Inter-laboratory calibration

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Refresher Training for Male' declaration
AIT, March 13-16, 2006

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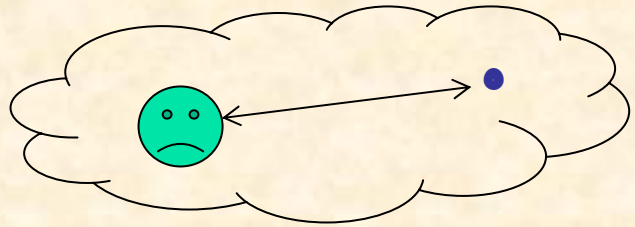
Expression of monitoring errors

Correct value (Y_c) = Observed (Y_o) ± Bias (E_o)

- **Bias:** measure of accuracy

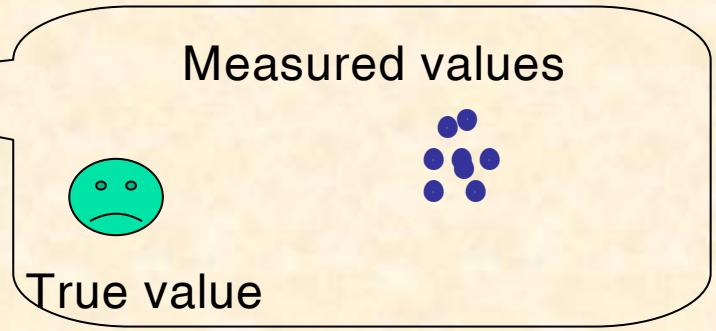
  $Eo = |Y_c - Y_o| \neq 0$



- **Precision:** reproducibility

  Precision vs. accuracy

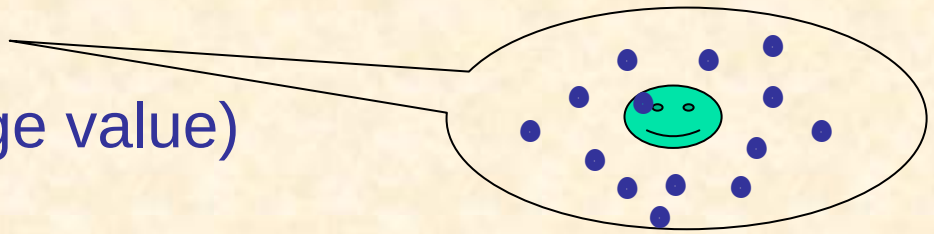
  Bias (systematic error) ≠ 0



- **Accuracy:** correctness

  Not precise (large σ)

  But accurate (average value)



