



HELMHOLTZ  
GEMEINSCHAFT

# SH Contributions to the Roadmap to Steady-State Operation - Discussion -

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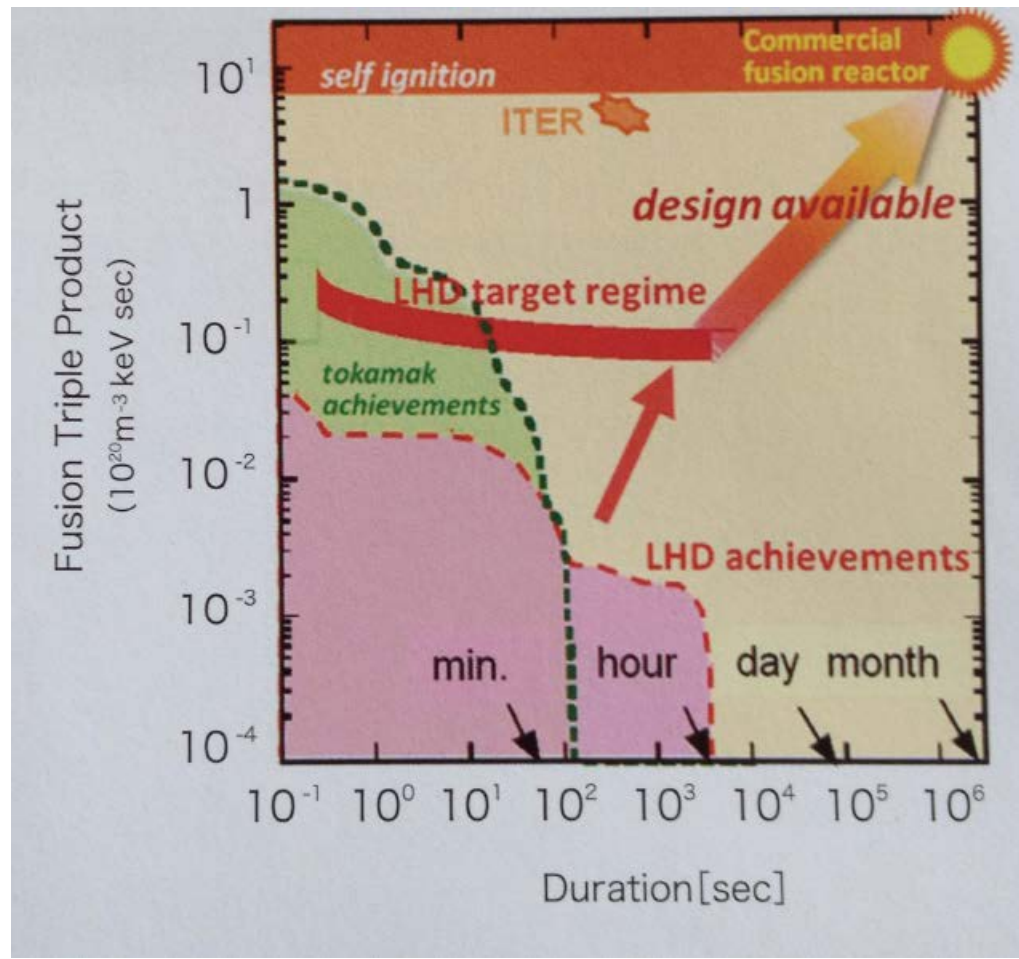
## A. Dinklage

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Wendelsteinstr. 1, D-17491 Greifswald, *Germany*

Feb. 27<sup>th</sup>, 2013

13th Coordinated Working Group Meeting

Uji , *Japan*



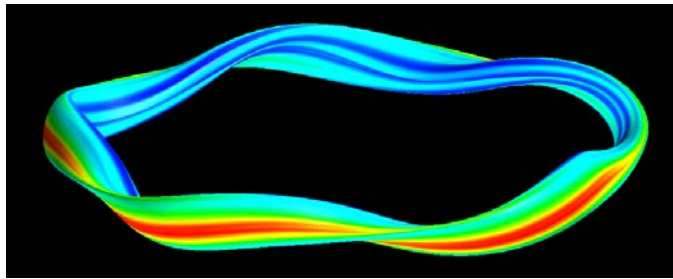
## Stellarators - 3D MCF

- + steady-state
- + no relevant current drive
- + no disruptions & inherently stable
- + high-density
  - + low  $p_\alpha$  @  $P_{fusion} = const$
- + large aspect ratio
- ? 3D confinement (thermal &  $\alpha_s$ )
- 3D engineering (access & maintenance)
- one generation behind
  - divertor concept?
  - operation scenarios?

