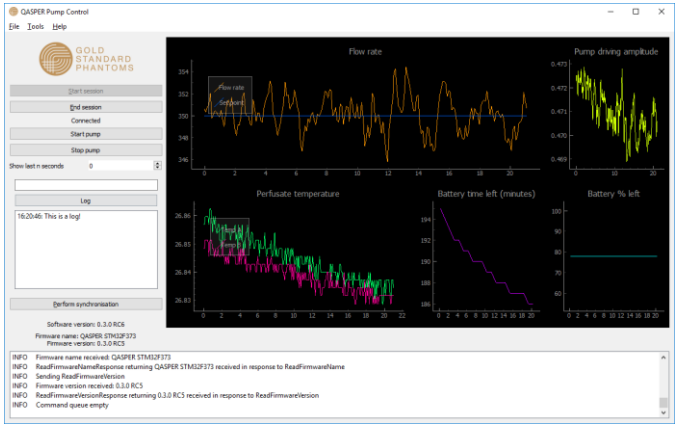
USB Data Link

Windows PC

Monitor
- Flow rate
- Perfusate temperature
- Battery status

Data are recorded as json file (some base64), Matlab functions available to read in.

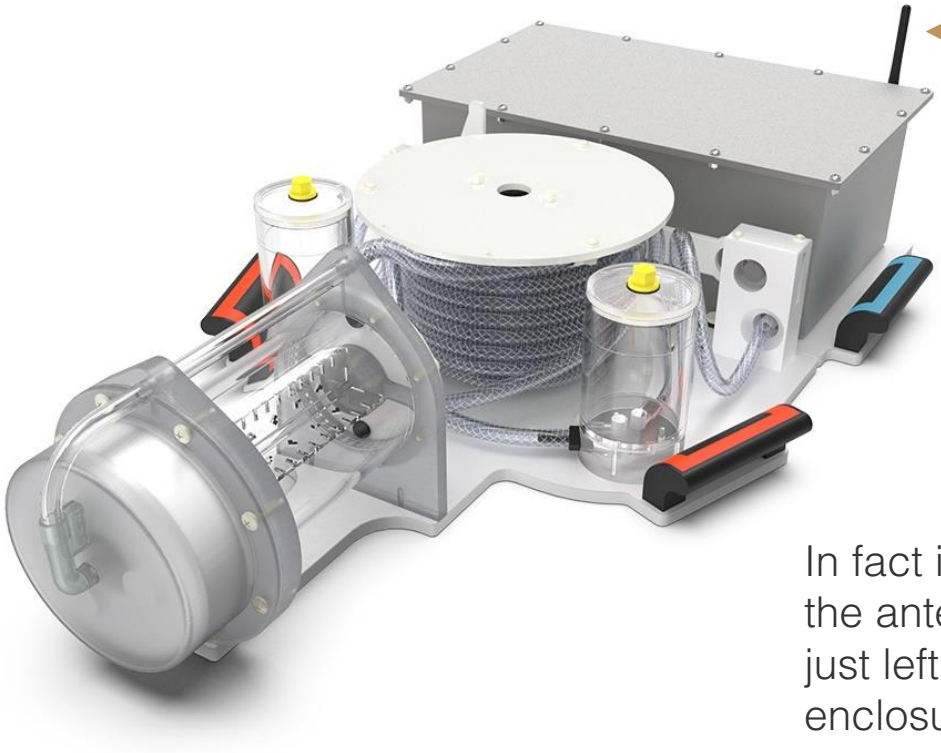
Control:
- Flow rate setpoint
- Auto flow control on/off
- Start/stop pump



Routine Checks and Maintenance

- Antenna
- Battery charging
- Clearing bubbles

Antenna



Make sure the antenna is correctly folded before placing the phantom in the transport case.

In fact it's not necessary to extend the antenna, and it will function fine if just left folded against the pump enclosure.

