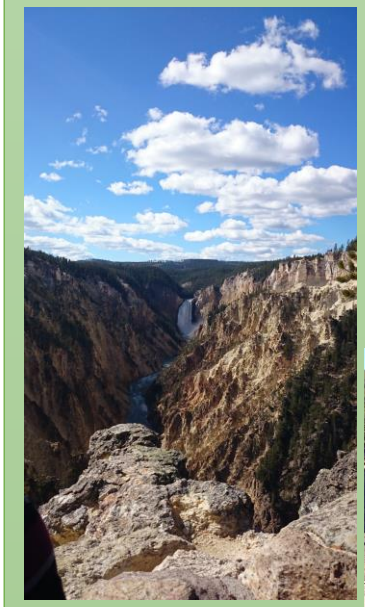
Internship in ISS

Shogo Noda

Idaho Falls, September - December 2017
Barcelona, July 2018

Yellowstone National Park

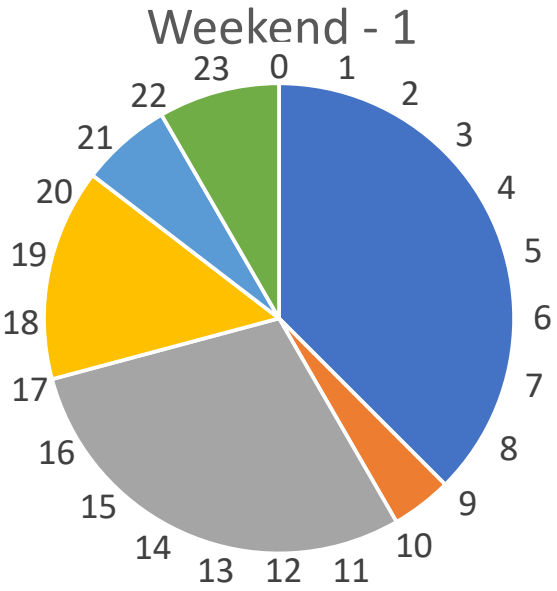


Waterfall

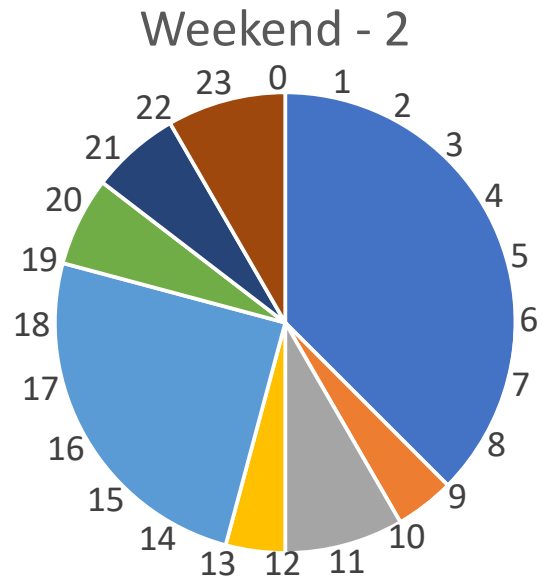
Idaho National Laboratory

サグラダ・ファミリア

Weekend

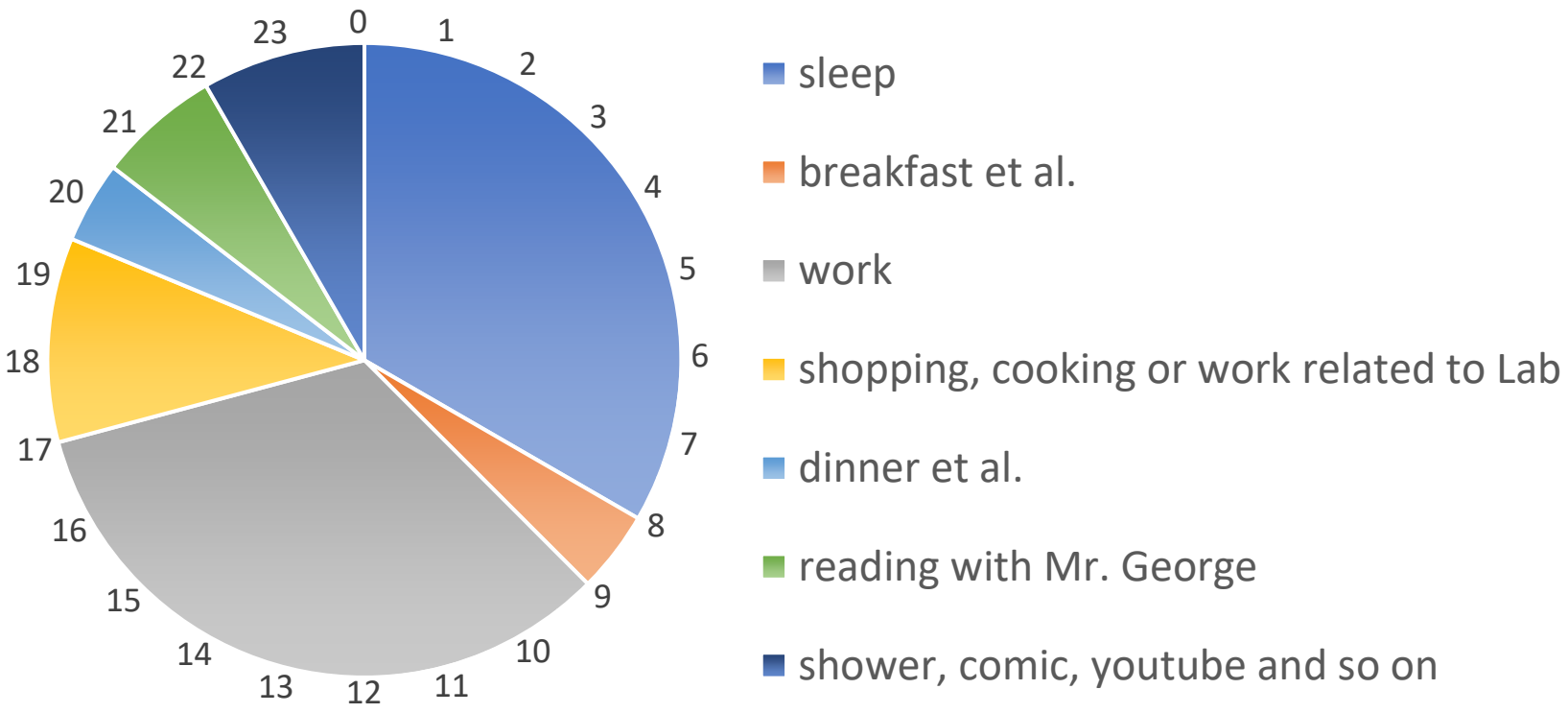


- sleep
- breakfast et al.
- go outside
- dinner et al.
- reading with George
