

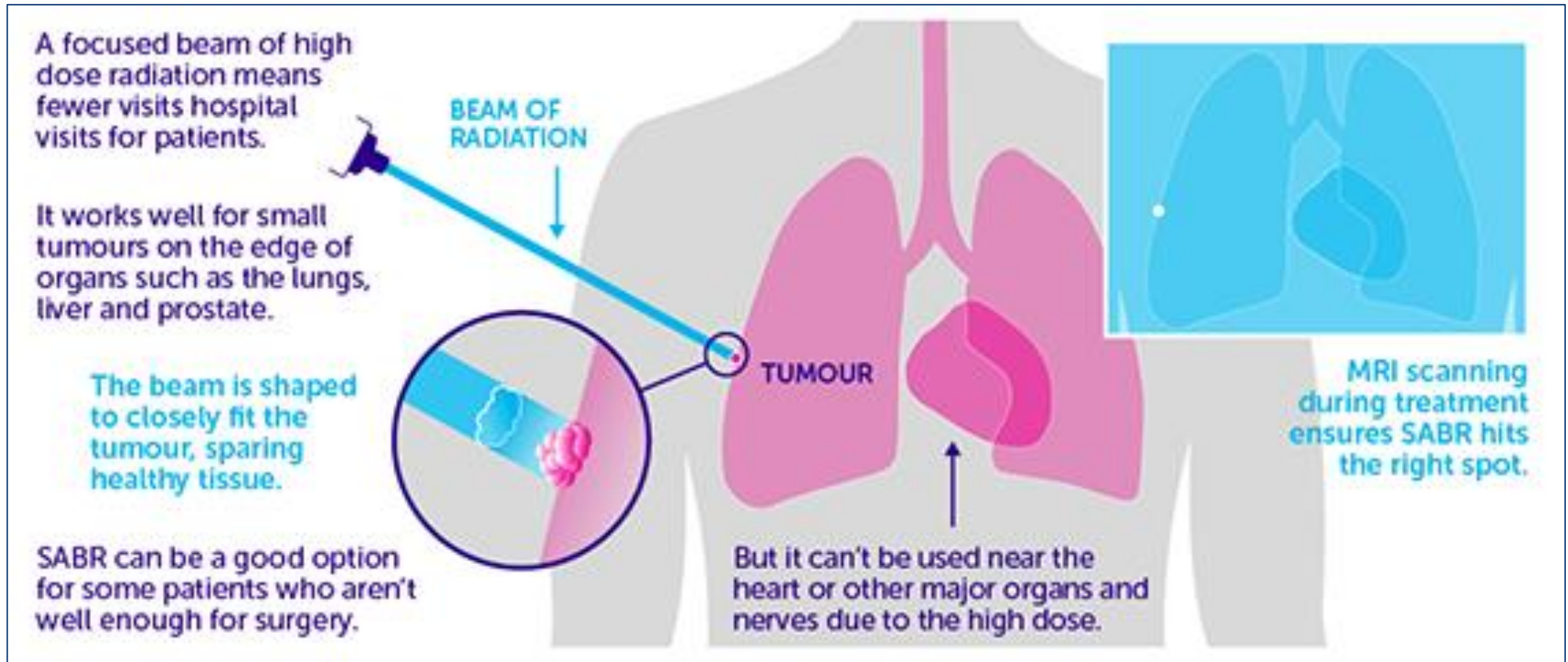
Meta-analysis of radiotherapy audit data

Elizabeth Cooke, Spencer Thomas, Ellie Smyth, Mo Hussein, Catharine Clark, Nadia Smith

Outline

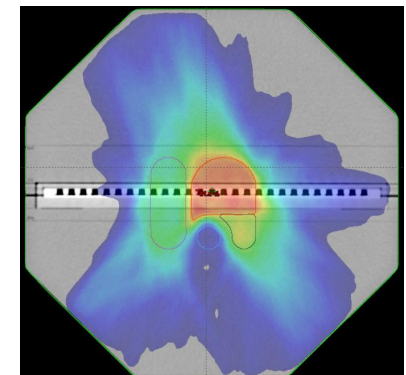
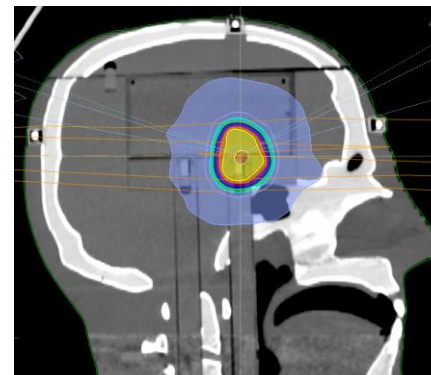
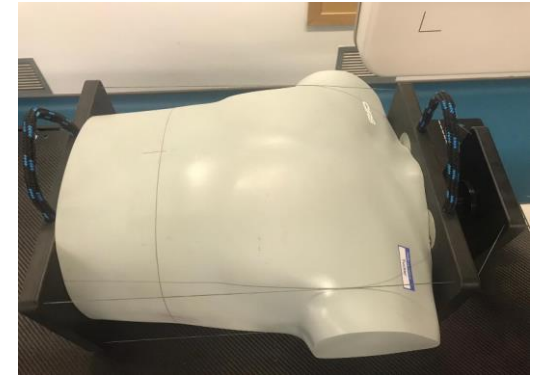
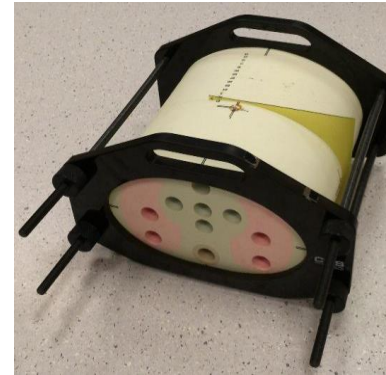
- Introduction to radiotherapy audits
- Database to improve audit reporting
- Meta-analysis of audit data
- Future steps

