

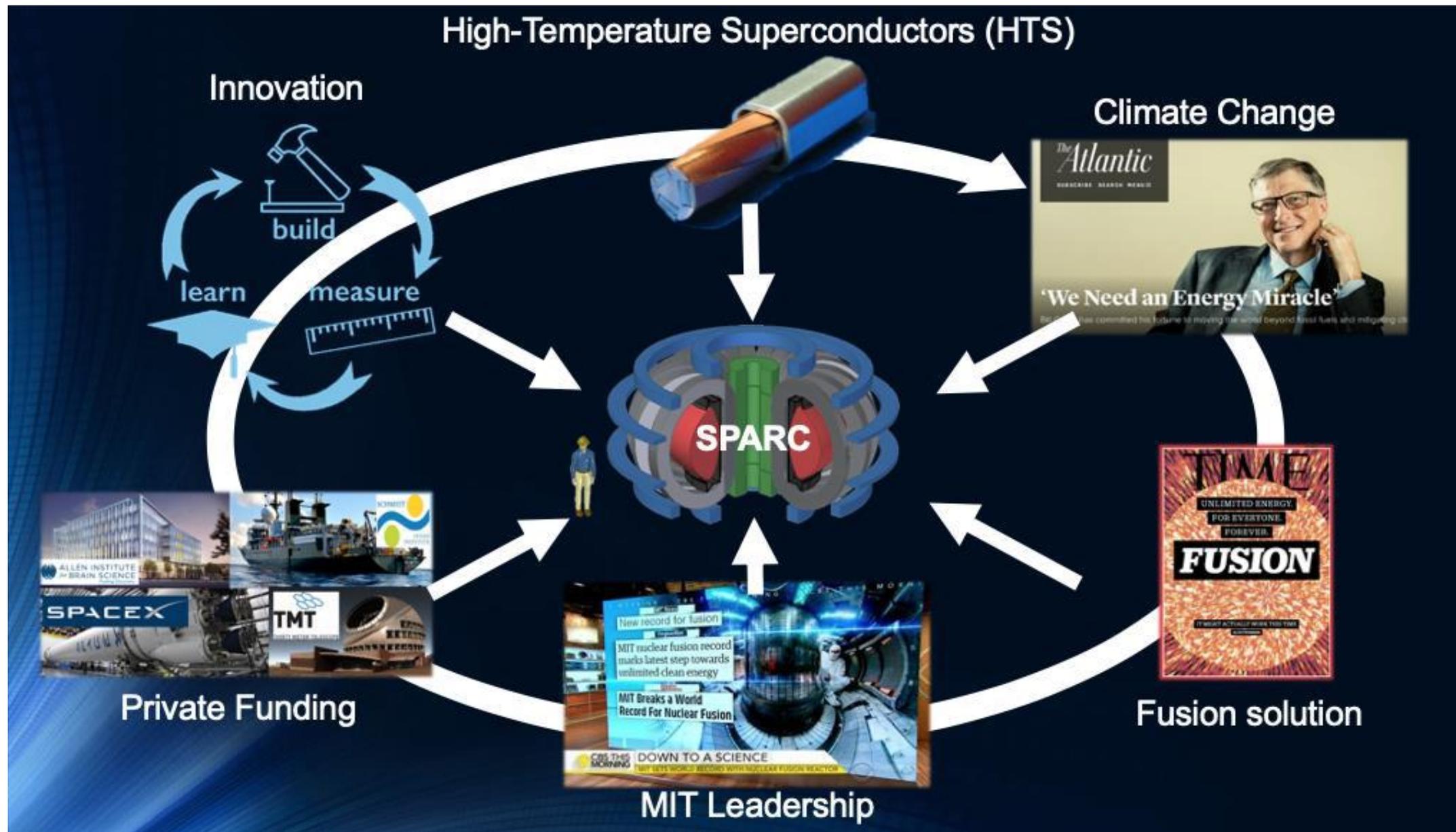


# Update & Opportunities

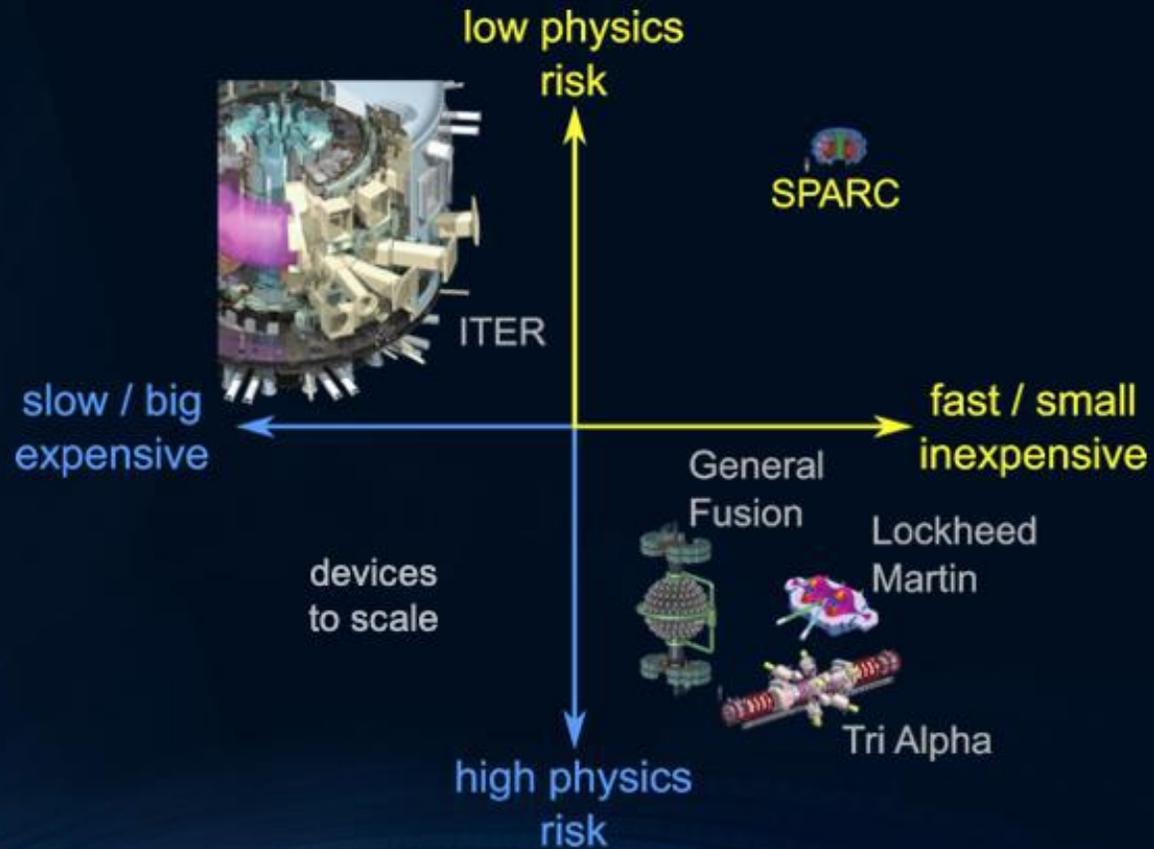
D. Whyte, MIT PSFC Director  
R. Mumgaard, CEO CFS

