Cold-rolling a ^{54}Fe Target for Nuclear Structure Studies and Student Training

Justin Diaz (SJSU),Matt Gott (Argonne), John Greene (Argonne), Nicholas E. Esker(SJSU)

Overview

- ^{54}Fe target production
- Cold-rolling student training for target production
- ^{54}Fe(^{50}Cr,*p3n*) and Importance of ^{100}In and ^{100}Sn
- Future directions

About this talk

- This talk was prepared by SJSU undergraduate student Justin Diaz, before he went off to start his PhD in chemistry at University of California, Santa Cruz.

- Both Justin and Nick Esker (Justin's research advisor and SJSU professor) are extremely grateful to the INTDS for supporting this work through the Karasek fund, and especially to Matt Gott for hosting us at Argonne & for delivering this talk in our stead. Thanks Matt!!

Motivation for producing ^{54}Fe target

- Nick Esker is a new professor at SJSU, and is starting a targetry production / characterization lab

- The Esker group is leading an experimental effort to study the nuclear structure of ^{100}In at TRIUMF via ^{54}Fe(^{50}Cr,*p3n*) using EMMA (pictured) and TIGRESS

Targetry at SJSU

- San José State University is a primarily undergraduate and minority serving institution located in the Bay Area of California, near LLNL and LBNL

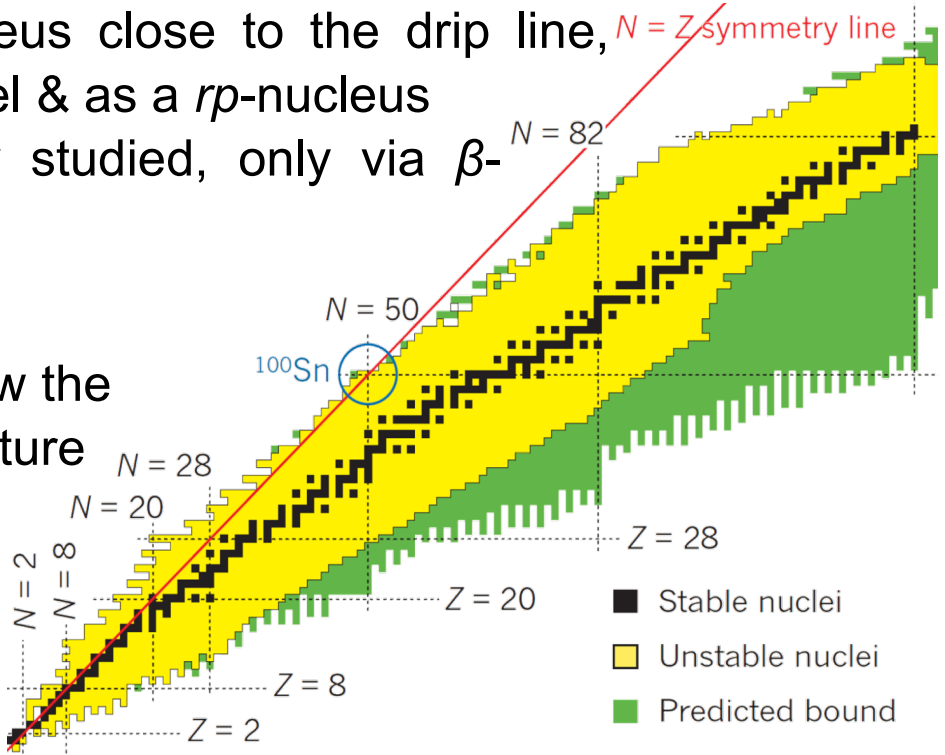
- Nuclear science in the US has a pipeline problem: most universities do not offer nuclear science courses / training-tracts.

- Targetry is a great entry for undergraduates to be introduced to nuclear, while meaningfully contributing to experimental efforts at accelerator facilities.

^{100}Sn and ^{100}In Importance

- The Esker group produced Fe targets to study the science of ^{100}Sn
  - ^{100}Sn is a doubly magic nucleus close to the drip line, useful in large scale shell model & as a *rp*-nucleus
  - ^{100}In has never been directly studied, only via β-decay of ^{100}Sn

- Production of these targets will allow the Esker lab to study the nuclear structure of ^{100}In through a reaction of ^{54}Fe(^{50}Cr,*p3n*).



