ICRP TG108 Workshop

Optimisation of Radiological Protection in Digital Radiology Techniques for Medical Imaging
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Building optimisation into routine practice

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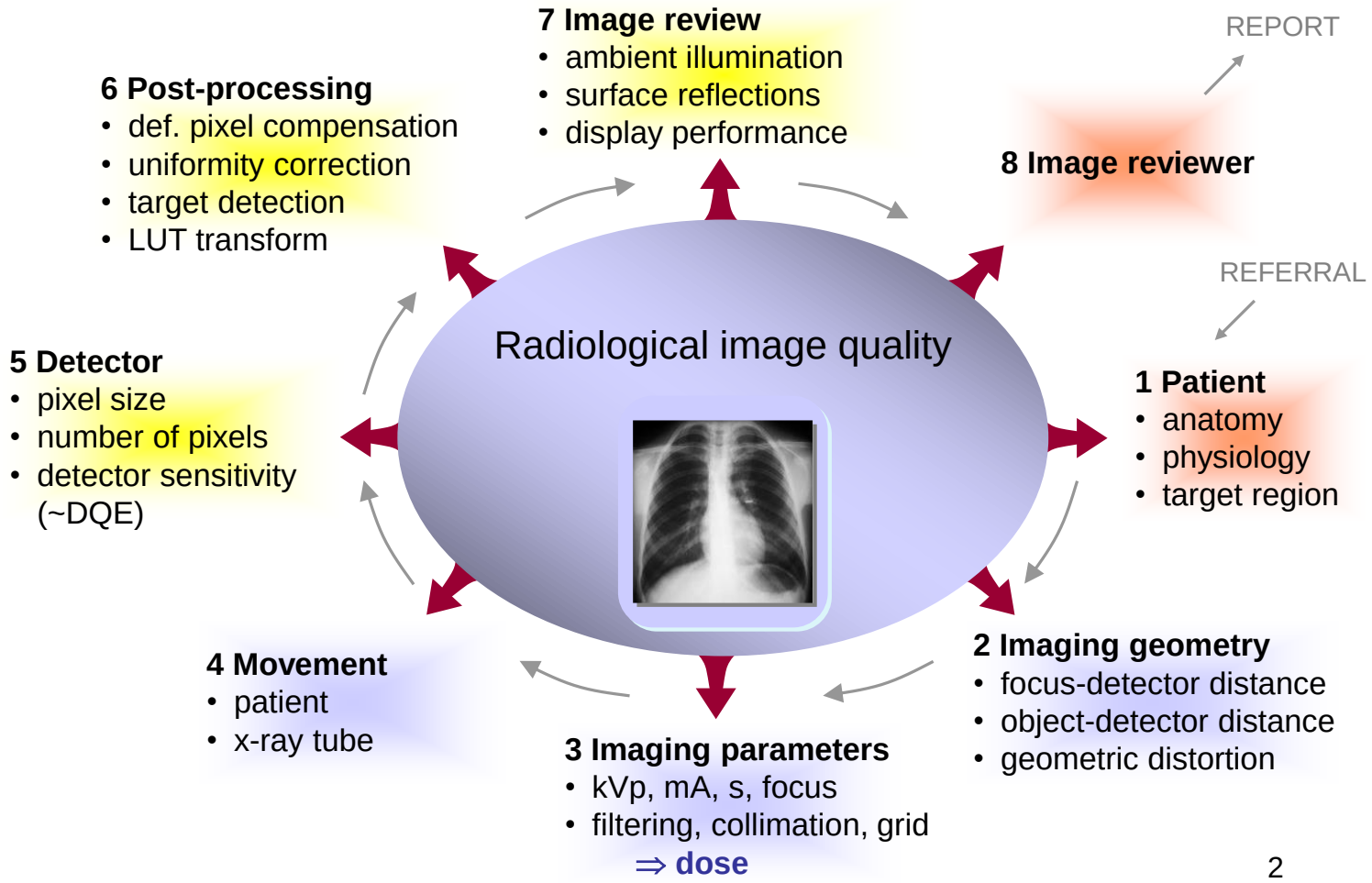
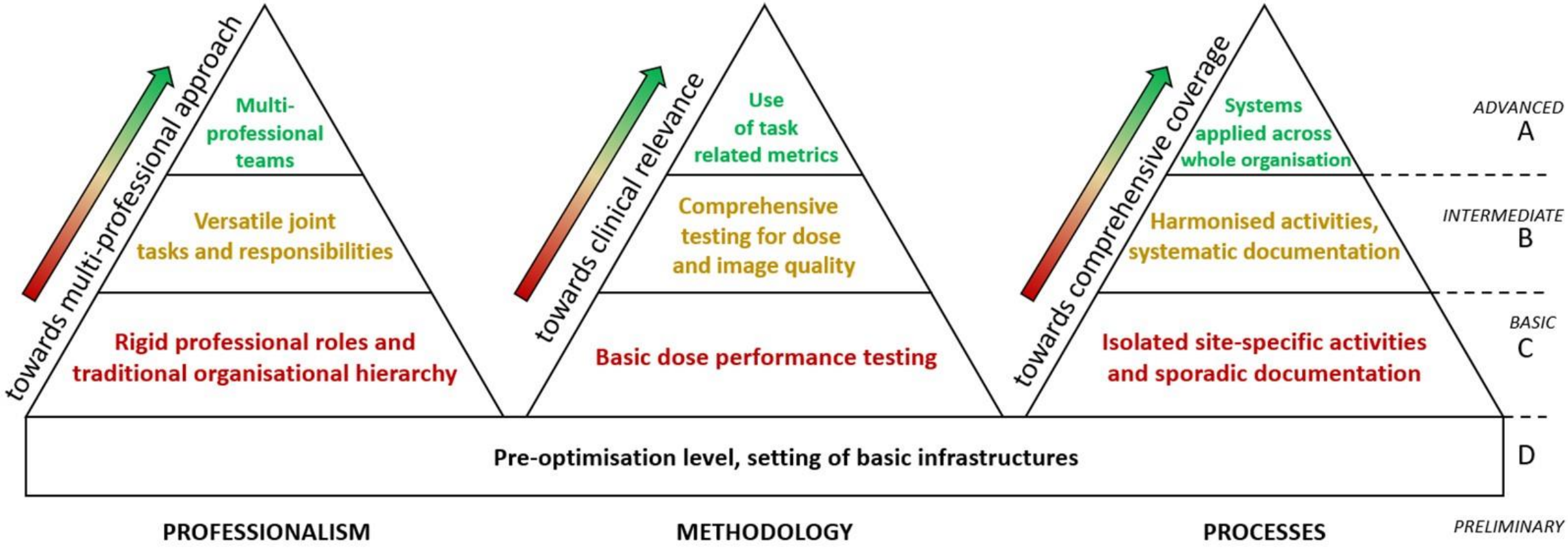
Factors affecting dose and image quality in digital imaging