Errors in monitoring data

Total Errors = Systematic + Random

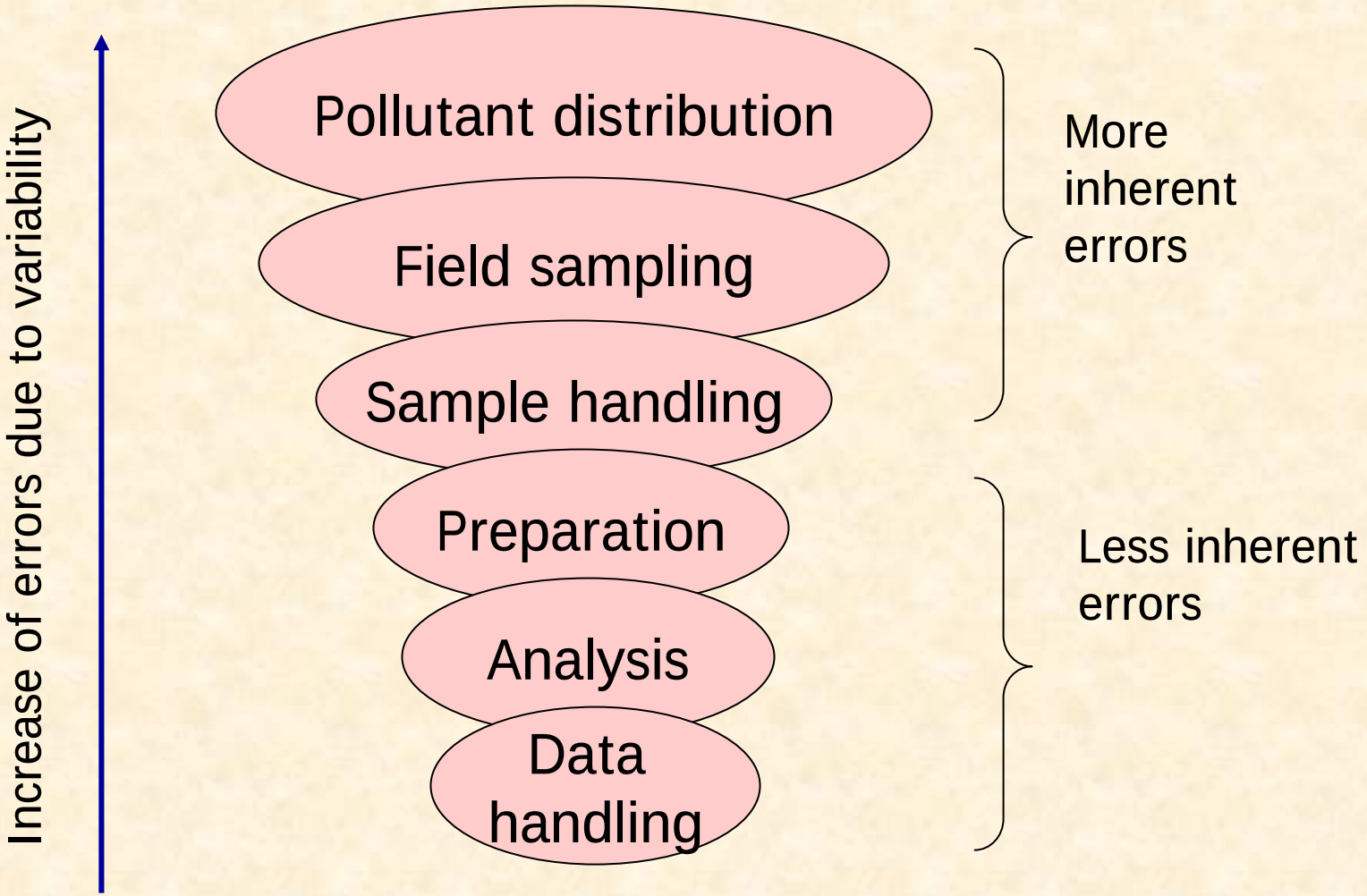
Systematic errors producing bias

- May be constant, either positive or negative; due to choice of sampling and analytical procedures, i.e. times, points, equipment, preservation, transportation or personnel

Random error producing imprecision

- Is variable in magnitude and sign (+/-)
- Caused by uncontrolled variables exist in experiment (environmental conditions & human factors)
- Described by law of probability with approximate normal distributions

Sources of variability in the environmental sampling and analysis



Potential sources of contamination

Steps in sampling and analysis	Contamination sources
Sample collection	Equipment Sample handling and preservatives Ambient contaminations Sample containers
Sample transport and storage	Containers, Cross-contamination from other samples/reagents, Sample handling
Sample preparation	Glassware, Reagents, Ambient contaminations, Sample handling
Sample analysis	Syringes for injections, Glassware, Equipment, Reagents

