
ULTRA SAFE NUCLEAR
RELIABLE ENERGY ANYWHERE

Current and future heat exchanger needs in USNC microreactor systems

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USNC Core Technology Powers Reliable Energy. Anywhere

EARTH & SPACE

- Family of nuclear power products to address multiple needs
- Carbon-free, Risk-Free
  - from Watts to Mega Watts
- All based on Ultra Safe principles & technologies
- Shared manufacture, deployment operation and services resources

MMR
Earth

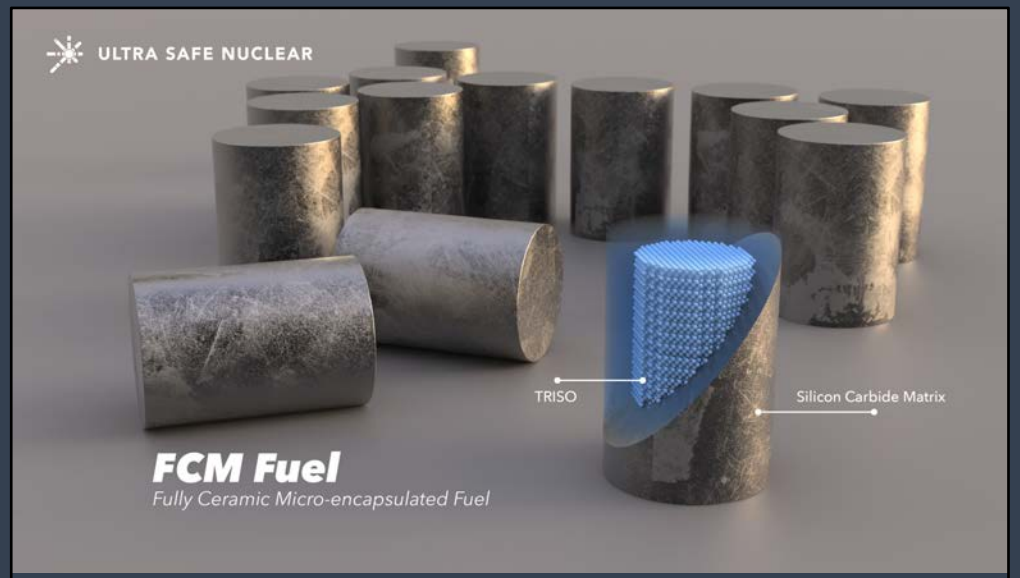
PYLON
Space

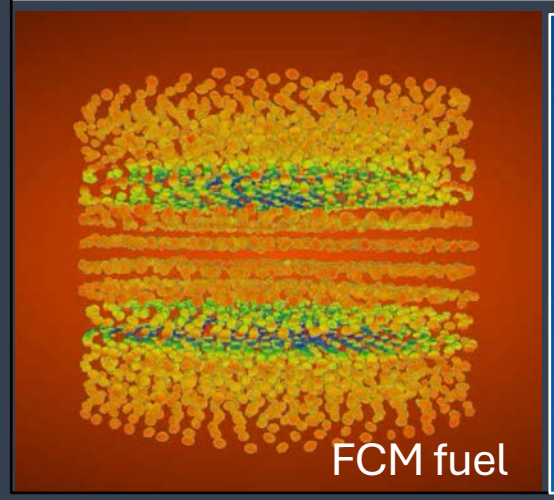
WARP
Earth - Mobile

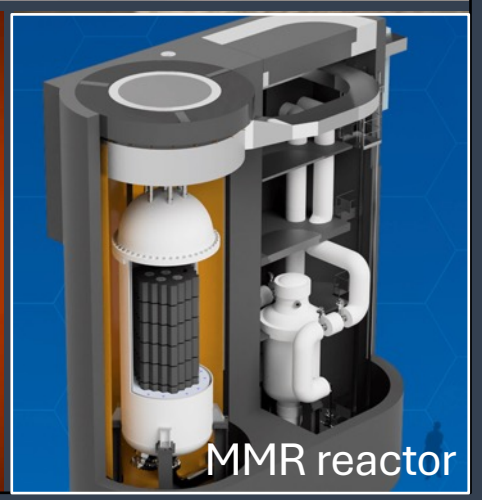
EmberCore
Earth & Space

PADME
Space - Propulsion

Ultra Safe Nuclear Commercial Power (micro modular reactors):
Safe to Environment, People, and Investment – Virtually Indestructible







