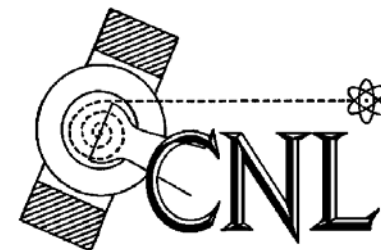
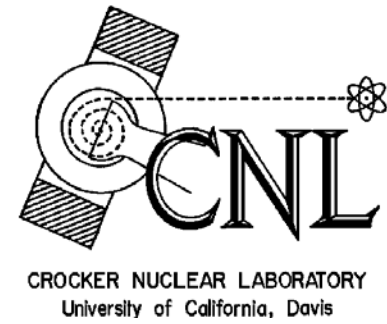


IMPROVE Sampling Methods Evaluation & Development

Chuck McDade
Crocker Nuclear Laboratory
University of California, Davis
Durango, Colorado
September 2007



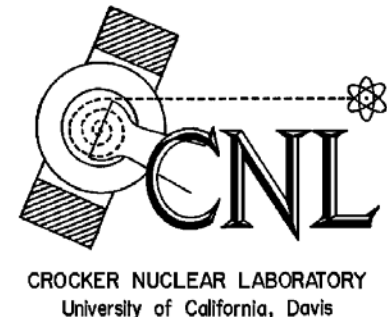
CROCKER NUCLEAR LABORATORY
University of California, Davis



REDESIGN OF TEMPERATURE PROBE



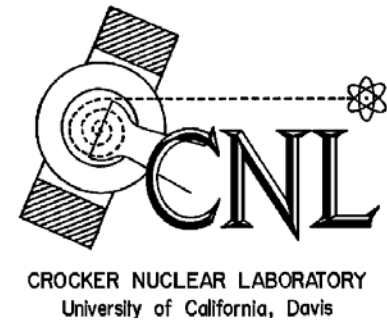
Tighter Tolerances on Temperature Measurements



- Old IMPROVE tolerance designed for $\pm 10^{\circ}\text{C}$
 - 10°C tolerance represents $< 2\%$ flow uncertainty, incorporated into our nominal 3% volume uncertainty
- STN desired IMPROVE-type module with $\pm 2^{\circ}\text{C}$ tolerance
 - 2°C tolerance represents $\sim 0.3\%$ flow uncertainty
 - New probe will be used in both IMPROVE and STN
 - New probe eliminates temperature-dependent diode



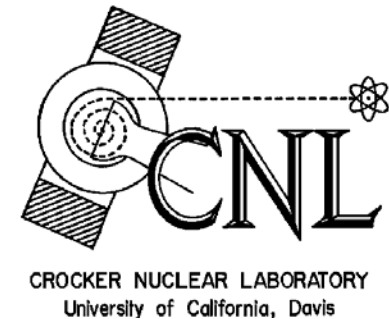
Testing & Deployment of New Temperature Probe



