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Automated Ultrasound QC methods

Sander Dekker

Literature overview

- 9 studies to date – 7 published
- Total of 1647 transducers tested
- 5 countries
- Average of 26.7% transducers with defect(s)

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Literature review

- Users do not notice defects [5,6]
- Regular QA reduces number of defective transducers [6]
- No significant difference between manufacturers [5]
- Uniformity issues are the most prevalent in 6 out of 9 studies (2 studies solely focussed on this type of defect)[2, 3, 4, 6, 7]
- Geometric accuracy measurements are not effective [1, 3]

1: ECR 2010 / C2986
2: European Journal of Radiology, Volume 80, Issue 2, Pages 519–525
3: Ultrasound in Medicine & Biology, Volume 37, Issue 8, August 2011, Pages 1350-1357
4: Ultrasound in Medicine & Biology, Volume 43, Issue 9, September 2017, Pages 1930-1937
5: European Journal of Echocardiography, Volume 11, Issue 9, pages 801-805
6: ECR 2015 / C-2303
7: Ultrasound, Volume 24, Issue 4, pages 190–197

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International standards

- Element dropout and SNR

  IEC TS 62736:2016

- Distance accuracy and resolution

  IEC 61391-1:2006/AMD1:2017

- Penetration Depth and Contrast

  IEC 61391-2:2010

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Existing national guideline

ACR Ultrasound accreditation (USA, 2014)

- Annual testing (required):
  - Physical and mechinical inspection
  - Uniformity
  - SNR
  - Display performance
- Annual testing (optional):
  - Distance accuracy
  - Contrast
  - Resolution
  - Reading room display performance
- Semi-annual testing (optional):
  - Physical and mechinical inspection
  - Uniformity
  - Display performance
  - Distance accuracy
  - Reading room display performance

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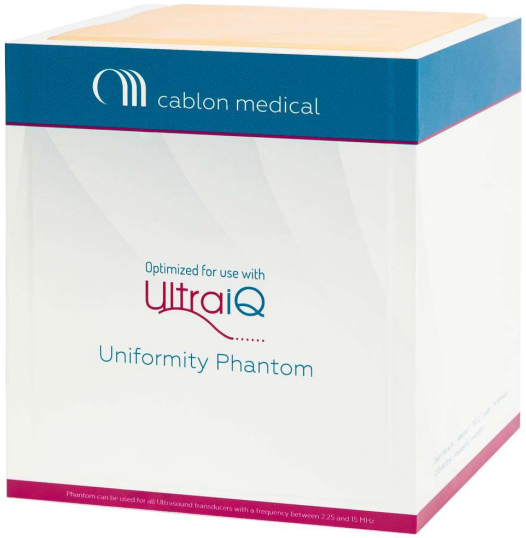
Signal to noise ratio

- Goal: find maximum depth of visualization
- Method: plot signal and noise levels vs depth
- Status test

IEC TS 62736:2016



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Signal to noise ratio

- Signal levels vs depth:
  - Measured on a uniform phantom
  - Largely depend on frequency of emitted ultrasound
  - Higher frequency = lower penetration depth
  - Signal levels decrease with depth
- Noise levels vs depth:
  - Measured by holding the transducer in air
  - Largely depends on system noise
  - Noise increases with depth

