4D SCANNING FOR ABDOMINAL RADIOTHERAPY PLANNING

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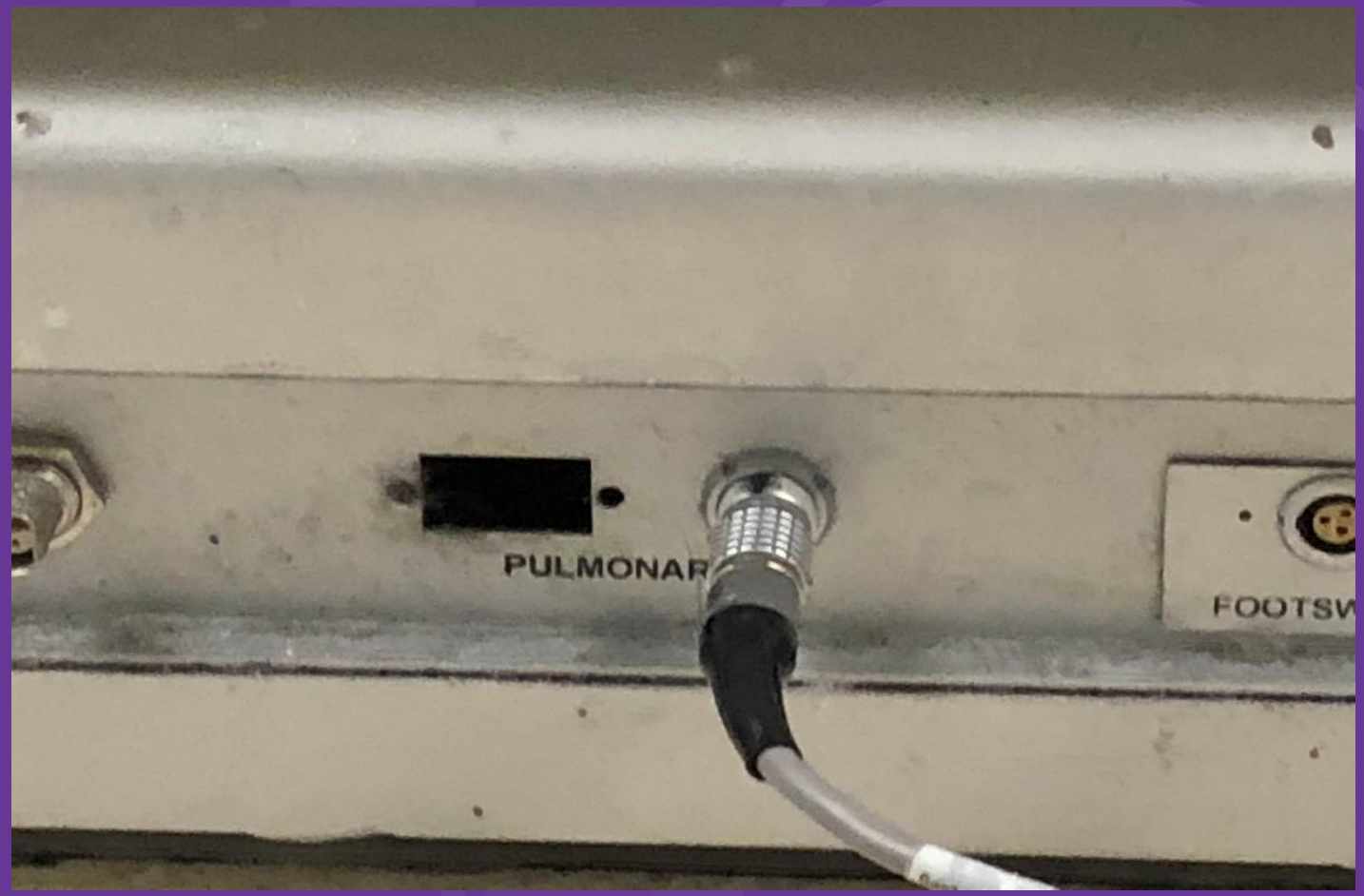
Bellows

Pulmonary Toolkit

Pulmonary Port



Why 4D?

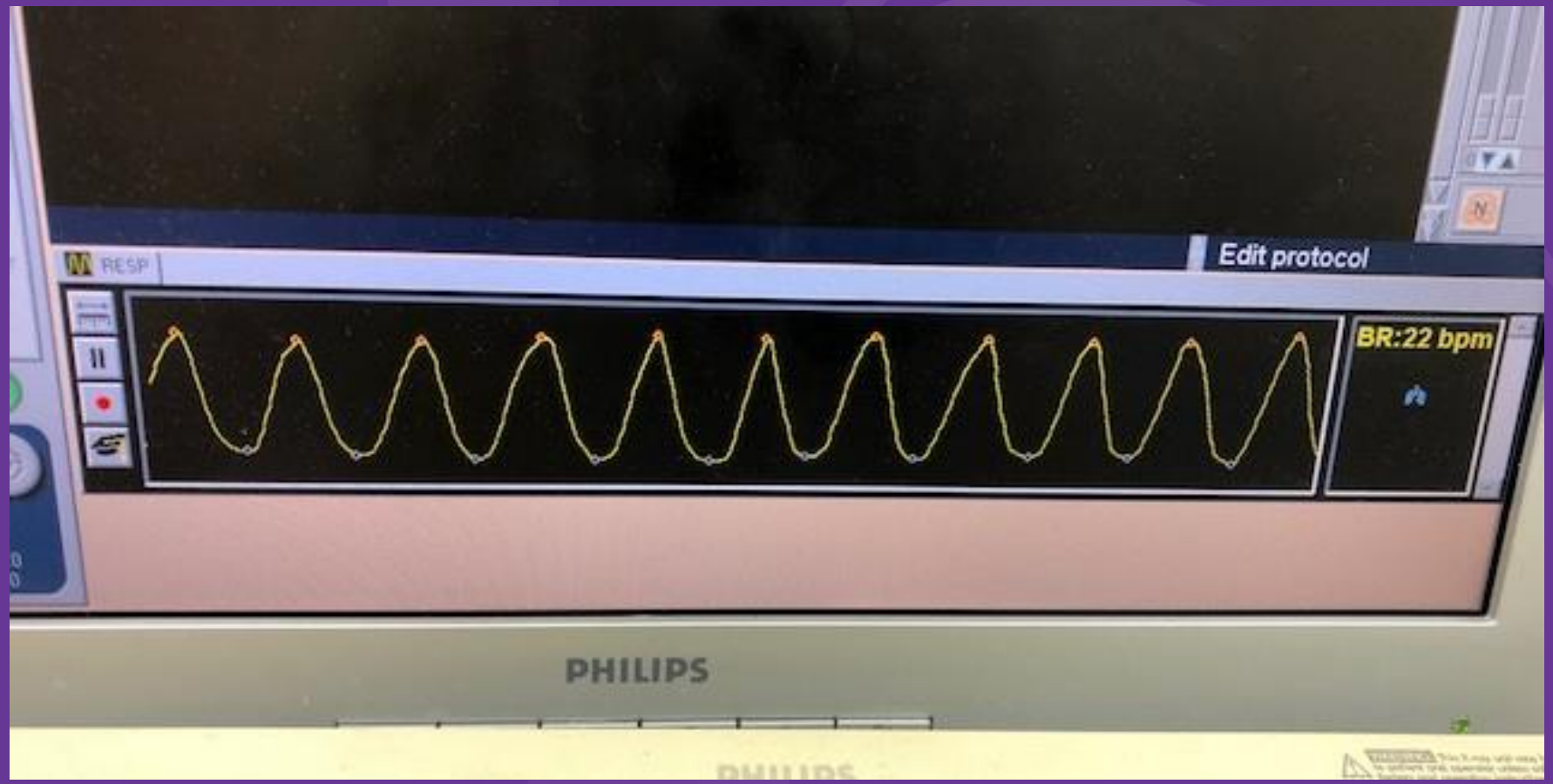
- Abdominal SABR

  Livers, Adrenals, Renal, Pancreas, Gall Bladder, Abdominal Nodes
- Generation of mGTV
- SABR Guidelines for motion management
- Often used in conjunction with a 3D Ex-BH

How it works..

- Bellows expand / contract
- Air travels along tubing to the PTK
- Air change is measured in the PTK
- Measurement sent back along through the Pulmonary port
- This is converted into a wavelength and displayed on the CPU

