A 'big data' analysis of radiotherapy beam output measurements:
Do constancy devices under report beam output?

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BACKGROUND

- The radiation dose delivered by radiotherapy treatment machines is monitored (daily).

- Range of measurement techniques.

  - Farmer chamber – weekly/monthly

  - Constancy device – daily

- Ideally measurements with different devices/setups should produce the same results.
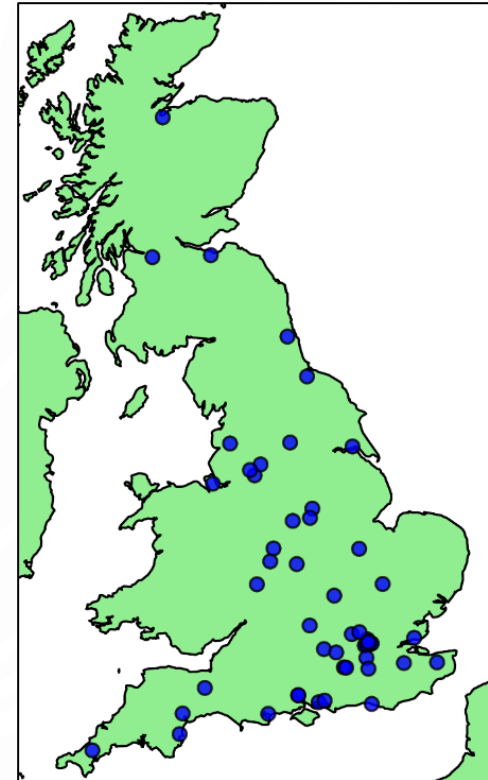
EXAMPLE DATASET
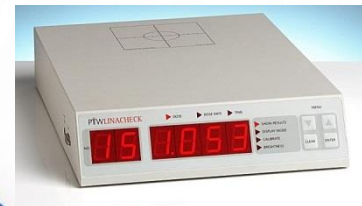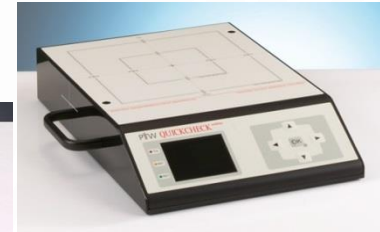
- Measurements should allow reliable monitoring of the beam output
  - Trends, recalibrations, etc.

Output measurements for a single treatment machine

DATA COLLECTION

- 6 months beam output data requested from UK radiotherapy centres for 6 months.

  - Received data from 204 machines.