- shower, comic, youtube and so on



- sleep
- breakfast et al.
- cleaning
- lunch
- shopping, cooking, work related to Lab
- dinner et al.
- reading with George
- shower, comic, youtube and so on

Weekday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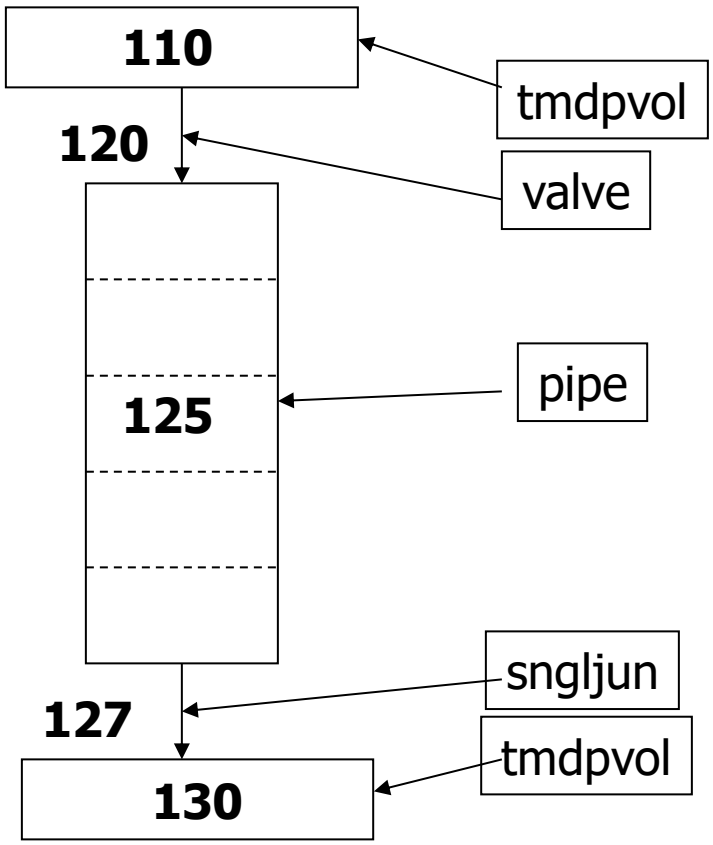
sleep
breakfast et al.
work
shopping, cooking or work related to Lab
dinner et al.
reading with Mr. George
shower, comic, youtube and so on

