USL16-NGL: Operational Throughput Improvements

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Outline

- USL16-NGL
  - Current System Overview and Process
- Sample Throughput Improvements
  - Motivation
  - Methods
- Detector Calibration and Analysis

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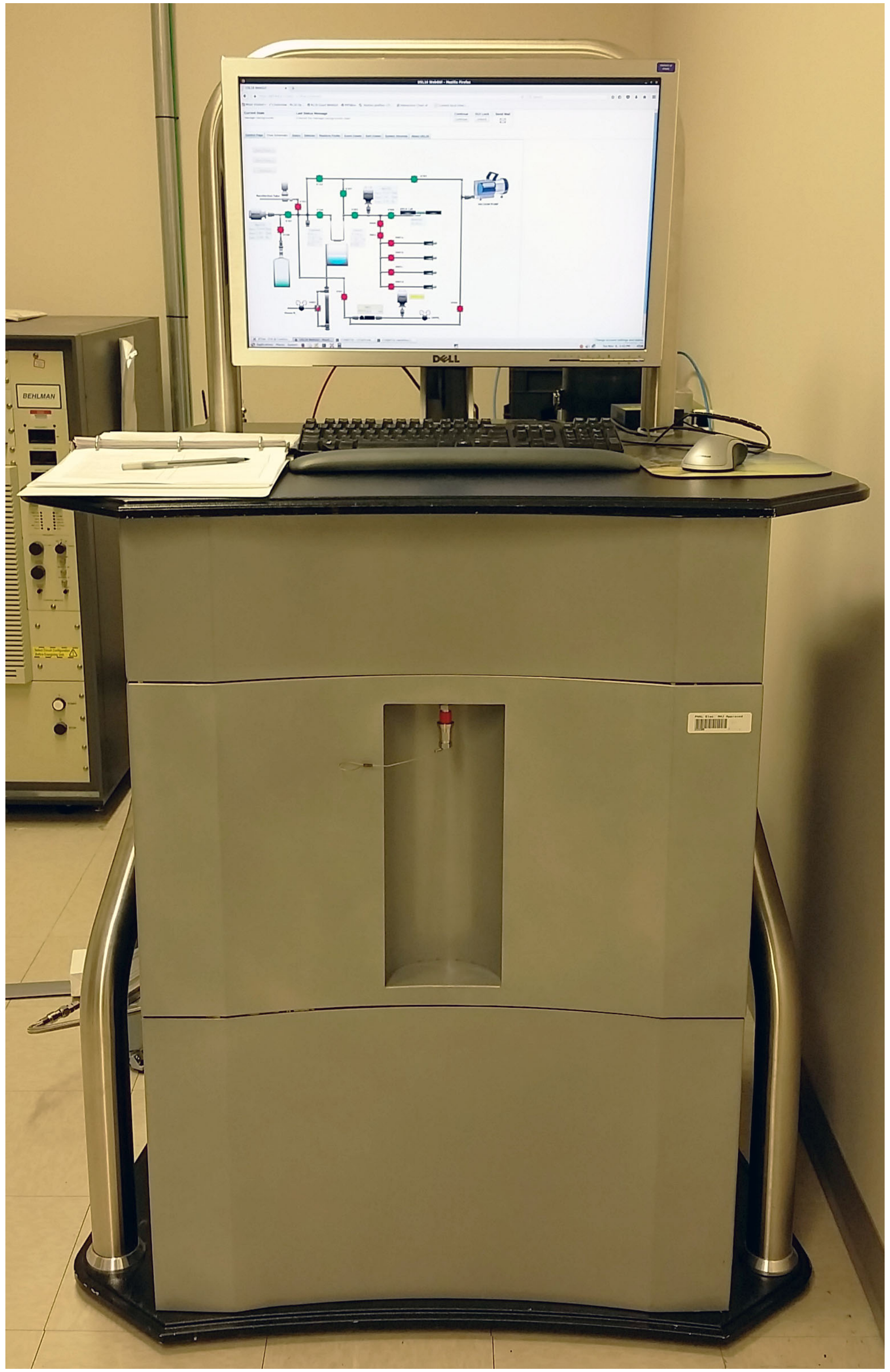
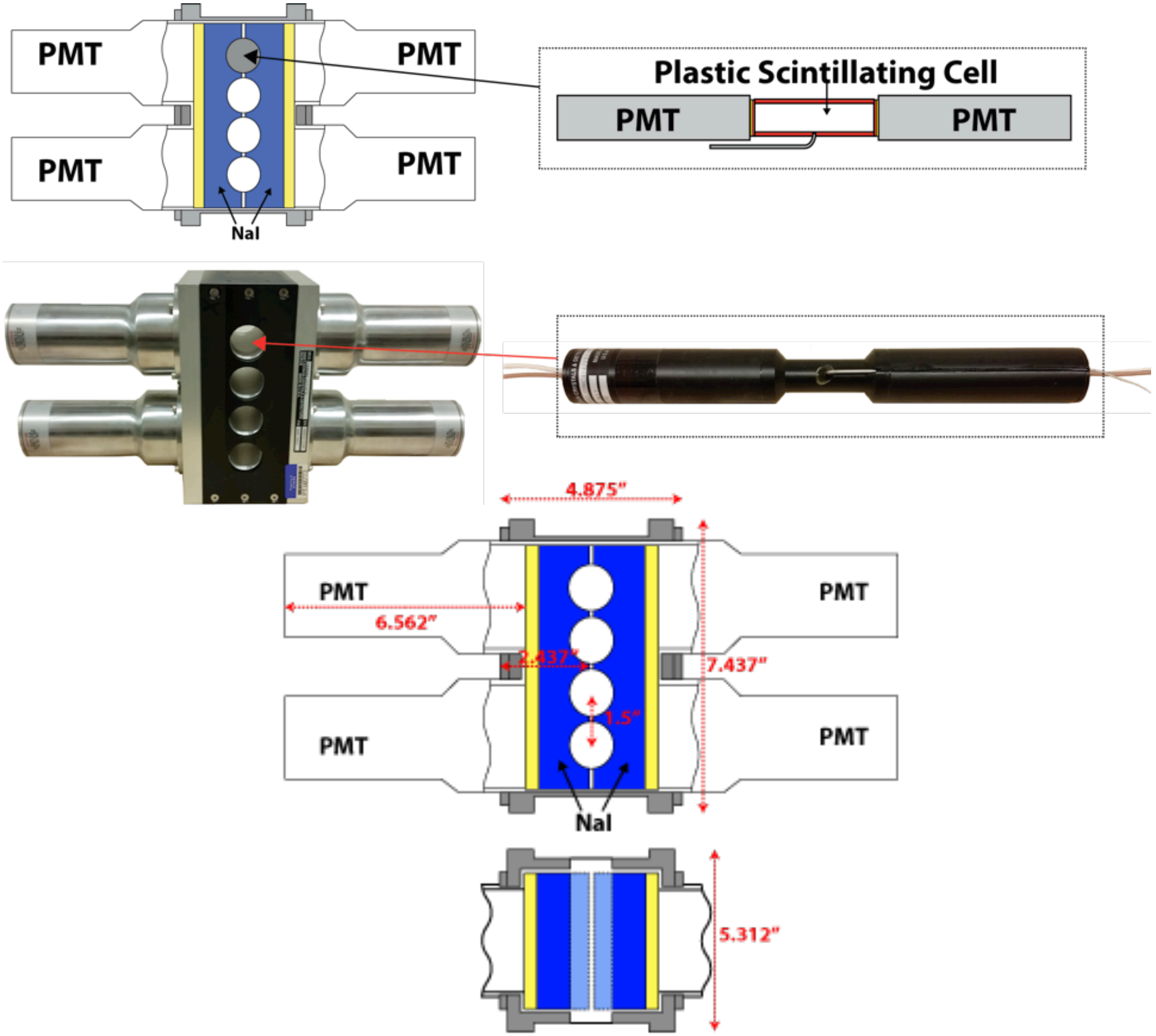
USL16-NGL