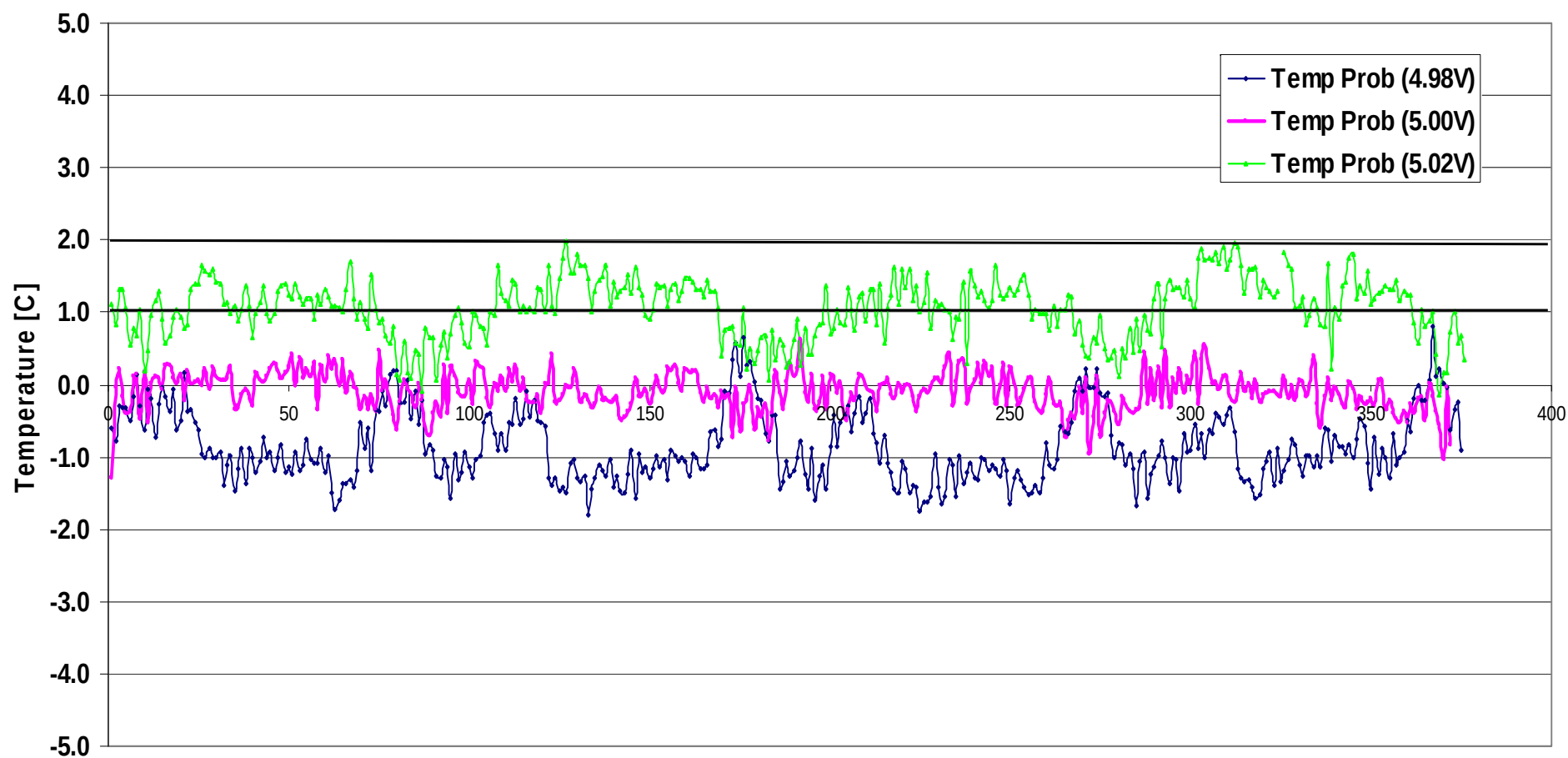
- Redesigned circuitry requires voltage regulator:
 5 ± 0.02 volts
- Each regulator tested against this tolerance
prior to deployment
- IMPROVE network being retrofitted this year as
part of maintenance

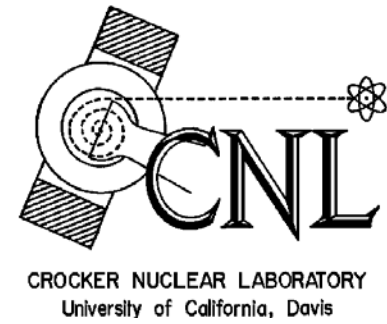


Results of the Probe Tests



Error in Degrees Celsius

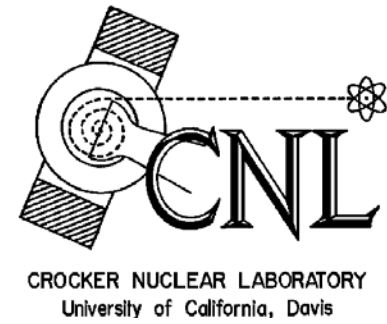




INLET SCREENS



Some inlets clogged with insect debris, discovered spring 2005





New design is easier to clean,
but still clogs on occasion



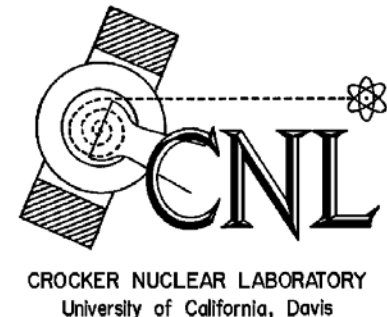


Retrofit screen is being installed this year





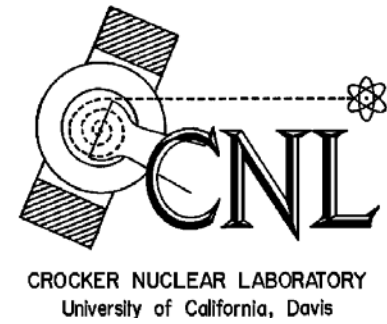
Testing of Inlet Screens



- 8 collocated IMPROVE A modules run simultaneously at UC Davis
 - 4 modules - new PM2.5 inlets with screens
 - 4 modules - new PM2.5 inlets w/o screens
- 12 or 24 hour samples, Teflon filters, mass measured
- 18 sampling days in summer of 2006 and winter of 2007
 - Some samples included rain and fog events



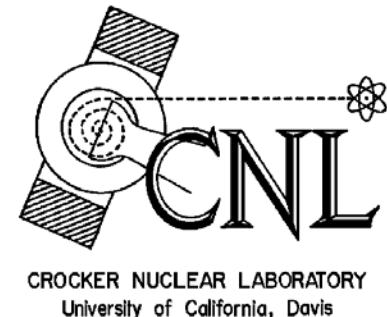
Results of Inlet Screen Tests



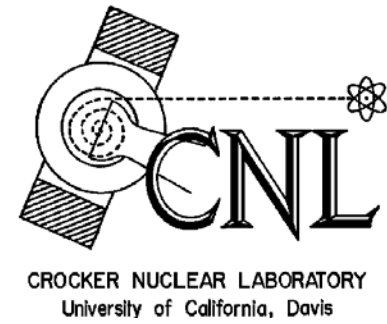
- No statistically significant differences observed
 - True for each individual sampling day
 - True for all sampling days together
- Average 0.54% bias for all samples is not statistically significant with 95% confidence