Work

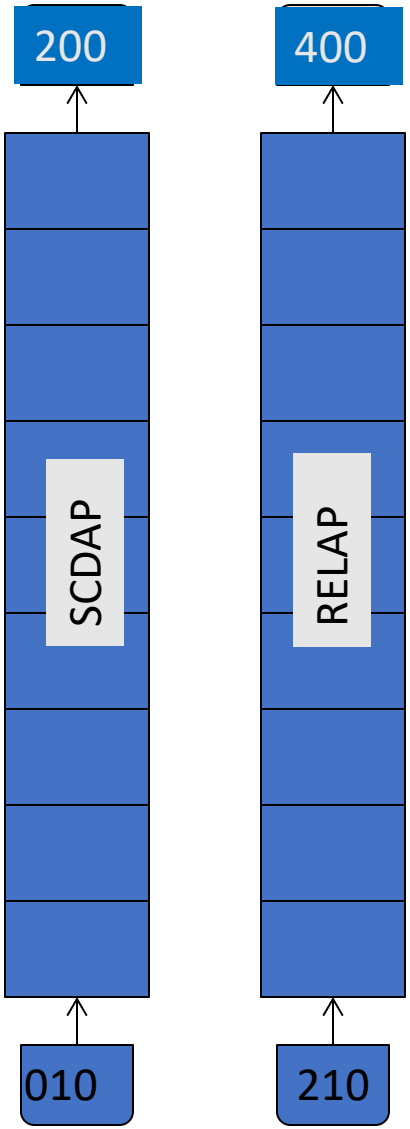
- Study how to use RELAP/SCDAPSIM
- Analyze the test case of RELAP/SCDAPSIM
- Study how to modify the source code and modify the source code to analyze SCWR
- Study the past study
- Make the input file of SCWR