QA/QC for monitoring

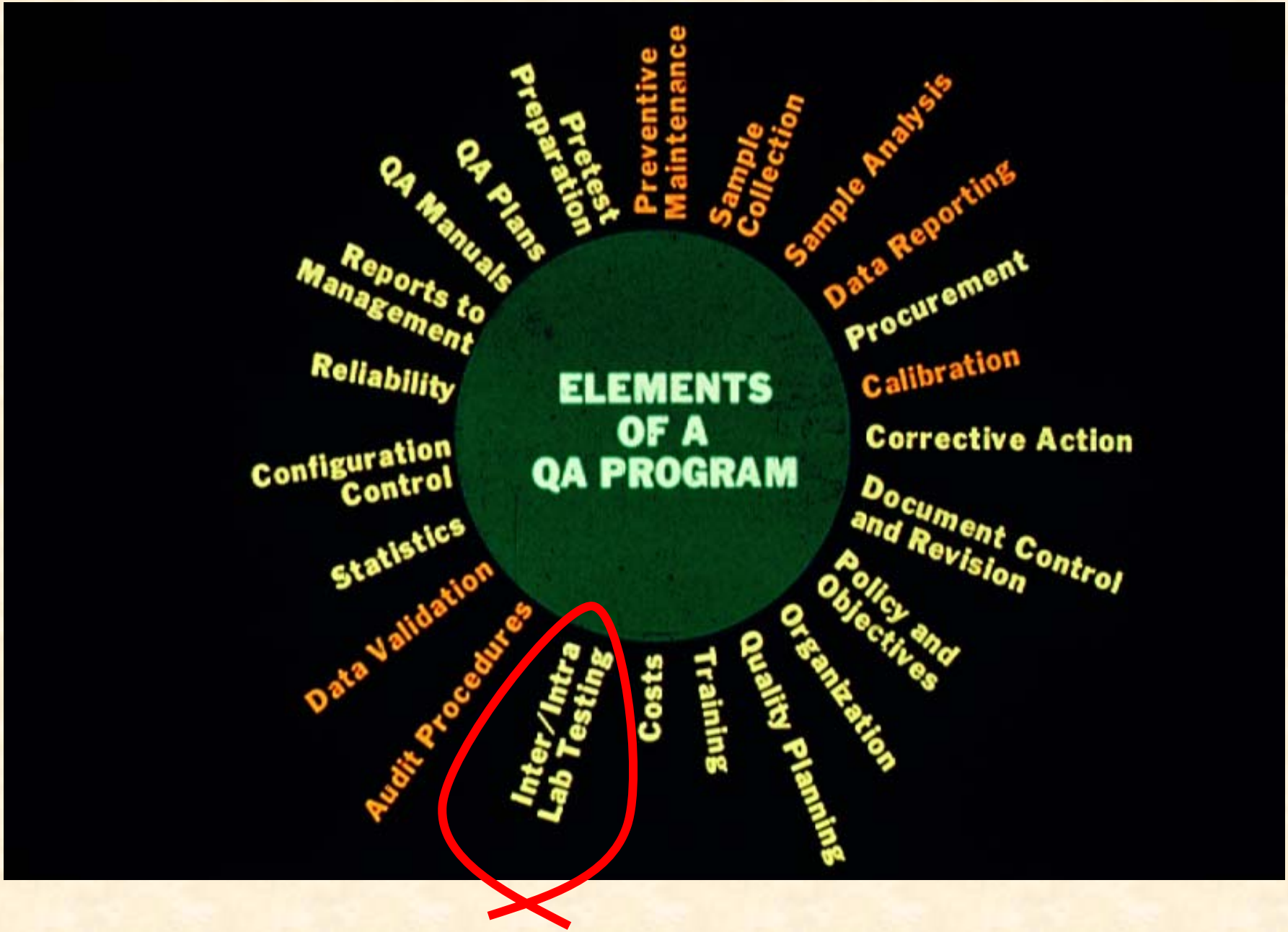
- QA/QC is independent function of monitoring process to establish accuracy, precision, and validity of data
- QC: everything **YOU** do to make sure that your monitoring is performed according to specifications: e.g. periodic calibration, split, spiked samples
- QA: is everything you have **SOMEONE ELSE** do to assure you that your QC is being performed according to specifications ➔ QA assesses adequacy of QC, e.g. independent performance audit and inter-laboratory calibration

Why QA/QC ?