The clinical value of images is dependent on physical characteristics of the imaging method (~medical physicist), image capture and presentation system (~radiographer) and the interpreter (~radiologist).



The whole imaging chain and process must be evaluated

Components and levels required for continuously improving optimisation



Within each component, levels of achieved performance will vary in different organisations.

Radiological professionals working together

C. Basic: Radiologists, radiographers, and medical physicists perform roles separately and independently of each other.

Establishing Diagnostic Reference Levels (DRLs) is involved in move from level C to B.

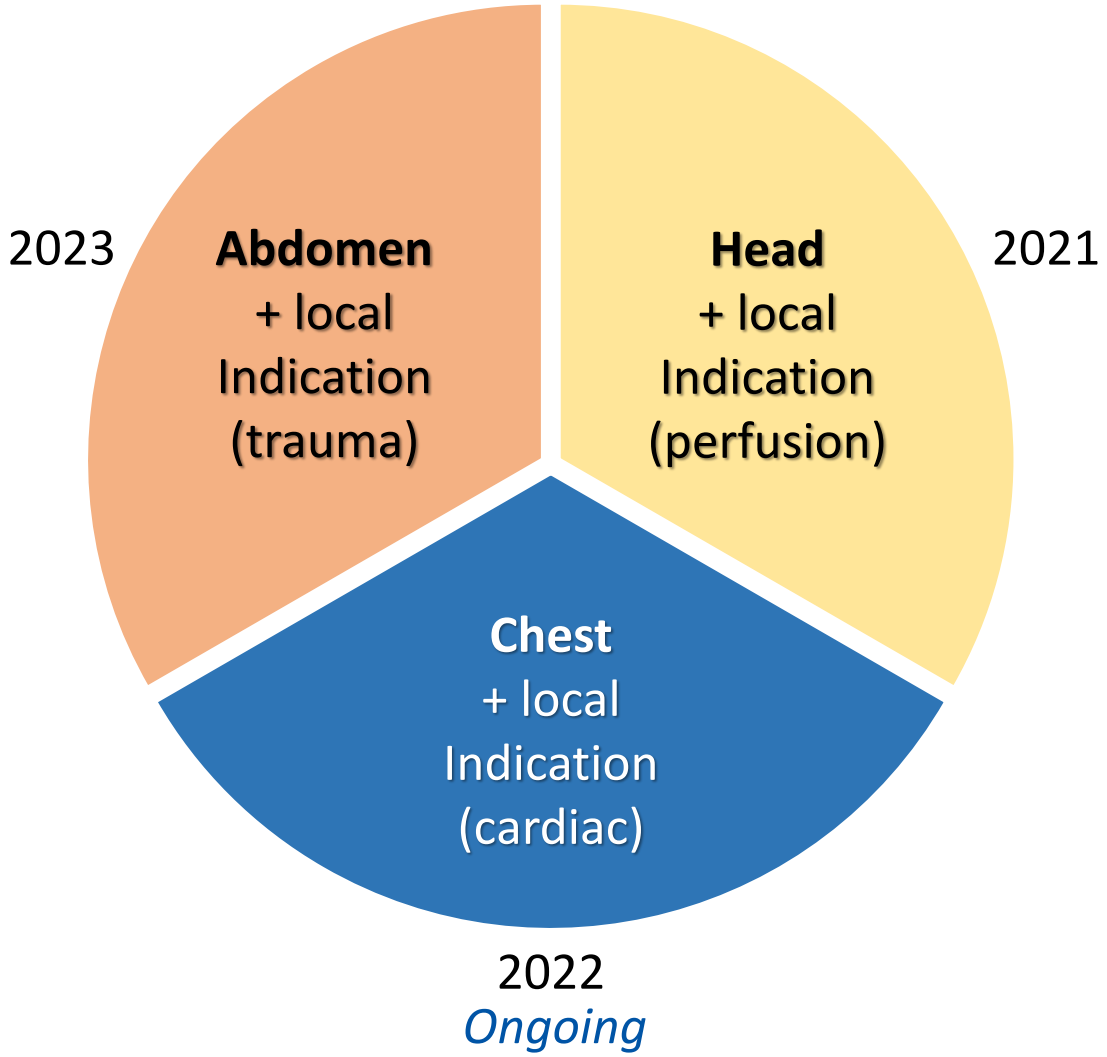
B. Intermediate: Optimisation Teams comprising radiographers, radiologists, and medical physicists established.

