

원자력열수력 실험실

(Nuclear Thermal Hydraulics Laboratory)

Byongjo, Yun

School of Mechanical Engineering
Pusan National University

Members of NSTHEL

- 석사과정
 - 2인
- 박사과정
 - 4인 (부산대)
 - 1인 (하노이 공대)
- 석사 후 연수
 - 2인
- 졸업생 현황
 - 석사 1인 원자력안전기술원 선임연구원
 - 박사 1인 스위스 ETH 연구원
 - 박사 2인 한국원자력연구원 선임연구원
 - 박사 1인 한국기계연구원
 - 박사 1인 한국국방과학연구원
 - 석사 14인 한국수력원자력



원자력 열수력 연구실 (NSTHEL)

□ 기초 열수력 및 원자력 계통 실험/모델 개발

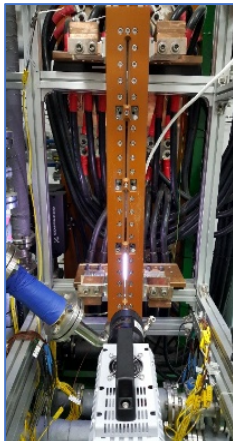
- 원전 안전성 향상 및 신안전 / 피동 계통 개발을 위한 열수력 실험
- 단상 및 2상 유동 측정 기술 개발
- 1차원 및 다차원 열수력 해석 모델 개발 및 코드 적용 (기계학습 기술 적용)

□ 원자력 시스템 전산유체역학 해석

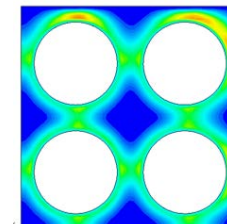
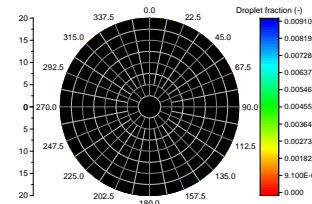
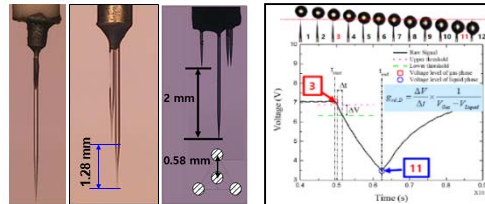
- CFD 적용을 위한 기초 열수력 및 2상유동 열전달 모델 개발 실험 및 해석
- 전산유체역학 코드 원전 해석 적용 기술 개발 및 응용



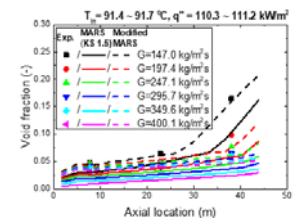
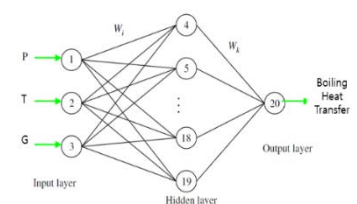
응축 및 비등 열전달 실험



