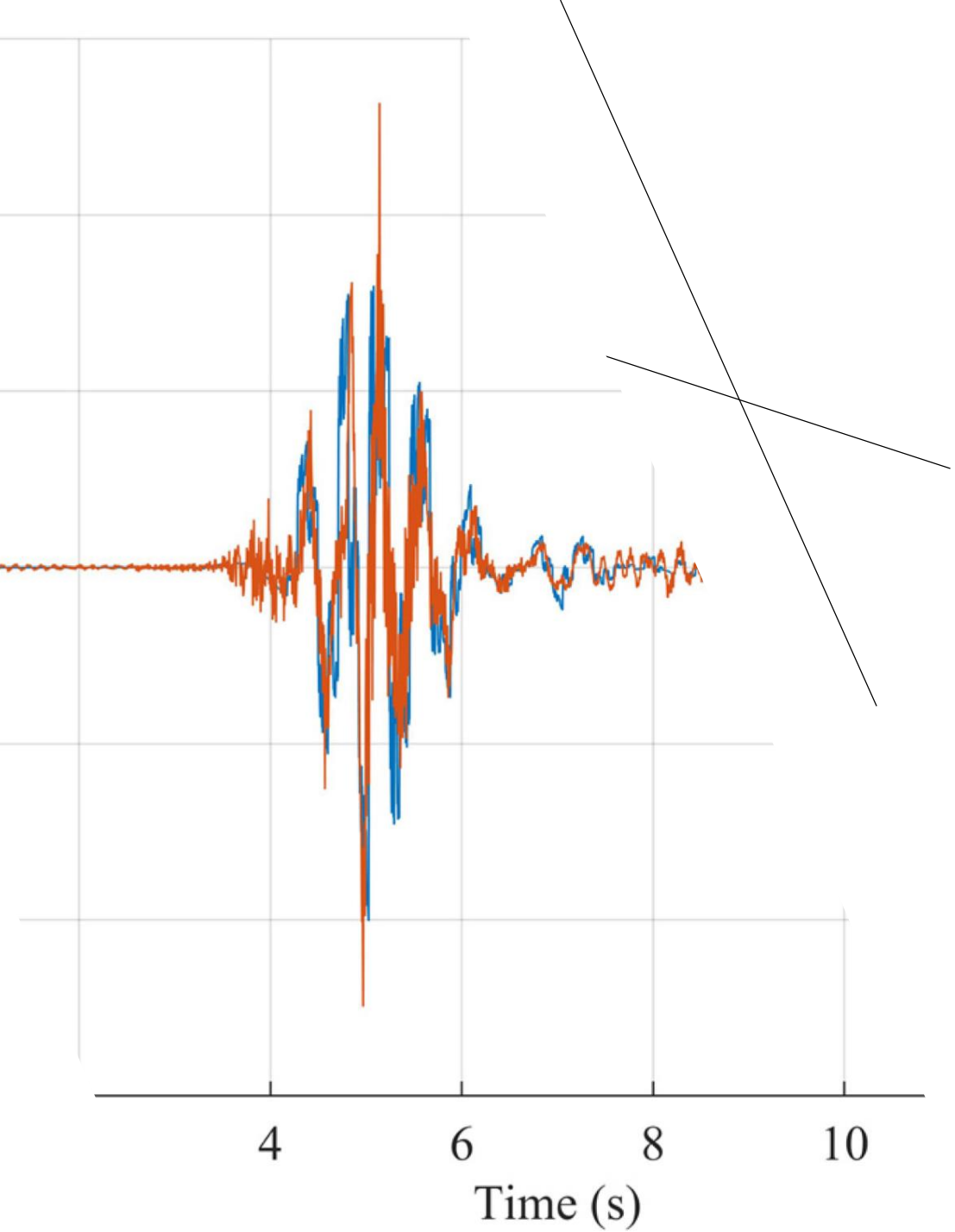
TRACKING MOVING TARGETS FROM VIDEO IMAGES

Dr. Eleftherios Tournas
GEOVISION IKE



PROBLEM DESCRIPTION

The determination of 3D trajectories of moving objects under seismic action is always a challenging task. Several methods, using both contact and non-contact sensors have been proposed, but for large scale objects composed of many blocks, vision-based systems are of grate potential. Since the objects to be modelled are moving quickly, video image sequencies acquired from high-speed cameras are used.

