

# Comments on FESAC charge #2

*(perspective on a flat MFE budget for 10 years)*

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U.S. DEPARTMENT OF  
**ENERGY** | Office of  
Science



An MFE domestic program at flat-funding  
(~ \$260M, excluding GPS, HEDP)

Criteria:

- World-leading research on important topics  
Focus on original, important, selected, exciting activities where the US can lead or be at the world forefront
- Linked/preparatory to ITER and a fusion roadmap to DEMO  
Maintain ability to contribute to ITER and breakout into fusion energy development program

Therefore,

- Choose work with breakthrough potential
- Do not choose development work that is incremental or secondary to similar but larger efforts elsewhere  
(except in some cases to maintain core capability needed for breakout to fusion development program)
- Choose activities over full range of three topic categories
  - Confinement (high performance, steady-state, burning)
  - Plasma-material interface
  - Harnessing fusion power

Examples of research activities for US leadership in 10 yrs  
(~ \$15M to ~ \$50M blocks)  
(listed in unprioritized order)

1. Plasma confinement

(high performance, steady-state, burning plasmas)

Fusion simulation program

Examples of research activities for US leadership in 10 yrs  
(~ \$15M to ~ \$50M blocks)  
(listed in unprioritized order)

1. Plasma confinement

(high performance, steady-state, burning plasmas)

Fusion simulation program

Magnet development

High field, high Tc superconductors

potentially significant implications for tokamak, stellarator

e.g., reduction in size

Examples of research activities for US leadership in 10 yrs  
(~ \$15M to ~ \$50M blocks)  
(listed in unprioritized order)

1. Plasma confinement

(high performance, steady-state, burning plasmas)

Fusion simulation program

Magnet development

Tokamak facility (AT or ST)

investigating novel features (e.g, new divertors, new PFCs)

preparing for ITER, FNSF

maintaining tokamak operational expertise

Examples of research activities for US leadership in 10 yrs  
(~ \$15M to ~ \$50M blocks)  
(listed in unprioritized order)

1. Plasma confinement

(high performance, steady-state, burning plasmas)

Fusion simulation program

Magnet development

Tokamak facility (AT or ST)

Stellarator program

steady-state, disruption-free, good confinement

novel designs for US research

new confinement science

preparing for FNSF

Examples of research activities for US leadership in 10 yrs  
(~ \$15M to ~ \$50M blocks)  
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1. Plasma confinement

(high performance, steady-state, burning plasmas)

Fusion simulation program

Magnet development

Tokamak facility (AT or ST)

Stellarator program

*Perhaps support  $\leq 2$  confinement facilities by end of decade  
(AT, ST, stellarator)*



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1. Plasma confinement

(high performance, steady-state, burning plasmas)

Fusion simulation program

Magnet development

Tokamak facility (AT or ST)

Stellarator program

International collaboration on SC facilities

~ maintain scientific balance of trade

Examples of research activities for US leadership in 10 yrs  
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1. Plasma confinement

(high performance, steady-state, burning plasmas)

Fusion simulation program

Magnet development

Tokamak facility (AT or ST)

Stellarator program

International collaboration on SC facilities (quid pro quo)

Exploratory fusion concepts

re-evaluate opportunities

Examples of research activities for US leadership in 10 yrs  
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## 2. Plasma-material interface

New divertor geometries

(e.g, snowflake, super-X)

Examples of research activities for US leadership in 10 yrs  
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## 2. Plasma-material interface

New divertor geometries

Liquid metals

unique advantages as first wall

US at forefront, can lead

some synergies with blanket liquid metal issues

Examples of research activities for US leadership in 10 yrs  
(~ \$15M to ~ \$50M blocks)  
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## 2. Plasma-material interface

New divertor geometries

Liquid metals

Tungsten development

studies in plasma test stands and confinement facilities

high temperature

developing new tungsten alloys

(not obvious can be at world forefront)

Examples of research activities for US leadership in 10 yrs  
(~ \$15M to ~ \$50M blocks)  
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2. Plasma-material interface

New divertor geometries

Liquid metals

Tungsten development

3. Harnessing fusion power

Modified US accelerator neutron source

e.g, ORNL, LANL for fusion relevant neutrons,  
joining IFMIF

Examples of research activities for US leadership in 10 yrs  
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## 2. Plasma-material interface

New divertor geometries

Plasma test stands

Liquid metals

Tungsten development

## 3. Harnessing fusion power

Modified US accelerator neutron source

Blanket studies

possible niche is DCLL

some synergy with liquid lithium PFC

(not obvious can be at world forefront)

possibly needed capability for breakout potential

Examples of research activities for US leadership in 10 yrs  
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#### 4. Scoping studies for activities after 2020