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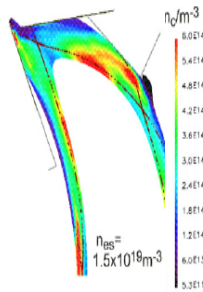


Gyro-kinetic turbulence simulations for W7-X.

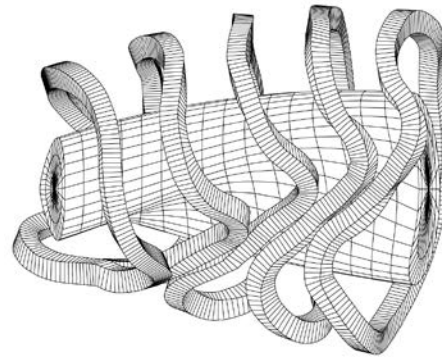


<https://www.youtube.com/watch?v=DWbuLaDD6OE>

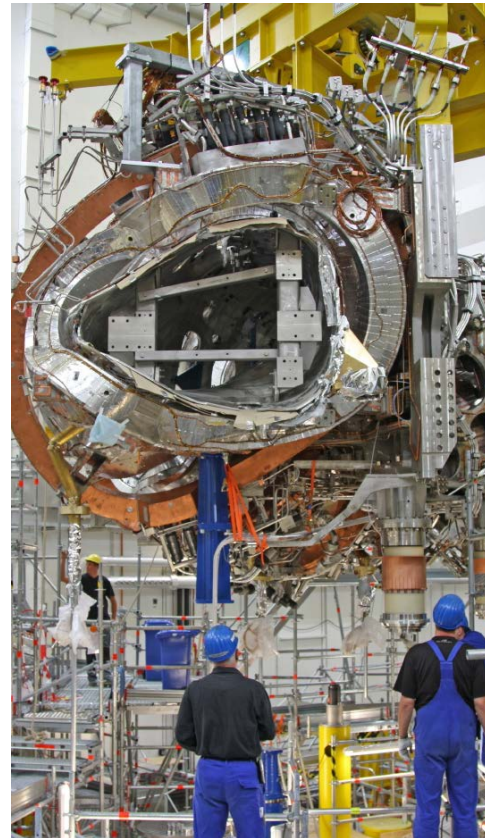
Nucl. Fusion 49 (2009) 095002 Y. Feng et al



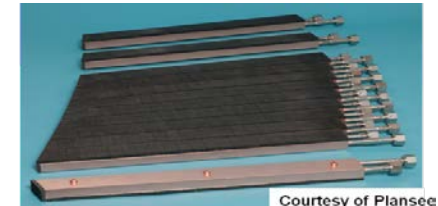
3D edge physics



stellarator optimization



3D engineering & assembly.



Courtesy of Plansee



High-heat flux in-vessel components.



