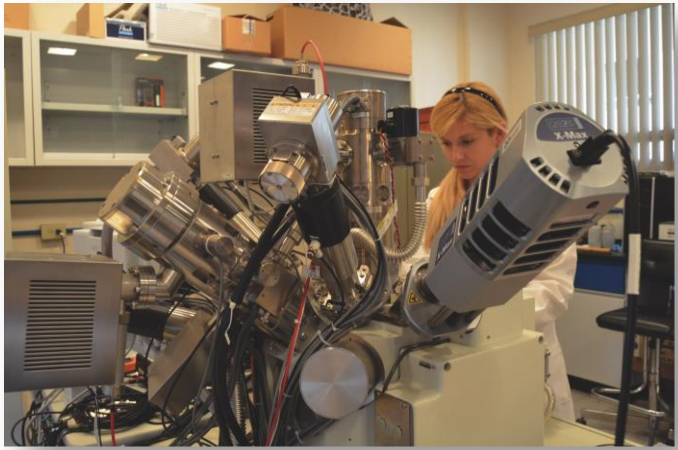
CaliBaja Center for Resilient Materials and Systems

Revolutionizing the way we design, test and manufacture materials and systems for extreme environments



- **Design** materials and systems for extreme environments such as ultra-high temperatures, extreme pressures and deformations, radiation, and acidic conditions, *etc*.
- **Manufacture** materials and systems using innovative techniques.
- **Innovate** advanced technologies for:
  - Aerospace
  - Defense
  - Energy
  - Nuclear
  - Biomedical
  - Environmental

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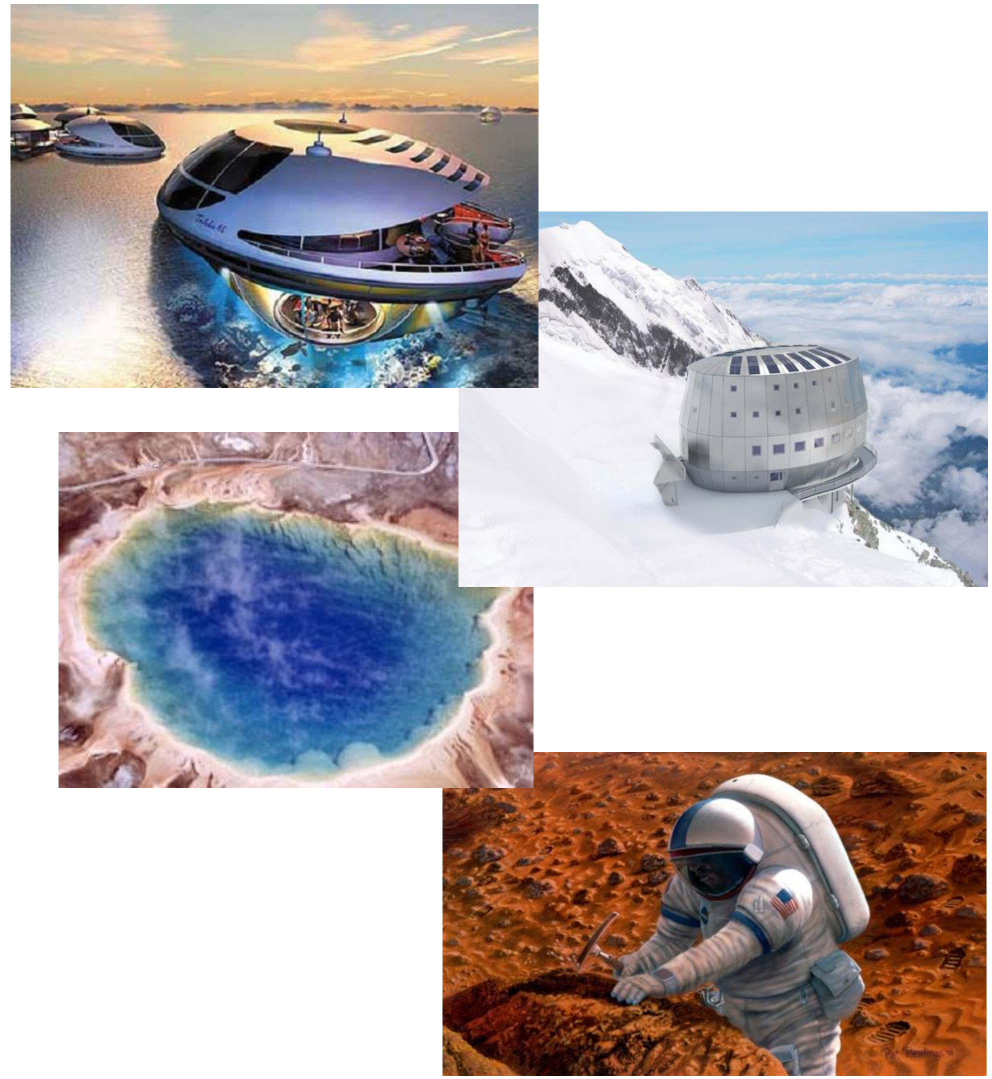
Motivation