Scoping/conceptual design studies

Fusion Nuclear Science Facility (FNSF)

Toroidal facility for plasma-materials interface

Stellarators

Roadmapping and socioeconomic studies

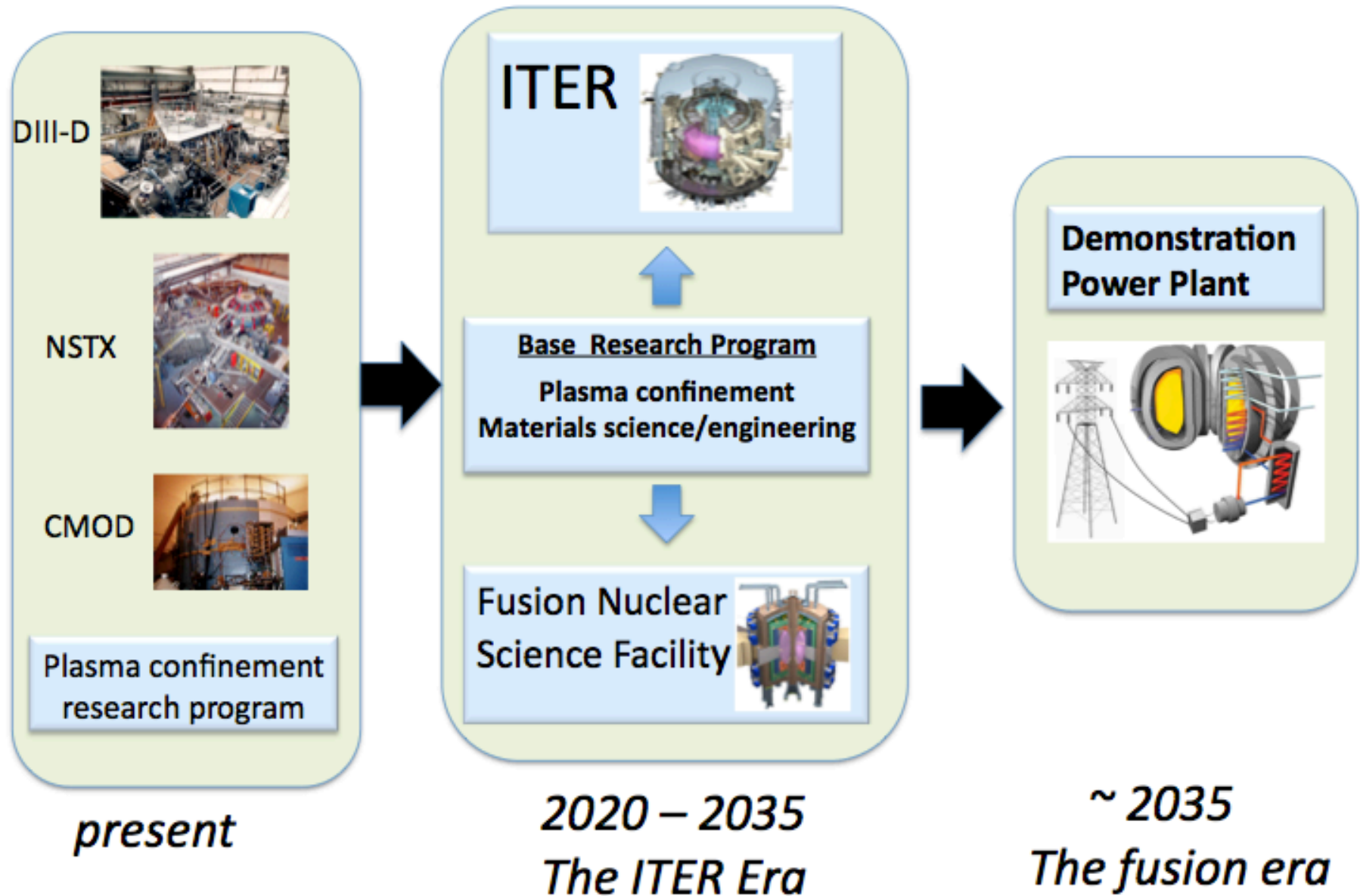
Considering the international context,  
possible international collaboration on FNSF/DEMO



# Some strategic issues

- Workforce
  - key to maintain and evolve workforce, nondisruptively
  - what core capabilities to emphasize?  
(among plasma, material science, technology?)
  - influenced by potential areas of world leadership
  - an answer:
    - maintain plasma science workforce at world forefront,
    - build materials/technology workforce in selected areas
- Impact on fusion roadmap

