MARITIME FUSION

An Introduction: Low Power Density Tokamaks for Off Grid Applications

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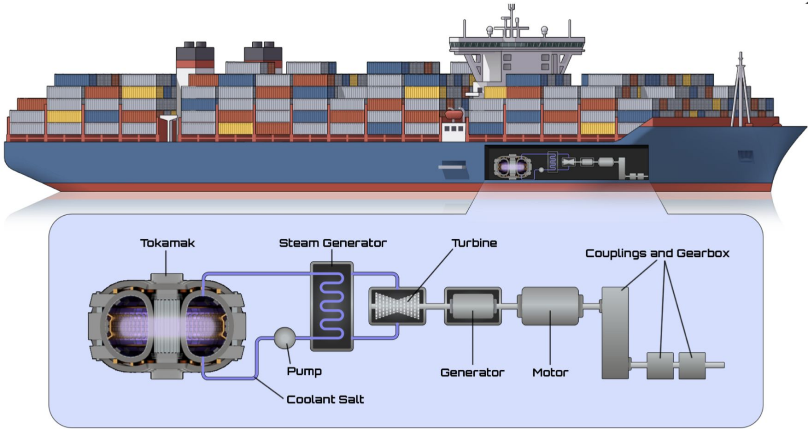
Maritime Fusion: Past, Present, and Future

- Company launched via Y Combinator in early 2025
- Rough 0D reactor design
- Closed our seed round earlier this year
- Opened our HQ in San Francisco, grew headcount to 8



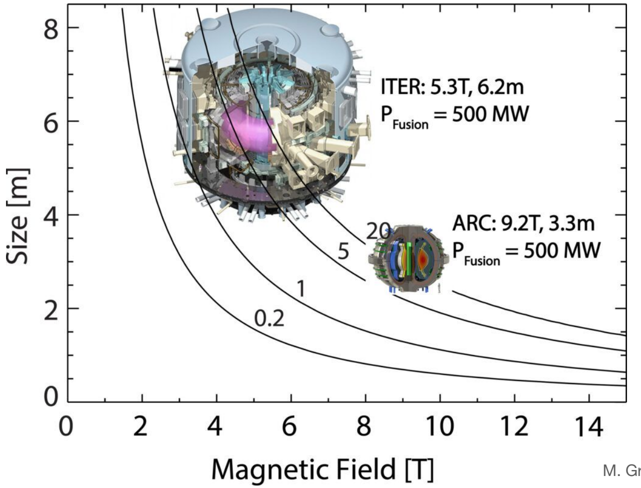
- Develop, manufacture, and test our HTS cable
- Publish a detailed physics basis
- Model the economically viable operations of fusion powered vessels
- Contractual obligations with customers

- No intermediate sized device, full scale Yinsen tokamak demonstrator 2032-2035

WHY NOT THE GRID?

The FOAKs Battle Against Material Science for Cost

Trade large expensive reactor that doesn't require any more Nobel prizes → smaller cheaper reactor that requires decades of innovation for commercial viability



M. Greenwald, 2019

- Minimize Reactor Construction Cost
- Compact and High Field
- High Heat Flux, Mechanical Stresses, Activated Structures
- Low in Vessel Lifetimes, Maintenance Operations, Low Capacity Factor
- **Not Competitive Power Source on the Grid**

