SEMATECH Immersion Workshop

Photoresist Component Extraction Measurements using Radiochemical Analysis

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Introduction

- Objective
  - Determine the identities, amounts and rates of photoresist components extracted by water
- Method: Radiochemical analysis
  - Why?
  - Experimental design
  - The big question: What comes out?

Analysis of Radiochemical Analysis

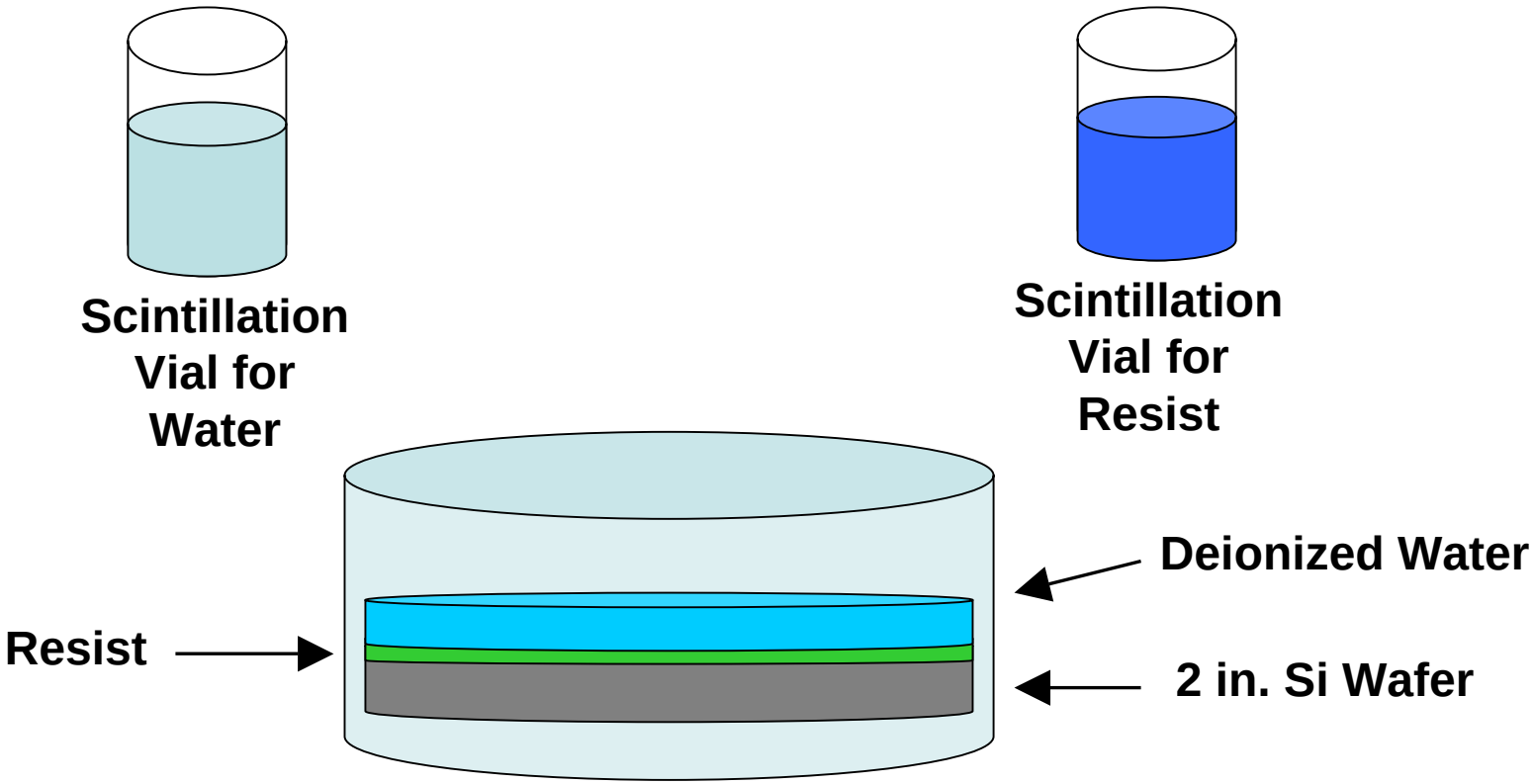
- Benefits
  - Statistically very accurate
  - High signal-to-noise ratio
  - Allows a determination of absolute value
- Detriments
  - High overhead
  - Training
  - Requires licensing