Comparison of dose survey results with DRLs, followed by review and optimise protocols for some modalities

A. Advanced: The whole Optimisation Team is involved in regular review of clinical protocols for all modalities.

Example of dose monitoring annual cycle plan

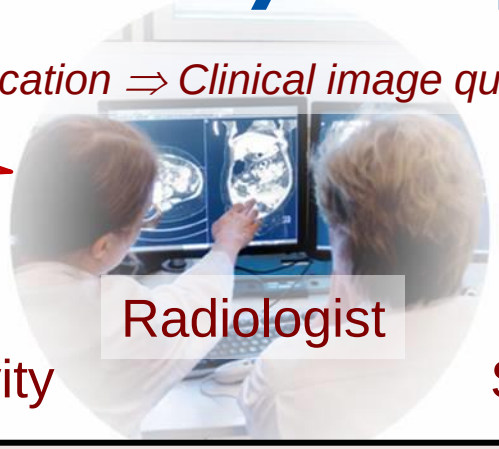
Comparing patient doses vs DRLs



Multiprofessionality in optimisation

It's not just about primary diagnostics. Differential diagnostics and incidential findings matter as well.

Indication ⇒ Clinical image quality



Radiologist

Sensitivity

Specificity

Quality assurance

Exam workflow

OPTI MISA TION

Physicist

Imaging parameters
⇒ resolution, contrast, noise, dose

Dosimetry

Patient safety

Radiographer

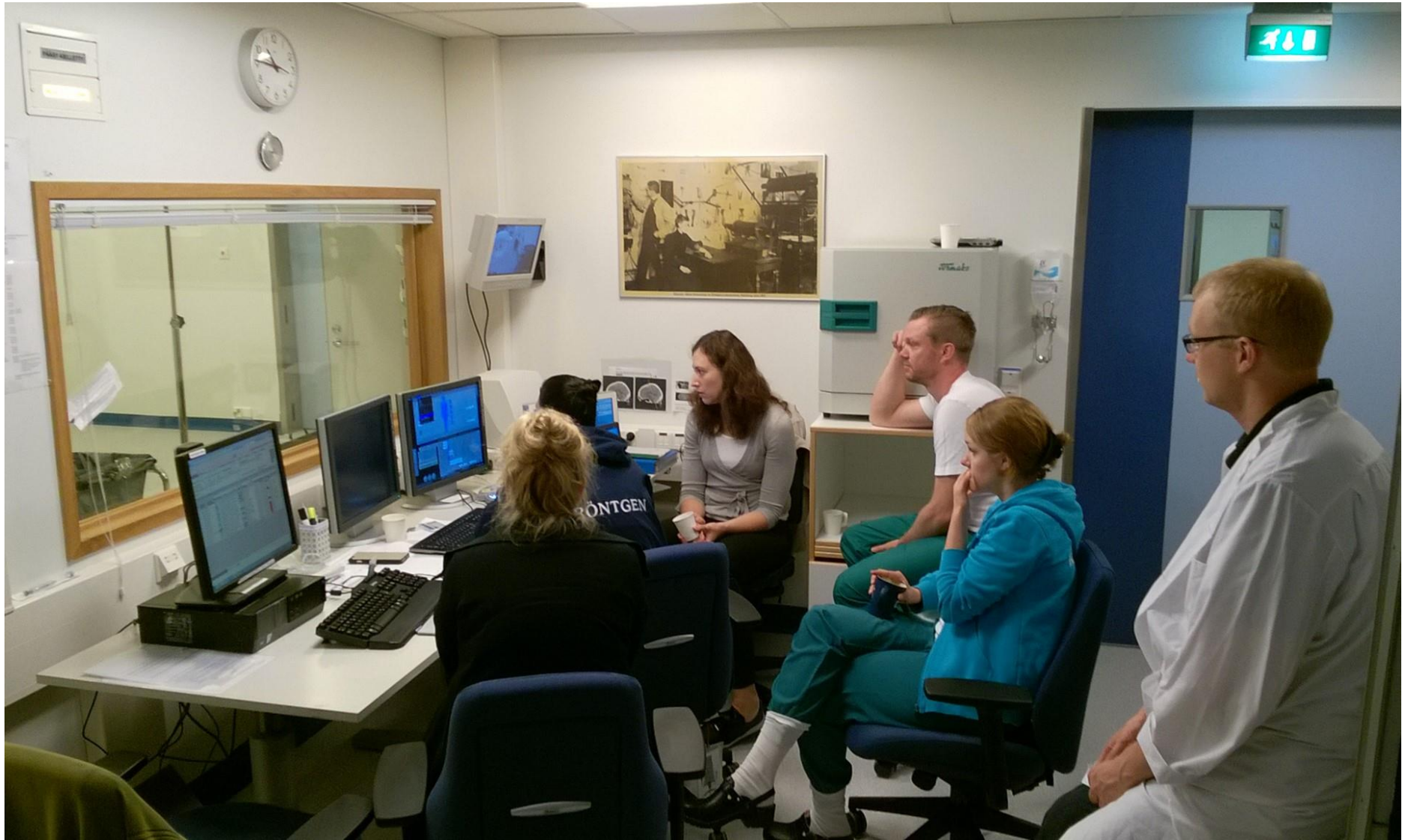
Imaging equipment & work methods

Operation of digital x-ray equipment

- Successful operation of digital x-ray equipment requires **high levels of knowledge and skill** from clinicians, radiographers and medical physicists.
- Settings should be agreed by members of the **multi-professional** imaging team and **documented** in protocols
- All members of the team must be given the necessary expertise through **training and experience**
- **Training must be updated** regularly, so everyone fully understands equipment operation

Take full advantage of user training

It's not just a system – require also the functionality and optimised protocols



Qualifiers of successful optimisation

- **Ongoing, forward-looking, iterative process ⇒ continuous improvements** with quantitative and qualitative evaluation.
- **Systematic and carefully structured** to ensure that all relevant aspects in the diagnostic chain are taken into account.
- Requires **commitment at all levels** as well as **adequate procedures and resources** in organisations.
- **Optimisation is not minimisation of dose** – it's a question of balance; the best option is not necessarily the one with the lowest dose.

Two levels of optimisation

Regular review of every aspect of the imaging process is key to the successful achievement of optimisation.

