CLAIMS

1. A method for imaging of a sample, the method ~~including the steps of:~~
~~1.~~ **being automated and including:**
recording images from at least one projection angle and carrying out image pair cross-correlation analysis encoding velocity data for the sample in terms of Cartesian coordinates~~; and~~
~~2. reconstructing a 2D or 3D velocity field directly from the image pair cross-correlations from the analysis;~~
~~wherein the reconstruction is performed without first reconstructing 2D or 3D images~~ **to measure encoded parameters of:**
**(i) velocity (u, v** and w~~here~~**) aga**in-st~~eps 1 and 2 are automated.~~

~~2. A method for imaging of a sample according to claim 1, wherein step 2 includes:~~
~~2(a) using an iterative method or alternatively a direct method, reconstructing a 3D velocity field directly from the image pair cross-correlations from the analysis; and~~
~~2(b) repeating the iterative method or direct method to produce a 4D velocity field;~~
~~wherein the method includes the further step of using the 4D velocity field to provide further information.~~

~~3. A method for imaging of a sample, according to claim 1 wherein step 1 includes:~~
~~1(a) recording images from multiple projection angles;~~
~~1(b) allocating images into rectangular interrogation windows;~~
~~1(c) deriving velocity components u, v and w in the x, y and z di~~ **time opposite Cartesian co-ordinates (x, y and z), and**
**(ii) a further physical parameter (p) chosen from the group comprising pressure or volume; and**
**reconstructing, without first** ~~rections from the images; and~~
~~1(d) carrying out cross-correlation analysis on image pairs defined by the interrogation windows.~~

~~4. A method for imaging of a sample according to any one of claims 1 to 3 wherein step 1 includes:~~
~~1(a) recording images from at least one projection angle and carrying out image pair cross-correlation analysis to measure encoded parameters of;~~
~~(i) velocity (u, v and w) against time opposite Cartesian co-ordinates (x, y and z),~~
~~(ii) a further physical parameter (p) chosen from the group comprising pressure or volume;~~
~~and step 2~~**reconstructing 2D or 3D images, a 2D or 3D velocity field directly from the image pair cross-correlations from the analysis, the reconstructing** includ~~es~~**ing**:
~~2~~(a) integrating the measurements to provide a single 3D velocity field; and
~~2~~(b) describing regional compliance in terms of derivatives defined by (δu/δx+δv/δy+δw/δz) /δp.

~~5~~**2**. A method for imaging of a sample ~~according to any one of claims 1 to 3 wherein step 1 includes:~~
~~1(a)~~ **, the method being automated and including:**
recording images from at least one projection angle and carrying out image pair cross-

correlation analysis **encoding velocity data for the sample in terms of Cartesian coordinates** to measure encoded parameters of~~:~~**:**
(i) motion (u and v) opposite Cartesian co-ordinates (x and y), and
(ii) sample thickness (t), pressure (p) and volume (V);
and ~~**step 2 includes**~~
**reconstructing, without first reconstructing 2D or 3D images, a 2D or 3D velocity field directly from the image pair cross-correlations from the analysis, the reconstructing analysis including**:
~~**2**~~(a) integrating the measurements to provide a single 3D velocity field;
~~**2**~~(b) describing regional compliance in terms of derivatives defined by
(δu/δx+δv/δy+δw/δz)/δp; and
~~**2**~~(c) solving for t, by mathematical comparison of total compliance with the total compliance determined by adding the regional compliances, according to,
t=V/Σ/(δu/δx+δv/δy).

~~**6. A**~~**3. The** method according to ~~**any one of the preceding**~~**claim 1 or** claim~~**s**~~ **2,** which further includes ~~**the steps of:**~~
~~**3(a)**~~ **:**
segmenting an image of the sample; and
~~**3(b)**~~ associating each segment with regions of the 2D or 3D ~~**velocity**~~**data** field.

~~**7. A**~~
**4. The** method according to ~~**any one of the preceding**~~ claim~~**s**~~ **1,** wherein the projection angle covers a range of between 1° and 360°~~**, more preferably between 30° and 180°**~~.

~~**8**~~**5**. ~~**A**~~**The** method according to ~~**any one of the preceding**~~**claim 1 or** claim~~**s**~~ **2,** wherein the sample comprises human or animal tissue and the method is used for measuring motion.

~~**9**~~**6**. ~~**A**~~**The** method according to claim ~~**8**~~**1 or claim 2,** wherein the m~~**otion of tissue is measured.**~~

~~**10. A**~~**ethod is used for measuring the motion of human or animal tissue.**

**7. The** method according to claim ~~**8**~~**1 or claim 2,** wherein the m~~**otion of a fluid is**~~**ethod is used for** measur~~**ed,**~~**ing** the motion ~~**being**~~**of a fluid** chosen from the group comprising air, blood, lymph or combinations thereof.