Experimental Design

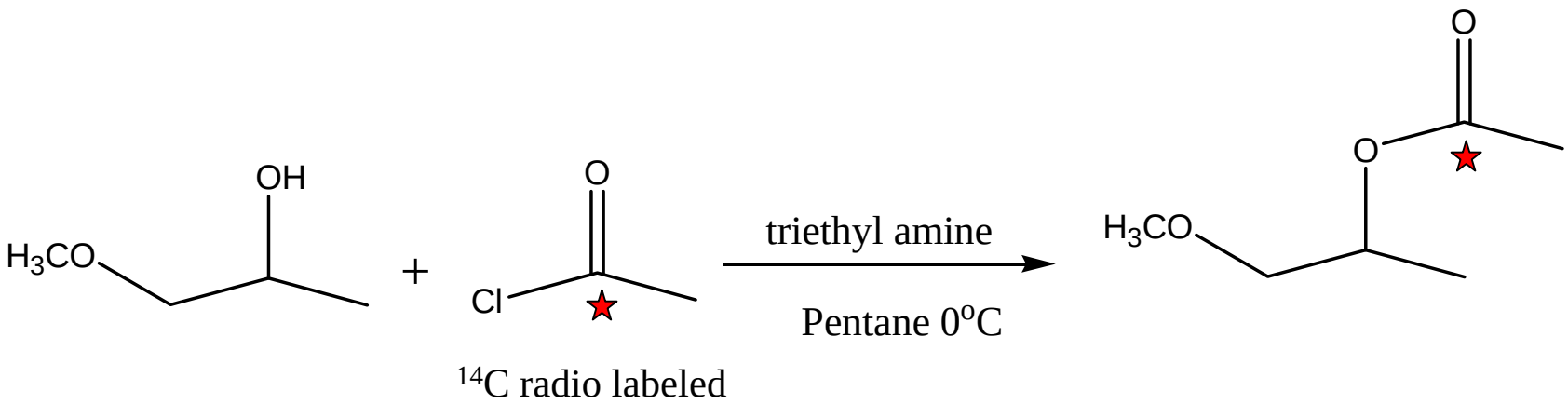
- Use TOK ILP formulations
- Synthesize ^{14}C-labeled photoresist components and incorporate into formulations for extraction experiments
  - ✓Residual casting solvent, RCS (PGMEA)
  - ✓Photo-acid generator, PAG (TPS nonaflate)
  - – Base (Triethanolamine)