2019 MIT EAB

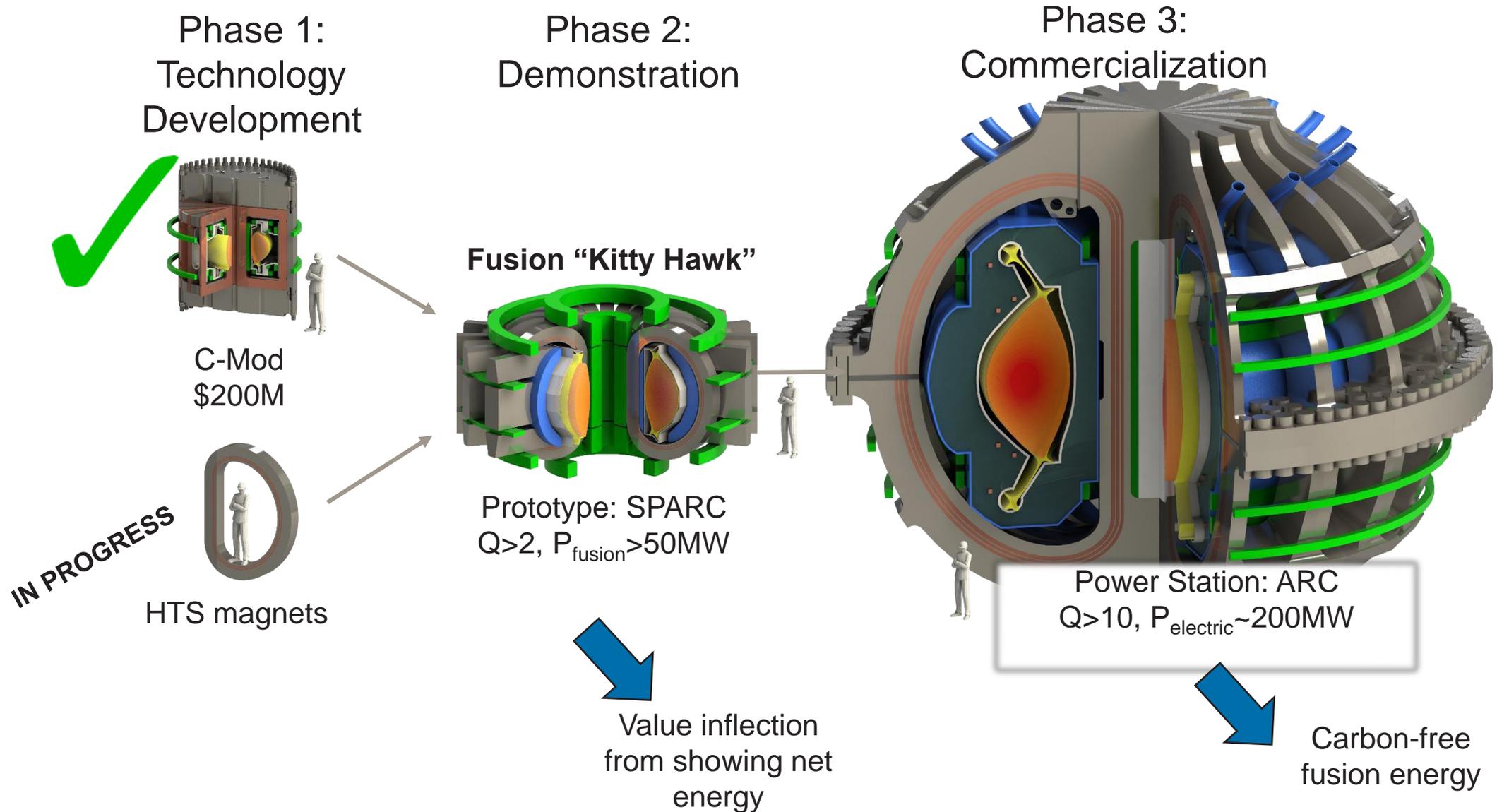
# Presentation to EAB in 2016



## SPARC uses proven physics at compact scale to rapidly demonstrate net fusion energy



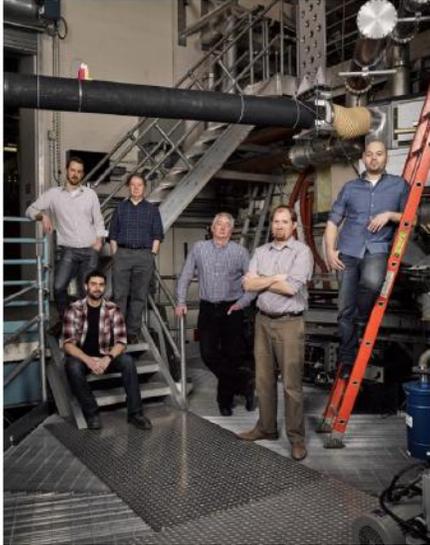
# EAB 2018: Privately funded, with staged risk retirement & staged investment



# 2018 to EAB: CFS/SPARC launch



**CFS was announced in March 2018**



## **CFS & MIT created a novel framework, enabled by MITEI**

- CFS provides funding to MIT
- Collaborative R&D
- CFS is MITEI member
- A framework that can be applied throughout MIT & academia for tough tech development



## **CFS closed its initial financing on 6/1/18**

- \$50M strategic investment from ENI
- Additional investments from world-leading financial investors



# Four coupled pieces got SPARC off the ground



1. Innovative and technically diverse fusion team at PSFC
2. MITEI as a convenor
3. ENI as a MITEI member and first investor
4. EAB + MIT leadership support

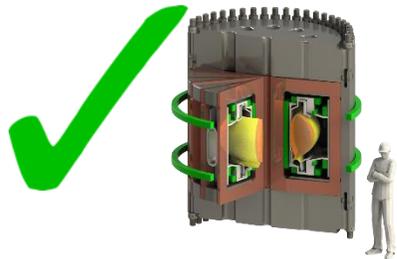


- Eni as *first investor* provided credibility
- *Engagement* of Eni with PSFC/MITEI changed both organizations
  - Eni has a fusion division
  - PSFC has LIFT, a technology development division
- MIT, PSFC *moved fast & changed how they did things*
- *These were hugely important from venture standpoint*

# CFS and MIT are now executing a 15 year plan to fusion



Phase 1:  
Technology  
Development



C-Mod



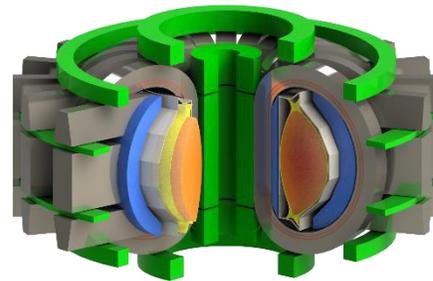
HTS magnets

IN PROGRESS

Full-scale TF by Q2 2021

Phase 2:  
Demonstration

Fusion "Kitty Hawk"