Wavelength display

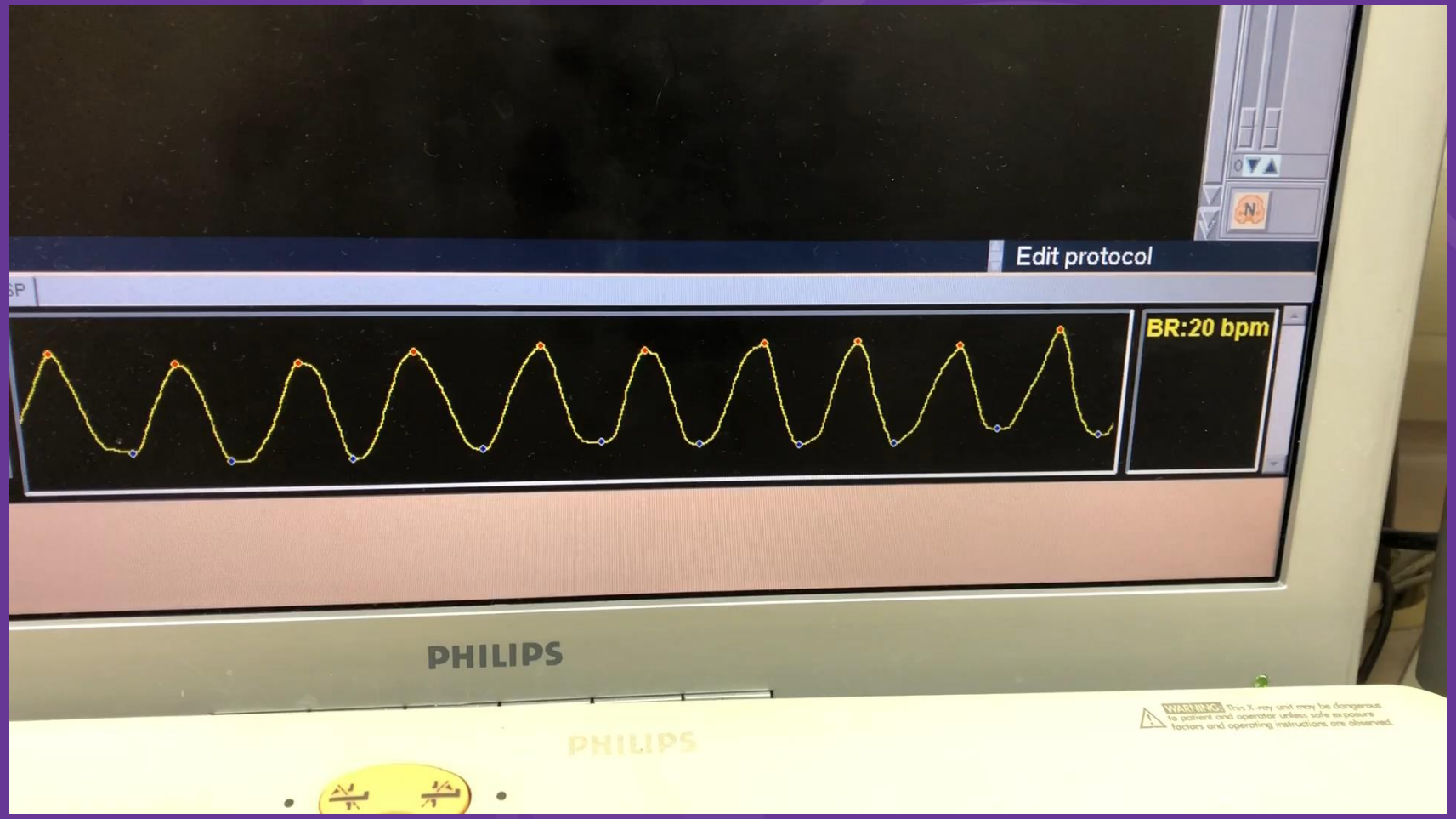


Positioning of bellows

- If 4DCT is the sole planning scan – do not allow it to cause skin deformation over intended area of delineation for trmt / OARs
- Tight – really, really tight!
- Flat surface for tabs to stabilise on
- Skin contact
- Where it will detect motion

Typical position for Bellows on 4D Scans for Lungs

Typical 4DCT Wave



Bellow Position for Abdo's

- ✓ No skin deformation over trmt area
- ✓ Chest breathers
- × Breast tissue can be problematic
- × tabs can dig into axilla

Bellow position for Abdo's

- ✓ No skin deformation over trmt area
- ✓ 'Belly' breathers
- × Difficulty in gaining a trace

Abdominal SABR

- SABR consortium guidelines advise that motion restriction should be used if the motion is more than 5mm..

So this is where the fun begins..!

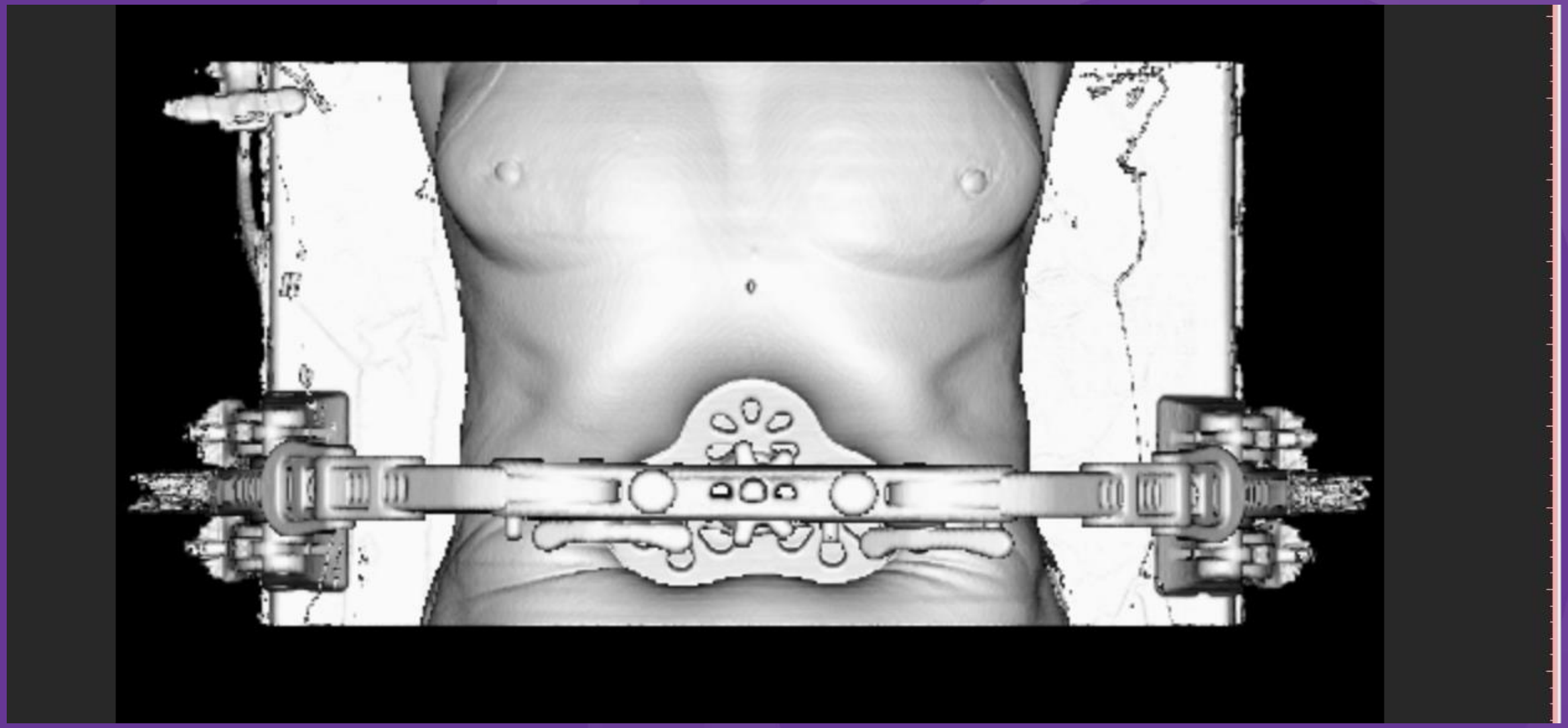
4DCT Vs Abdominal SABR

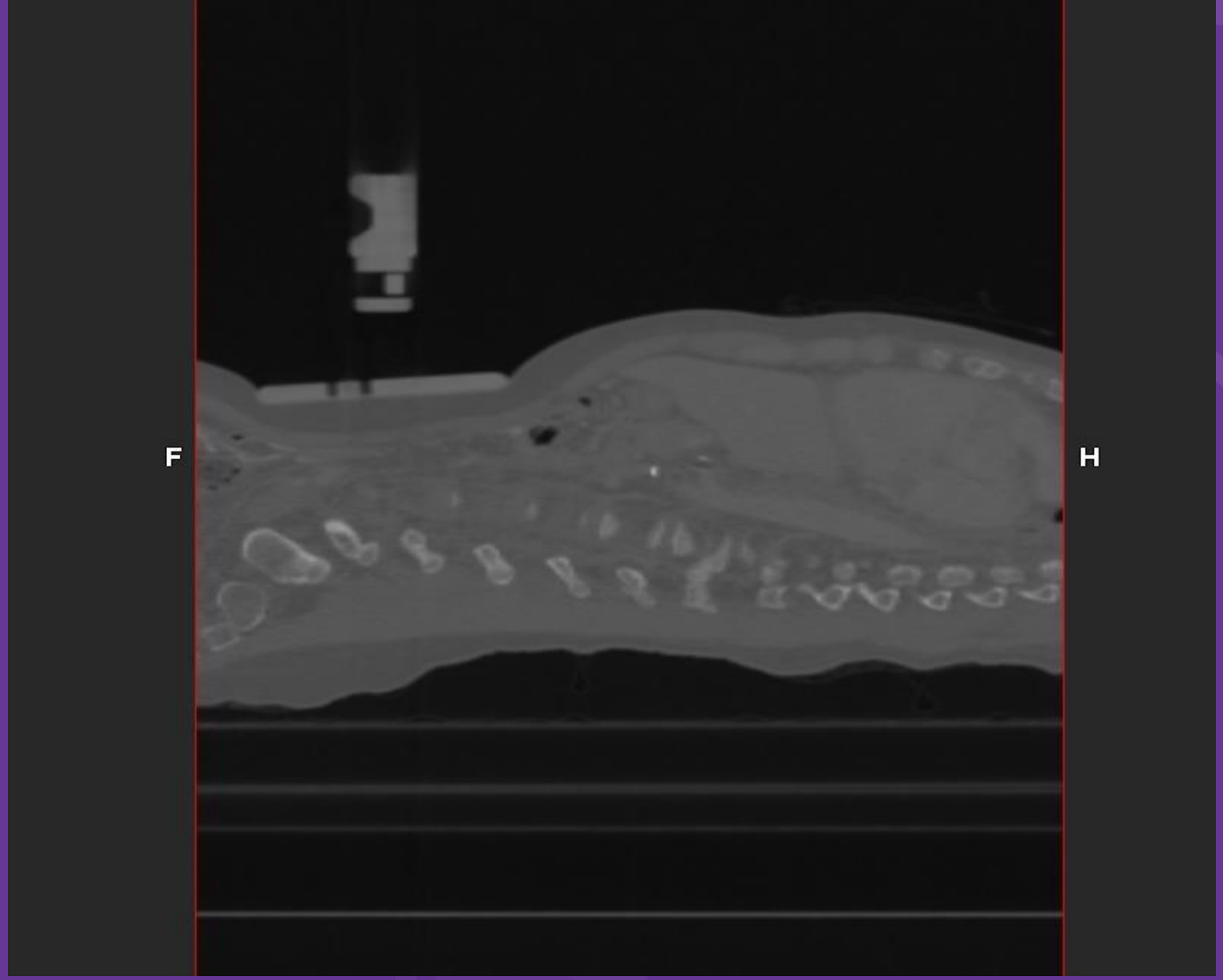
4DCT Needs	Abdo SABR Needs
-Detectable breathing motion	-Minimal breathing motion
-Good contact points	-No skin deformation
-Even, regular, steady motion	-Motion management