Experimental Design

- Extraction Experiments



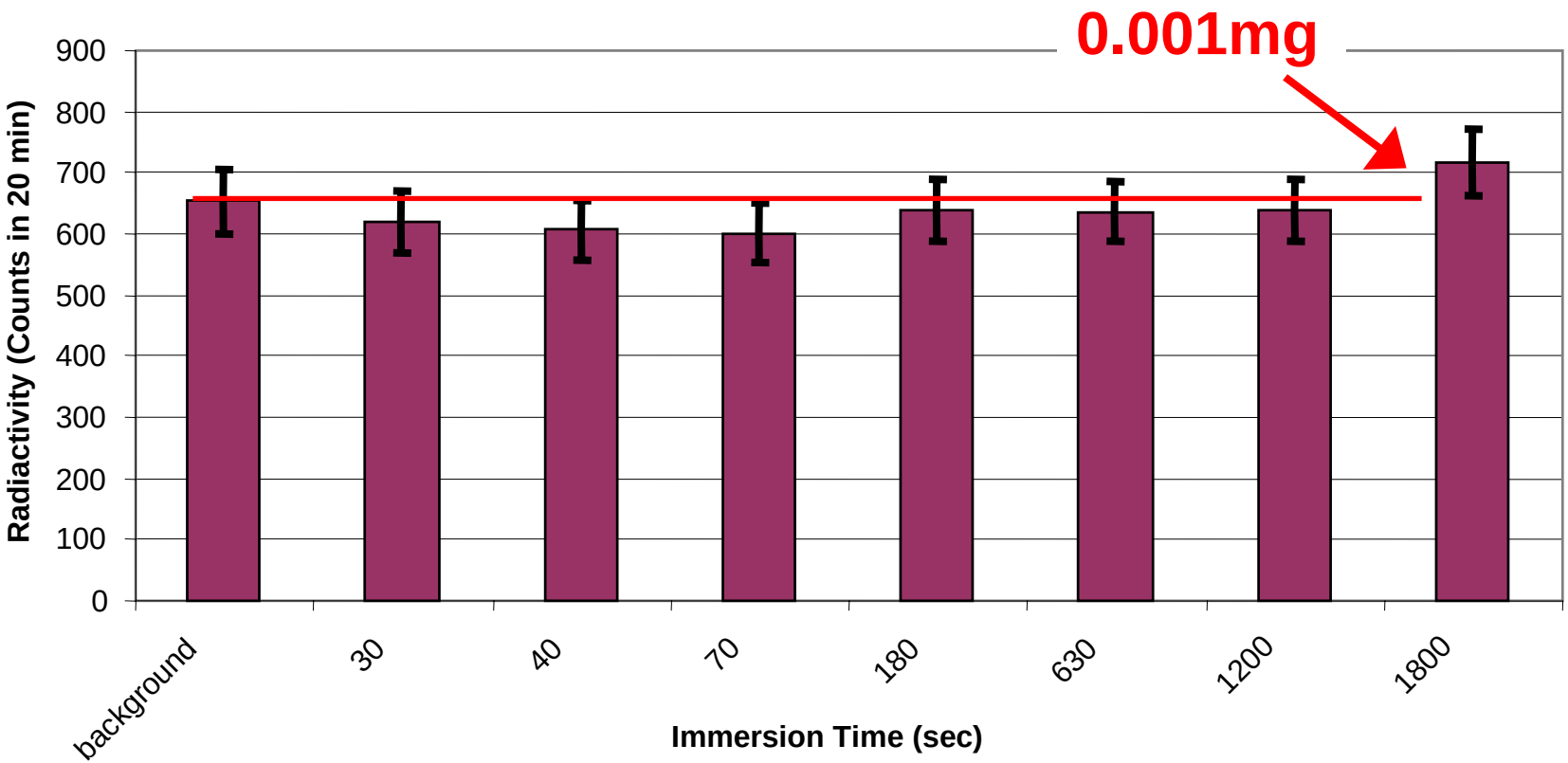
RCS Extraction Experiment - Synthesis



^{14}C radio labeled

Acetyl Chloride