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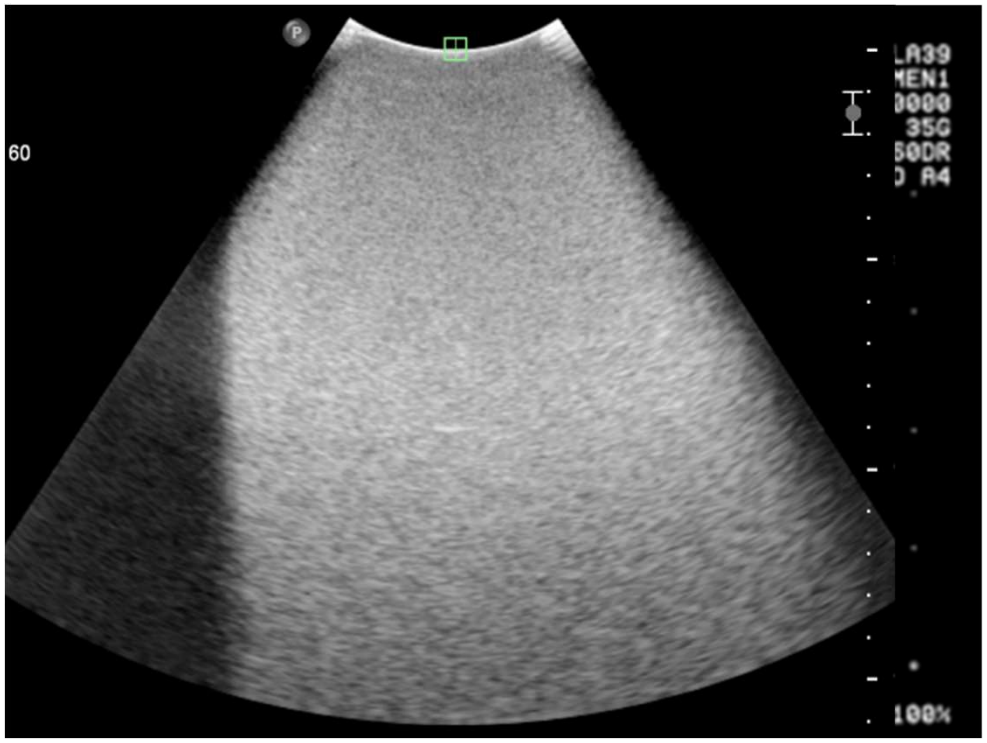
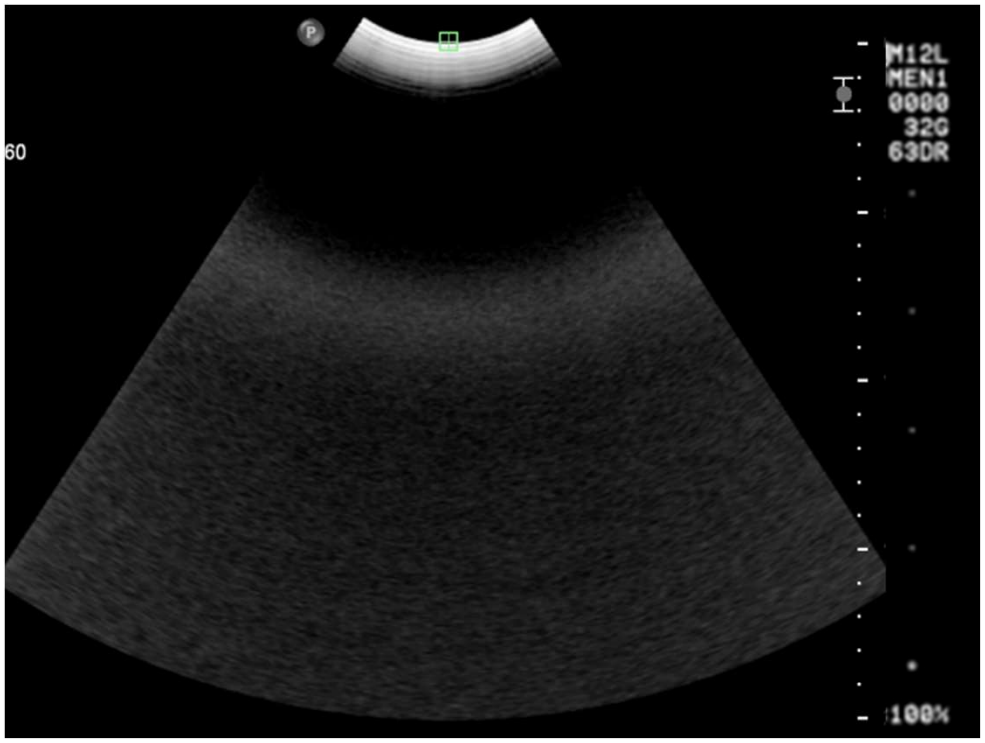
Signal to noise ratio



Phantom image (signal + noise)



In-air image (noise only)