- Security
  - Certified Personnel
  - Chain of Custody
- Environmental Monitoring
  - Temperature & Humidity
  - Radon – Not needed for beta-gamma (see it if it is present)
- Documentation
  - Quality Control
  - Serial Numbers and Calibration Certificates
  - Maintenance Log
  - Only make approved updates
- Software/Calculation
  - Version Control
  - Automated sample processing



Current USL16-NGL Detector

- Beta gamma system
  - Plastic beta cell
  - NaI
- Dual PMT readout for both the plastic scintillator and NaI
- Gain matching of PMTs performed during calibration process



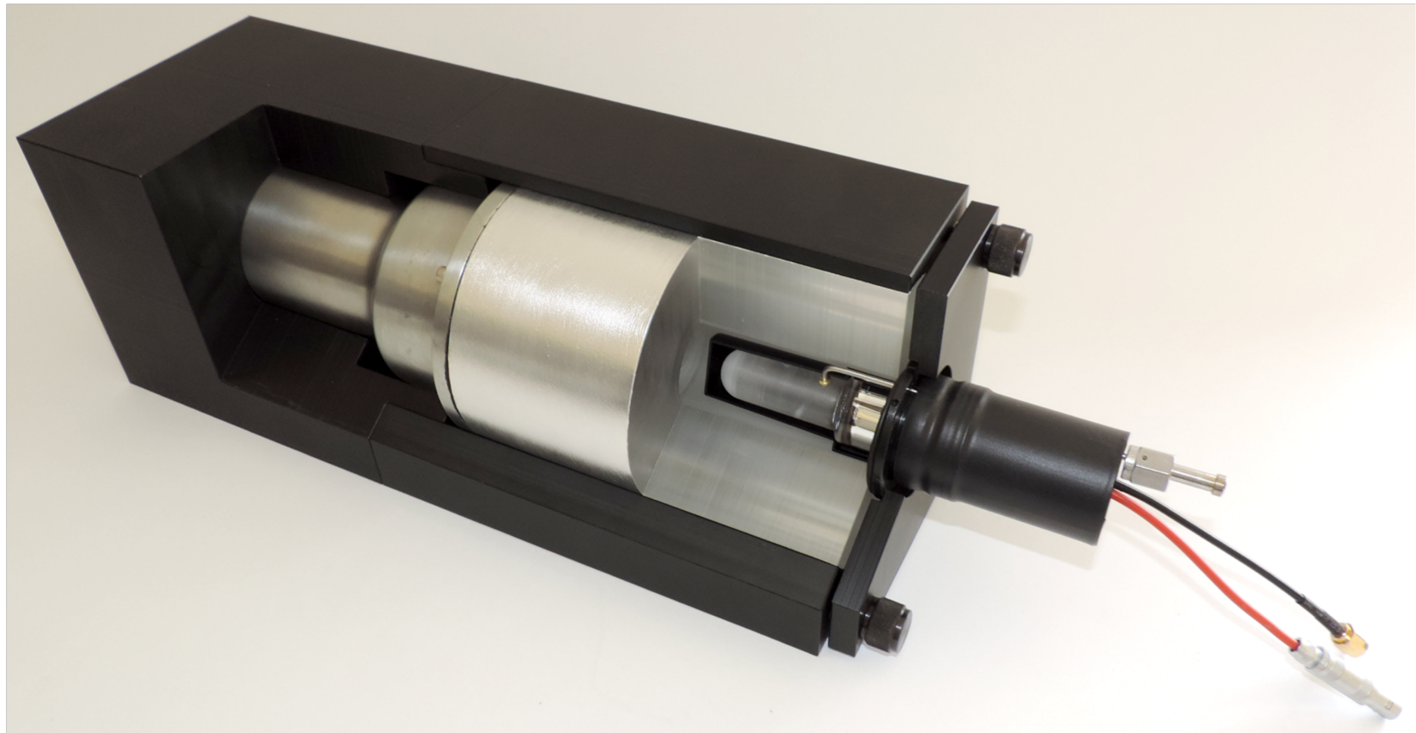
Motivation for Higher Throughput

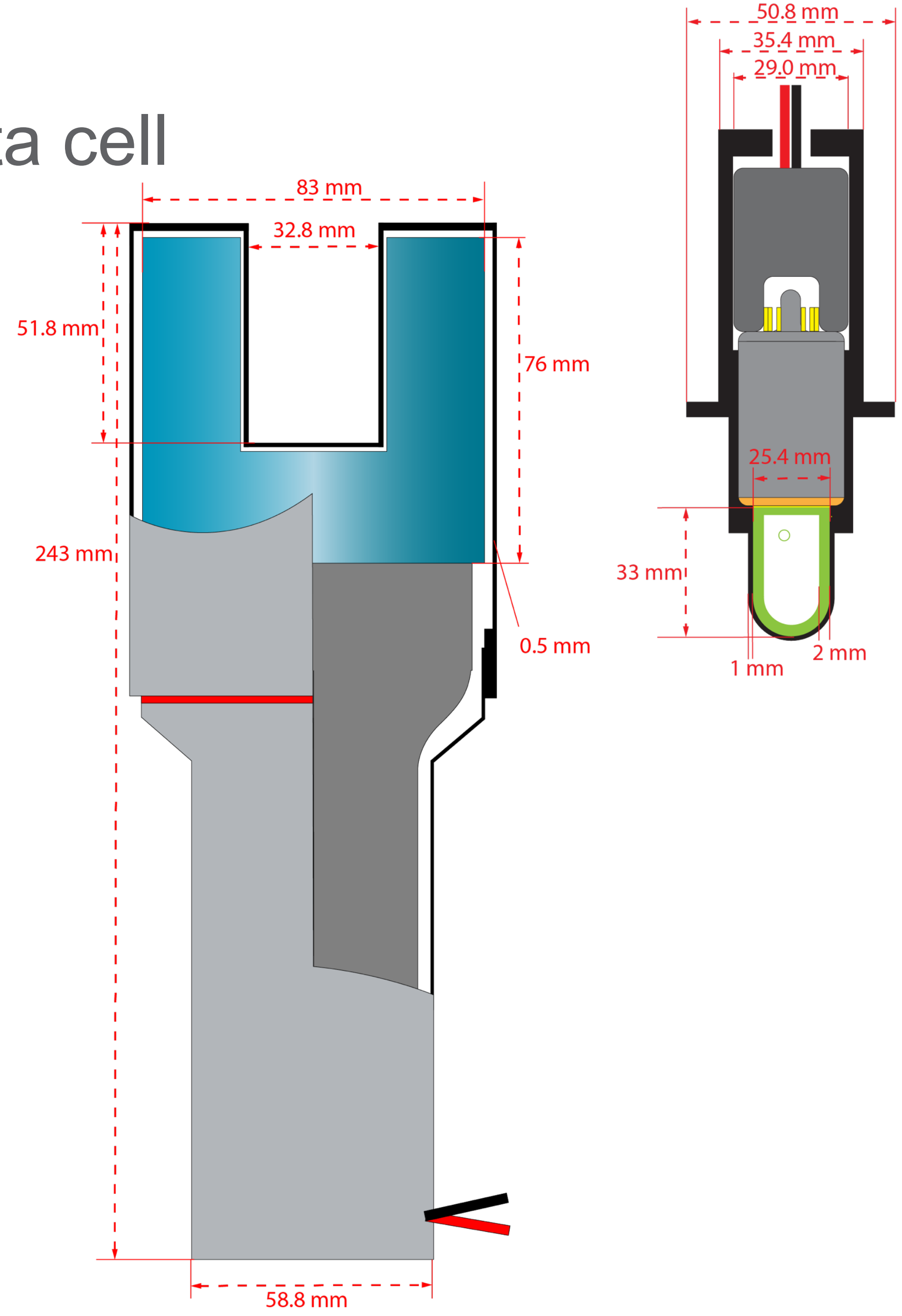
- Multiple samples in a Proficiency Test Exercise (PTE)
