High speed Imaging
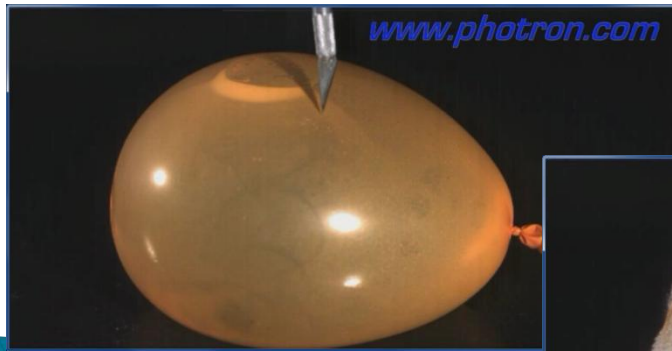
André Damas Mora
FCT-UNL
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Application Areas

- Industry
  - Fault Detection
  - Processes Optimization
- Sports
  - Training and analysis
  - Biomechanics
  - Therapy
  - Lesion prevention
- Military
  - Ballistics
  - Equipment Optimization
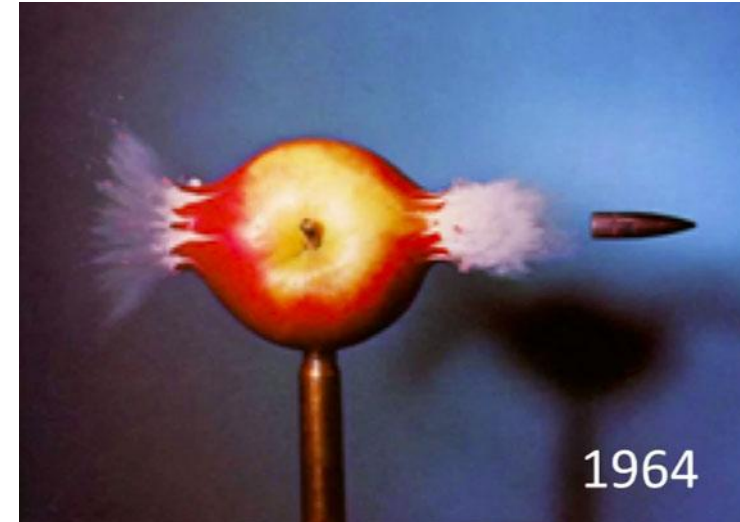- Vehicles
  - Crash Tests
  - Dynamic analysis

Image acquisition rates?

▶ 250 fps – 250,000fps – 25 Million fps

▶ The shutter speed is a very important factor

▶ The speed is usually inversely proportional to the image resolution

Example Photron catalogue – (2025)

	Pharsighted E9-150S	FASTCAM NOVA S16	FASTCAM NOVA R5-4K
Maximum Image resolution [pixels]	640x480	1024x 1024	4096 x 2304
Maximum Frame Rate at Full Resolution [fps]	489.000	16.000	1.250
Maximum Frame Rate at reduce image Resolution [fps]	2.720.000 (640 x 48 px)	1.100.000 (128 x 16 px)	200.000
Price (USA)	?	$70,000 – $100,000	?

