‘22년도 추계 KNS 다물리-다중스케일 통합해석 워크숍

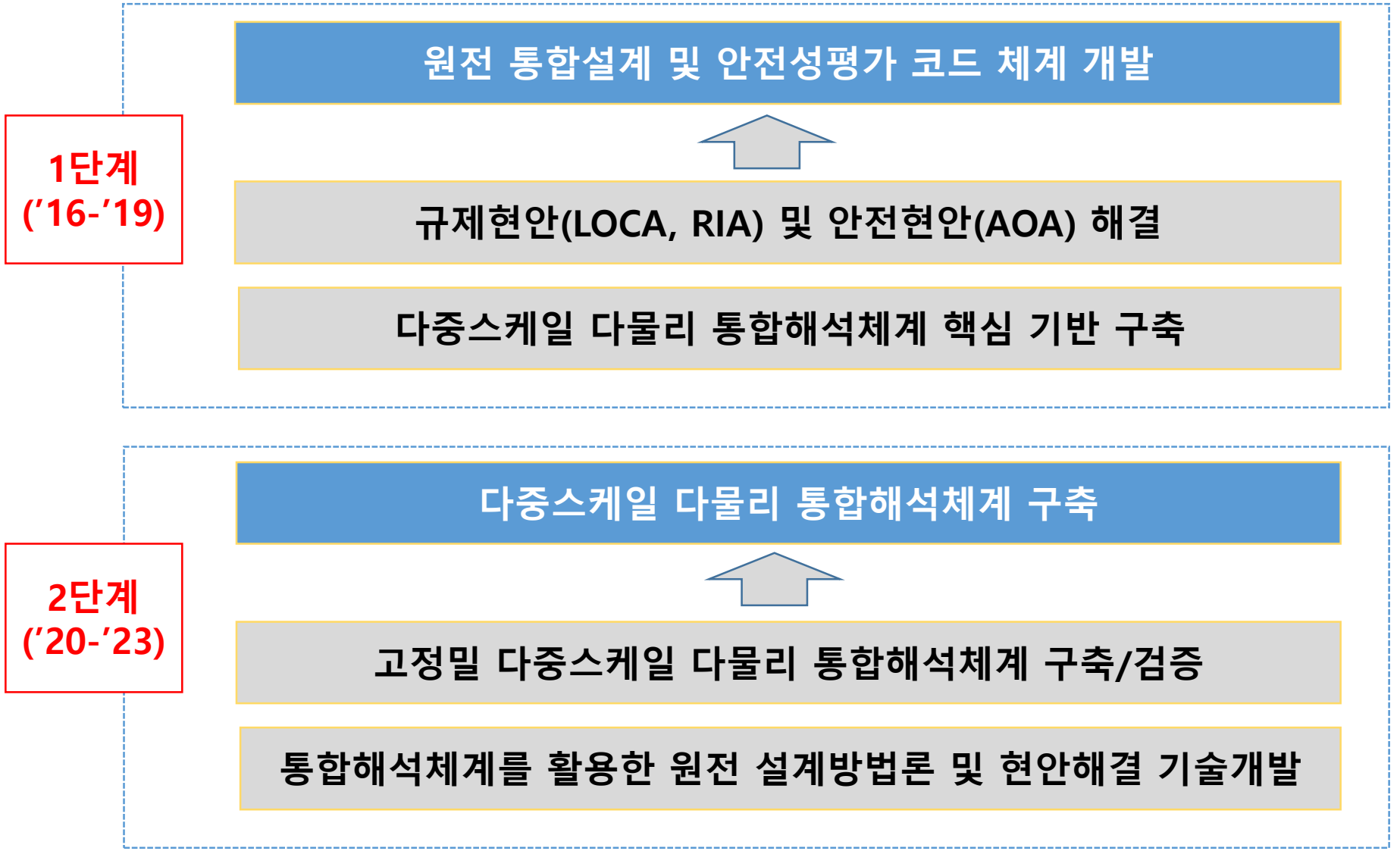
한국수력원자력 통합해석체계 개발 현황 및 특징

2022.10.19.

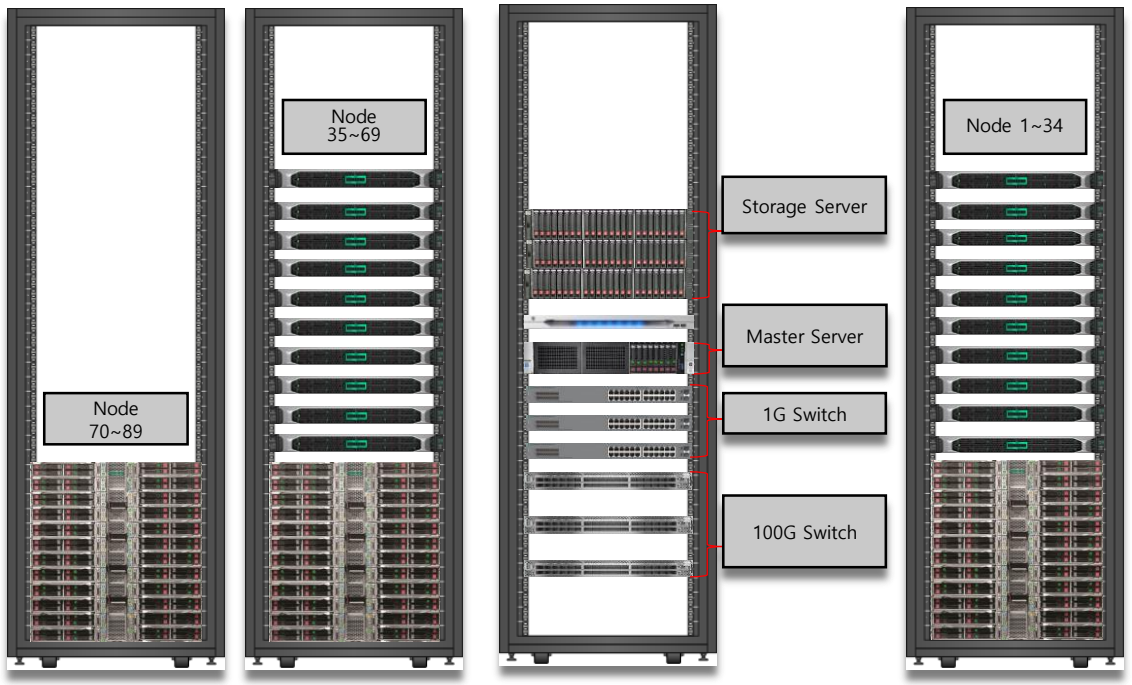
안전연구소 안전해석그룹
선임 유일용

KHNP

1. 한수원 통합해석체계 개발 개요



2. 한수원 통합해석체계 지원 자원



- **2,576 코어 장착 (6세대 Skylake CPU), 207 Tflops 연산 성능 ('2009, EdF BlueGene – 214.2 flops)**
  - 업무망 PC (2021년) 3.0 GHz, i7-9700, 8 Cores – 81 Gflops → 207,000 / 81 = 2,555배
- **122 TB 데이터 저장용량 확보 및 100GB/s 자료 고속통신 성능 보유**