Visit to Argonne

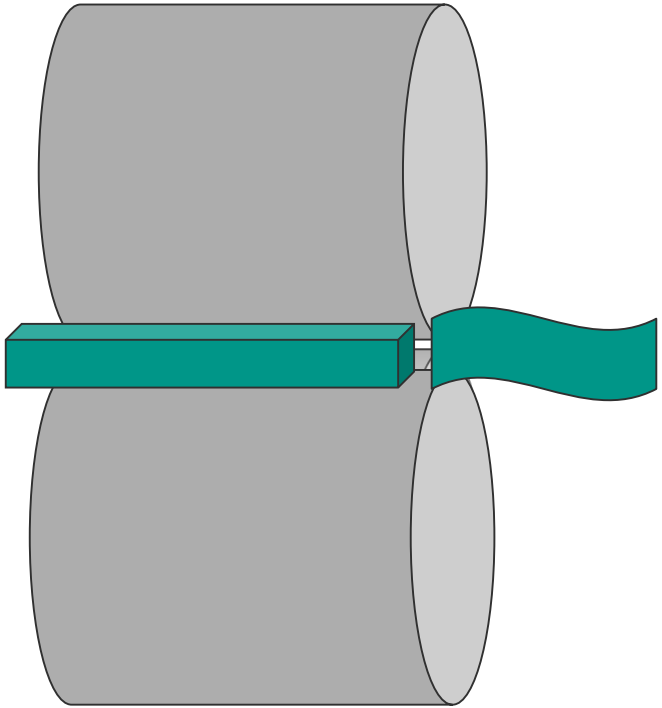
- Nick Esker and Justin Diaz visited Argonne from Jun 06 – 10
- ANL provided SJSU students training in cold rolling production with natural Fe and ^{54}Fe
- These efforts opens the door for students to pursue a career in nuclear science via target production

Cold rolling and foil production

- Cold rolling allows for production of target foils for nuclear based experiments
- Esker Group at SJSU cold rolled a pellet of ^{54}Fe into a foil
- ^{54}Fe target was produced at Argonne, and characterized at SJSU.

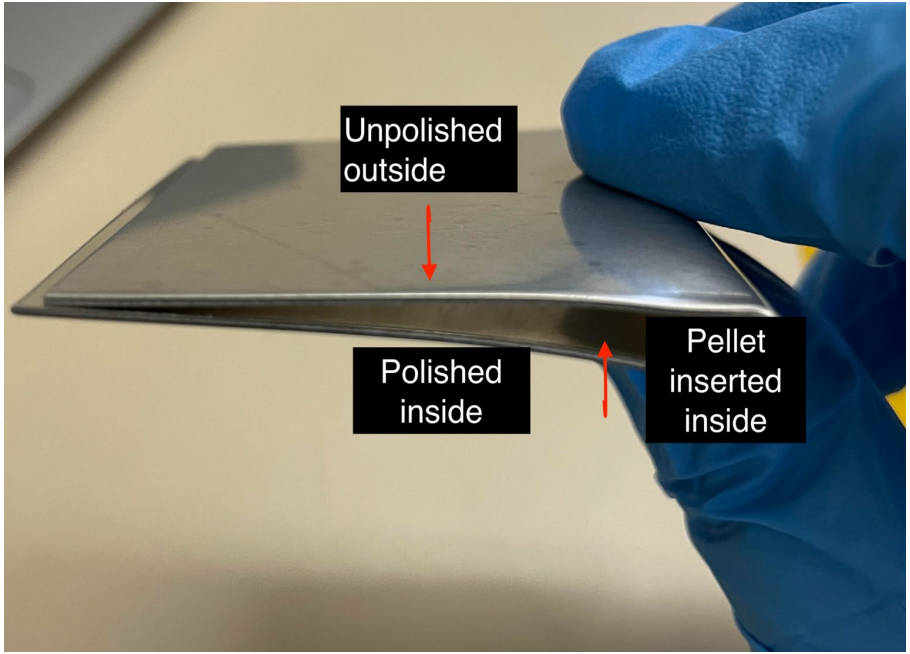
What is Cold Rolling?