Power Supply Unit

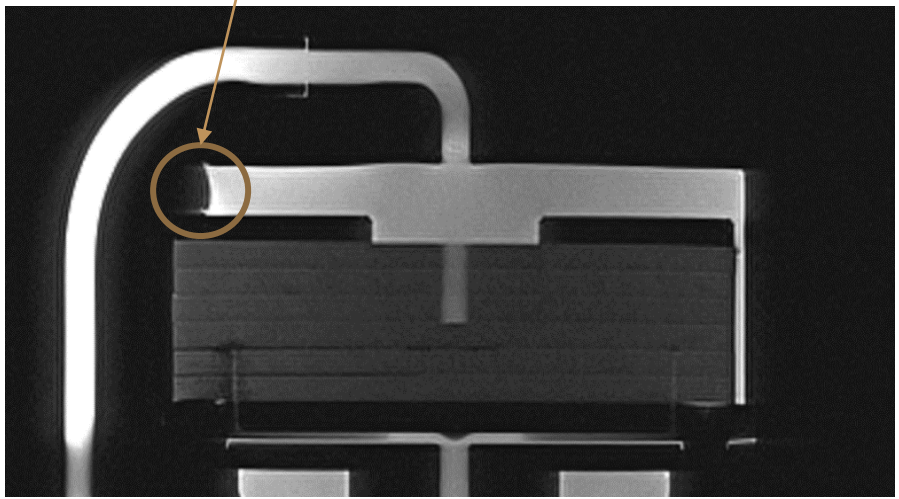
- Contains a 11.1V Li-Ion Battery
- Battery will discharge even when the unit is off.
- QASPER pump will not run if the battery charge is less than 5%.
- Ensure that the unit is re-charged after each use, and at least on a monthly basis.
- If the phantom is not going to be used for a long period, the battery can be internally disconnected – contact GSP for instructions.
- In the event the battery becomes fully discharged a special cable is used to directly connect to the battery to charge it.

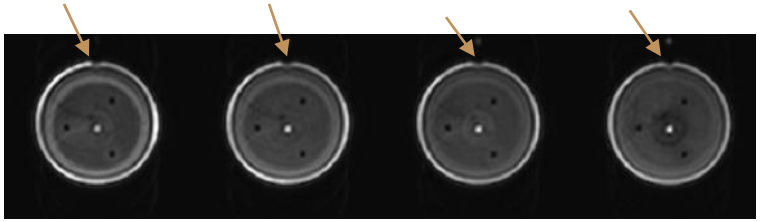
QASPER-LINK Wireless

- Contains a 3.7V Li-Ion Battery
- Unit has minimal self-discharge.
- Powered and charged by 5V over USB.
- Can be operated whilst being charged.

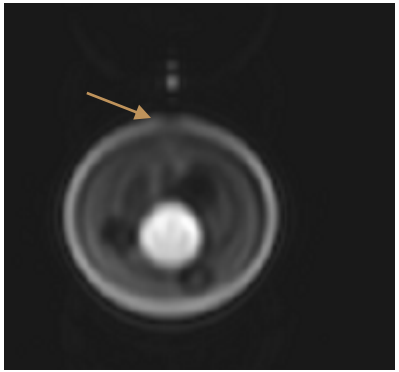
Air Clearance

Bubbles may form in the perfusion chamber, this is normal





Can be very subtle, but has a significant effect on image distortions!

