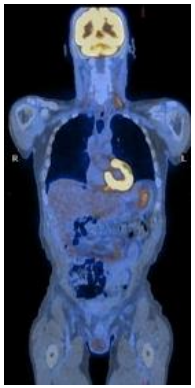
Quantitative Medical Imaging (CCRI(II)/13-30)

Quantifiable Radioactivity in Diagnostic Imaging

- Usefulness of medical imaging in trials depends on *consistent subject data* over time and distance
- *Persistent variability* in results from PET, SPECT images (in addition to subject variability)
  - Between clinical sites
    - Activity calibration (injected or phantom)
    - Conversion of image intensity to activity
    - Protocols for acquisition, reconstruction, analysis
  - Between scanners
    - Conversion of image intensity to activity
    - Different reconstruction algorithms
  - Between scans
    - Activity calibration (injected or phantom)
    - Conversion of image intensity to activity

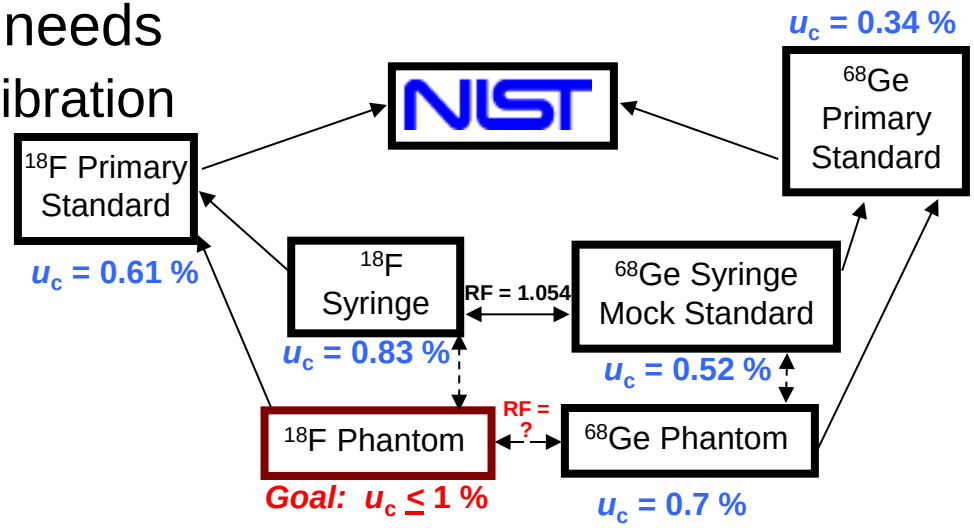


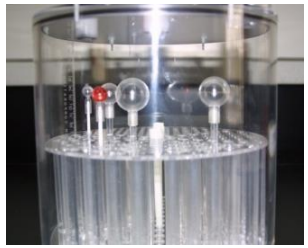
Goal: calibrations traceable to national standards for more quantitative results in patient assessment, drug development, and treatment planning

Meeting the Metrological Challenge

Traceability of ^{18}F Despite 2-hour Half-Life

- Input from stakeholders show needs
  - Traceability for instrument calibration
  - Longer-lived
  - Phantom variety
  - Protocols
- Ge-68 ($t_{1/2}$ = 271 d)
  - National standard
  - Calibration for different geometries (syringe, phantoms)
- Issues discovered
  - Traceable ^{68}Ge mock-syringes, 3 clinical sites (30+)
  - Manufacturer-recommended settings for ^{18}F
  - Comparison with NIST traceable activity value for ^{18}F
  - Results all 5-6 % too high
- Status
  - Calibration transferred to NIST Secondary Standard IC (routine future calibrations)



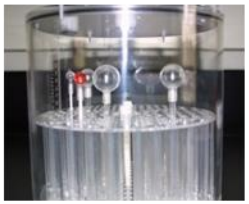


Impact

- Clinical relevance
  - Same tools
  - Close collaboration with users
  - Collaboration with universities
  - Discussions with regulators
- Leveraging of other NMI expertise (e.g., IT)
- Joint with CT and dosimetry efforts
- Availability of primary standard enables advances in the industry

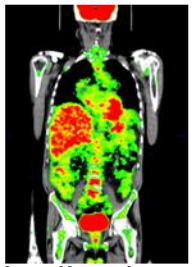
Injected activity

Activity calibrators calibrated against NIST ^{18}F standard, linked to ^{68}Ge (geometry-specific calibration factors)



Scanners calibrated against NIST ^{68}Ge standard using calibrated phantom

Calculated activity



Standardized protocols, analysis methodologies