Search for charged particle emissions resulting from Pd-D Co-Deposition

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We have attempted to replicate Pd-D Co-Deposition charged particle results reported by Mosier-Boss et al. [1,2]. CR-39 pits similar to those reported by Mosier-Boss et al. were found using both in-situ CR-39 and Mylar-protected CR-39. However, CR-39 protected by a combination of Mylar and a small air gap did not show any pits. The electrolyte, as its chemistry changes during the electrolysis, is shown to damage the acrylic cell containing the experiment and to damage an aluminum foil separated from the electrolyte by a Mylar film. This damage together with the absence of pits when a small air gap is added to the Mylar protection suggests chemical reactions may be the source of the observed CR-39 pits.

[1] P. Mosier-Boss et al., Eur. Phys. J. Appl. Phys. **40** 293-303 (2007)
[2] P. Mosier-Boss et al., Eur. Phys. J. Appl. Phys. **46** 30901 (2009)

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Presented at ACS 241st Meeting - New Energy Technology
Sunday March 27, 2011

NOTES BY RICK CANTWELL

Coolescence has been looking at LENR for last 6 years, focusing on replication.
Co-dep studies were performed over a 1-1/2 year period.
Studies were limited to charged particles; we did not look for neutrons.

Outline

SPAWAR [1,2] has reported charged particles generated during Pd-D co-deposition using CR-39 detector

Chronology of search for charged particles

- Phase 1: YAP:Ce Scintillator
- Phase 2: YAP:Ce + CR-39
- Phase 3: Reproduce SPAWAR Mylar-protected CR-39 experiments

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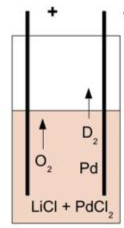
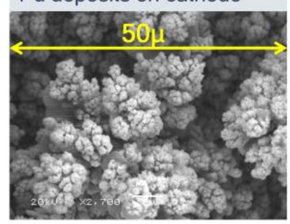
This presentation describes our effort to find reported charged particles. It is organized chronologically; in the order in which we performed the experiments.

Pd-D Co-Deposition Experiment

- Electrolyte is LiCl + $PdCl_2$ in heavy water
- Pt anode, Pt or Au cathode
- Electrolysis Protocol
  - Low current plate-out ~2 weeks
  - ~ 1 week higher currents
- Produces cauliflower-like Pd deposits