광섬유센서 2상유동 측정기술 개발

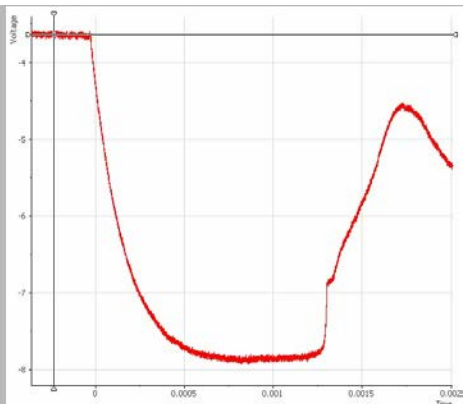
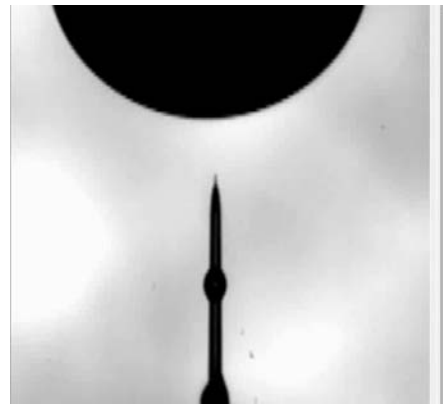
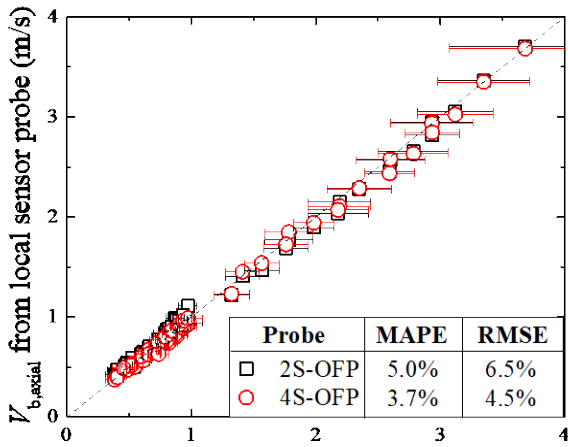
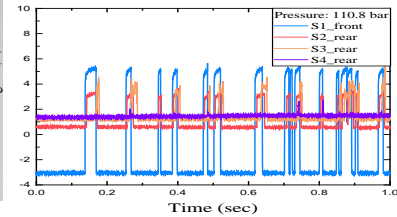
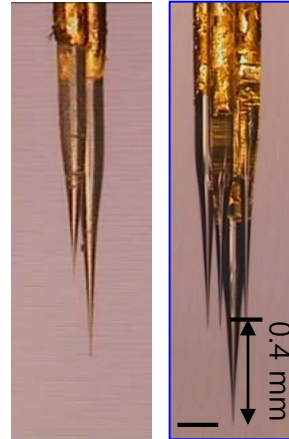
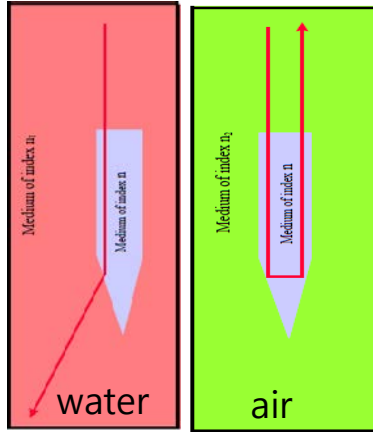
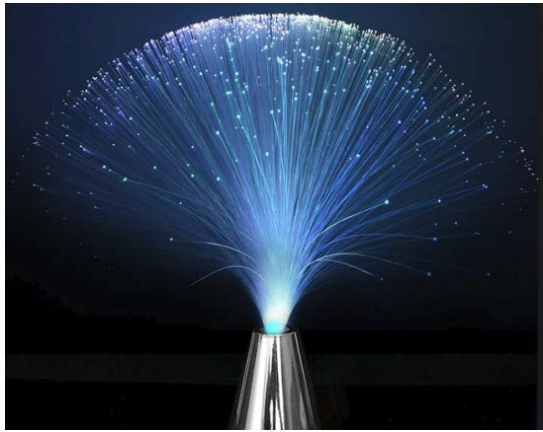


열수력 모델 개발 및 1D, CFD 코드 적용



2상유동 측정기술 개발 (1)

