Quality control of computed tomography by automated monitoring of key performance indicators

CT USERS GROUP 14th MEETING

Edinburgh, October 2012

Patrik Nowik, Robert Bujila, Henrik Andersson, Cathrine Jonsson

Department of Medical Physics, Section for X-ray Physics

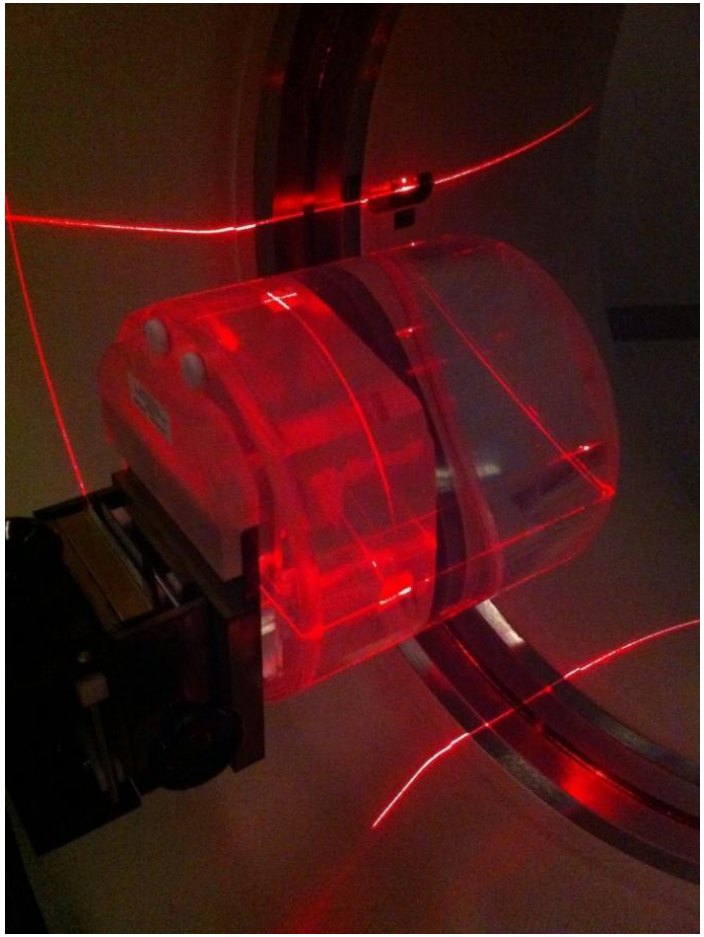
KAROLINSKA University Hospital

Current quality assurance at Karolinska University Hospital

- Commissioning
- Acceptance
- Routine quality controls
  - Annual quality controls – No trends

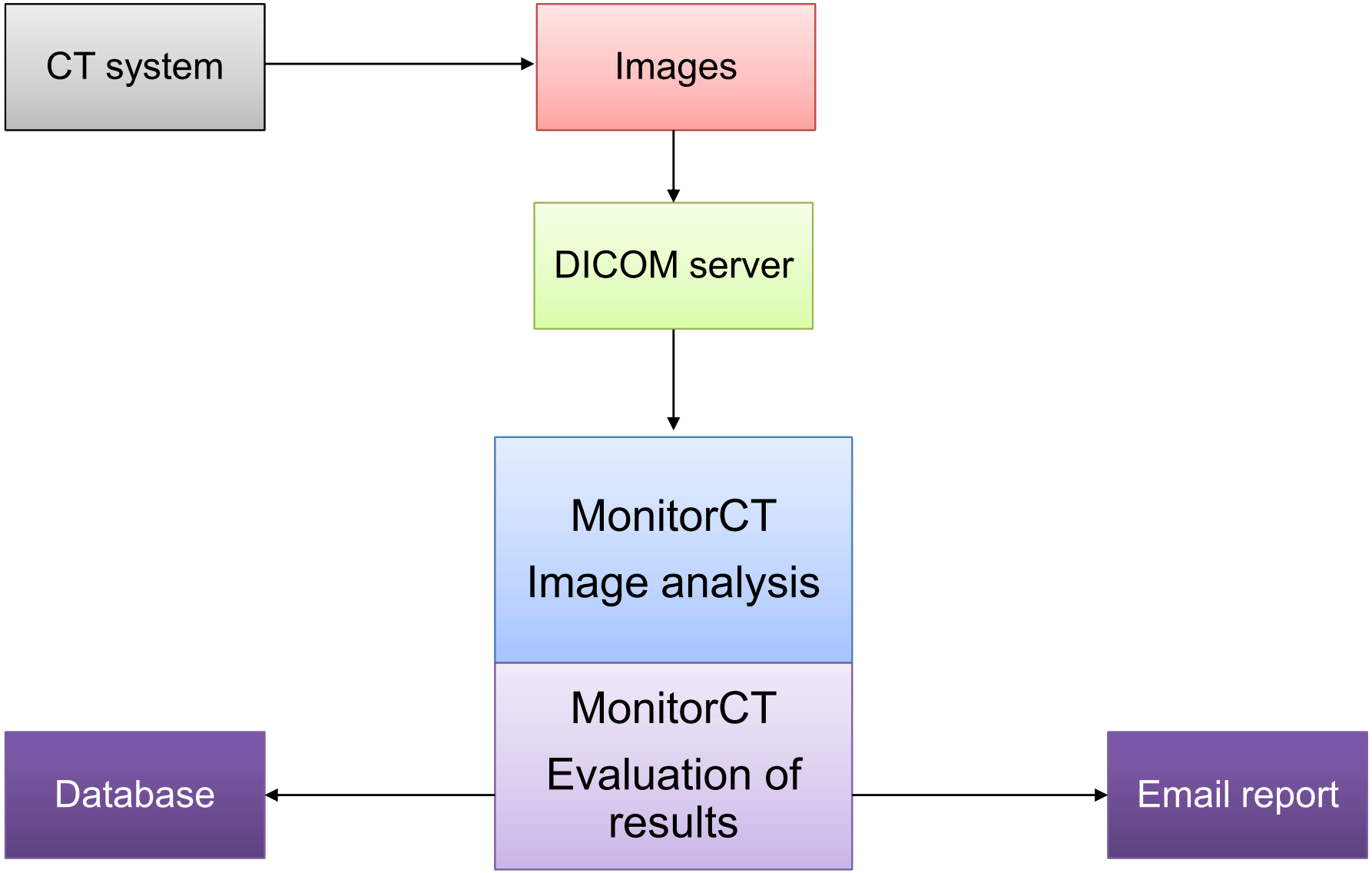
Current routine quality control at Karolinska University Hospital