- Multiple station samples shipped at once
- Memory effect from calibration or PTE spikes

- Two solutions:
  - Coated cells
    - ✓ Solves the memory effect issues, but still requires gas backgrounds during sample processing
  - Additional detectors
    - ✓ See memory effect if not coated, but can alternate high and low-activity detectors
    - ✓ Can convert serial sample processing to parallel
    - ✓ Allows for additional re-verification of a measurement if there is uncertainty on the results

Implementation of Four Additional Detectors

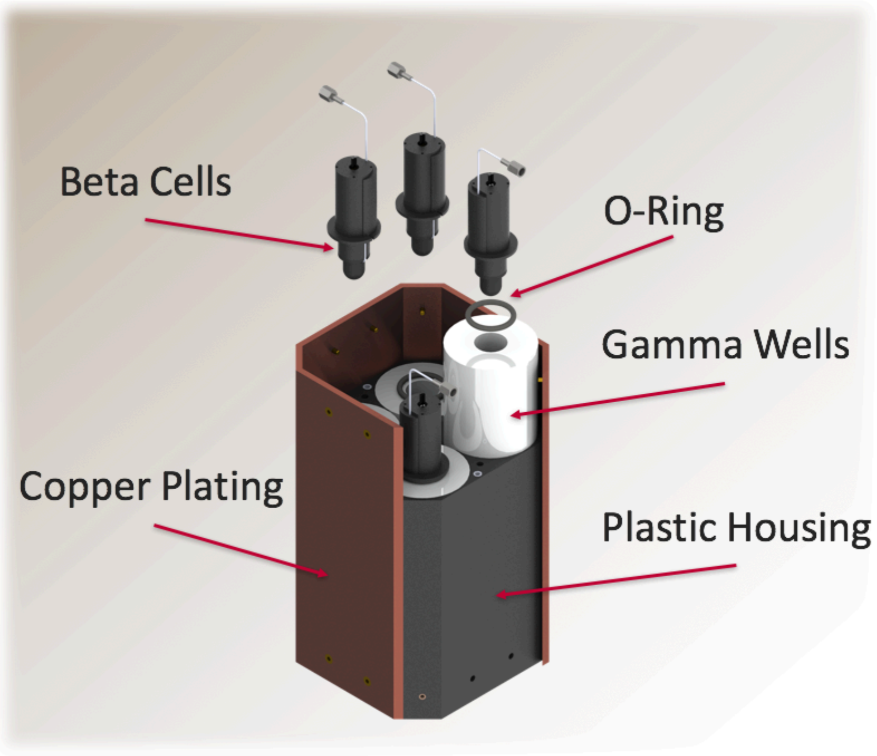
- Single PMT readout instead of double ended beta cell
  - Fewer PMTs
  - Improved energy resolution
  - Smaller detector volume