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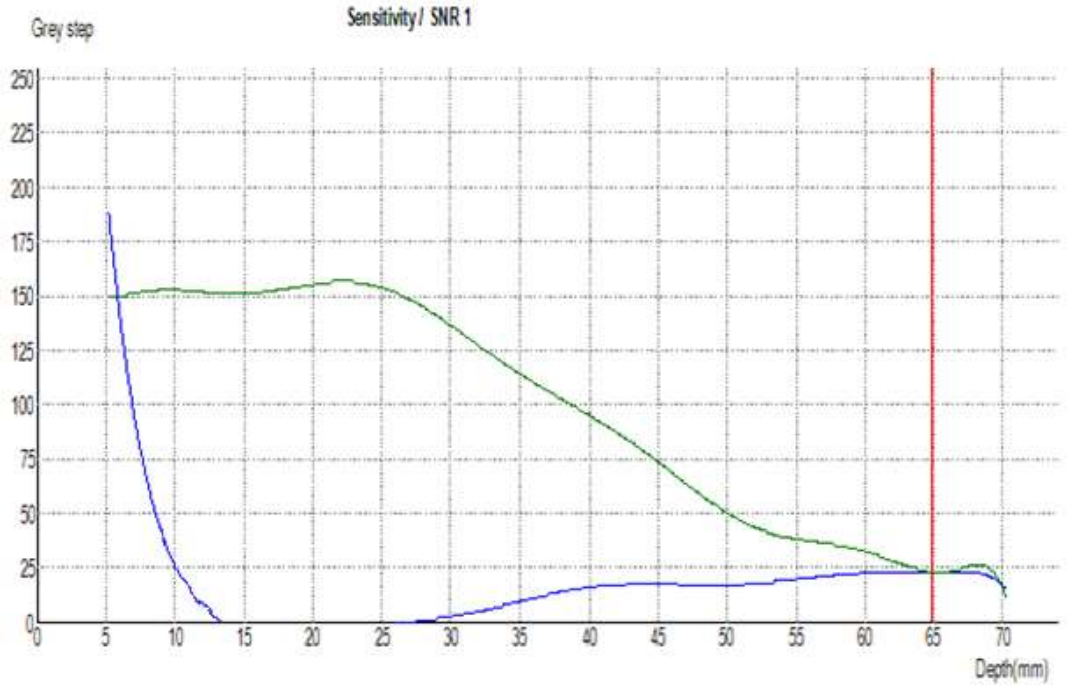
Signal to noise ratio

- Depth where signal and noise lines cross = maximum depth of visualization
- SNR=1 at this depth



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Practical QA with UltraiQ

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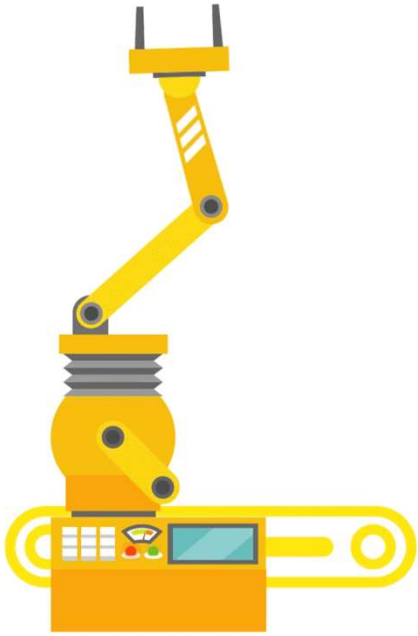
Workflow

- Scan phantoms
- Transfer images (PACS, USB)
- Analyze images
- View report

- On average, full image QC test takes 2 minutes per probe



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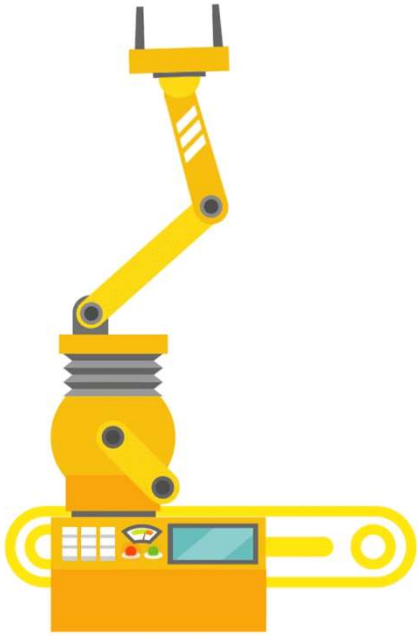
Organizing the QA process

- Lots of probes (3-5 per scanner)
- Lots of measurement results
- How do we organize the results?