Stereotactic Radiotherapy (SABR)

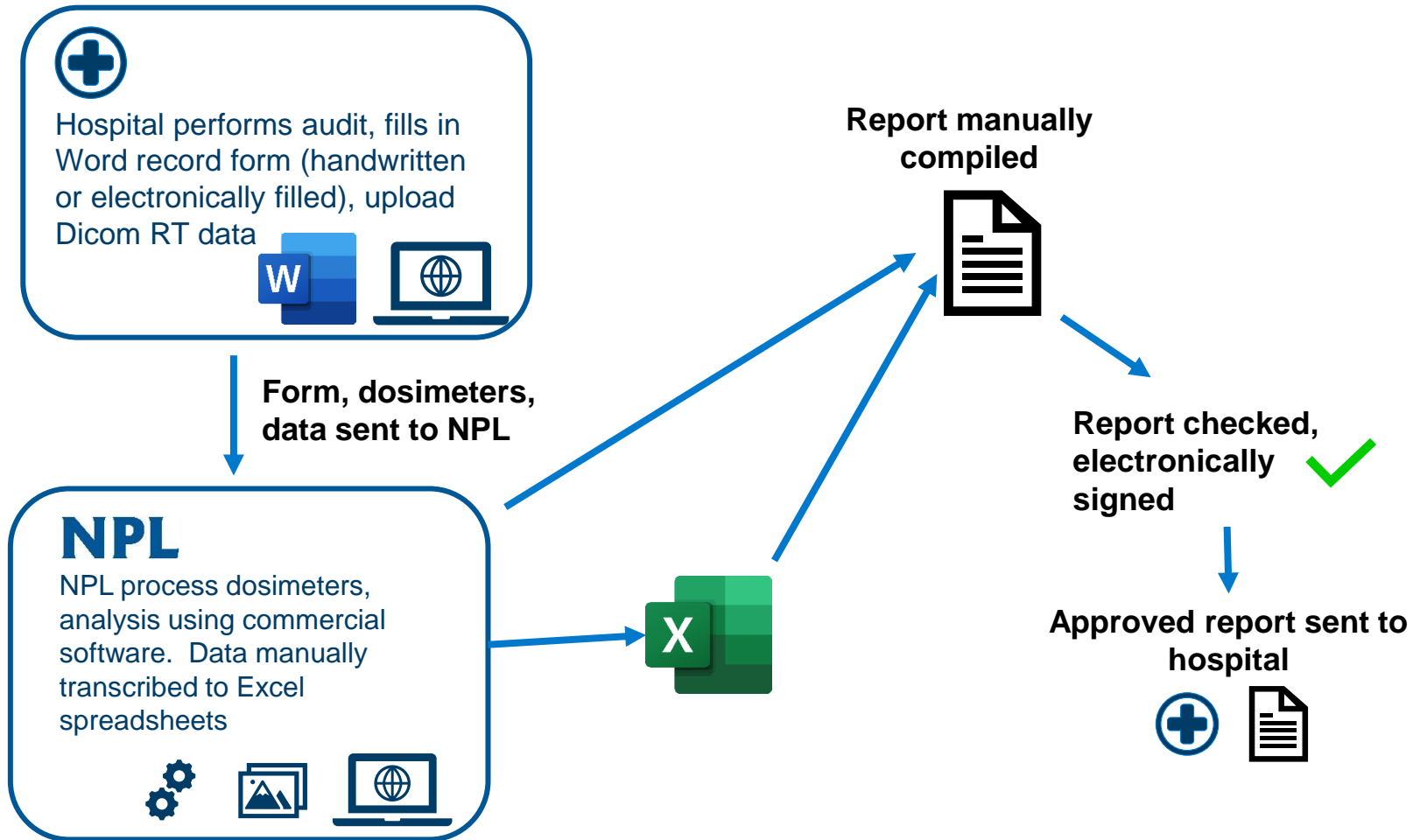


Radiotherapy dosimetry audits

- Radiotherapy audits conducted at hospitals across the UK
- Commercial test objects adapted by NPL
- Audits contain several predictions and measurements
- Information on equipment used at the hospital