- What is the principal product of air quality monitoring?

  DATA
- What is the principal product of QA/QC program?

  VALID DATA
- Why a QA/QC program important?
  - Cost effectiveness
  - Data credibility


ELEMENTS
OF A
QA PROGRAM
Preventive Maintenance
Sample Collection
Sample Analysis
Data Reporting
Procurement
Calibration
Corrective Action
Document Control and Revision
Policy and Objectives
Organization
Quality Planning
Training
Costs
Inter/Intra Lab Testing
Audit Procedures
Data Validation
Statistics
Configuration Control
Reliability
Reports to Management
QA Manuals
QA Plans
Pretest Preparation

Need for Valid Monitoring Data

- To reduce monitoring errors ➔ obtaining valid monitoring data is the ultimate goal of any monitoring program with considerations of cost-effective elements
- Valid monitoring data are basis for decision making process ➔ erroneous data could be expensive:
  - Actions be initiated on erroneously high concentration
  - No actions be taken if monitoring gives erroneously low concentrations

Examples of Quality Control in Monitoring

- Sampling process design
- Representative monitoring data
- Sample handling/preservation procedures
- Analytical method requirements (splits, replicated, matrix spikes)
- Calibration check procedures
- Formulas for calculating data quality indicators

Principal Indicators of Data Quality

- Accuracy
- Precision
- Representativeness
- Spatial coverage
- Temporal completeness
- Detectability
- Comparability/harmonization