RSC Extraction Experiment - Results

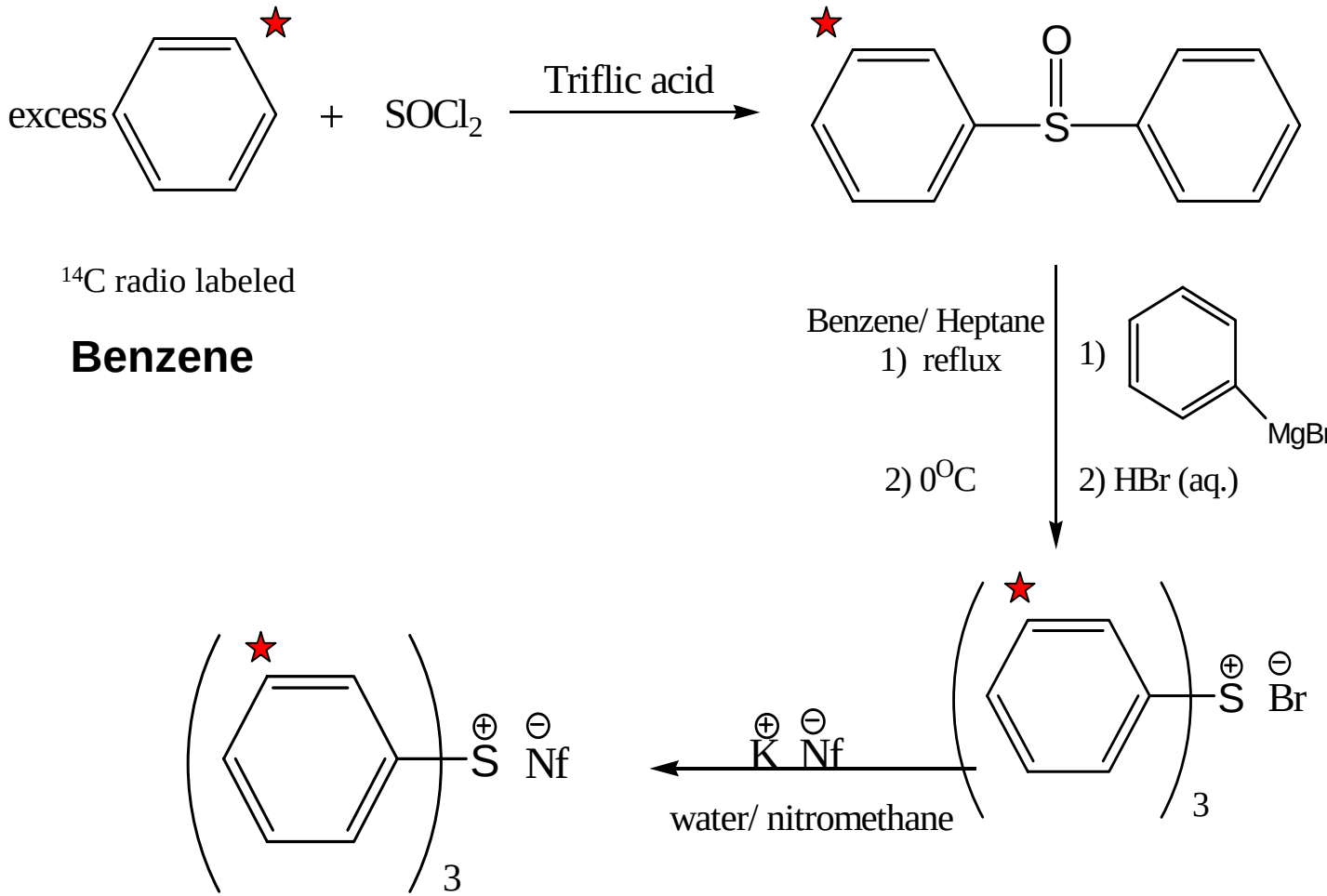


Radioactivity From ^{14}C-PGMEA in Immersion Water vs. Time

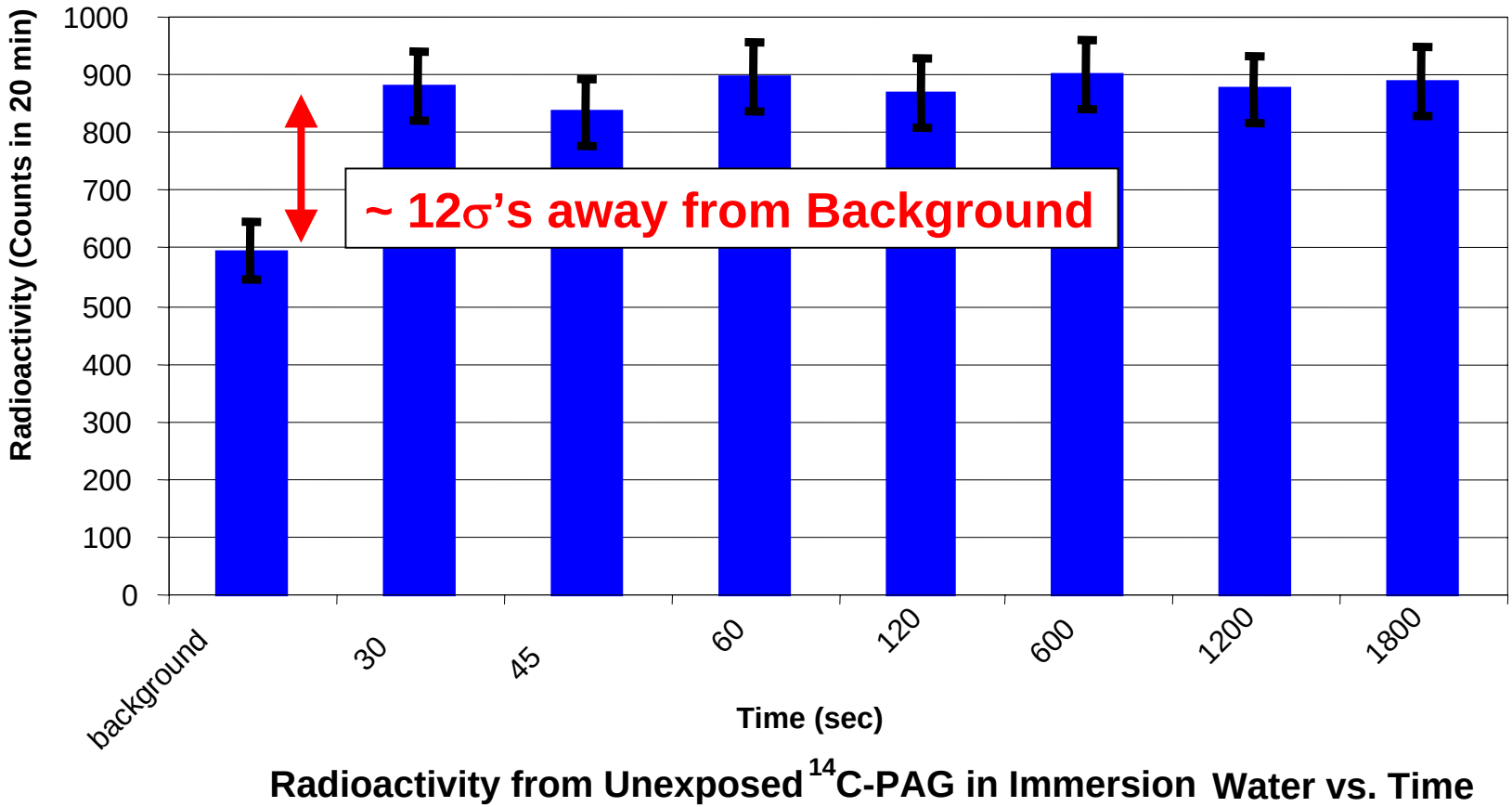
RSC Extraction Experiment - Conclusions

- No statistically detectable amount of RCS is extracted under 20 min.
- At most, 0.001mg of RCS is extracted after 30 min.