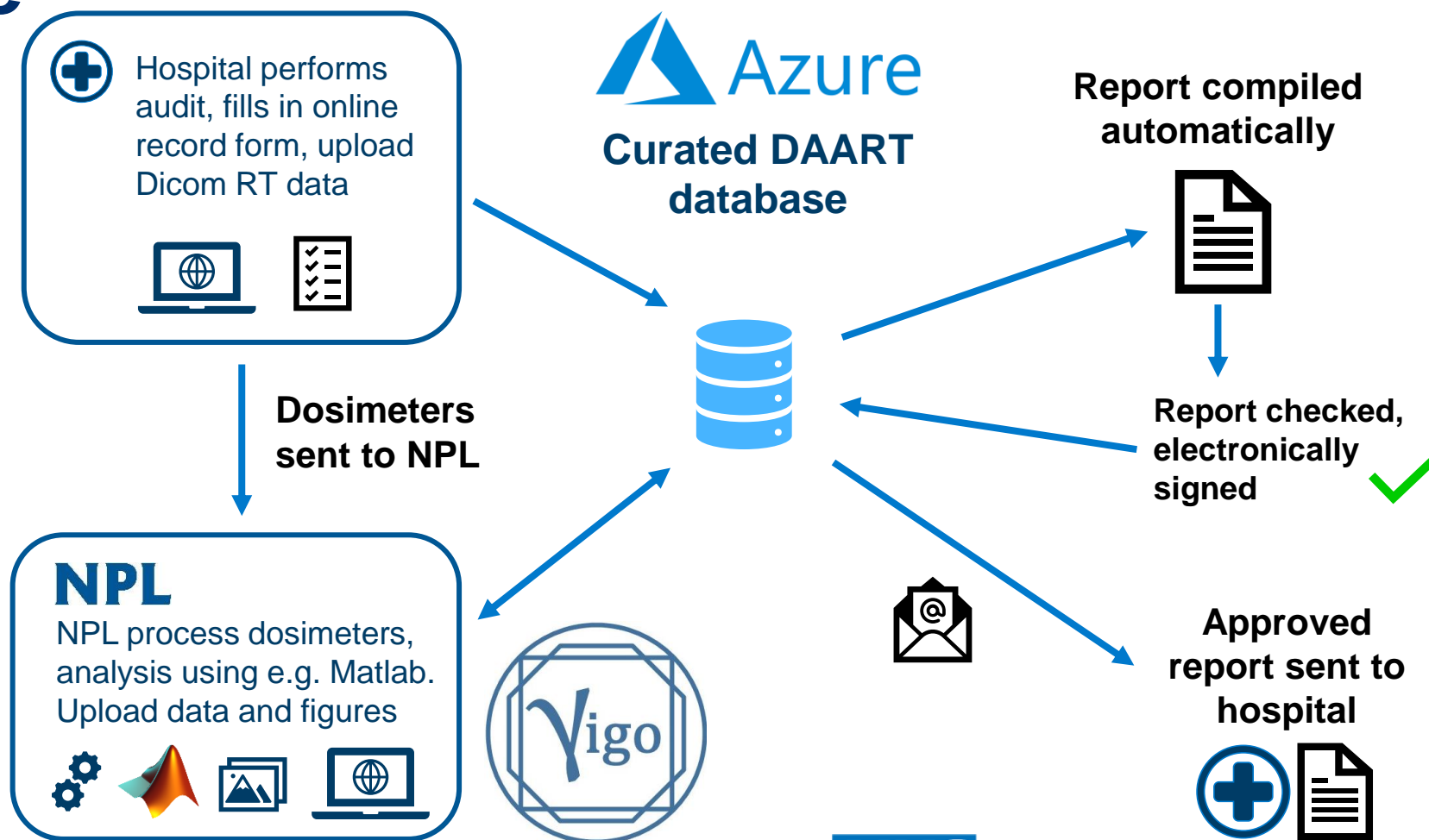
Audit reporting process



- A lot of manual steps
- Data stored at NPL
- Data not used beyond audit report

Dosimetry Audits for Advanced Radiotherapy (DAART) database

- Automates repetitive steps
- Data stored in database
- Data can be accessed and used beyond report

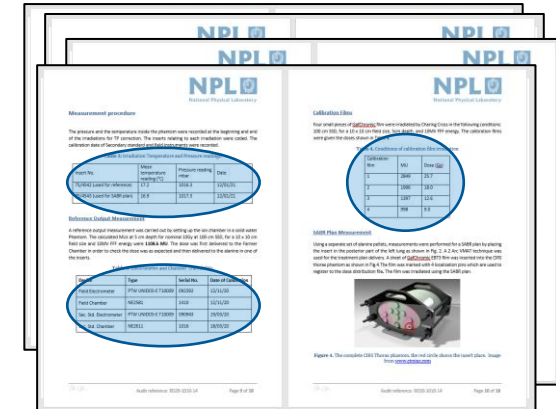


In partnership with

Data extraction and populating database



- Read Word document reports
- Search for data tables
- Extract data
- Structure using JSON format
- Upload to DAART



NPL

Extract data from existing reports. Structure into JSON format and upload data.