Nuclear Levels of Safety:

- Active Safety – Requires external intervention
- Passive Safety 1 – Dependent on external conditions

Others

- Passive Safety 2 – Independent of external conditions
- Intrinsic Safety – Design Power and Power Density
- Inherent Safety – Physics, Fuel and Materials

Ultra Safe Nuclear

Ultra Safe Nuclear is stronger safety in more compact form

How we do it:

- **Low power**
- **Low power density**
- **Low-intensity coolants**
- **High Temperature fuels (FCM®) – meltdown proof**
- **High Temperature materials – full ceramic cores**

Results:

- Systems lack internal energy - No permanent damage
- **Malfunctions cannot become "accidents"**
- Zero-carbon
- Zero-risk
- Zero-consequences

MMR™ Energy System

Layout for Remote Off-grid applications

Thermal Power

30 MWt (15 x 2)

Electrical Power

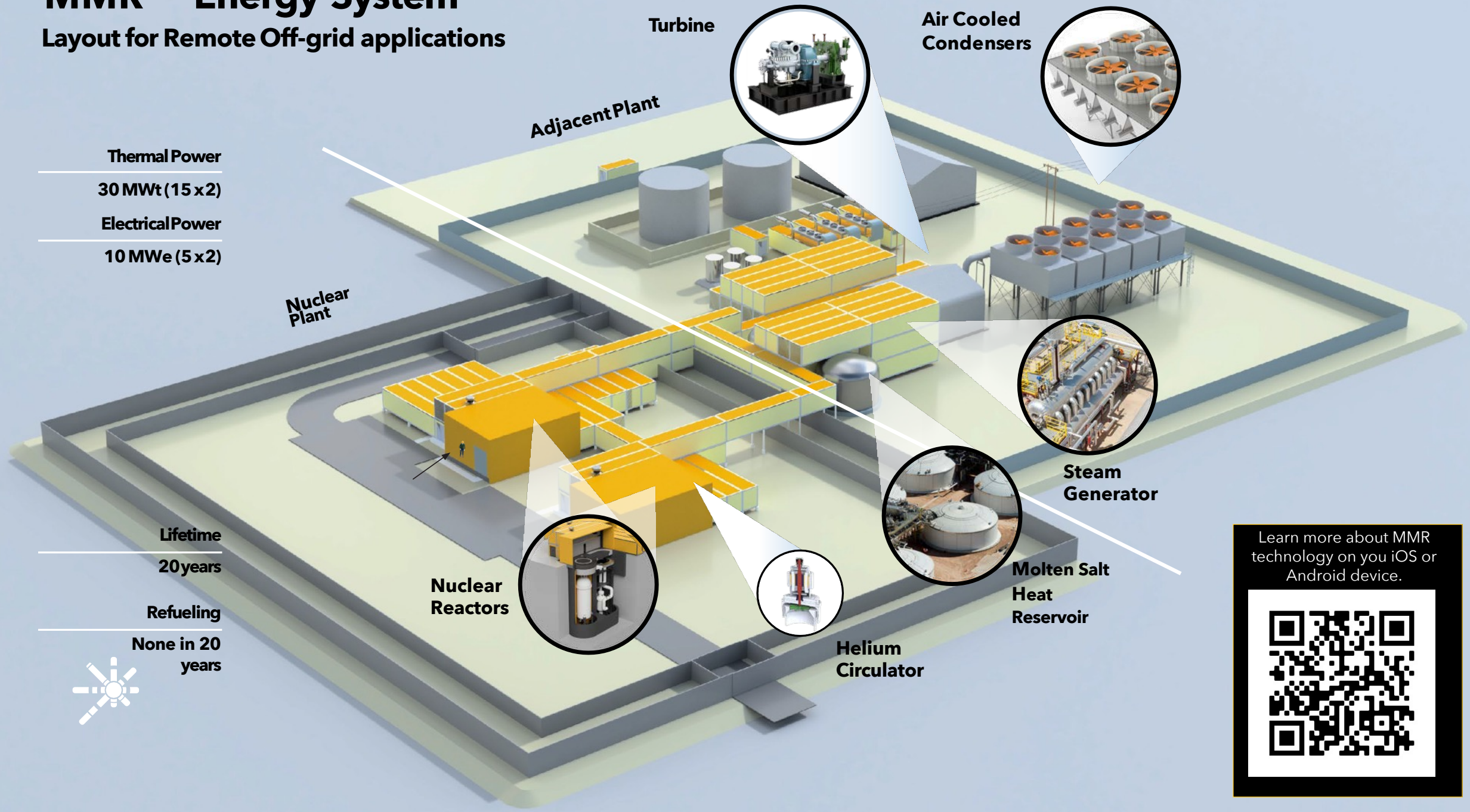
10 MWe (5 x 2)