Simple Pipe

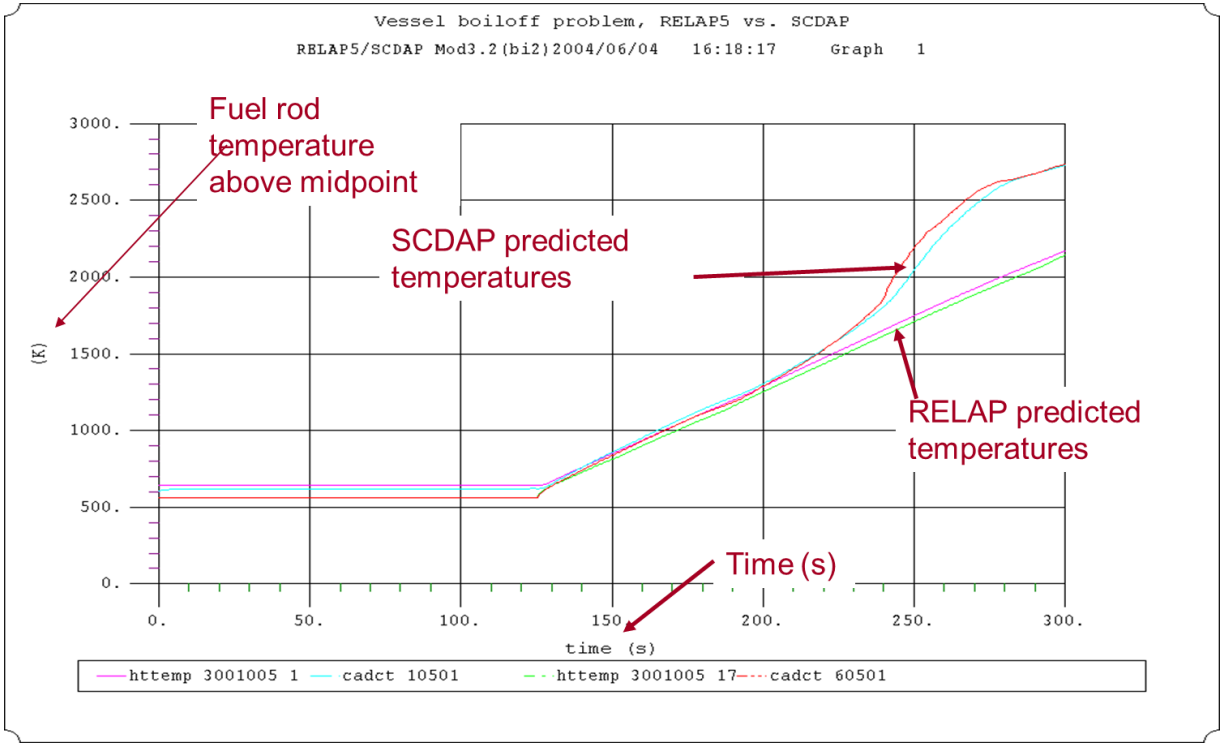


- To study about basic inputs of:
  - Volume
  - Pipe
  - Heat structure
  - several kinds of valve
  - Strip file

Boiloff



- In BWR condition, the boiloff is simulated with comparing RELAP and SCDAP components



Marina "Assignment – Simple boiloff with SCDAP and RELAP5 bundle "

Boiloff

- Simulate the following components
  1. Several group of fuel rods in one assembly
  2. PWR control rods
  3. BWR channel box & blade
     (but it cannot model by the view factor and path length)
  4. Electrically heated fuel rods

Other cases

- Demo PWR
  - To understand the simulation of multi-channel
- Simple plant
  - To understand PWR plant design

Source code

- Understand basic source code structure
- Read the source code partly
- Practice the modification
- Change the heat transfer correlation in the source code from Dittus-Boelter to Watts

SCWR plant

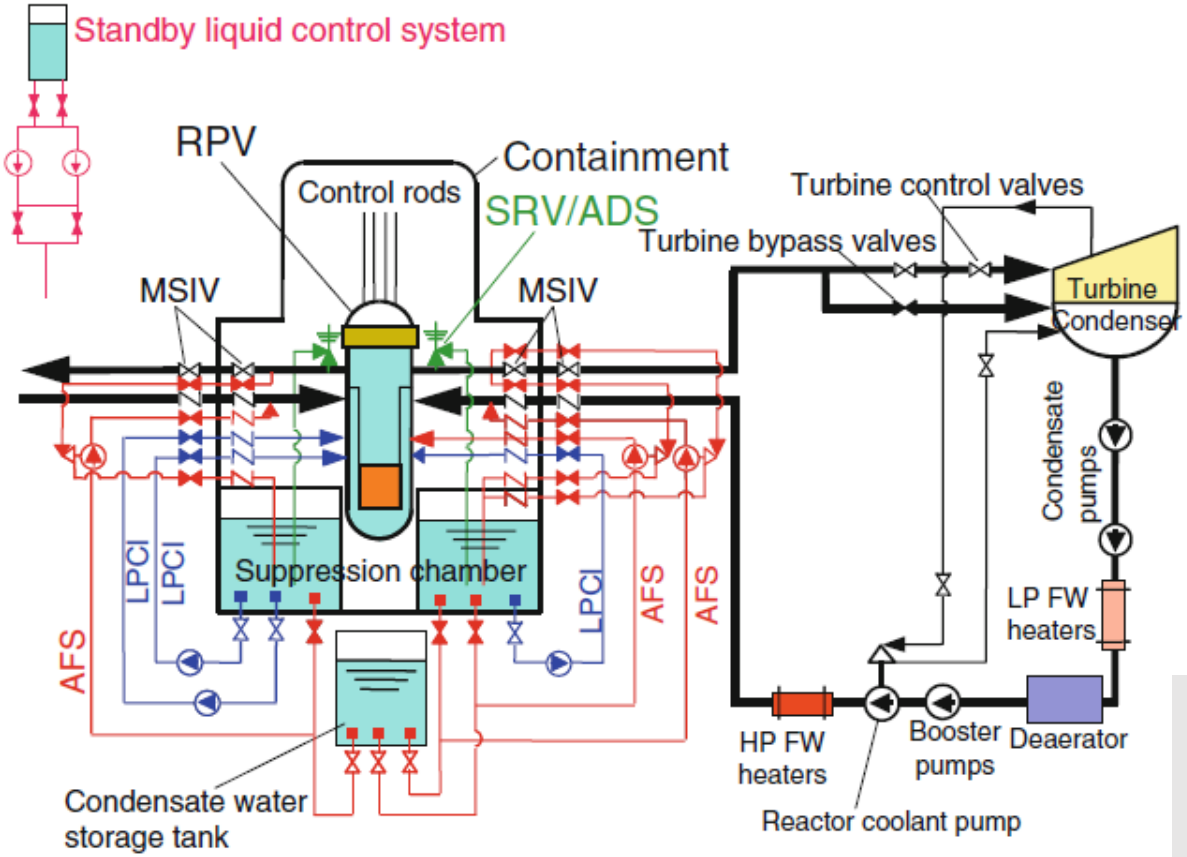


Fig1. Plant and safety systems of Super LWR and Super FR [1]