Pd deposits on cathode



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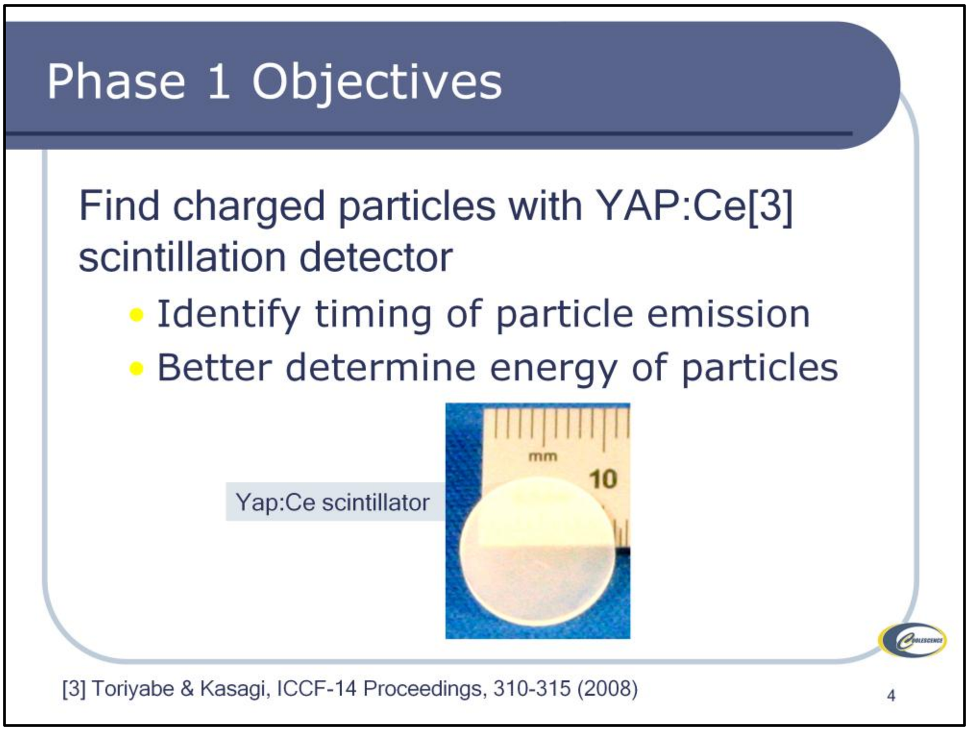
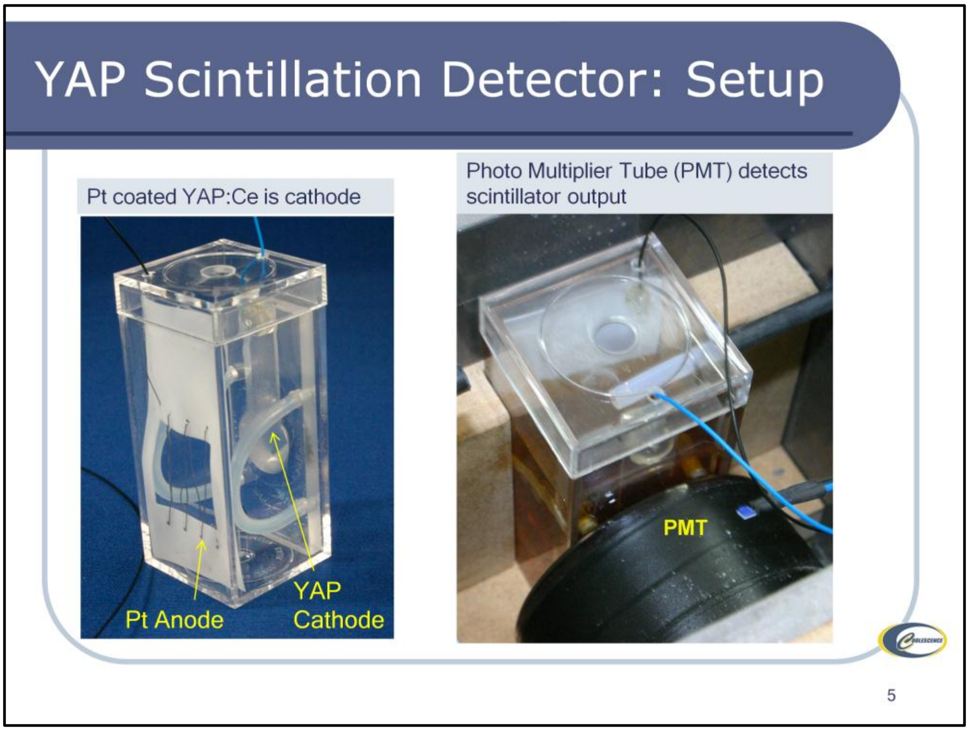
We followed a well-know protocol from SPAWAR: Plate Pd in presence of evolving D, 3-week electrolysis period.