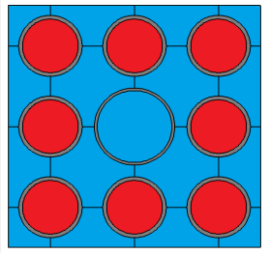
1단계 개발내용

원전 통합설계 및 안전성평가 코드 체계 개발 (‘16~’19)

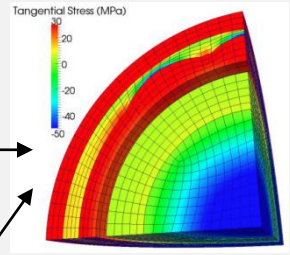
1-1. 통합해석체계 설명(상용코드)

Thermal Hydraulics

Fluid Temperature
Fluid Density / Void



CTF



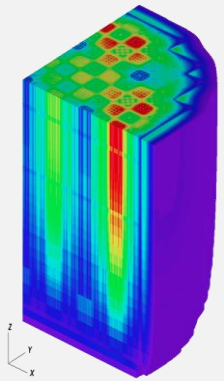
Fuel Performance

Fuel Temperature
Clad Heat Flux
Clad Surface Temperature

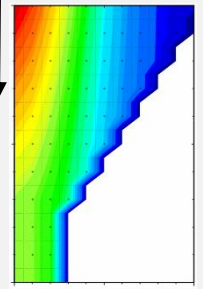
FRAPCON/
FRAPTRAN

Neutronics

Neutronic Power
Burnup
Boron Concentration



RAST-K



BOA

Chemistry

Crud Thickness
Crud Composition (Boron)
Crud Thermal Resistance

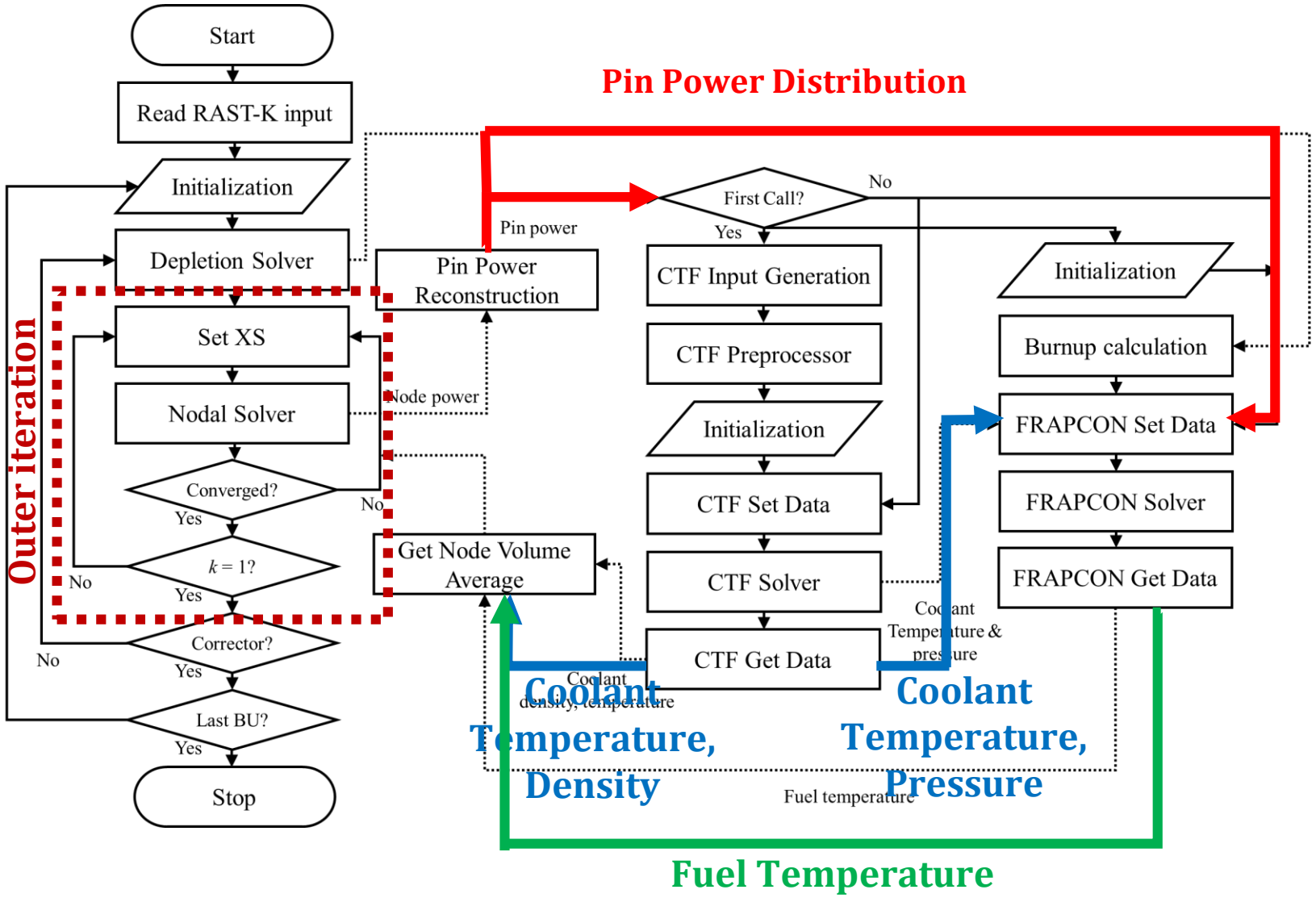
활용 분야

- ❖ 노심설계코드 정확도 향상
- ❖ 발전소 현안(AOA) 합리적 수준의 해결
- ❖ 단기적 규제현안(LOCA/RIA) 대응

장단점

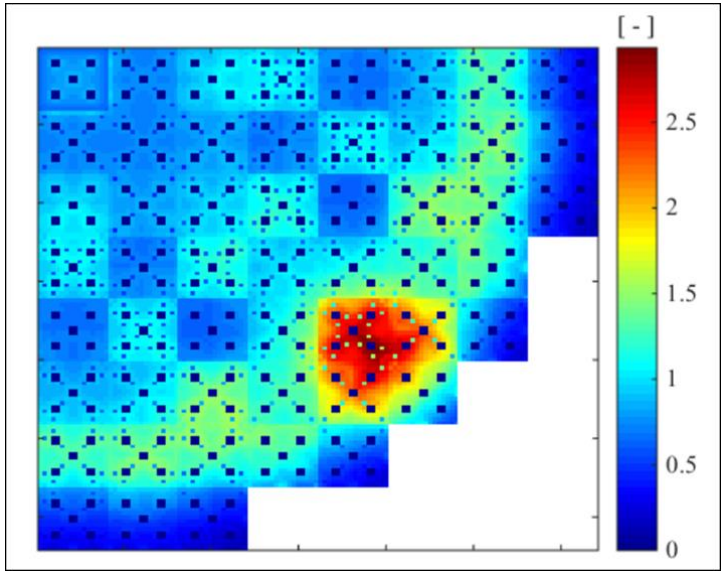
- ❖ 규제기관 다물리 코드체계 유사
- ❖ 많은 사용자 그룹/지속적 유지•보수
- ❖ 고속 병렬처리 및 Localization 불리