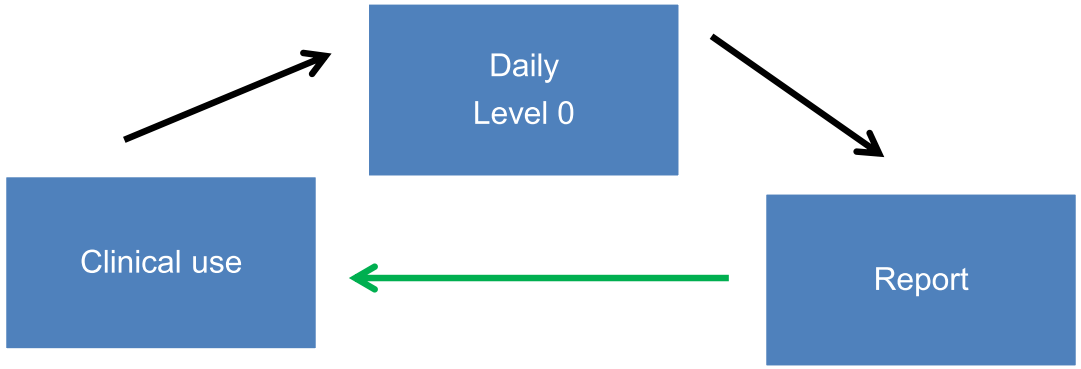
- Time consuming
- A lot of equipment
- Evaluation time
- User dependent tests



Method

- Analyze the relationships between parameters from current quality assurance
- Isolate **key performance indicators**
- Daily quality control by automatic monitoring of key performance indicators
- Develop a means of troubleshooting the system when key performance indicators deviate


CT system
Images
DICOM server
MonitorCT
Image analysis
MonitorCT
Evaluation of results
Database
Email report



Daily scan performed by the staff at the clinic

Scan of manufacturer phantom | Before patient examinations

Images from scan

Sent automatically by the CT scanner

Automatic analysis of scan images

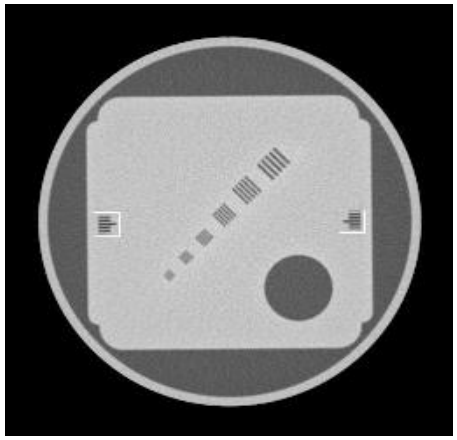
Noise | CT numbers | Uniformity | Positioning

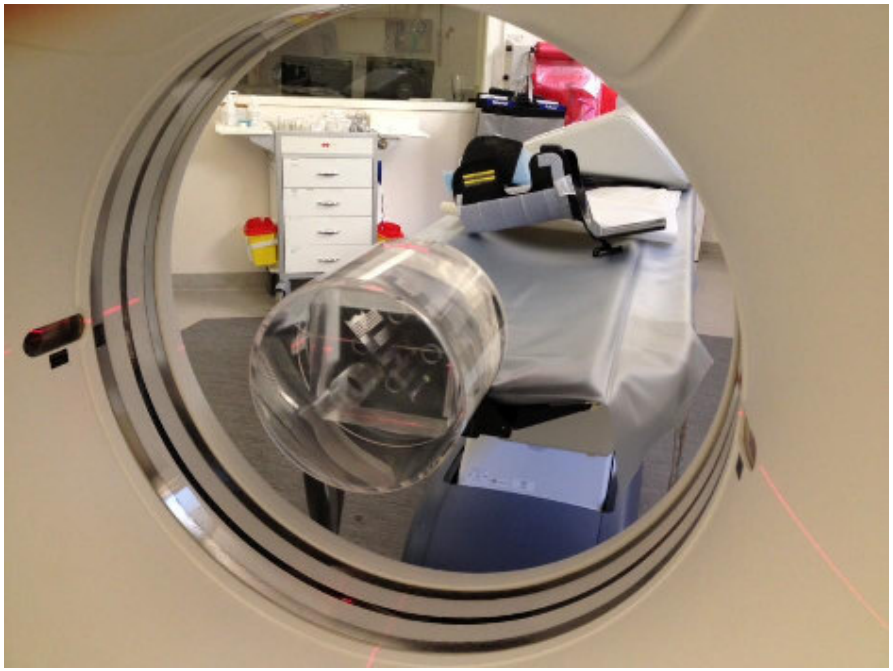
Quality of CT scanner's condition assured on a daily basis