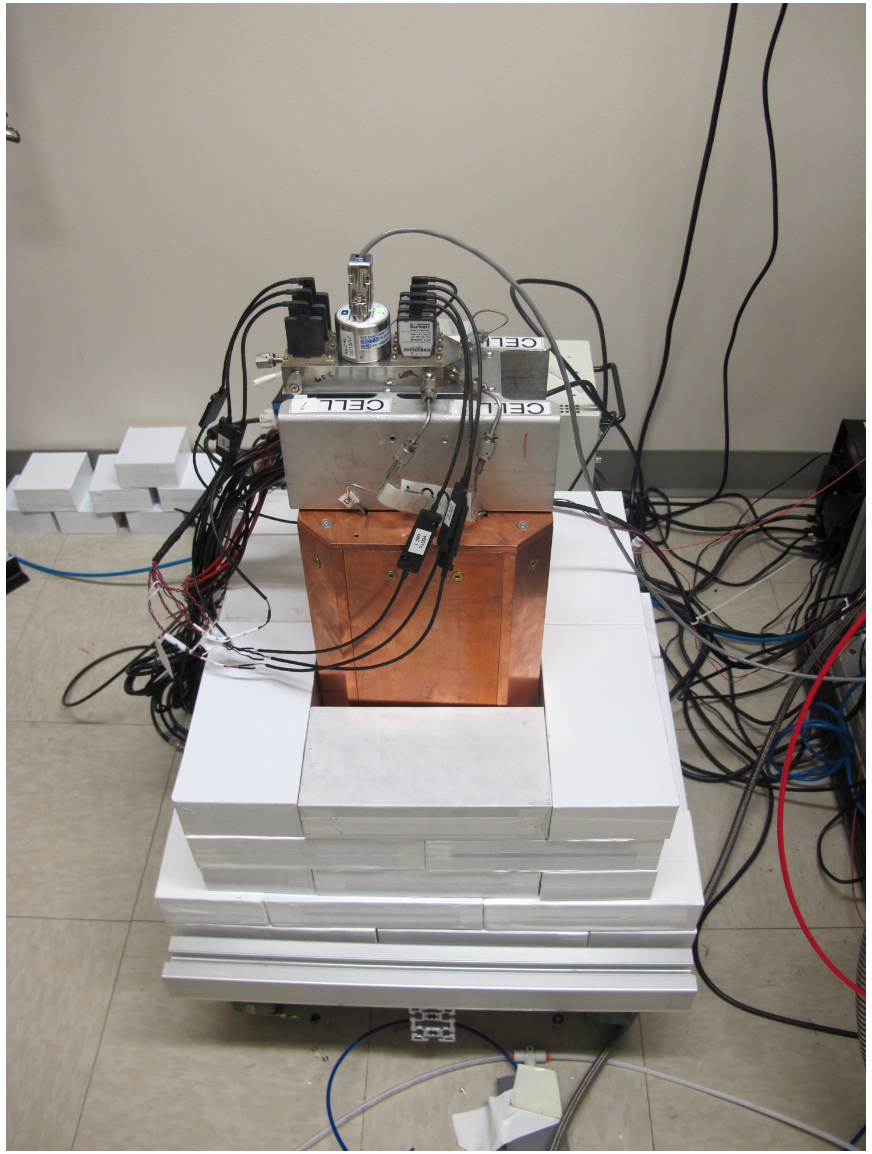




"Quad" Detector Setup

- Small volume manifold and cryotrap
- Additional roughing pump to purify samples





Required System Improvements

- Slightly smaller cells
  - Must be accounted for when performing volumetric transfers
    - ✓ Required a new lower-manifold for the additional detectors

- Plumbing connection between the processing manifold and the lower quad detector manifold
  - Use nitrogen to push the xenon down to the lower manifold

- Retain the recollection ability if we want to re-count the sample
  - Secondary recollection port to minimize sample loss