~~**11**~~**8**. An application **stored on non-transitory medium** adapted to enable imaging, said application comprising a predetermined instruction set adapted to enable a method according to ~~**any one**~~**claim 1** o~~**f**~~**r** claim~~**s 1 to 10.**~~

~~**12. A computer program product comprising a computer usable medium having computer readable program code and computer readable system code embodied on said medium, and**~~ **2.**

**9. A computer readable storage medium for storing in non-transient form** an application to enable image pair cross-correlation analysis and reconstruction of velocity fields according to ~~any one of~~ claim~~s~~ 1 ~~to 10.~~

~~13. An apparatus when used for the method of any one of claims 1 to 10, the~~**or claim 2.**

**10. An** apparatus **when used for the method of any one of claims 1 to 7** comprising:
(i) one or more energy source;
(ii) one or more detectors for recording images created by energy from the one or more energy sources passing through a sample; and
(iii) a sample retainer for locating the sample intermediate the one or more energy sources and the one or more detectors;
wherein ~~in use~~, the sample retainer rotates the sample through multiple energy projection angles**,** and **(1)** at least one image is recorded at each of the projection angles~~.~~

~~14. An apparatus when used for the method of any one of claims 1 to 10, the~~ **and image pair cross-correlation analysis is carried out encoding velocity data for the sample in terms of Cartesian coordinates, and (2) a 2D or 3D velocity field is reconstructed directly from the image pair cross-correlations from the analysis, wherein the reconstruction is performed without first reconstructing 2D or 3D images, (1) and (2) being automated.**

**11. An** apparatus **when used for the method of any one of claims 1 to 7** comprising:
(i) one or more energy source; and
(ii) one or more detectors for recording images created by energy from the one or more energy sources passing through a sample;
wherein ~~in use,~~**,**
**(1a)** a sample is located intermediate the one or more energy sources and the one or more detectors, the sources and detectors being rotated relative to the sample through multiple energy projection angles ~~and~~**,**
**(1b)** at least one image of the sample is recorded at each of the projection angles~~.~~

~~15. An apparatus when used for the method of any one of claims 1 to 10 the~~ **and image pair cross-correlation analysis is carried out encoding velocity data for the sample in terms of Cartesian coordinates, and**
**(2) a 2D or 3D velocity field is reconstructed directly from the image pair cross-correlations from the analysis, the reconstruction being performed without first reconstructing 2D or 3D images, (1) and (2) being automated.**

**12. An** apparatus **when used for the method of any one of claims 1 to 7** comprising:
(i) two or more energy sources having respective projection angles; and
(ii) one or more detectors for recording images created by energy from the energy sources as it passes through a sample;
wherein
**(1)** recordings at each of the projection angles are made simultaneously **and image pair**

**cross-correlation analysis is carried out encoding velocity data for the sample in terms of Cartesian coordinates, and**
**(2) a 2D or 3D velocity field is reconstructed directly from the image pair cross-correlations from the analysis, the reconstruction being performed without first reconstructing 2D or 3D images, (1) and (2) being automated**.

1~~6~~**3**. A computer implemented system ~~**used for control of the apparatus used according to any one of claims 13 to 15.**~~
**used for control of the apparatus used according to any one of claims 10 to 12 comprising:**
**(i) one or more energy source;**
**(ii) one or more detector for recording images created by energy from the one or more energy sources passing through a sample; and**
**(iii) a sample retainer for locating the sample intermediate the one or more energy sources and the one or more detectors;**
**wherein in use the system controls automation of:**
**(1a) rotating the sample retainer and sample through multiple energy projection angles,**
**(1b) recording at least one image at each of the projection angles,**
**(1c) carrying out image pair cross-correlation analysis encoding velocity data for the sample in terms of Cartesian coordinates, and**
**(2) reconstructing a 2D or 3D velocity field directly from the image pair cross-correlations from the analysis, the reconstruction being performed without first reconstructing 2D or 3D images.**

**14. The method according to claim 2, wherein the projection angle covers a range of between 1° and 360°.**

**15. The method according to 4, wherein the projection angle covers a range between 30° and 180°.**

**16. The method according to 14, wherein the projection angle covers a range between 30° and 180°.**

**CLAIMS**

1. A method for imaging of a sample, the method being automated and including:
recording images from at least one projection angle and carrying out image pair cross-correlation analysis encoding velocity data for the sample in terms of Cartesian coordinates to measure encoded parameters of:
(i) velocity (u, v and w) against time opposite Cartesian co-ordinates (x, y and z), and
(ii) a further physical parameter (p) chosen from the group comprising pressure or volume; and
reconstructing, without first reconstructing 2D or 3D images, a 2D or 3D velocity field directly from the image pair cross-correlations from the analysis, the reconstructing including:
(a) integrating the measurements to provide a single 3D velocity field; and
(b) describing regional compliance in terms of derivatives defined by
$(\delta u/\delta x+\delta v/\delta y+\delta w/\delta z)/\delta p$.

