

Molten Salt Reactor – Is It the Game Changer?

Doctoral Candidates' Day 2023

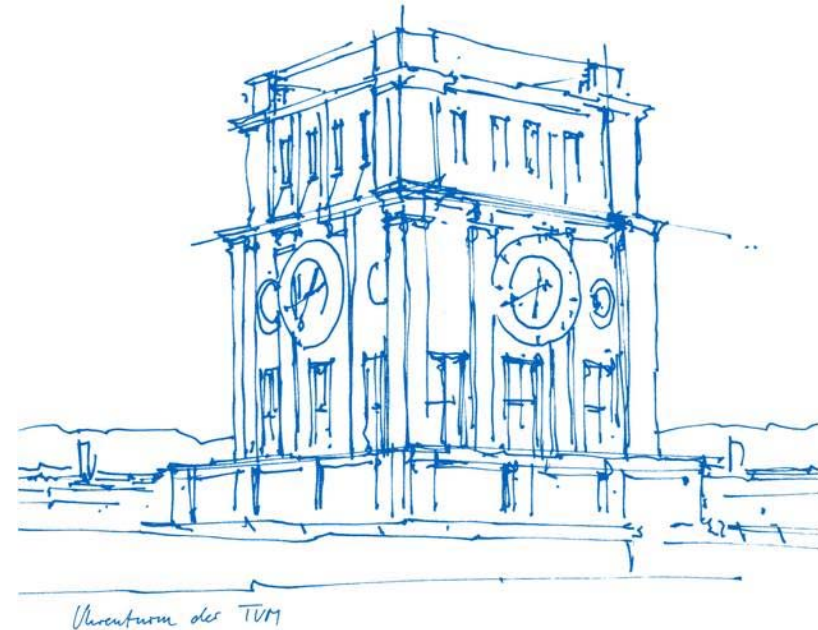
Tianqi Li

Technische Universität München

TUM School of Engineering and Design

Lehrstuhl für Nukleartechnik

München, 16.03.2023

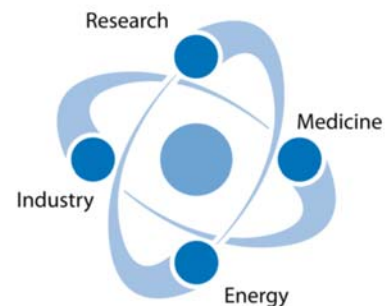


My field of expertise

Chair of Nuclear Technology

Prof. Rafael Macián-Juan

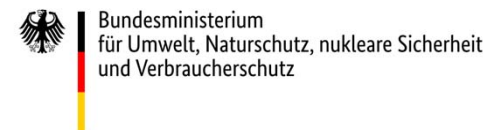
- Nuclear Reactor Safety Analysis of Current and Future Reactor Designs
- Experimental Two-Phase Flow Thermal-hydraulics
- Fuel Behavior Analysis
- Development and Design Optimization of the Dual Fluid Reactor(GFR) Concept
- Medical Applications



<https://www.epe.ed.tum.de/ntech/home/>

My research field since 2020

Thermal-Hydraulics and related Safety Analysis of Innovative Nuclear Power Plant Design
System codes for plant behaviors