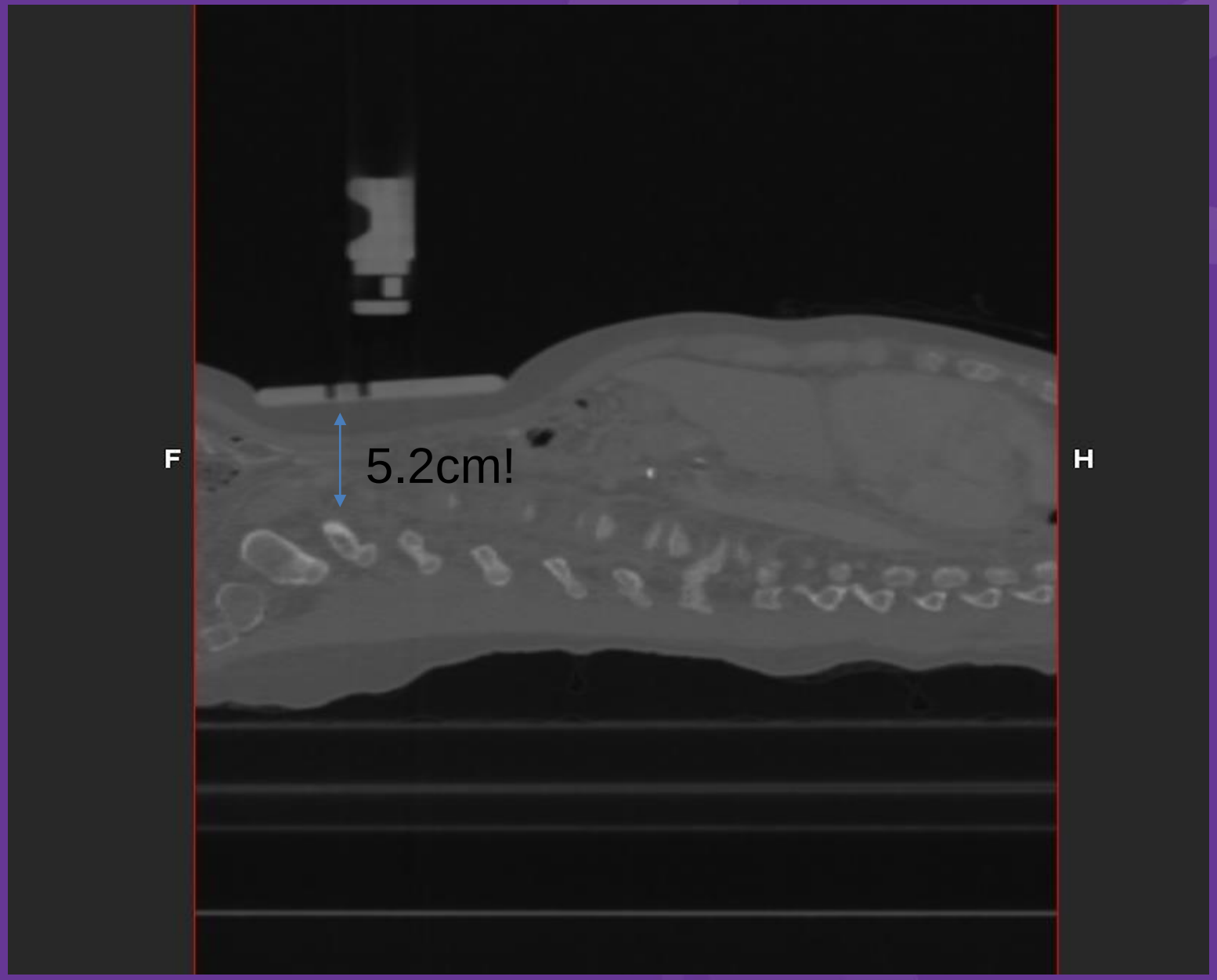
Two principles are working against each other!