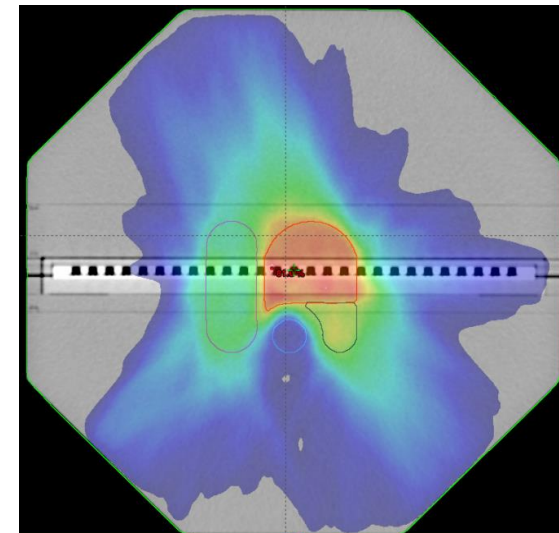
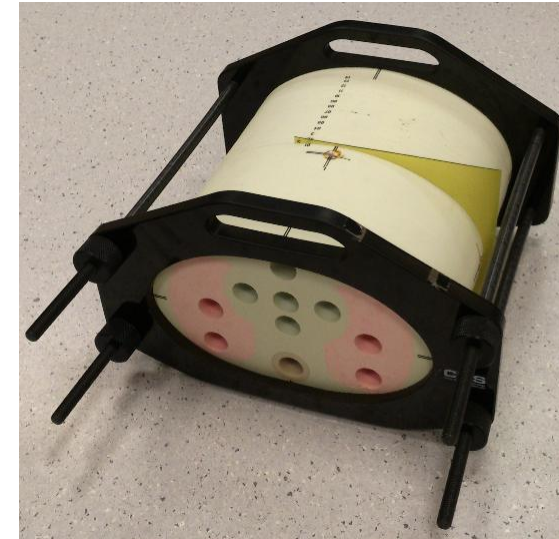
Curated DAART database



Lung SABR audit data

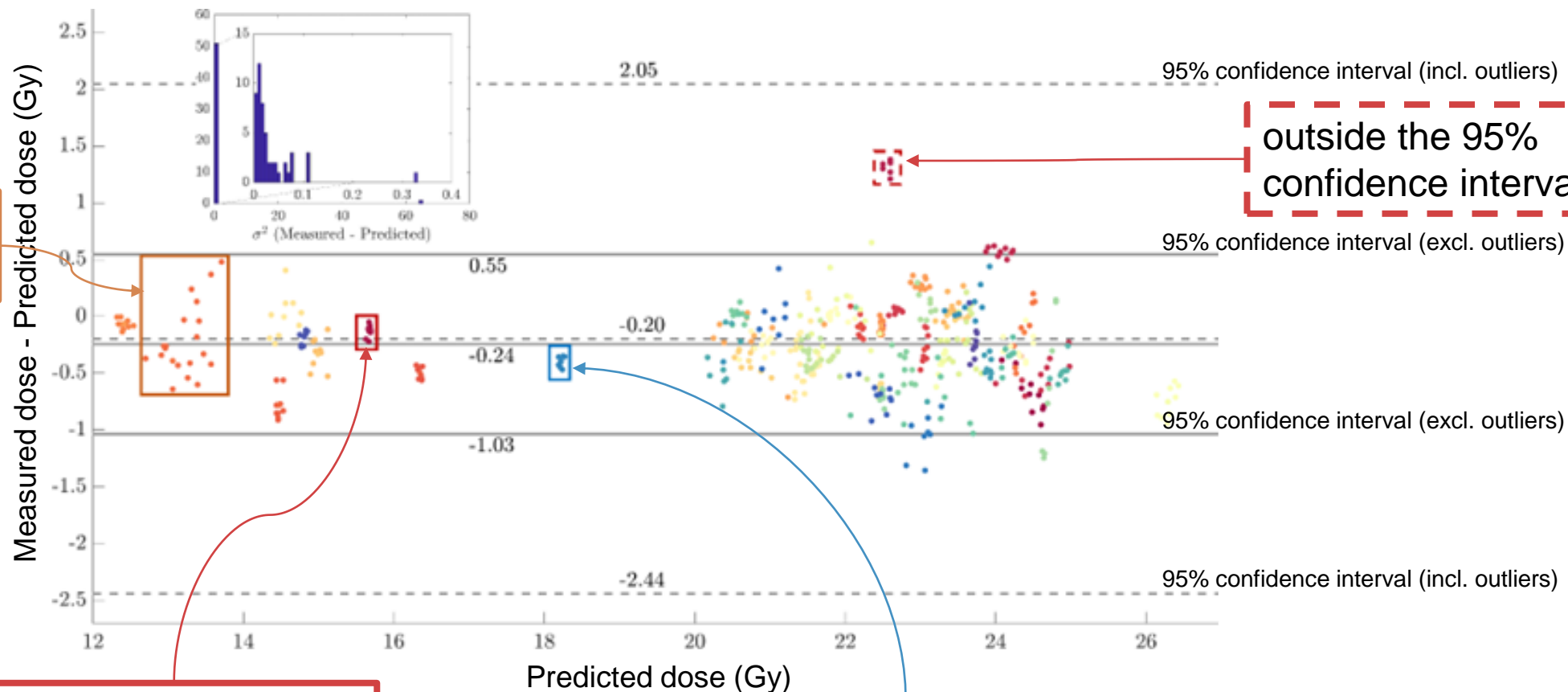
For each hospital/audit:

- Dosimeter number (location within phantom)
- Treatment planning system predicted dose
- Measured dose
- Calibration film type
- Machine
- Electrometer manufacturer, type, serial no
- Energy
- Technique used
- Monitor units – “beam on” time
- Temperature
- Pressure



Data analysis – summary statistics

Variance of difference between measured and predicted dose values in Lung SABR audits



highly variable measurements

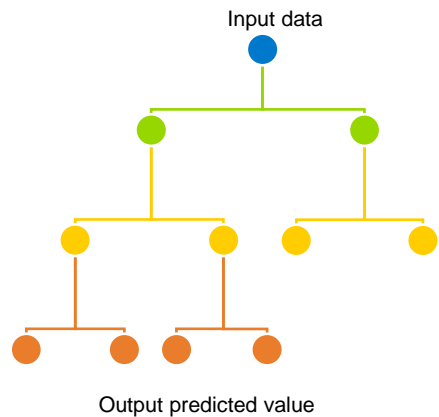
small differences between measured and predicted values

highly repeatable measurements, i.e. low variance

outside the 95% confidence interval

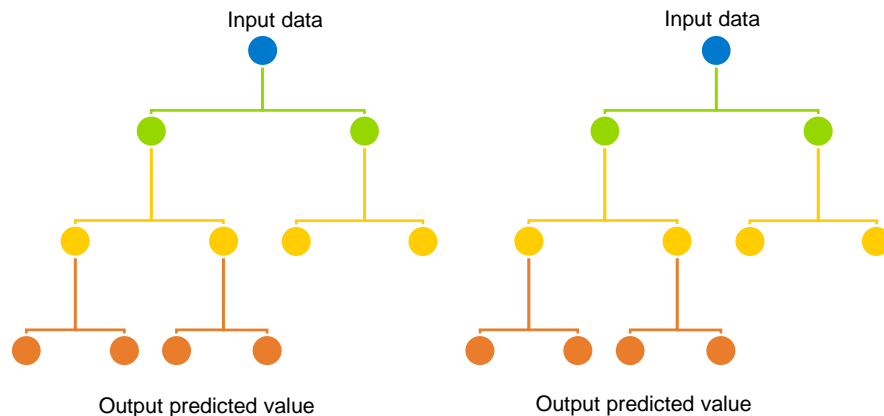
Data analysis – machine learning model

- Regression model – predicting the measured value from the data
 - Temperature
 - Pressure
 - Dosimeter number (location)
- Random forests
 - $N_{\text{trees}}=100$
 - Bootstrap samples used to build trees