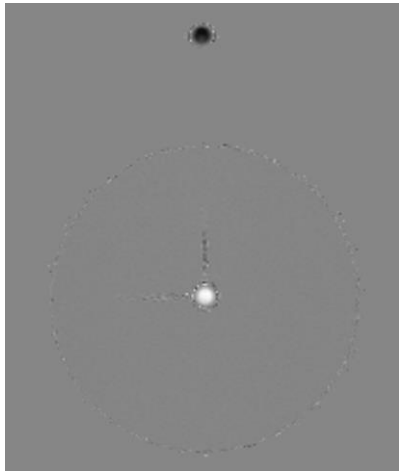


Basic ASL QC Protocol

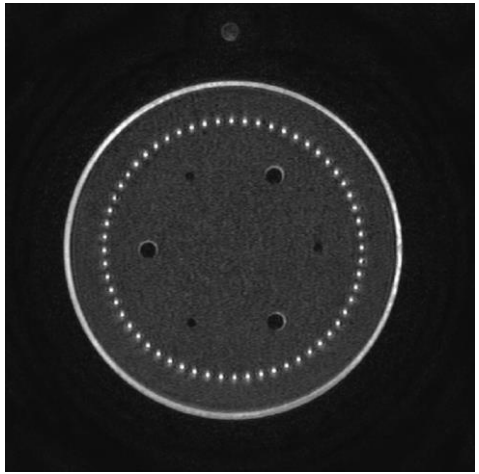
- QC of the ASL acquisition

- QC of the Phantom – ensure nothing has changed.
  - Assess flow rate and velocity using phase contrast.
  - Assess the integrity of the flow path using a time-of-flight angiogram.
  - Assess the T1 of the perfusate using a T1 map.
  - Assess the filling of the porous material using a T2 map.

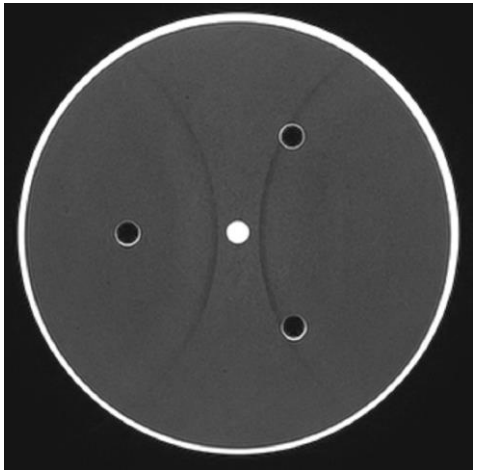
Phantom QC



Phase Contrast Velocimetry
- Slice at labelling plane.
- Measurement for each flow rate used.



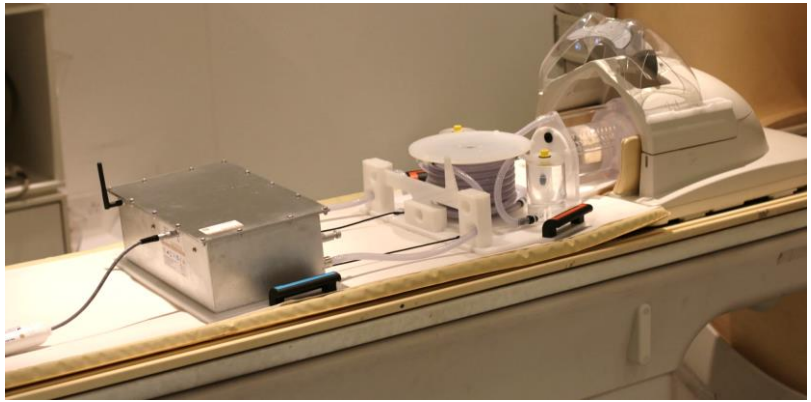
Time-of-Flight Angiogram
- Cover entire perfusion chamber
- At the highest flow rate used for the best SNR.

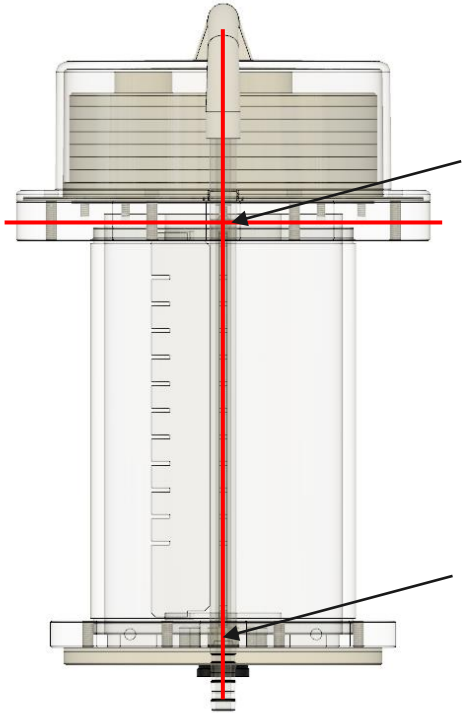


Multi-Echo Spin Echo T_2 Map
- Cover the porous material
- Pump off

T_1 Map
- Saggital/Coronal slice through PLC.
- Pump off.