Motion Management

Abdominal Compression for motion management

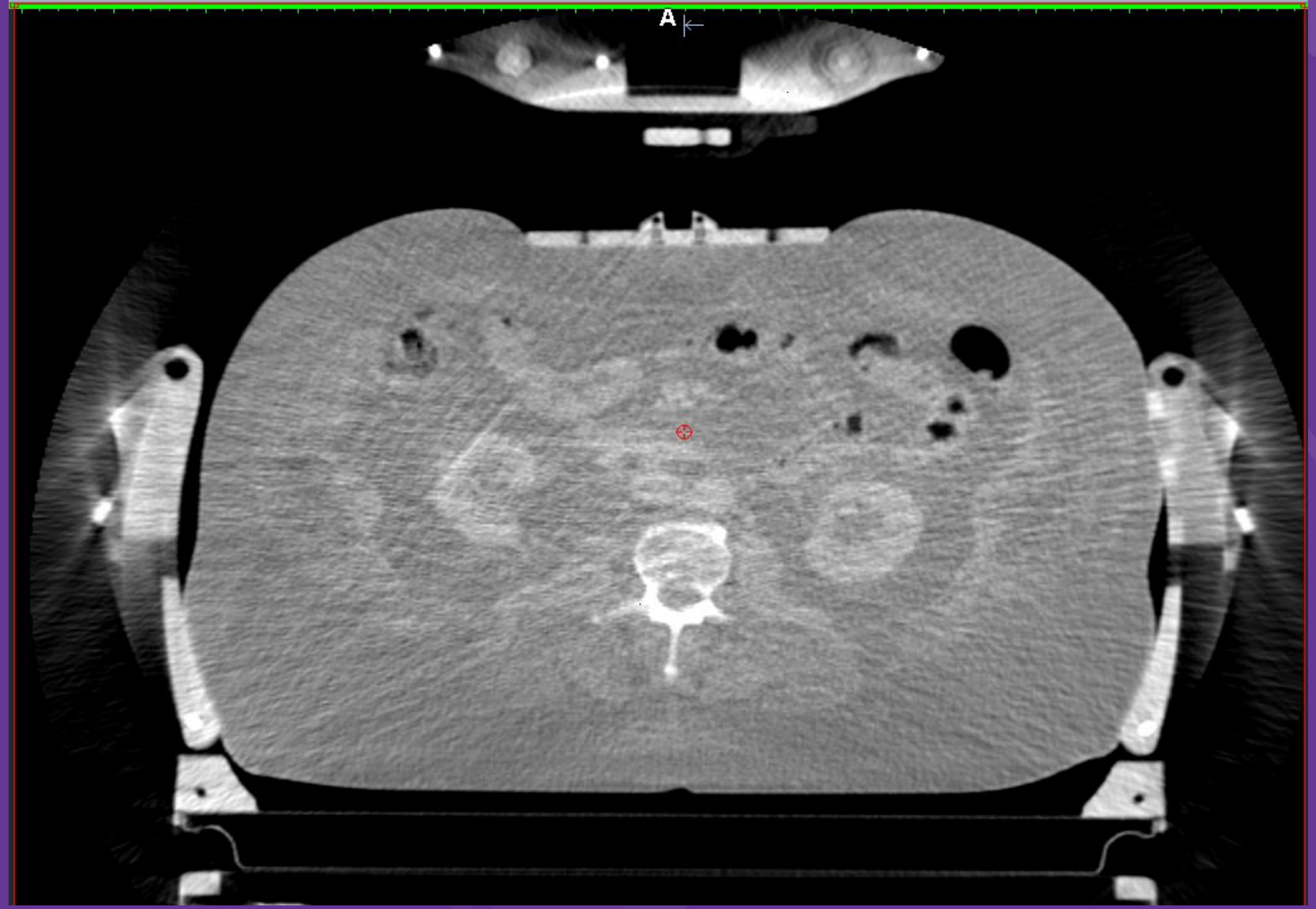


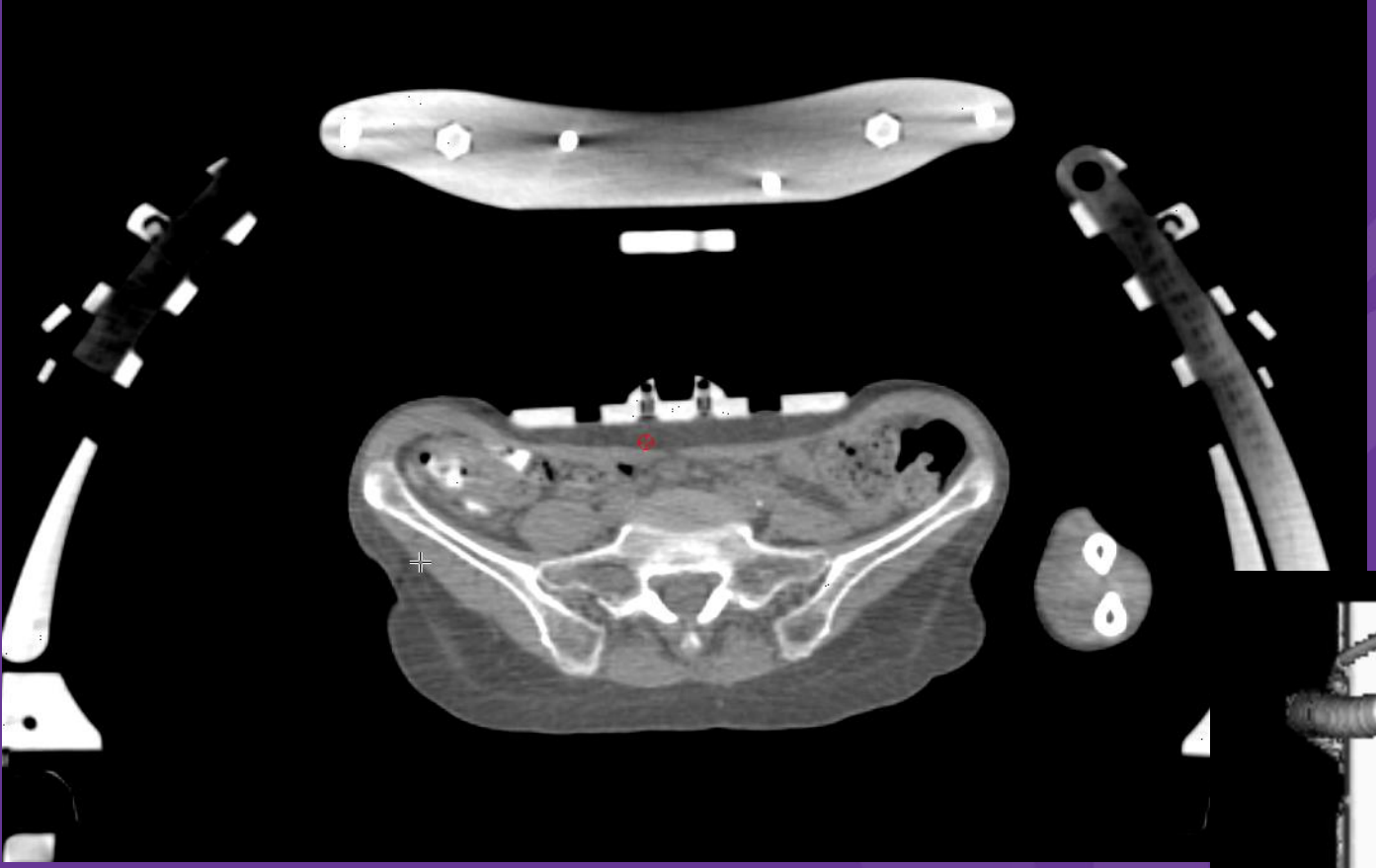

F
H



This patient is slim

Compresses well
Straight plate
No lateral displacement


A



Unable to raise both arms

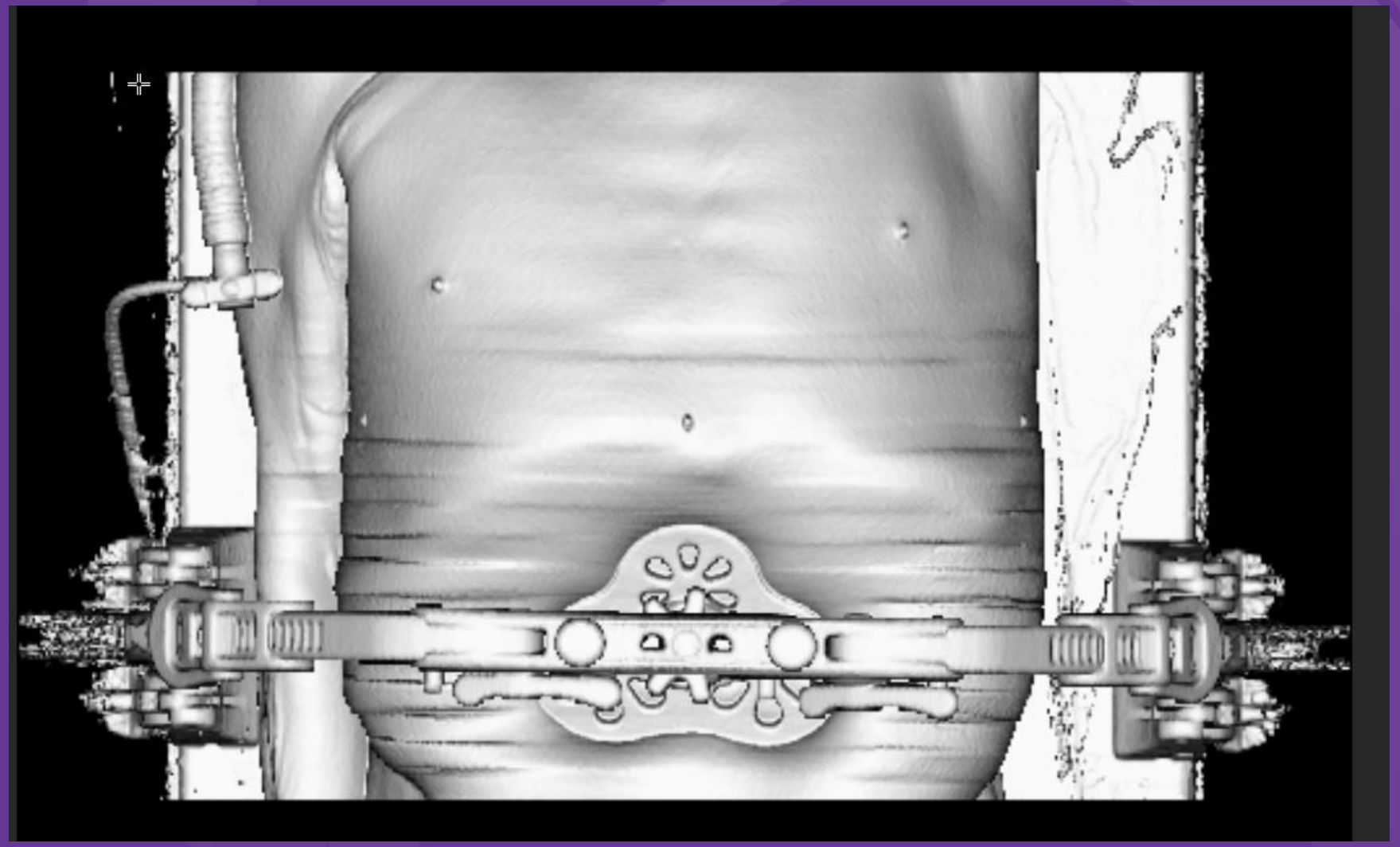