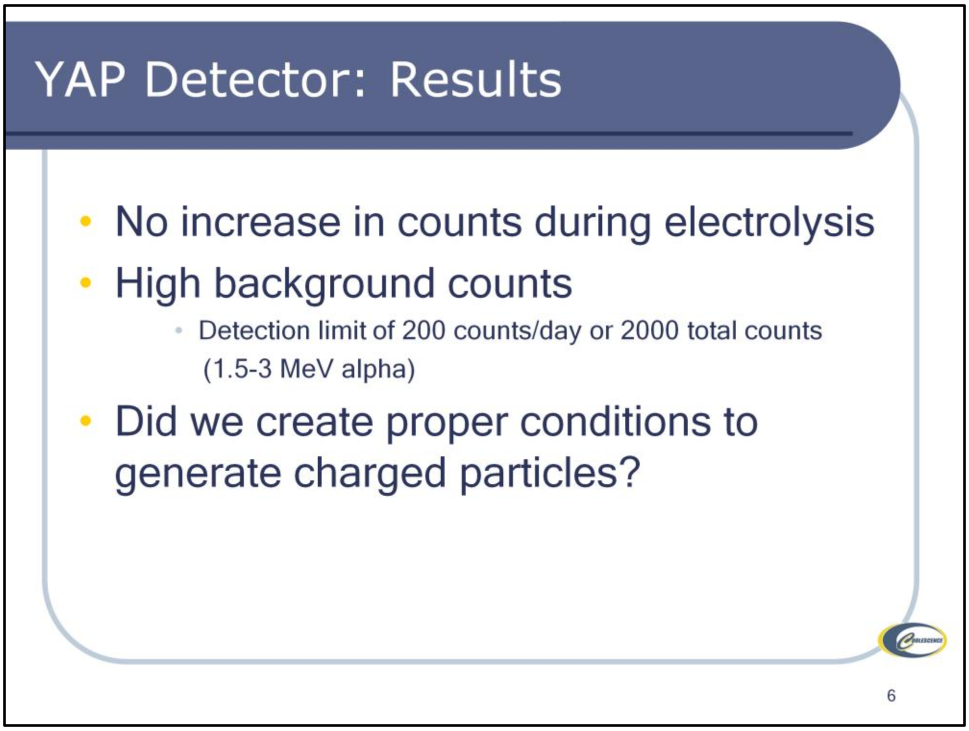


SPAWAR & others used CR-39 – an integrating detector – that yields no temporal data, and has limited precision on particle energy.

Our goal: to find particles with a different detector: YAP:Ce – mentioned at ICCF-14 by Toriyabe & Kasagi. This is a rugged crystal that can be used in electrolyte.



Pt thin-film is evaporated onto YAP to make cathode.
The back side of YAP is optically coupled to a photo multiplier tube to detect scintillation output.
We calibrated with a Po-210 source before adding electrolyte.
During electrolysis, Pd is co-deposited onto the surface of YAP.



After several runs, no counts were detected above background.

Did we have enough sensitivity? In the end, our results left us wondering if we had created the proper conditions to generate charged particles.

Phase 2 Objectives

- Why no YAP counts above background?
- Prove cell works with CR-39 in same geometry as YAP

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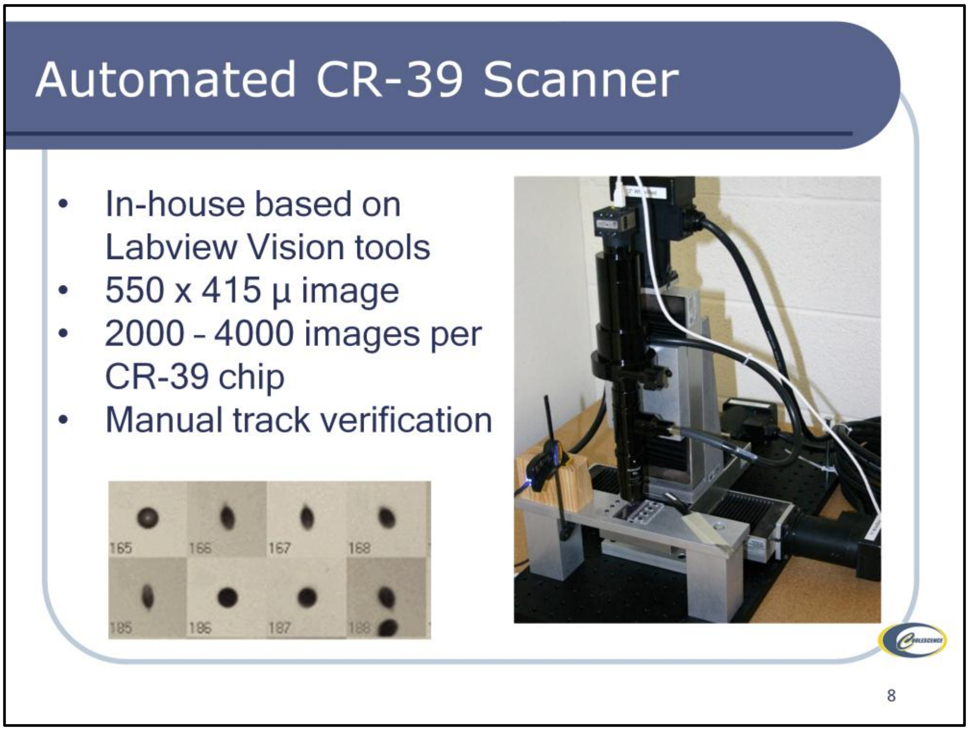
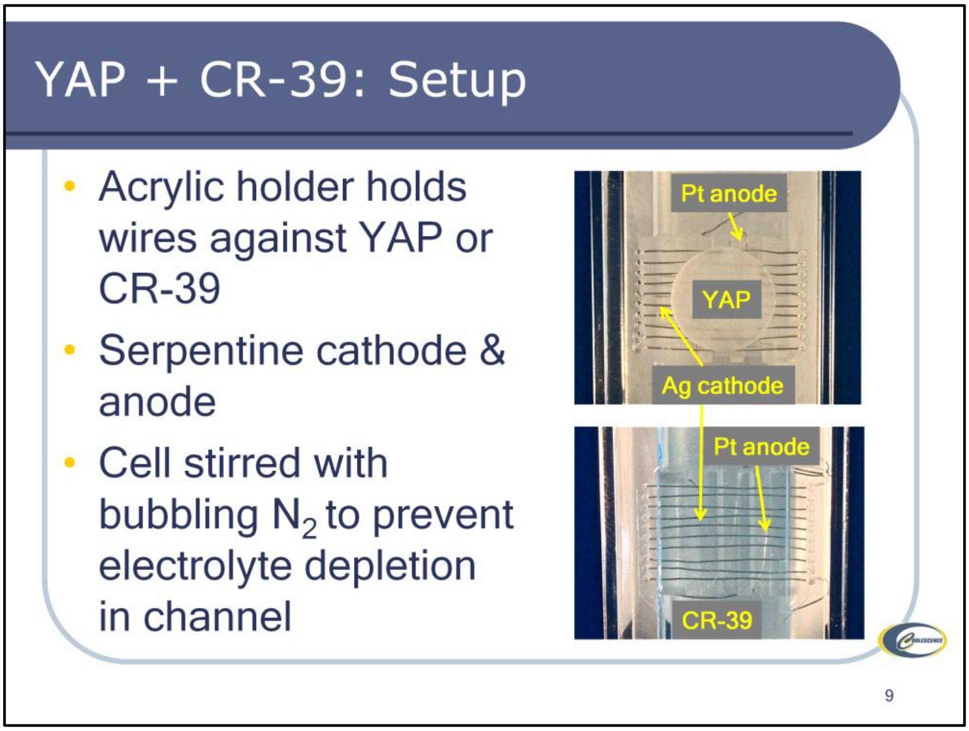
In order to prove the cells work, we used CR-39 in addition to YAP.