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iQMonitor

- A part of the UltraiQ application
- Website that runs within hospital network
- Stores all Ultrasound QA results

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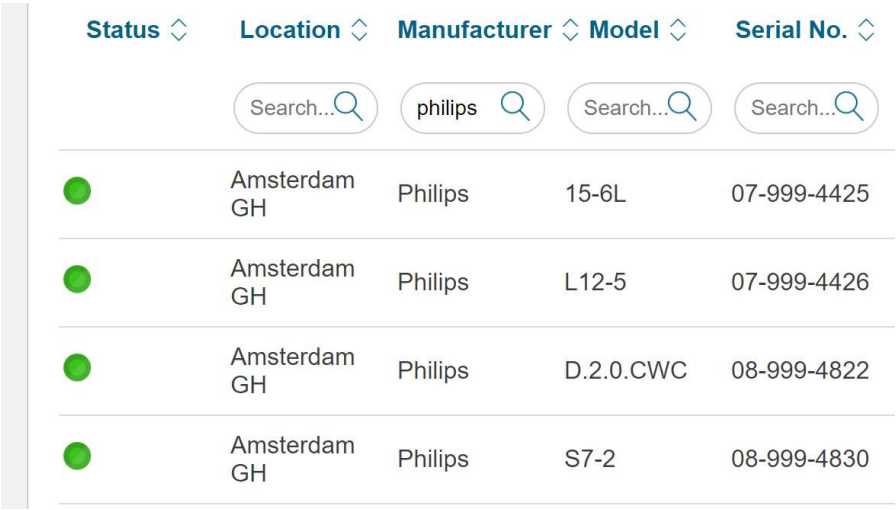
iQMonitor

- User-defined tolerance values
  - Advisory thershold values available in literature
- Traffic lights

To iQMonitor



Status	Location	Manufacturer	Model	Serial No.
	Search...	philips	Search...	Search...
	Amsterdam GH	Philips	15-6L	07-999-4425
	Amsterdam GH	Philips	L12-5	07-999-4426
	Amsterdam GH	Philips	D.2.0.CWC	08-999-4822
	Amsterdam GH	Philips	S7-2	08-999-4830

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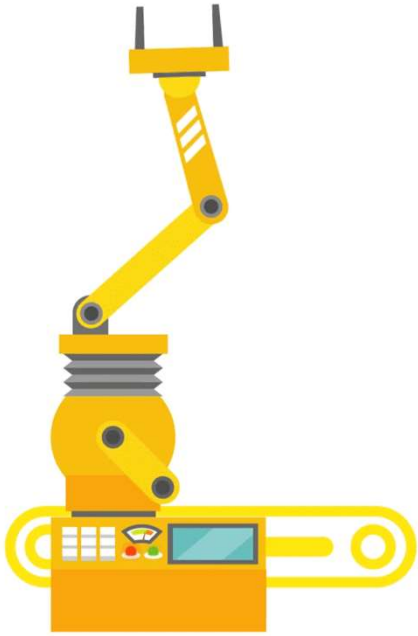
General description UltraiQ concept

- Short downtime of transducers
- Compliance with all (inter)national standards
- Any B-mode ultrasound transducer
- Manufacturer independent
- Portable solution



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UltraiQ Phantoms

Set of 2 phantoms

- Uniformity phantom
- General purpose phantom

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UltraiQ General Purpose Phantom

Unique features

- Frequency range 2-15 MHz
- 10+ years expected lifetime
- No calibration necessary
- Flat surface for easy use with all probes

