20150321-L1 student questions and their answers

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In response to request for students' preferred subjects for one or two future classes, the following are the responses and a summary:

	Student feedback	Category
1	The coupling between the plasma physics, the material and the thermal-hydraulic analyses.	Integration (incl. PMI)
2	The procedure of a fusion reactor design.	Design
3	The evolution of the plasma-facing material.	PMI
4	The influence of plasma-facing material acting on plasma. And which section of the first wall has the biggest influence on core plasma operation?	PMI
5	The progress of plasma transport form the core to the edge, and the interactions between plasma and the plasma-facing material. The latest experiment and simulation result should be added.	PMI
6	The comparison of materials which can be used on the divertor, like C and W.	PMI
7	The influence of high-Z impurities acting on plasma confinement and stability.	PMI
8	Introduction of all the plasma instability factors from the core to the edge. Like the curvature of magnetic field.	Toroidal MHD
9	The impurity transport from the edge to the core plasma.	Impurity transport
10	The method of thinking when facing a problem.	Research approach
11	The progress of ITER R&D, and the experience of cooperation and management.	ITER Project
12	Please give some suggestion on the plasma, plasma-facing material and thermal hydraulic research.	PMI+PFC
13	Please introduce your working experience on spherical tokamak.	Research approach
14	The difference between ADS and fusion reactor.	Design
15	The impurity transport and the procedure of a fusion reactor design.	PMI+design

Summary	**PMI + Integration (7.5)**; design (2.5); **research approach (2)**; plasma physics (2); ITER (1)

Design has a lot of content to cover in a few classes.　So, PMI and research approach are chosen.　This leads to the following class plan:

Mo.Date	Topic
03.21	L1B: Overview: from plasma core, to edge, to interface, to material surface, to component, then to outside 概述：从等离子体的核心，到边缘，到界面，到材料表面，到组件，才到外面
03.28	L2A: 特别讨论: 周一夫：关于道德经（的一，二，三）and how they could provide new insights to our R&D? 以及他们如何可能给我们的R&D提供有用的见解？ L2B: How a researcher can make important R&D contributions, learning from Einstein? 研究人员怎样可以做出重要的研发贡献,学学爱因斯坦？
04.18	L3A: How to write papers for scientific and technical journal publication? 如何写用于科学和技术期刊出版的论文？ L3B: Why most PPT presentations sucks, and how you can make them better? 为什么大多数PPT演讲很烂，你如何使他们更好？
04.25	L4: Plasma-facing material: bombarded by edge plasma and particles, and supported by plasma facing component 面对等离子体的材料：由边缘等离子和微粒轰击，也有面对等离子体组件支持
05.16	L5: PMI and PFC integration: weakly and strongly interacting conditions PMI和PFC一体化：弱和强相互作用环境
05.23	L6: From plasma core to PFC: an integrated system 从等离子核心到PFC：一个综合系统

The following questions were raised and discussed during the class:

1. **What's the difference between the two figures in slide 4?**

   Answer: The difference is meant to be how we imagine the ITER device would look like internally before and after the tokamak plasma is created.

2. **What impurity is used in the simulation in slide 5?**

   Answer: According to paper lead-authored by Roth (**2009-Roth-JNM-v390-391-p1**, with Kukushkin as a coauthor), the widely quoted result of ITER divertor plasma simulation assumed C-W divertor target chosen for H-D operation. Carbon was the primary impurity included in the simulation.

   Note that W-only divertor have since been chosen for D-T operation of ITER. More recently, neutron damage in W and He interaction in the W surface layer have studied by a number of researchers.　Their results pointed to potentially important effects not yet considered for the design of the W-only divertor. Take a look at:

   2013-Hatano-NF-v53-p073006,

   2013-Ueda-JNM-v442-pS267.

3. **How can we reduce the heat flux of divertor without affecting the core plasma too much? Could you give some proposal?**

   Answer: As noted in 20141220-L4 问题总结, the divertor was introduced initially to "divert" the impurities from returning to the plasma core. With the subsequent discovery of the H-mode in diverted plasmas, it has become main-stream thinking and has been included in ITER.

   A consequence of divertor is that it actually concentrates the heat and particle fluxes to a small area on the divertor target plate, making the high and particle fluxes limiting constraints of the ITER design.

   One way to reduce this heat flux is to inject high-Z inert gas into the divertor plasma channel to radiate the heat away. Since this would increase the amount of impurities that could return to the plasma core, this counters the initial intent of the divertor, which is to divertor the impurities away from the plasma core.

   MAST-upgrade has included a divertor configuration with strongly expanded magnetic field lines (see, 2012-Morris-IEEE-Trans-plasma science-v40-p682; 2013-Helickova-JNM-v438-pS545). Simulations of this divertor plasma configuration indicate a strongly reduced heat flux on the divertor plate.

Copied from 20141220-L4 问题总结：

2. **We limit the heat flux to the divertor. Is this due to the technology limit or heat transfer limit?**

   Answer: Neither. Divertor is included initially to improve impurity control, with a surprise, a la, the discovery of H-mode that substantially improved plasma confinement, which is now included in the ITER and CFETR design. A divertor concentrates the plasma heat and particle fluxes toward a reduced material surface area, the so-called "divertor footprint", leading to designs that are framed by the limits in heat and particle handling.