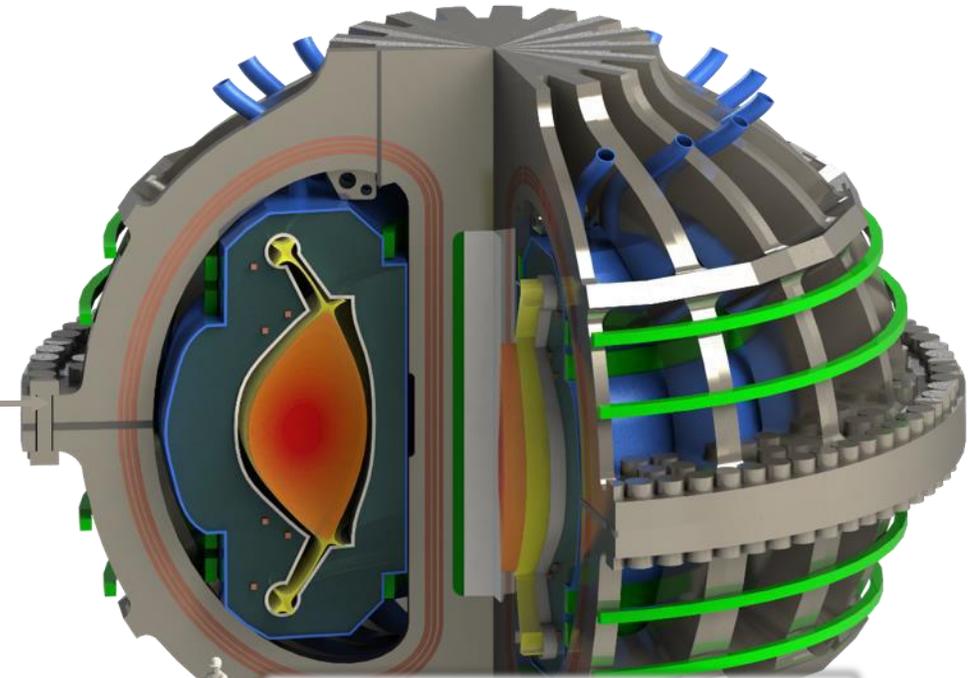


Prototype: SPARC  
 $Q > 2$ ,  $P_{\text{fusion}} > 50\text{MW}$

First plasma: 2025

DT: 2026

Phase 3:  
Commercialization



Power Station: ARC  
 $Q > 10$ ,  $P_{\text{electric}} \sim 200\text{MW}$

First plasma: Early 2030s

Power on the grid ASAP

# HTS magnets: The key enabling technology

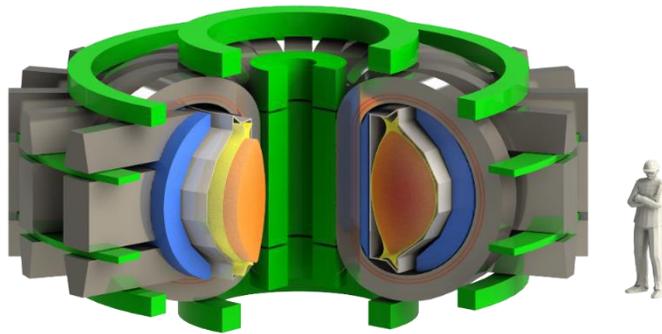


**Developing high-field HTS magnets at scale**

- We are the largest buyer of HTS
  - Industry scaling to meet our needs
- Successful 1 year program to develop 50kA-class HTS cable:
  - 4 tests in 5 months
  - Quench detection, cyclic loading, high current density in hand
  - Publication upcoming
- Now proceeding to full-scale full-field model coil – Done by next APS
- Planning for serial manufacturing



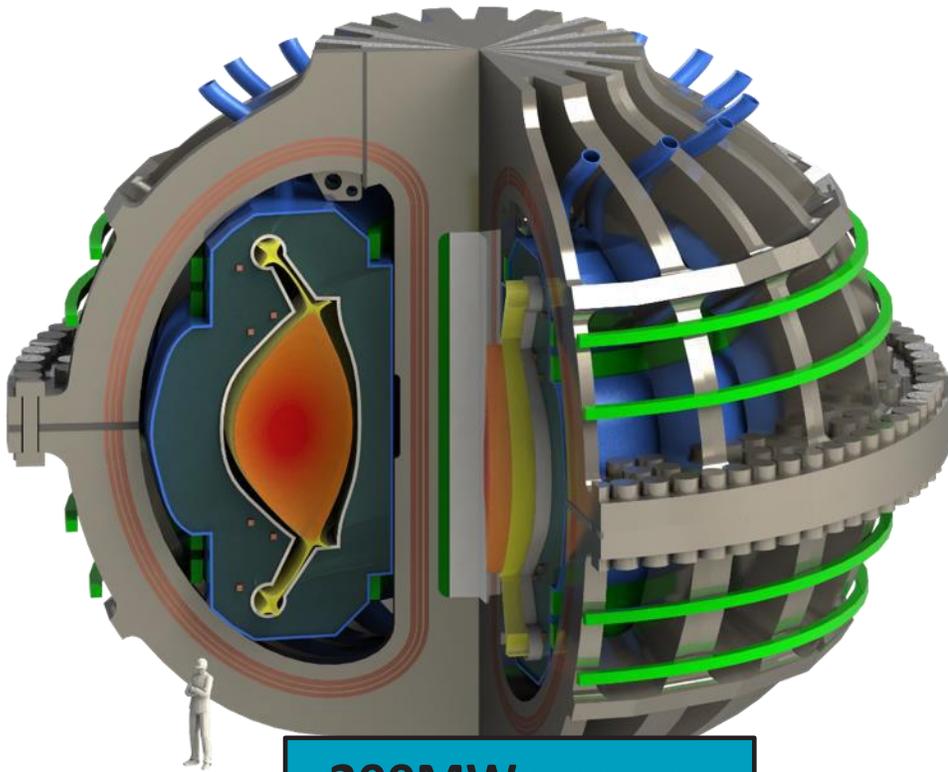
# SPARC: A fast-track HTS-based net-energy machine



**A net-energy device at the scale of DIII-D**

- DT device aiming for  $Q > 2$  using conservative physics
- Physics results looking good on the design
- Now in preliminary design and small-scale prototyping
- Starting negotiation stage with regulator