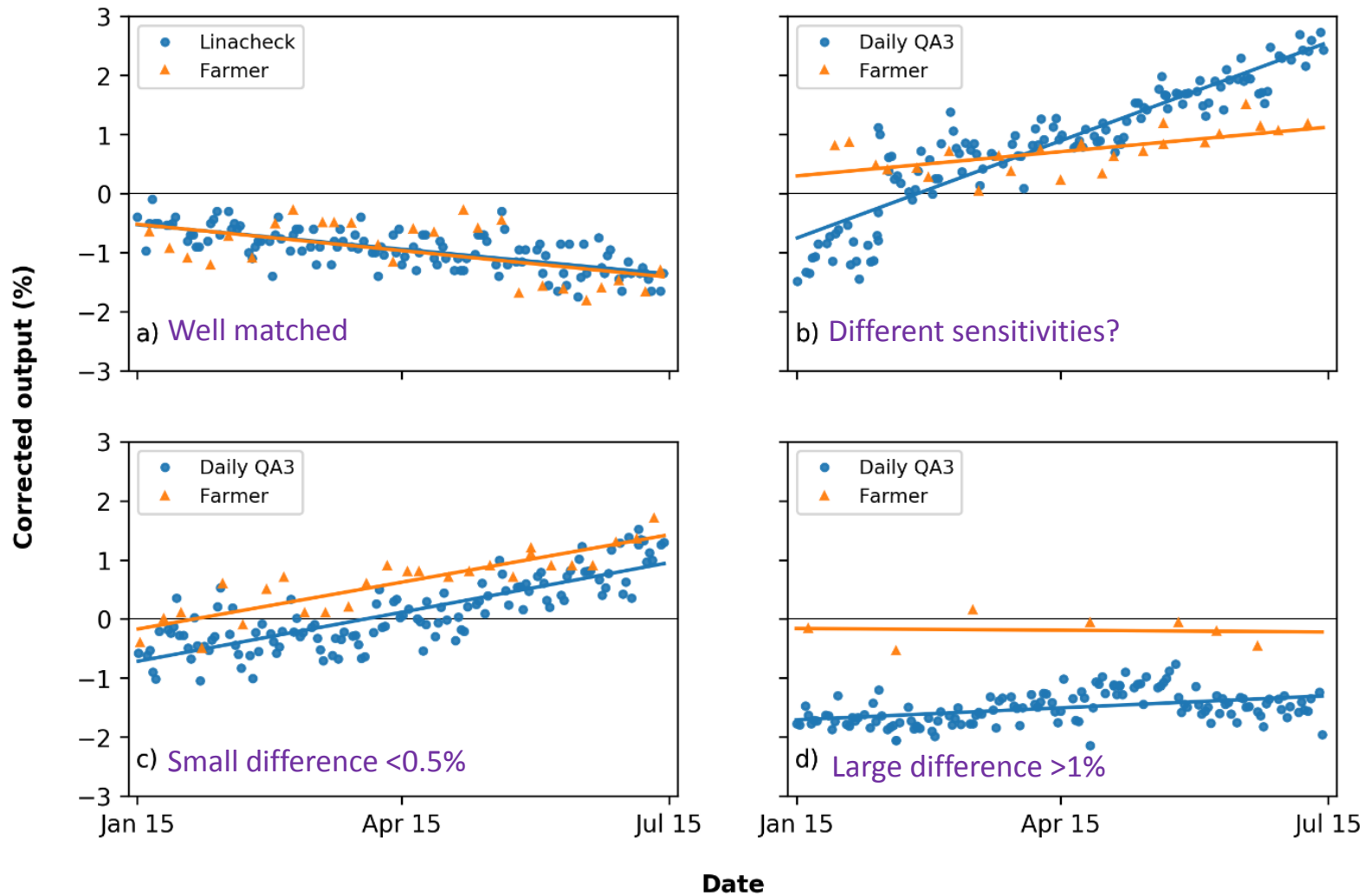- 95 machines with data from Farmer and constancy device

DATA COLLECTED

- 29 centres

- 95 machines

- >10k measurements
  - Usually only a few

- Excluded any machines with Farmer results < monthly

Manufacturer	Model	No. centres	No. machines
Various	Farmer chamber	29	**95**
PTW	Linacheck	8	**42**
Sun Nuclear	Daily QA3	15	**34**
PTW	QuickCheck	5	**13**
Standard Imaging	Beam Checker	3	**14**
Sun Nuclear	CheckMate	3	**10**
Varian	MPC	1	**4**