Standardise placement

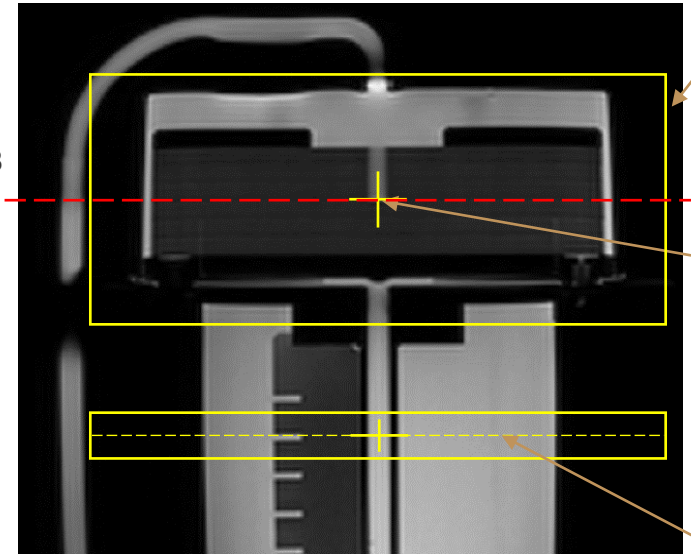




The crosshair of the laser marker should be located here

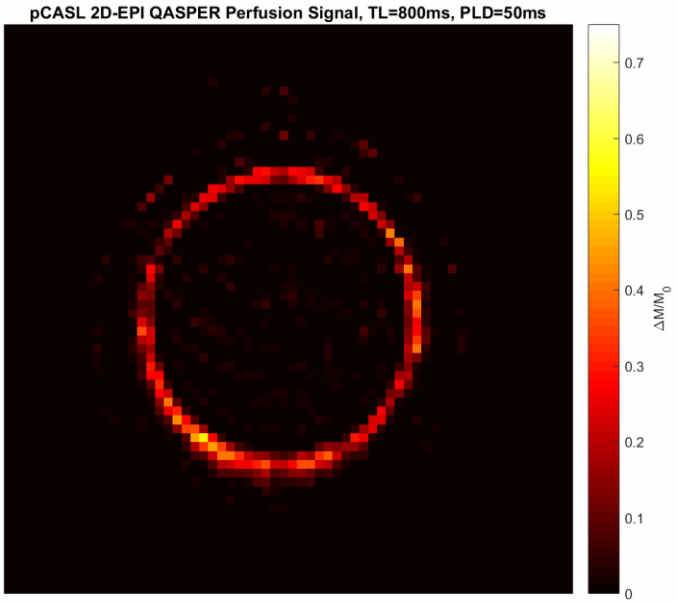
The axial laser line should cross here

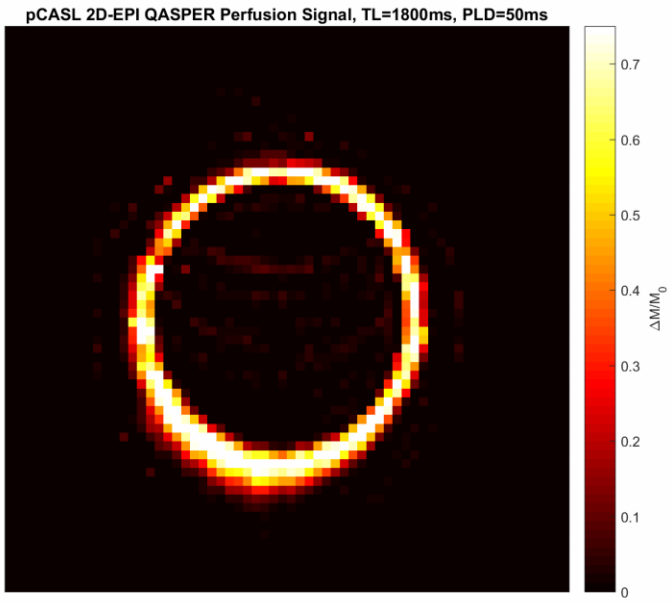
Standardise ASL FOV



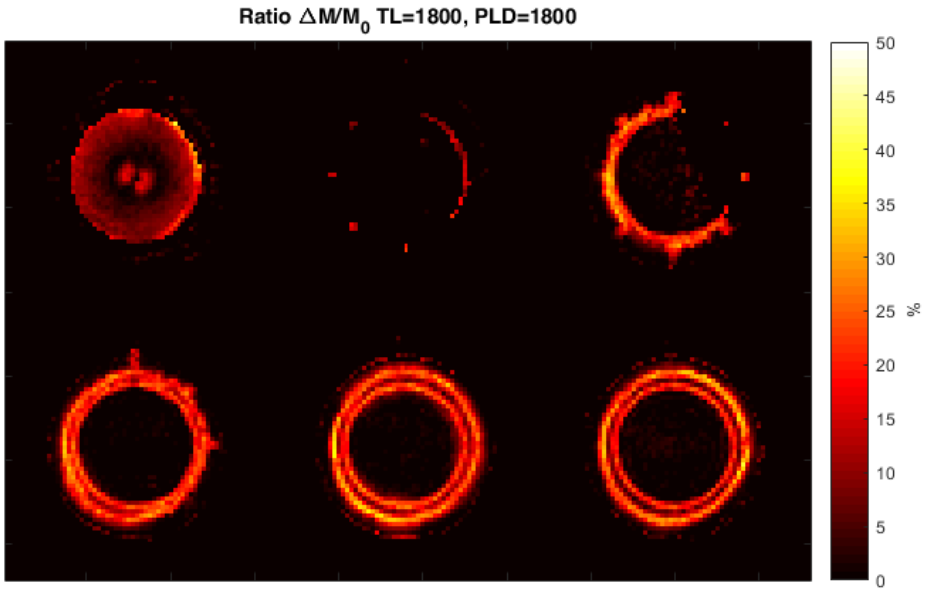
ASL QC Protocol

- Compare apples with apples. Ensure the same thing is done each time:
  - Labelling parameters
  - FOV, acquisition matrix, acquisition parameters.
  - Phase encode directions