Lifetime

20 years

Refueling

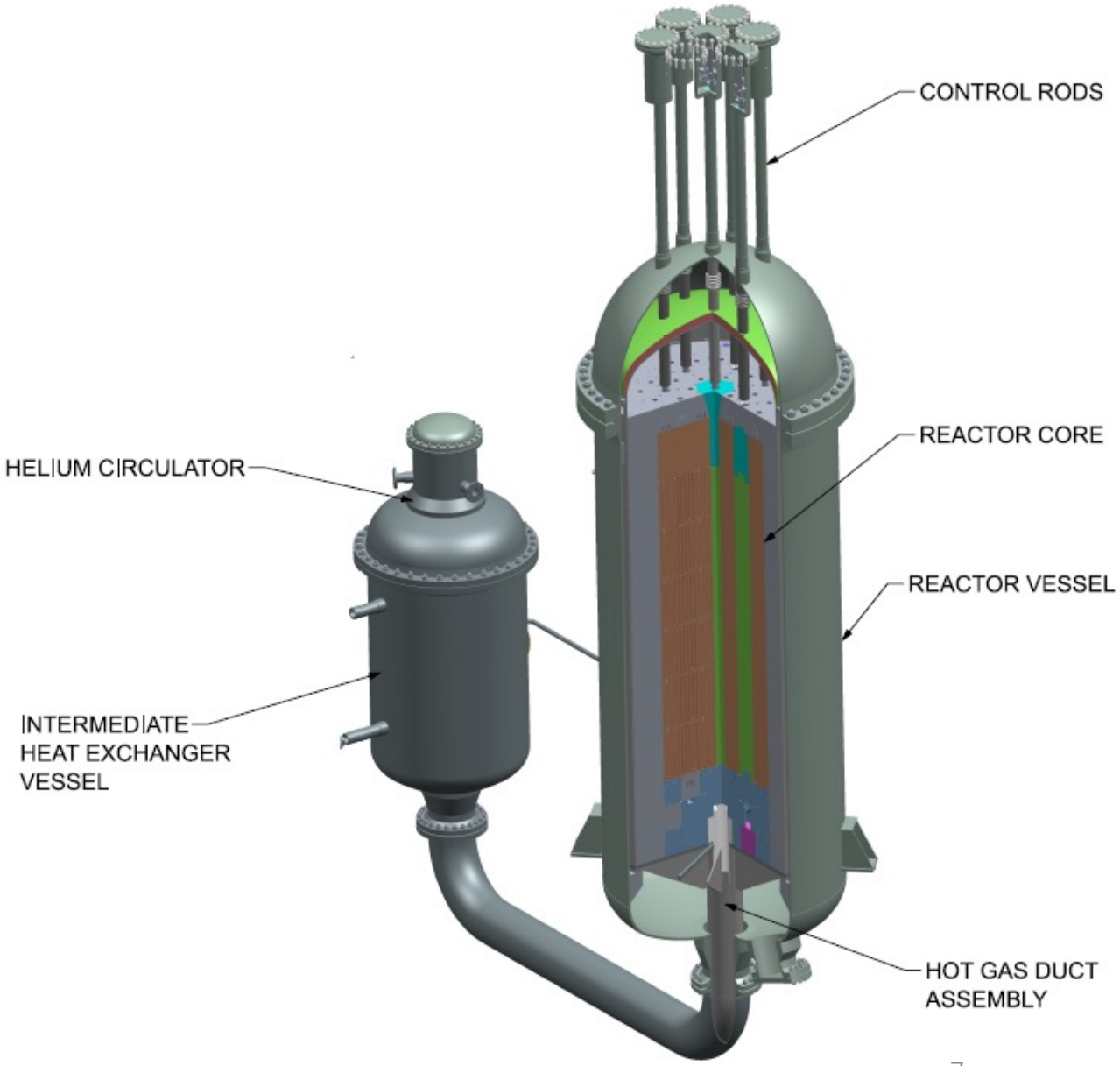
None in 20 years



Learn more about MMR technology on you iOS or Android device.