Immediate feedback to the clinic | All data to quality control database

Key performance indicators - Positioning

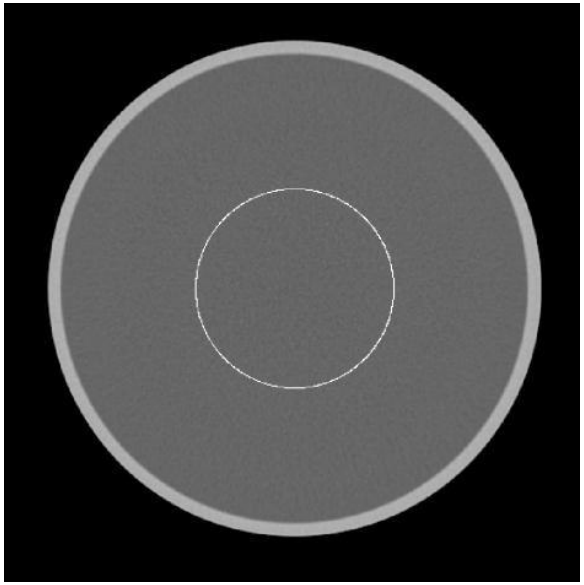
- Keystone to correctly calculated key performance indicators
- Determined in x-, y- and z-direction
- Depends on:
  - Lasers
  - Functionality of the tabletop
  - *Collimation*





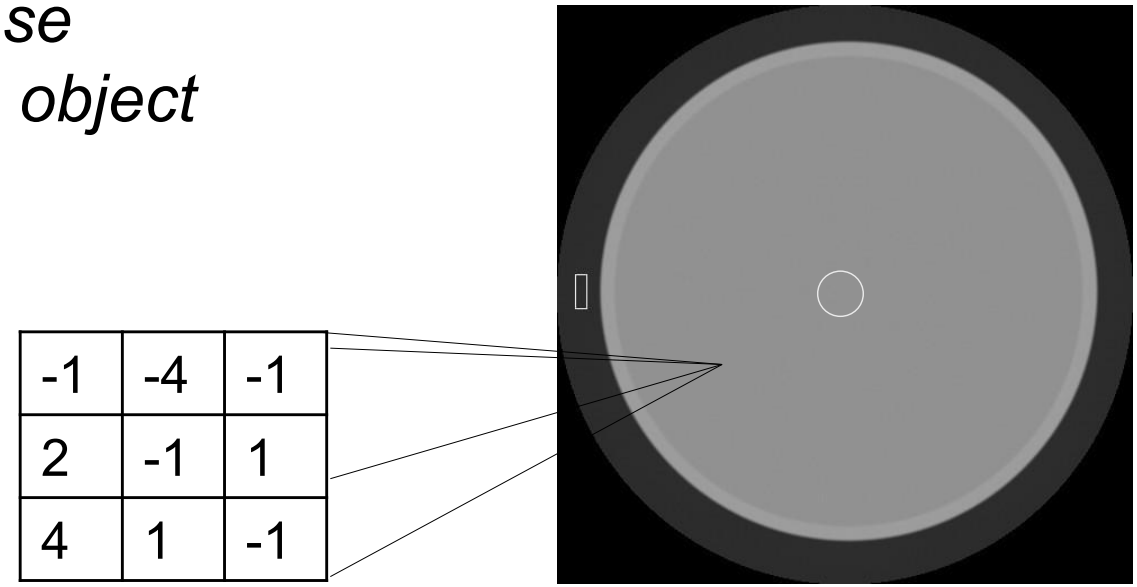
Key performance indicators - Noise

- Tolerance lowered to 5% of the base value
- Depends on:
  - Radiation quality
  - Detector response
  - Reconstruction
  - Collimation
  - *Positioning of the object*