EXAMPLE DATASETS

a) Well matched
b) Different sensitivities?
c) Small difference <0.5%
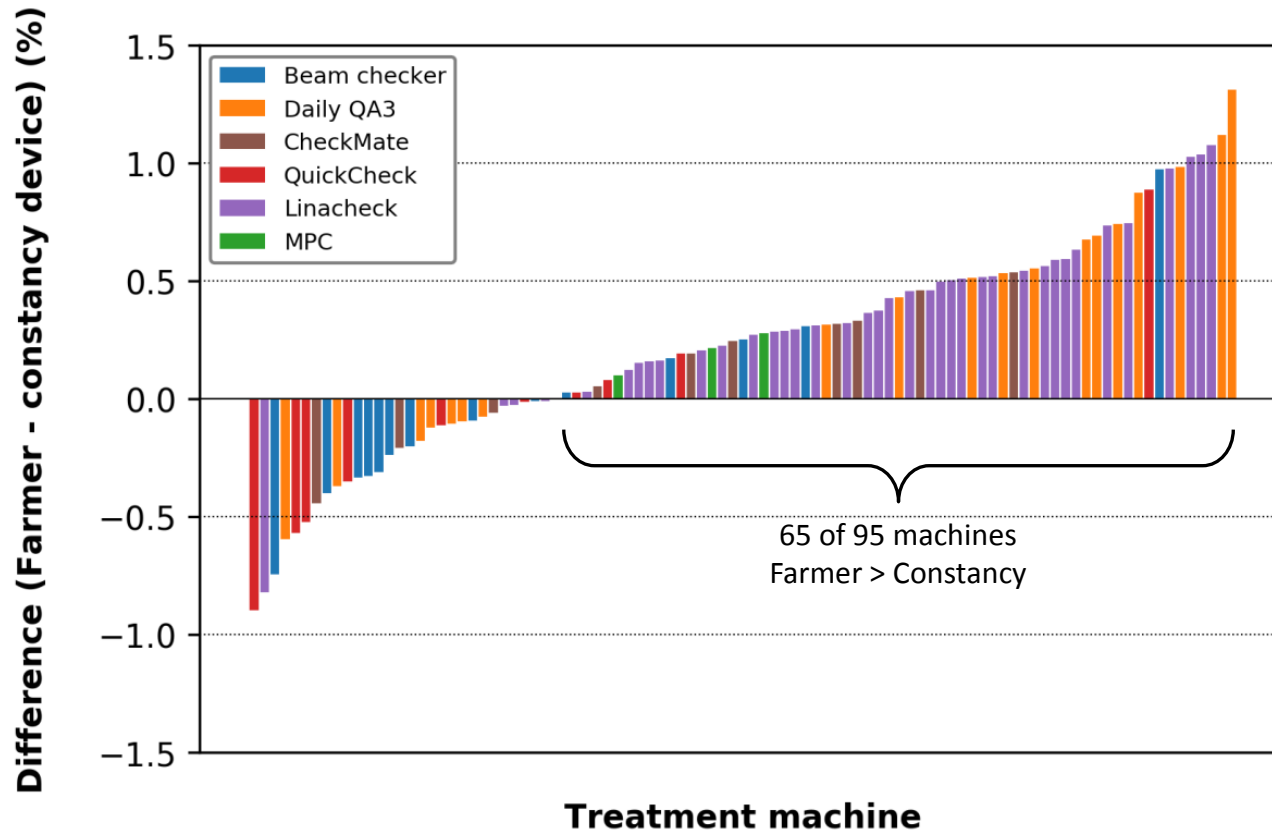d) Large difference >1%

DATA ANALYSIS

- Split by measurement device on each machine

- Examine difference between mean results on each machine.

  - Ideally zero difference (particularly over a long period).