- All advanced technologies depend on the development of advanced materials.
- **Problem:** Current materials cannot withstand extreme conditions, that is, they are not resilient.
  - Only function under a few conditions
  - Deteriorate under many circumstances
- **Goal: Cutting-edge research and development of new and innovative materials and systems under multiple extreme conditions.**



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Center Mission

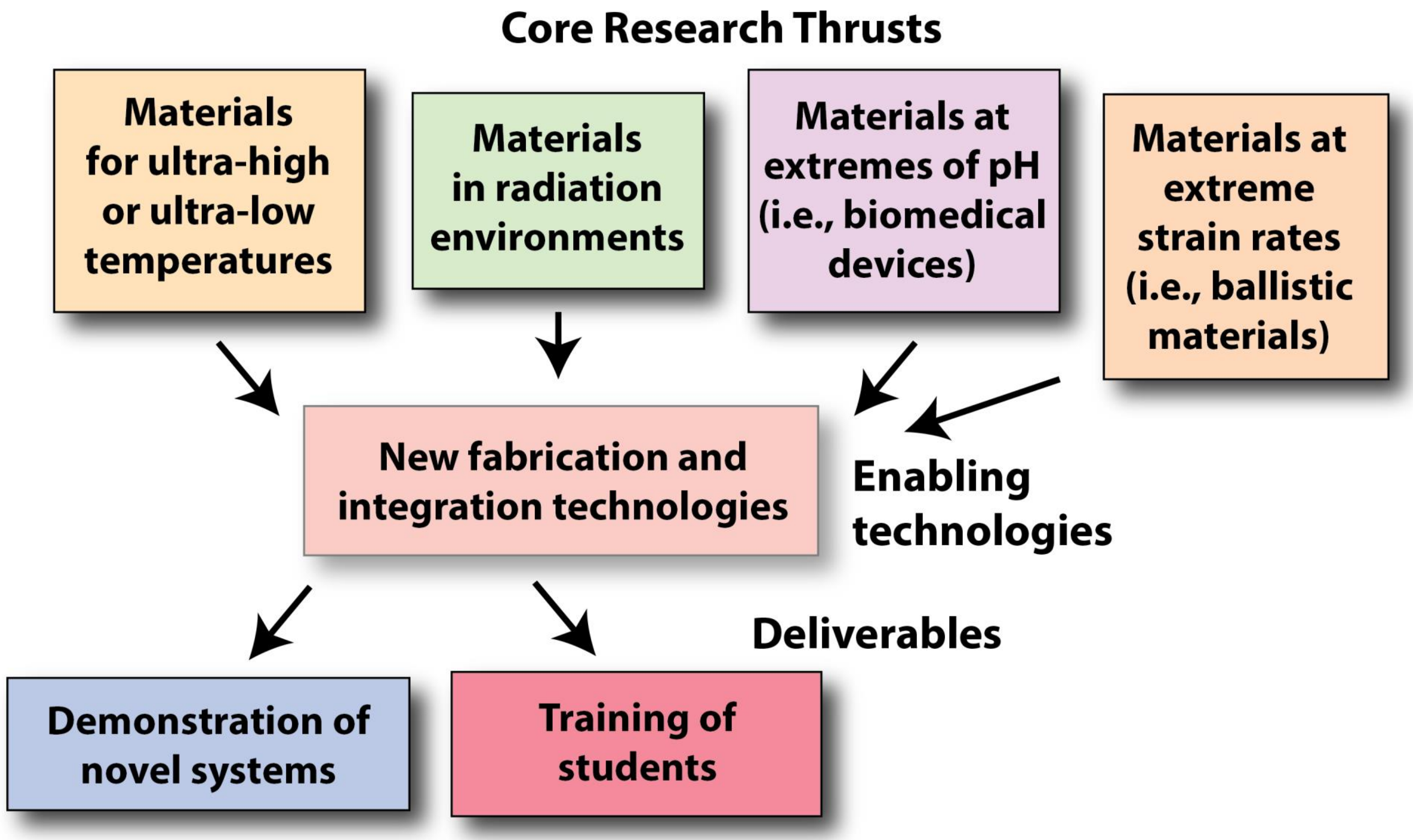
The **CaliBaja Center for Resilient Materials and Systems** aims to advance the frontiers in a variety of technologies, focusing primarily on **extreme environment materials and device solutions**. Our specific goals are to:

❶ Bring together extensive complementary expertise and the unique talent found at UC San Diego to solve challenges in the area of materials and systems in extreme environments,

❷ Accelerate lab-to-market technology transfer and support the economic development of industries in the aerospace, medical, and environment sectors, and

❸ Educate the 21st century technologist.

Center Research Structure



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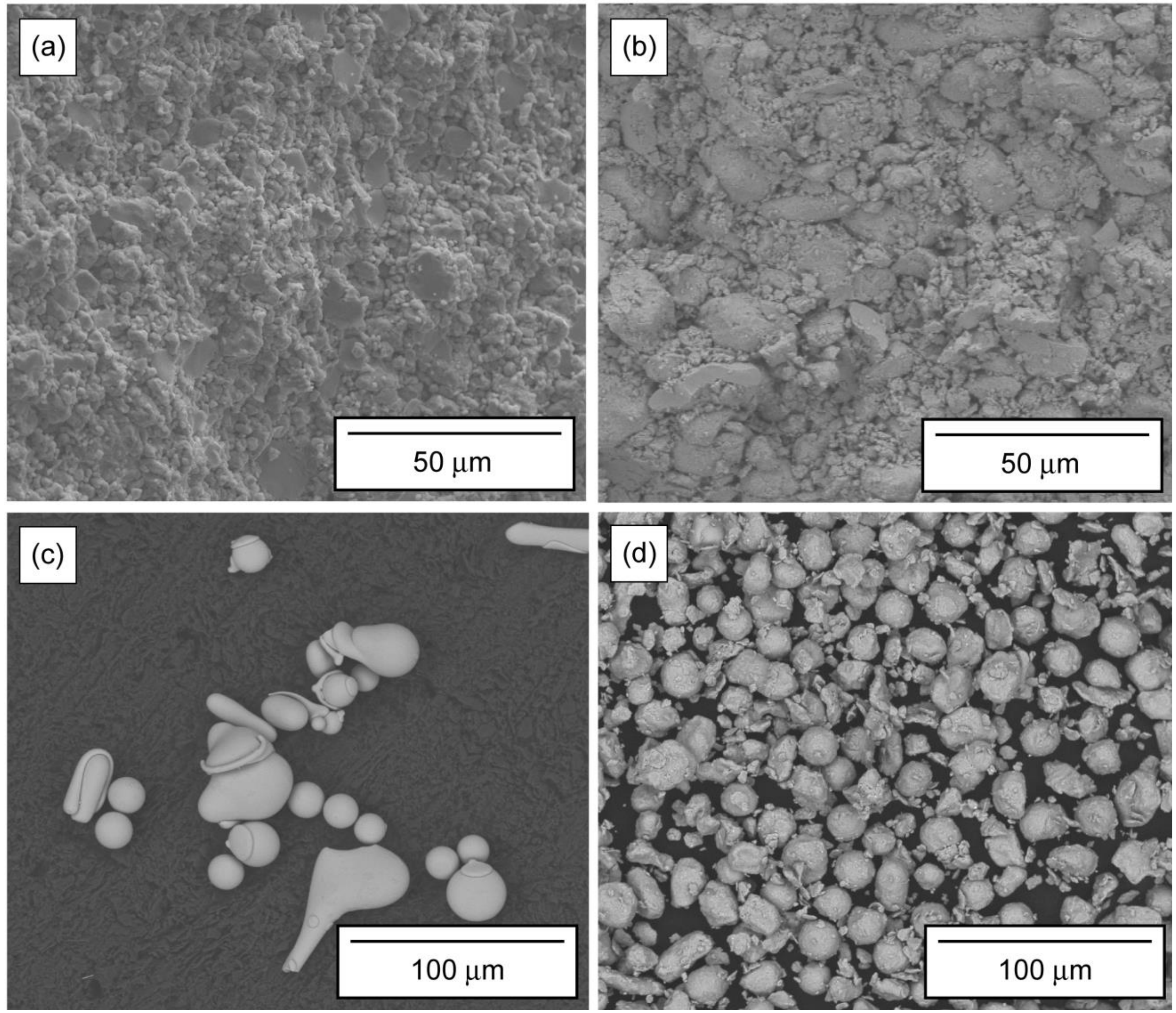
$T_g \approx 579°$ C
$T_x \approx 628°$ C
$T_m \approx 1133°$ C
$\rho_{theoretical}$ = 7.63 g/cm^3

