MAX-PLANCK-INSTITUT
FÜR PLASMAPHYSIK

Pellet Sources: Plan B

ASDEX Upgrade

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EUROfusion

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Background

Pellet Launching System for JT-60SA designed to host up to three pellet sources

Contract to deliver 2 sources has been awarded to PELIN (in 2020):

- 1 source for fuelling purpose
- 1 source for ELM pacing purpose

Initial agreed delivery date: Oct 2021

Delay in manufacturing / testing: system still not ready for shipment.

Additional issue:

PELIN is a company located in St. Petersburg, sanctions due to Ukrainian crisis may apply.

Motivation

Contract for centrifuge system has been awarded to SENER

Pellet Launching System completion and commissioning is planned at IPP pellet lab (mimicking QST environment)

Pellet source is required to assess centrifuge system:

→ How to get pellets (at least) for assessment of centrifuge system?

Options:

1. Replica of ASDEX Upgrade cryostat
2. Batch extruder with big reservoir
3. Combine screw extruder technology with cutter technology

Fall back option 1: replica of AUG cryostat

This option would provide pellet with size ø 2.4 mm

Potential:

- Up to ~80 fuelling size pellet size (~4.5% of JT-60SA need for 100s)

Pro:

- Assessment of centrifuge possible w.r.t. stop cylinder adjustment, funnel and ex-vessel guiding tube functionality as well as pellet diagnostics
- Basic PLS commissioning possible: centrifuge, one single pellet source and MasterPLC

Con:

- Ice temperature lower than for screw extruder (→ stop cylinder issue)
- Multi pellet source commissioning not possible
- Unfavourable for operation at JT-60SA due to LHe- cooling and low number of pellets

Fall back option 1: replica of AUG cryostat actual status

A remaining cryostat from pellet source development in mid eighties is being restored:

- Some defective parts has been replaced (e.g. leaky bellow, temperature sensor)
- Currently: extrusion nozzle 1.9 mm (square) to be extended to 2.4 mm
- Proof of principle was successful

Next steps:

- Enhance test bed PLC: → temperature control and data acquisition

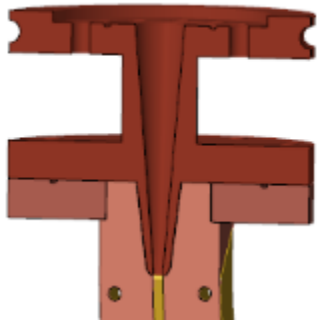
Fall back option 2: batch extruder with big reservoir

Chose big reservoir in order to create an “apparent steady state“

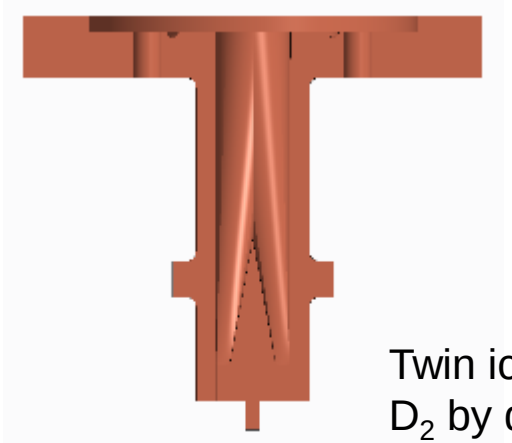
Challenge: provide required extrusion speed

Result from ORNL-IPP cooperation :

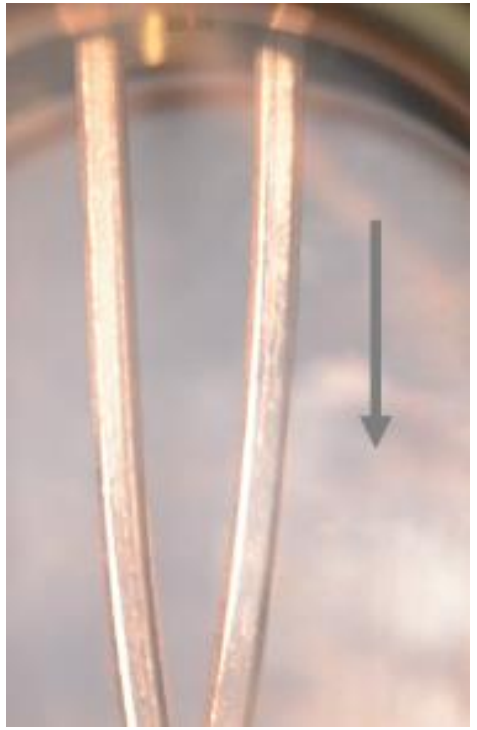
- Dual nozzle setup could achieve extrusion speed suitable for up to 45 Hz@ Ø2.4 mm



Single 1.9 mm opening nozzle used in initial batch extruder experiments with a downstream attached channel.



L.R. Baylor et al., SOFE2021



Twin ice rod produced from solid D_2 by dual 1.9 mm extrusion forming ribbons at 14 K

Fall back option 3: combine screw extruder with cutter technology

Complete replacement of PELIN technology:

Combine technology foreseen for ITER (by ORNL) with proven cutter technology from ASDEX Upgrade

Moreover: take benefit from a task within WPTFV:

TFV-T.01-04-T9: “Technical development of a potential alternative pellet injector design”

→ Required for DIPAK-PET (DEMO fuel cycle test bed)

Conclusion

There are severe risks that pellet sources from PELIN will not arrive.

In a first step, activities have been launched in order to open a way to enable the assessment of the centrifuge (provided by SENER) at IPP lab.

Point in time not yet clear, when a decision for further steps is required. But the time window is going to close.