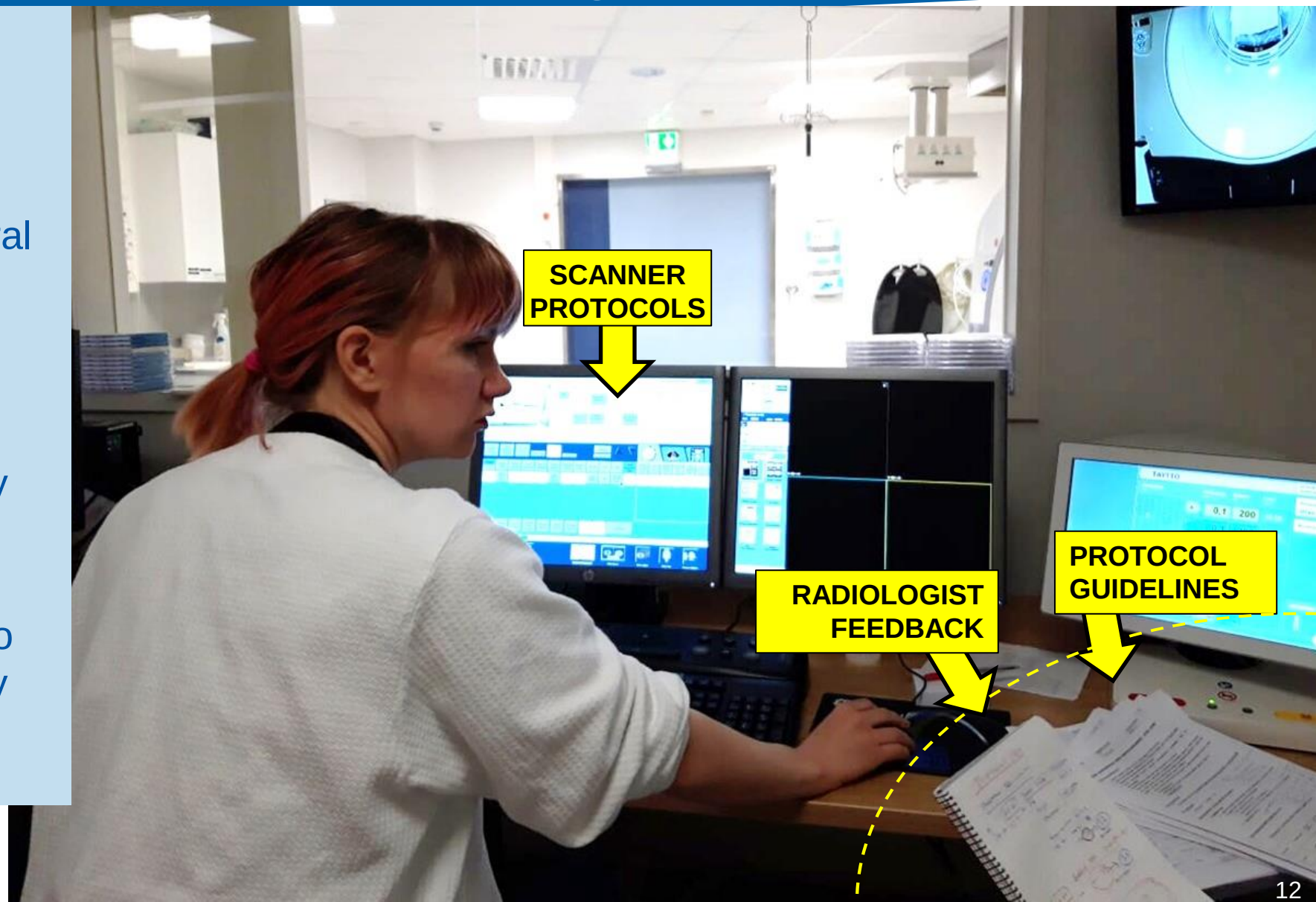
1) The **design and construction** of the equipment and the installation
2) The **day-to-day working procedures** performed by the staff involved