- Cold rolling is a process by which metal is passed through rollers at temperatures below its recrystallization temperatures.
- The metal is compressed and squeezed, increasing the yield strength and hardness of the metal.
- Cold rolling mills can process and produce metal foils with varying thicknesses in the micron range



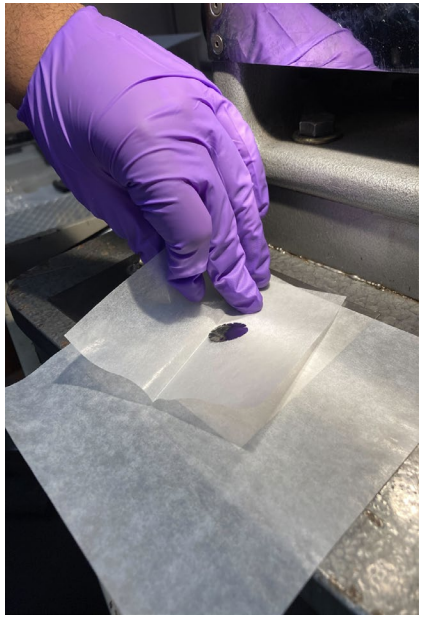
Process of Cold Rolling at Argonne

- Student Justin Diaz was taught cold-rolling using natural Fe before attempting w/ ^{54}Fe
- Target foil thickness goal ~800 $\mu g/cm^2$
- 15 mg pellet of ^{54}Fe was rolled using stainless steel frames
- Pellet was pressed inside folded frame and rolled through to make a foil

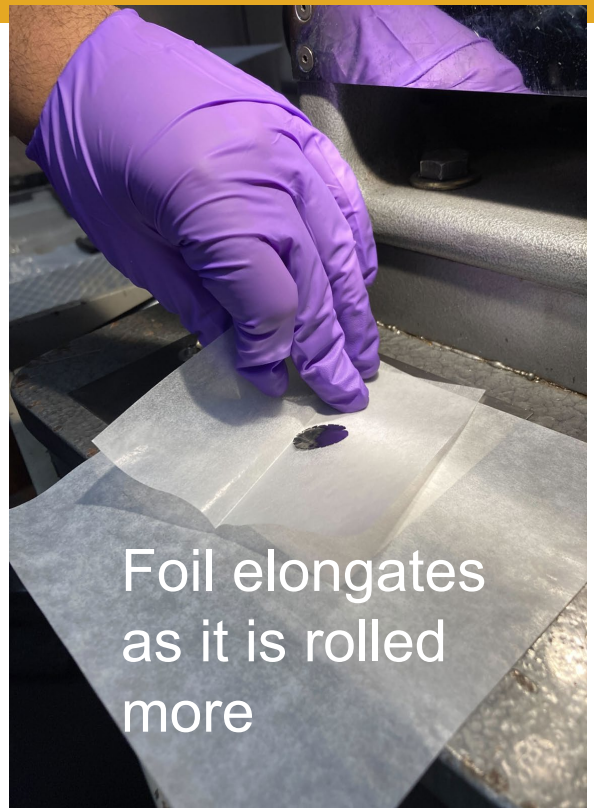


Process of Cold Rolling at Argonne

- Foil was rotated using tweezers to ensure uniformity of foil
- The distance between the rollers was slowly reduced
- Estimated thickness was calculated by measuring the aerial density of the foil divided by its original mass