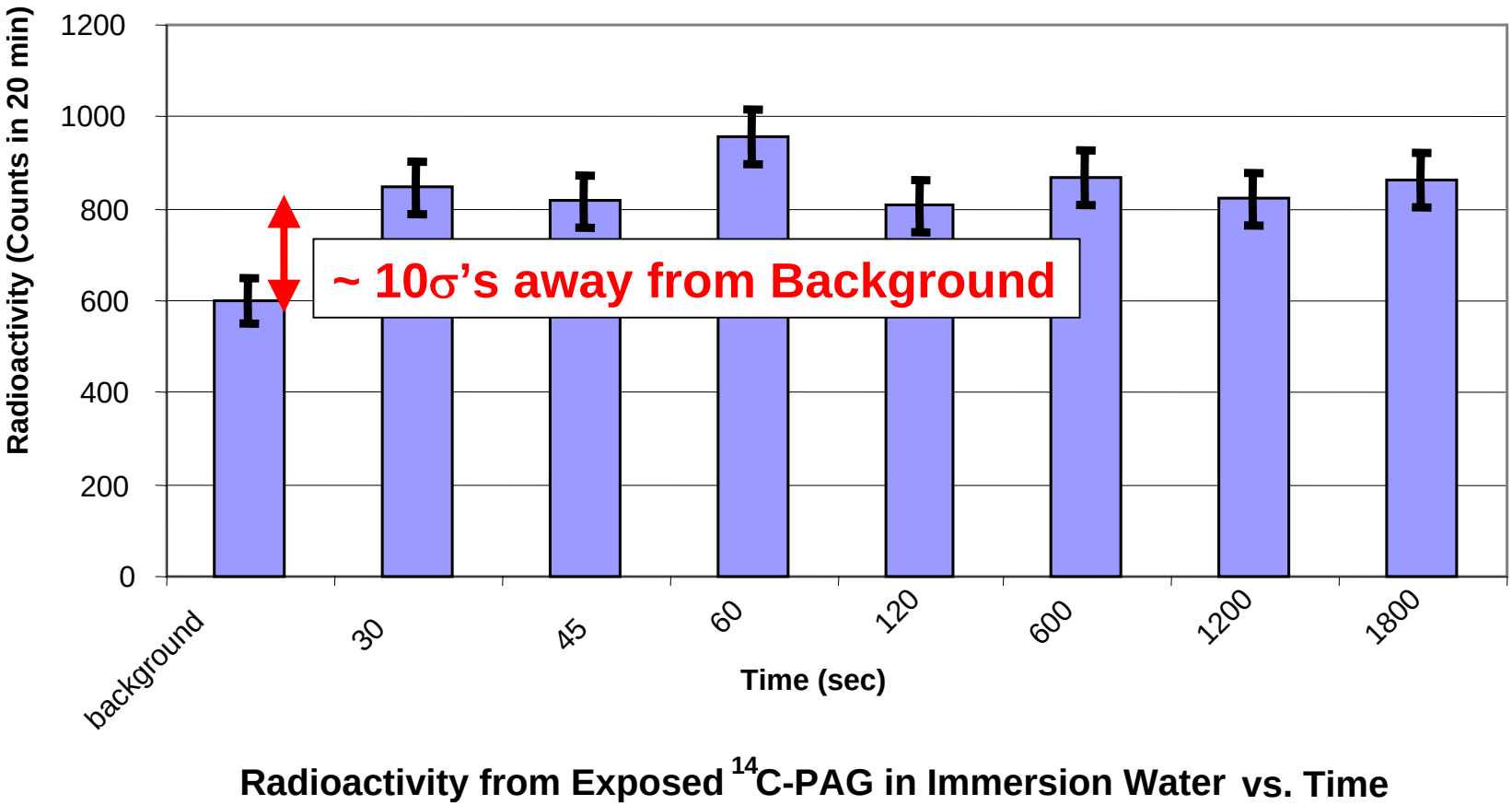
PAG Extraction Experiment - Synthesis



PAG Extraction Experiment - Statistical Analysis of Results

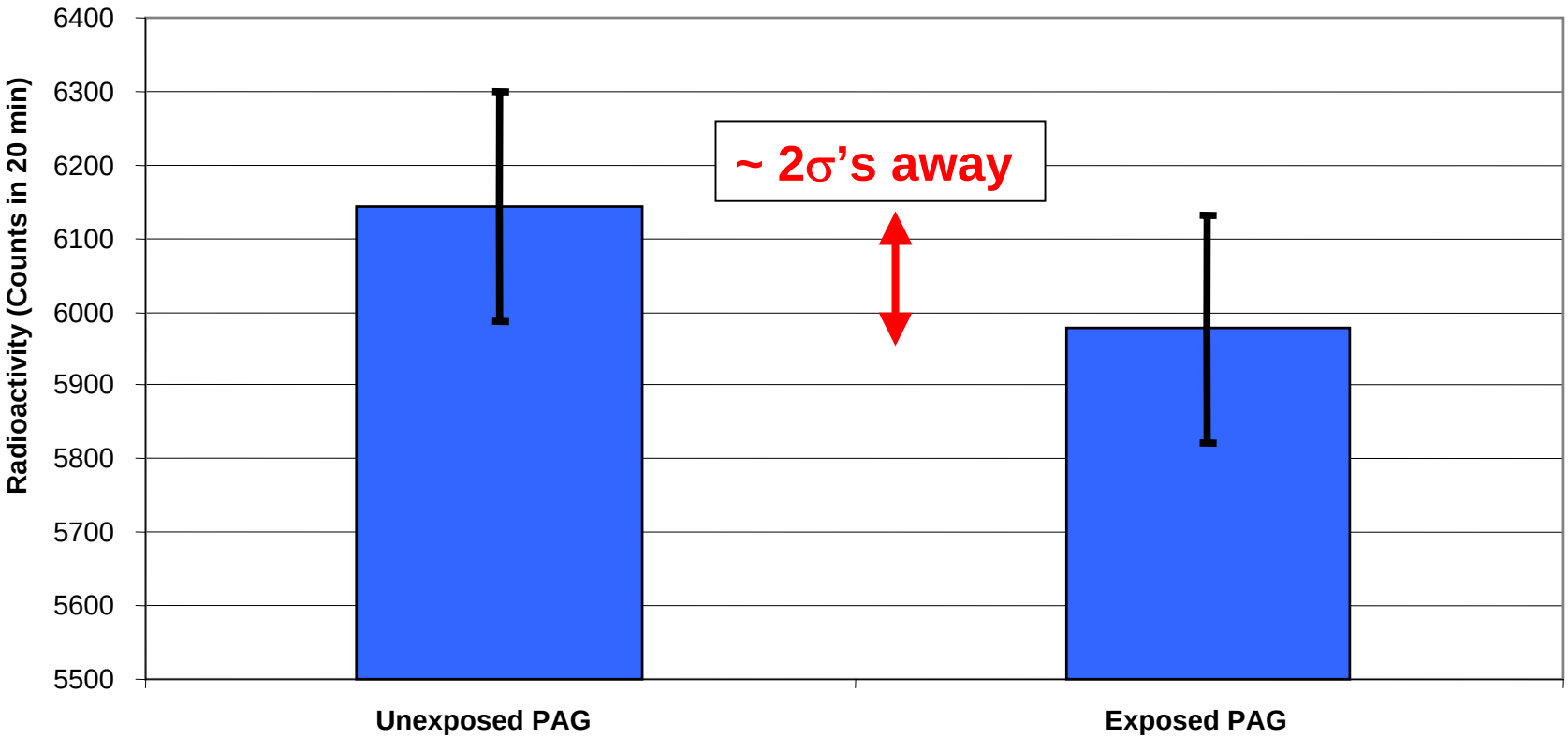