Tokamak Design Point

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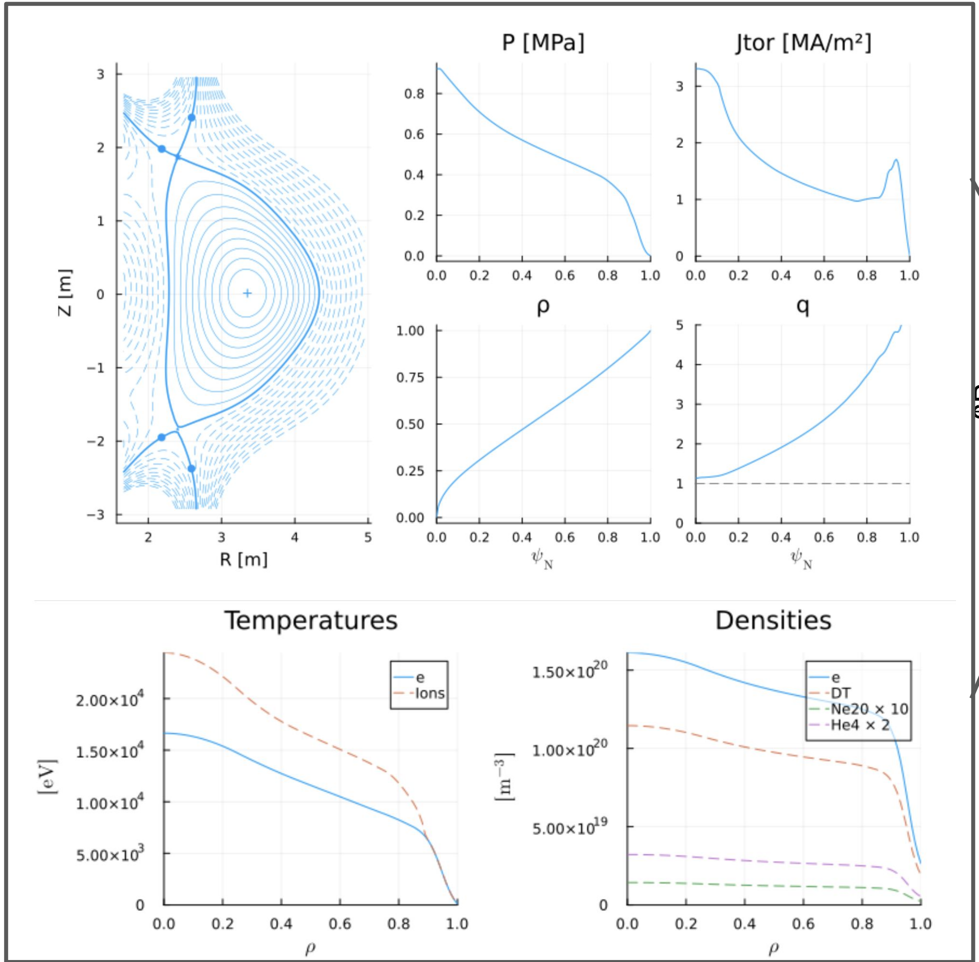
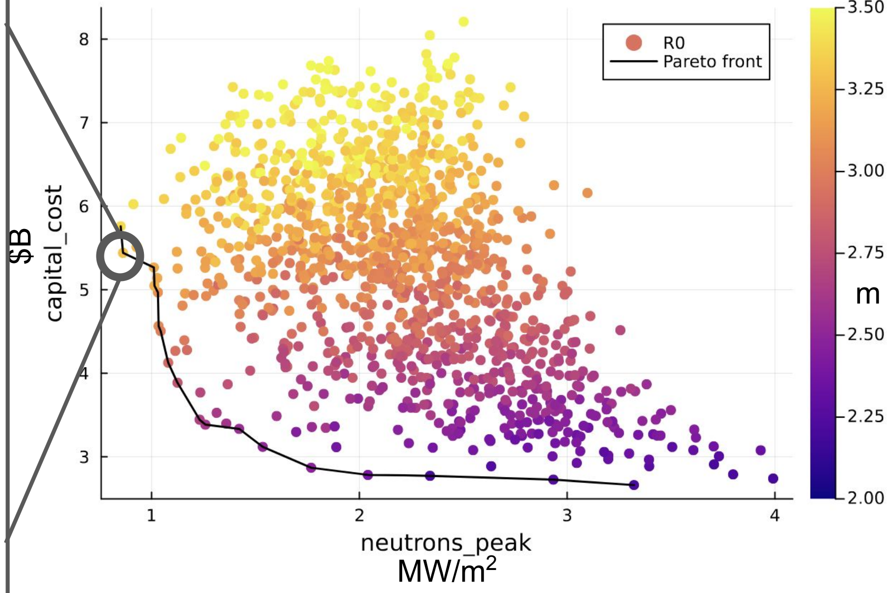