Example – Pharsighted – E9

Resolution	E9·150S*			E9·100S**			E9·80S**			E9·50S***		
Width x Height (pixels)	Max Frame Rate (fps)	Record Time 162GB	Frames 162GB	Max Frame Rate (fps)	Record Time 108GB	Frames 108GB	Max Frame Rate (fps)	Record Time 108GB	Frames 108GB	Max Frame Rate (fps)	Record Time 54GB	Frames 54GB
640 x 480	489,000	1.15 sec	562,000	326,000	1.15 sec	375,000	272,000	1.38 sec	375,000	164,000	1.14 sec	187,000
640 x 384	601,000	1.17 sec	705,000	404,000	1.16 sec	469,000	336,000	1.39 sec	469,000	203,000	1.15 sec	234,000
640 x 320	710,000	1.18 sec	842,000	481,000	1.17 sec	562,000	400,000	1.41 sec	562,000	242,000	1.16 sec	281,000
640 x 240	918,000	1.22 sec	1,125,000	629,000	1.19 sec	751,000	523,000	1.44 sec	751,000	318,000	1.18 sec	374,000
640 x 160	1,299,000	1.29 sec	1,674,000	910,000	1.23 sec	1,124,000	755,000	1.49 sec	1,124,000	462,000	1.21 sec	560,000
640 x 128	1,557,000	1.34 sec	2,093,000	1,108,000	1.27 sec	1,408,000	918,000	1.53 sec	1,408,000	565,000	1.24 sec	702,000
640 x 64	2,582,000	1.62 sec	4,186,000	1,961,000	1.42 sec	2,788,000	1,619,000	1.72 sec	2,788,000	1,014,000	1.38 sec	1,405,000
640 x 48	2,720,000	2.05 sec	5,582,000	2,428,000	1.53 sec	3,718,000	2,000,000	1.86 sec	3,718,000	1,267,000	1.46 sec	1,854,000
640 x 32	2,720,000	2.90 sec	7,880,000	2,720,000	2.05 sec	5,577,000	2,457,000	2.27 sec	5,577,000	1,685,000	1.65 sec	2,781,000
640 x 16	2,720,000	5.47 sec	14,886,000	2,720,000	4.10 sec	11,154,000	2,457,000	4.54 sec	11,154,000	1,980,000	2.81 sec	5,562,000

How to choose the camera

- Parameters you should consider:
  - Frame Rate
  - Image Resolution
  - Exposure Time (Shutter speed)
  - Sensitivity
  - Bit depth (dynamic range)
  - Color or Monochrome
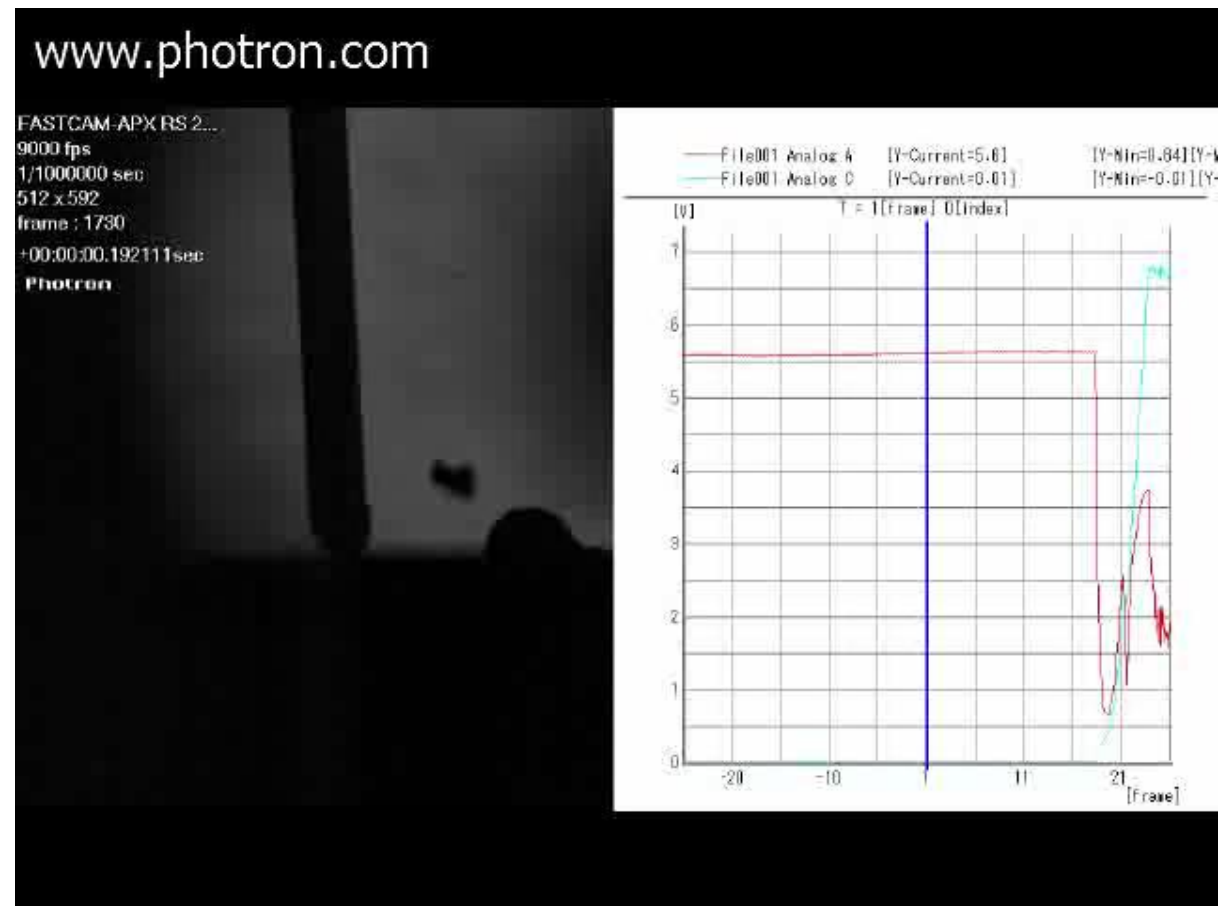 - Camera interface
  - Physical size
  - Storage capacity