In order to do quantitative work with CR-39, we needed a way to repeatable count tracks – hand counting was too tedious.

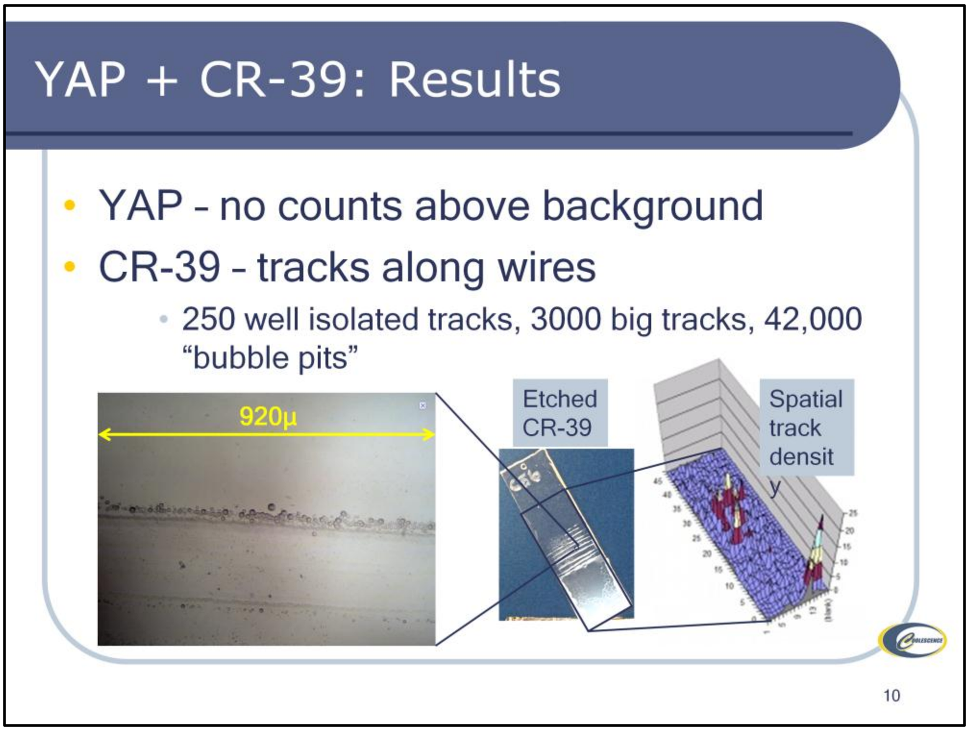
Microscope on 3-axis stage with digital camera.
Take lots of images and analyze tracks with software.
All tracks are placed in a montage (shown) for manual verification.
Post processing gives location, size and shape distributions.