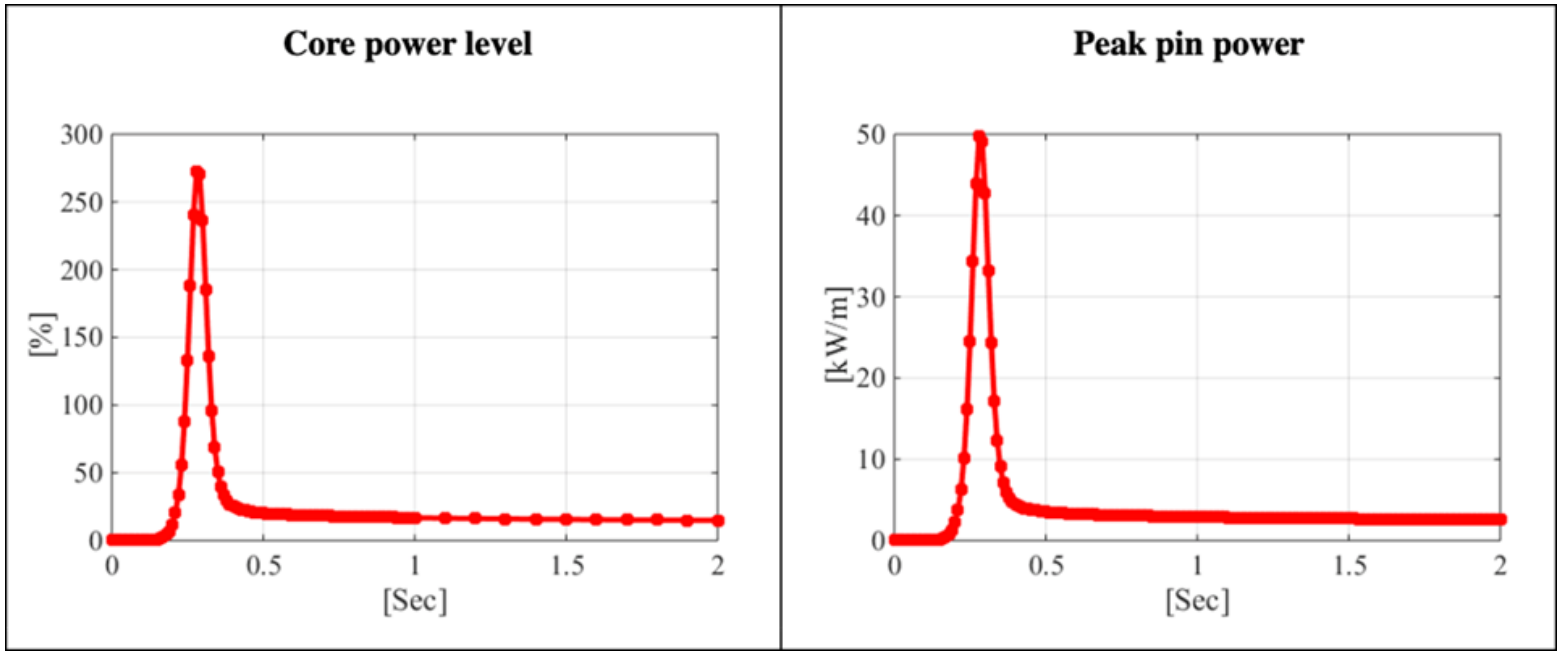
1-2. 통합해석체계 연결도(Flowchart)



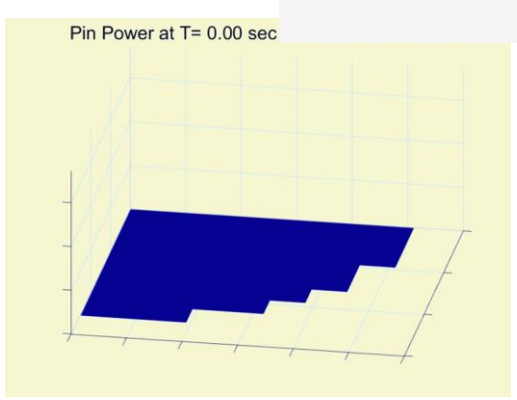
1-3. 통합해석체계 사고해석(REA)

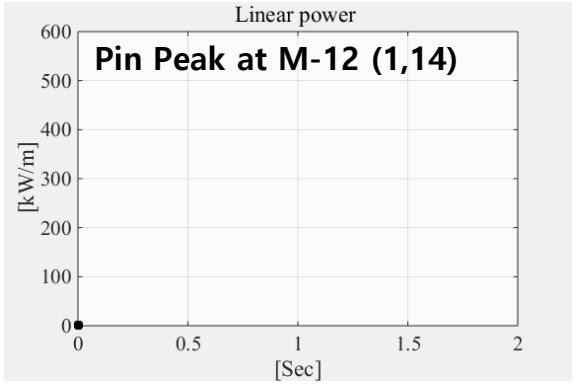
- **OPR-1000 초기노심 BOC HZP**
  - M12 위치의 제어봉 인출
  - Peak 출력 발생 시간의 봉출력 분포

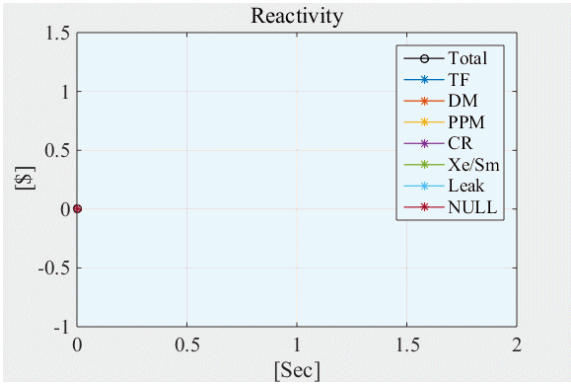




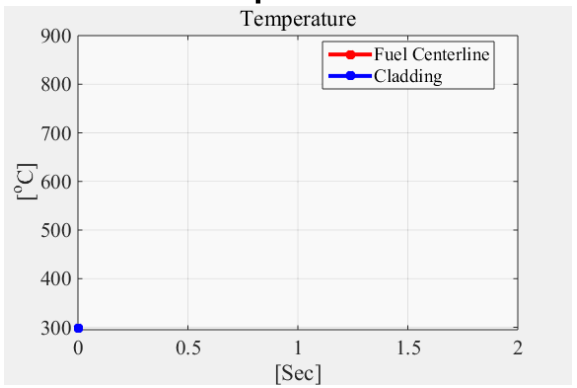
1-3. 통합해석체계 사고해석(REA)