One arm down

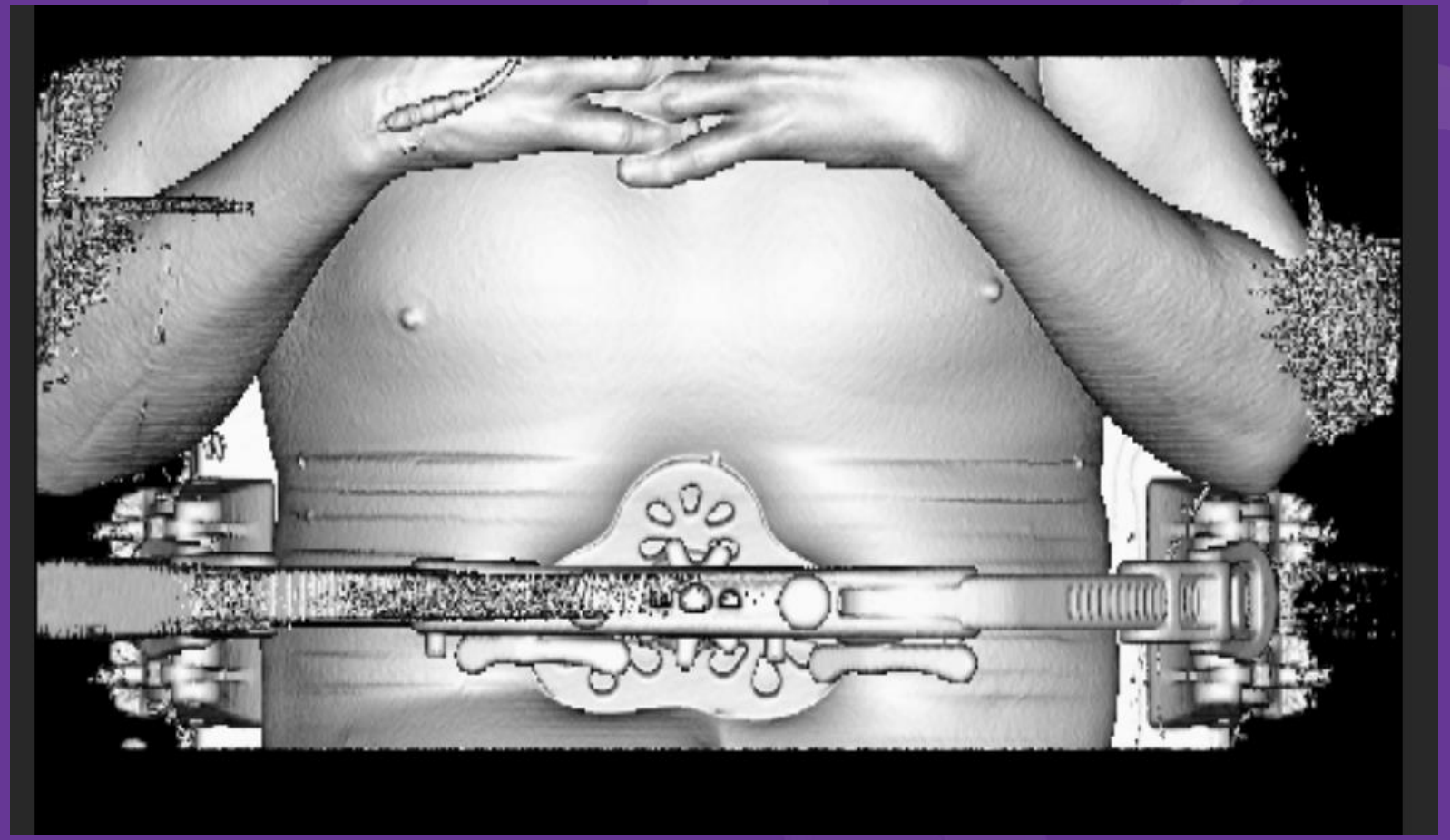
Arm inside the arch

Other arm down

Slightly larger patient

Arm tucked under torso



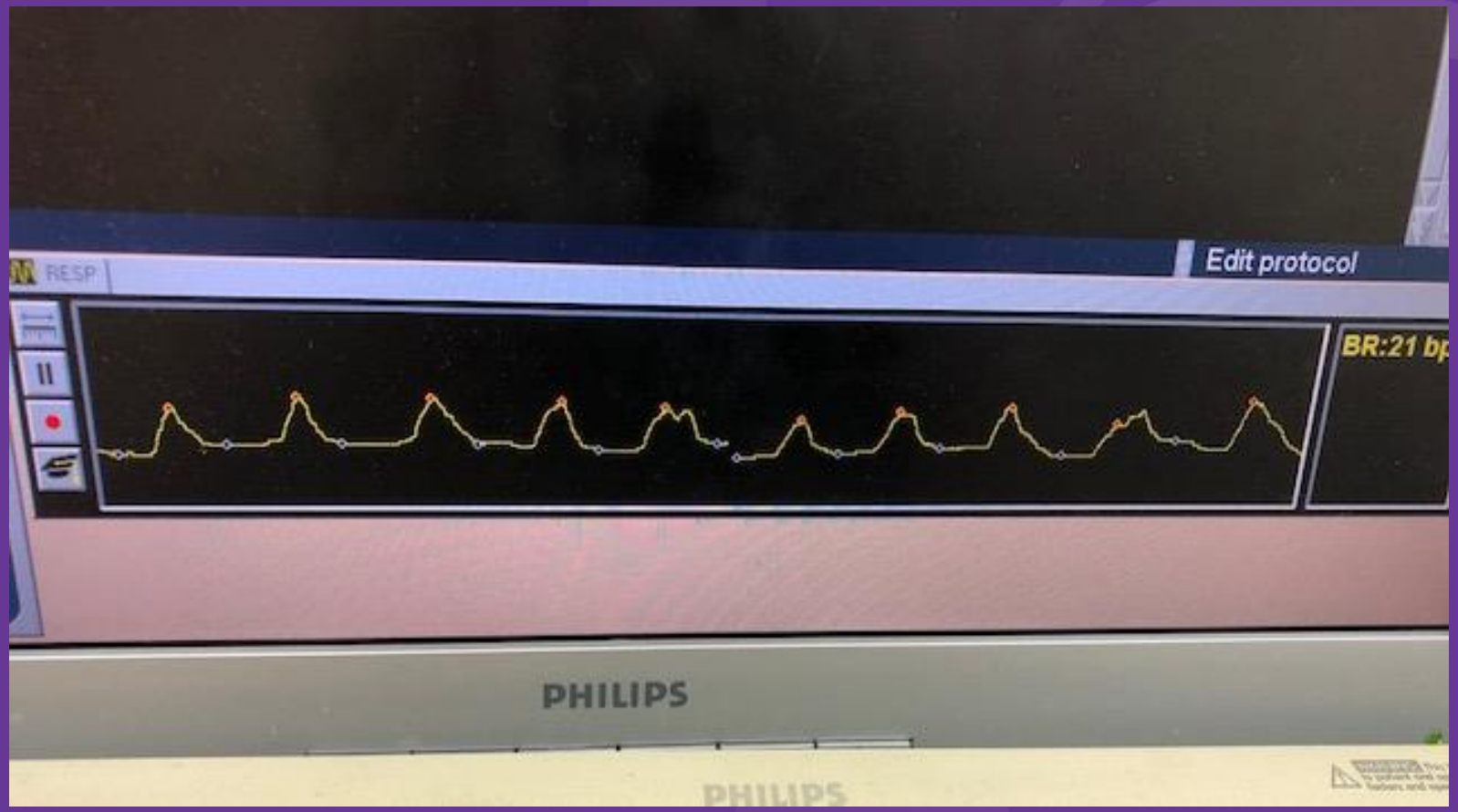


Both arms down

No room inside arch

Hands on Chest

Abdominal 4D Wave (in compression)