- In final site selection stage
- Groundbreaking in 2021
- Net energy operation in 2025

# ARC: A flexible compact pilot plant

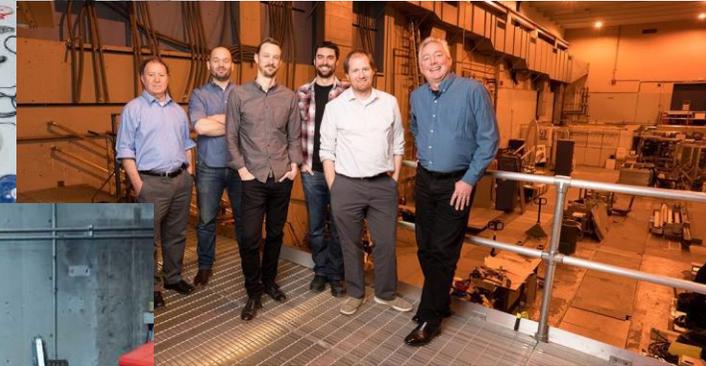


**200MWe power plant at the scale of energy plants**

- Aimed for a 200MWe electric output for multiple markets
- Lots of interest in this platform from energy companies, energy investors, and component manufacturers
- Validating the model of getting fusion on the grid in the early 2030s
- Learning lessons from off-shore wind, fission, and solar from the people that have done it before
- Building the commercialization view – via the start-up – into the early stage R&D so we deliver innovation that impacts energy markets

# Attracting the brightest from all fields to both PSFC and CFS

- SPARC is building a team to develop and field fusion devices
- Currently >100 head count
- Fusion experience:
  - MIT PSFC, ITER, GA, PPPL
- Magnets
  - MIT, NHMFL, CERN, LBNL, Fermi, GE, Phillips
- Adjacent high-tech industries
  - SpaceX, Hyperloop, TerraPower, Tesla, GM, Google, COMSOL, Intel
- A wide range of experience under one roof solving problems together as fast as possible