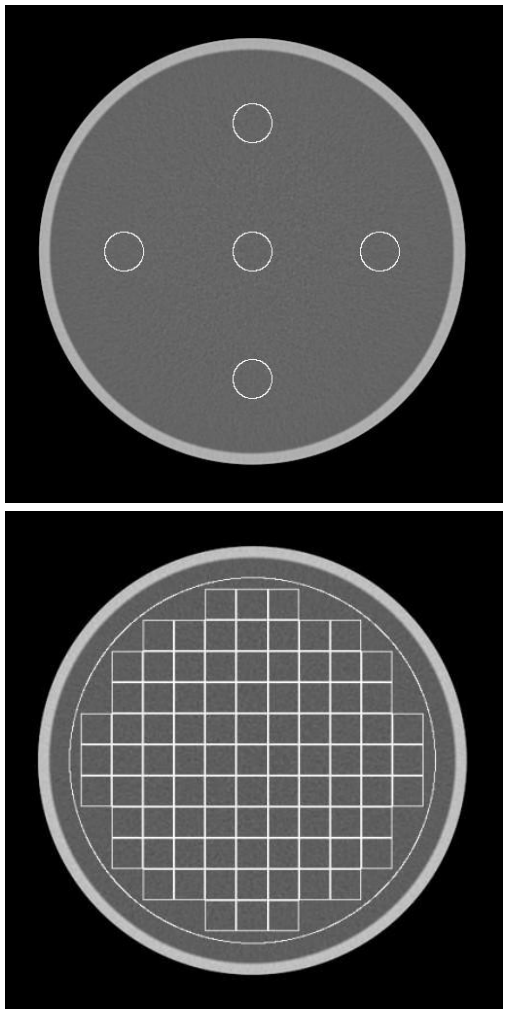
Key performance indicators - CT numbers

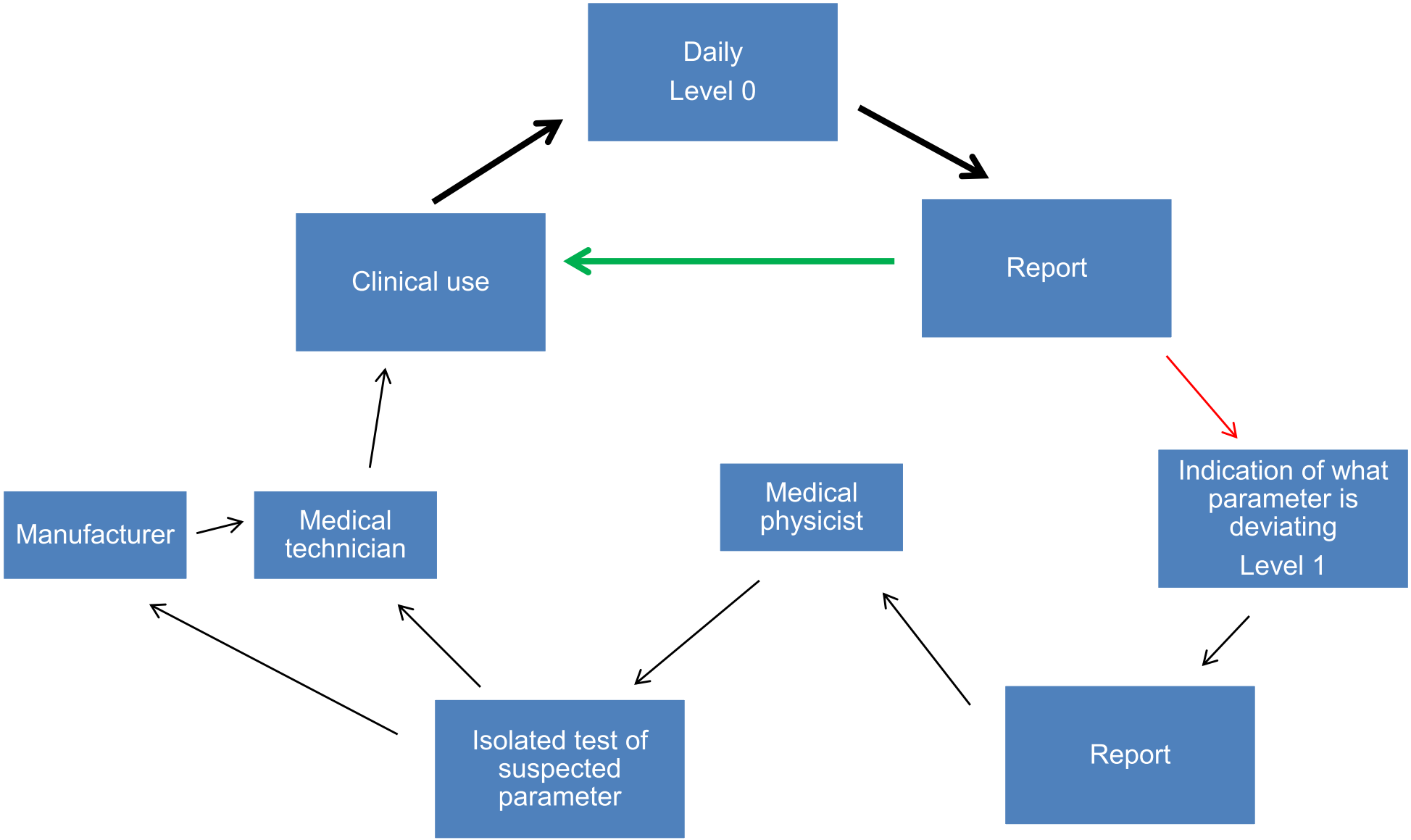
- Depends on:
  - Water calibration
  - Air calibration
  - *Radiation quality*
  - *Detector response*
  - *Centering of the object*



Key performance indicators - Uniformity

- Two tests
- Depends on:
    - Shaped filter
    - *Reconstruction*
    - *Radiation quality*
    - *Detector response*
    - *Centering of the object*




Daily
Level 0
Report
Clinical use
Indication of what parameter is deviating
Level 1
Medical physicist
Medical technician
Manufacturer
Report
Isolated test of suspected parameter

Protocols

Level 0

Aq	Im	kVp	mA	s	Start	End	SliceThick (mm)	Images	Coll (mm)	Conv. Kernel	Shaped filter	SFOV (mm)	DFOV (mm)
1	1	120	260	1	I0	S0	5	1	5	standard	Head	320	250
2	2-9	120	260	1	S65	S100	5	8	40	standard	Head	320	250