Each point in the plot is a fully resolved design - each with solutions for equilibrium, transport, HCD, etc…

Resulting device is roughly JET-sized…

GEOMETRY

- R0 → 3.31 [m]
- a → 1.02 [m]
- 1/ϵ → 3.23
- κ → 1.82
- δ → 0.82
- ζ → -0.0155
- Volume → 106 [m³]
- Surface → 180 [m²]

JET R0: 2.96 m
JET a: 1.25 m

EQUILIBRIUM

- B0 → 7.86 [T]
- ip → 7.51 [MA]
- q95 → 4.85
- <Bpol> → 1 [T]
- βpol_MHD → 1.11
- βtor_MHD → 0.0179
- βn_MHD → 1.97

Operating at nearly twice JET's field and 1.5x plasma current

TEMPERATURES

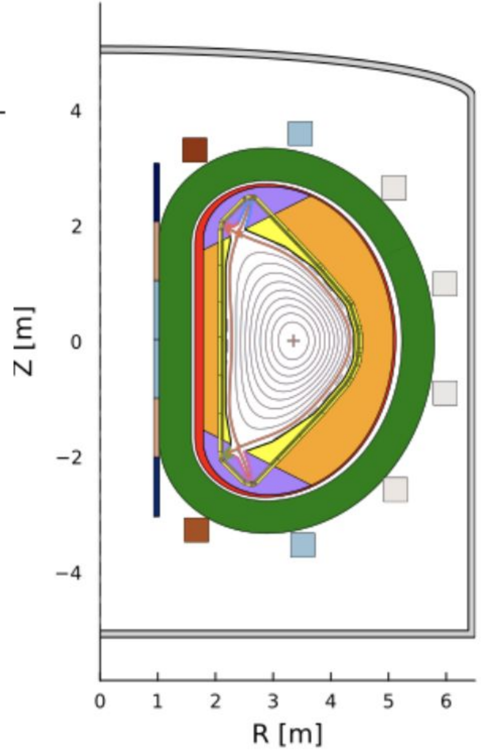
- Te0 → 16.6 [keV]
- Ti0 → 24.4 [keV]
- <Te> → 9.5 [keV]
- <Ti> → 13.2 [keV]
- Te0/<Te> → 1.75
- Ti0/<Ti> → 1.85

DENSITIES

- ne0 → 1.61e+20 [m⁻³]
- ne_ped → 1.08e+20 [m⁻³]
- ne_line → 1.37e+20 [m⁻³]
- <ne> → 1.24e+20 [m⁻³]
- ne0/<ne> → 1.3
- fGW → 0.602
- zeff_ped → 2
- <zeff> → 2
- impurities → DT Ne20 He4

PRESSURES

- P0 → 0.947 [MPa]
- <P> → 0.439 [MPa]
- P0/<P> → 2.16
- βn → 1.91
- βn_th → 1.91



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But achieves a SPARC-like P_{fusion} and 30+ MW net electric

Yinsen has an advantage over other devices in power handling with P_{SOL} / R limited to **9.6 MW/m** in this case → 67% the ITER/DEMO limit of 15 MW/m! [1]

SOURCES

Pec → NaN [MW]
rho0_ec → NaN [MW]
Pnbi → NaN [MW]
Enbi1 → NaN [MeV]
Pic → 7.66 [MW]
Plh → NaN [MW]
Paux_tot → 7.66 [MW]
Pα → 33.7 [MW]
Pohm → 0.456 [MW]
Pheat → 41.8 [MW]
Prad_tot → −10 [M

SPARC P_{fusion} = 140 MW

BOP

Pfusion → 168 [MW]
Qfusion → 22
thermal_cycle_type → rankine
thermal_efficiency_plant → 36.9 [%]
thermal_efficiency_cycle → NaN [%]
power_electric_generated → 63.1 [MW]
Pelectric_net → 38.4 [MW]
Qplant → 2.56
TBR → 1.1