# Backed by capital to put fusion power on the grid

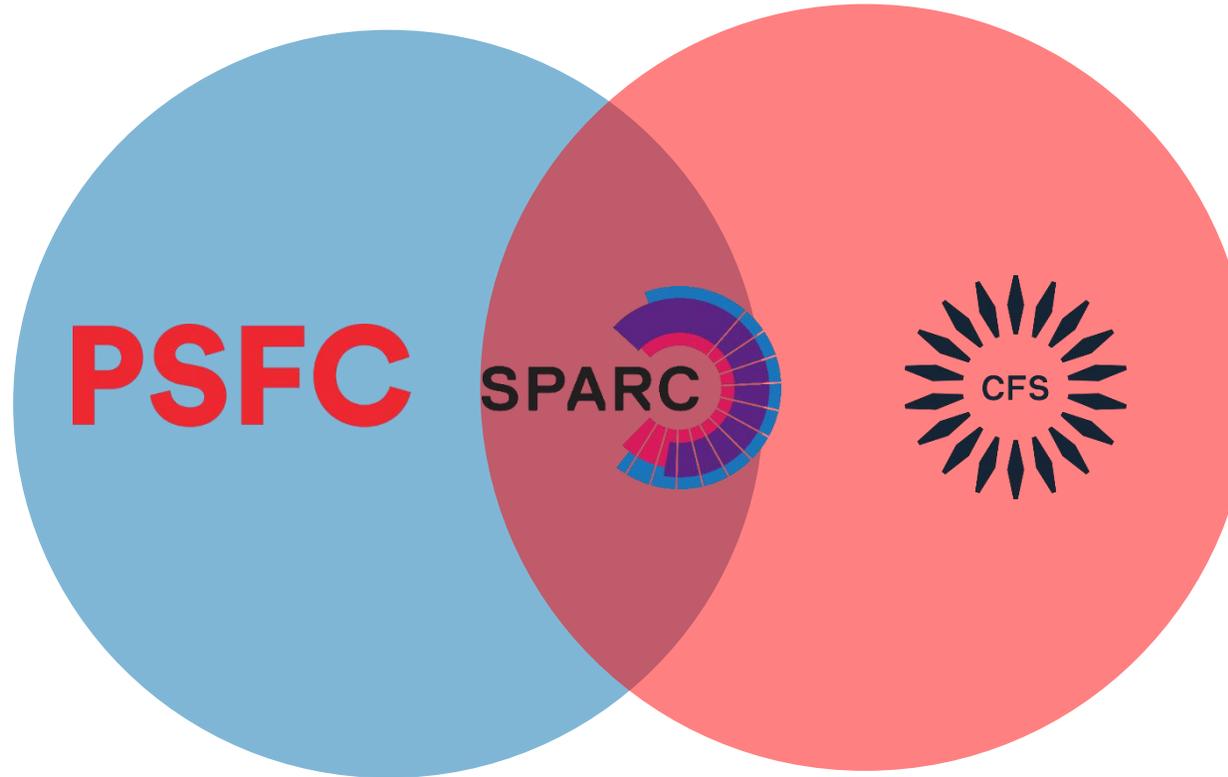
- Investors committed to displacing CO2 and building a fusion business
- Bought into the novel structure between MIT and CFS
- Last year: \$65M, this year \$115M
- Early investors in Google, SpaceX, Tesla, Amazon
- Enough capital to get it done and to accelerate while doing it
- Understanding of and appetite for the technical risks
- Anything less than power on the grid is a failure



# Partnership between MIT and CFS a success

MIT PSFC remains an independent research establishment

Providing scientific and R&D to the joint project



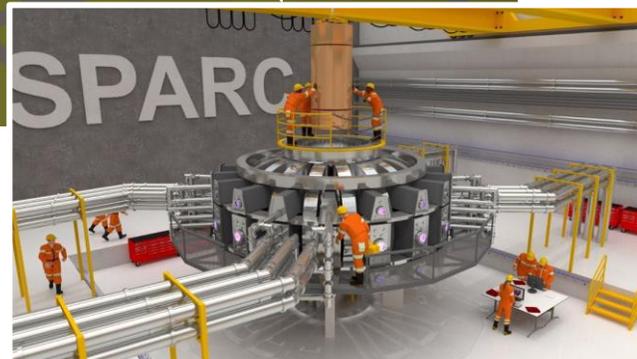
CFS is a private company

Focused on developing the commercial fusion product in time to make a difference

Bringing the best of all worlds together:  
The scientific underpinnings from tokamak research and the speed, capital and drive of the private sector and the capabilities around the world

**Breaking news: The MIT-CFS deal won the 2019 “Deal of Distinction” for the major technology licensing society. Seen as a new model for venture creation.**