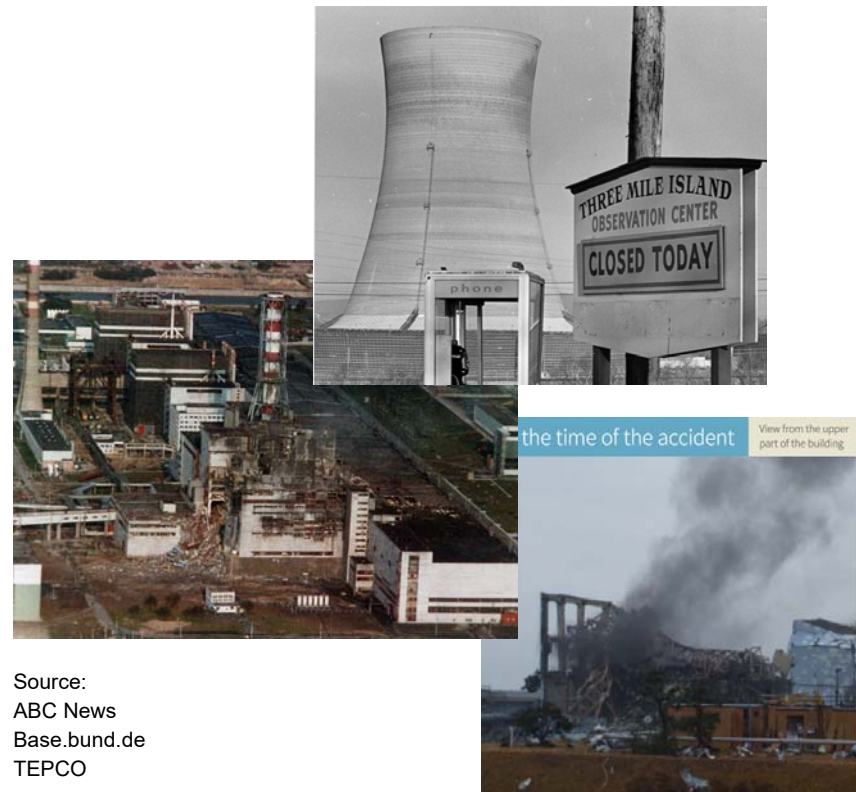


Meltdown - severe accidents

International Nuclear and Radiological Event Scale (INES)

Windscale	1957	INES 5
Three Mile Island	1979	INES 5
Chernobyl	1986	INES 7
Fukushima Daiichi	2011	INES 7 + INES 3

Design flaws, human error, the nature of LWR



Source:
 ABC News
 Base.bund.de
 TEPCO



Evolution of reactor technology

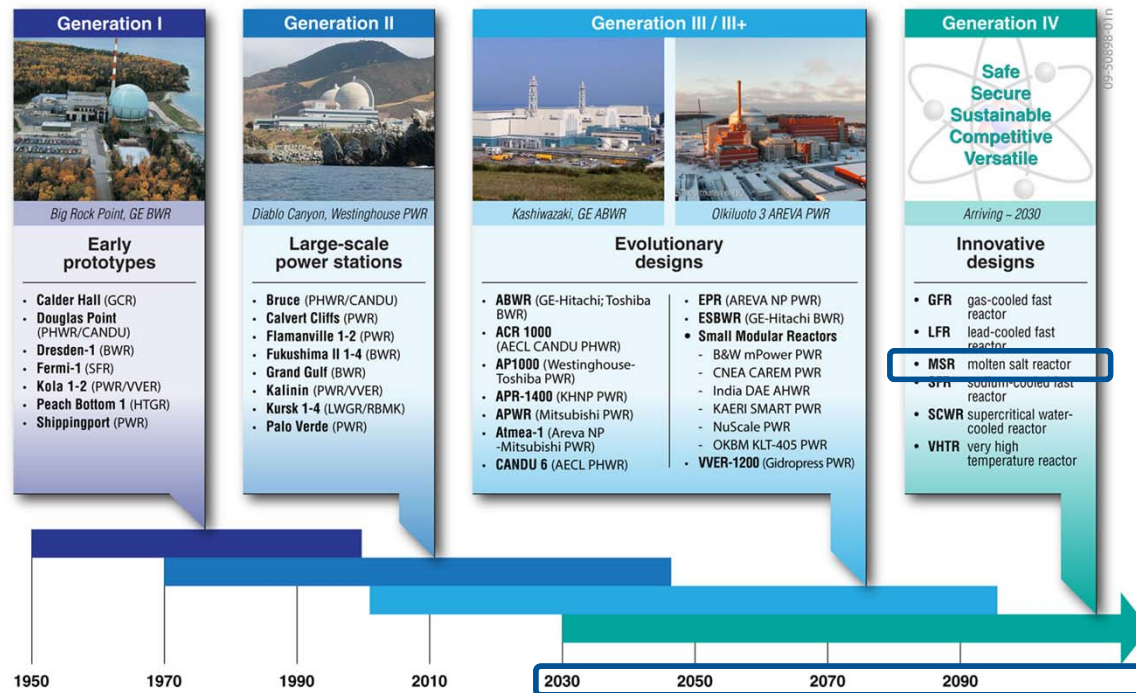
Generation IV reactors start from 2030

Gen IV International Forum founded in 2001

14 Members

Argentina*	Japan
Australia	Republic of Korea
Brazil*	Russian Federation
Canada	Republic of South Africa
People's Republic of China	Switzerland
Euratom	United Kingdom
France	United States

Source: gen-4.org



Source: gif.jaea.go.jp

Molten salt reactor (MSR) - history

Aircraft Reactor Experiment (ARE)

1946 – 1961

AEC and U.S. Air Force



Molten Salt Reactor Experiment (MSRE)