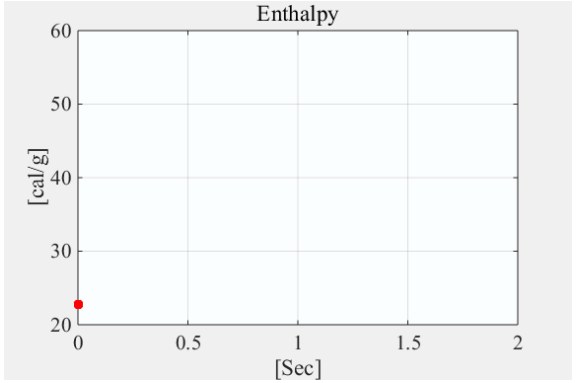


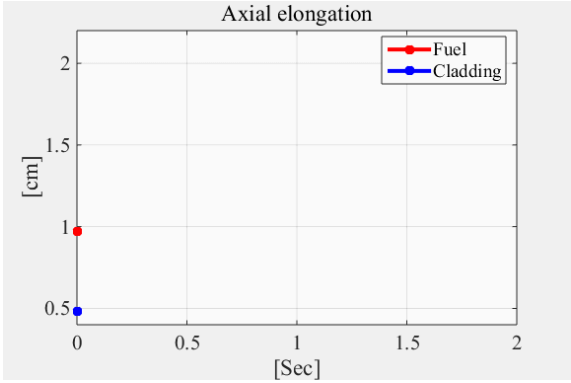


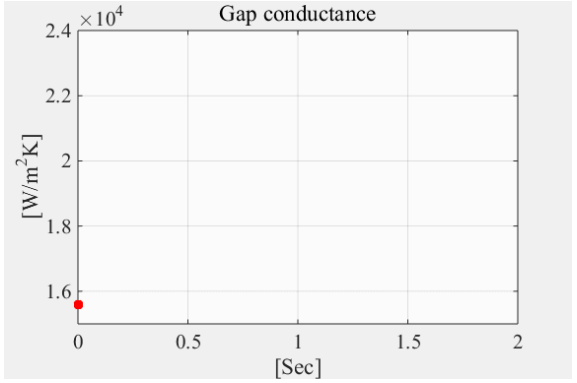


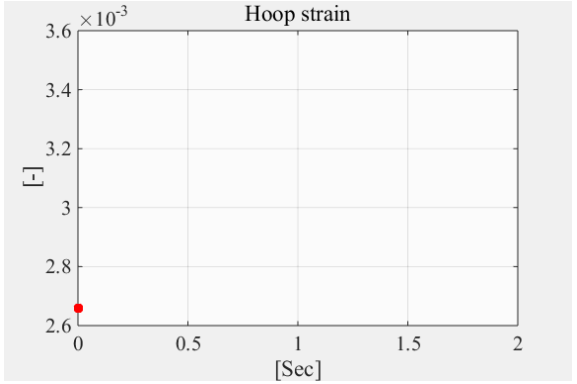
Max Temp. at 7th Level

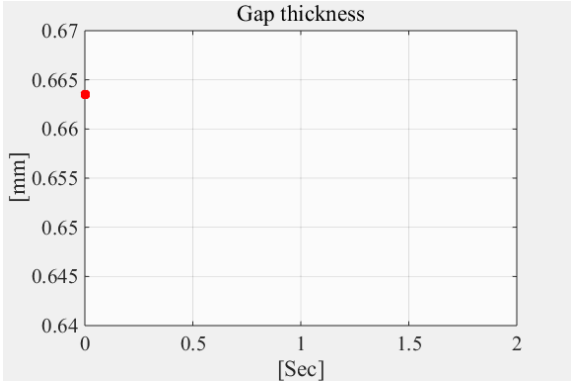




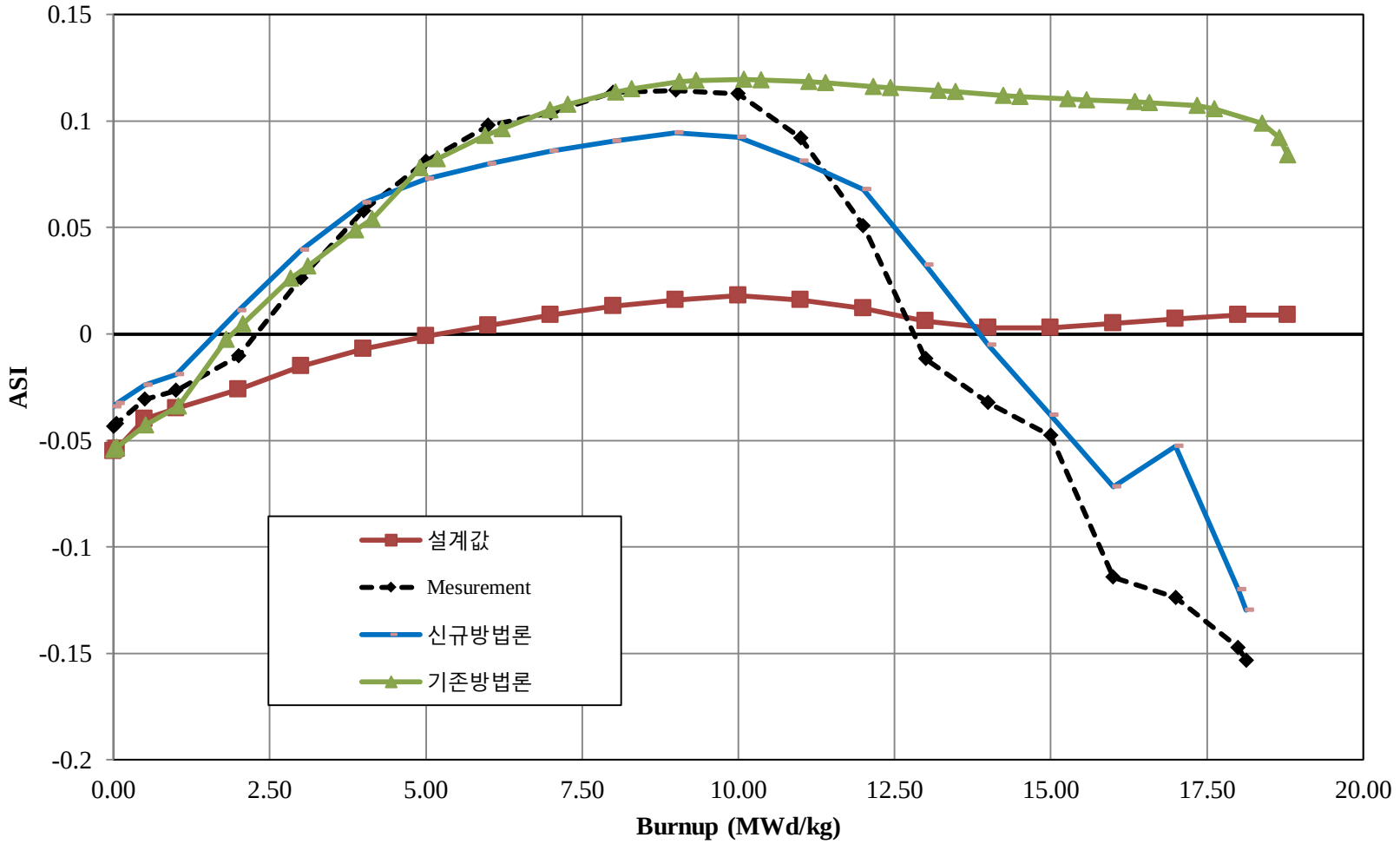






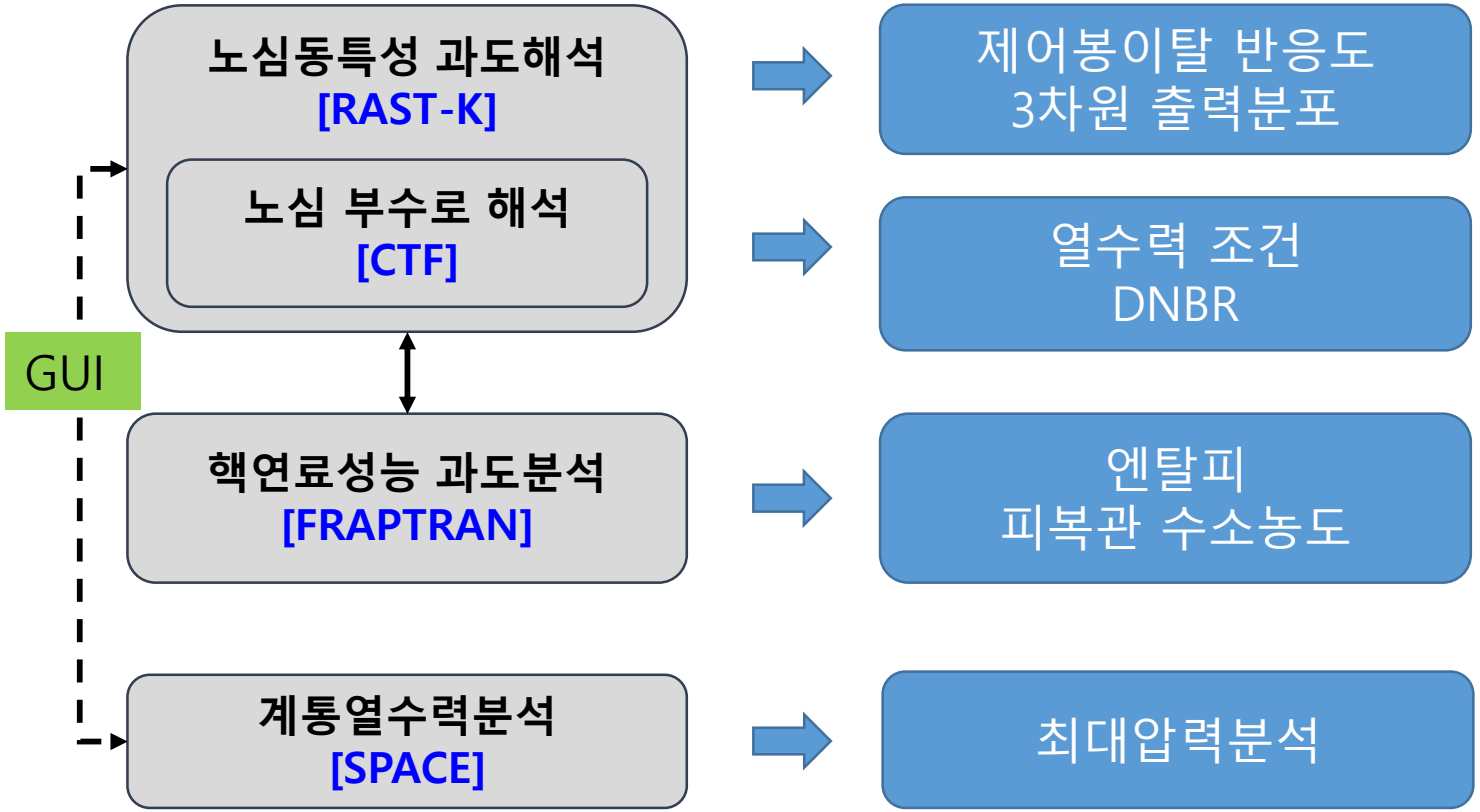


1-4. 통합해석체계 발전소운전 현안해석(AOA)