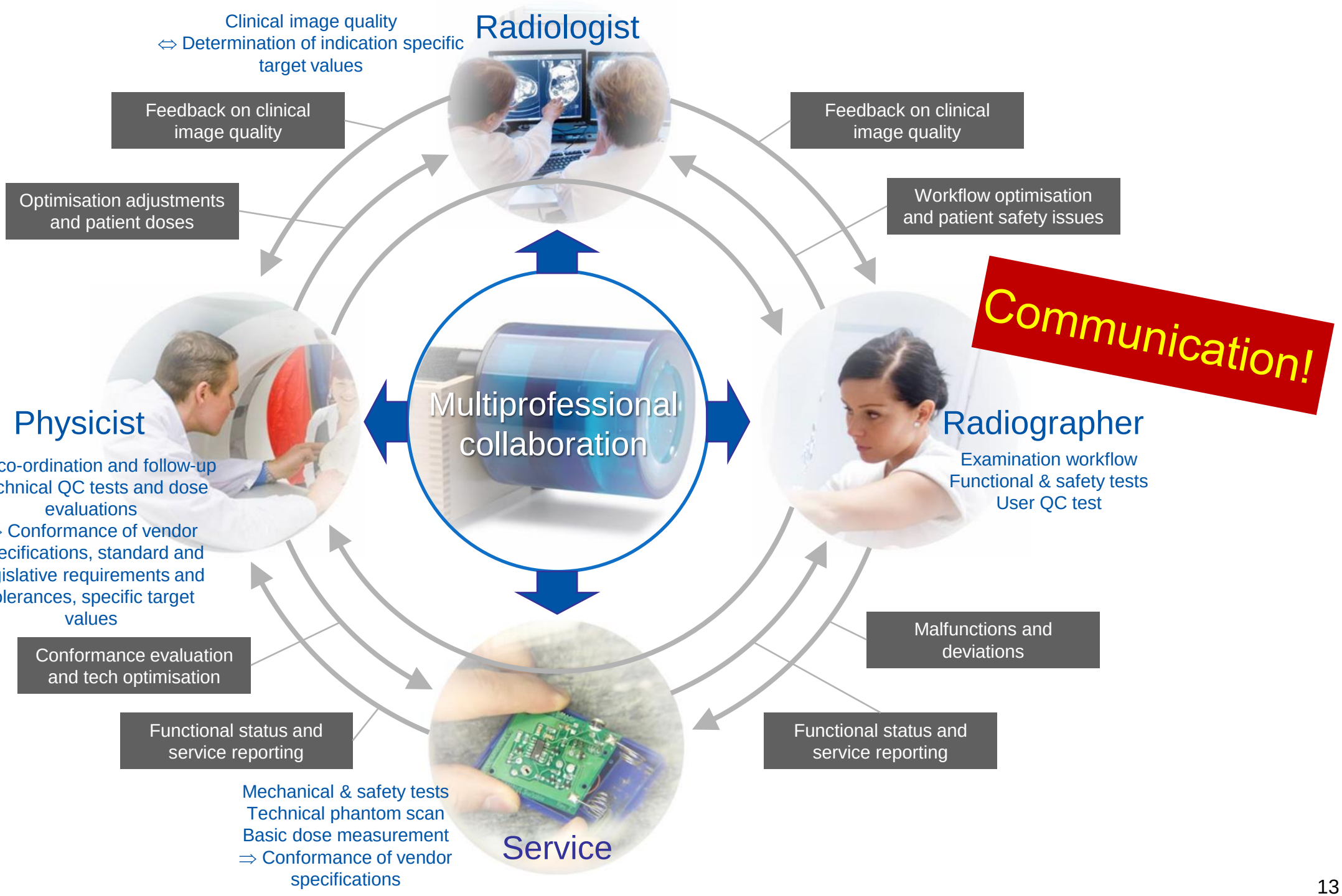
Optimisation will only occur if:

1) All staff are **properly trained** in their roles
2) Equipment operation is ensured through a **comprehensive QA programme**
3) There is **ongoing monitoring**, review, and analysis of performance
4) This feeds back into **continual improvement** of protocols.

Practical multiprofessional optimisation during commissioning

- C: Set the basic parameters
- B: Adjust indication specific parameters to maximise image quality per dose unit (e.g. spectral optimisation)
- A: Adjust patient-specific parameters (typically mAs by ATCM) in individual exams to achieve diagnostic image quality with the lowest dose
- Harmonise protocols (incl. exposure parameters) in order to achieve consistent image quality throughout the organisation

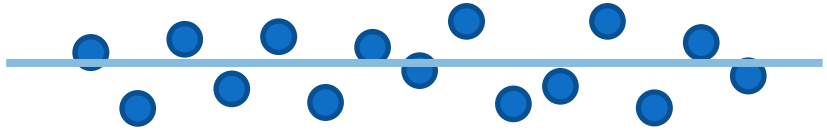



Clinical image quality
⇔ Determination of indication specific target values
Radiologist
Feedback on clinical image quality
Feedback on clinical image quality
Optimisation adjustments and patient doses
Workflow optimisation and patient safety issues
Communication!
Multiprofessional collaboration
Physicist
QA co-ordination and follow-up
Technical QC tests and dose evaluations
⇒ Conformance of vendor specifications, standard and legislative requirements and tolerances, specific target values
Radiographer
Examination workflow
Functional & safety tests
User QC test
Conformance evaluation and tech optimisation
Malfunctions and deviations
Functional status and service reporting
Functional status and service reporting
Mechanical & safety tests
Technical phantom scan
Basic dose measurement
⇒ Conformance of vendor specifications
Service