USNC Reactor Technology

Parameter	Value
Type	High temperature gas cooled
Fuel	LEU in FCM™
Power	15 MWt, 5MWe
Moderator	Graphite
Coolant	Helium
Inlet Temp	300°C
Outlet Temp	630°C
Fuel cycle	Once fuelled for 20 year life

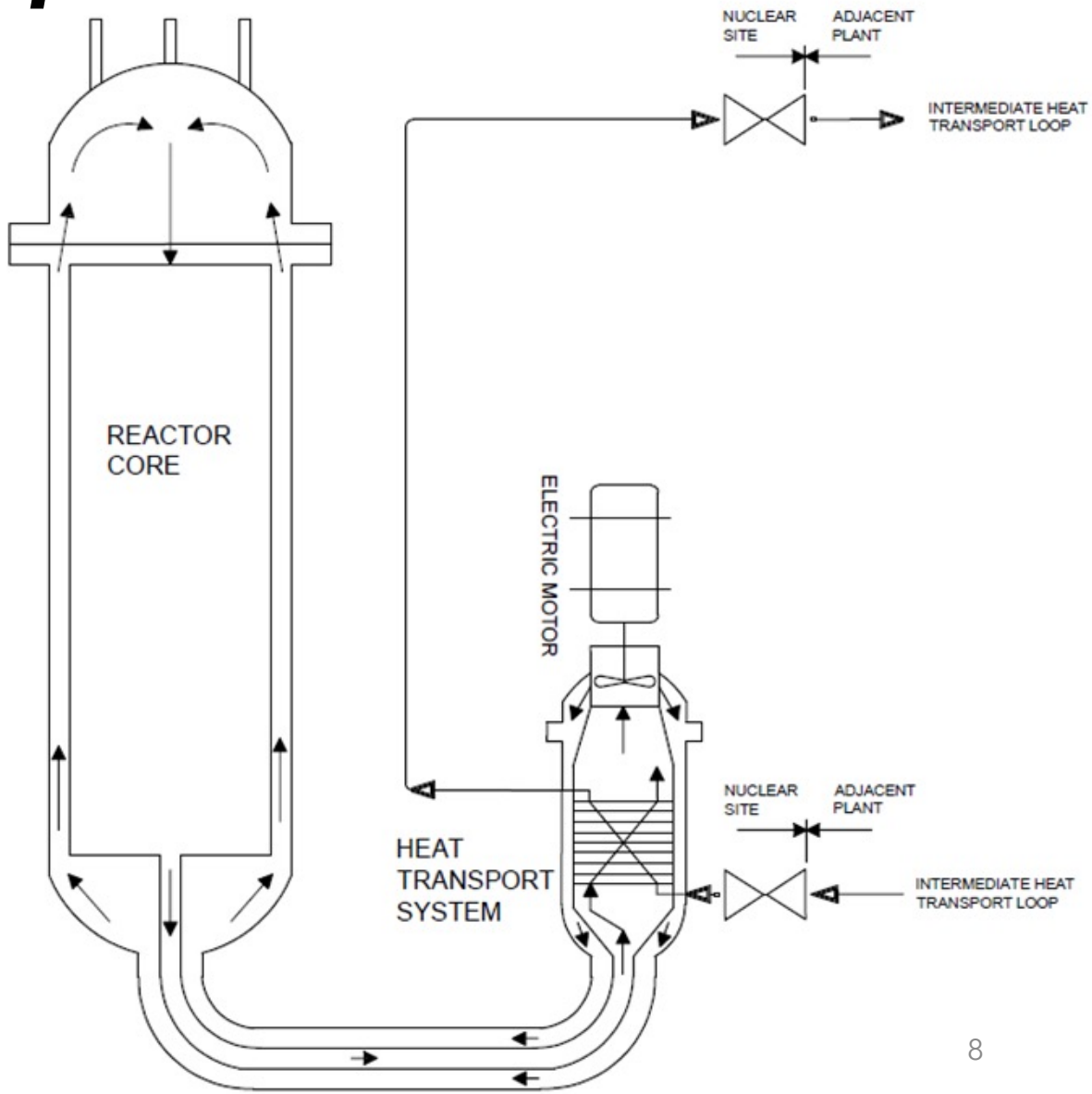


MMR Heat Transport System Description

Design:
- PCHE / DCHE
- ASME VIII design code
- High temperature austenitic material