SAM2X5 – $Fe_{49.7}Cr_{17.7}Mn_{1.9}Mo_{7.4}W_{1.6}B_{15.2}C_{3.8}Si_{2.4}$

Scanning electron micrographs of:

(a) sintered SAM7 fracture surface,
(b) sintered SAM2X5 fracture surface,
(c) as-received SAM2X5 powders,
(d) milled SAM2X5 powders.



O.A. Graeve, M.S. Saterlie, R. Kanakala, S. Diaz de la Torre, and J.C. Farmer, "The kinetics of devitrification of amorphous alloys: The time-temperature-crystallinity diagram describing the spark plasma sintering of Fe-based metallic glasses," *Scripta Materialia*, **69** [2] 143-148 (2013).

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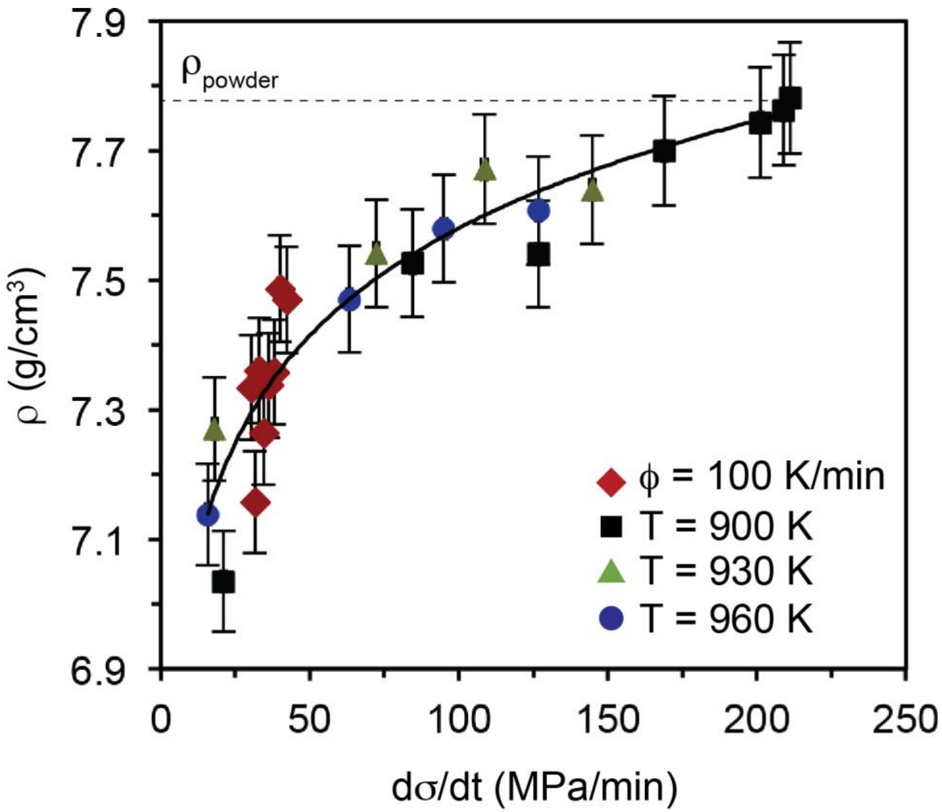

Largest samples produced:
- 4 in diameter
- 5-7 mm thickness

Density correlates to the rate of pressure application during sintering . . .

J.P. Kelly, S.M. Fuller, K. Seo, E. Novitskaya, V. Eliasson, A.M. Hodge, and O.A. Graeve, "Designing *In Situ* and *Ex Situ* Bulk Metallic Glass Matrix Composites from Marginal Glass Formers via Spark Plasma Sintering in the Super Cooled Liquid State," *Materials & Design*, **93**, 26-38 (2016).