- Two loops
- Once-through coolant cycle and the simplified plant system by the single phase flow.
- High pressure around 25 MPa and High enthalpy rise in the core
- The ratio of the core flow rate to the reactor thermal power is 1/8 of BWR)[1]

ADS: automatic depressurization system
AFS: Auxiliary Feed water Systems
LPCI: Low-Pressure Core Injection system
MSIV: Main Steam Isolation Valve
SRV: Safety Relief Valve

[1] Yoshiaki Oka・Seiichi Koshizuka・Yuki Ishiwatari・Akifumi Yamaji, “Super Light Water Reactors and Super Fast Reactors Supercritical-pressure Light Water cooled Reactors”, 39, Springer, 2010

SCWR plant

Table. Actuation conditions of safety system for LOCA analysis [2]

	ABWR	PWR	Super LWR
Reactor scram	Drywell pressure high, or Rapid decrease in core flow rate	Pressurizer pressure low, or ECCS startup	*Flow rate low level 1, or **Pressure low level 1, or Drywell pressure high
Accumulator	—	Core pressure below 4 MPa	—
HP ECCS	Neglected	Containment pressure high, or Pressurizer pressure abnormally low, or Pressurizer pressure low and pressurizer water level low (32 s delay)	Neglected
LP ECCS	Water level 1, or Drywell pressure high (30 s delay)	Containment pressure high, or Pressurizer pressure abnormally low, or Pressurizer pressure low and pressurizer water level low (32 s delay)	*Flow rate low level 3, or **Pressure low level 2, or Drywell pressure high (30 s delay)
MSIV	Water level 1.5 (no delay)	—	*Flow rate low level 3, or **Pressure low level 2, or Drywell pressure high (no delay)
ADS	Water level 1, and Drywell pressure high (30 s delay)		

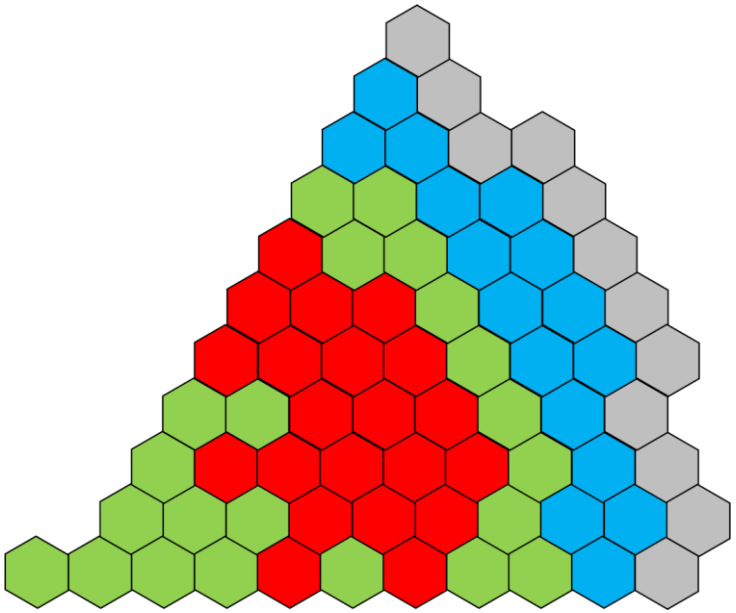
*Flow rate low level 1 (90%), level 2 (20%), level 3 (6%)
**Pressure low level 1 (24.0 MPa), level 2 (23.5 MPa)