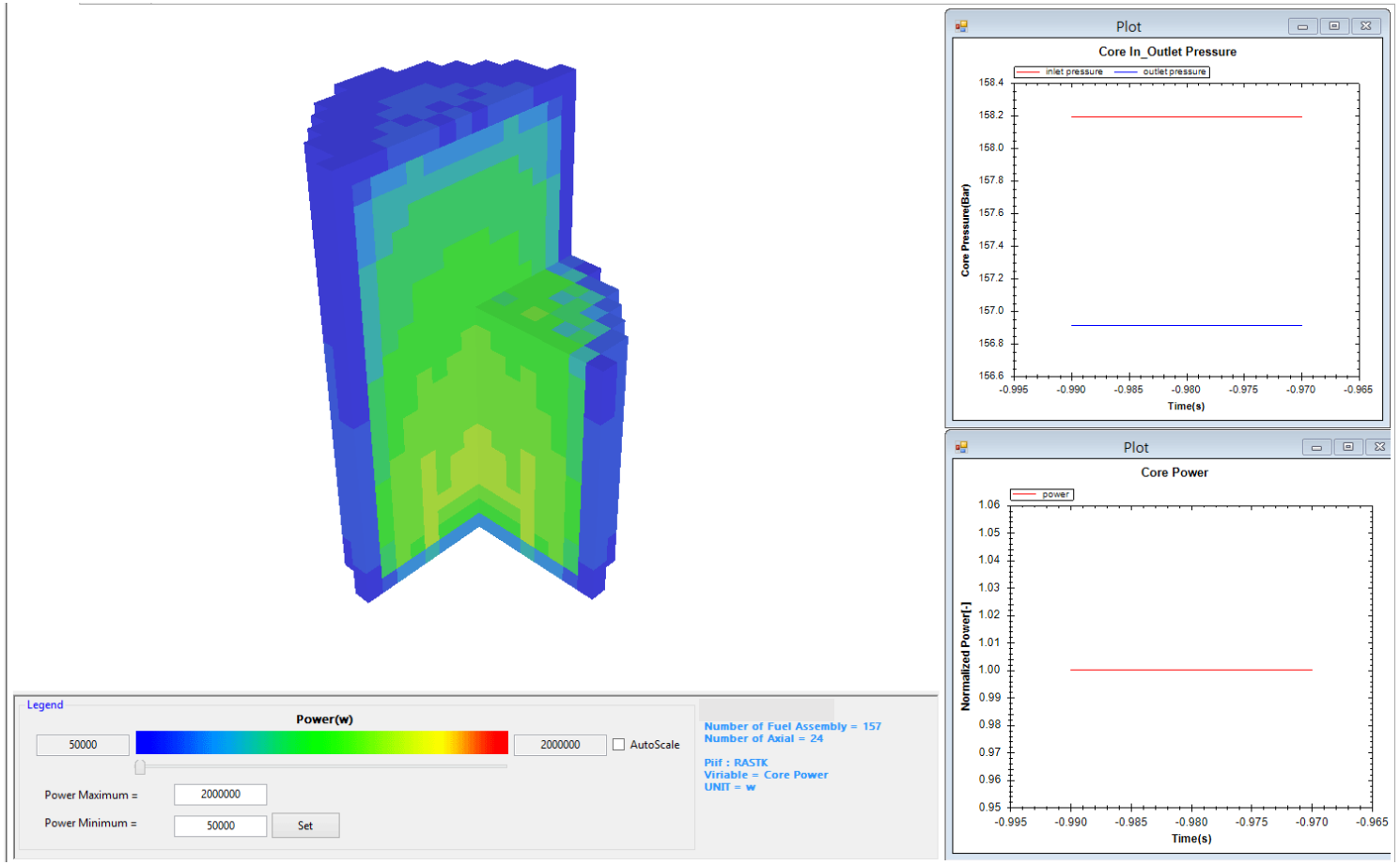


- **More detailed, accurate and reasonable benchmark by BOA/RAST-K Coupling**

1-5. 계통코드(SPACE) 연계체계



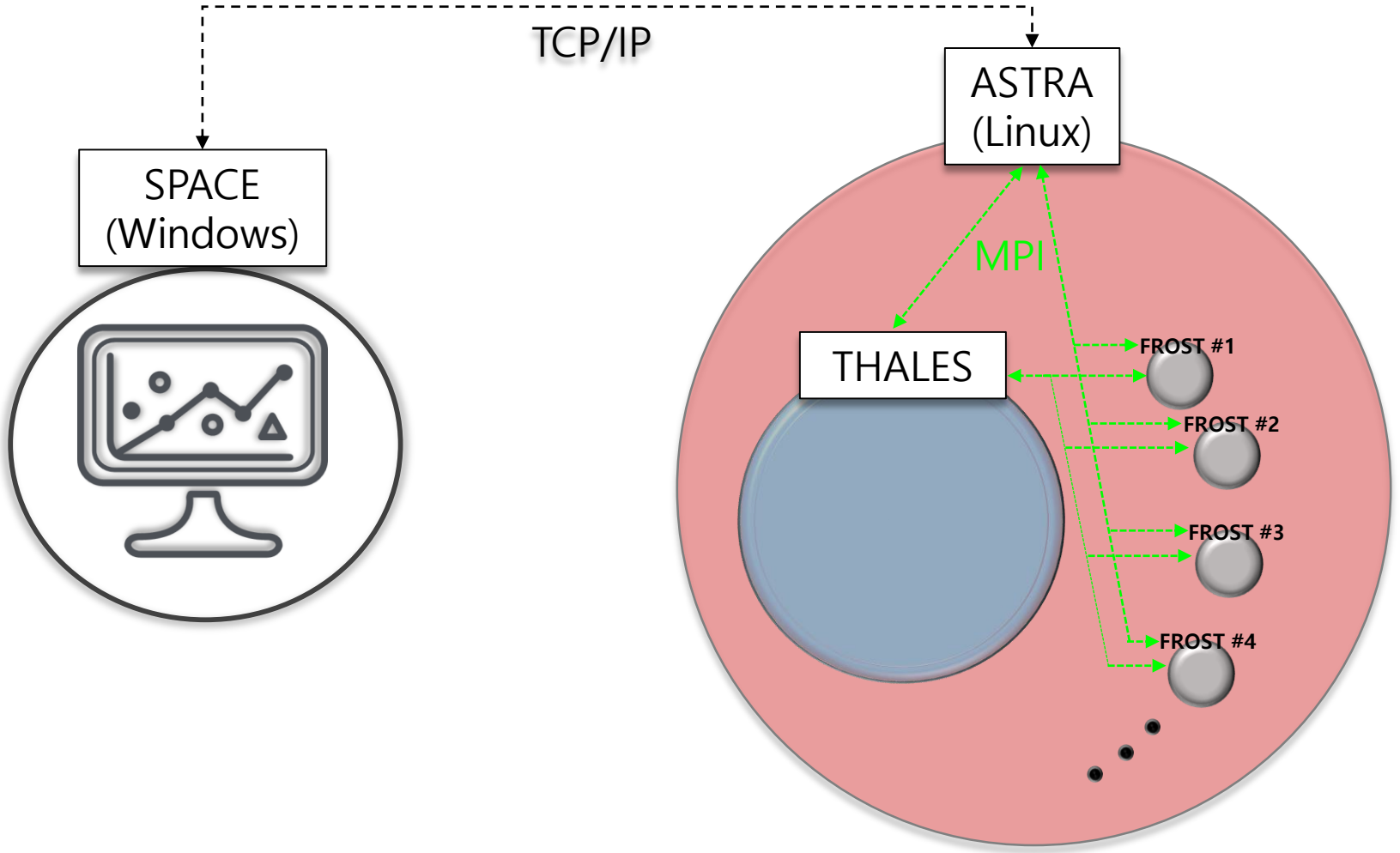
1-6. GUI를 통한 사고해석(REA)