- 단일 및 다중 광섬유 센서 측정기술
 - 기포 및 액적 인자 측정

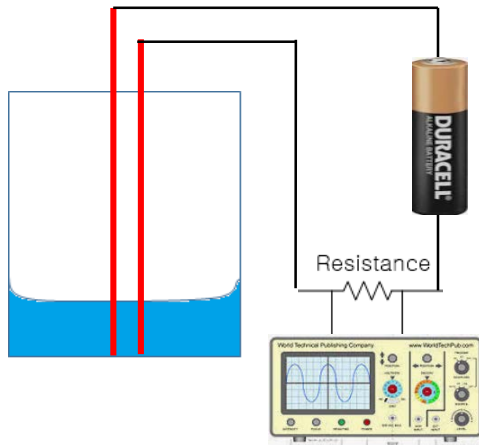


<기포 속도 측정>

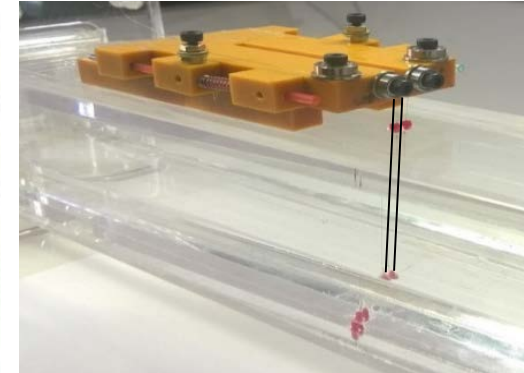
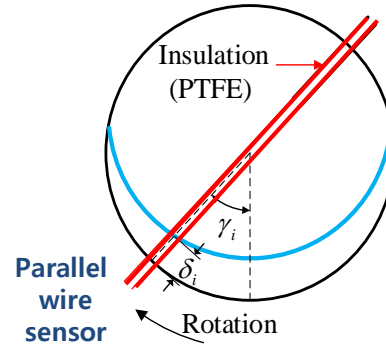
<액적 변수 측정>

2상유동 측정기술 개발 (2)

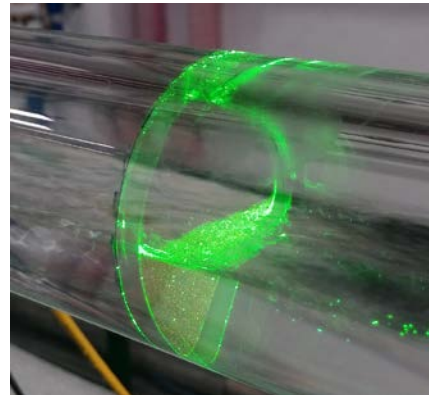
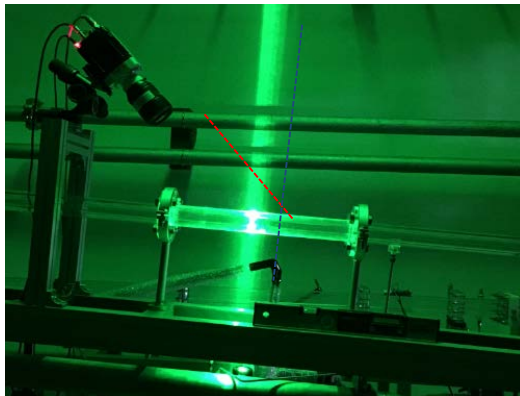
■ 레이저 및 임피던스 2상유동 측정 기술



<Concept of impedance sensor>



<Parallel wire impedance sensor for the thick liquid film>



<laser를 이용한 원형관 내부 2상유동 측정>

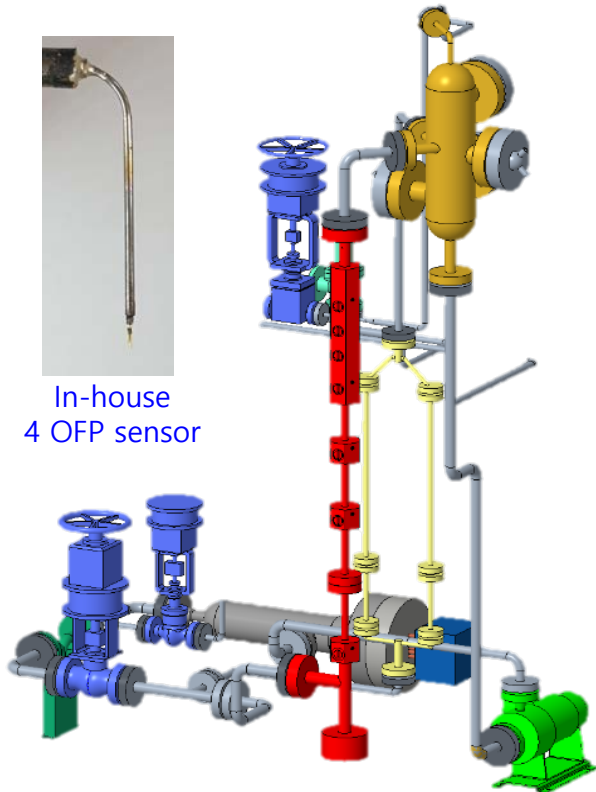
열수력 모델 개발 연구 (1)