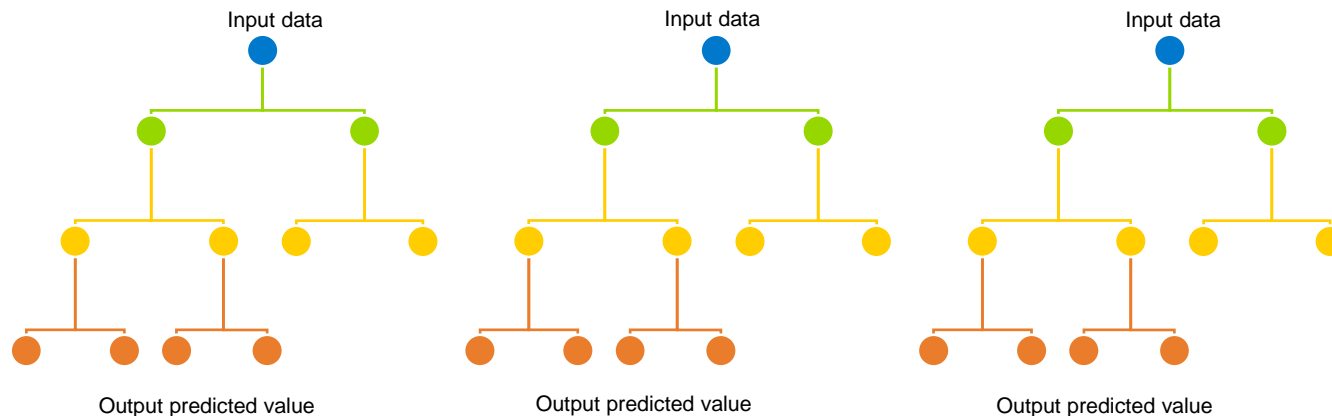
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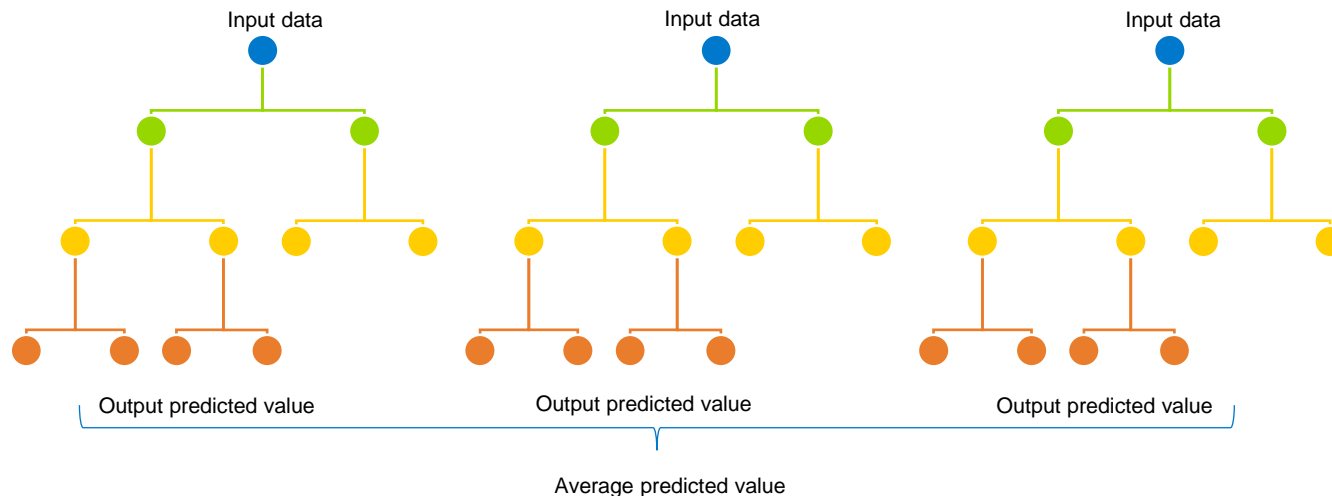
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