Two cells, one with CR-39, and one with un-protected C-39 , were employed.

In CR-39 cell (lower photo) a blue protective film is seen on back side of the CR-39.

Both cells were run with the same 3-week electrolysis protocol.



Lots of CR-39 tracks – illustrates challenge of counting – what is a pit?

Bubble pits were well over our YAP background.

Also note the lower right of CR-39, where N2 bubbler was located. Why are there no YAP counts?

Phase 3 Objectives

- Why no YAP counts above background even though we had CR-39 tracks?
- Faithfully reproduce SPAWAR Mylar-protected CR-39 experiments

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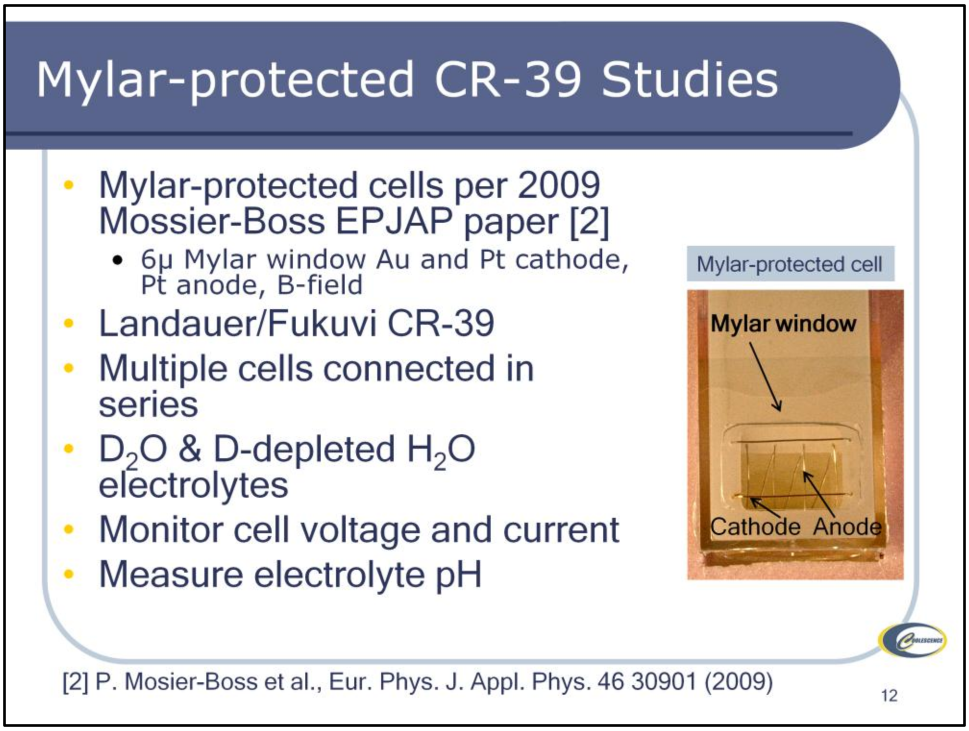
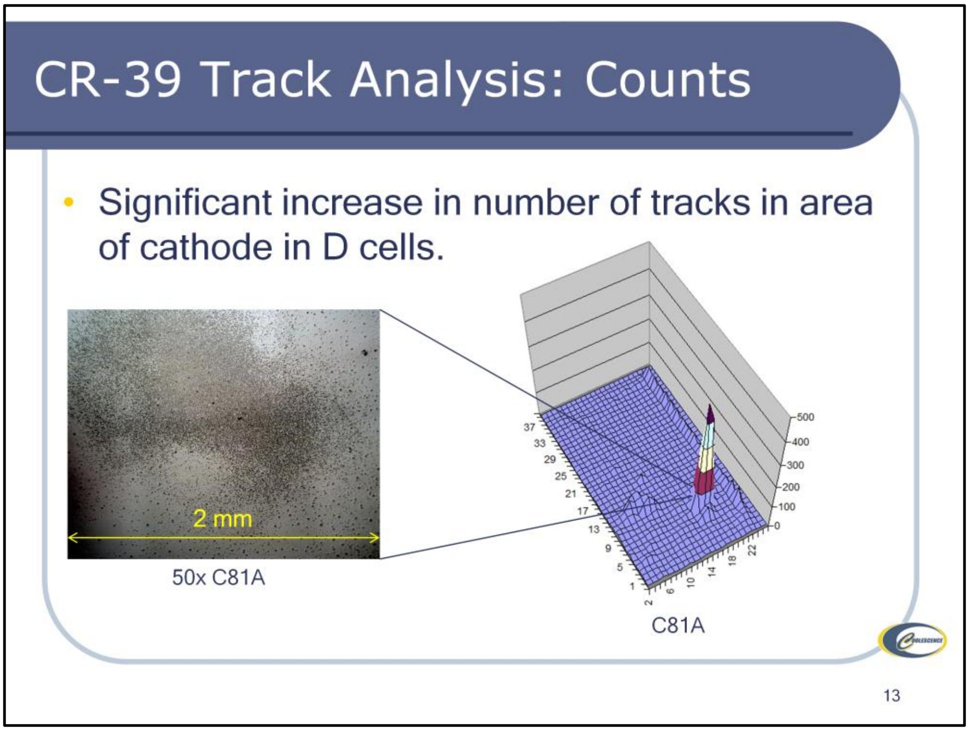
Our objective was to avoid concerns about damage to CR-39 being damaged by electrolyte.