Level 1

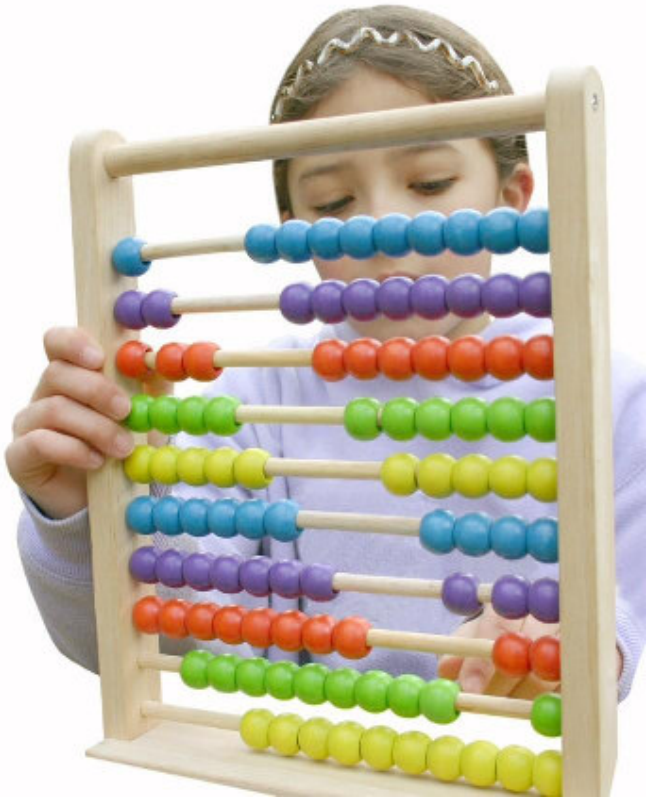
Aq	Im	kVp	mA	S	Start	End	SliceThick (mm)	Images	Coll (mm)	Conv. Kernel	Shaped filter	SFOV (mm)	DFOV (mm)
1	1	120	260	1	I0	S0	5	1	5	standard	Head	320	250
2	2	80	260	1	S85	S85	5	1	5	standard	Head	320	250
3	3	100	260	1	S85	S85	5	1	5	standard	Head	320	250
4	4	120	100	1	S85	S85	5	1	5	standard	Head	320	250
5	5	120	180	1	S85	S85	5	1	5	standard	Head	320	250
6	6	120	260	0,5	S85	S85	5	1	5	standard	Head	320	250
7	7	120	260	1	S85	S85	5	1	5	standard	Head	320	250
8	8	120	260	2	S85	S85	5	1	5	standard	Head	320	250
9	9-16	120	260	1	S65	S100	5	8	40	standard	Head	320	250
10	17-24	120	260	1	S75	S92.5	2,5	8	20	standard	Head	320	250
11	25-28	120	260	1	S85	S92.5	2,5	4	10	standard	Head	320	250
12	29	120	260	1	S85	S85	5	1	5	standard	Medium	320	250
13	30	120	260	1	S85	S85	5	1	5	standard	Body	500	250
14	31	120	600	1	S85	S85	5	1	5	standard	Head	320	250
15	32	120	600	1	S85	S85	5	1	5	edge	Head	320	250
16	33	140	260	1	S85	S85	5	1	5	standard	Head	320	250

Results

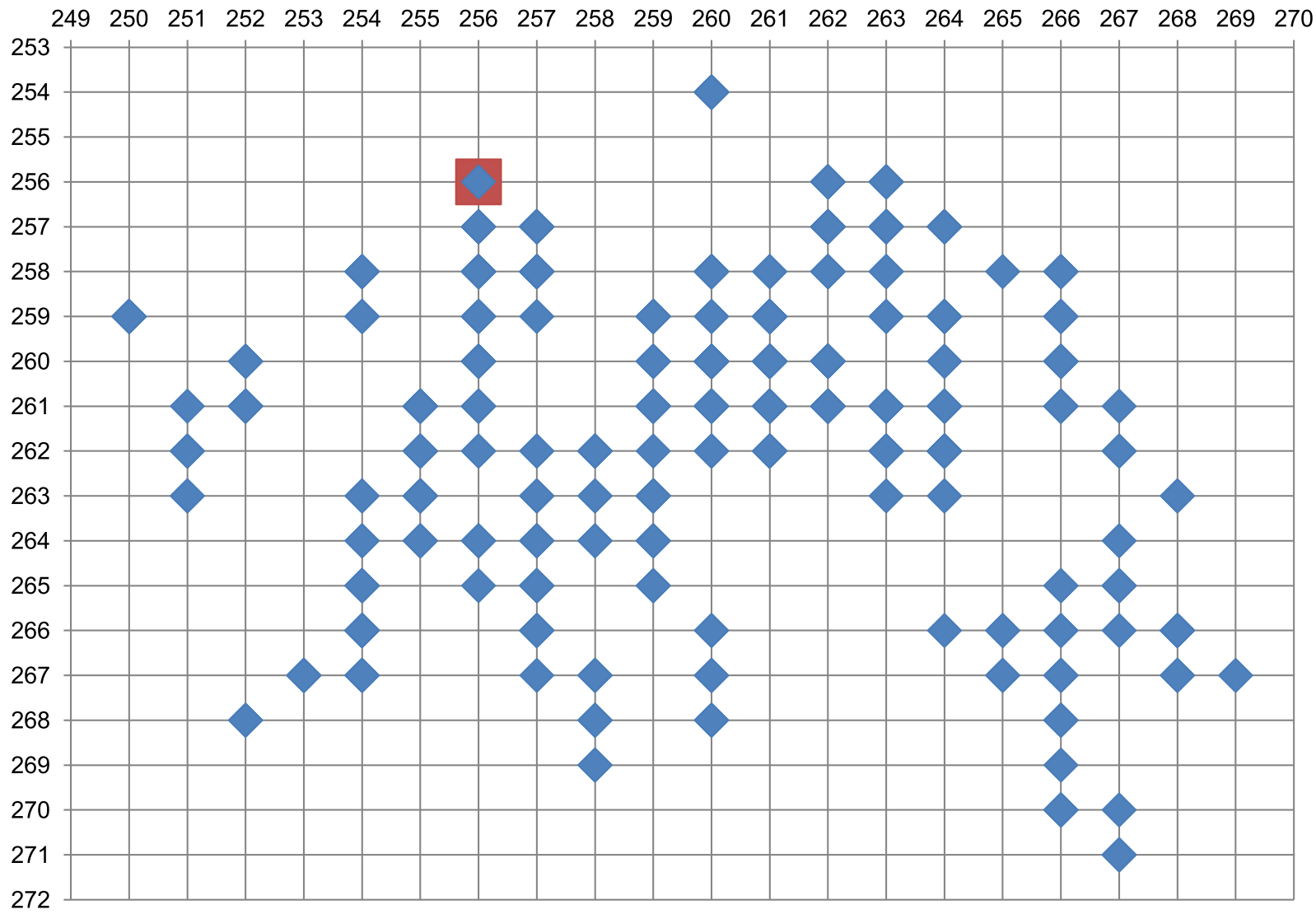
Approximately 4000 images automatically analyzed since the start