1965 – 1969

Oak Ridge National Laboratory



Molten salt reactor (MSR) - technology

Safety

- Liquid fuel
- Inherent stability
- Passive cooling

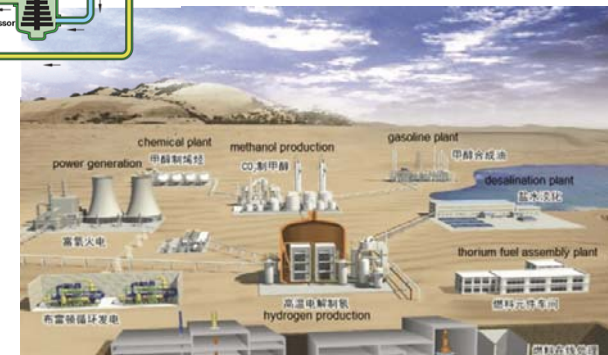
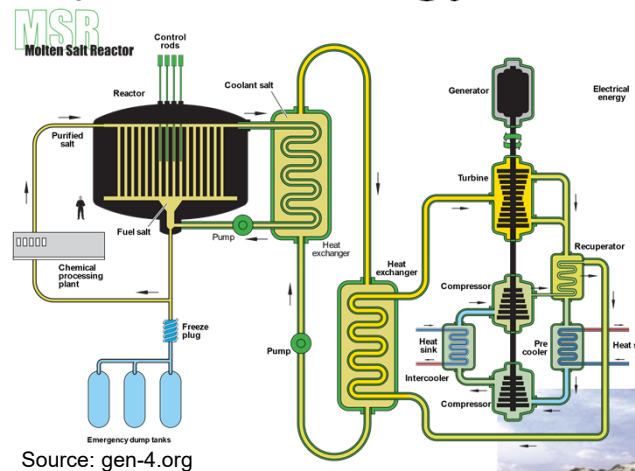
Economy and Environmental benefits

- High efficiency
- Fuel cycle
- Thorium based fuel
- Actinide Burning

Diversity

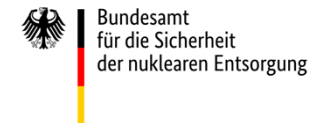
- Location
- Fuel flexibility
- Application

Nonproliferation



Opinion of the Federal Office

BASE: “Since 2011, the Atomic Energy Act has set a shutdown date for each nuclear power plant.”



Isar-2 and GKN-2 as "Einsatzreserve bis Mitte April 2023"



As to Gen IV... cautious

- no plans to build or deploy
- not ruled out the possibility
- preserving the know-how
- participation in research and international collaborations

One of the projects on software simulation

Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH

“has been Germany's central expert organisation in the field of nuclear safety since 1977.”

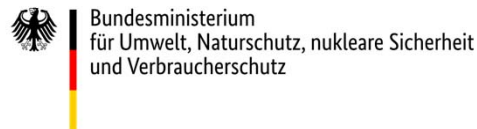


ATHLET (Analysis of THERmal-hydraulics of LEaks and Transients)

“is being developed by GRS for the analysis of the whole spectrum of leaks and transients in PWRs and BWRs.”



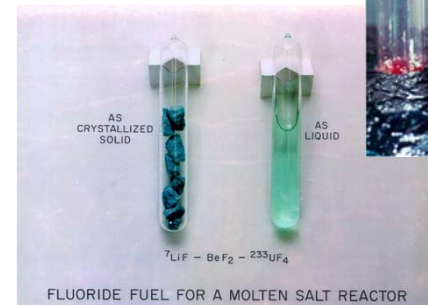
Source: grs.de



Further development and validation

Initiative for MSR

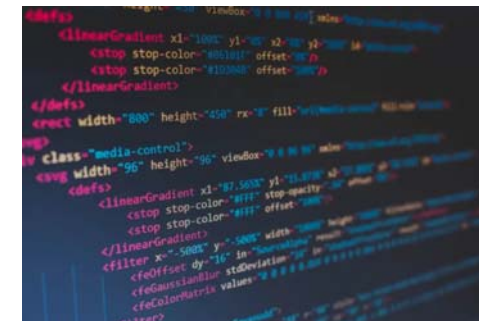
- Development of code
- Implementation of physical properties and neutronics
- Development of MSR Model
- Simulation for steady states and transients
- V&V and Benchmark



Source: nrc.gov

Further utilization (potential use in solar plants)

Challenges: Lack of information for Modelling, Complex fluid dynamics, Coupling of neutronics and thermal-hydraulics, limited experimental data for V&V...



Source: google



Thank you

Tianqi.li@tum.de