VIDEOGRAMMETRY

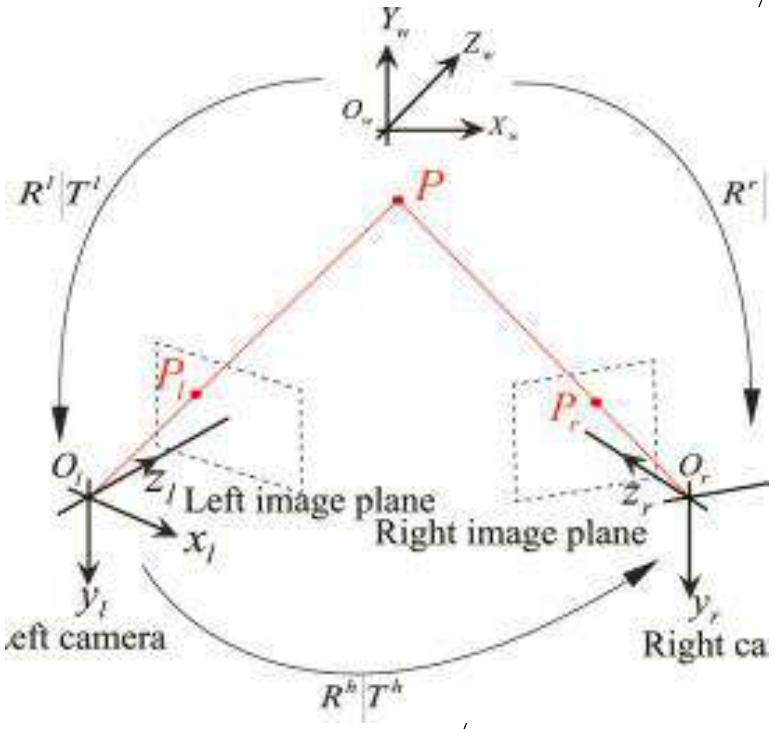
Videogrammetry is a measurement technology in which the 3D coordinates of points on an object are determined by measurements made in two or more video images taken from different sensors and different angles. Accurate synchronization to ensure that a distinct model is generated at each frame epoch is very important.