2. A method for imaging of a sample, the method being automated and including:
recording images from at least one projection angle and carrying out image pair cross-correlation analysis encoding velocity data for the sample in terms of Cartesian coordinates to measure encoded parameters of:
(i) motion (u and v) opposite Cartesian co-ordinates (x and y), and
(ii) sample thickness (t), pressure (p) and volume (V); and reconstructing, without first reconstructing 2D or 3D images, a 2D or 3D velocity field directly from the image pair cross-correlations from the analysis, the reconstructing analysis including:
(a) integrating the measurements to provide a single 3D velocity field;
(b) describing regional compliance in terms of derivatives defined by
$(\delta u/\delta x+\delta v/\delta y+\delta w/\delta z)/\delta p$; and
(c) solving for t, by mathematical comparison of total compliance with the total compliance determined by adding the regional compliances, according to,
$t=V/\Sigma/(\delta u/\delta x+\delta v/\delta y)$.

3. The method according to claim 1 or claim 2, which further includes:
segmenting an image of the sample; and
associating each segment with regions of the 2D or 3D data field.

4. The method according to claim 1, wherein the projection angle covers a range of between 1° and 360°.

5. The method according to claim 1 or claim 2, wherein the sample comprises human or animal tissue and the method is used for measuring motion.

6. The method according to claim 1 or claim 2, wherein the method is used for measuring the motion of human or animal tissue.

7. The method according to claim 1 or claim 2, wherein the method is used for measuring the motion of a fluid chosen from the group comprising air, blood, lymph or combinations thereof.

8. An application stored on non-transitory medium adapted to enable imaging, said application comprising a predetermined instruction set adapted to enable a method according to claim 1 or claim2.

9. A computer readable storage medium for storing in non-transient form an application to enable image pair cross-correlation analysis and reconstruction of velocity fields according to claim 1 or claim 2.

10. An apparatus when used for the method of any one of claims 1 to 7 comprising:
(i) one or more energy source;
(ii) one or more detectors for recording images created by energy from the one or more energy sources passing through a sample; and
(iii) a sample retainer for locating the sample intermediate the one or more energy sources and the one or more detectors;
wherein, the sample retainer rotates the sample through multiple energy projection angles, and (1) at least one image is recorded at each of the projection angles and image pair cross-correlation analysis is carried out encoding velocity data for the sample in terms of Cartesian coordinates, and (2) a 2D or 3D velocity field is reconstructed directly from the image pair cross-correlations from the analysis, wherein the reconstruction is performed without first reconstructing 2D or 3D images,

(1) and (2) being automated.

11. An apparatus when used for the method of any one of claims 1 to 7 comprising:
(i) one or more energy source; and
(ii) one or more detectors for recording images created by energy from the one or more energy sources passing through a sample;
wherein,
(1a) a sample is located intermediate the one or more energy sources and the one or more detectors, the sources and detectors being rotated relative to the sample through multiple energy projection angles,
(1b) at least one image of the sample is recorded at each of the projection angles and image pair cross-correlation analysis is carried out encoding velocity data for the sample in terms of Cartesian coordinates, and
(2) a 2D or 3D velocity field is reconstructed directly from the image pair cross-correlations from the analysis, the reconstruction being performed without first reconstructing 2D or 3D images, (1) and (2) being automated.

12. An apparatus when used for the method of any one of claims 1 to 7 comprising:
(i) two or more energy sources having respective projection angles; and
(ii) one or more detectors for recording images created by energy from the energy sources as it passes through a sample;
wherein
(1) recordings at each of the projection angles are made simultaneously and image pair cross-correlation analysis is carried out encoding velocity data for the sample in terms of Cartesian coordinates, and
(2) a 2D or 3D velocity field is reconstructed directly from the image pair cross-correlations from the analysis, the reconstruction being performed without first reconstructing 2D or 3D images, (1) and (2) being automated.

13. A computer implemented system used for control of the apparatus used according to any one of claims 10 to 12, comprising:
(i) one or more energy source;
(ii) one or more detector for recording images created by energy from the one or more energy sources passing through a sample; and

(iii) a sample retainer for locating the sample intermediate the one or more energy sources and the one or more detectors;
wherein in use the system controls automation of:
(1a) rotating the sample retainer and sample through multiple energy projection angles,
(1b) recording at least one image at each of the projection angles,
(1c) carrying out image pair cross-correlation analysis encoding velocity data for the sample in terms of Cartesian coordinates, and
(2) reconstructing a 2D or 3D velocity field directly from the image pair cross-correlations from the analysis, the reconstruction being performed without first reconstructing 2D or 3D images.

14. The method according to claim 2, wherein the projection angle covers a range of between 1° and 360°.

15. The method according to 4, wherein the projection angle covers a range between 30° and 180°.

16. The method according to 14, wherein the projection angle covers a range between 30° and 180°.