■ 비등 열전달 실험 및 모델 개발

- Max. operating P ,T and V : 107 bar, 315°C, 5 m/s
- Development of subcooled boiling flow models for the 1D and CMFD codes



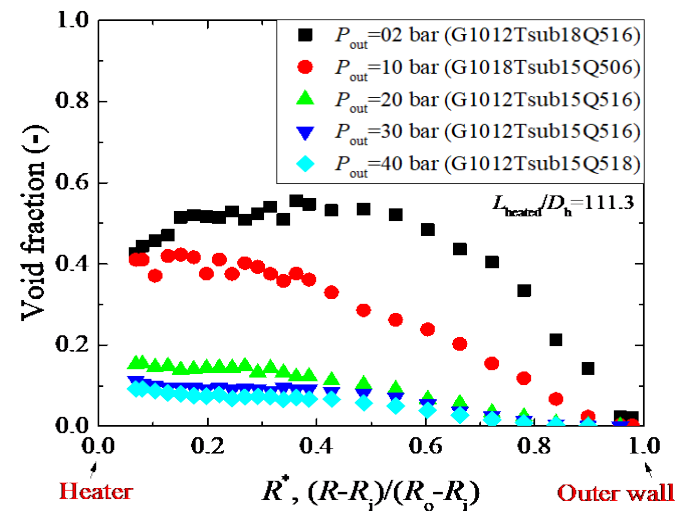
In-house
4 OFP sensor



<PHIBO 3D view>



<PHIBO Facility>

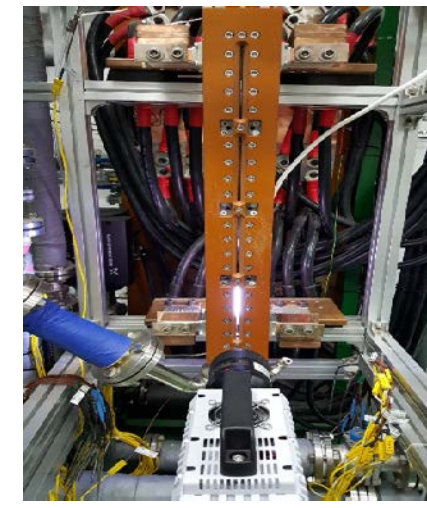


열수력 모델 개발 연구 (2)