We should note that by doing these procedures, we did not follow McKubre's replication rules; we tried to "improve" the original experiment before reproducing it.



In these studies we looked for charged particles using the setup outlined in SPAWAR 2009 paper. Cathode against 6 micron Mylar window – CR-39 held against window by magnets.

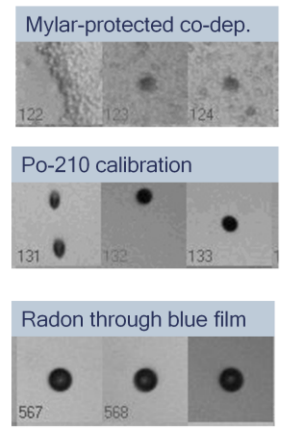
We used Landauer CR-39. We also used TASL, which we found is very susceptible to chemical damage.



All deuterium runs showed lots of tracks in area of cathode. What does this mean?

Track Analysis: Appearance

- Tracks under cathode lighter than tracks made by charged particles
- 7.7 MeV alpha from radon daughter is not stopped by protective film on CR-39



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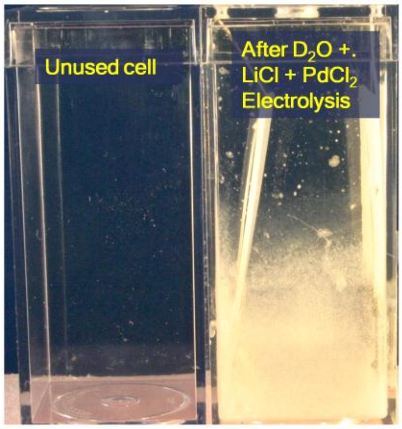
Lots of prior discussion on track appearance – we also note differences.

As an aside: Radon daughter NOT stopped by blue film. Radon tracks through blue film are very low energy alpha, and look much different from the co-dep tracks.

Physical Damage To Cell



- All cells damaged by 3 weeks of electrolysis
- D_2O cells more damaged than H_2O cells