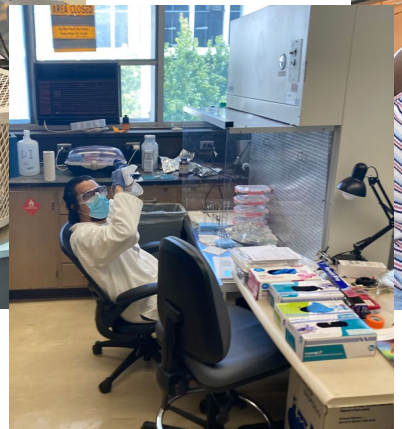


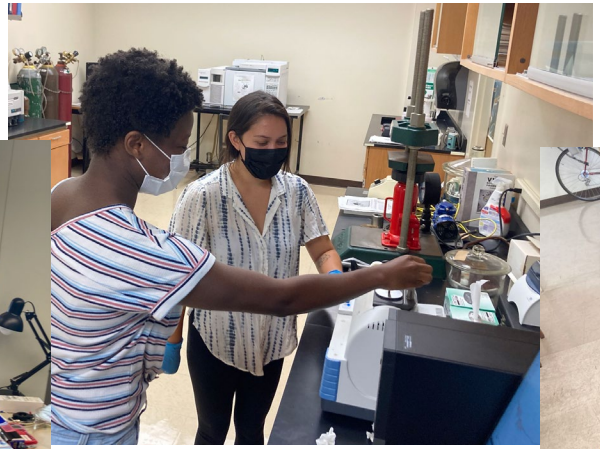
Formation of ^{54}Fe foil overtime

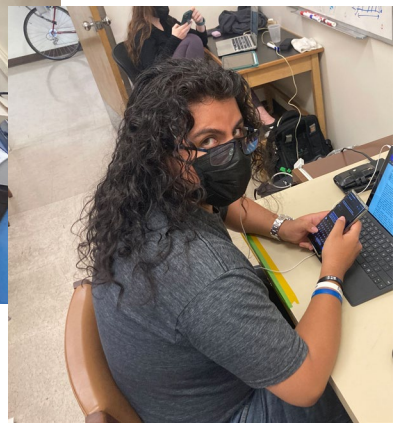


Impact on SJSU Targetry Lab

- Produced two usable ^{54}Fe targets
  - Verified thickness via α-energy loss, 860 μg/cm^2 and 920 μg/cm^2
- Esker group purchased a Durston rolling mill, Justin trained fellow SJSU students in rolling technique







Testimonial

- Justin Diaz: **“Performing work at Argonne and sharing the knowledge I gained there will help show students at SJSU the wonderful research that is done in nuclear science. Many students like myself are curious about nuclear research and if we can expand this research and implement it more at SJSU, we can attract more national labs to do more collaborative work.”**
- Nick Esker: “**I cannot thank Matt Gott and John Greene enough for their help and support, they have been fantastic mentors and friends. And I’m especially grateful to the INTDS for their support through the Karasek fund. When I first attended INTDS2018 as a post-doc, I had just started developing my career plan to pursue targetry at a PUI / MSI as a way to introduce undergraduates, especially underrepresented students, to nuclear science. But the welcoming, supportive, and fun community I found at INTDS solidified that this was the right direction for me and my group. I’m sorry I was unable to attend this year, I look forward to seeing y’all at INTDS2024!”**

Future Directions

- **Esker group plans to directly produce and populate excited states in ^{100}In using the ^{54}Fe(^{50}Cr,*p*3*n*) heavy- ion induced fusion-evaporation reaction.**
- The Esker group will explore the structure of ^{100}In
- Esker group plans to do future rollings of gold, iron, and other metals as needed

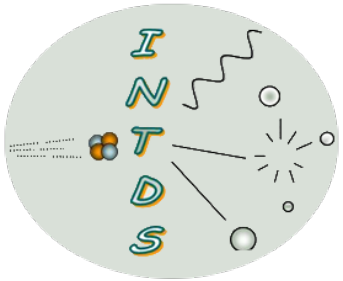
Conclusion

- Collaboration with ANL has shown to improve student learning outcome in research
- SJSU students at ANL were trained in thin film production and various characterization techniques that is applicable to both industry and academia
- Esker group developed methods applicable to their institution, specifically cold rolling
- The Esker group produced two ^{54}Fe targets at ~800 ug/cm^2

Acknowledgement

- INTDS Karasek fund and SJSU Research Foundation for travel support for Justin Diaz and Nick Esker to visit Argonne
- Matt Gott and John Greene for their support and mentorship
- You for your attention.

Questions?



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