Fluid 1
- Helium
- 630°C / 300 °C
- 3 MPa
- ~9 kg/s

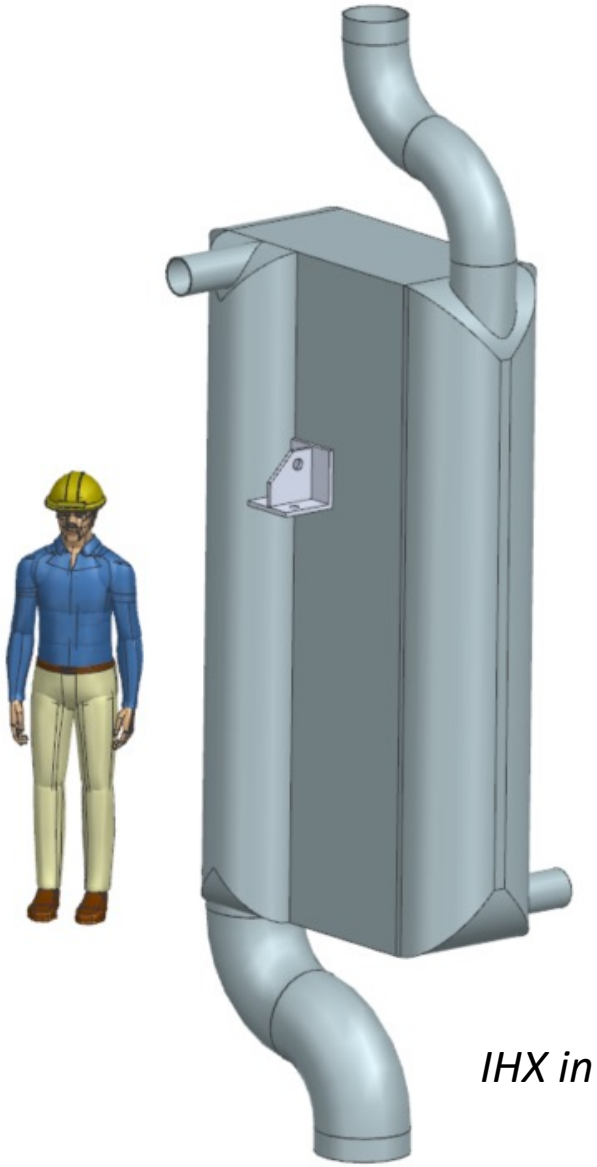
Fluid 2
- Solar Salt
- 275°C / 565 °C
- 0.3 MPa
- ~35 kg/s

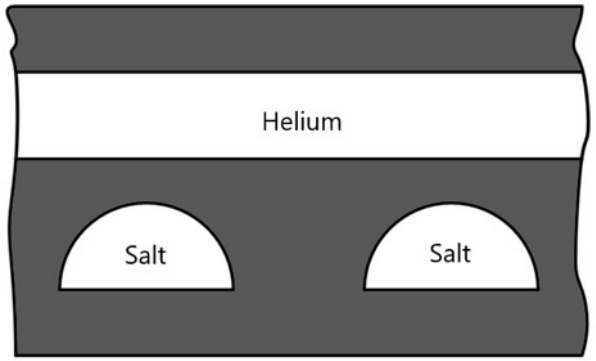


MMR IHX Design

Baseline

- IHX is inside the IHX vessel
- semi circles channel geometry
- Required heat transfer 15MW
- Design temp 650°C
- High purity (K,Na)NO_3 salt