■ 모델 개발 실험



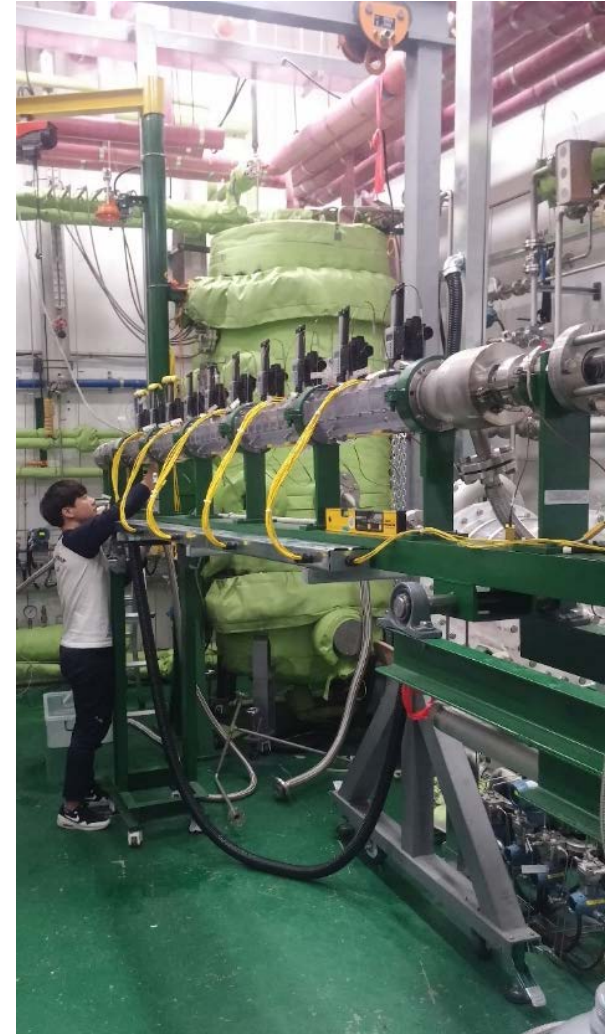
<4x4 bundle subcooled boiling>



<CHF for research reactor>



<Boiling facility of an inclined downward wall-heated rectangular channel for core catcher>

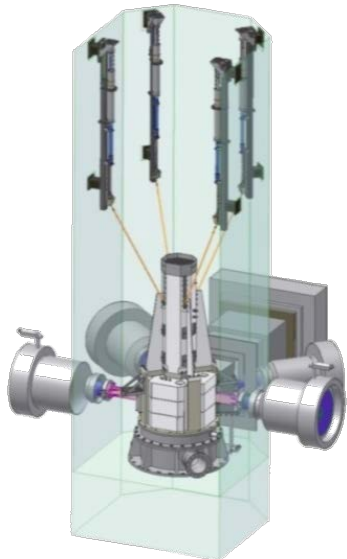
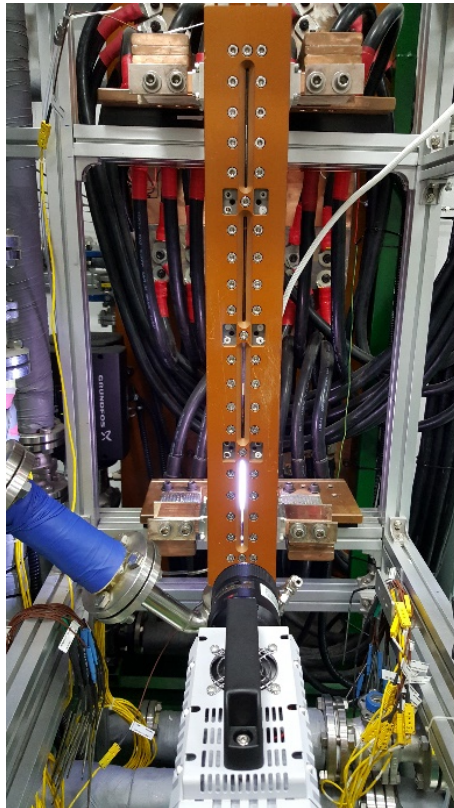


<Inclinable condensation facility for passive Aux. feed system of APR1400>

원자로 안전성 향상 및 신안전 계통 개발 연구 (1)

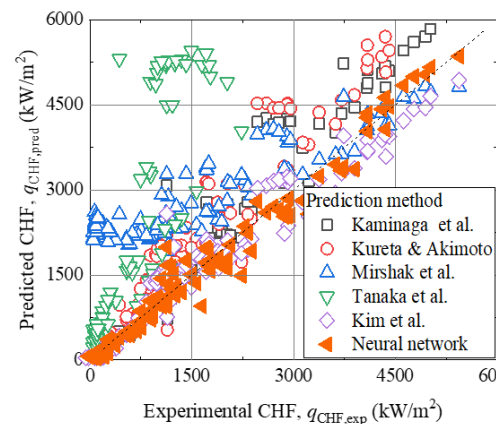
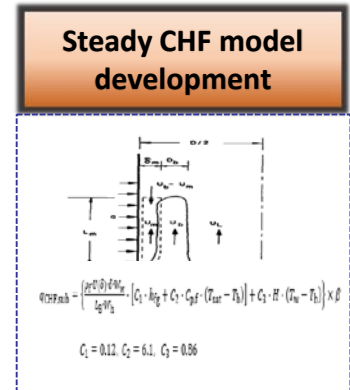
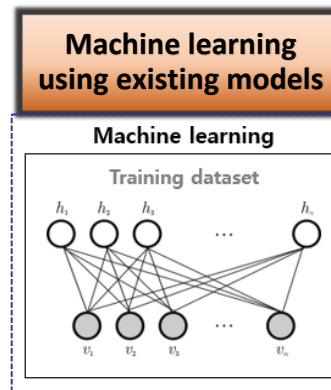
■ 기장 연구로 임계열유속 인허가 연구