Main directions of developing methods

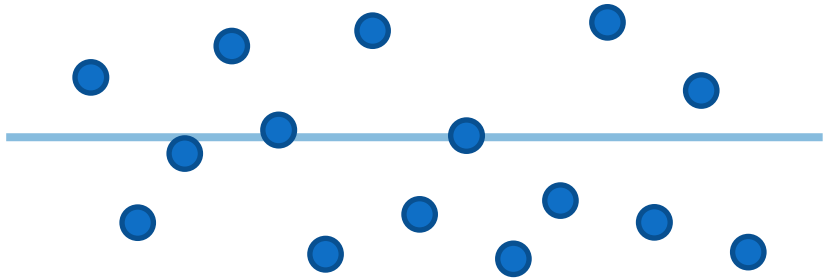
reducing variability

Consistency



Quality

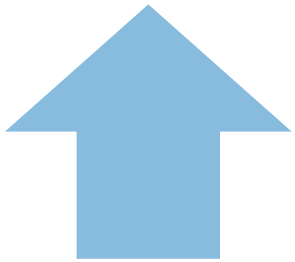
on average



Main directions of developing methods

reducing variability

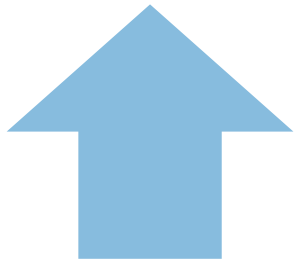
Consistency



Quality

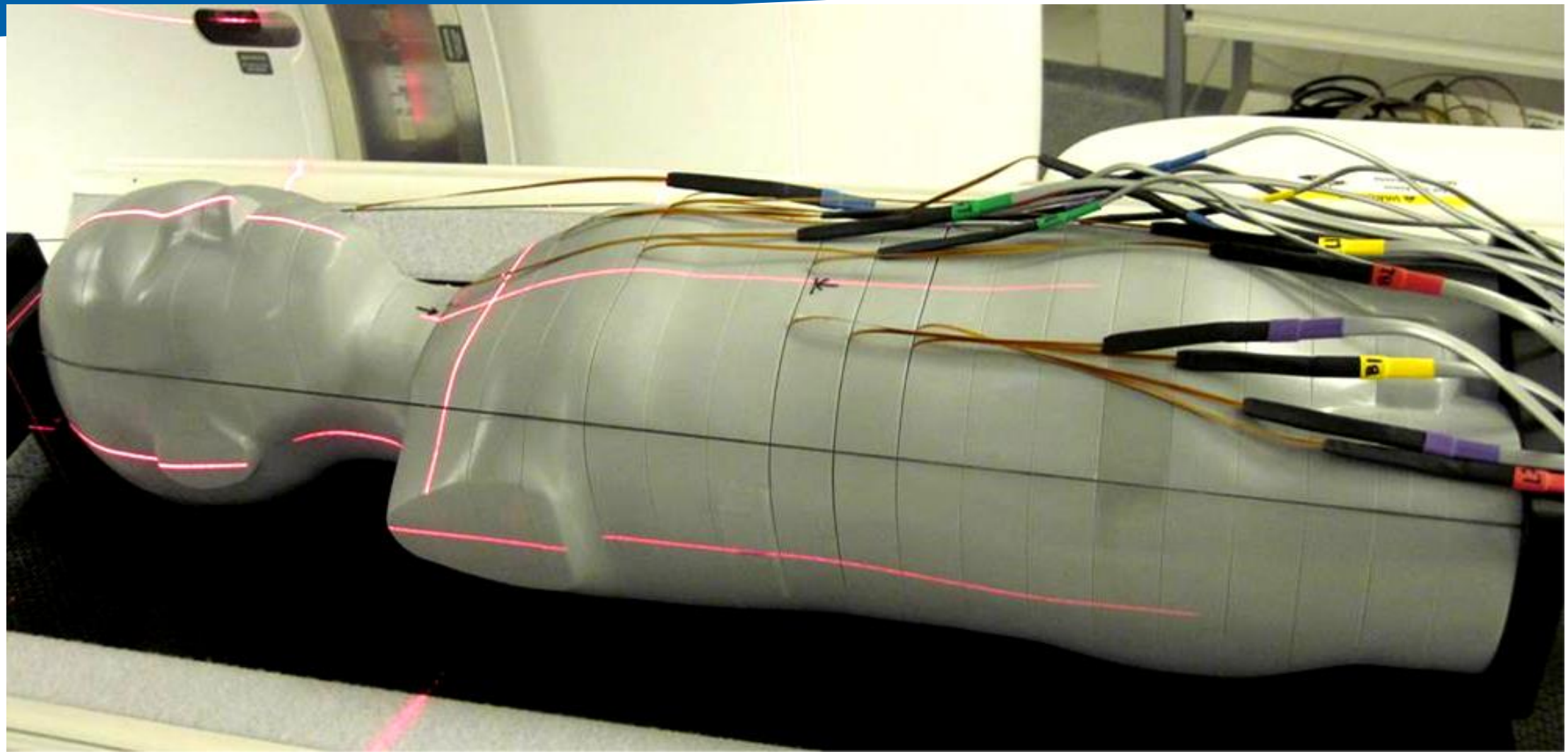
on average

Clinical relevance



Technical performance

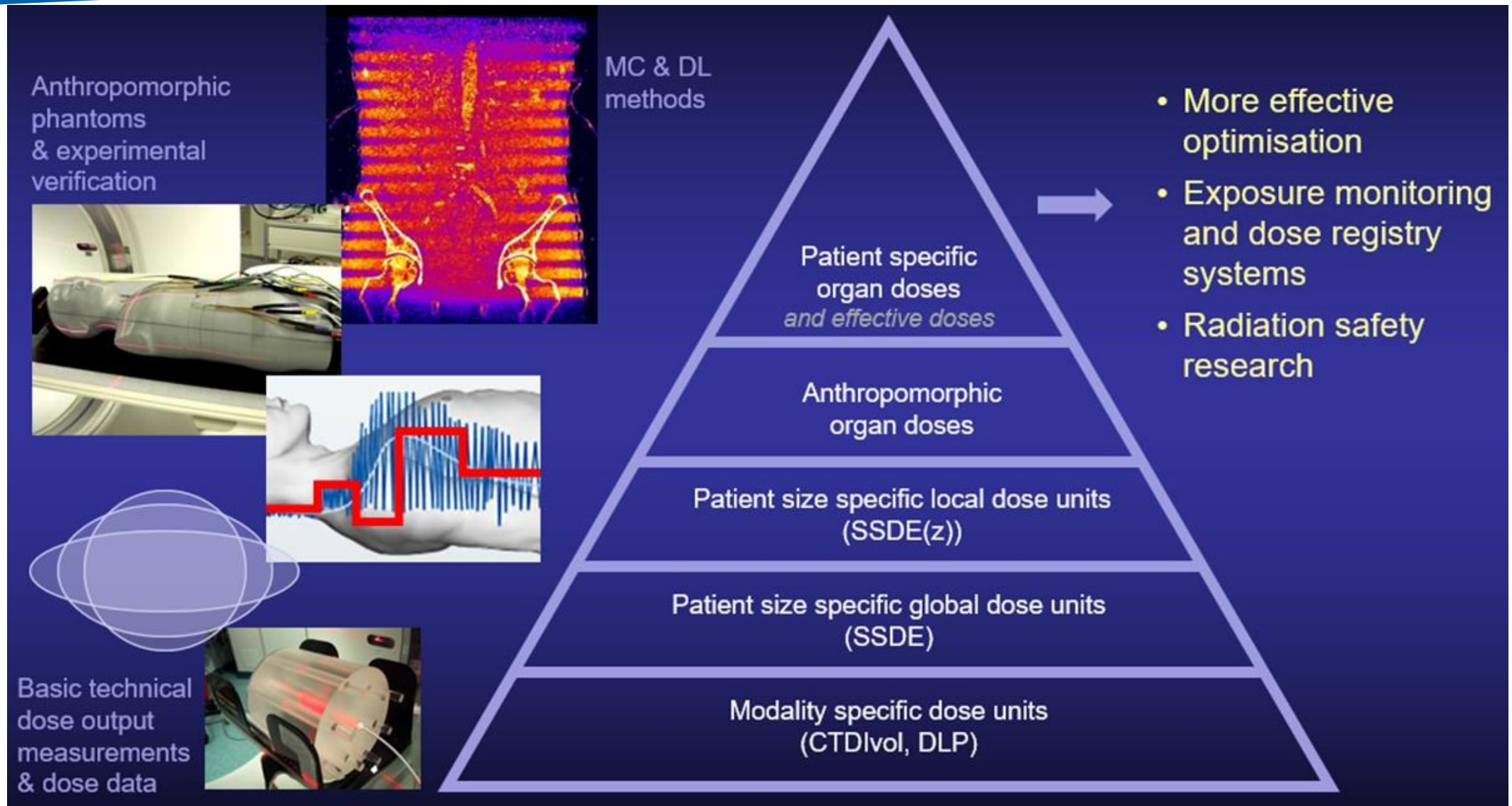
Utilising athropomorphic models in optimisation
⇒ Aiming closer to clinical cases