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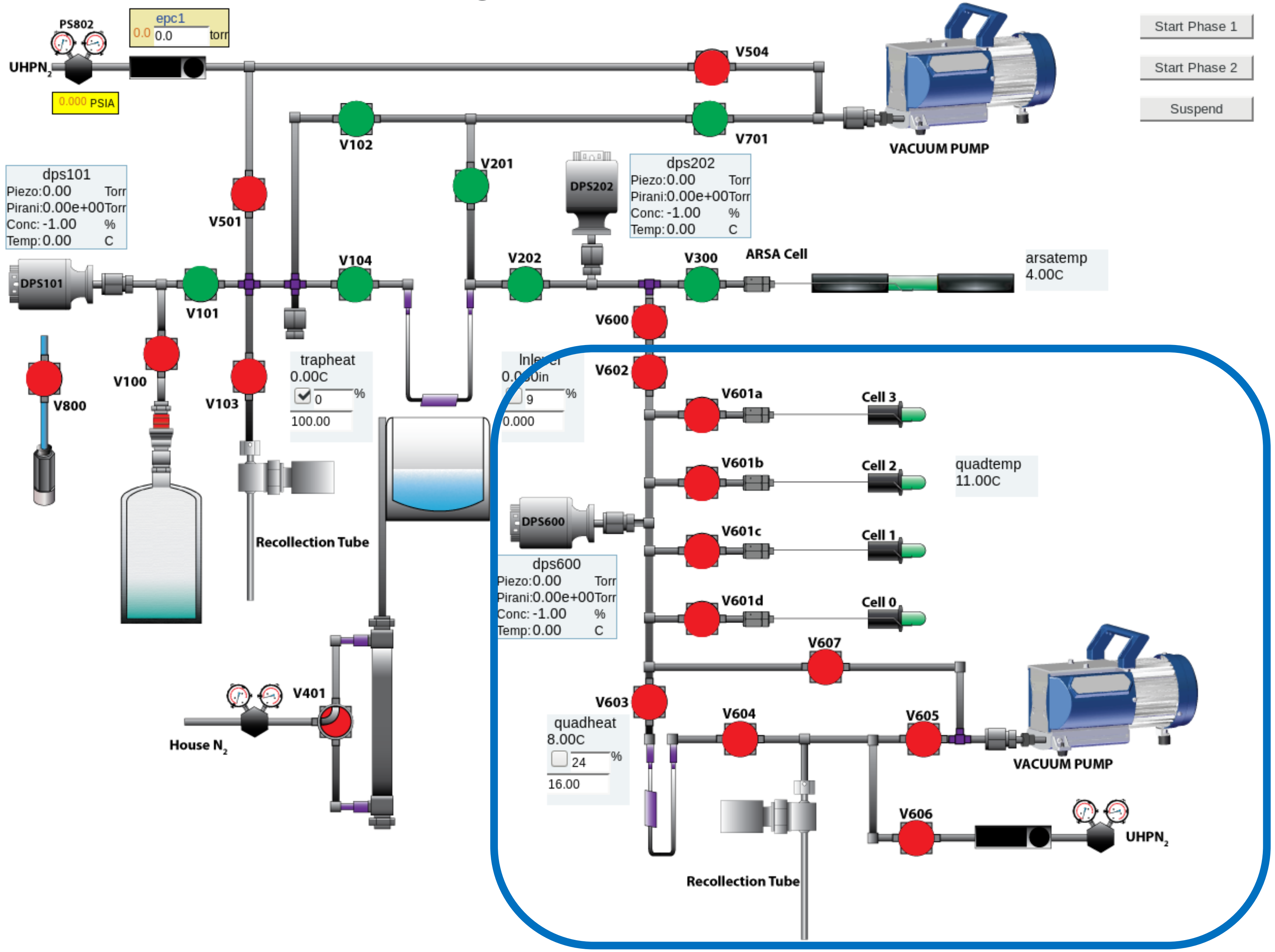
Gas Manifold

- Xenon volume is quantified using MKS 910 pressure sensors
- Xenon is collected on a liquid nitrogen cooled low volume, high surface area trap
- Xenon is pushed with nitrogen to the lower manifold
- Xenon is volumetrically transferred to a beta-gamma detector

Processing Manifold



Lower Detector Manifold

Sample Processing Upgrades

	00:00	02:00	04:00	06:00	08:00	10:00	12:00	14:00
Sample processing		Process sample #1	Process sample #2	Process sample #3	Process sample #4	Process sample #5		
ARSA cell	Gas Background	QC Count	Count Sample #1					
Quad cell 0	Gas Background		QC Count	Count sample #2				
Quad cell 1	Gas Background		QC Count	Gas Background	Count sample #3			
Quad cell 2	Gas Background		QC Count	Gas Background		Count sample #4		
Quad cell 3	Gas Background		QC Count	Gas Background			Count sample #5	

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Control Page – Automation of Processes

Current State	Last Status Message	GUI Lock	Send Mail
purify-sample	Waiting for LNLevel to come up to 4.00 inches. Currently at: 0.03	04:17	

Control Page | Flow Schematic | Status | Detector | Realtime Plotter | Event Viewer | SoH Viewer | System Volumes | About RL16

Parameter	Value	Default	Units	Last Modified
COLLECTION_END_PRESSURE	2.18	2	torr	2016/06/20-15:19:18
COLLECTION_PREP_INTERVAL	30	30	s	
COLLECTION_START_INTERVAL	30	30	s	
COLLECT_RESIDUAL_SAMPLE_INTERVAL	180	180	torr	2016/04/01-13:18:04
COLLECT_RESIDUAL_TRAP_TEMP	-170	-170	C	2016/04/01-10:26:54
ELUTION_EQUILIBRATION_TIME	180	180	s	
ELUTION_TRAP_TEMP	27.0	27.0	C	2016/04/01-13:18:04
FINAL_PNF_CYCLE_COUNT	3	3	none	2016/06/20-13:50:08
FINAL_PNF_FINAL_PUMP_INTERVAL	600	600	s	2016/06/16-09:37:17
FINAL_PNF_FLUSH_INTERVAL	60	60	s	2015/06/15-14:35:44
FINAL_PNF_PUMP_INTERVAL	600	600	s	2015/05/21-13:55:07
GAS_BACKGROUND_INTERVAL	79200	86400	s	2016/06/21-16:47:06
HISTOGRAM_COUNT_INTERVAL	86400	86400	s	2016/06/08-13:53:22
HISTOGRAM_PRELIM_INTERVAL	7200	7200	s	2016/04/01-13:18:04
INITIAL_PNF_CYCLE_COUNT	3	3	none	2016/06/03-11:28:20
INITIAL_PNF_FINAL_PUMP_INTERVAL	120	120	s	2016/06/03-11:28:20
INITIAL_PNF_FLUSH_INTERVAL	10	10	s	2015/05/21-13:55:07
INITIAL_PNF_PUMP_INTERVAL	120	120	s	2015/02/17-17:17:36
LOAD_CELL_FLUSH_INTERVAL	15	15	s	2015/06/17-15:25:49
LOAD_CELL_VOLUMETRIC_INTERVAL	120	120	s	2015/06/17-15:53:50
LOAD_CELL_VOL_FLUSH_PREP_PRESSURE	250	250	torr	
PUMP_AND_FLUSH_PRESSURE	300	300	torr	2016/02/25-14:49:56
PURIFY_CYCLE_COUNT	3	3	cycles	2016/06/20-13:50:08
PURIFY_FREEZE_INTERVAL	180	180	s	2016/04/01-13:18:04
PURIFY_PUMP_INTERVAL	45	45	s	2013/09/23-15:56:14
PURIFY_THAW_INTERVAL	180	180	s	2016/06/03-11:19:04
QC_COUNT_INTERVAL	1200	1200	s	2016/06/03-11:28:20
REGEN_CARRIER_INTERVAL	20	20	s	
REGEN_CARRIER_PRESSURE	100	100	torr	2016/02/29-14:27:01
REGEN_COOL_DOWN_TEMP	100	100	C	
REGEN_TRAP_TEMP	100	100	C	
REGEN_VACUUM_INTERVAL	600	600	s	2016/02/26-12:07:24
TRAP_COOL_DOWN_INTERVAL	300	300	s	2015/05/21-13:55:07
TRAP_LN_LEVEL	4.0	4.0	in	2016/06/08-13:53:22
UNLOAD_QUANTIFICATION_INTERVAL	30	30	s	2015/06/22-09:36:06
UNLOAD_SAMPLE_FREEZE_INTERVAL	120	120	s	2015/06/22-09:36:06
UNLOAD_SAMPLE_PUMP_INTERVAL	45	45	s	2015/06/22-09:36:06