- 요르단 원전 및 기장 연구로 인허가 실험자료 생산 및 모델 개발

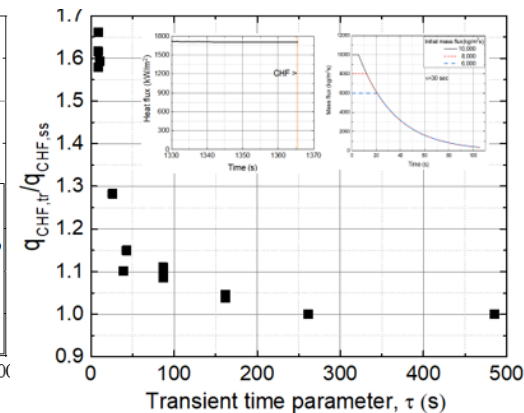


<Research Reactor>

<Test section for plate-type fuel>



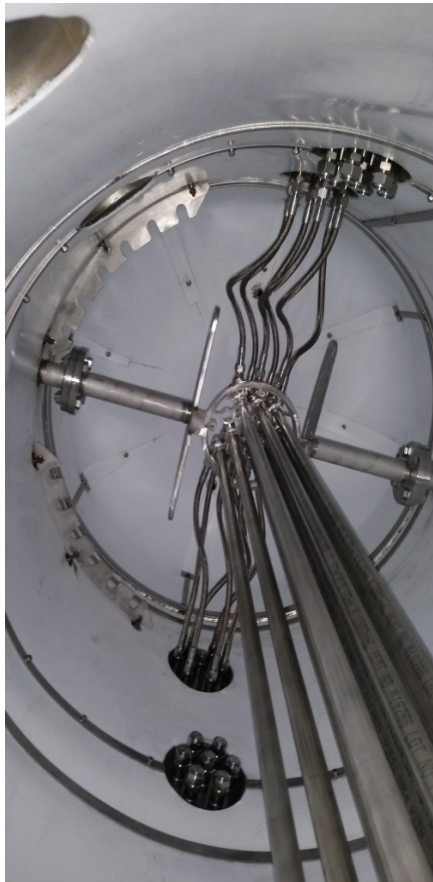
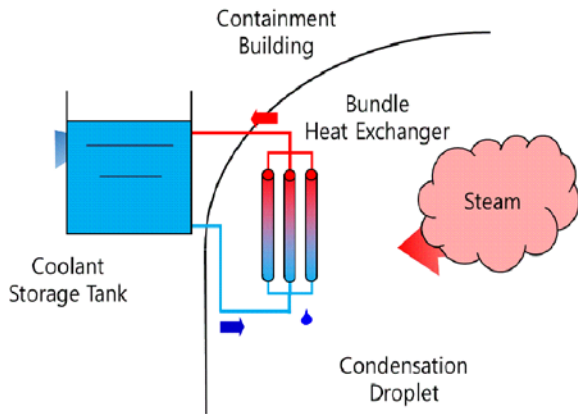
<Local steady CHF model>



