



UMo dispersion fuels : Status and results of Qualification Programs

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Outline

- *World-wide main activities on UMo dispersion fuels*
- *US-RERTR program status and results*
- *French Group program status and results*
- *Synthesis results and burn-up limitations*
- *Conclusions*



World-wide main activities on UMo-Al dispersion fuel

| | | FE and FA tested | | Process |
|-----------|---------------------------|----------------------------|------------------------|-----------|
| | | Plate type | Pin type | |
| USA | ANL | Mini-plates | -- | Rolling |
| France | CEA* | Full-sized plates | -- | Rolling |
| Argentina | CNEA | Full-sized plates | -- | Rolling |
| Russia | RDIPE/IPPE VNIINM/NCCP | IRT type FA (tube type) | Mini-pins & Pins FA | Extrusion |
| Canada | AECL | -- | Mini-pins | Extrusion |
| Korea | KAERI | -- | Pins FA | Extrusion |

* For French Group (CEA-AREVA Group)

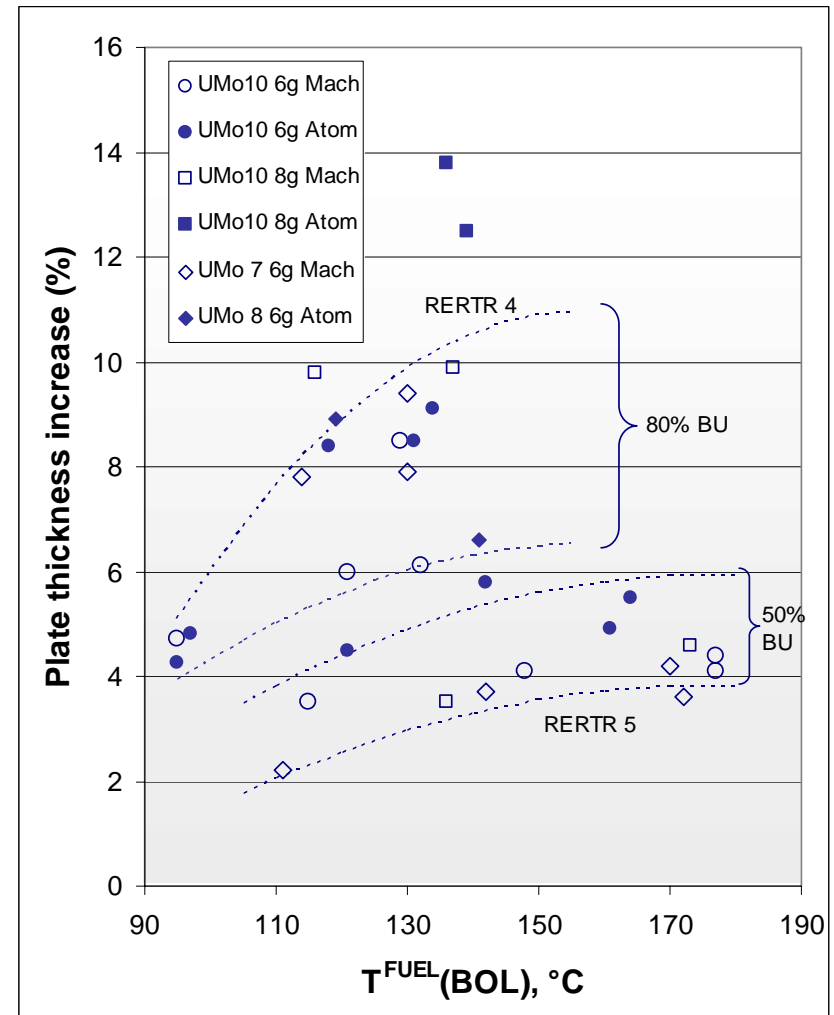
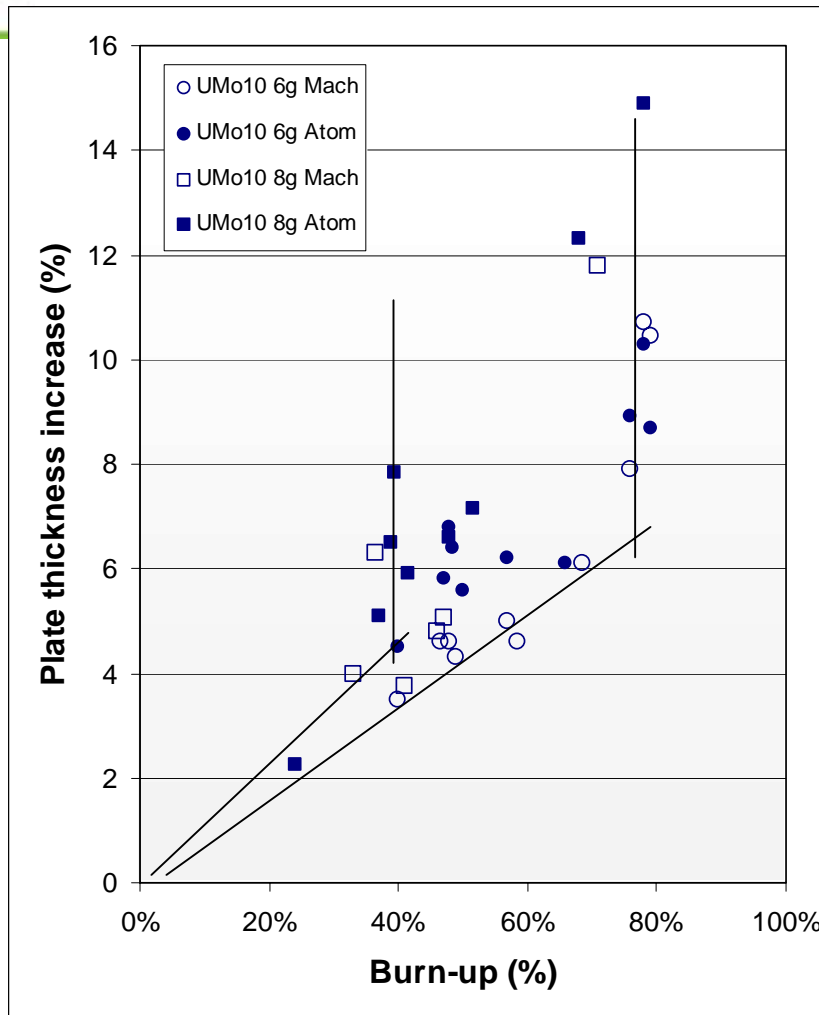