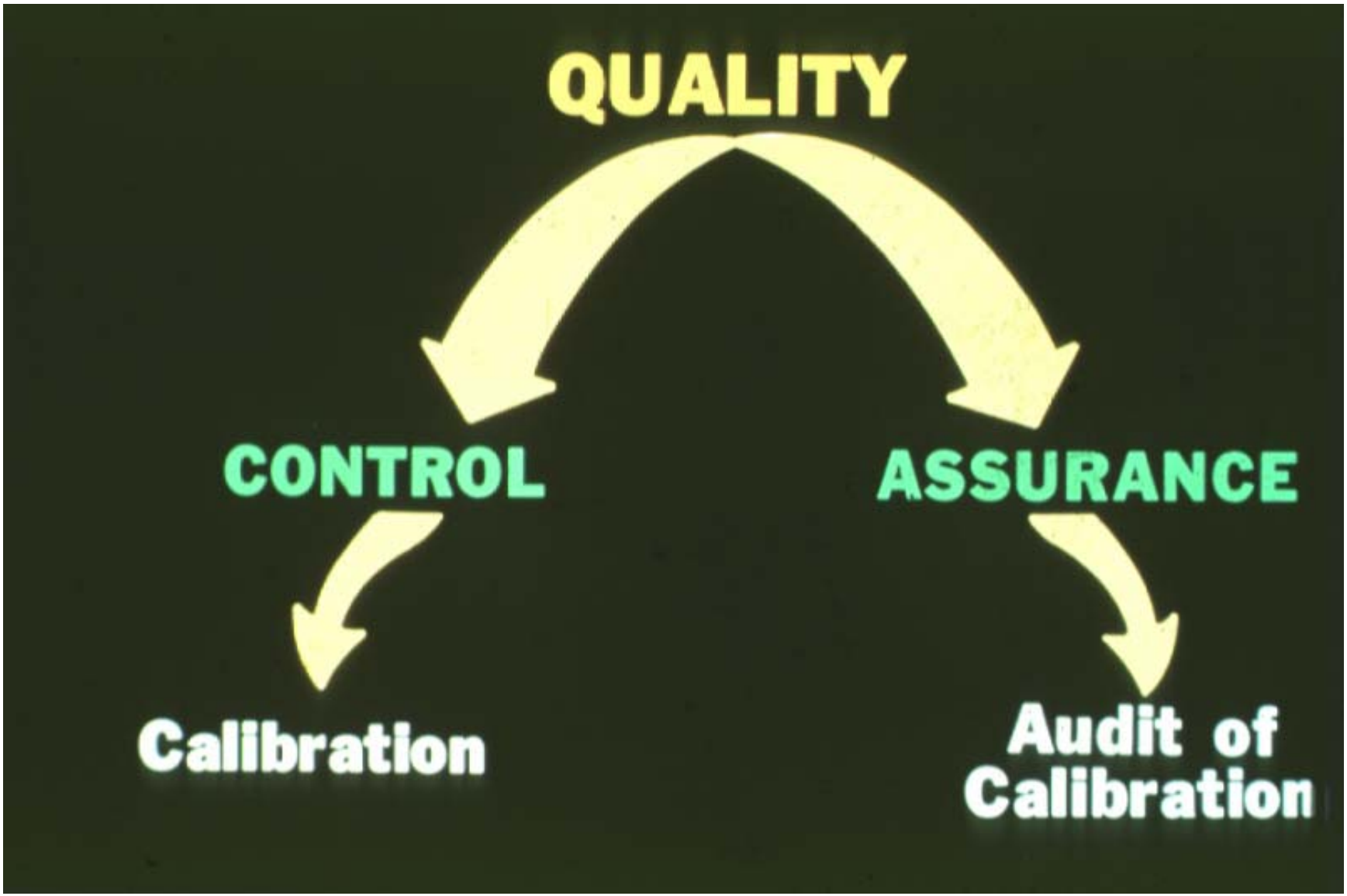
Quality Control Checks

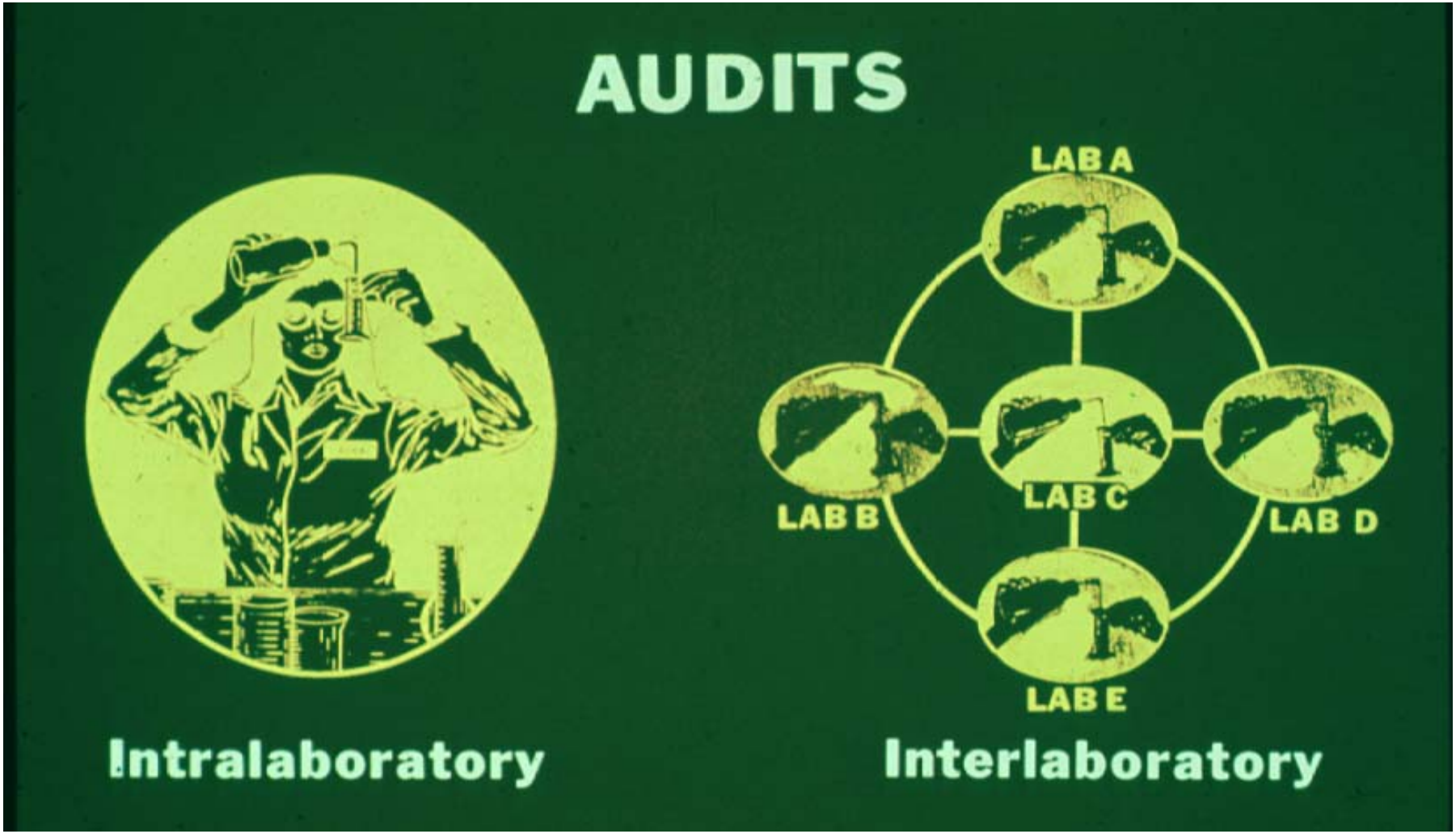
	Quality Control	Information Provided
Blanks	Field Blank	Transportation & field handling bias
	Reagent Blank	Contaminated reagent
	Rinsate Blank	Contaminated equipment
	Equipment Blank	Response/baseline
Spikes	Matrix spike	Analytical bias
	Matrix spike replicate	Analytical bias and precision
	Surrogate spike	Analytical bias, recovery