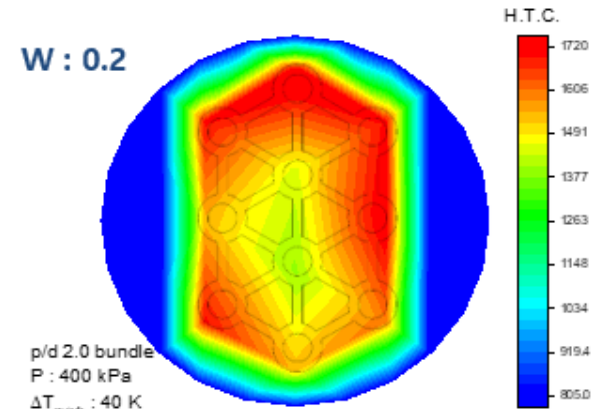
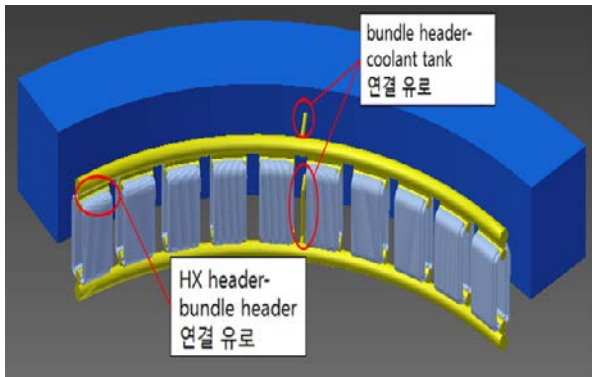
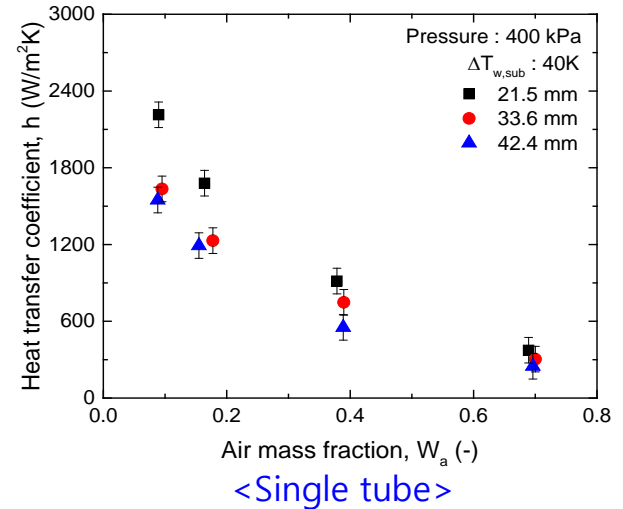
<Flow transient CHF>

원자로 안전성 향상 및 신안전 계통 개발 연구 (2)