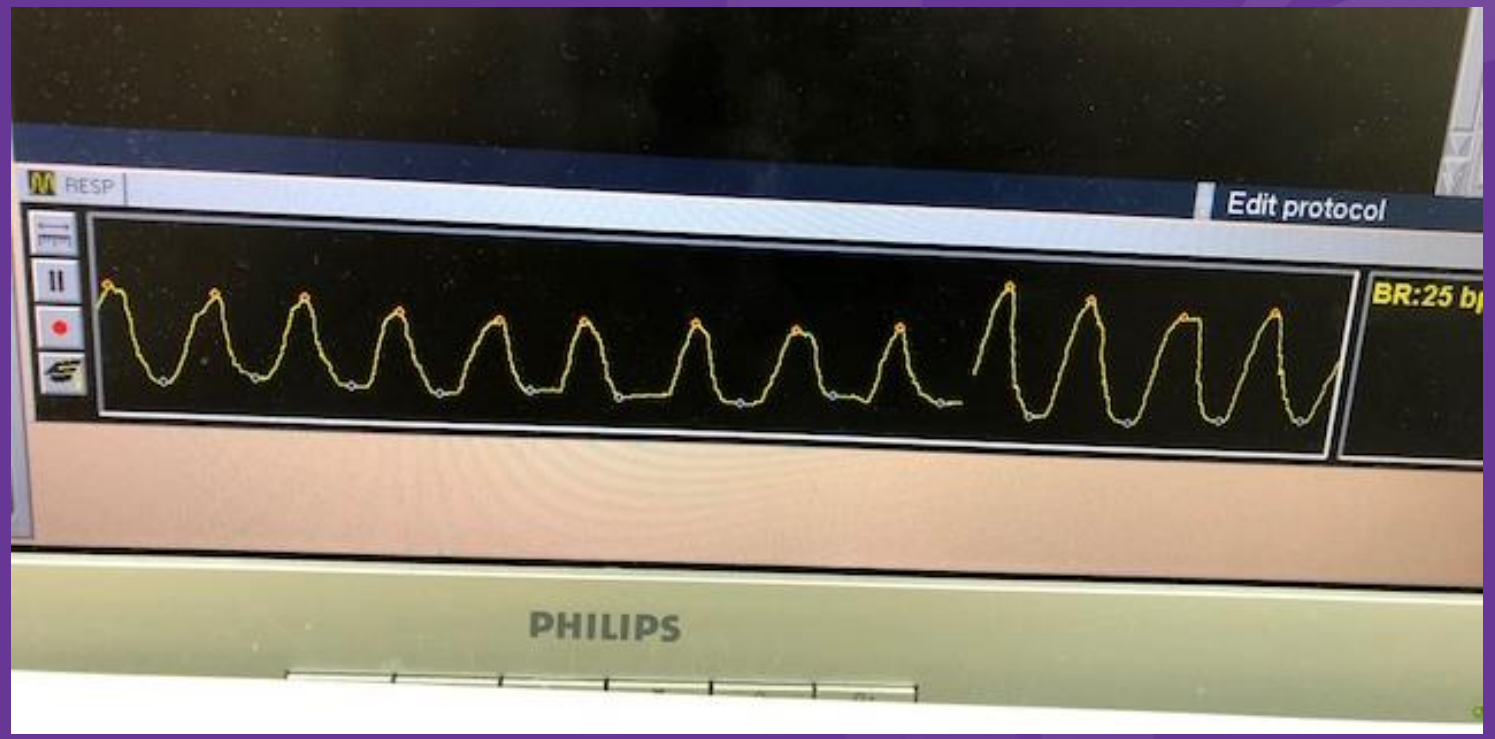


Irregular

Shaky

Shallow

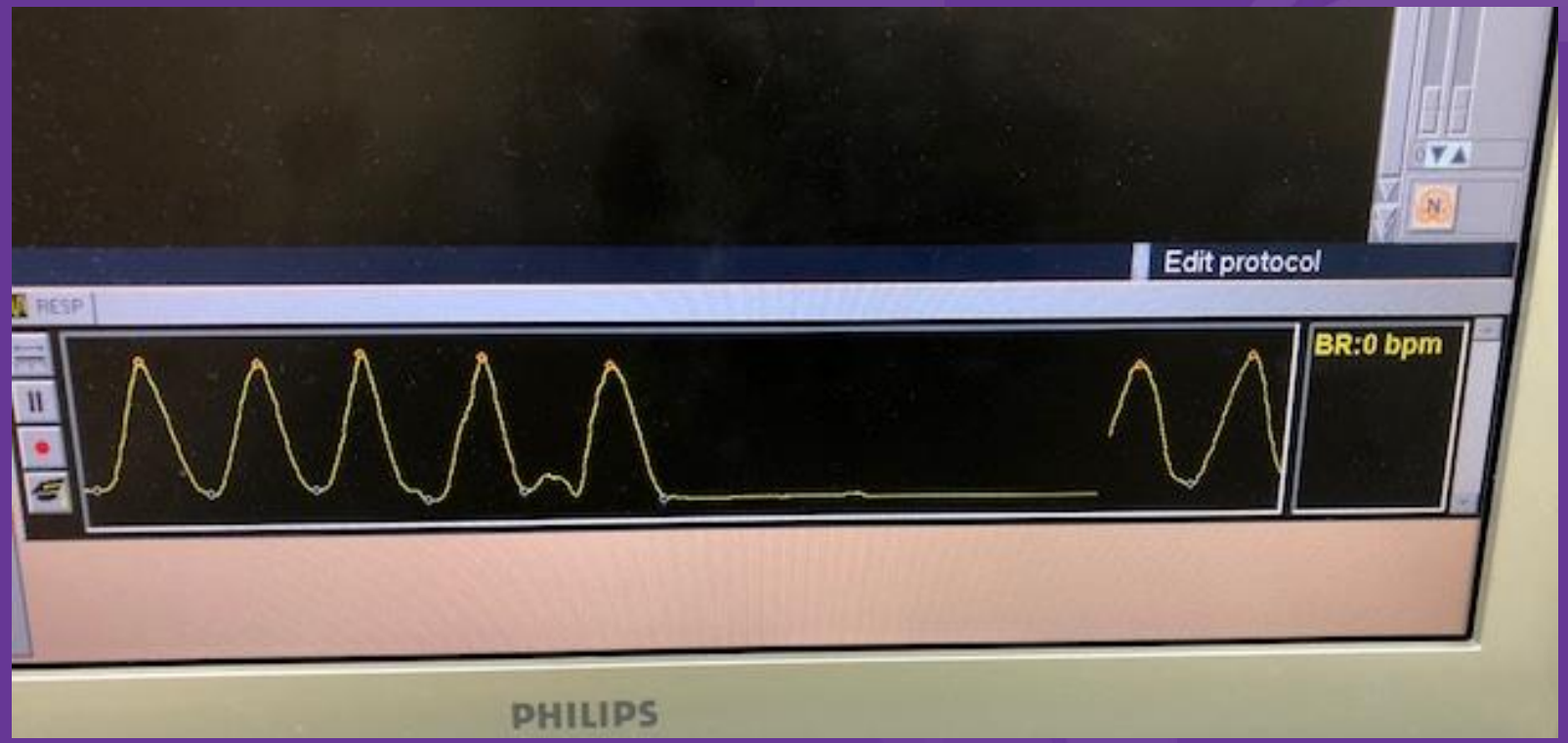
Abdominal 4D Wave (in compression)



Fast – hyperventilating?

"I'm panicking!"

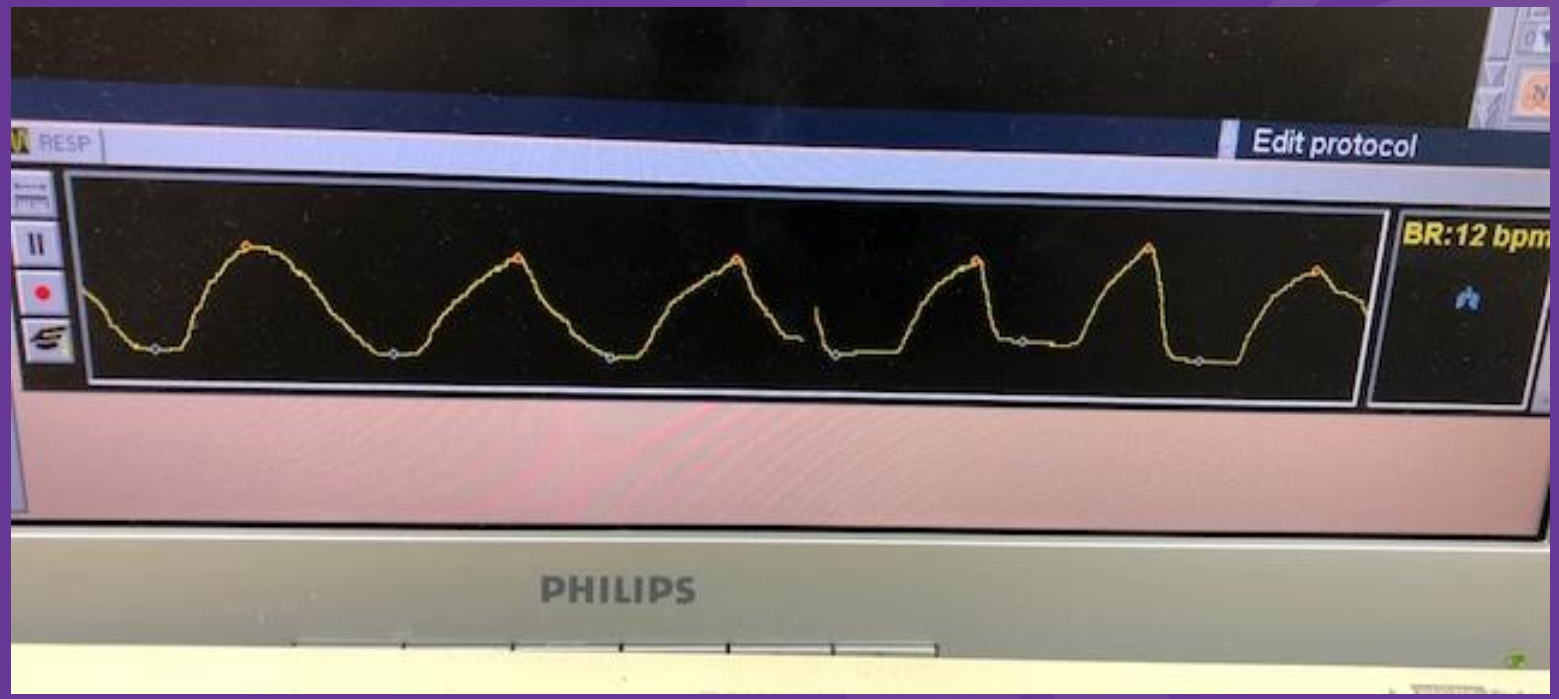
Abdominal 4D Wave (in compression)



‘Flat-lined’

(Radiographer now panicking!)

Abdominal 4D Wave (in compression)



Slow

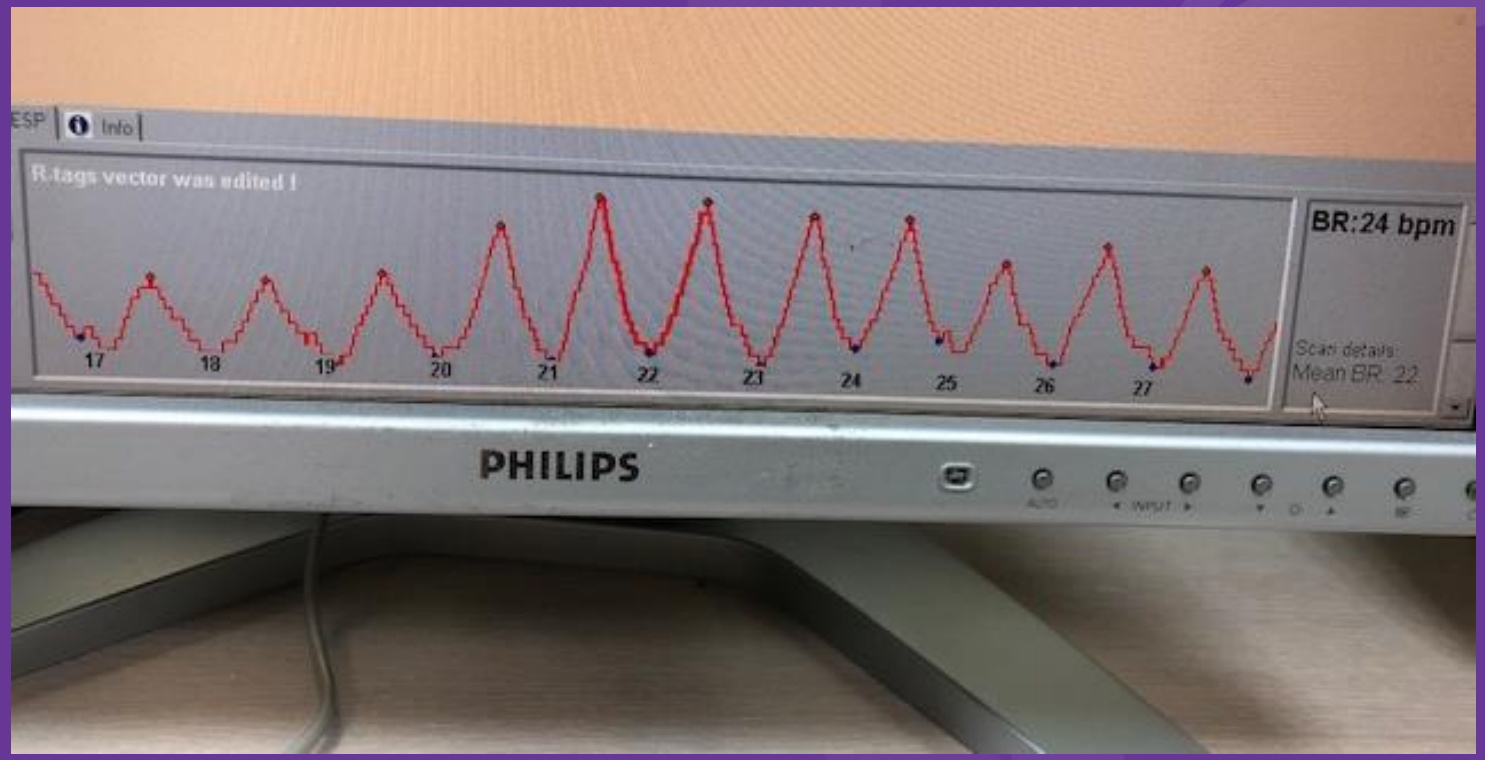
Controlled

?Artificial

How ‘perfect’ does the trace need to be?