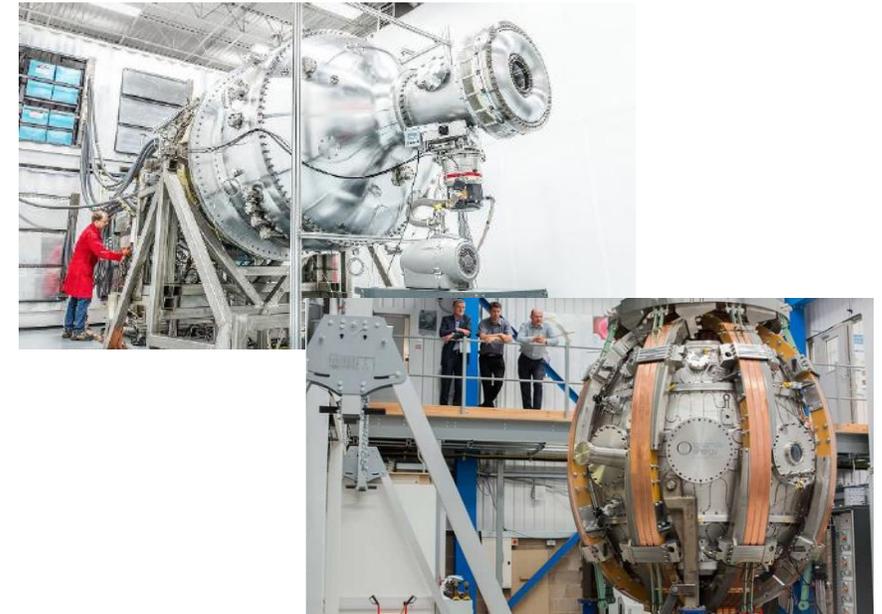
# The next step is to build SPARC



- Extend the MIT-CFS research into next phase along same lines
- We will build a world-changing device on a new site
- MIT Bates site is a strong candidate
- Other sites will be evaluated
- MIT alongside CFS on any site is key

# These are exciting times for fusion, we need to be bold!

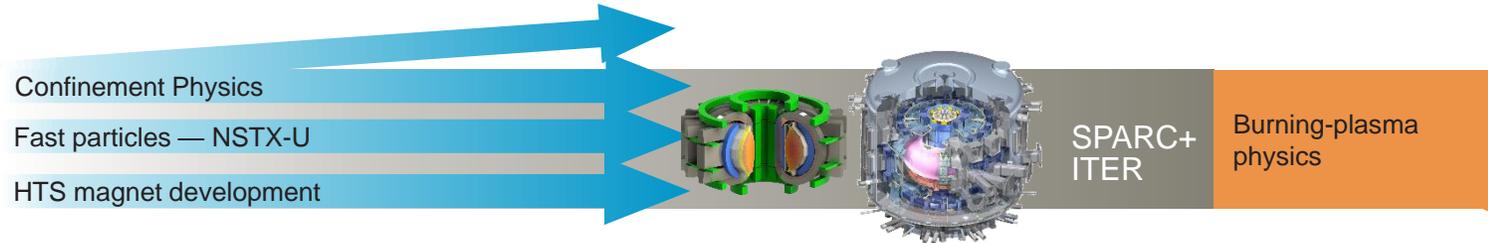
- Congress is aligned with an expanded fusion energy mission
- DOE is aligned with an expanded fusion energy mission
- There is a nascent fusion industry
  - Similar private capital in fusion as US gov't money in ITER
  - Growing quickly and accomplishing things
- There are long-standing technical gaps to be filled and good science to be done
- Other nations are ramping up fusion energy efforts
- We should be bold and put together a plan that starts now and gets fusion on the grid ASAP and leverages the entire ecosystem



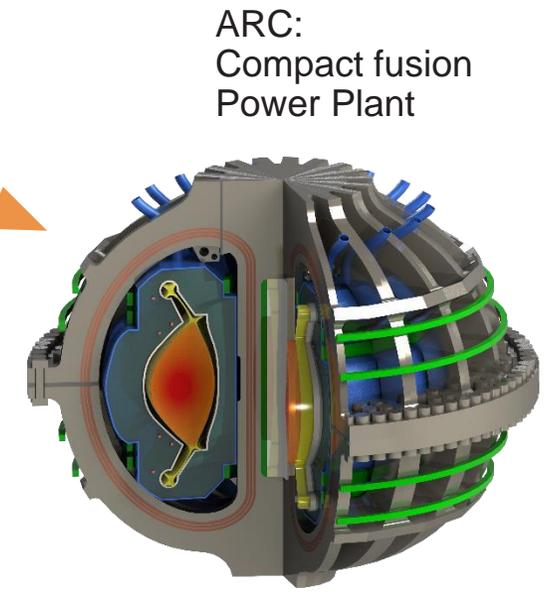
# SPARC is the springboard to create a fusion energy industry