- True M0 is not always possible. A pseudo-M0 can be used for normalisation, the perfusion values will not be correct, but they should be consistent.
- Save the ‘source’ control/label acquisitions, rather than rely on the calculated images.

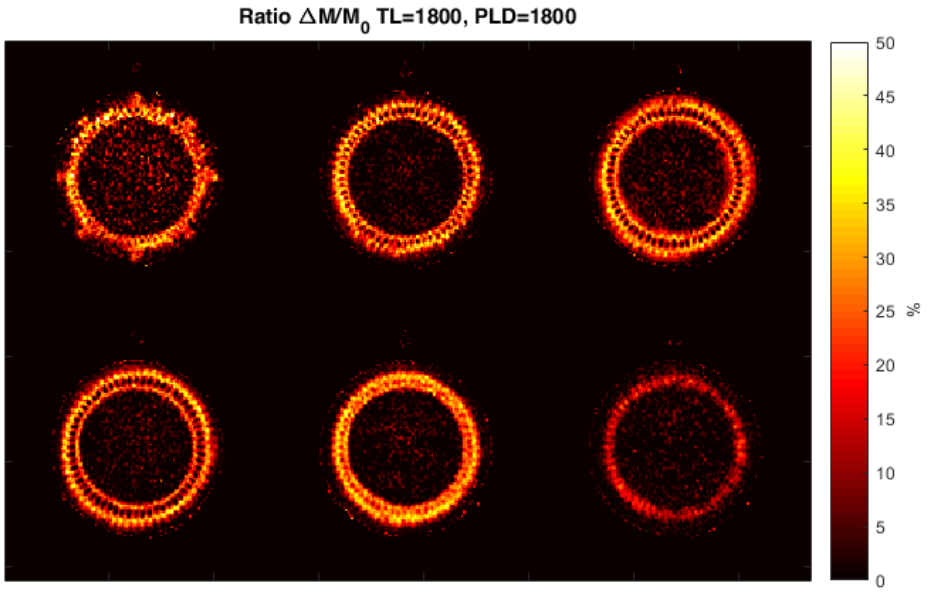

pCASL 2D-EPI QASPER Perfusion Signal, TL=800ms, PLD=50ms
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
ΔM/M0


pCASL 2D-EPI QASPER Perfusion Signal, TL=1800ms, PLD=50ms
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
ΔM/M0