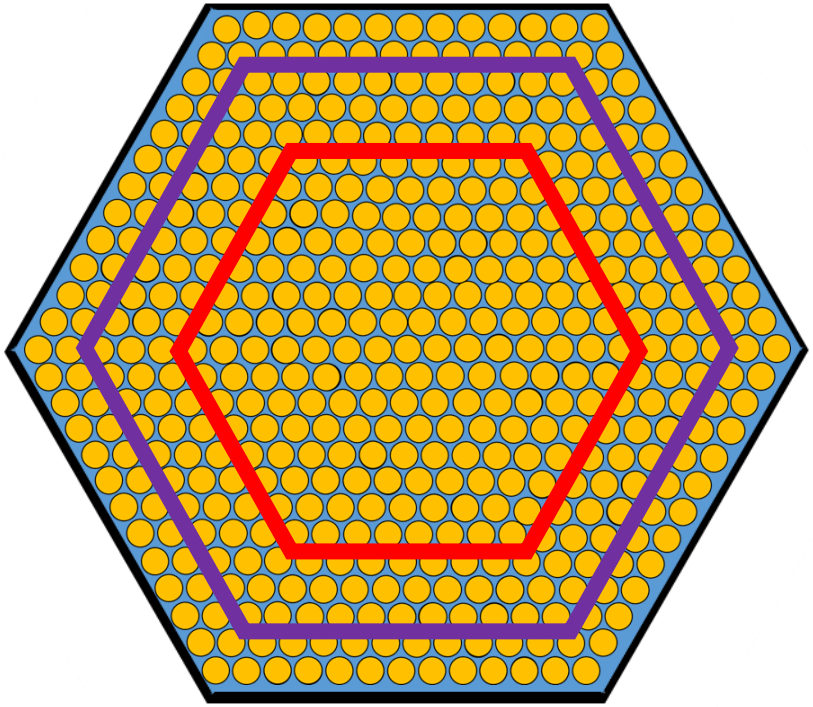
Basic functions of the safety system

- Reactor scram
- Depressurization…SRV, ADS
- Cooling…AFS (High pressure)
  LPCI(Low pressure)
  (induced flow by depressurization)
- Isolation…MSIV

[2]Yuki ISHIWATARI, Yoshiaki OKA, Seiichi KOSHIZUKA and Jie LIU, 2006, “LOCA Analysis of Super LWR”, Journal of NUCLEAR SCIENCE and TECHNOLOGY