US RERTR Program on UMo Mini-plates: Status

| | RERTR-1,-2 | RERTR-3 | RERTR-4,-5 |
|--|--------------------------------------|----------------------------------|--|
| UMo Powder (6-10 wt% Mo) | Gr, At 4 g/cm³ | At 8 g/cm³ | Mach, At 6-8 g/cm³ |
| Max Heat Flux at BOL | 50-70 W/cm² | 400 W/cm² | 210-320 W/cm² |
| BOL Clad Temp. Coolant velocity | 65-70°C 9 m/s | 150°C 6 m/s | 130-175°C 4 m/s |
| Duration of experiment | 94-232 days | 48 days | 116-230 days |
| Max BU at EOL | 40-70% | 40% | 50-80% |
| Status of the experiment | Complete | Complete | Complete |



US RERTR-4,-5 mini-plates experiments: Results



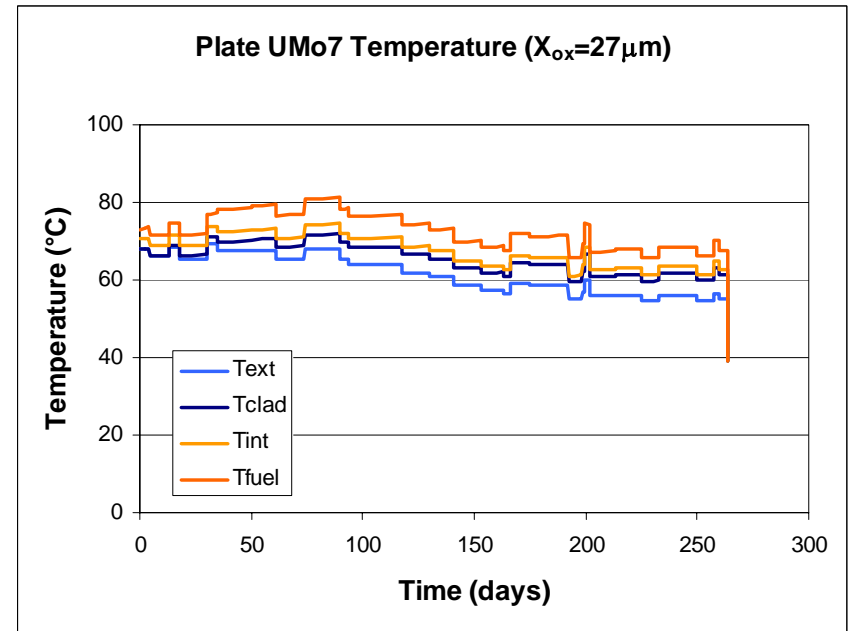
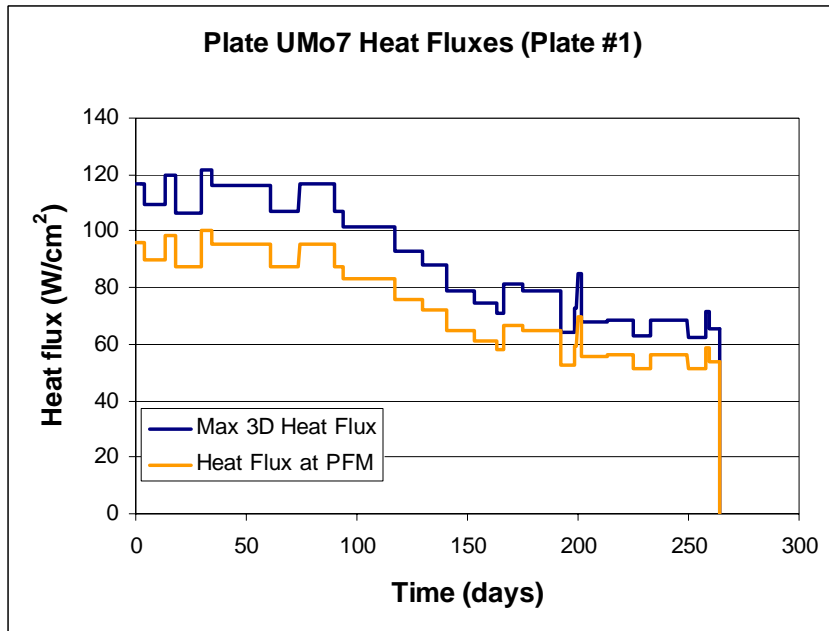