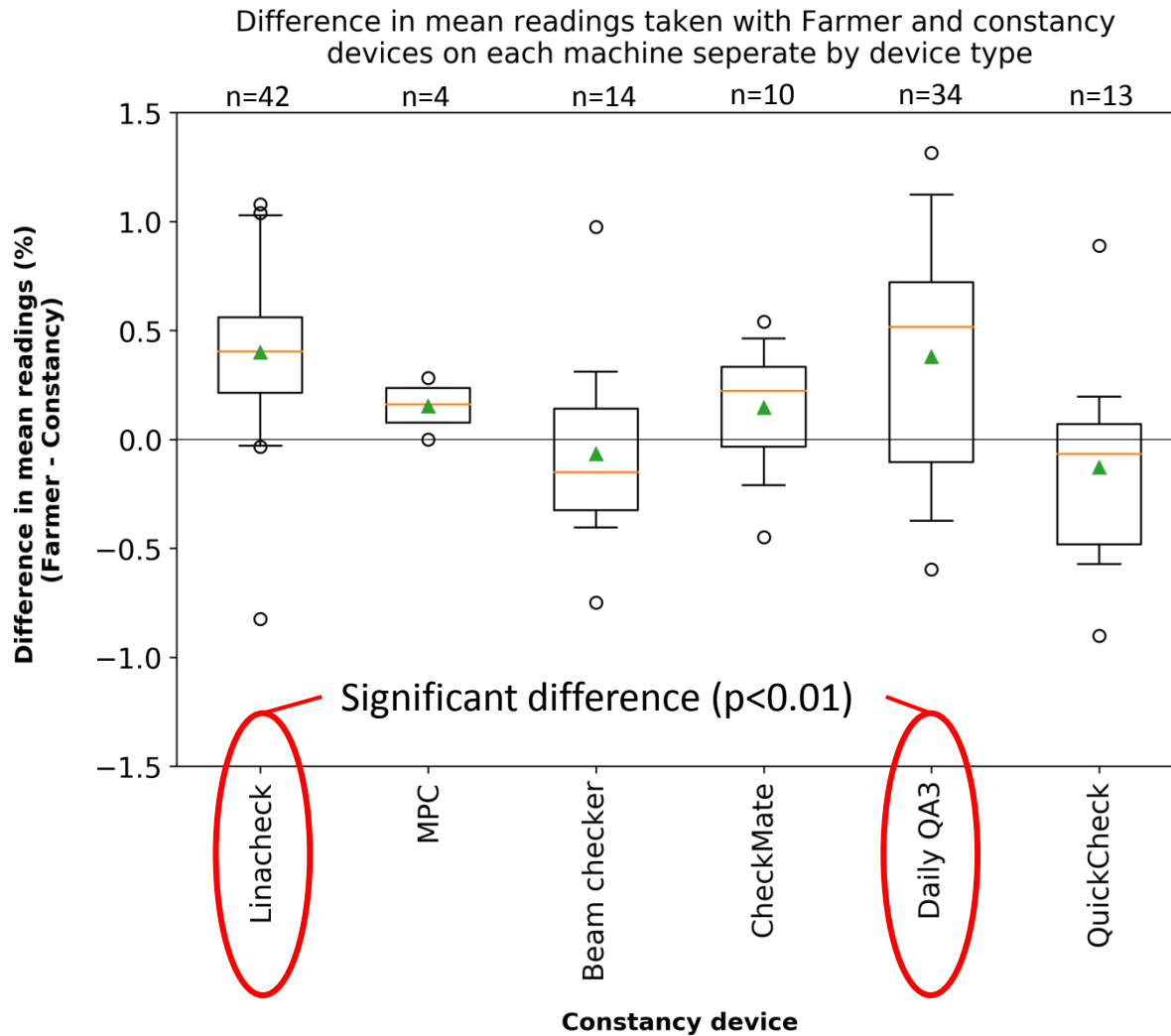 - Would expect even distribution around this.
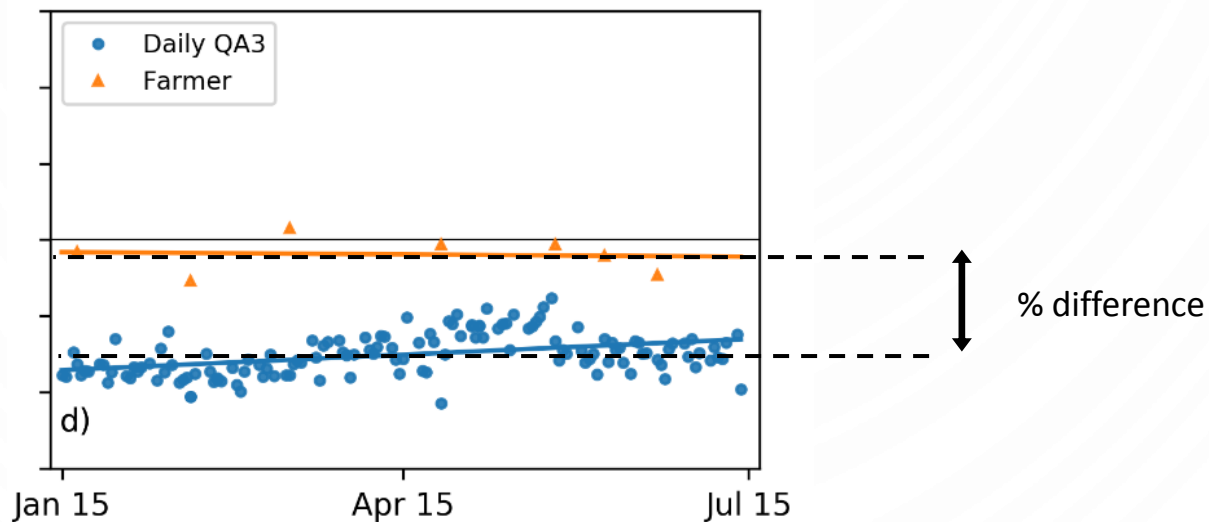
RESULTS