Grouping of Assemblies and Rods



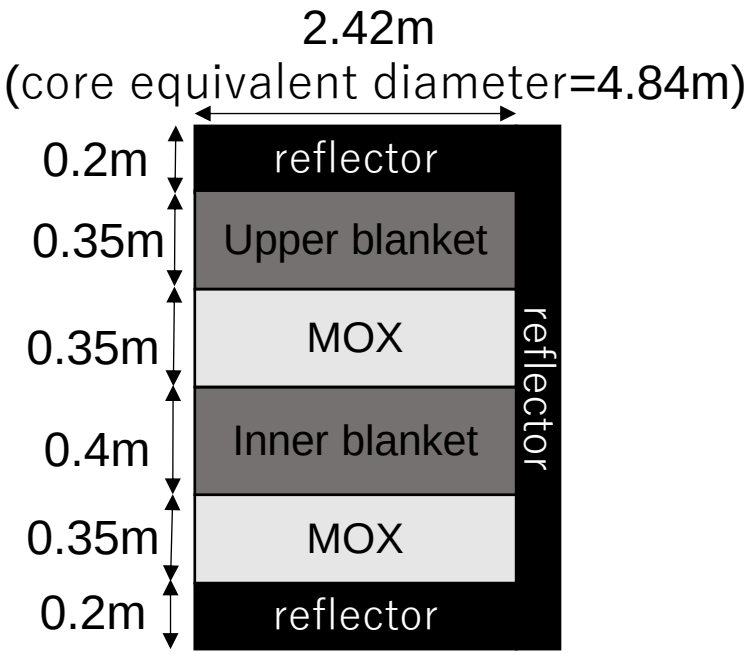


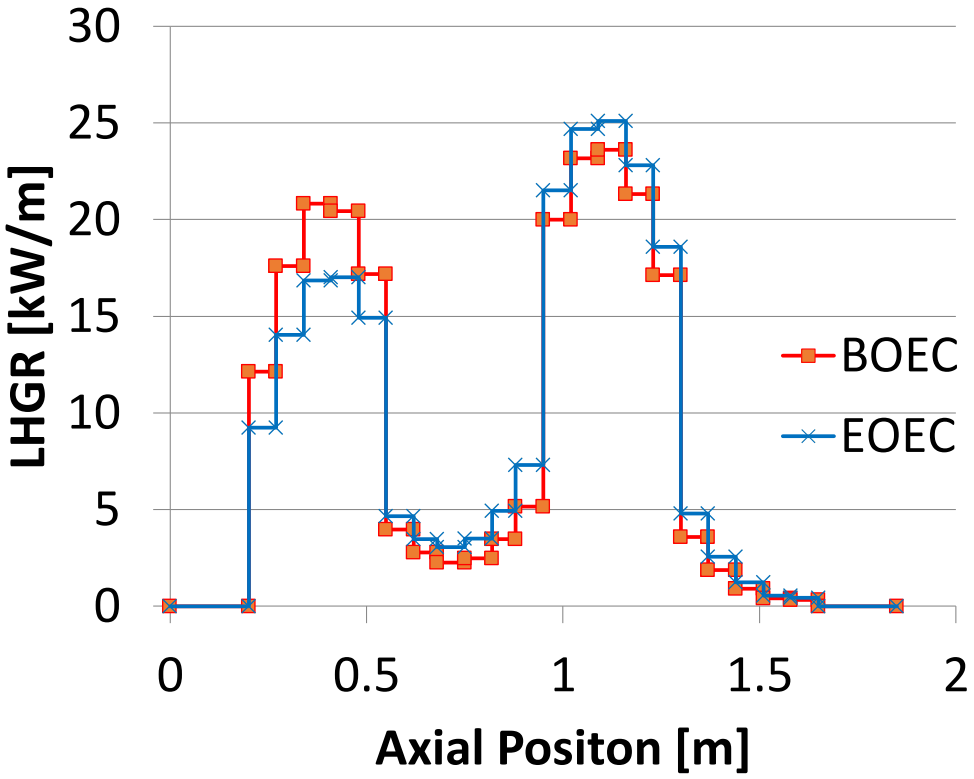
Core→ 3 assembly groups

One assembly→ 3 rod groups

9 channel

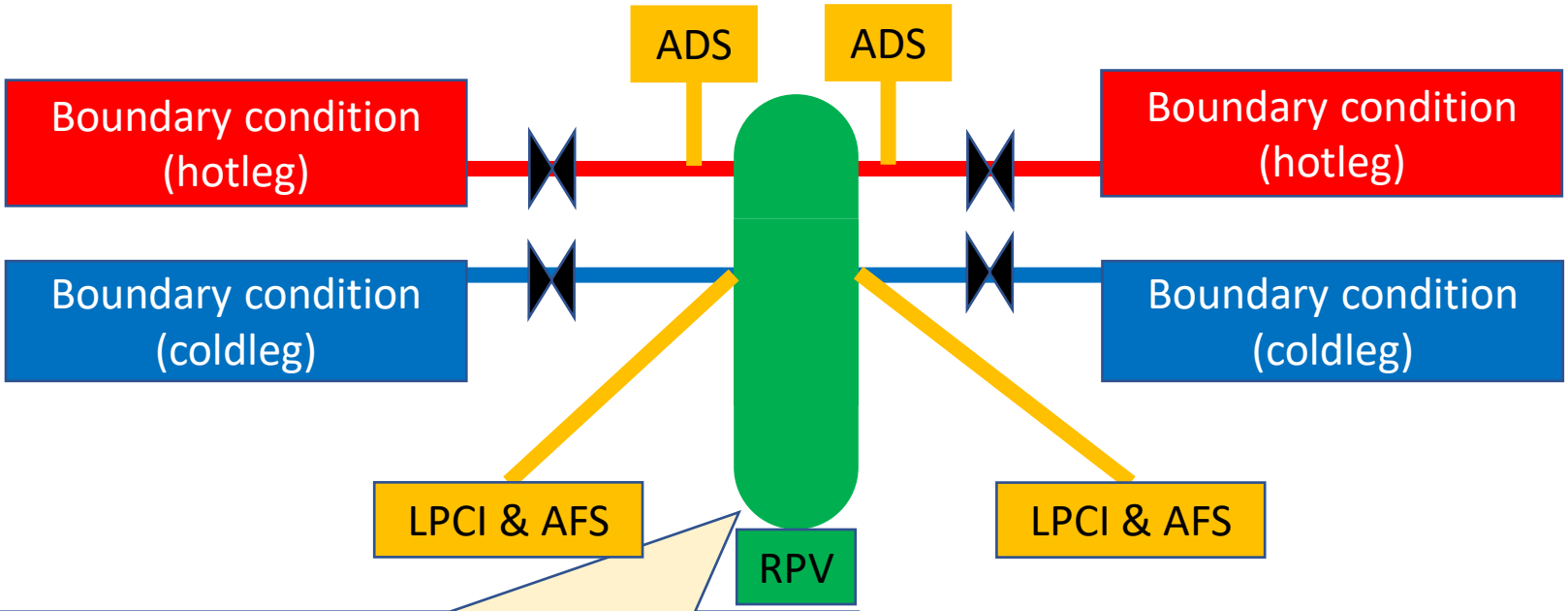
Core configuration

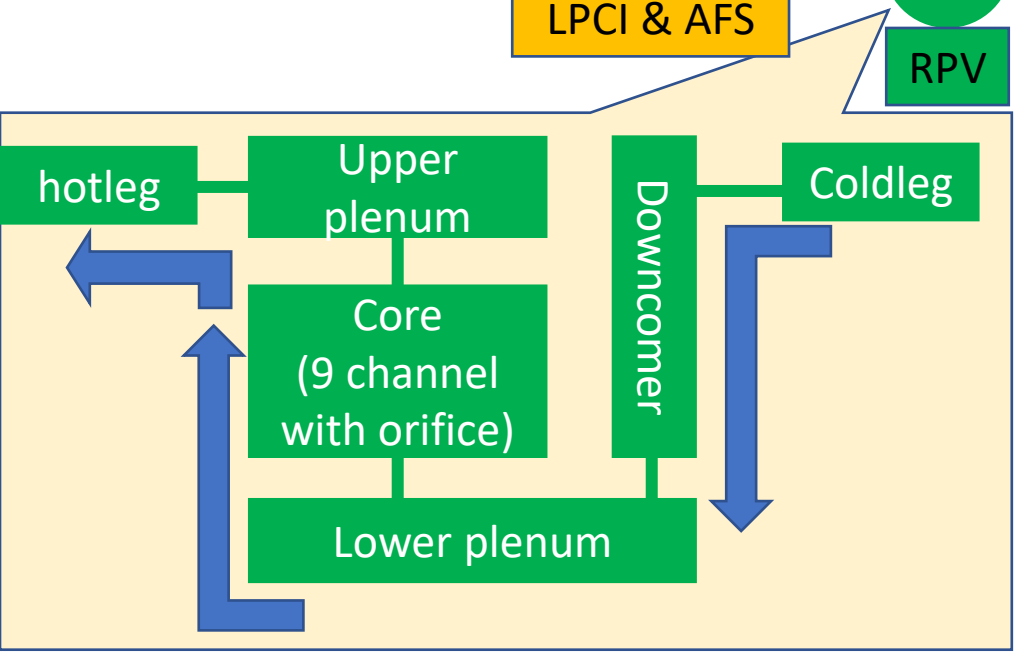




BOEC: Beginning of equilibrium cycle
EOEC: End of equilibrium cycle

Simplified system figure





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Current & future analysis

- I could simulate the steady state.
  (Each MCST of hot channel became 650 C)
- LOCA (Loss Of Coolant Accident) analysis
  - I will analyze LOCA analysis (small/large LOCA of hot/cold-leg)
  - I tried to analyze small break of coldleg, but there was an error when the pressure became below pseudo-critical pressure