High Res ASL

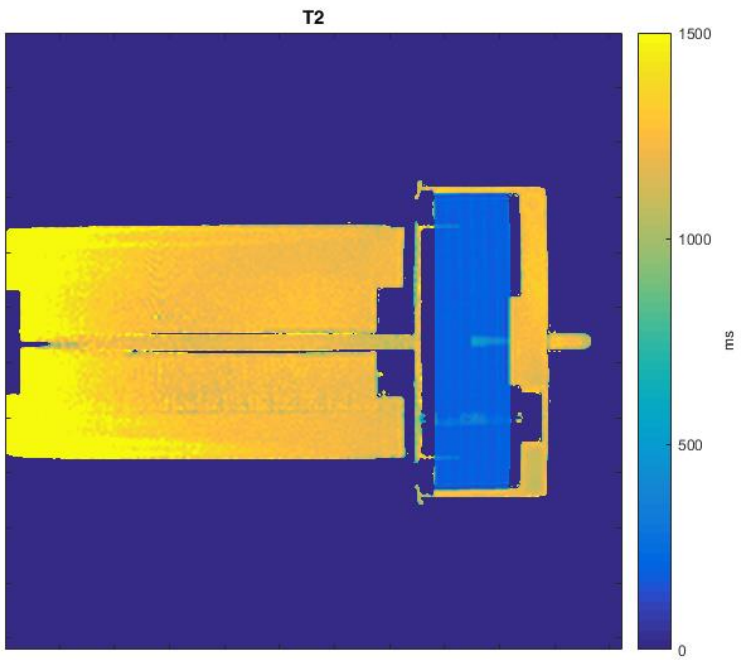


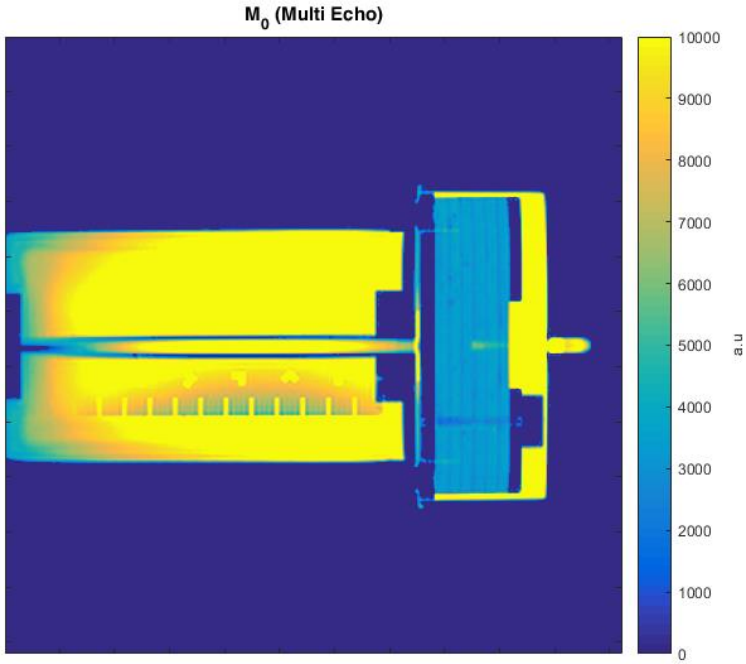
3mm in-plane



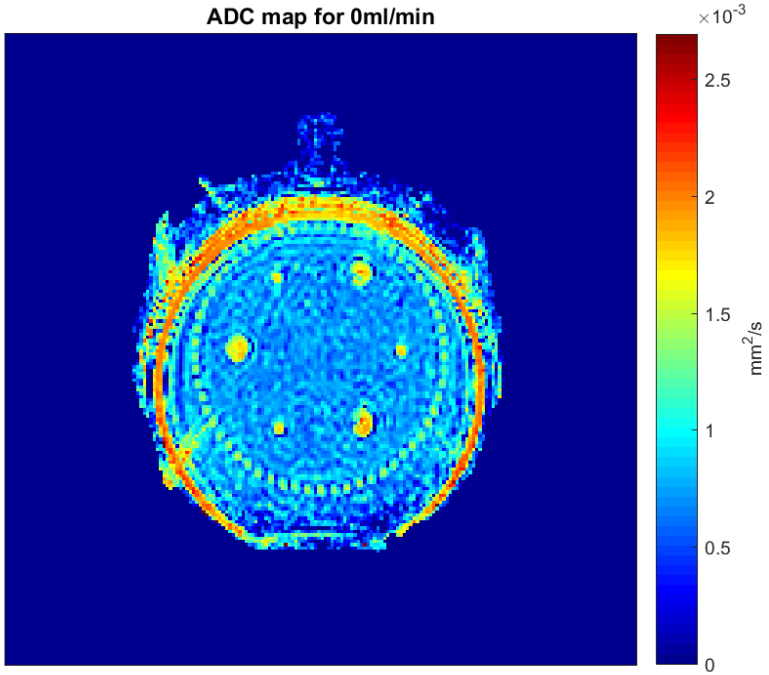
1.5mm in-plane
ETL = 3
10 minute scan!

T_2


T2
1500
1000
500
0
ms

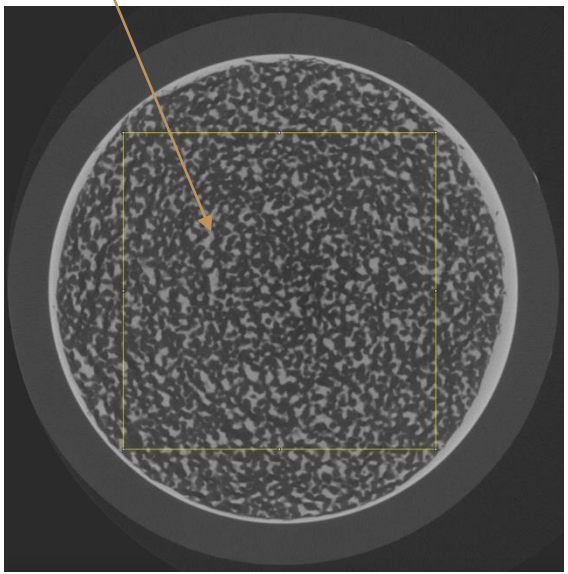

M0 (Multi Echo)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
a.u