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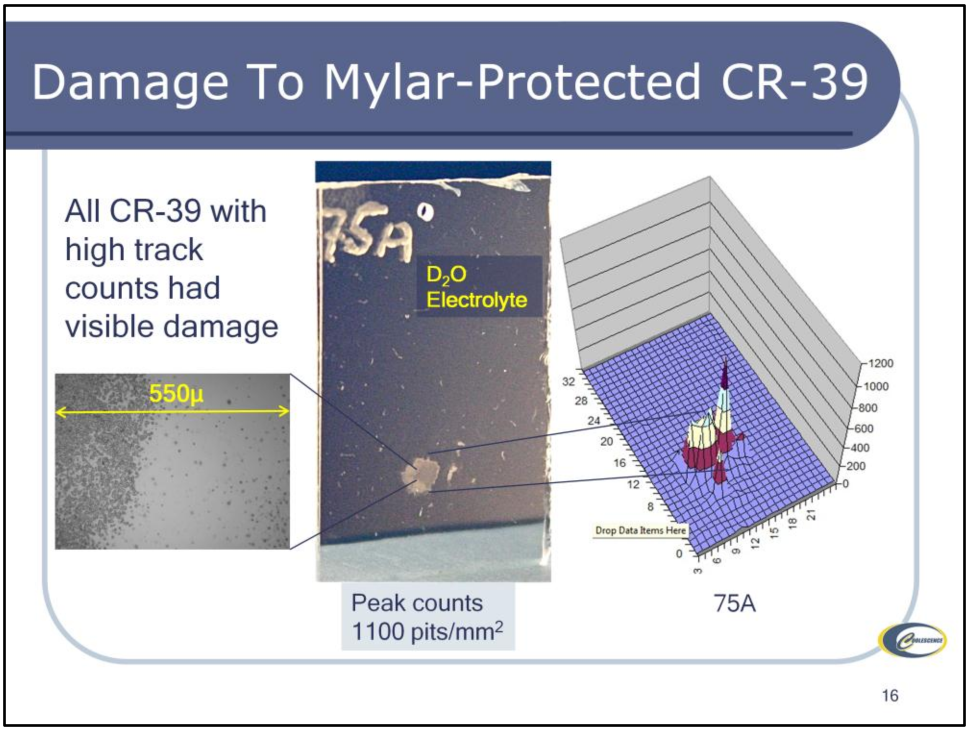
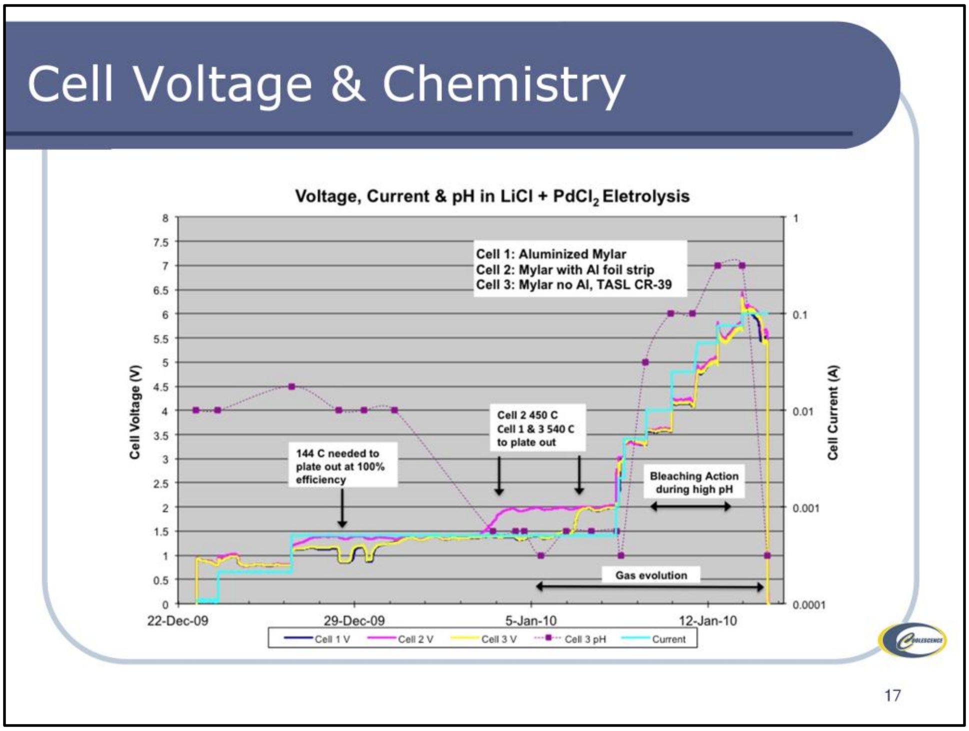
We do not know why D cells were more damaged than H cells. The question leaves us asking more about cell chemistry



In all case with high track counts we saw damage visible to the un-aided eye on the CR-39