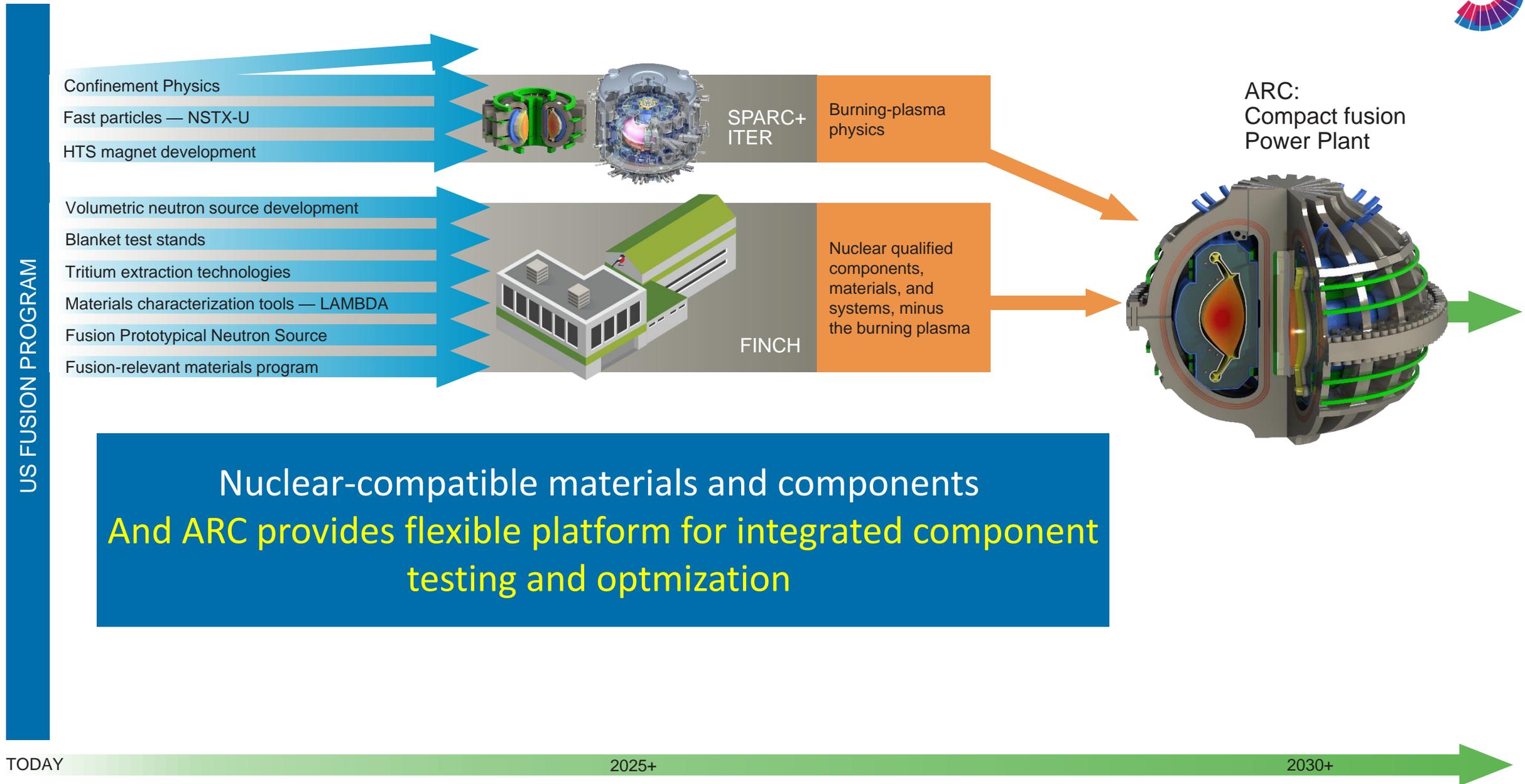
US FUSION PROGRAM



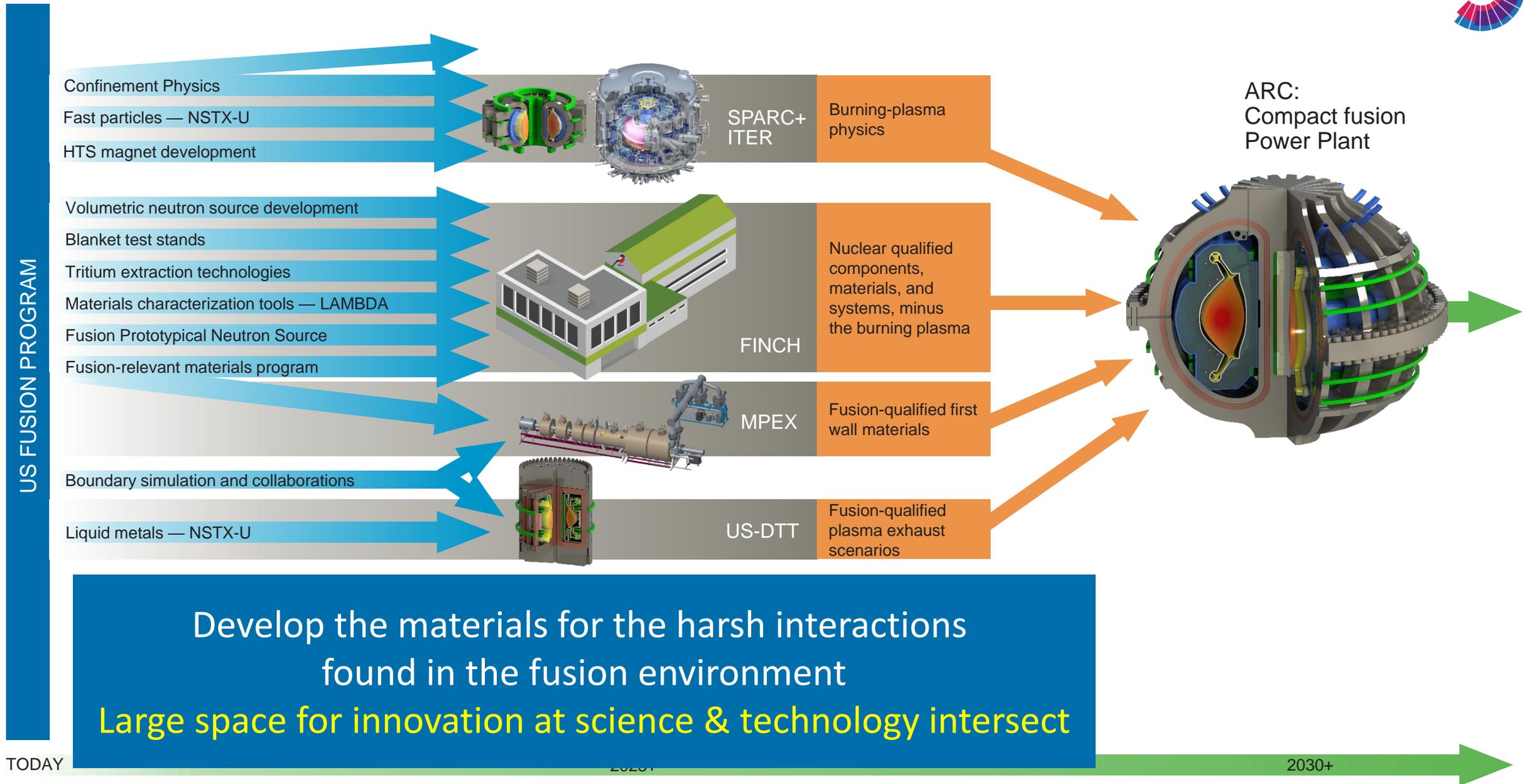
**SPARC: show fusion makes more power as soon as possible**  
**And the science of a self-heated plasma**  
**Operate the world's premier fusion science facility**