# How will this charge affect the “standard” roadmap discussed in the US



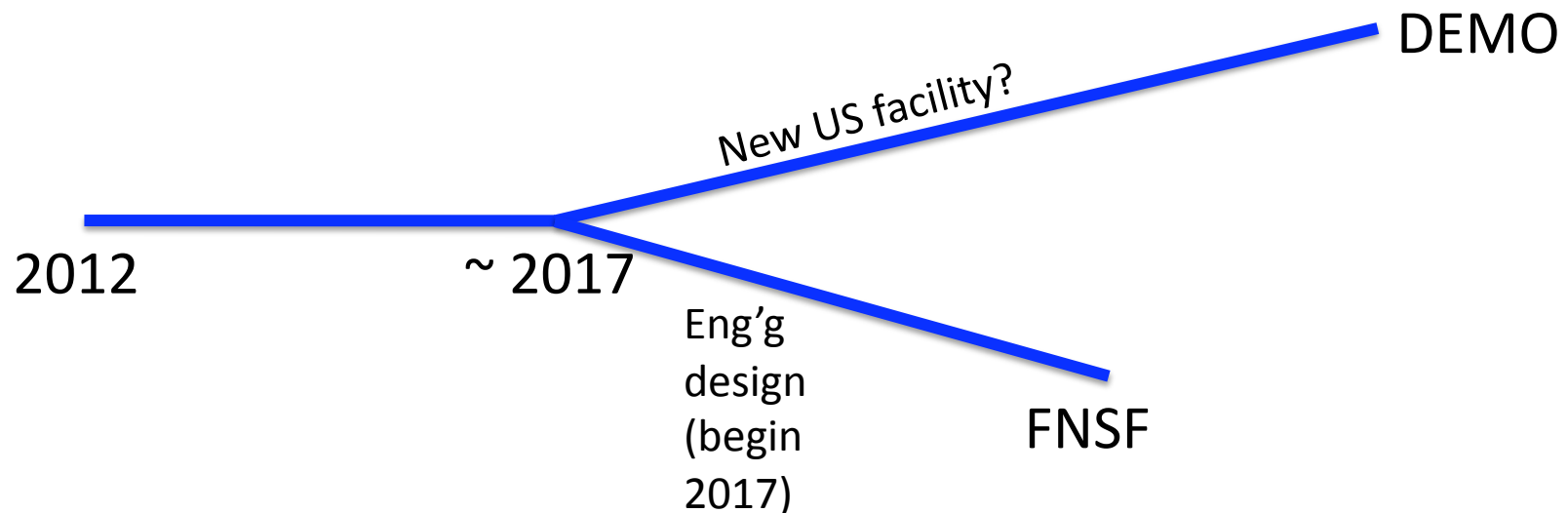
# Impact on roadmap

One scenario:

- Engineering design of FNSF not affordable in next ten years (~ \$50M per year in second five-year period?)
- Delays FNSF start to ~ 2032 (10 year design/construction), DEMO to ~ 2047 if place FNSF and DEMO in series
- Therefore, consider option to proceed straight to DEMO, with FNSF mission as phase I  
(similar to plans of other ITER parties)
- Orient research program to solving long-range issues for fusion, emphasizing innovative solutions

# Possible path

- Proceed for 5 years along path to either FNSF or DEMO
- Develop physics basis (AT, ST, stellarator) and materials basis to FNSF or DEMO
- In ~ 5 years, proceed toward FNSF (possibly with international collaboration) if US funding situation changes dramatically or proceed straight to DEMO



# A sample “new” lean OFES program in ~ 8 years

## Plasma confinement \$170M

magnet developmnt (hi Tc SC, hi B)

~ 2 confinement facilities (AT, ST, stellarator)

int'l collab on SC facilities (quid pro quo)

exploratory fusion concepts

FSP/theory

## Plasma-material interface \$40M

new divertor geometries

plasma test stands

liquid metals

## Harnessing fusion power \$30M

Modified accelerator neutron source

Blanket studies (DCLL)

## Scoping studies \$15M

scoping/design for next-step facilities

roadmapping/socioeconomic

TOTAL \$275M (incl. \$20M “other”)

- Even without any “competitive-scale” facility, minimal set of opportunities barely fits within a flat budget
- At \$40M - \$50M less:
  - eliminate whole research areas  
(PMI or confinement facility or FNS),  
huge negative impact on workforce and US core capabilities,  
impede ability for breakout to fusion development program  
(an assessment of core capabilities might be useful)

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