Diffusion



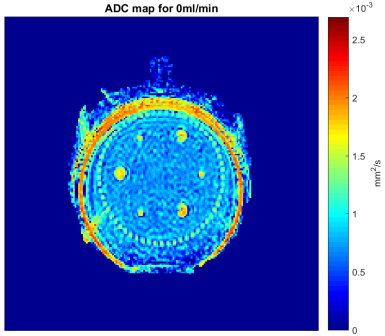
B-value = 1000 s/mm^2

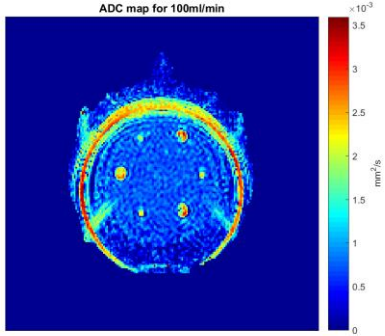
Water diffusion is restricted by the microscopic structure of the porous material

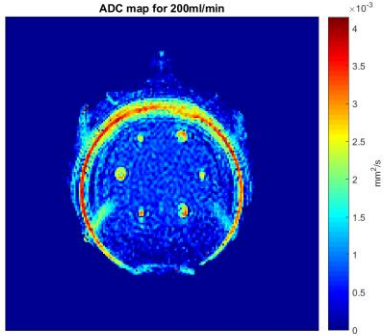


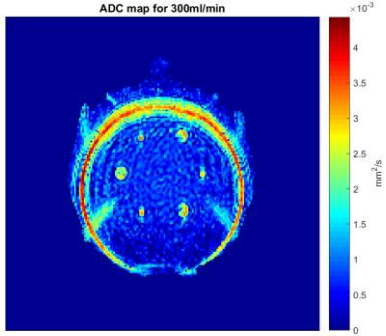
XCT image with contrast agent in voids (light regions)