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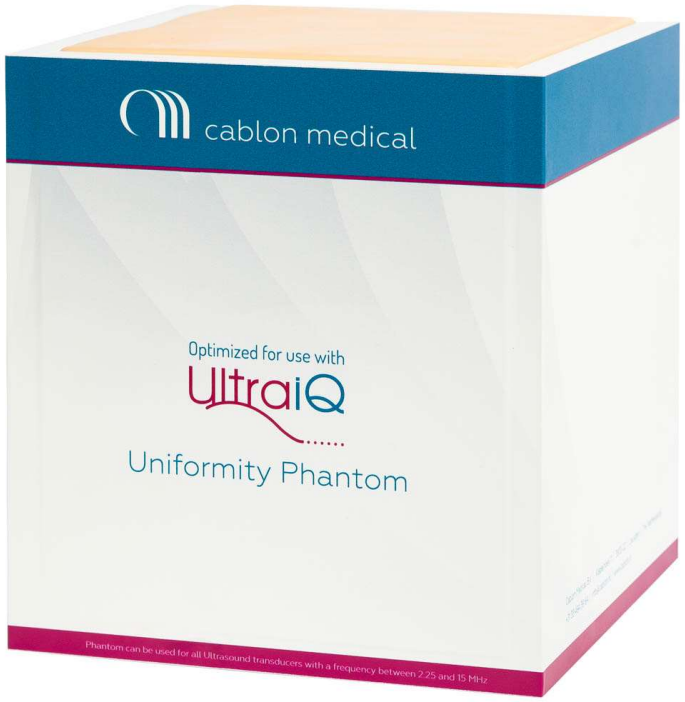
UltraiQ Uniformity Phantom

Unique features

- Frequency range 2-15 MHz
- 10+ years expected lifetime
- No calibration necessary
- Soft surface for easy coupling with any type of transducer



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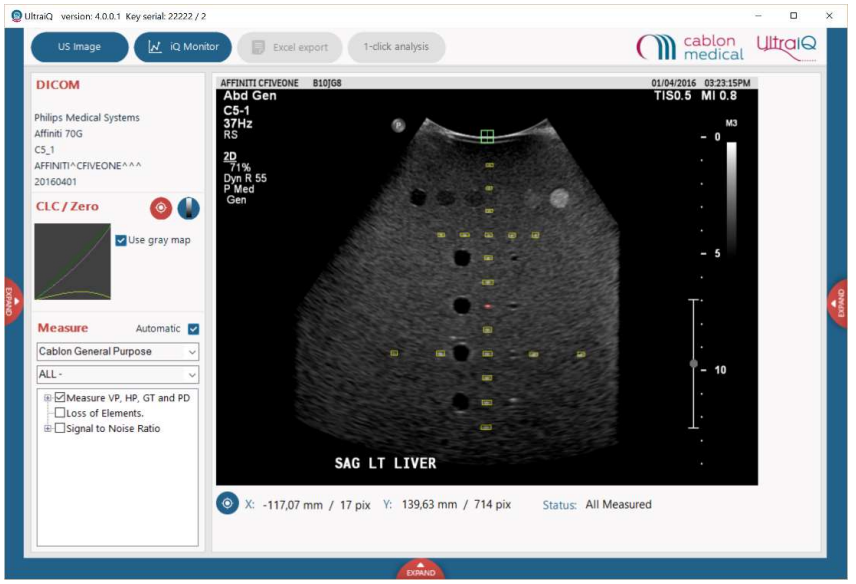
Software

- Easy to use
- Any Windows PC
- Database for measurement results



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Other ways CQ can help in daily routine

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How can CQ help in daily routine

Use case 1 – discussions with end users

End user vs. biomedical department

Complaints about image quality

UltraiQ gives objective results

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How can CQ help in daily routine

Use case 2 – verify repairs

Defective probe sent to service company for repairs

Upon return, probe test with UltraiQ

Verify whether the repair has done good, bad or nothing at all…

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How can CQ help in daily routine

Use case 3 – acceptance testing

New equipment of manufacturer X delivered on radiology dept.

5 identical machines with transducers

Tested with UltraiQ for acceptance

One outlier

Outlier was replaced

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Thank you!

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