- Application issues you need to address:
  - Sufficient time resolution – being able to see the event happen
  - Motion blur – being able to freeze the event
  - Light levels – having the right illumination source and camera sensitivity
  - Location – portability, communication cable lengths
  - Lens type – image coverage of sensor
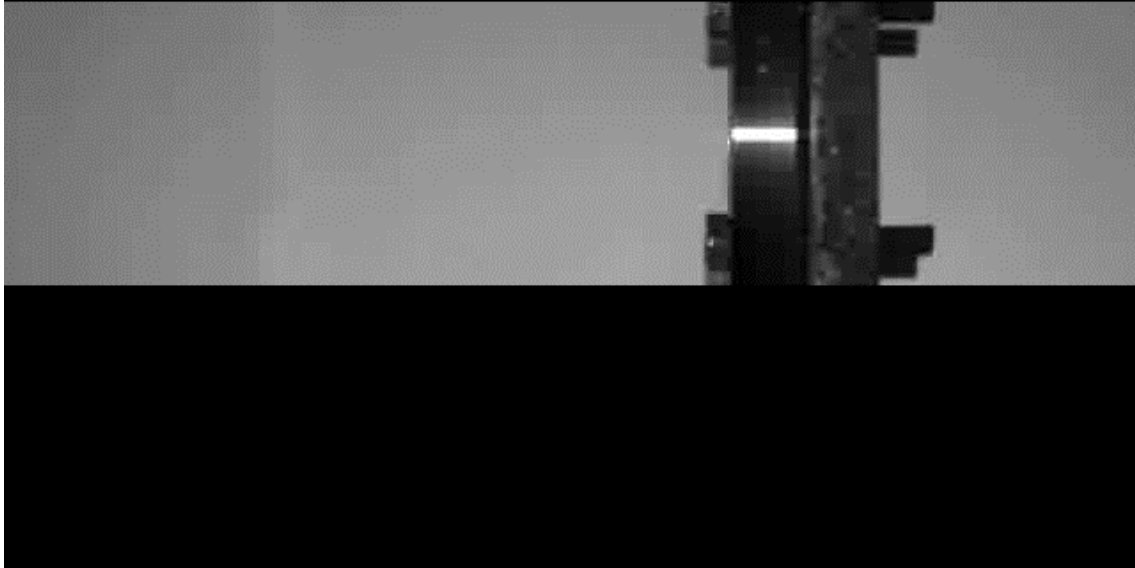 - Budget – Compromise but at what cost?

DEMOs

▶ http://www.photron.com

Bubble & Welding (9000fps)

Ballistics & Safety

www.photron.com

50.000fps

www.photron.com

Sports

Nuno Pombo – FCT/UNL student at
2008 Pequim Olympics

Trilions of fps – capturing light