French Program on full-sized plates: Status

| | IRIS-1 | IRIS-2 | FUTURE |
|---|--------------------------------------|---|--|
| UMo Powder (7-9 wt% Mo) | Ground 8 g/cm³ | Atomized 8 g/cm³ | Atomized 8 g/cm³ |
| Max Heat Flux at BOL | 140 W/cm² | 240 W/cm² | 340 W/cm² |
| BOL Clad Temp Coolant velocity | 75°C 9 m/s | 100°C 9 m/s | 130°C 12 m/s |
| Duration of experiment | 240 days | 60 days | 40 days |
| Max BU at EOL | 67% | ~ 40% | 33% |
| Status of the experiment | Complete | Stopped $\Delta e > 250 \mu\text{m}$ | Stopped $\Delta e = 180 \mu\text{m}$ |

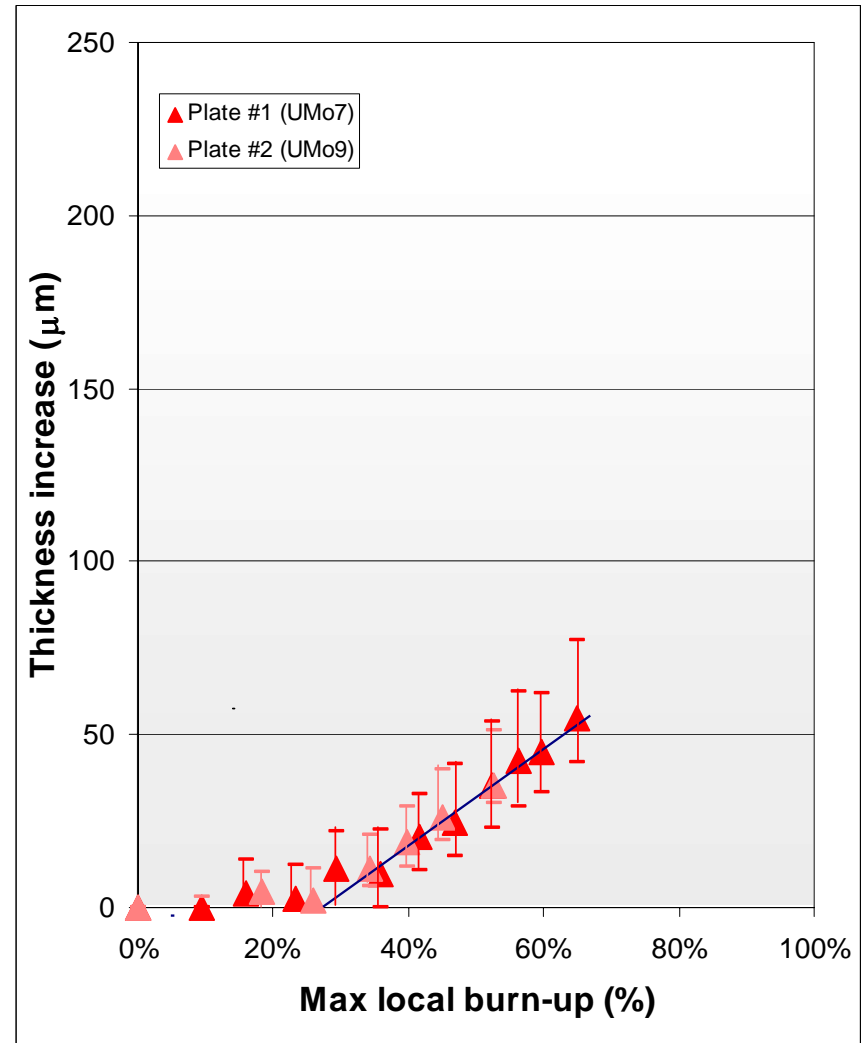
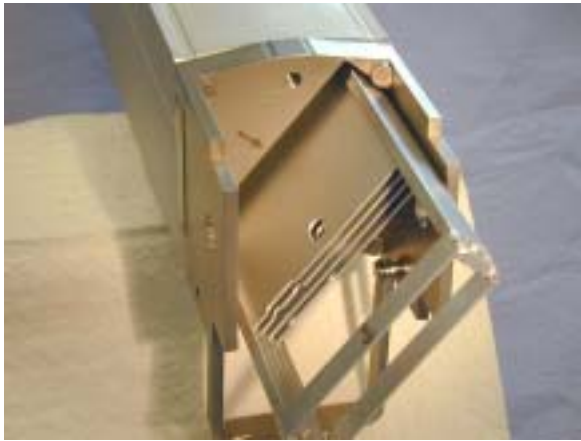