EXHAUST

Psol → 31.8 [MW]
PLH → 25 [MW]
Bpol_omp → 1.15 [T]
λq → 0.965 [mm]
qpol → 1.21e+03 [MW/m^2]
qpar → 6.45e+03 [MW/m^2]
P/R0 → 9.62 [MW/m]
PB/R0 → 75.6 [MW T/m]
PBp/R0 → 9.62 [MW T/m]
PBϵ/R0q95 → 4.83 [MW T/m]
neutrons_peak → 0.863 [MW/m^2]

BUILD

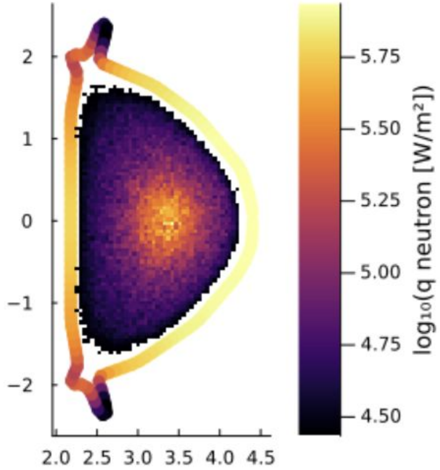
PF_material → rebco
TF_material → rebco
OH_material → rebco
TF_max_b → 16.4 [T]
OH_max_b → 8.21 [T]
TF_j_margin → 1.15
OH_j_margin → 1.15
TF_stress_margin → 1.15
OH_stress_margin → 1.26

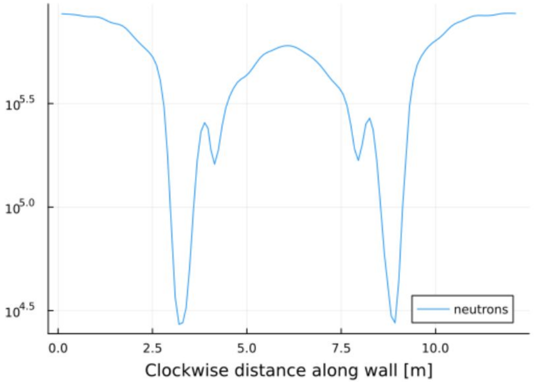
CURRENTS

ip_bs_aux_ohm → 7.52 [MA]
ip_ni → 2.51 [MA]
ip_bs → 2.26 [MA]
ip_aux → 0.253 [MA]
ip_ohm → 5.01 [MA]
ejima → 0.4
flattop → 0.105 [Hours]

COSTING

capital_cost → 5.44 [$B]
levelized_CoE → 2.05 [$/kWh]
TF_of_total → 10.5 [%]
BOP_of_total → 3.98 [%]
blanket_of_total → 3.2 [%]
cryostat_of_total → 0.865 [%]





[1] Kallenbach et. al, 2013 Plasma Phys. Control. Fusion 55 124041

MARITIME FUSION

Proposals for Collaboration DIII-D <> Maritime Fusion
(more are welcomed)

Focus Area	DIII-D Experiment	Relevance for Maritime Fusion
Power-exhaust control (P_SOL, f_rad)	20 MW NBI + 4 MW ECH, impurity seeding (Ne/N_2/Ar), SAS divertor, f_rad ≈ 0.9 possible	Anchors radiative-mantle and detached operation needed for low-heat-flux Yinsen wall
Edge/SOL similarity (λ_q, detachment)	λ_q ∝ B_p^{-1} scaling accessible via Ip/q95 scans; SAS tungsten divertor for heat-flux mapping	Extrapolate λ_q and detachment windows to Yinsen's high-B_p regime
ELM-free confinement (NT & QH)	Mature negative-triangularity and QH-mode; ELM-quiet plasmas at βN ≈ 3–4	Benchmarks pedestal structure and transport regime for Yinsen's steady, ELM-quiet flattops
Tungsten compatibility	First wall test section for W source/leakage studies at high f_rad	Demonstrates impurity screening and allowable Z_eff for compact devices
High βN confinement with benign wall loading	βN up to ~5, strong shaping control (κ ≈ 2, δ ±0.4), dimensionless similarity scans (ρ*, ν*)	Validates achievable pressure & MHD stability limits for compact high-field reactor