

# The ALLEGRO Experimental Gas-Cooled Fast Reactor Project

## Summary / Objectives:

The webinar presents the main design features of the ALLEGRO nuclear reactor demonstrator as developed in the frame of the European V4G4 Consortium “V4G4 Centre of Excellence” associating nuclear research organizations from the Czech Republic, Hungary, Poland, Slovakia and France. The presentation provides an overview of the existing concepts of ALLEGRO, goals of the development, specific design solutions, and the safety approach and safety characteristics of ALLEGRO, touching the most important aspects of the demonstrator. Latest developments associated with both the use of UOX fuel and the new safety features are briefly presented as well. The remaining research challenges are summarized in the light of the present technology understanding to highlight the present status of knowledge and further steps to be pursued.

## Meet the Presenter:

**Dr. Ladislav Bělovský** works at the ÚJV Řež, a. s., Husinec-Řež close to Prague, Czech Republic as a senior engineer and has over 30 years of experience in nuclear energy research. At ÚJV Řež, Dr. Bělovský participates in the development of the helium-cooled demonstration Fast Reactor ALLEGRO in the frame of the international association “V4G4 Centre of Excellence” in the following areas: 1) Design & Safety of the reactor, 2) Related R&D focused on safety, helium technology and material research. His background in the Czech republic and France in the period from 1988 to 2011 is mainly characterized by activities in the development & application of computer codes for modelling of LWR fuel behavior in design basis & severe accident conditions.



## 1. A first ever GFR demonstrator ALLEGRO

The purpose of a first ever GFR demonstrator ALLEGRO is verification and validation of the fuel, proving that it works safely and getting the experience of gas cooled fast reactor.

### Why to have a first ever GFR demonstrator ALLEGRO



- To establish **confidence** in the GFR technology with the following objectives:
  - A) To **demonstrate the viability** in pilot scale & **qualify specific GFR technologies** such as:
    - **Core behavior & control including fuel**
    - **Safety systems (decay heat removal, ...)**
    - **Gas reactor technologies (He purification, refueling machine ...)**
    - **Integration of the individual features into a representative system**
  - B) To contribute (by Fast flux irradiation) to the **development of future fuels** (innovative or heavily loaded in Minor Actinides)
  - C) To provide test capacity for high-temp components or heat processes
  - D) To dispose of a first validated Safety reference Framework
- Power conversion system is currently not required in ALLEGRO.

## 2. The main technological challenges of ALLEGRO:

ALLEGRO will touch the challenges concerning the high temperature resistant, safety, fuel handling and so on.

### ALLEGRO faces the main tech. challenges of CEA GFR2400



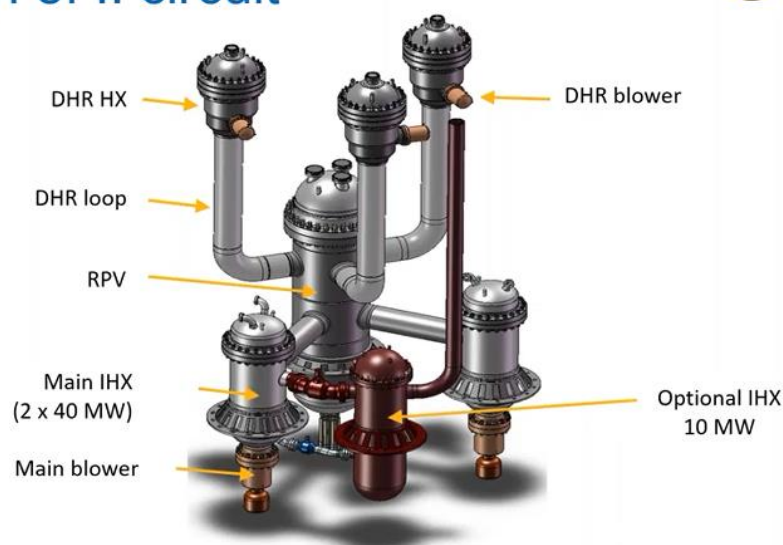
- **High-temperature resistant (refractory) fuel (tolerant to overheating)**
  - (U,Pu)C in SiCf-SiC tubes
- **Safety systems – Reliable shutdown and decay heat removal (DHR)**
  - With use of natural circulation
- **Fuel handling machine**
  - Under He flow to cool the fuel
- **He/gas main heat exchanger**
  - Large (?) dimensions
- **Materials & components & helium-related technology**
  - Heat shielding, He sealing, He purification, He recovery, ...
- **+ one challenge related to ALLEGRO only:**
  - Driver core based on the **existing SFR** technology

### 3. Pre-conceptual design of ALLEGRO:

Characteristic of Pre-conceptual design of ALLEGRO are:

- Two main circuits and loops, which would be a safer solution
- Three decay heat removal heat exchanger using the Chimney effect
- Optional gas heat exchanger

#### ALLEGRO CEA 2009 (75 MWt): Design of I. circuit



### 4. Advantages and disadvantages of the latest version of ALLEGRO:

The latest version of ALLEGRO has advantages such as core cooling without any active system (except some cases), no more LOFA transients, etc. The disadvantages are complex management for start-up and shutdown, etc.

#### ALLEGRO CEA 2010: Innovative option 3

##### ■ ADVANTAGES (MOX ALLEGRO 530 °C):

- 1) **Increase of inertia:** Core cooling (few hours) without any active system except the SCRAM actuation and the depressurisation of the secondary circuit (could be passive, and even without depressurization the “grace delay” would be significantly longer than few minutes).
- 2) **No more LOFA transients:** This initiating event is no more possible because the primary blowers are driven by the secondary circuits turbomachinery.
- 3) **Limitation of water ingress risk:** Because of gas in the II. circuit


##### ■ DISADVANTAGES:

- 1) **Operation:** Complex management of the single shaft for start-up and shutdown
- 2) **Technology:** Very complicated to make it feasible (rotating seal in GV)
- 3) **Once the TM stops in passive operation it cannot restart**

## 5. ALLEGRO V4G4 Centre of Excellence:

V4G4 Centre of Excellence is an association system for ALLEGRO preparatory phase between SK, CZ, HU, PL and FR. Each of them is in charge of an assigned development topic.

### ALLEGRO V4G4: Background



- 2002-2010: CEA - Development of GFR2400 & ALLEGRO 50-75 MWT
- 2010-2025: CZ-HU-SK- PL- Preparatory phase of ALLEGRO:
  - 05/2010: MoU: Prepare documents (pre-conceptual design) for decision makers (ALLEGRO Yes/No)
  - 08/2013: „V4G4 Centre of Excellence” - Association (legal entity) founded in SK
 

VUJE Trnava (SK):	Responsible for Design & Safety (with ÚJV)	Industry
ÚJV Řež (CZ):	Helium technology, R&D and Experimental support	
MTAEK Budapest (HU):	Fuel & Core	Research
NCBJ Swierk (PL):	Materials (?)	
Associated members:	CEA (FR) 2017, CV Rez (CZ) 2018	
- ALLEGRO Preparatory phase by V4G4 CoE:
  - Pre-conceptual Design: Revision of ALLEGRO CEA 2009 → New ALLEGRO V4G4 concept (2020-25)
  - Safety: Core coolability (passive mode)
  - R&D and Exp. support: Under formulation (helium technologies underway)

## 6. Time schedule overview:

ALLEGRO project is planned to proceed with the time schedule below:

- 2020 : Providing pre-conceptual design
- 2025 : Providing conceptual design
- 2026 - : Decision to continue and post-conceptual phase