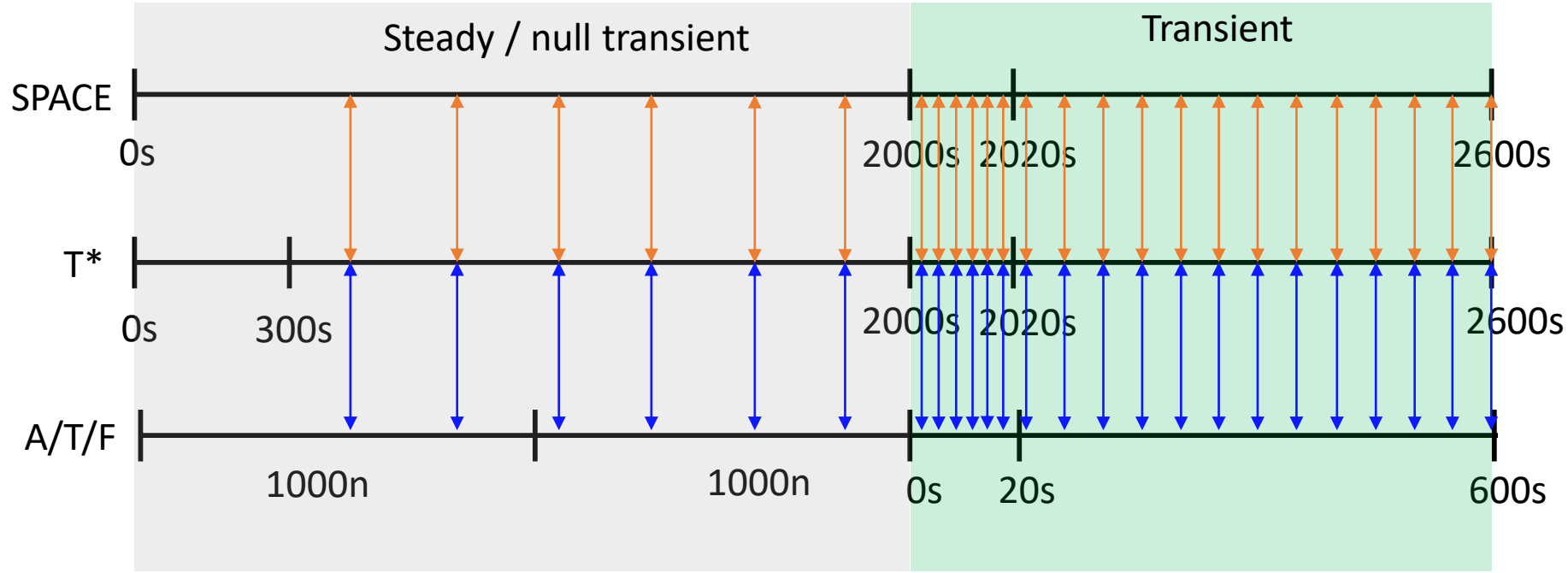
2단계 개발현황

다중스케일 다물리 통합해석체계 구축 (’20~’23)

2-1. CAPLER(Comprehensive Analysis Package for Light watER reactors)