- 신형원전 및 소형 모듈원전 피동안전계통 개발 연구
 - 격납용기 냉각계통 열교환기 개발 연구



<Containment Simulating Tank>



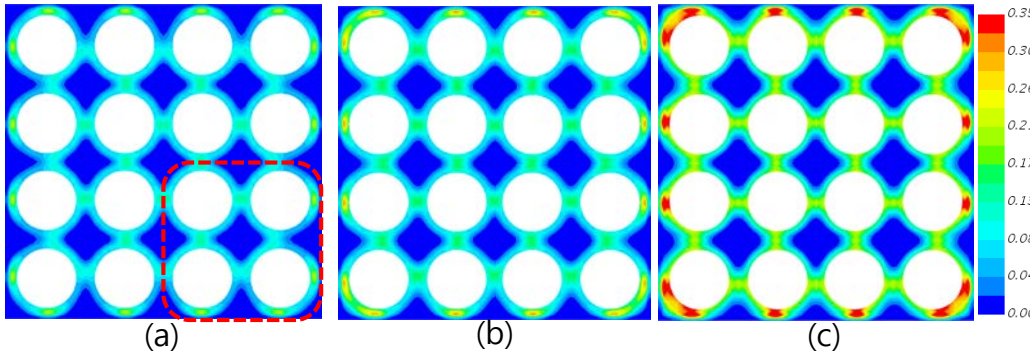
CMFD 원자력 해석 적용 연구

Research Goal

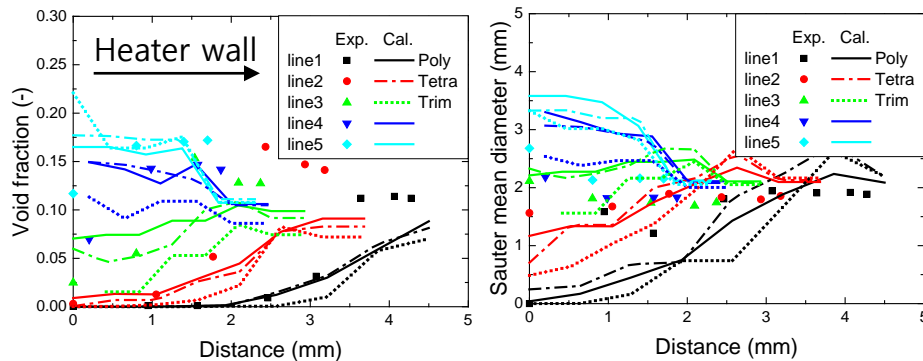
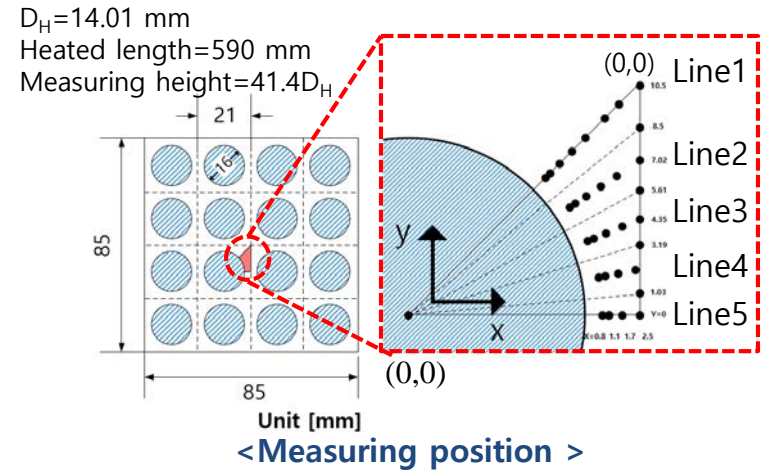
- Boiling heat transfer analysis using CFD Code (STAR-CCM+)

Analysis Results

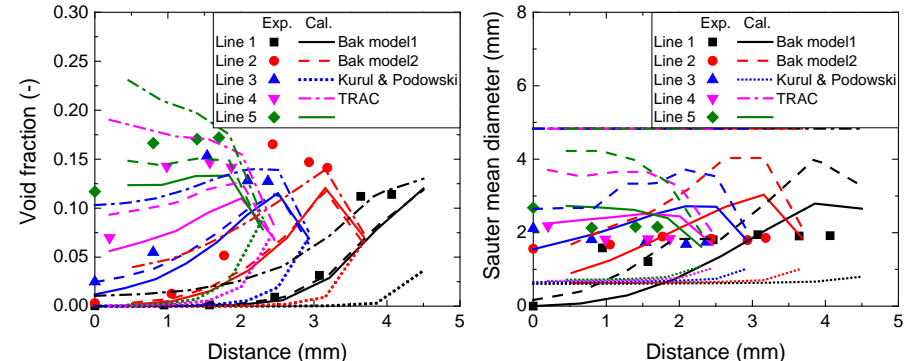
- Analysis condition : $G=310\text{kg/m}^2\text{s}$, $T_{in} (\Delta T_{sub})=97.5(22.5) \text{ }^\circ\text{C}$, $q''=200\text{kW/m}^2$



<Void fraction Contour (a) $q'' = 190 \text{ kW/m}^2$,
(b) $q'' = 210 \text{ kW/m}^2$, (c) $q'' = 230 \text{ kW/m}^2$ >



<Grid sensitivity analysis result>



<Analysis result with various bubble size models >