Approximately 100 ROI per image

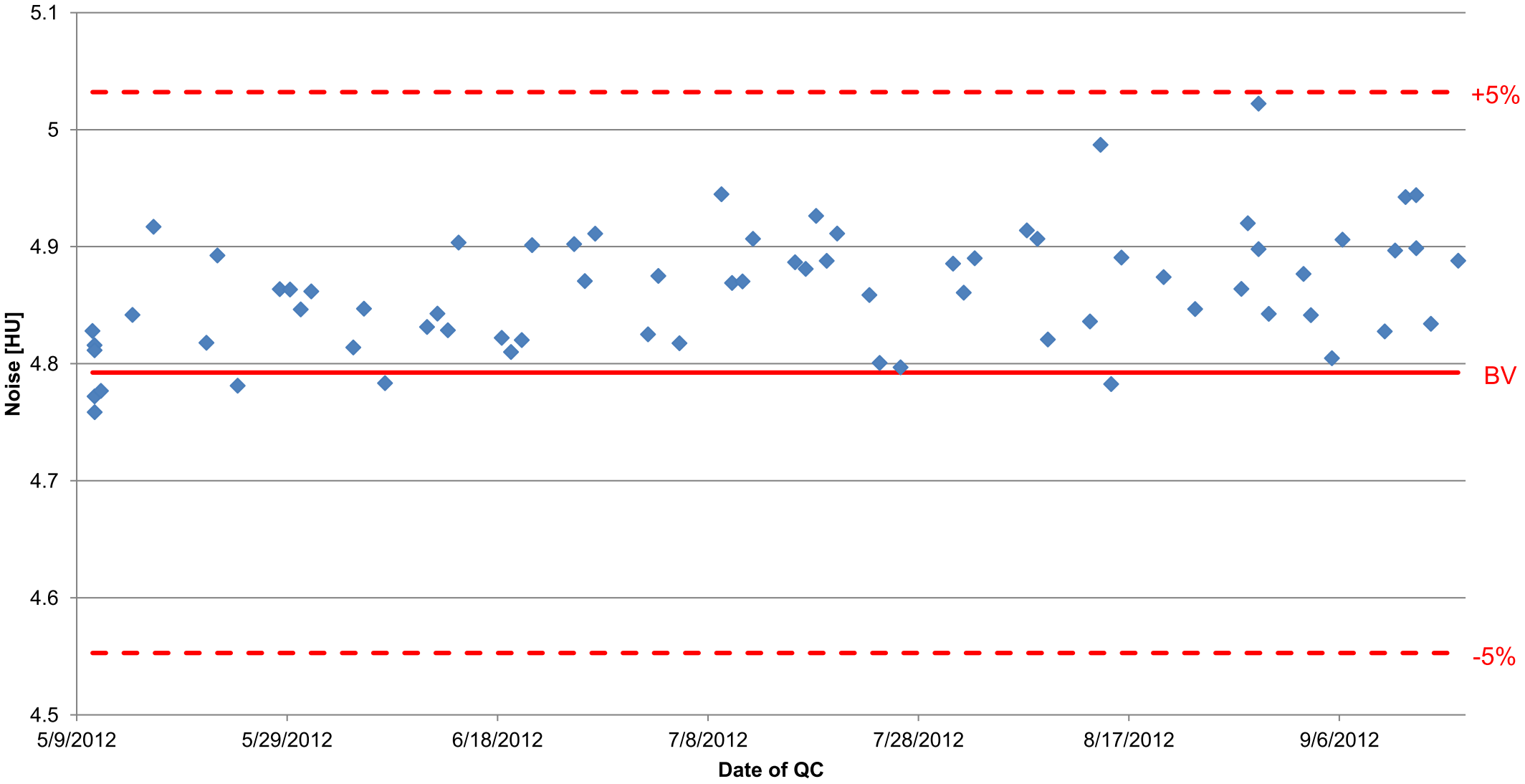
Results shown here are from a GE Discovery 750HD - Daily tests