IVIM

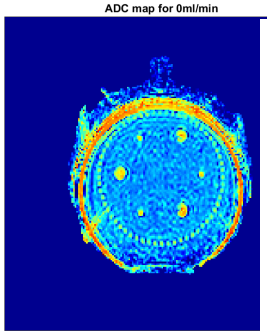

ADC map for 0ml/min
×10^-3
2.5
2
1.5
1
0.5
0
mm^2/s

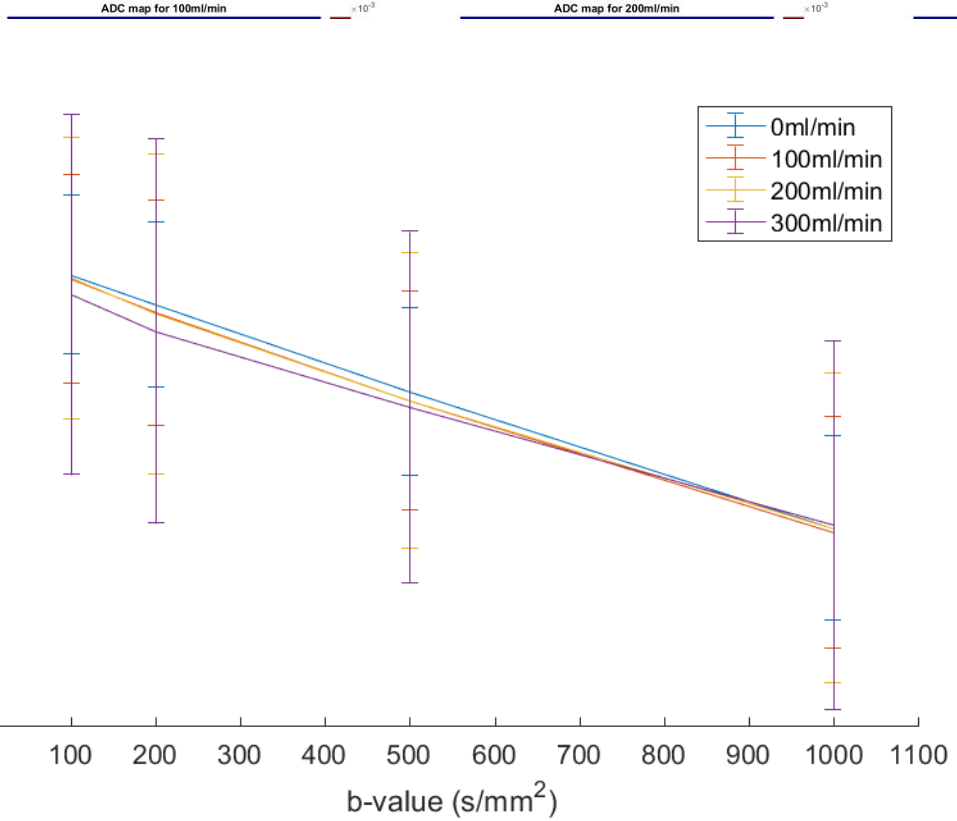

ADC map for 100ml/min
×10^-3
3.5
3
2.5
2
1.5
1
0.5
0
mm^2/s

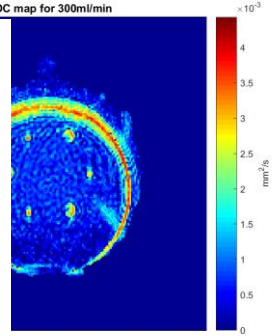

ADC map for 200ml/min
×10^-3
4
3.5
3
2.5
2
1.5
1
0.5
0
mm^2/s


ADC map for 300ml/min
×10^-3
4
3.5
3
2.5
2
1.5
1
0.5
0
mm^2/s

IVIM


ADC map for 0ml/min


0ml/min
100ml/min
200ml/min
300ml/min
ln(S/S0)
b-value (s/mm2)
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
0
100
200
300
400
500
600
700
800
900
1000
1100


ADC map for 300ml/min