140 GHz cw MW-gyrotron.

**Excellence in science ...**

**... and fusion technology...**

**... on way of qualifying steady-state reactor concepts.**



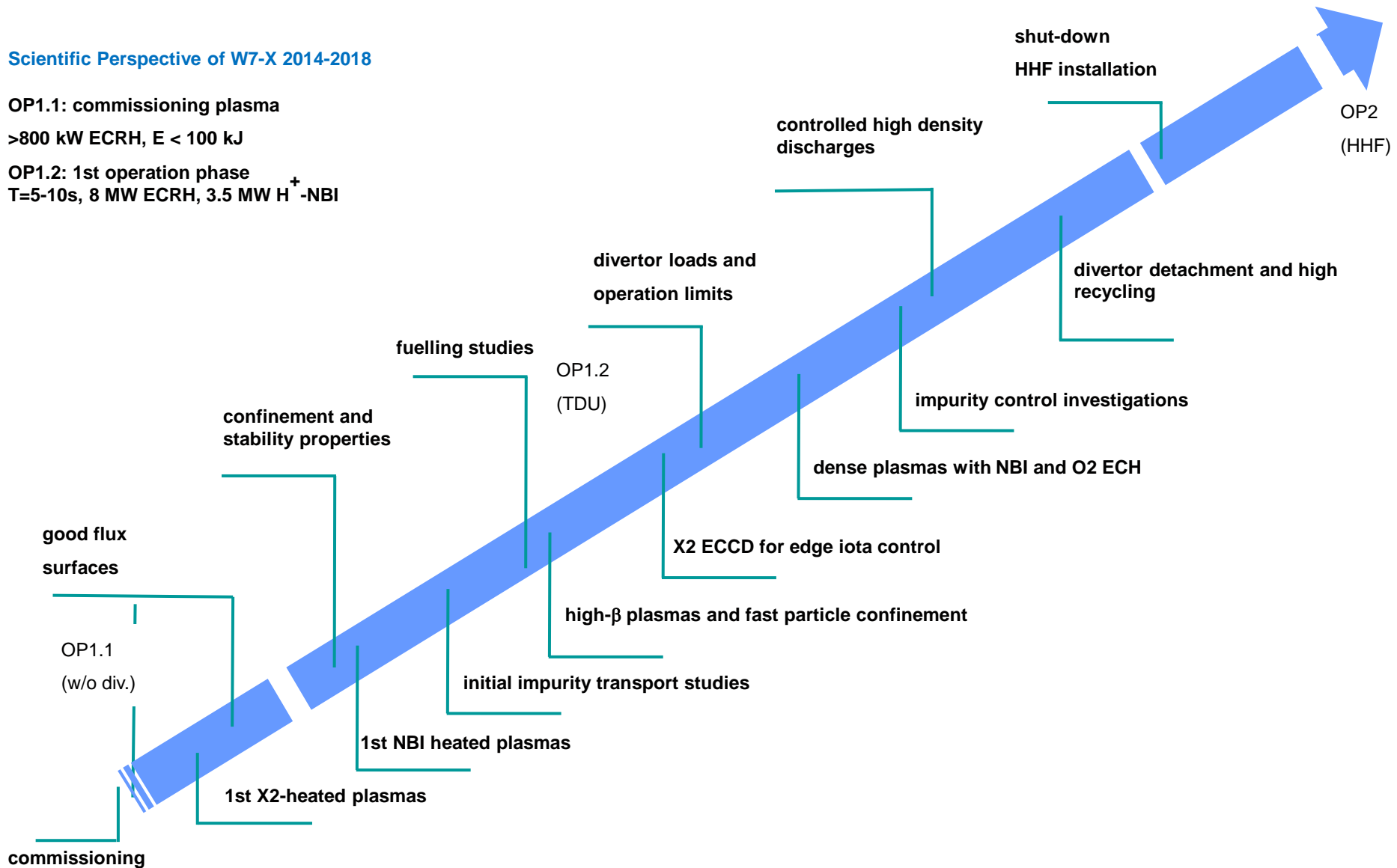
## Scientific Perspective of W7-X 2014-2018

### OP1.1: commissioning plasma

>800 kW ECRH, E < 100 kJ

### OP1.2: 1st operation phase

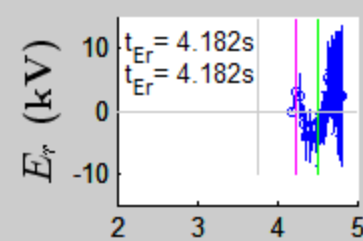
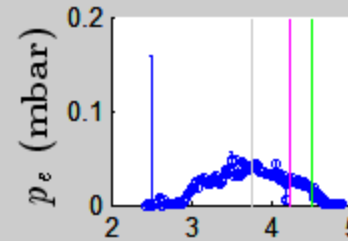
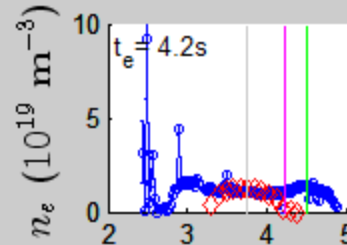
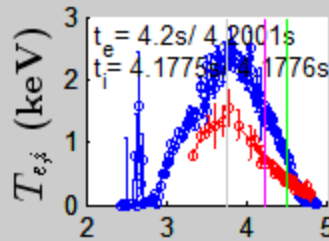
T=5-10s, 8 MW ECRH, 3.5 MW H<sup>+</sup>-NBI