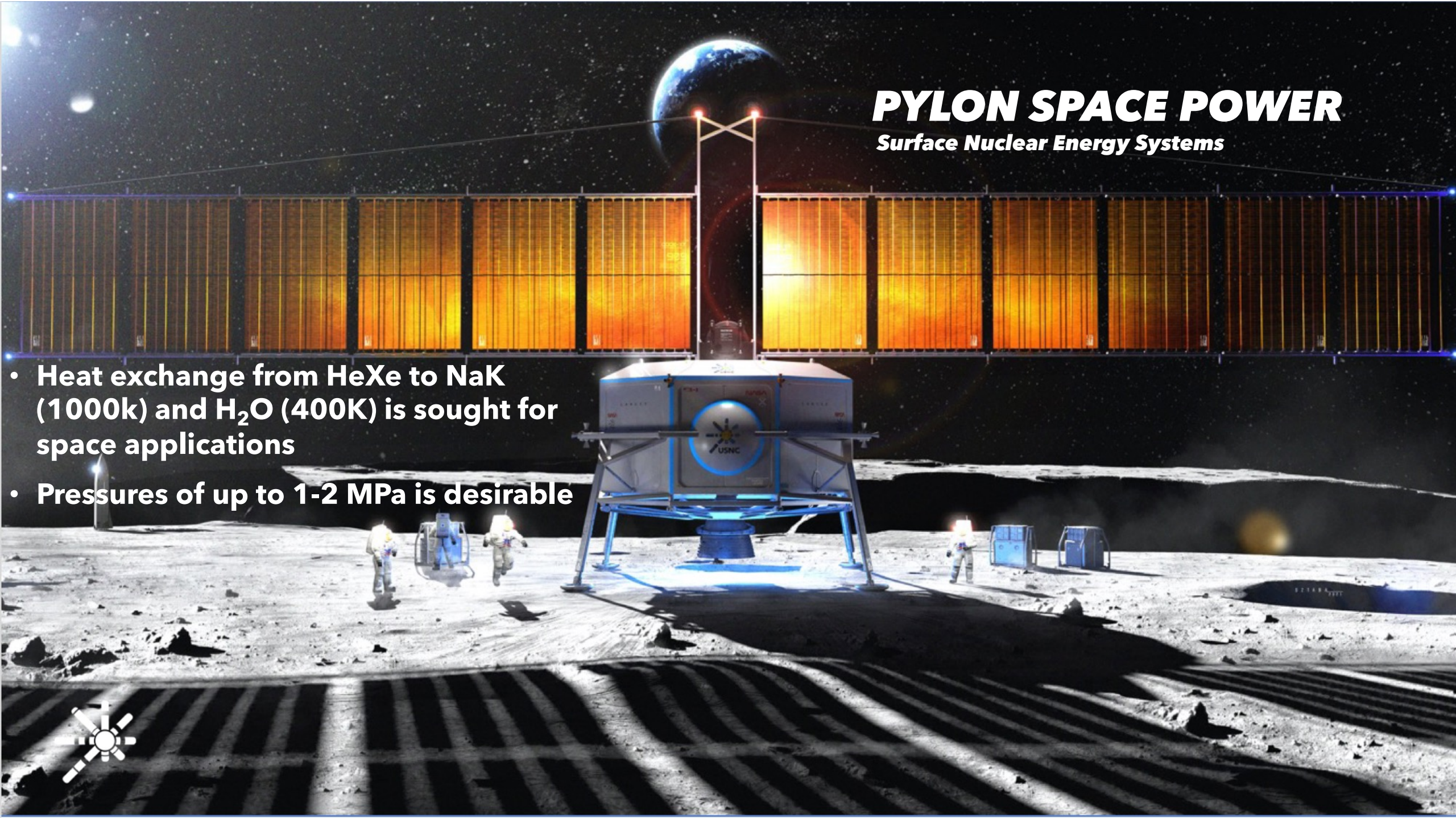


IHX in development with VPE

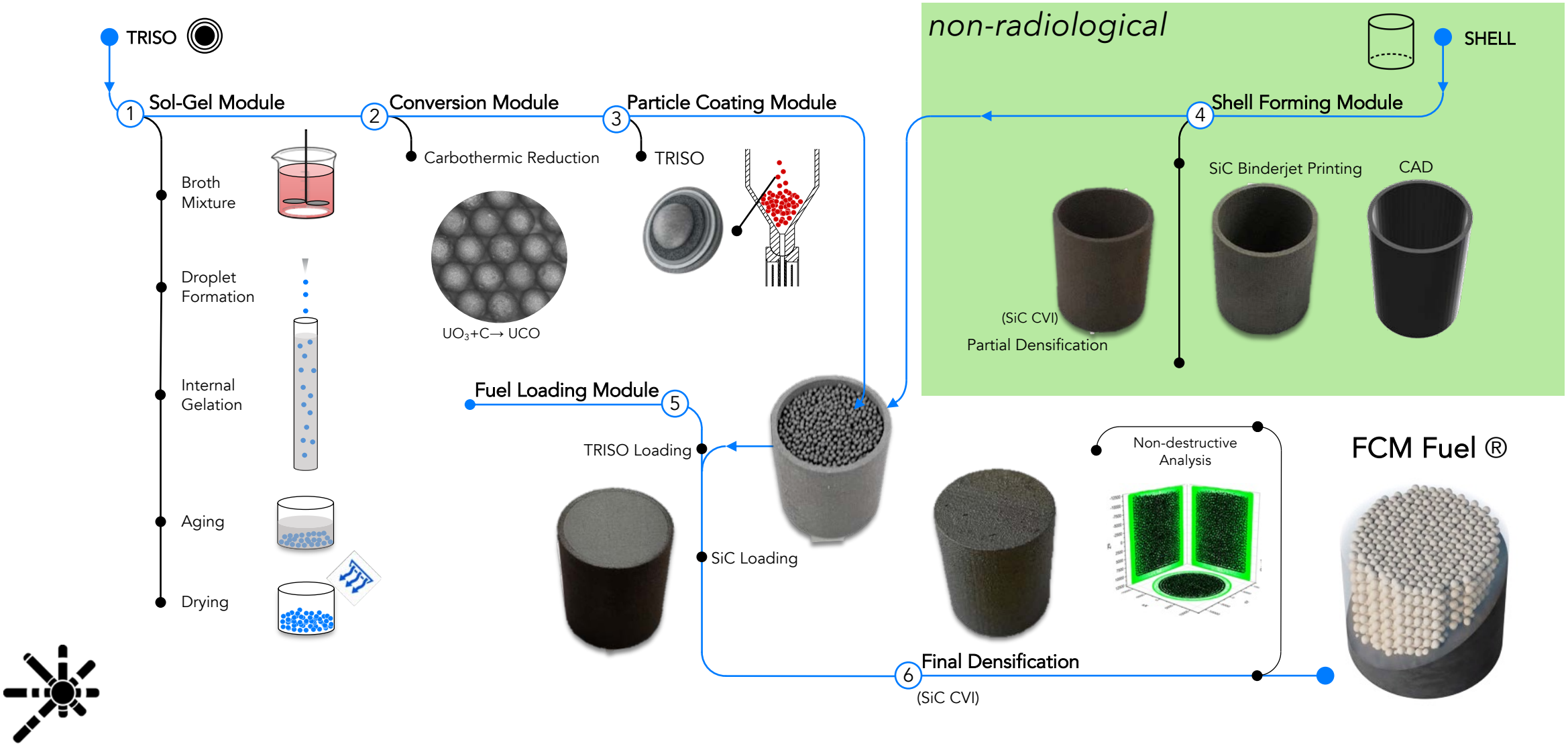
Future USNC Heat Exchanger Needs for Terrestrial Systems

1. Ability to facilitate exchange to more aggressive Cl- and F-based salts to achieve higher temperatures
2. A robust heat exchanger solution for supercritical CO_2 (high pressure problems) would be transformational
3. Meeting ASME III design code would be very desirable
4. Increase in heat exchanger working temp is always desirable (ceramics such as SiC)

Seeking applications beyond the steam and combustion regimes (e.g. H_2 generation) require new heat exchangers


PYLON SPACE POWER
Surface Nuclear Energy Systems
• Heat exchange from HeXe to NaK (1000k) and H_2O (400K) is sought for space applications
• Pressures of up to 1-2 MPa is desirable
USNC

USNC's TRISO and FCM® Manufacturing Process



USNC is currently commissioning its Advanced Ceramics Manufacturing Facility (Salt Lake City, UT) for 3D printing of high purity SiC