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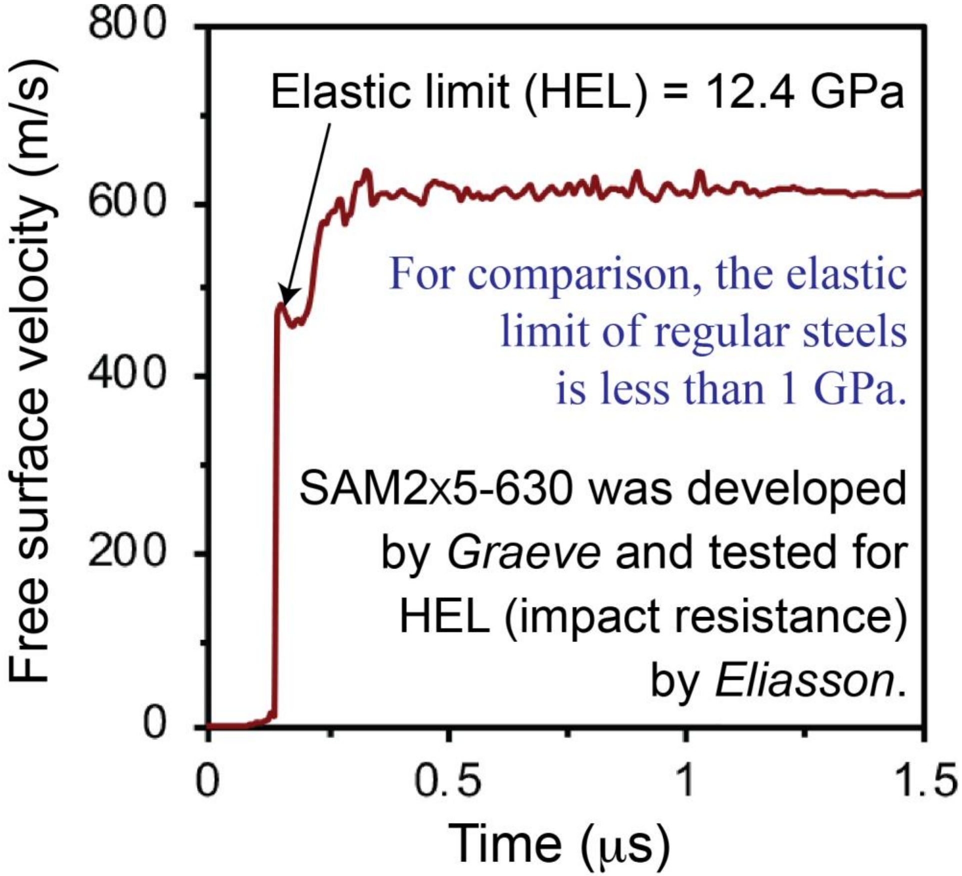
Elastic-Plastic Response

We have produced the highest ever recorded HEL for a metallic glass:
A value of 12.4 GPa

G.R. Khanolkar, M.B. Rauls, J.P. Kelly, O.A. Graeve, A.M. Hodge, and V. Eliasson, "Shock Wave Response of Iron-based *In Situ* Metallic Glass Matrix Composites," *Scientific Reports*, **6**, 22568 (2016).



Turneaure: 7.0 GPa on $Zr_{56.7}Cu_{15.3}Ni_{12.5}Nb_{5.0}Al_{10.0}Y_{0.5}$
Martin (2007): 6.86 GPa on $Zr_{57}Nb_5Cu_{15.4}Ni_{12.6}Al_{10}$
Xi (2010): 6.9 to 9.6 GPa on $Zr_{51}Ti_5Ni_{10}Cu_{25}Al_9$
Mashimo (2006): 6.2 GPa on $Zr_{55}Al_{10}Ni_5Cu_{30}$

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ENLACE 2018

Summer Research Experience

The ENLACE summer research program at UC San Diego aims to encourage participation of high school and college students in research in the sciences and engineering, while promoting cross-border friendships between Mexico and the USA.

- The program encourages students to contribute new discoveries and provides them the tools needed to excel in science and engineering.
- It is a 7-week residential program in the UC San Diego campus from which students leave with outstanding technical abilities and the soft skills needed to excel in the sciences and engineering.
- The program is bi-national with participation from Baja California students and Hispanic students from San Diego county. Students are organized in pairs (one from each side of the border) and they work together in research laboratories from across the UC San Diego campus.
- Participating areas include all fields of Engineering, Chemistry, Physics, and the Biological Sciences.