- Truthfully…? Not very!
- Remember .. Its not for planning, just mGTV
- Post processing - Edit the vectors
- Pitch / Velocity is the most important
- Radiographer experience paramount
- It will reconstruct to a useable scan

Recent trace on a 4DCT Abdo



Mean BR – 22

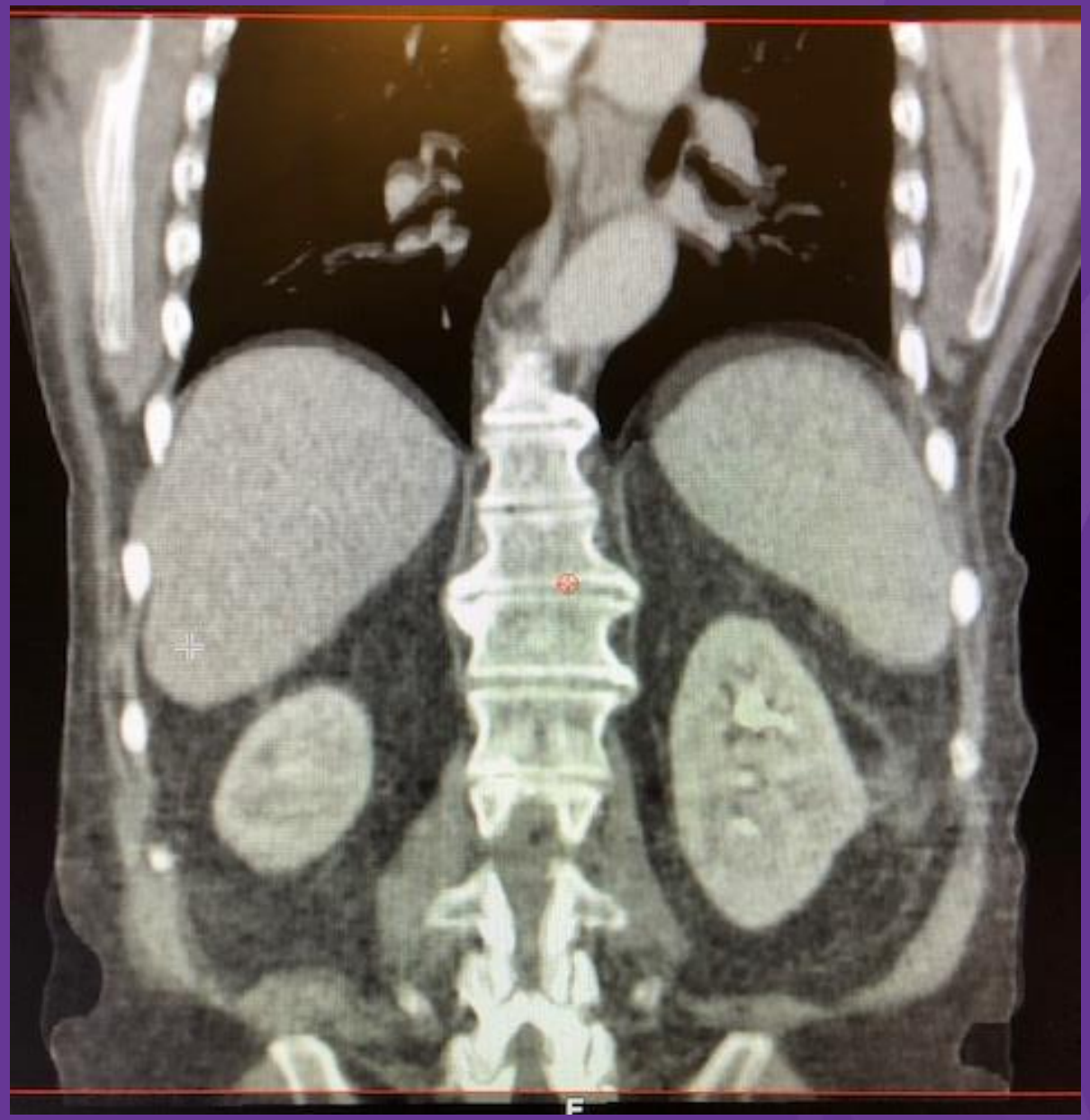
Snapshot – 24

Small Amplitudes

Large Amplitudes

Shaky

‘Poor trace’ ??

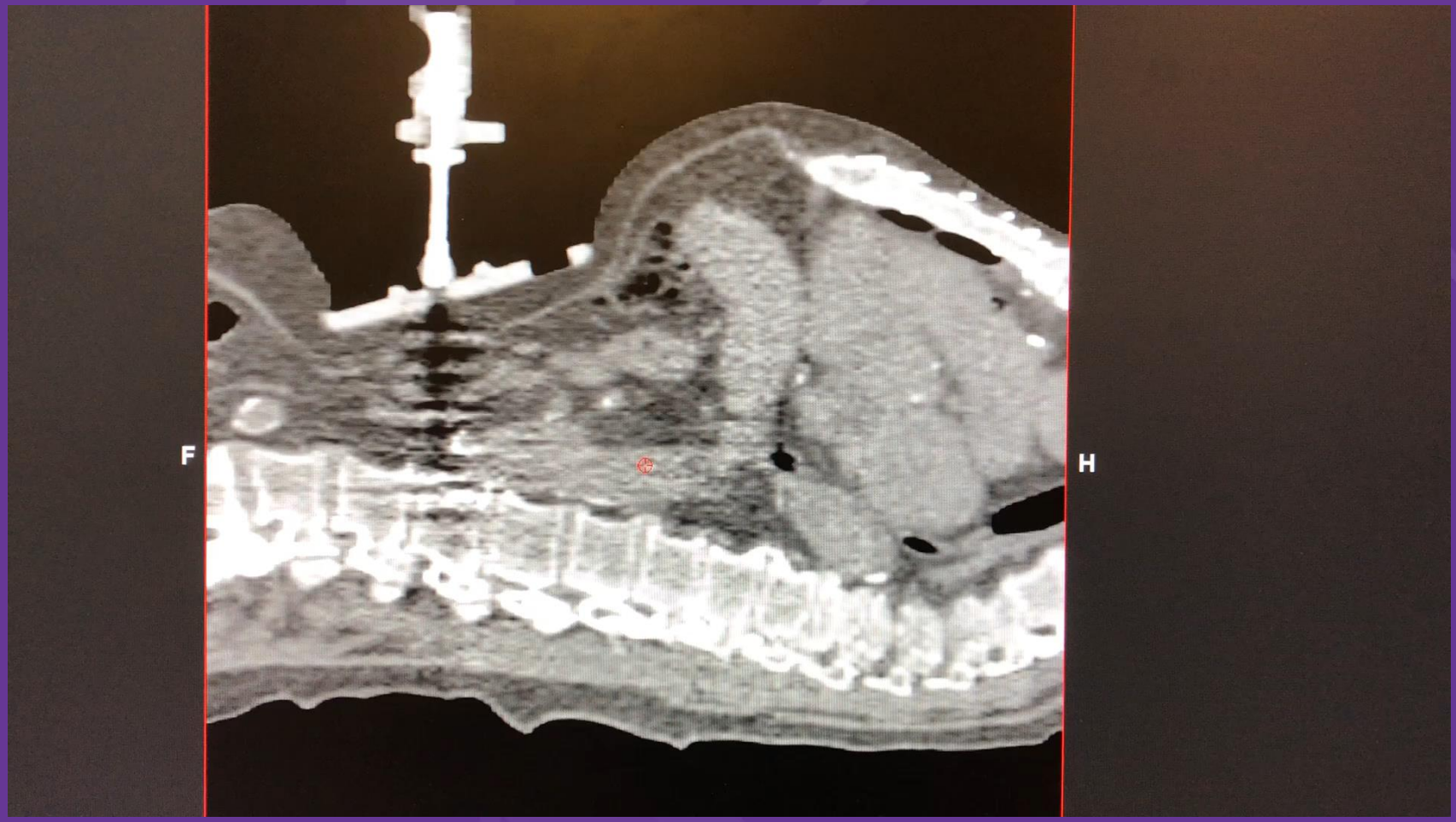


The Reconstruction

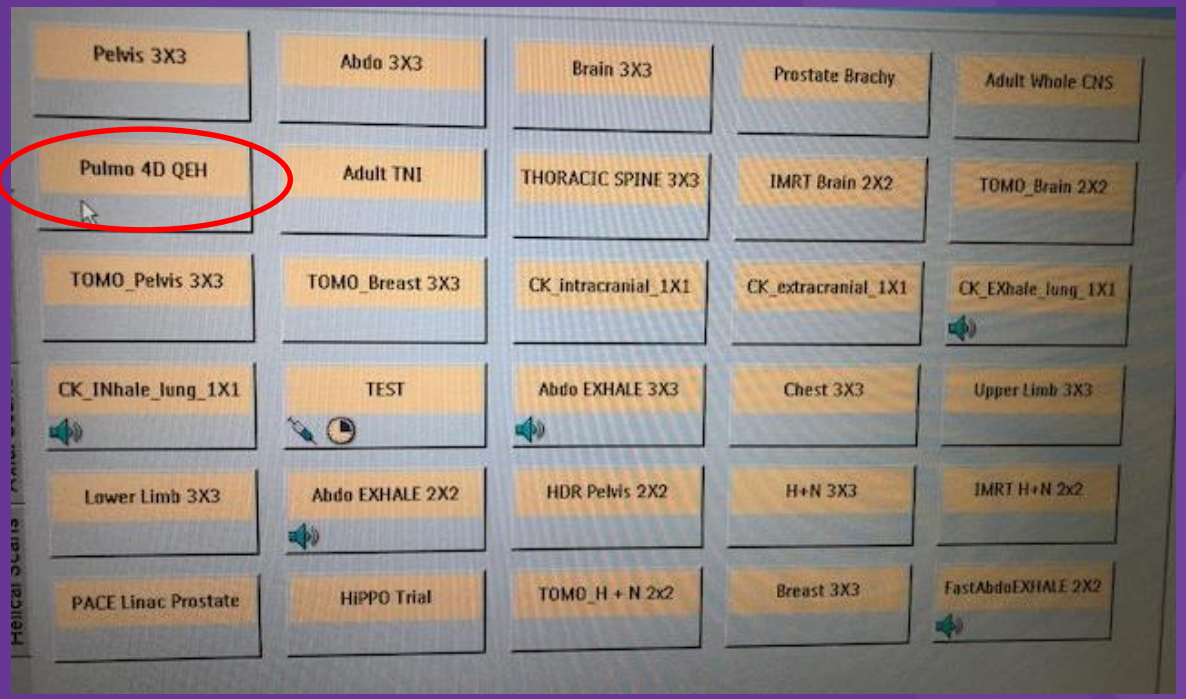
No artefacts visible despite the trace being sub-optimal