Inlet Screens: Conclusion & Plans



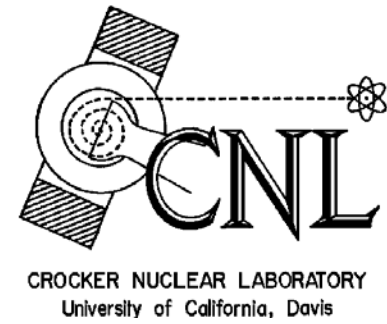
- Conclusion: New screens do not impact the measured concentration on IMPROVE PM_{2.5} samples
- Plans: Monitor performance in the field, especially at icy sites during upcoming winter



NEW CASSETTE SCREEN DESIGN



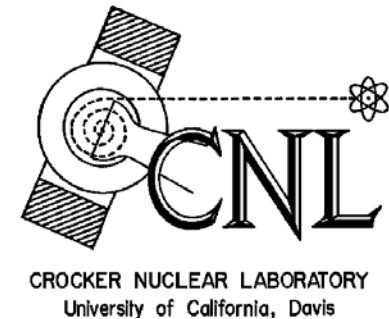
New Detached Screen Design



- Attached screens sometimes exhibit rings of deposit and missing crescents around edge
- New design uses detached screen, common in most samplers
- Testing is underway