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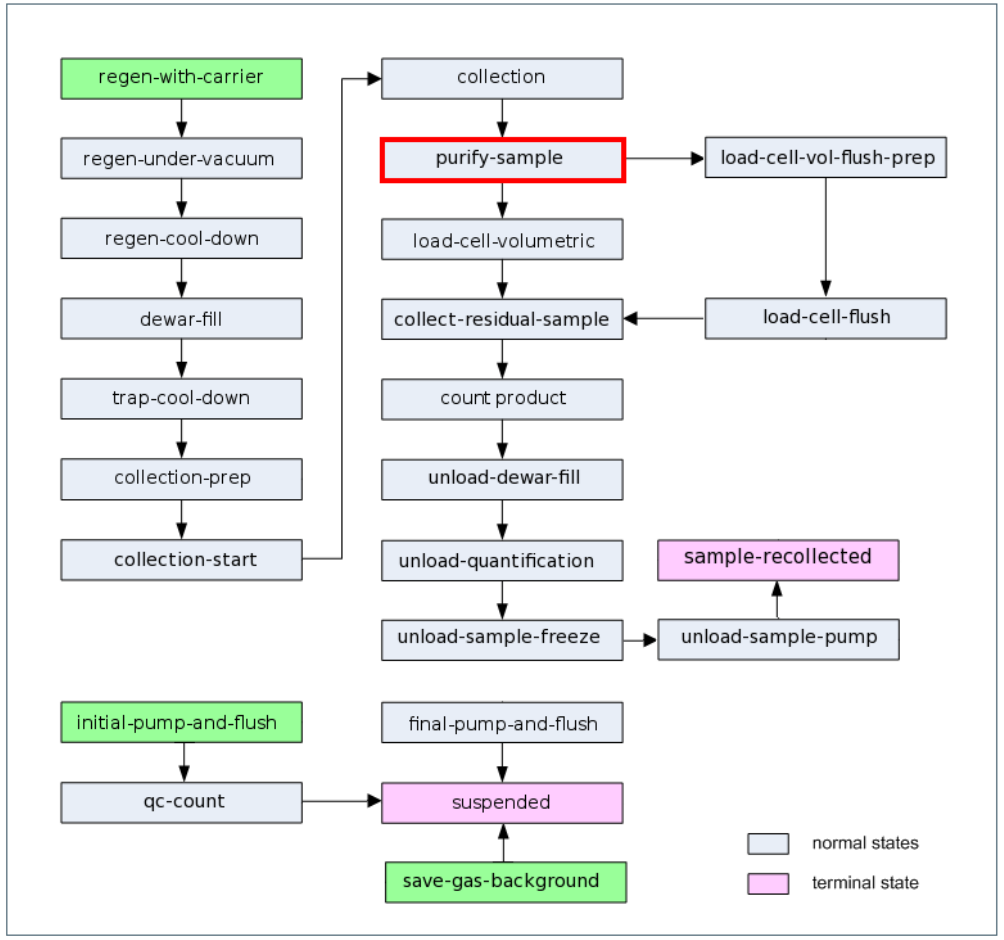


Detector Utilization

- 4 new detectors – alternate calibration cycles
- 2 detectors are "high activity/regular duration" counts
- 2 are kept for "low activity/long duration" counts
- Which 2 are which can be alternated once there has been a period of no activity so they are all "low activity" detectors
  - Avoid any biasing between detectors

USL16_005		USL16_005	PTE	USL16_005	Calibration	USL16_005	PTE	USL16_005	Station	USL16_005
USL16_006	Calibration	USL16_006	PTE	USL16_006		USL16_006	Station	USL16_006	Station	USL16_006
USL16_007	Calibration	USL16_007	PTE	USL16_007		USL16_007	Station	USL16_007	Station	USL16_007
USL16_008		USL16_008	Station	USL16_008	Calibration	USL16_008	PTE	USL16_008	Station	USL16_008
USL16_009		USL16_009	Station	USL16_009	Calibration	USL16_009	PTE	USL16_009	Station	USL16_009

Memory Effect

- Consistent memory effect measurements between detector types

Table 6. Memory Effect Results: 24 hour measurements calculated for the same reference time