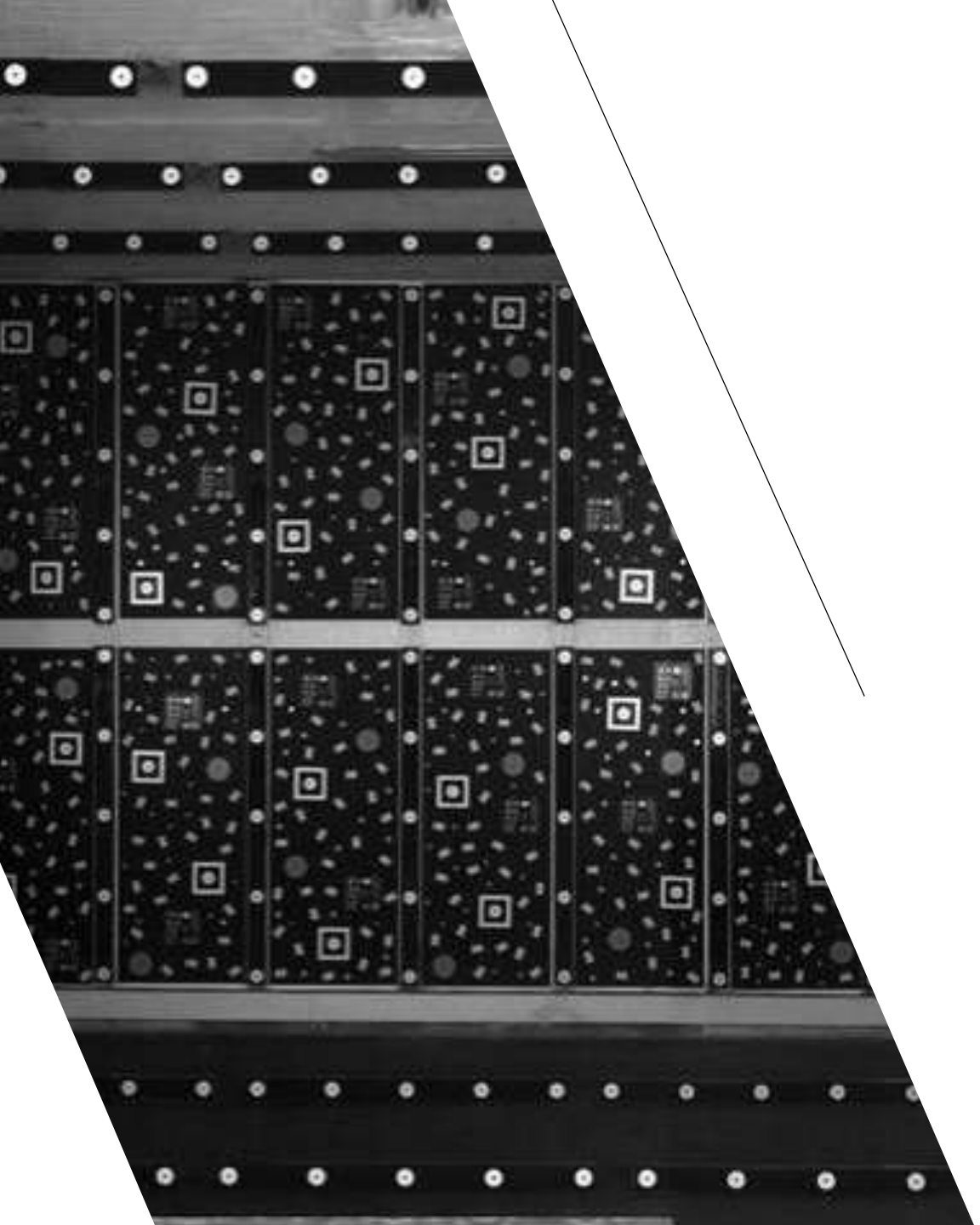
SYSTEM COMPONENTS

- 2 or more high speed video cameras
- computer hardware for camera synchronization and data storage
- software for stereoscopic acquisition, system calibration and image processing

PHOTOGRAMMETRIC SOLUTION

- a video frame maps a 3D object space XYZ to its corresponding 2D image space xy (projective transformation)
- the inverse transformation from image space to object space is mathematically ill conditioned
- the problem is solved by adding an extra camera station: 4 image coordinates are used to compute 3 object coordinates in 3D space with one degree of freedom
- image coordinate observations must be one on simultaneous views of the object
- the solution is widely known as “two-camera triangulation”





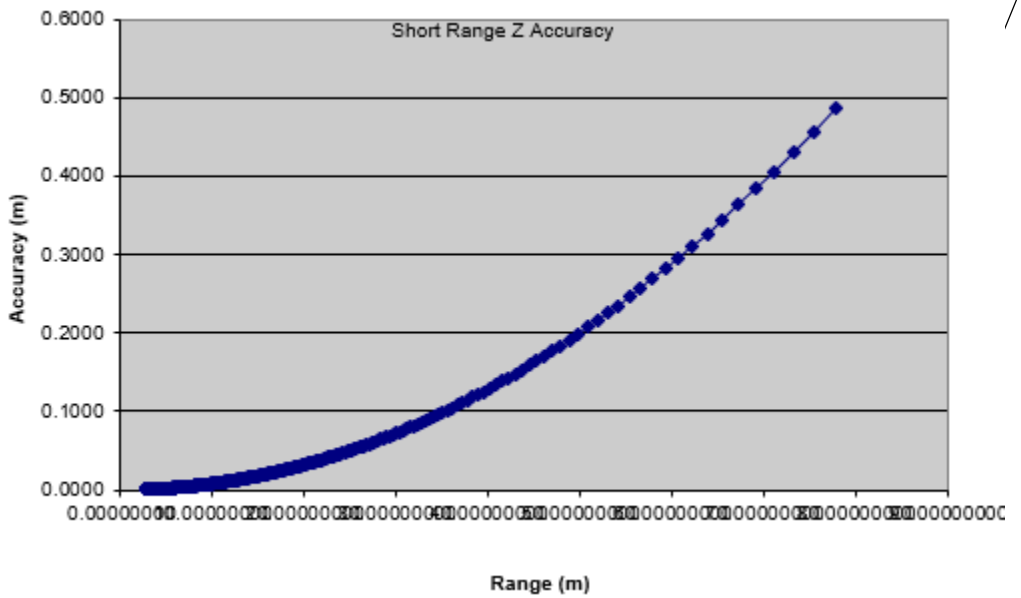
SYSTEM CALIBRATION

- rigorous system calibration is essential to get accurate results
- calibration parameters include camera position, orientation and distortion parameters
- several photogrammetric techniques may be employed
- a test field with several signalized control points is needed
- signalized control points are automatically detected on numerous image frames to estimate the unknown calibration parameters

ACCURACY

The obtained accuracy depends on:

- distance from the object
- image quality and resolution
- distance between cameras (base line)
- calibration accuracy
- camera synchronization
- Accuracy and repeatability of the image coordinate measurements



IAMON CONFIGURATION

- 4 cameras (FLIR Blackfly S USB3)
  - Grayscale (CMOS)
  - 5MP (2448x2024 pixels)
  - 64 fps
  - global shutter
- 4 high resolution lenses (Tamron 8mm 1/1.8” C mount)
- 2 USB 3.1 Host Controllers
- 2 camera synchronization cables
- 2 PCs for camera control and data acquisition

EXPERIMENTAL SETUP

- 2 stereo rings were formed to synchronously monitoring 2 faces of the object
- 0.8 m distance between cameras
- 6.5 m distance from the object
- 0.003 m expected accuracy in X,Y direction
- 0.007 m expected accuracy in Z direction

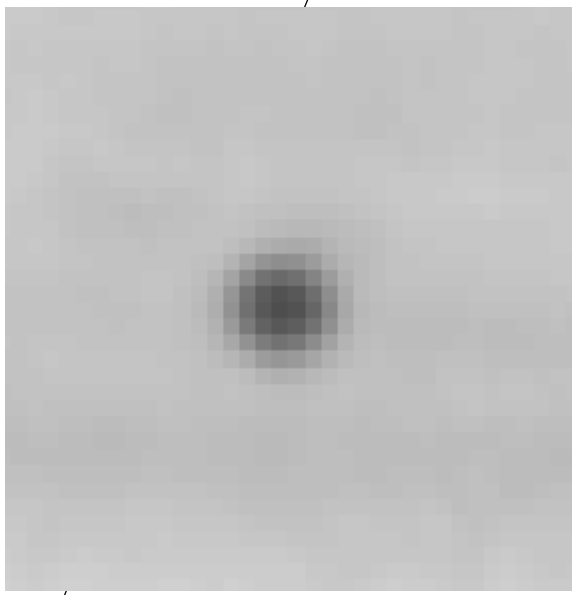
SYSTEM CALIBRATION

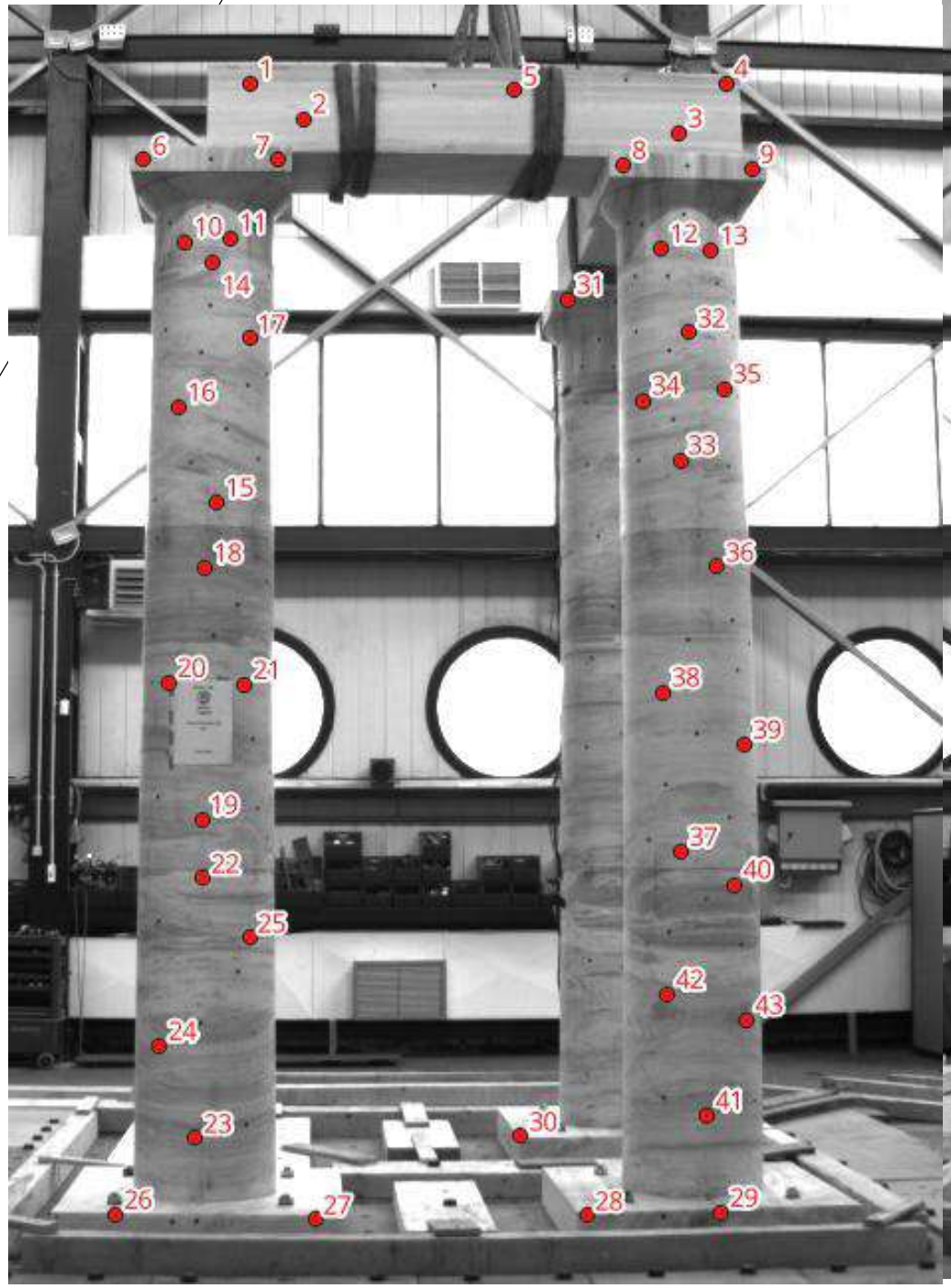
- 30-35 control points
- specimen corners with known object coordinates were use as control points
- the Root Mean Square Error (RMSE) in X,YZ direction was in the order of 0.005 m