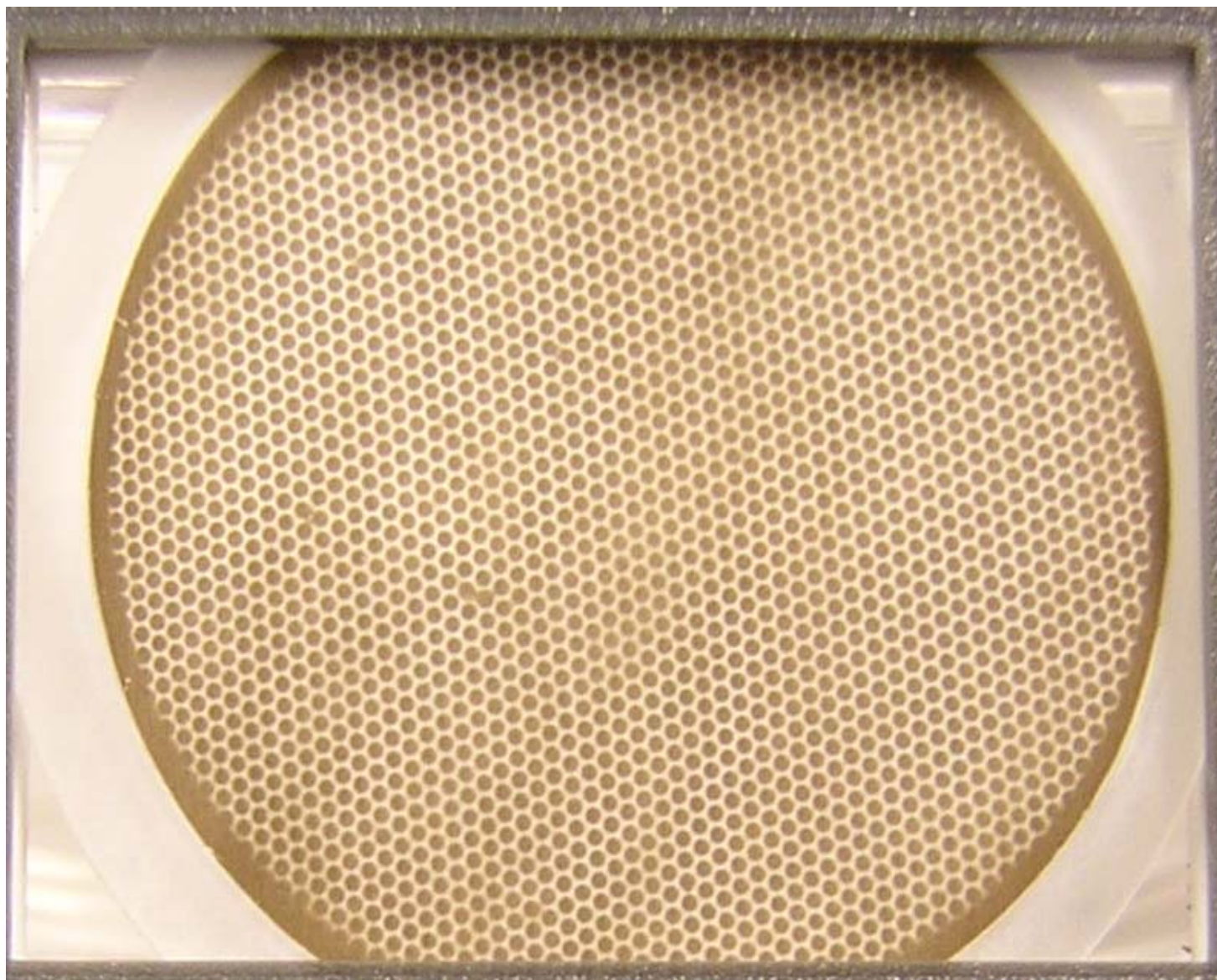


Some Filters Have a Crescent Cutout



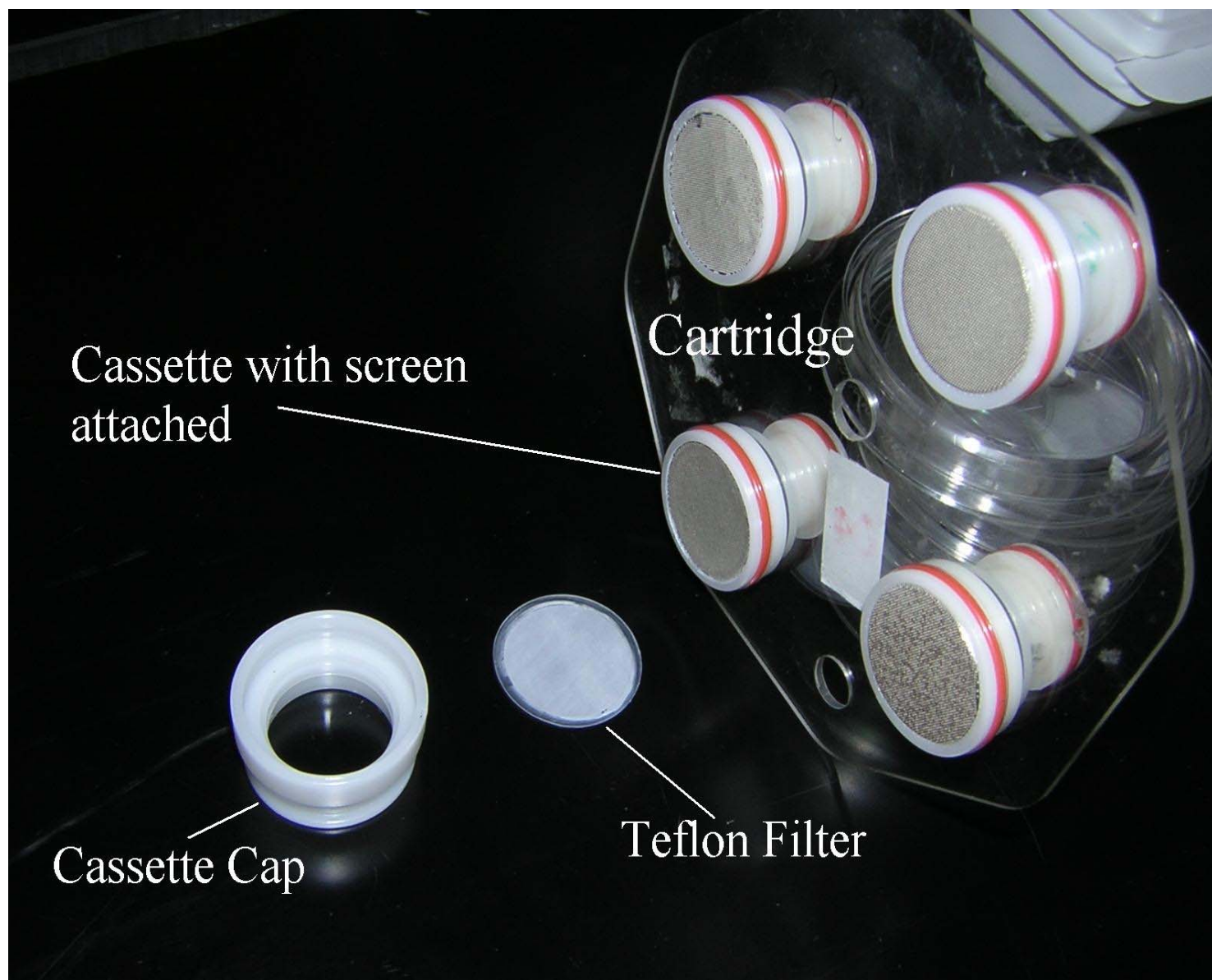


Some Filters Have a Ring of Deposit



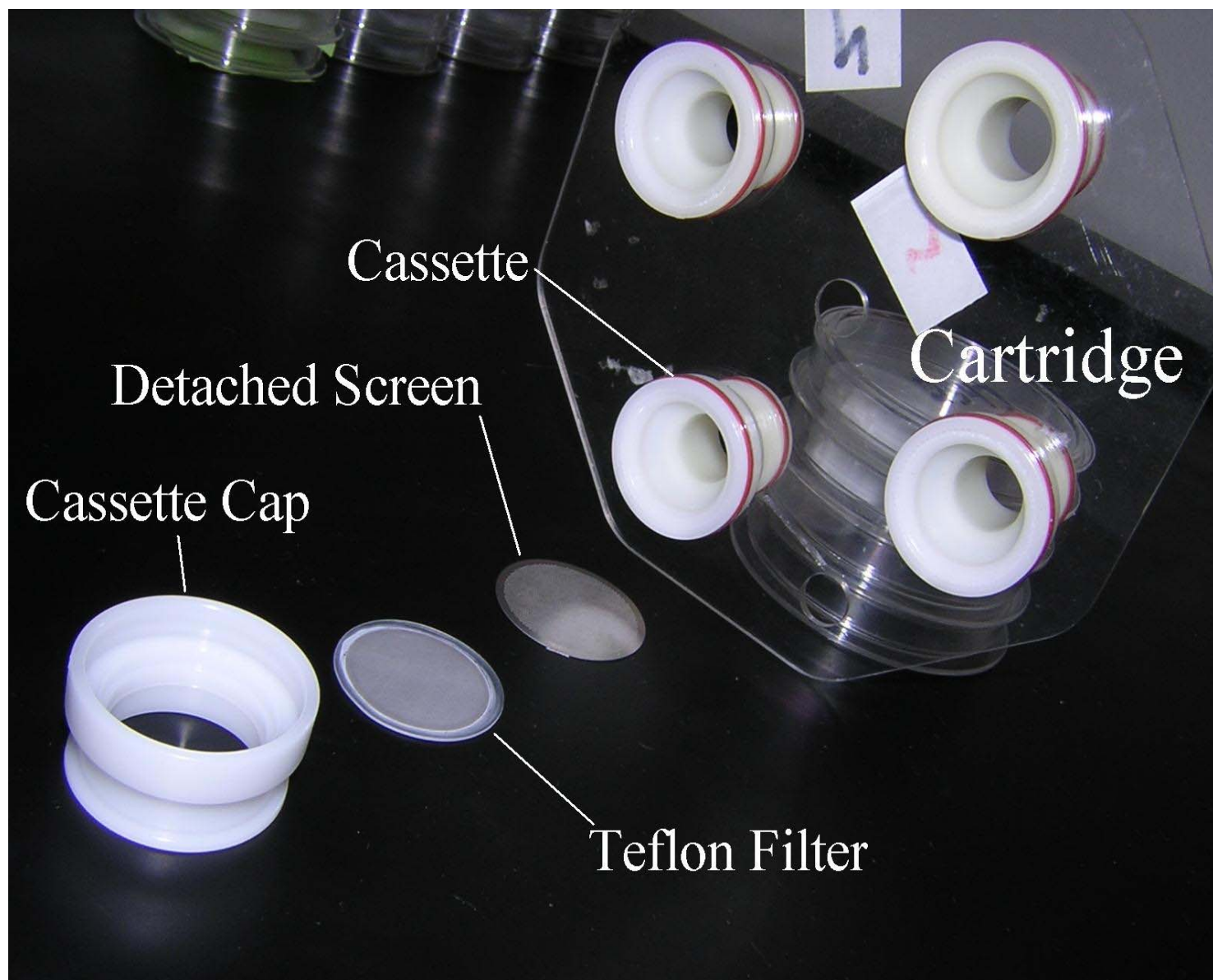