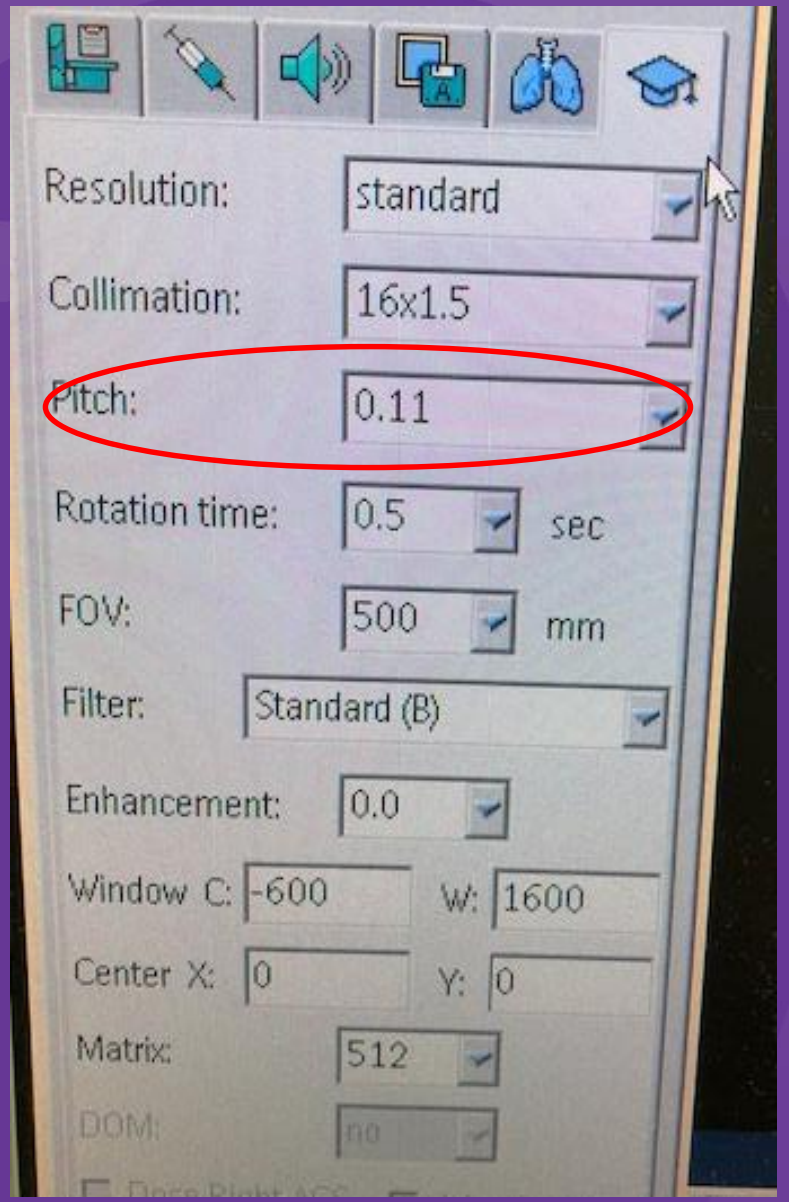
AP View – 4D recon

Lateral Abdo 4D recon



Specifics


Pelvis 3X3
Abdo 3X3
Brain 3X3
Prostate Brachy
Adult Whole CNS
Pulmo 4D QEH
Adult TNI
THORACIC SPINE 3X3
IMRT Brain 2X2
TOMO_Brain 2X2
TOMO_Pelvis 3X3
TOMO_Breast 3X3
CK_intracranial_1X1
CK_extracranial_1X1
CK_EXhale_lung_1X1
CK_INhale_lung_1X1
TEST
Abdo EXHALE 3X3
Chest 3X3
Upper Limb 3X3
Lower Limb 3X3
Abdo EXHALE 2X2
HDR Pelvis 2X2
H+N 3X3
IMRT H+N 2x2
PACE Linac Prostate
HiPPO Trial
TOMO_H + N 2x2
Breast 3X3
FastAbdoEXHALE 2X2


Resolution: standard
Collimation: 16x1.5
Pitch: 0.11
Rotation time: 0.5 sec
FOV: 500 mm
Filter: Standard (B)
Enhancement: 0.0
Window C: -600 W: 1600
Center X: 0 Y: 0
Matrix: 512
DOM: no

Why is pitch so important?

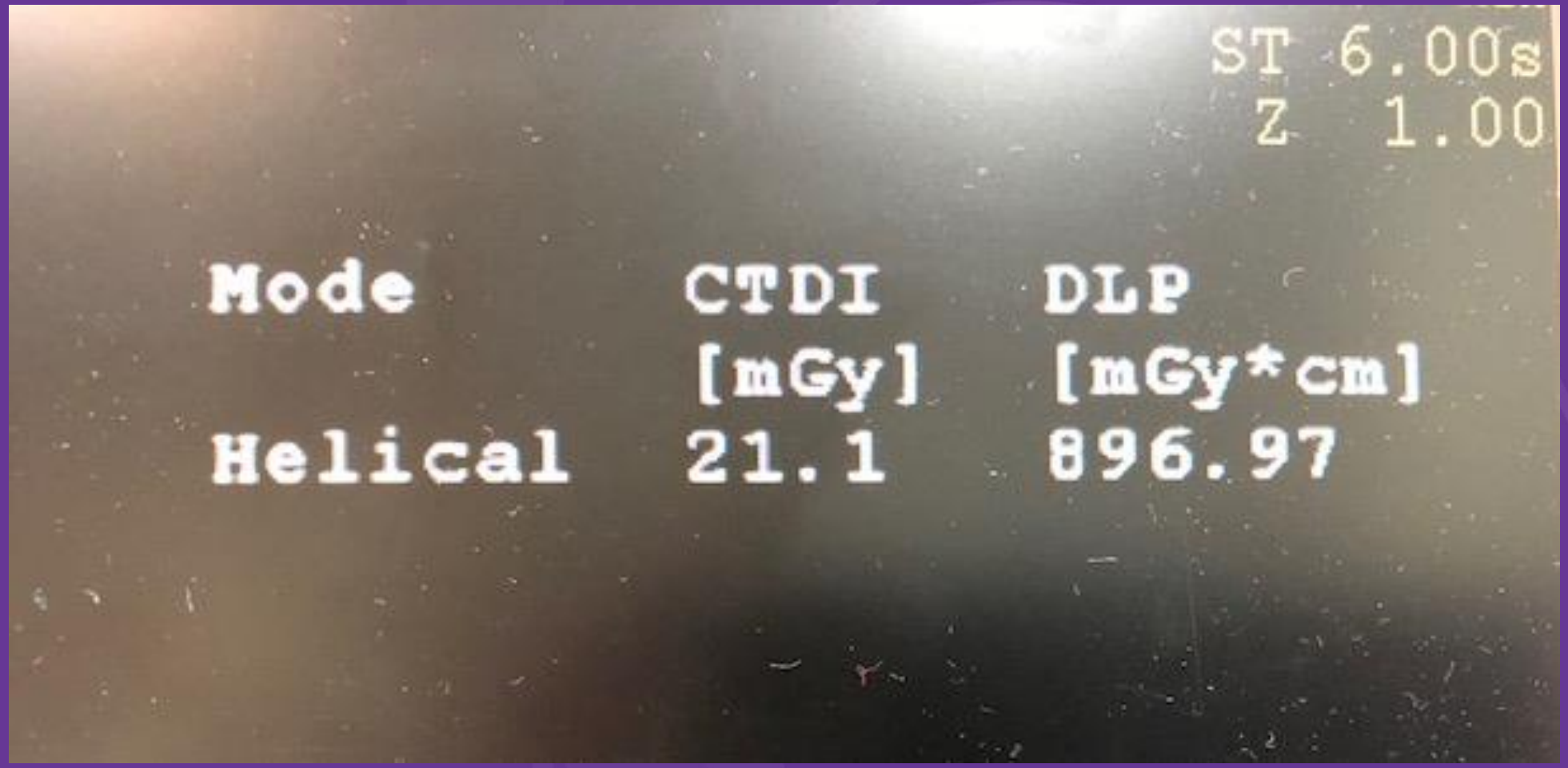
- Speed of couch movement must correlate to the breathing cycle otherwise the scan is pointless

Pitch < BR ….. Smeared images

Pitch > BR ….. Tumour may be captured at arbitrary position

Images are tagged with signals of breathing cycle and sorted to reconstruct into a 4D data set

Dose



Any Questions?

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