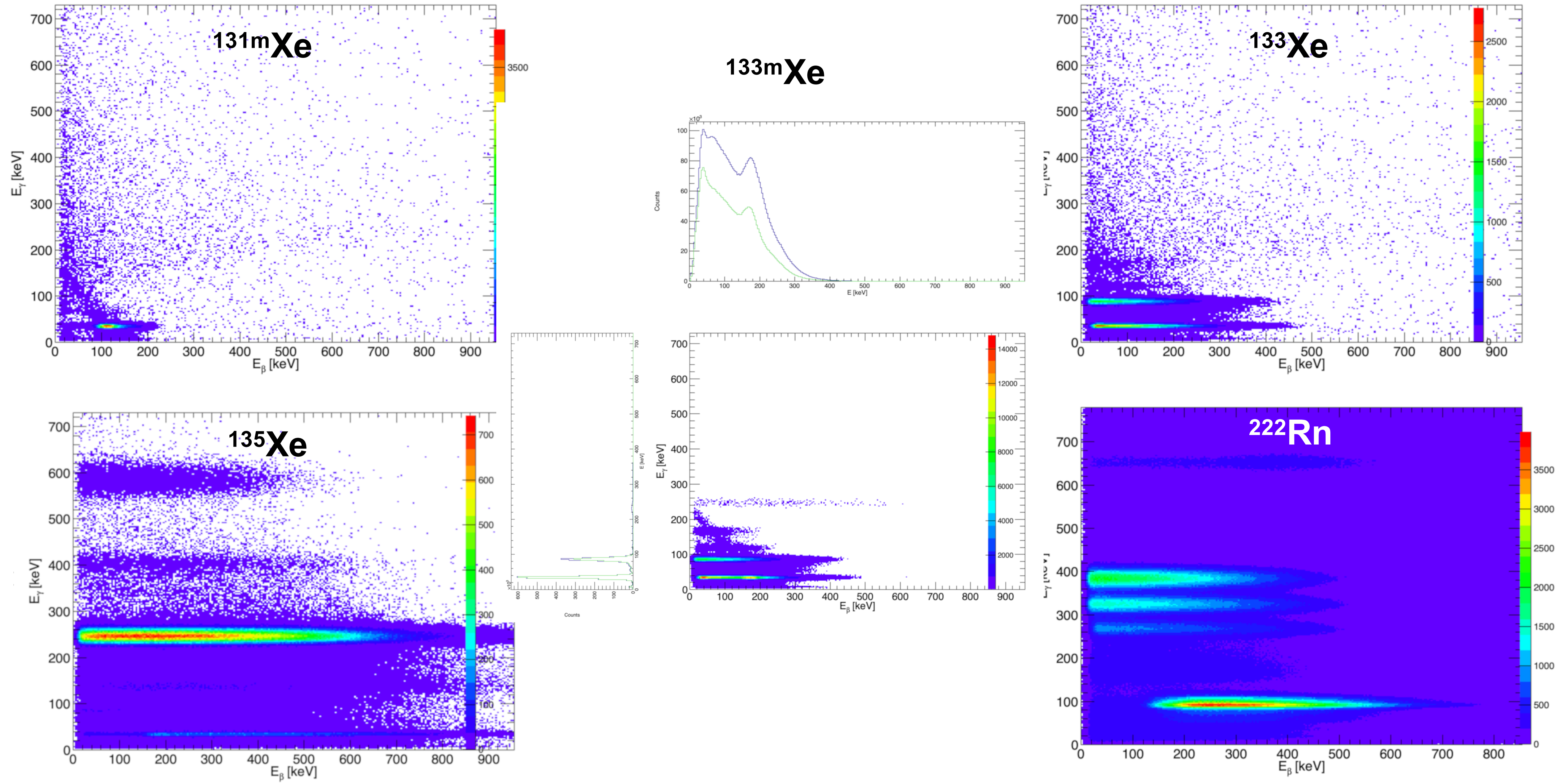
Original Double Ended Detector

	Sample Activity Concentration (mBq/m^3)	Gas Background Activity Concentration (mBq/m^3)	Memory Effect (%)
Xe-133 (80)	931	25.9	2.78
Xe-133 (30)	909	22.6	2.48
Xe-133 (sum)	924	25.1	2.72