Original 1999 Cassette Design Version II Sampler



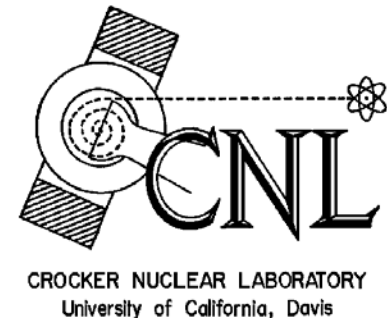


Prototype Cassette Design Detached Screen

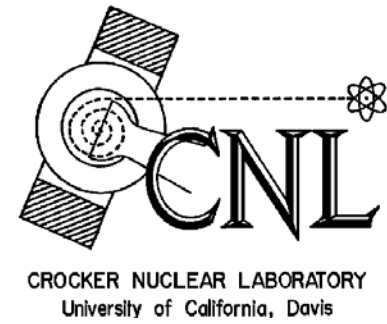




New Detached Screen Cassettes



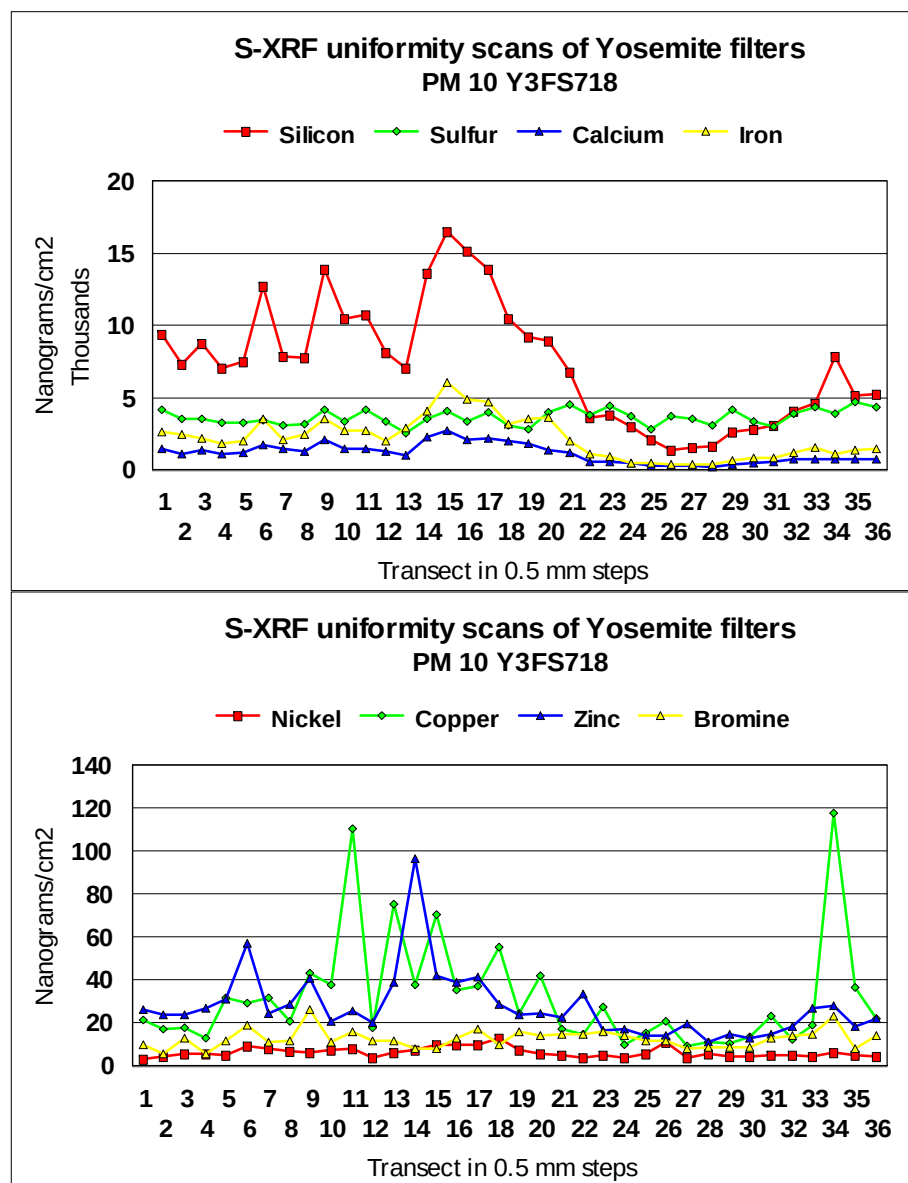
- Detached screen design consistent with most other samplers
- Consistently uniform sample deposits
- Testing underway; striving for gravimetric mass consistency with old design