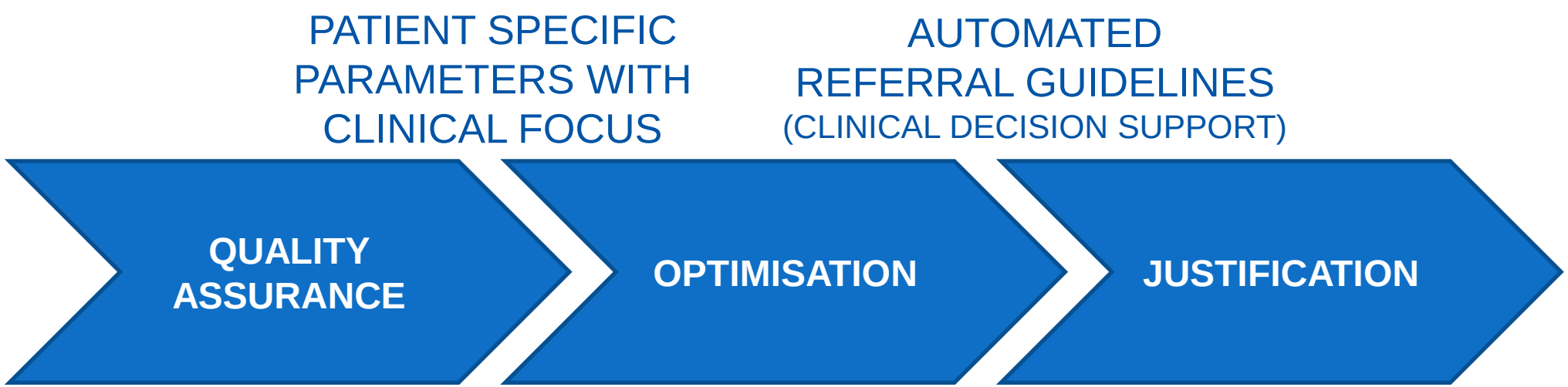
Example of anatomical & indication based DRLs
(for CT in Finland)

Examination type or indication	$CTDI_{vol}$ mGy	DLP mGy·cm
Head/brain	55	800
Sinuses	13	190
Chest	9	290
Abdomen	12	560
Body	12	770
Aorta (neck to groin)	10	630
Indication - HRCT	5	140
Indication - lung tumour	11	430
Indication - renal stones	7	330
Indication - lymphoma	11	970
Indication - trauma body	17	1300
Indication - colonoscopy (prone)	6.5	total from both positions: 930
Indication - colonoscopy (supine)	12	