PAG Extraction Experiment - Statistical Analysis of Results



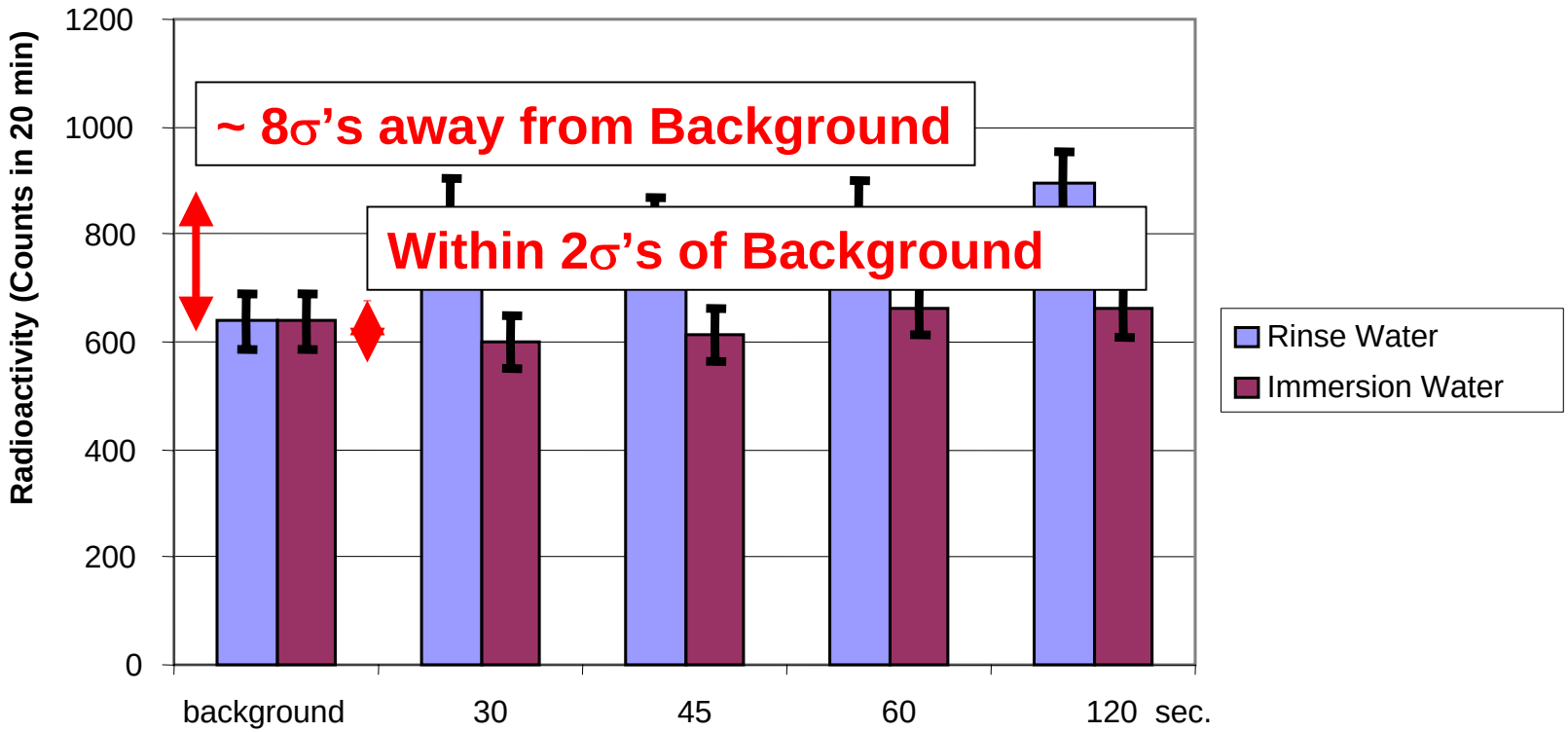
Radioactivity from Exposed ^{14}C-PAG in Immersion Water vs. Time