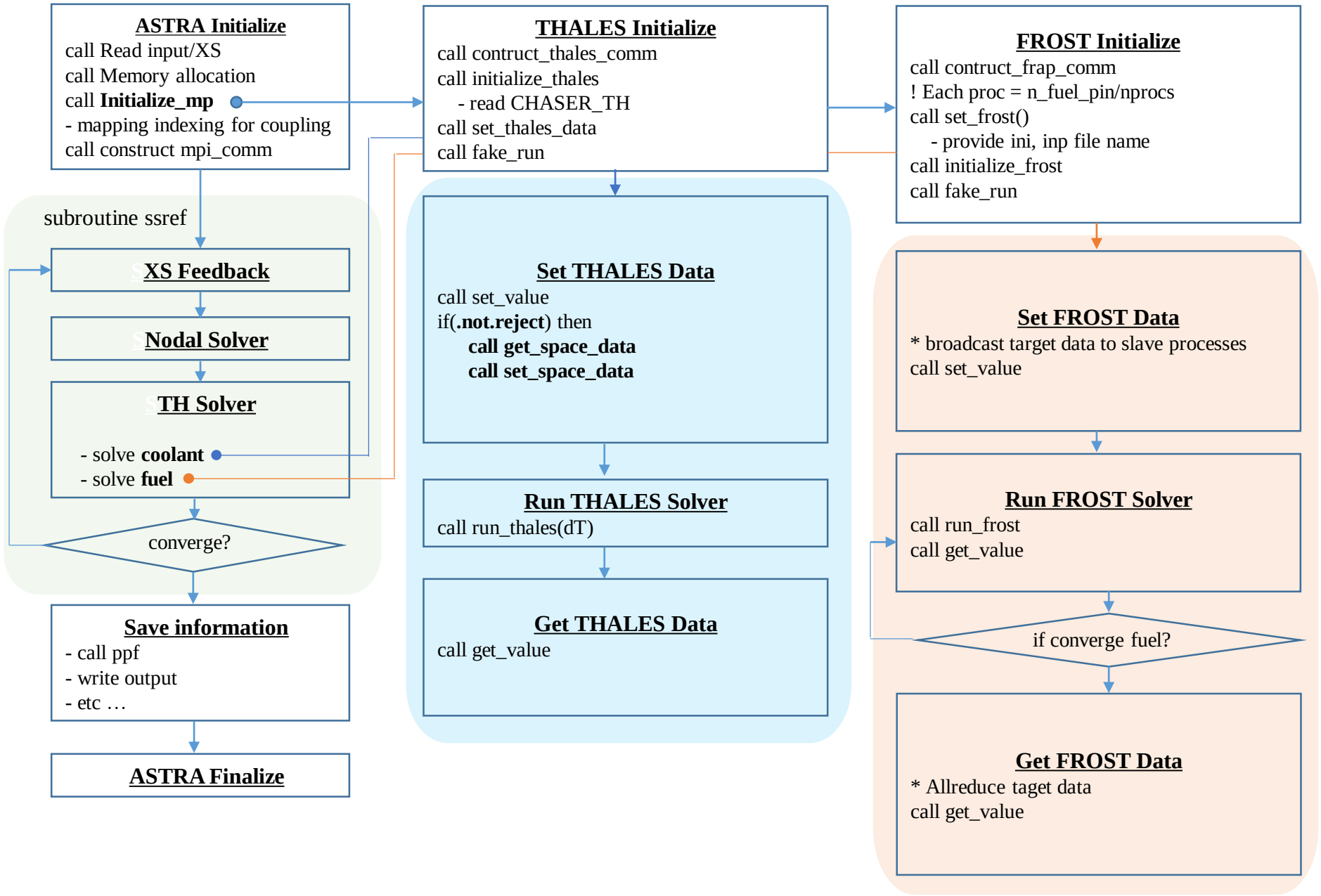


2-4. 시간 연계 개념

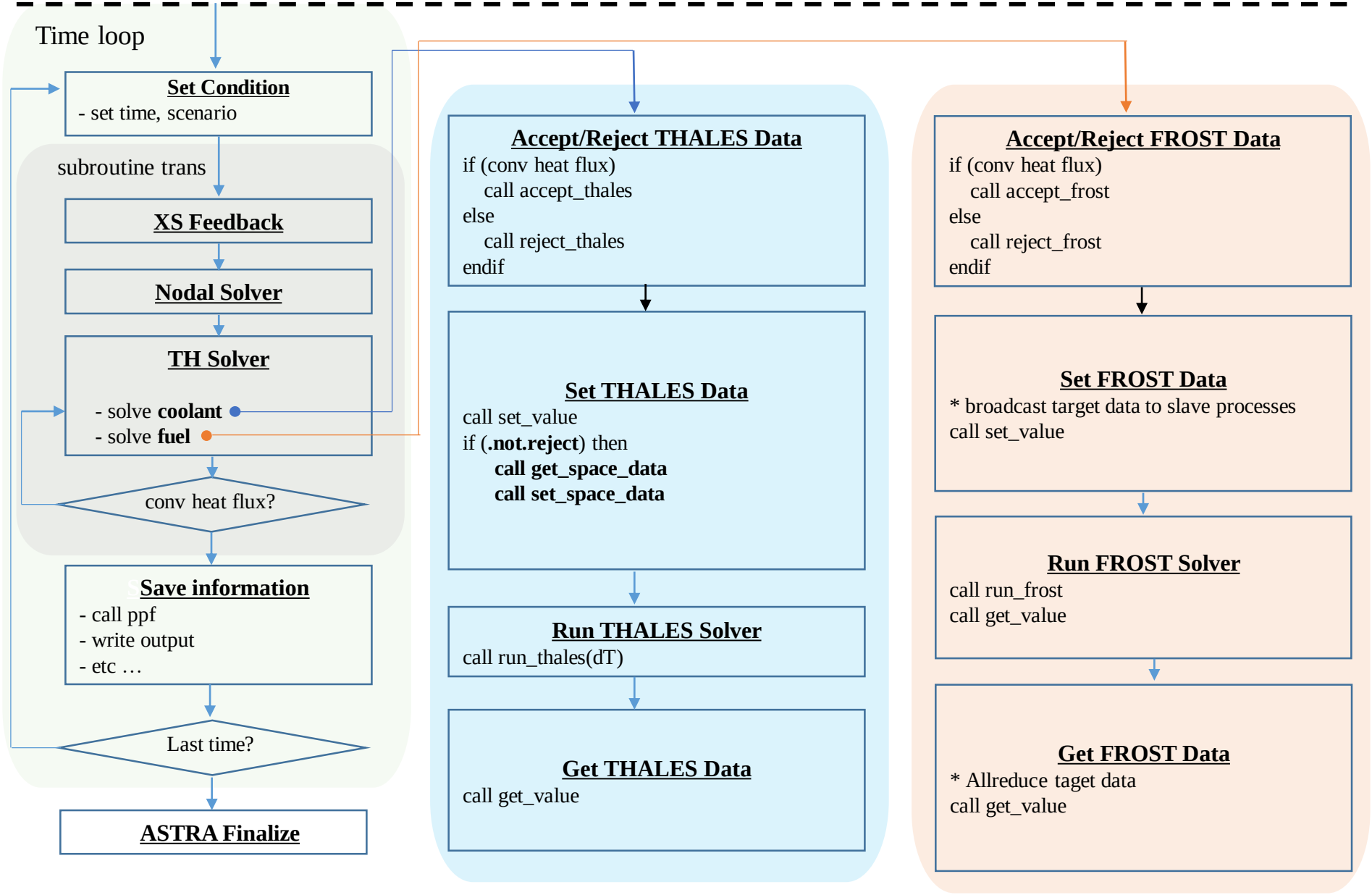


#	Time.last	dt[*]	# of comm.
1	300s	-	-
2	2000s	100.0s	17
3	2020s	0.05s	400
4	2600s	1.0s	580

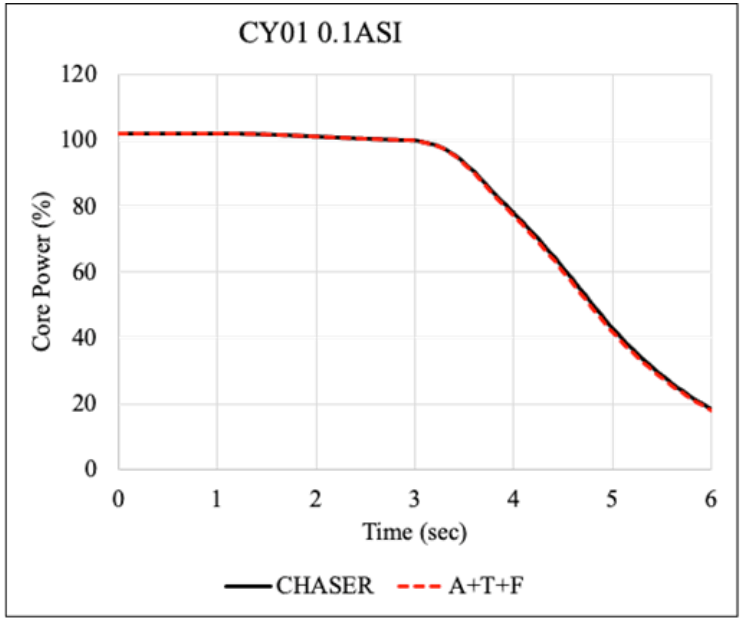