Towards patient-specific dosimetry – example: CT

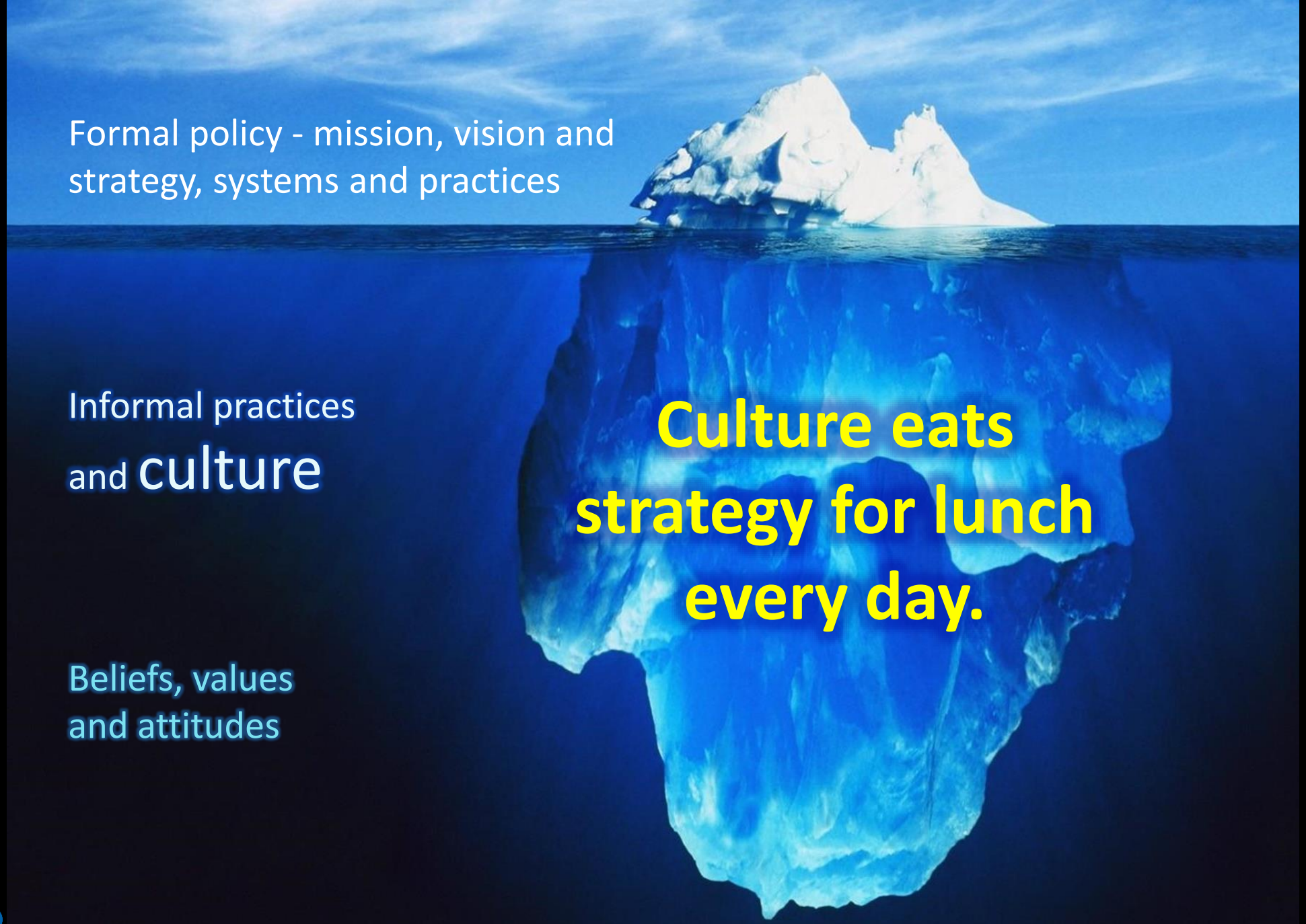


Gradual unification of core RP components by evolving methods and processes



Evolved QA methods enable more effective patient-specific optimisation with clinical relevance

Automated referral guidance and procolling connect optimisation and justification more closely together


Formal policy - mission, vision and strategy, systems and practices
Informal practices and culture
Beliefs, values and attitudes
Culture eats strategy for lunch every day.

When you aim for improvements by planning and doing, also check the the outcome systematically to reach effective outcome

"What if we don't change at all ...
and something magical just happens?"

Importance of continual improvement

Phantoms

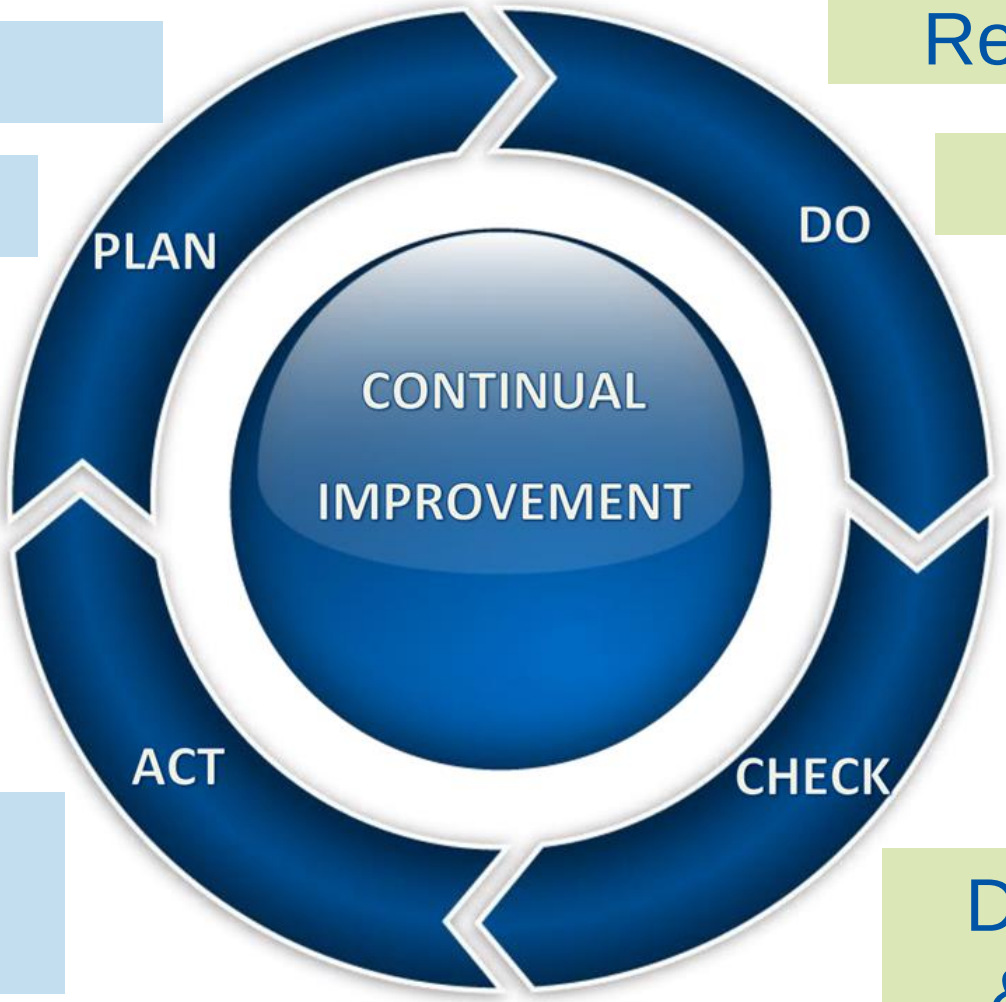
QA programme

Dose audits

DRLs

Regular
IQ evaluation

Dose monitoring
system



Resources

Roles

Training

Processes

Documentation

Data safety
& security

I acknowledge contributions from the members of

ICRP Task Group 108

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Thank you for your attention

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