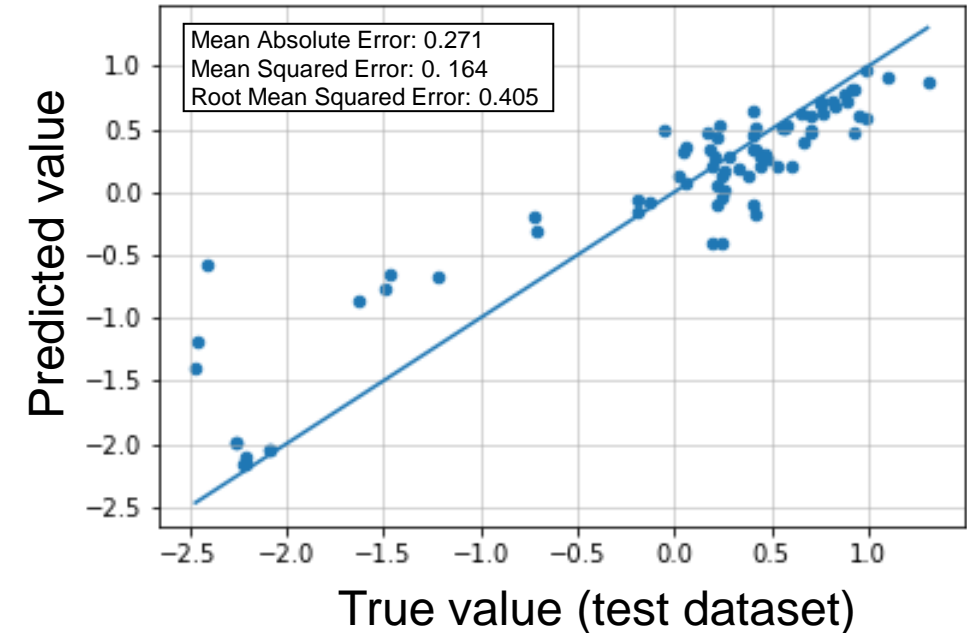
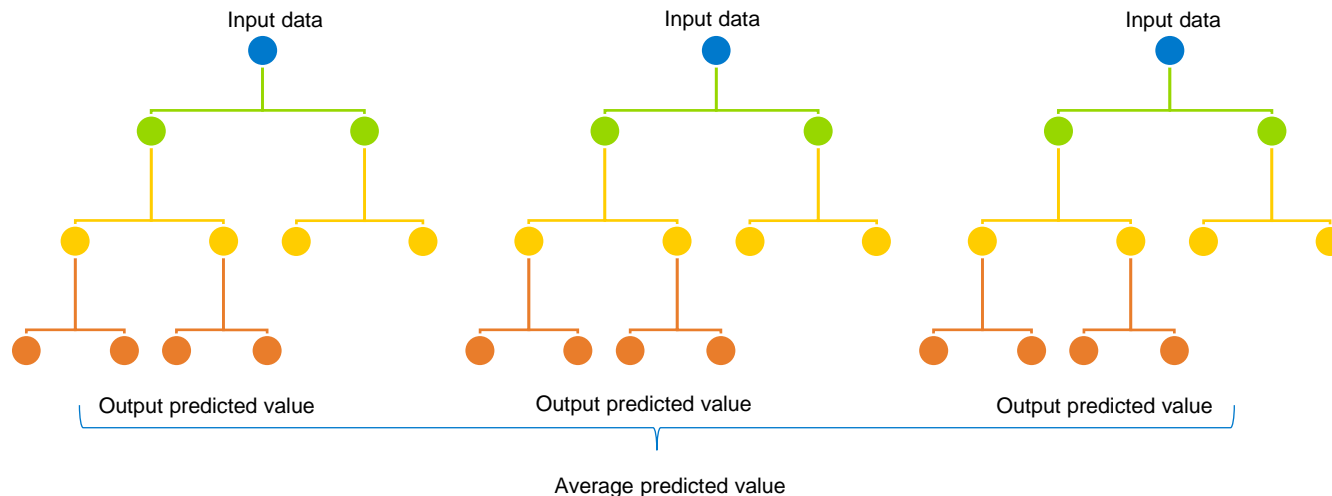
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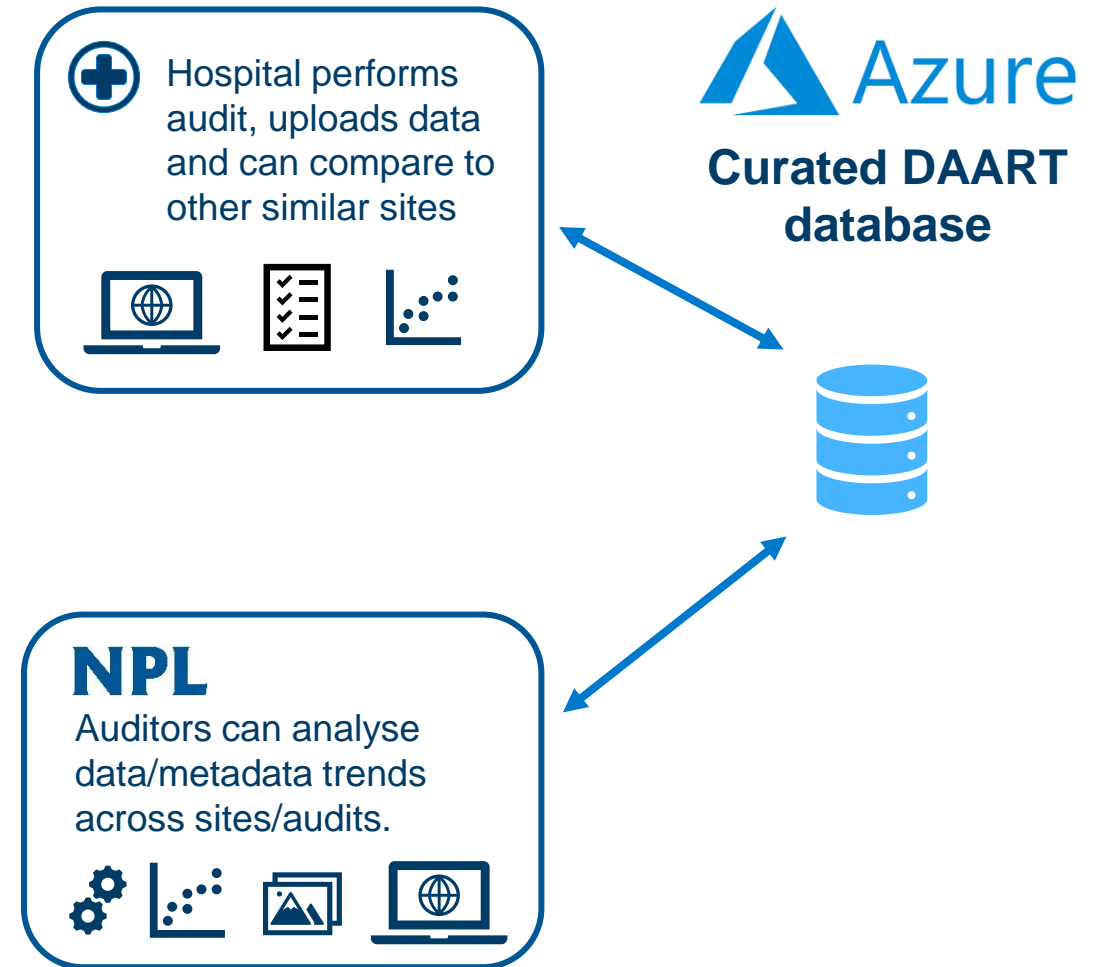