# SPARC is the springboard to create a fusion energy industry

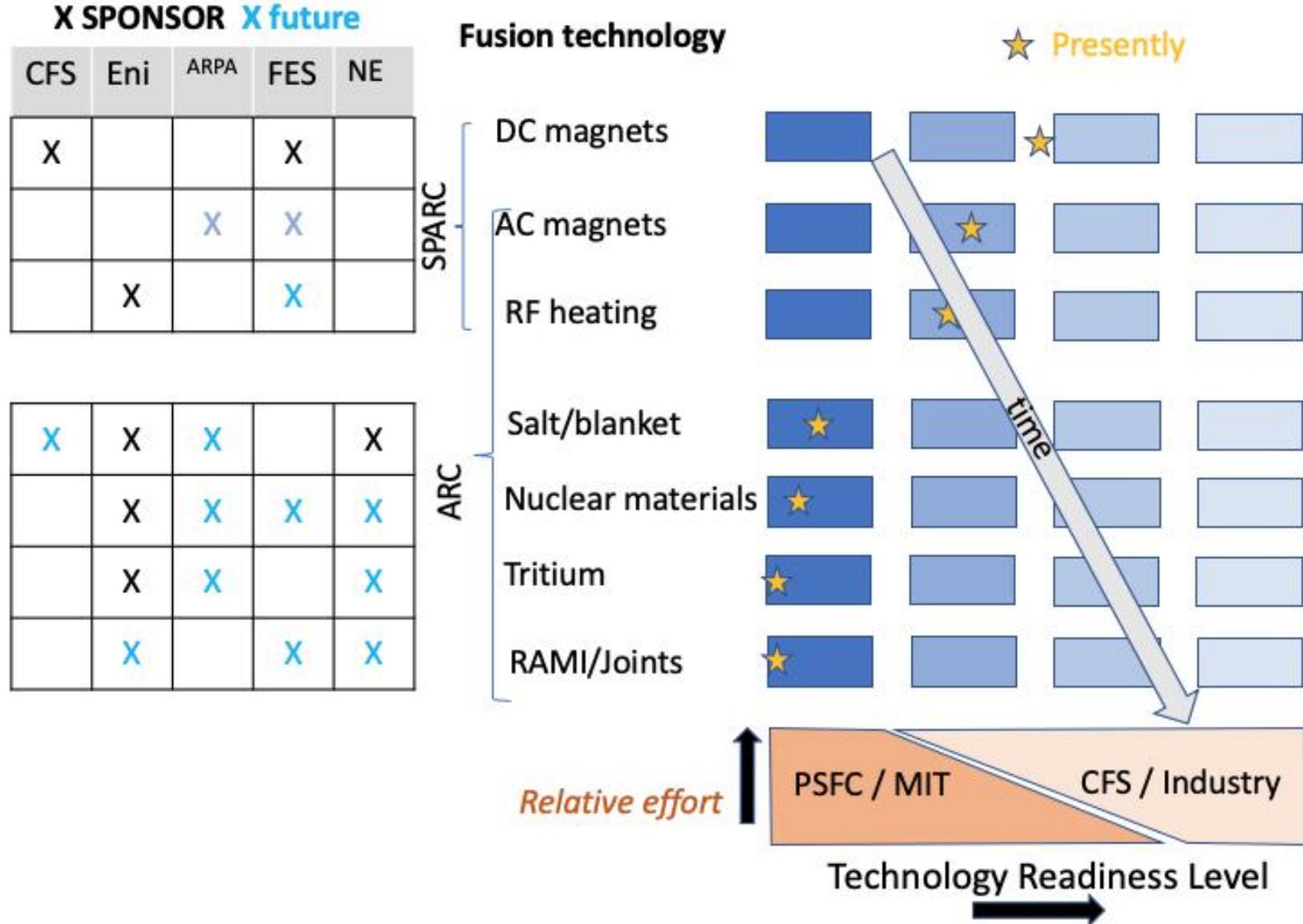


# SPARC is the springboard to create a fusion energy industry



# PSFC / MIT will

1. Be a joint partner on SPARC science
2. Relentlessly innovate on fusion tech
3. Leverage seed Eni investment in fusion tech → diversify funding
4. Tech transfer to CFS/industry on fastest timescale



# Propositions to EAB for consideration



- **MIT/PSFC should continue into the SPARC phase jointly with CFS independent of where it is located**
  - Seek to host premier fusion experiment + lead on fusion tech to ARC
  - Engagement through novel R&D contract, and expand this with CFS
- **MIT should continue and grow this type of engagements with energy industry: meaningful R&D engagement, act as convener, and spur growth at the federal level in energy innovation**
  - Both with O&G companies + start-ups and investors
  - Advocate innovative policies at the federal level
- **MIT should position itself to take advantage of this growing fusion ecosystem beyond SPARC and CFS and the US → world**
  - Larger, more diverse faculty and students engaged in fusion
  - Grow technology program LIFT on campus with international partners
  - We just returned on a “world-tour” from the broader engagement from the community, they are ready and hungry, is MIT?



**Thank you!**

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