Quality Control Checks (Cont-d)

	Quality Control	**Information Provided**
Calibra-tion	Zero Check Span Check Mid-Range Check	Calibration drift and memory effects
	Collocated samples	Sampling & analysis precision
	Field replicates	Precision of all steps after sample acquisition
Replicate, Splits, Others	Field splits	Shipping precision
	Laboratory splits	**Inter-laboratory precision**
	Lab. replicates	Analytical precision
	Analysis replicates	Instrument precision

Inter-laboratory comparison





Inter-laboratory QC by the third party

Samples used for inter-laboratory comparisons

- Use individual identical samples:
  - Standard/certified reference materials with certified values of analytes (elements, organic compounds, etc.) → for accuracy
  - Blind samples → accuracy
  - Real world samples → to check the variation between labs
- Use 1 sample and take turn for analysis (Round-Robin test) → delay in time between the labs

Inter-lab comparison study (1)

Purpose:

- Provide diagnostic tools for analysis
- Identify uncertainties and variation of analytical results
- Offer guidance and support toward corrective measures

Outcome:

- General agreement between labs on real world samples
- Performance of the labs on CRM, blind samples

Inter-lab comparison study (2)

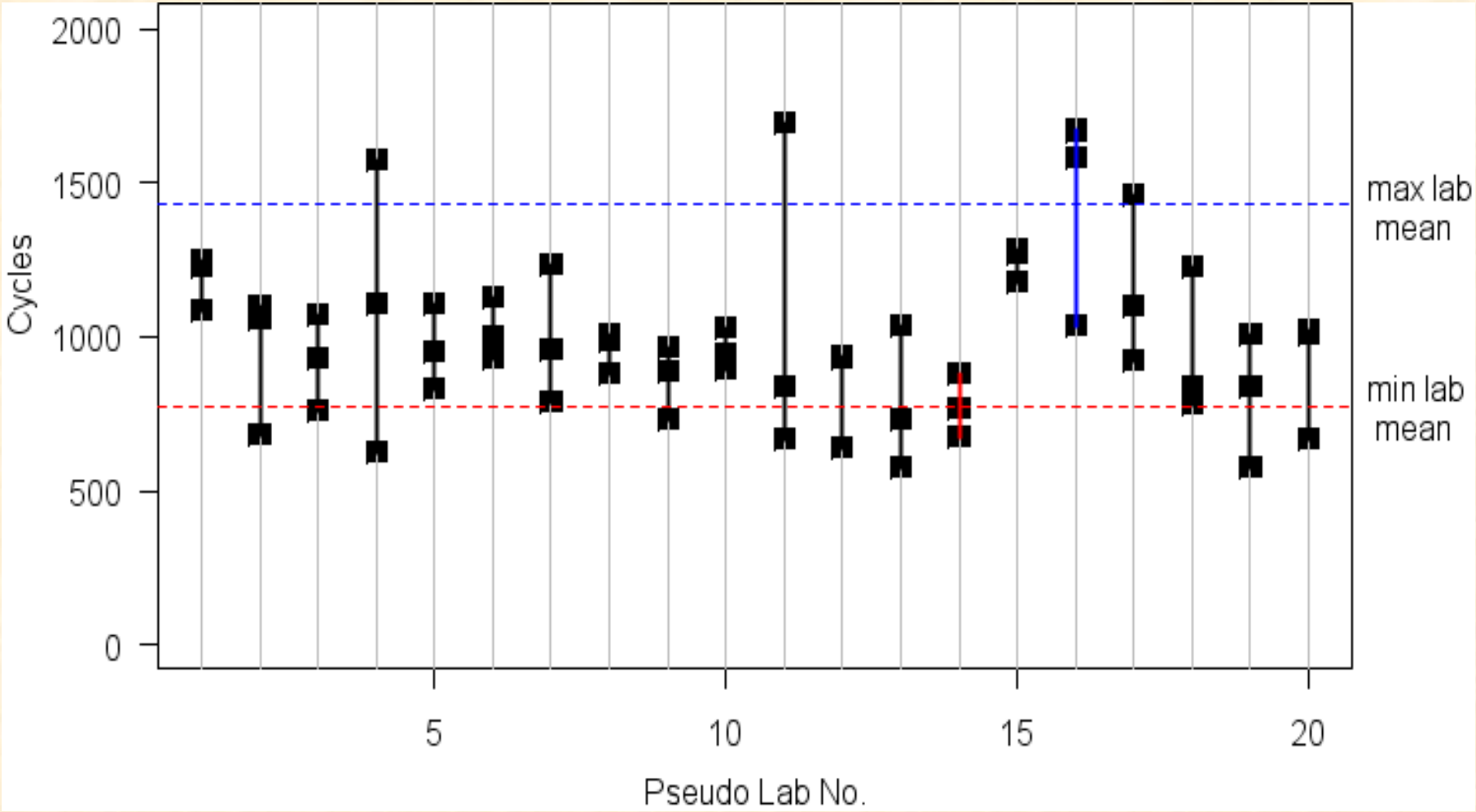
Main activities:

- Produce certified reference materials (CRMs)
- Distribute the certified reference materials
- Design and deliver a QA program to participating labs
- Each participating lab. analyzes sample following their standard operational procedure
- Collate the data from participating labs and assess data quality and comparability using advanced statistical tools

Inter-lab comparison study (3)

Data analysis and comparison:

- Collect analytical results and detection limits
- Review data to detect probable abnormality and communicate to labs
- Estimate average and STD of raw data set
- Establish lower and upper critical values and then omit outliers
- Calculate the adjusted mean and STD ➔ compare and assess lab performance



Labs 4 ,11: "abnormally" large scatter, due to poor QC
Labs 1, 8, 10, and 15: "superior" QC

C. Annis (2006)

Thank you