REPLACEMENT OF PM_{10} FUNNELS



PM₁₀ Sample Inhomogeneity from Microbeam XRF Scans



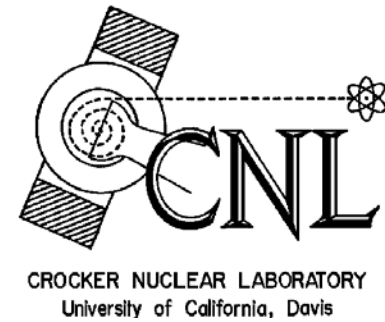


PM₁₀ Module





Some PM₁₀ Funnel's Had Slightly Different Dimensions



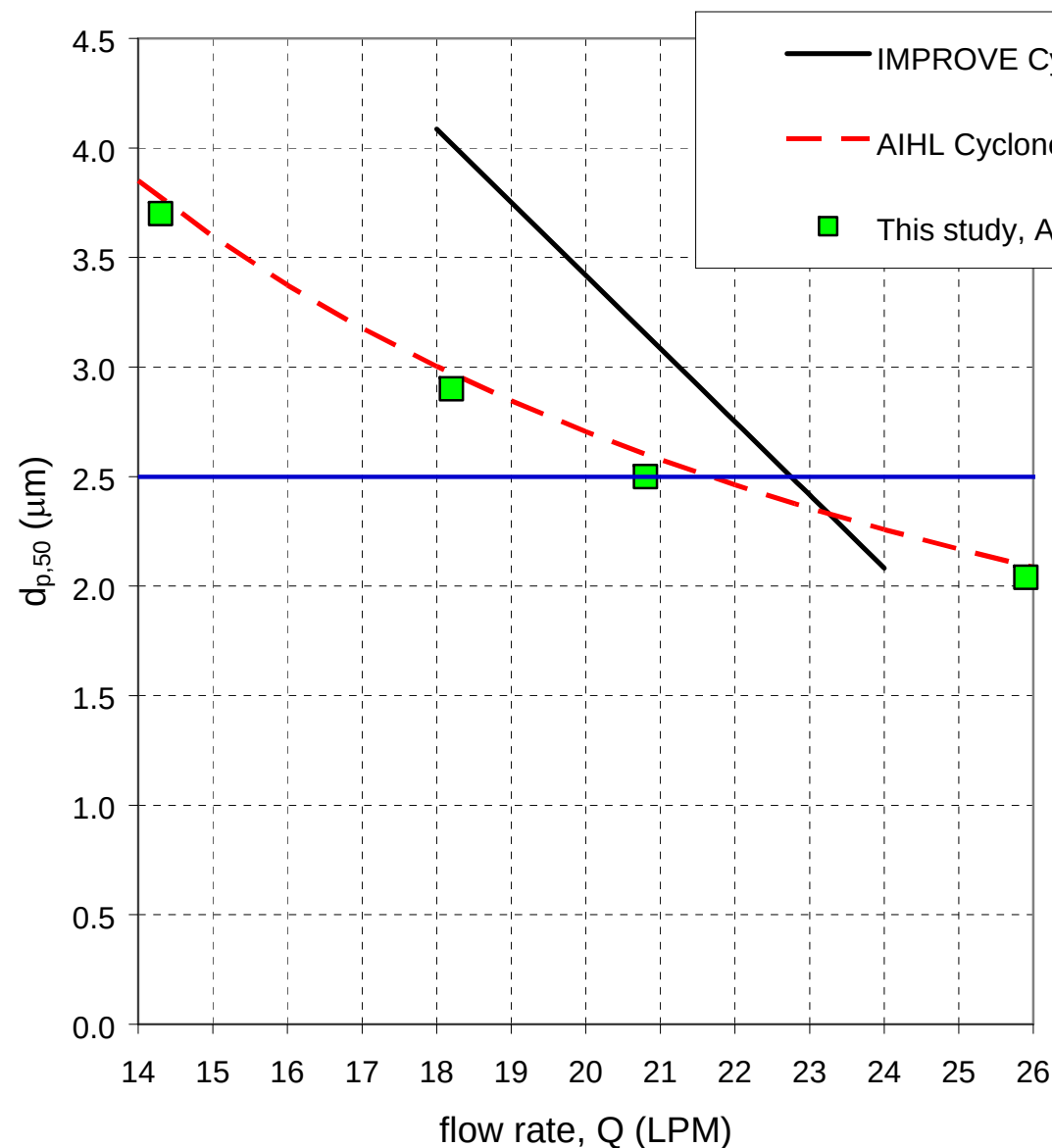
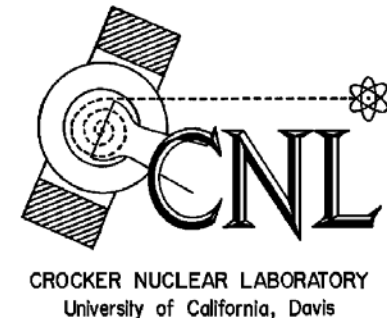
- Lip dimension changed 1/4" on second stage of manufacturing
- Change altered turbulence in plenum
- Inhomogeneity discovered preparing for PM10 speciation study in 2004.
- All samplers to be retrofitted with original design by end of 2007