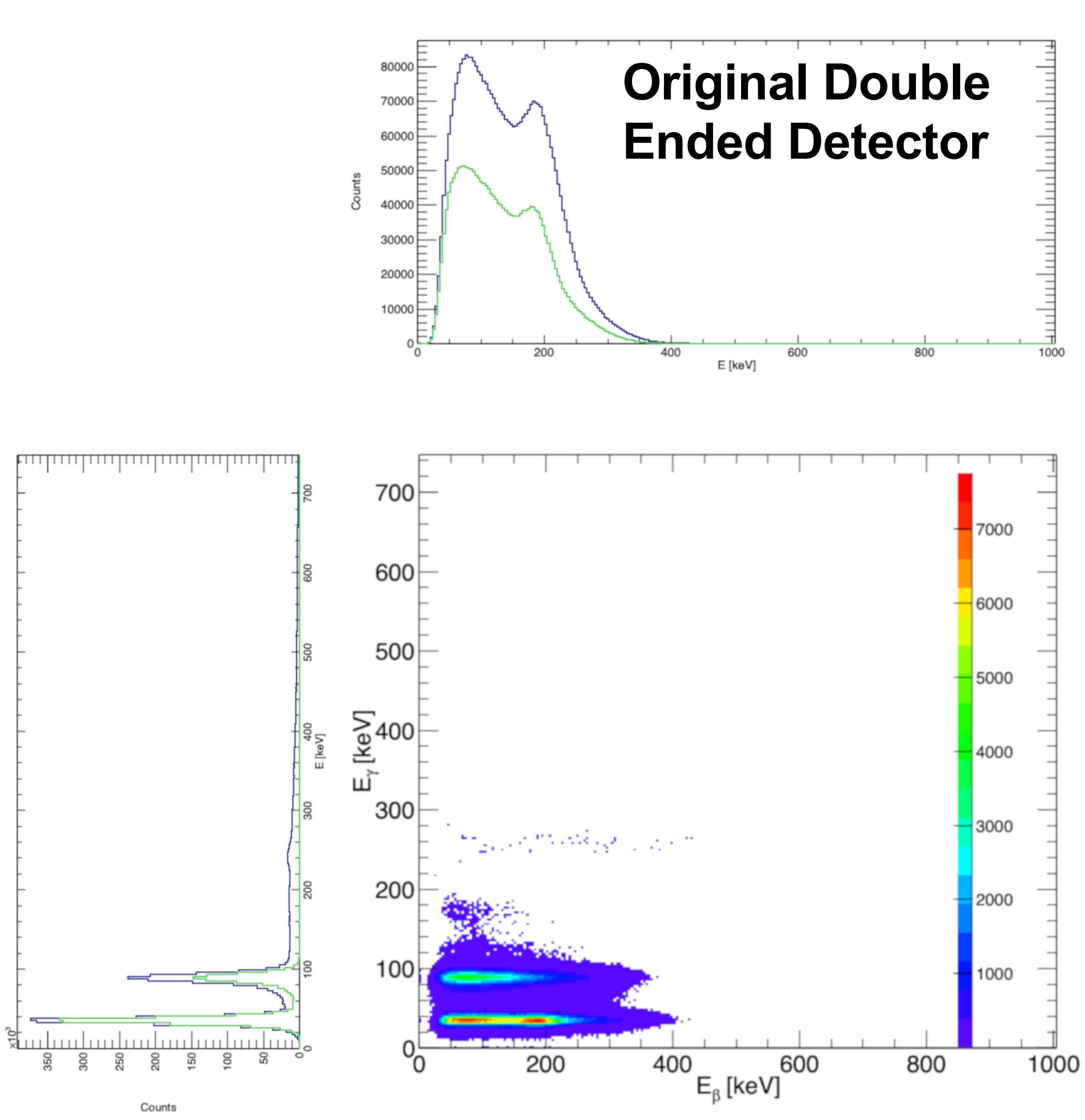
Additional Single Ended Detector

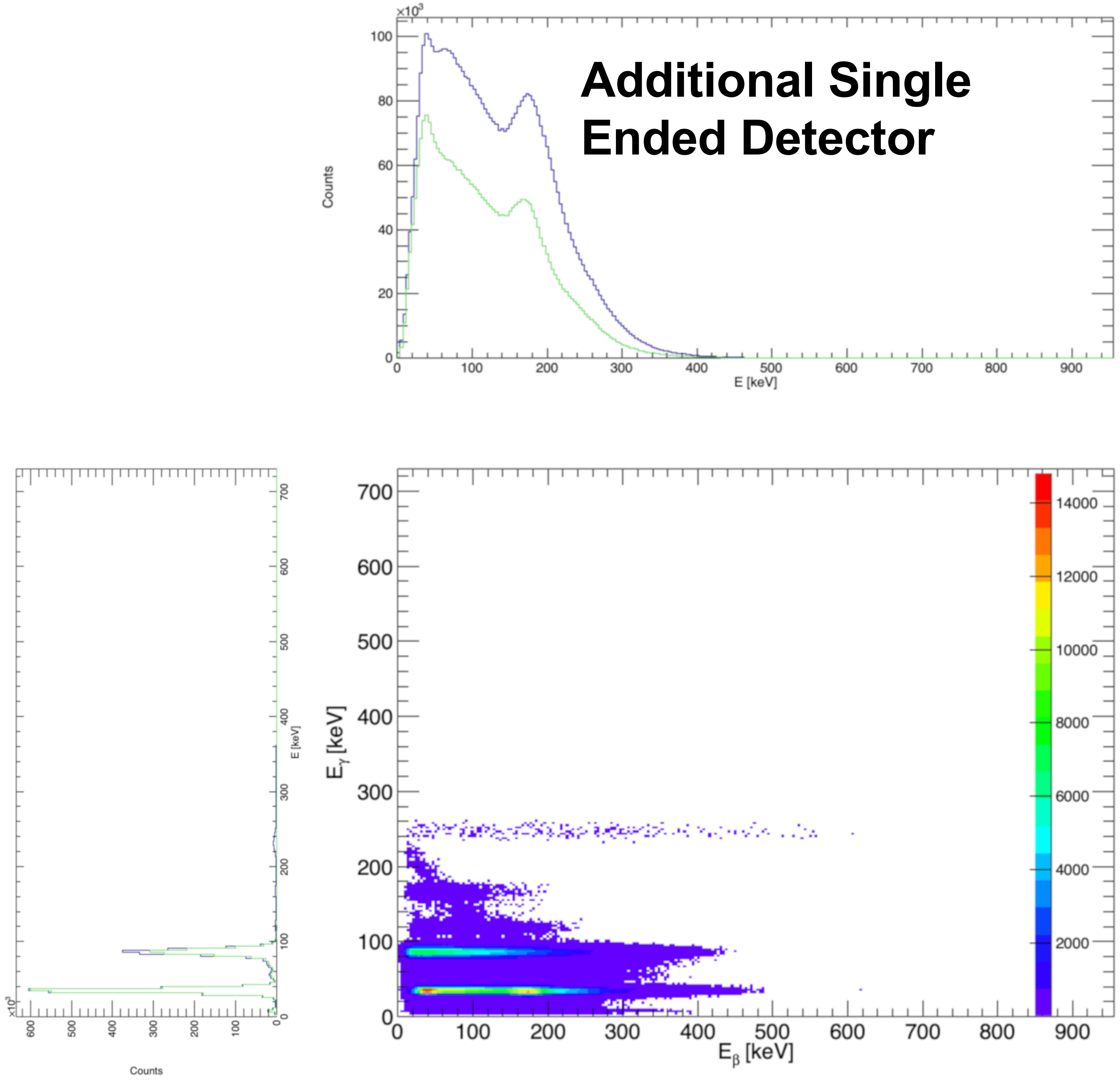
Xe-131m	14.5	0.32	2.21

Calibration – 5 Isotopes



Energy Resolution Improvement





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Conclusions

- As the noble gas laboratories move to a higher utilization rate, increased sample throughput is desired
- USL16-NGL is implementing 4 additional detectors to improve the sample throughput
- The additional detectors have improved energy resolution, but no memory effect coating
- USL16-NGL will have the capability of processing 2-4 samples per day with the additional detectors

Thank you