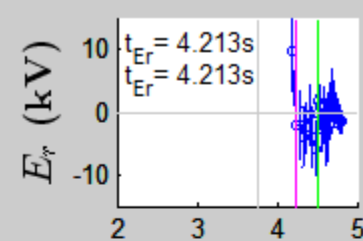
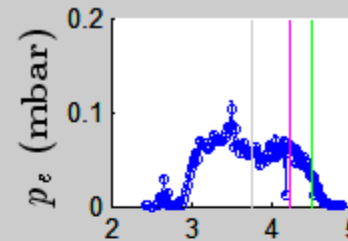
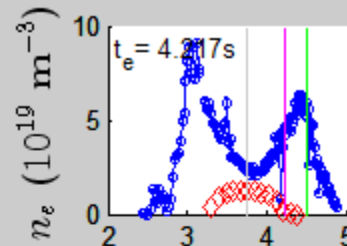
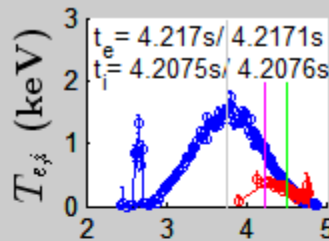
LHD

Nov. 28, 2013  
shot # 122758  
time = 4.175s.



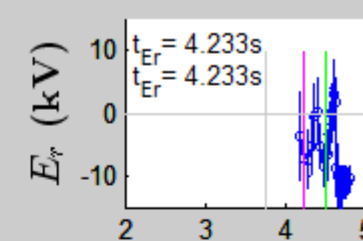
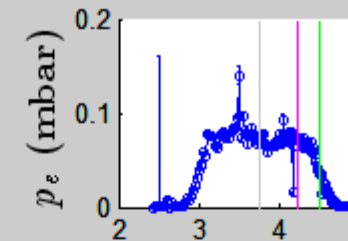
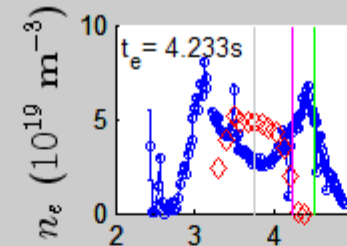
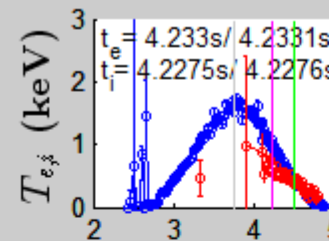
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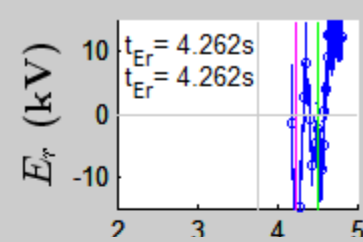
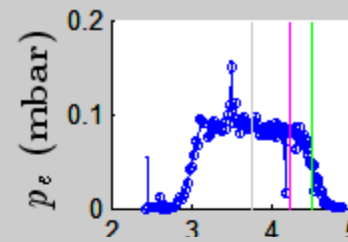
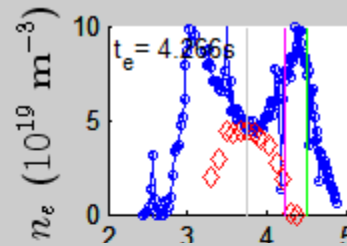
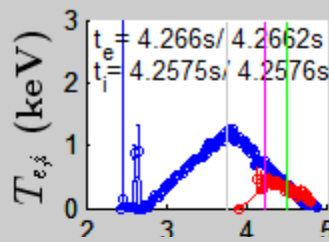
LHD

Nov. 28, 2013  
shot # 122758  
time = 4.225s.



LHD

Nov. 28, 2013  
shot # 122758  
time = 4.25s.





- Collect elements of steady-state SH operation
- Develop concepts for steady-state SH reactor operation and proposals for (quasi-?) continuous operation scenarios (cf. Goto)
- Proposal: Steady-State Scenario Development Group
  - steady-state heating and core fuelling
  - high-density operation: density control, impurities, alpha confinement
  - heat- and particle exhaust & steady-state PFCs
- SSO CG: Roadmap discussion in 2014 – SH contributions?