IMPROVE SAMPLER CYCLONE CHARACTERIZATION & FLOWRATE FLAGS



Jay Turner's work produced a new, flatter cyclone curve



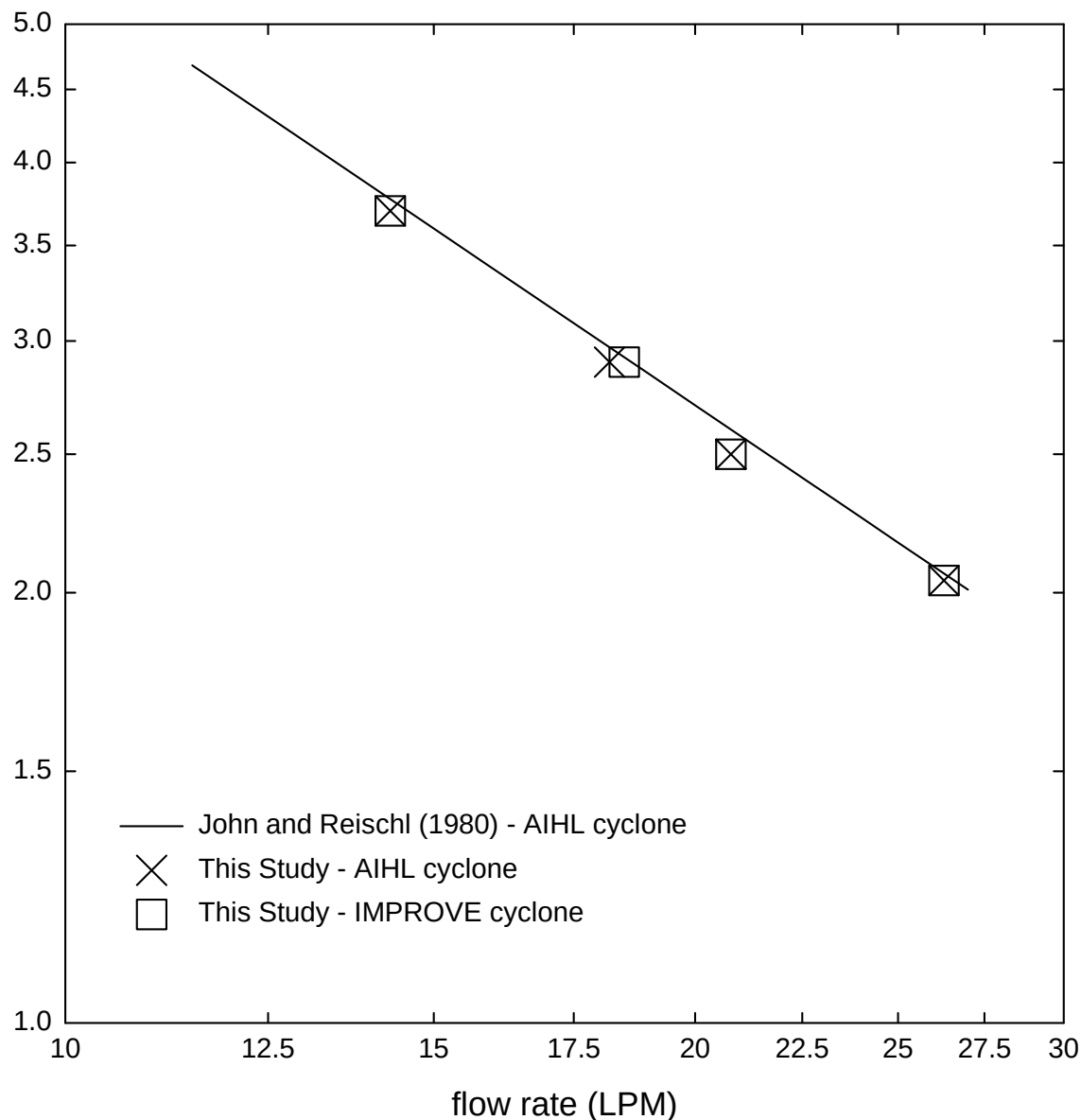
Flow rate for $d_{p,50} = 2.5 \mu\text{m}$:

AIHL = 21.6 LPM

IMPROVE = 22.8 LPM



Turner's tests yield the cutpoint/flowrate relationship of John & Reischl



This Study:

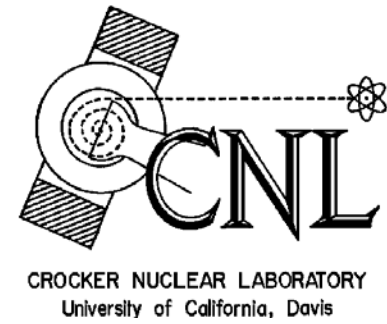
$$dp(\mu m) = 51.7 \times Q(LPM)^{-0.99}$$

John & Reischl (1980):

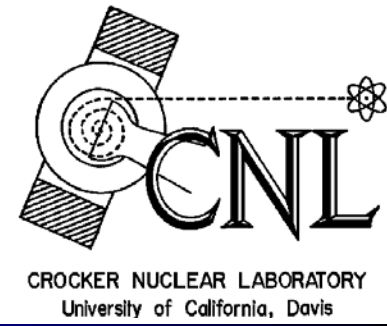
$$dp(\mu m) = 52.5 \times Q(LPM)^{-0.99}$$



New Flowrate Flags



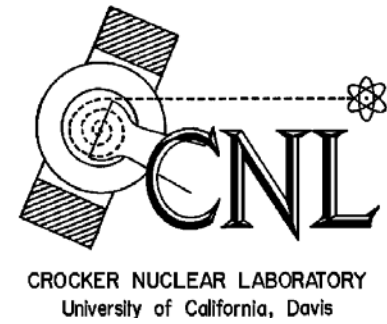
- Old flags were based upon incorrect relationship of flowrate/cutpoint.
- New flags represent similar flowrates, but with tighter cutpoints
 - LF limits (μm) are now 2.25 and 2.75, not 2 and 3.
- New flags effective with January 2005



NEW SAMPLER PROGRAM



New Sampler Program Features & Advantages



- Took advantage of work done by ARS in programming the URG 3000N for STN
- Code rewritten from scratch; cleaner code will provide fewer compromised flashcard files
- Unlimited flexibility in sampling schedules for special studies
- Final testing underway; deployment to follow