Difference in mean measurement results using Farmer and constancy device

- Mean = +0.23%

- Statistically different from zero (t-test, p<0.05)

RESULTS

- Compared each device individually

Difference in mean readings taken with Farmer and constancy devices on each machine seperate by device type

Discussion

- Where does this difference come from?

  - Battery charge state?

  - Warm-up period?

  - Reduction in sensitivity of constancy device?

  - Time of day?

    - Constancy measurements often early morning
    - Farmer might be later in the day

CONCLUSIONS

- Systematic (small) difference identified
  - Only possible with much larger dataset than usually used clinically.

- Further Work
  - Required warmup period?
  - Battery charge variation?
  - Similar for other beam energies?
  - Investigation of constancy devices at different times of day.

Distribution of differences between measurement devices
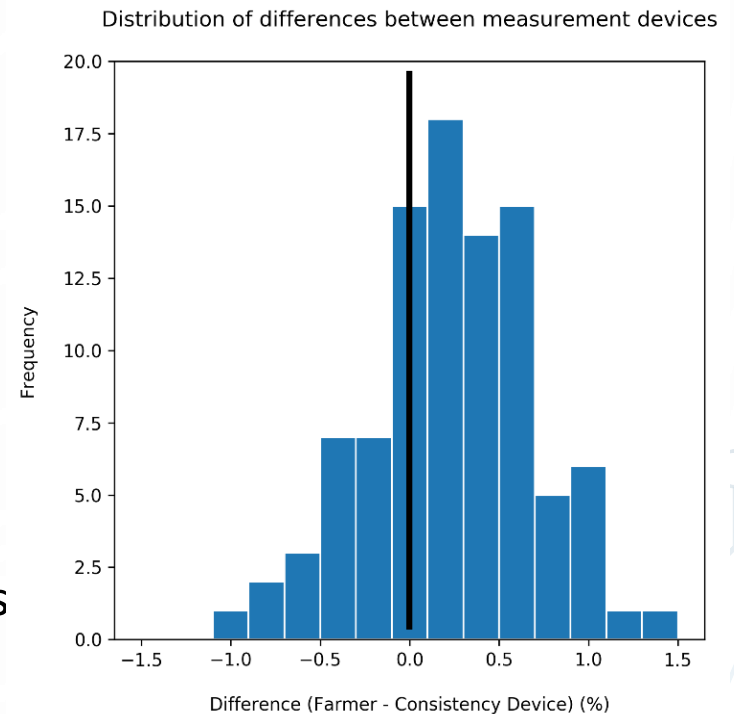
THANK YOU

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