  - I will recheck the source code and the correlation
- New laboratory member will analyze
  - RIA (Reactivity Initiated Accident)
  - SA (Severe Accident)←SCDAP component must be used

「本インターンを終えて」
参加前にはきちんと成果を持ち帰れるか不安でいっぱいだった海外インターンですが、終わってみれば、研究成果のみならず、国際的視野の獲得や語学力の向上など、多くのものを得られる４ヶ月間でした。
研究においては、各国の第一線の研究者の方々からモデル検討についてのアドバイスを受けることが出来たため、多くの課題を解決しながら研究を進めることが出来ました。
加えて、日本にいる先生や研究室のメンバーからの手厚いサポートにより、修士課程の修了などについても特に心配することなく、現地での研究に集中出来、納得のいく成果を得られました。
国際交流の点では、各国でのエネルギー事情についての生の声や、日本産業に対する期待感などを伺うことが出来たため、客観的な視点から日本の姿を見つめ直すことが出来ました。
語学面では、現地の方に親切にして頂き、コミュニケーションを取る機会に恵まれたため、語学力の大幅な向上につながりました。
中々経験できない貴重な機会を与えていただいた皆様、現地での研究・生活を支えて頂いた皆様には、感謝の念に堪えません。
この度の経験を日本・世界のエネルギー分野の発展に活かしていきたいと思います。

ご清聴ありがとうございました

Thank you for your attention!