Relative influence
on prediction

Mean temperature reading (°C)	0.401620
Mean pressure reading (mbar)	0.361086
Dosimeter No.**	-0.085856

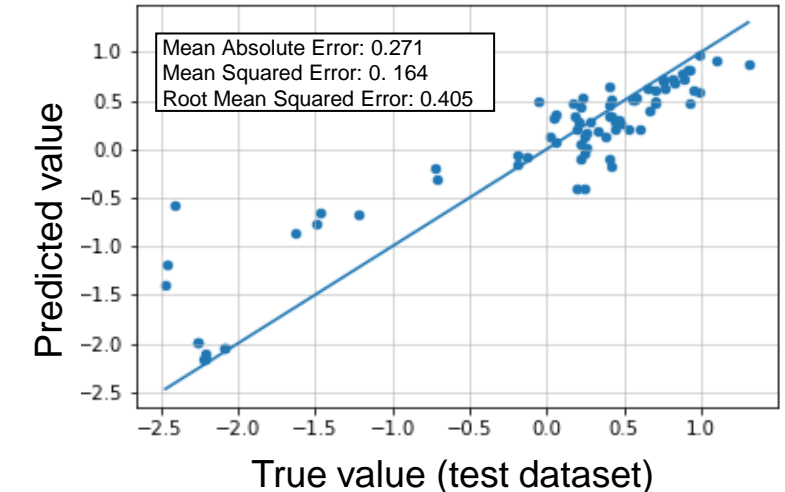
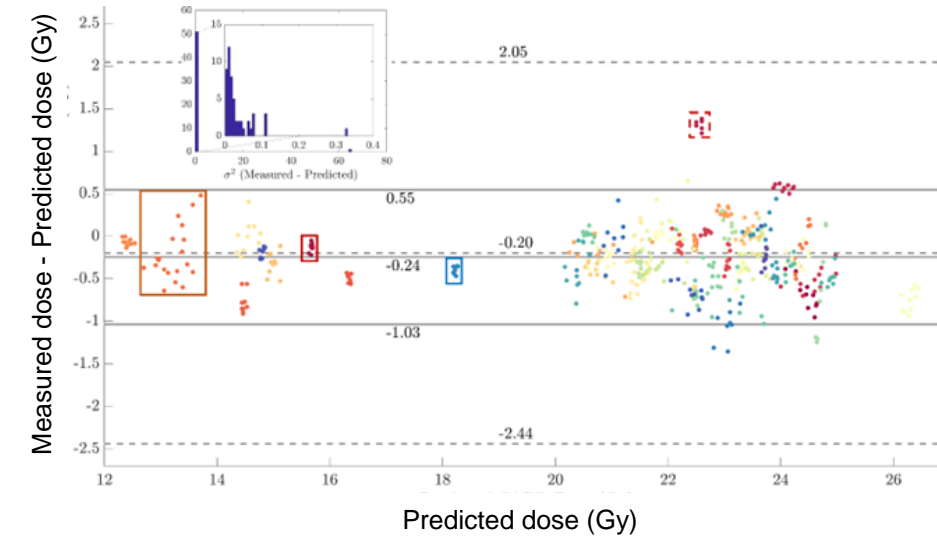
Data analysis – next steps

- Update models with more parameters in consultation with clinicians
- Populate DAART database with remaining data
- Live interaction with populated DAART
 - Auditors can see analysis from updated database
 - Hospitals can see how they compare to similar sites
 - Auditors and regulators may provide additional services or recommendations
 - Future standards, tolerances, patterns or dependencies



Summary

- NPL provide service to hospitals for radiotherapy audits
- New DAART database will improve service and provide new opportunities for data analysis
- Meta-analysis of existing audit data shows quantitative comparisons between hospitals – accuracy and precision of dose predictions
- Machine learning models provide insight into key parameters influencing delivered dose



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