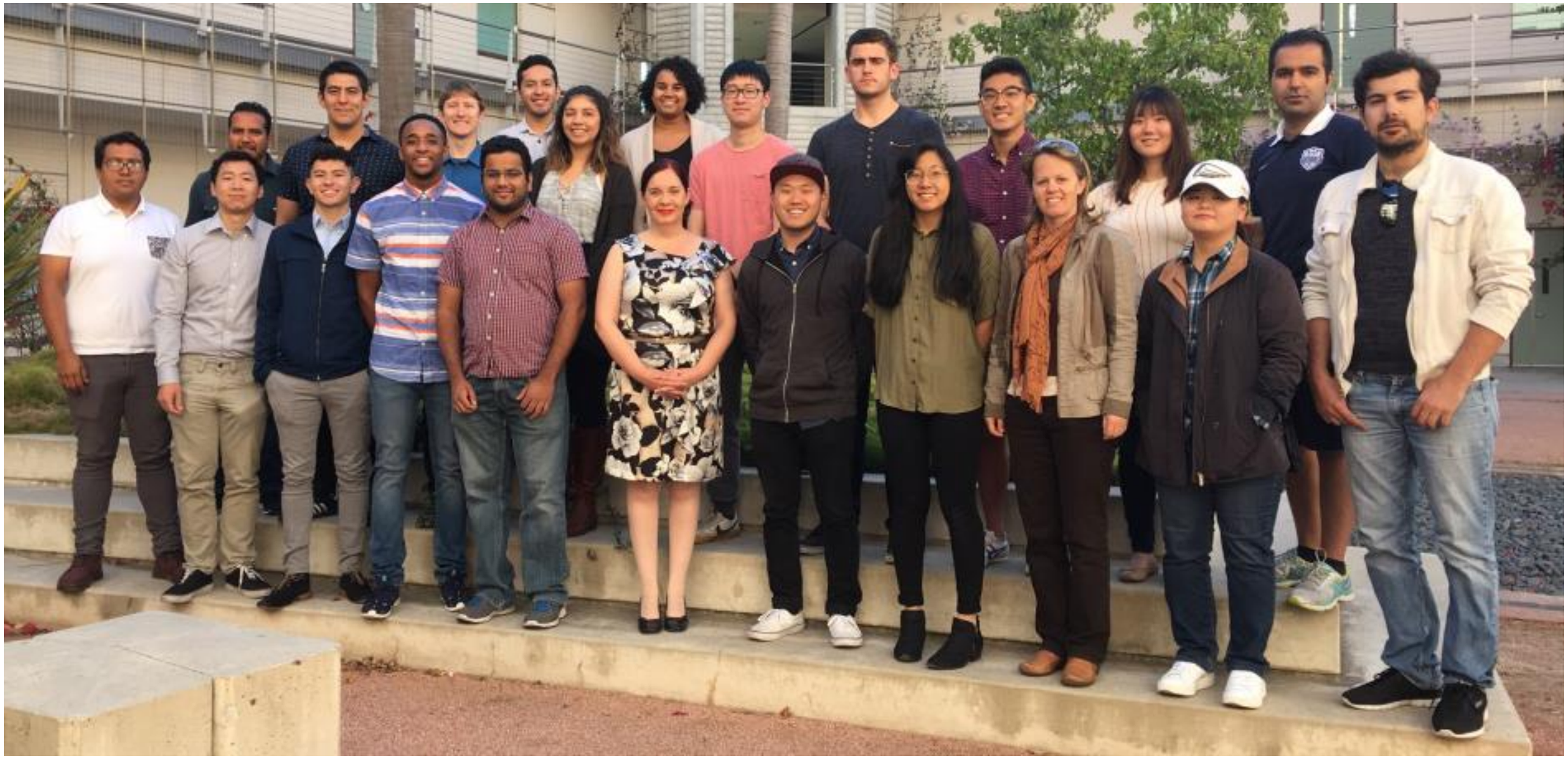
College + Grad School Prep

Student participants during summer 2015 at their college preparation session.

Lectures and Tours – ENLACE 2016

Science and Society Lectures:
Rommie Amaro, James Friend, Shirley Meng, Denise Ducheny
Tours:
Birch Aquarium, Midway Museum, San Diego Zoo, Old Town, Cabrillo National Monument, Air & Space Museum
Other Speakers:
Chancellor Pradeep Khosla, Consul William Ostick, Consul Marcela Celorio

Thank you!



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