PAG Extraction Experiment - Statistical Analysis of Results



Total Radioactivity of Exposed PAG Compared to Unexposed PAG

PAG Extraction Experiment - Results of Pre-Rinse Experiment

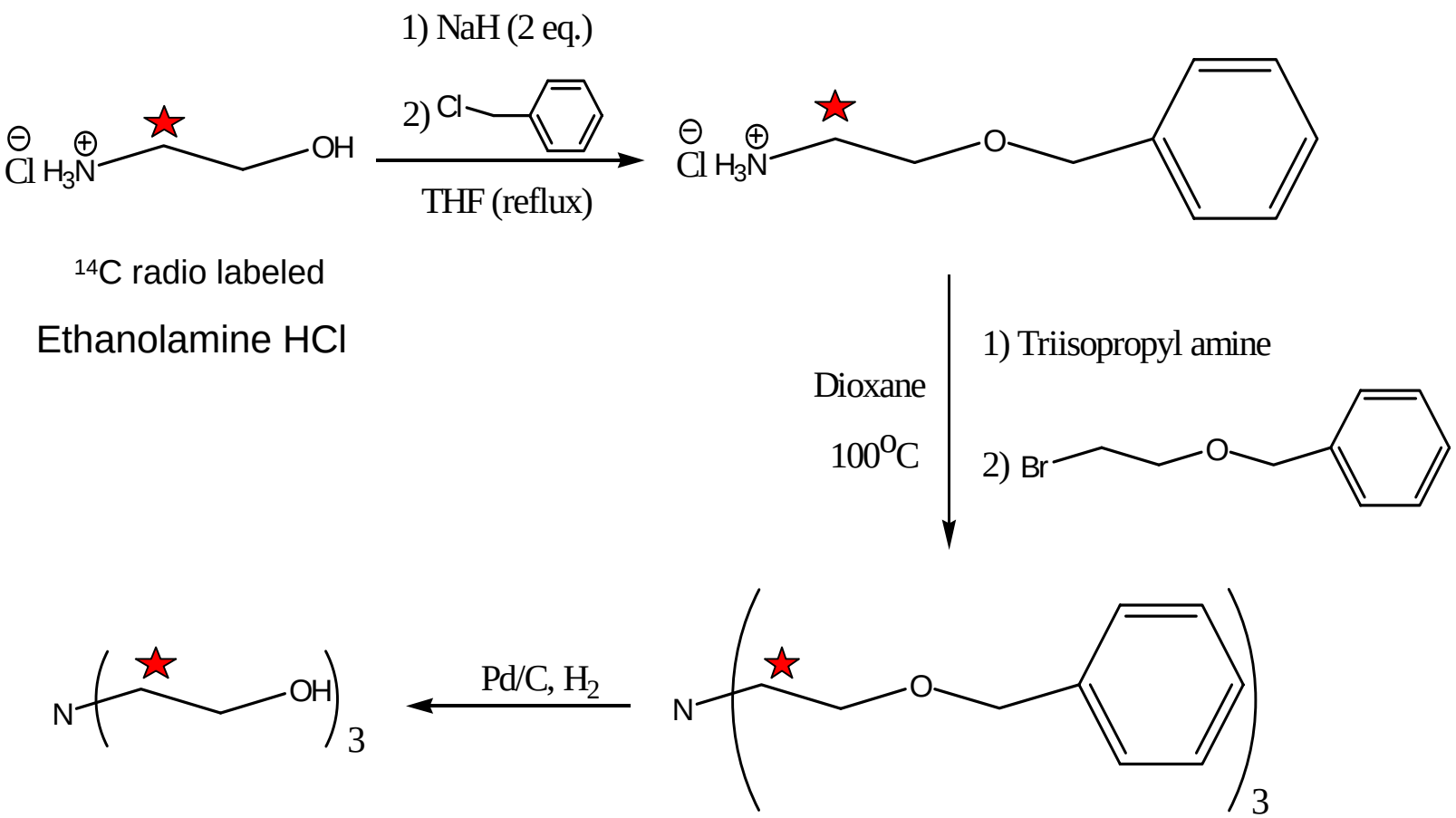


Comparison of Amount of Radioactivity in Rinse Water to Immersion Water

PAG Extraction Experiment - Conclusions

- Small but detectable amount of ^{14}C-PAG is extracted under 30 sec.
- No difference between amount of exposed and unexposed PAG extracted
- No PAG extracted after 30 sec. pre-rinse

Base Extraction Experiment - Synthesis



Base Extraction Experiment - Synthesis

- Purification of base in original synthesis was extremely difficult because of triethanolamine's affinity for water
  - Must have extremely pure sample to determine radioactivity per unit mass
- New synthesis avoids water

Conclusions and Future Work

- A 20 min. immersion extracts no statistically detectable amount of RCS
- A small, yet detectable amount of PAG is extracted in under 30 sec.
- A 30 sec. water rinse removes extractable PAG
- Synthesize ^{14}C-triethanolamine
- Perform base extraction experiment

Acknowledgements

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