Markers	Easting (m)	Northing (m)	Altitude (m)	Accuracy (m)	Error (m)
18	0.800000	3.820000	9.800000	**0.001/0.002**	0.007480
19	2.000000	3.820000	9.800000	**0.001/0.002**	0.006394
20	2.600000	3.820000	9.800000	**0.001/0.002**	0.007055
23	2.000000	3.740000	9.200000	**0.001/0.002**	0.006067
29	2.000000	3.740000	8.000000	**0.001/0.002**	0.003426
33	2.000000	3.820000	8.000000	**0.001/0.002**	0.004284
Total Error					
Control points					0.004503

TRACKING OF MOVING TARGETS

- numerous signalized targets are placed on the objects surface
- black spots of 8-12mm diameter are used
- image processing algorithms for noise reduction are applied to the images before target identification
- initial target positions are determined by cross-correlation
- targets are automatically transferred to the upcoming video frames by implementing an optical-flow technique (LUCAS-KANADE method)
- object coordinates for each target are estimated by two-camera triangulation





AutoSave Off

File Home Insert Page Layout Form

Paste Clipboard Aptos Narrow 11 B I U Font

A1 time

	A	B	C	D
1	time	x1	y1	z1
2	0	-0.23689	4.10957	2.15741
3	0.015568	-0.23397	4.10872	2.15727
4	0.031137	-0.23498	4.10871	2.15727
5	0.046705	-0.23654	4.1097	2.15741
6	0.062273	-0.23672	4.10968	2.15745
7	0.077841	-0.23737	4.11	2.15732
8	0.09341	-0.23795	4.11035	2.1572
9	0.108978	-0.23543	4.10897	2.15724
10	0.124546	-0.23281	4.10798	2.1569
11	0.140114	-0.23889	4.11032	2.15745
12	0.155683	-0.2399	4.11094	2.15752
13	0.171251	-0.23806	4.11002	2.15735
14	0.186819	-0.23918	4.1107	2.15749
15	0.202388	-0.23762	4.11006	2.15735
16	0.217956	-0.23594	4.10939	2.15735
17	0.233524	-0.24043	4.11143	2.15759
18	0.249092	-0.23623	4.10923	2.15732
19	0.264661	-0.2365	4.10937	2.15731
20	0.280229	-0.23788	4.10966	2.15755
21	0.295797	-0.23996	4.1109	2.15765
22	0.311365	-0.23689	4.10969	2.15737
23	0.326934	-0.23859	4.11048	2.1572

conbeams1_points_2

Ready Accessibility: Unavailable

FUTURE OUTLOOK

- proper synchronization between the seismic table and the cameras should be implemented by external triggering
- cameras may be placed closest to the object to increase the system accuracy
- the possibility to place the cameras on the seismic table to compensate for table movements may be also investigated

THANK YOU

Dr. Eleftherios Tournas

+30 6977 471980

ltournas@geovision.gr

www.geovision.gr