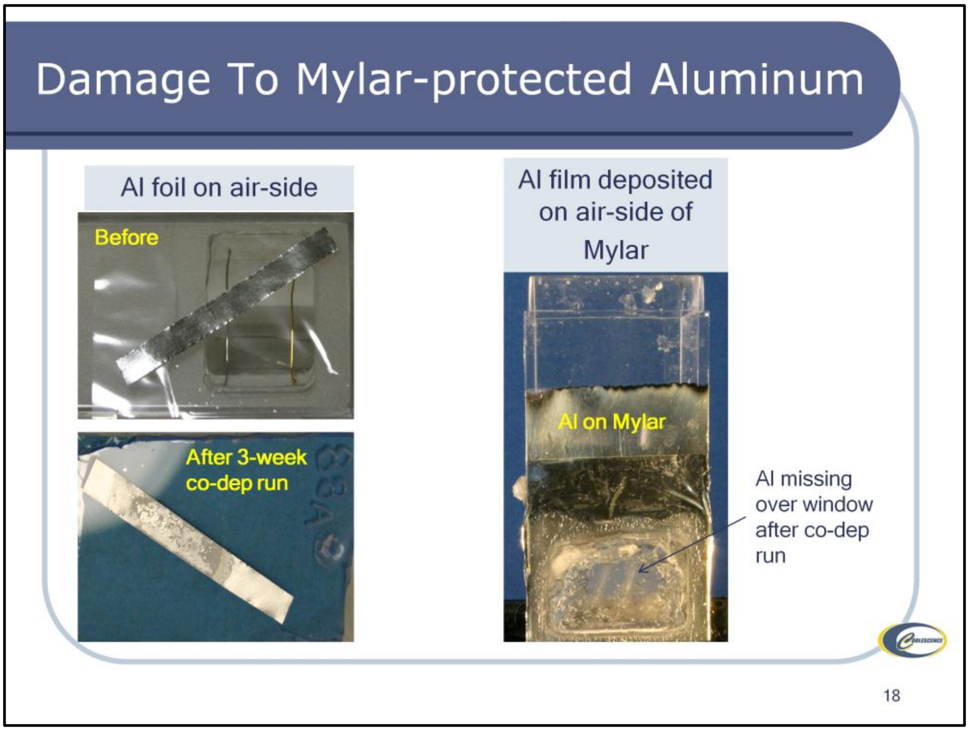
Three identical cells & electrolytes plate at different rates with low plating efficiency.

We can tell when Pd plating is complete by electrolyte clearing as well as by the increase in voltage.

There is no visible gas evolution during plating.

pH drops as Pt plates due to extra Cl- ions. pH rises with higher current forming hypochlorite (ClO-) which is bleach.

Could electrolyte cause damage through Mylar?



Does the electrolyte damage Al on outside of Mylar? Yes – both strip and Al evaporated onto Mylar

This test suggested by David Kidwell (NRL). Does electrolyte damage CR-39?

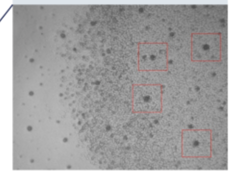
Mylar Protected CR-39 With Air Gap

0.5 mm air gap → .5 MeV proton loses ~20keV

5% energy loss should have little impact on track counts & track size

SPAWAR #8 CR-39 Counts		
	Cathode Tracks per mm^2	NonCath Tracks per mm^2
Cell 1 - no air gap (C135)	**2.1**	0.82
Cell 2 - air gap (C136)	0.61	0.75
Cell 3 - air Gap (C137)	0.56	0.7

Damaged area no air gap (C135)



Air gap (C136)

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Can we eliminate possible chemical damage? We thought that adding a small air gap that would not affect particle counts or size.

We found that with the air gap there were no counts, whereas there were lots of counts with the Mylar pressed against the CR-39.

Summary

- No counts with YAP scintillator
- Tracks on Mylar-protected CR-39 in D_2O cells
- Co-dep. tracks look different than alpha tracks
- Track location correlated with damaged areas
- Mylar does not prevent damage to Al foil
- No tracks with 0.5 mm air gap

Conclusion

- It is likely that chemical attack is the cause of CR-39 tracks we observed.
  - Tracks not present with air gap
  - Mylar film does not prevent damage to adjacent aluminum foil
  - Electrolyte damages the acrylic cells
- No evidence for charged particles in 14 runs
- Consistent with Mastromatteo [4] ICCF-15 report of no tracks

[4] U. Mastromatteo & R. Aina, ICCF-15, Rome (2009)

These results were not what we expected at start of the project. We conclude that chemical attack is the likely cause of observed CR-39 pits.