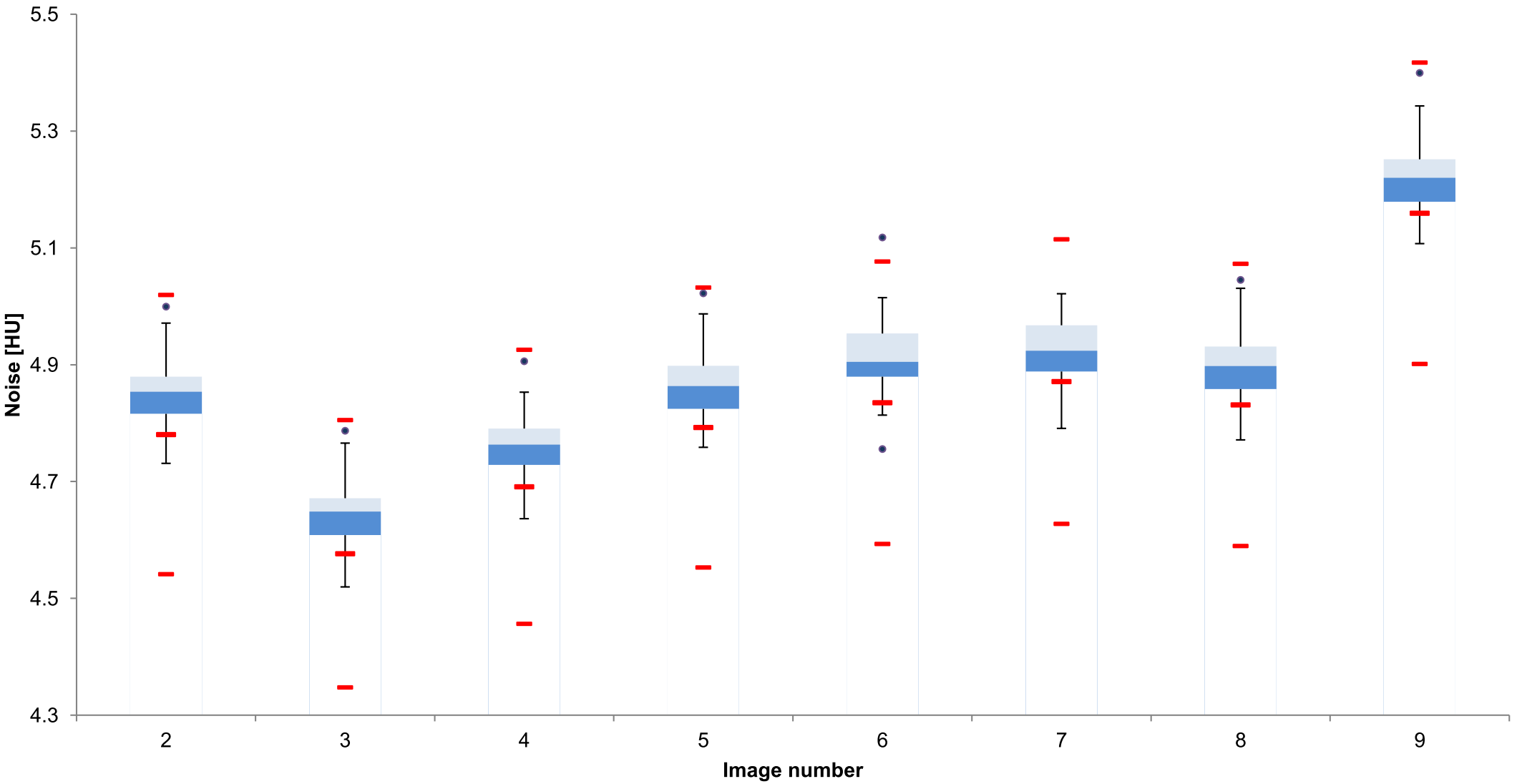
Results - Positioning: X and Y



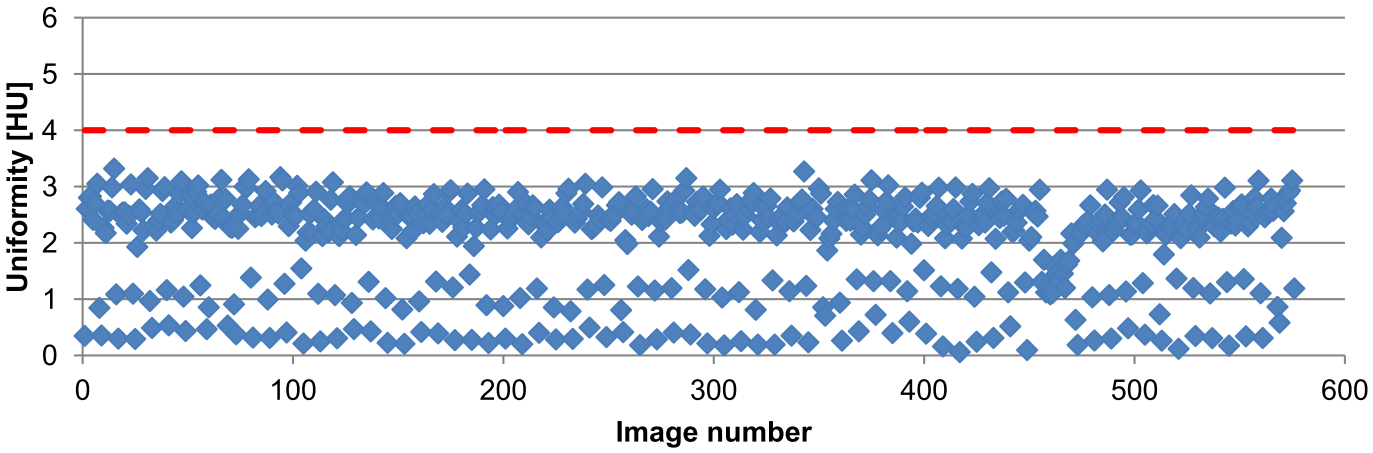
Results - Noise in one slice

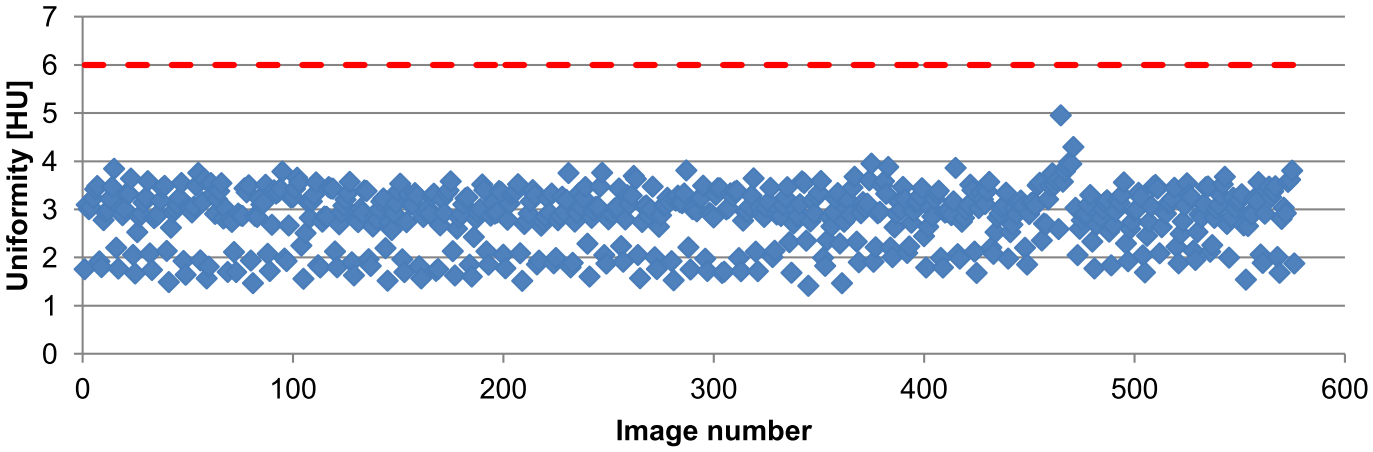


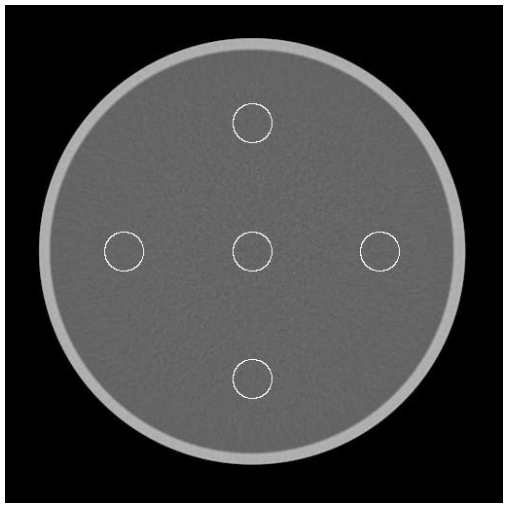
Results - Noise: Boxplots

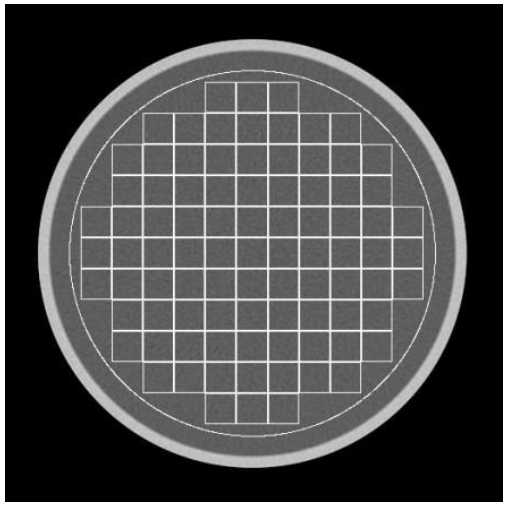


Results - Uniformity









Daily quality control benefits

- Trend analysis of CT system's condition which was not earlier possible
- Automatic evaluation of key performance indicators
- Daily monitoring of the CT system's condition
- Fast and effective troubleshooting

Thank you!