2.5 Steady state (ASTRA+THALES+FROST)

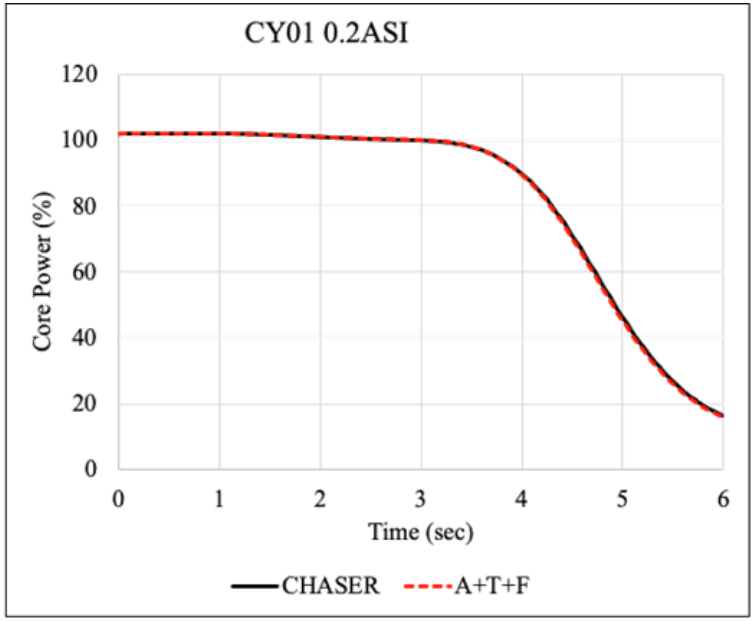


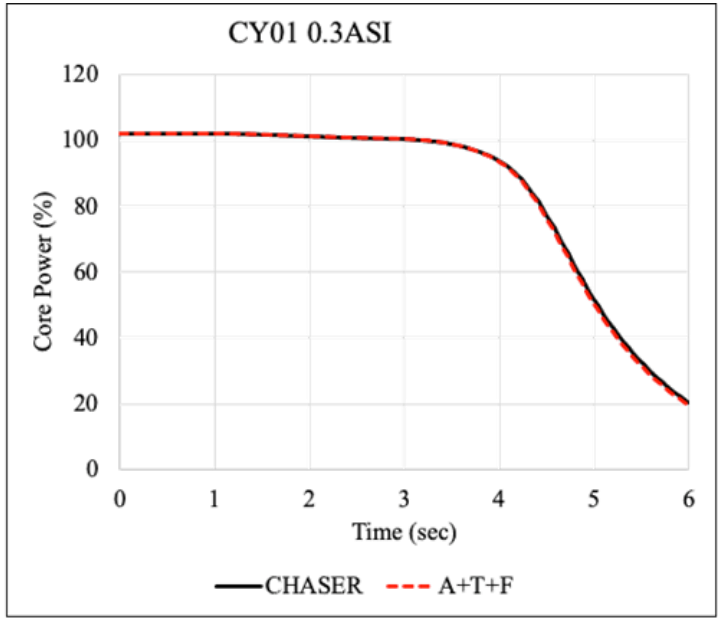
2.6 Transient state (ASTRA+THALES+FROST)



2-7. 결과 (Locked Rotor)







THANK YOU

KHNP