IRIS-1: Heat flux and Temperature histories

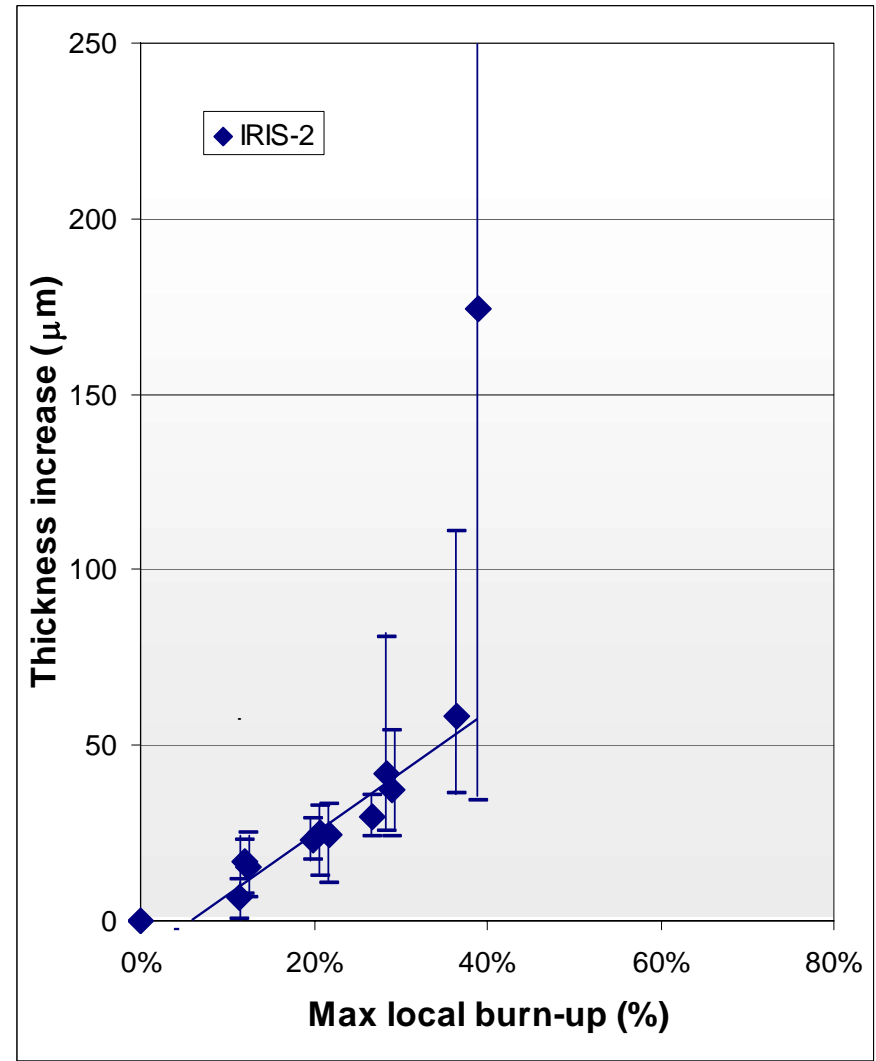
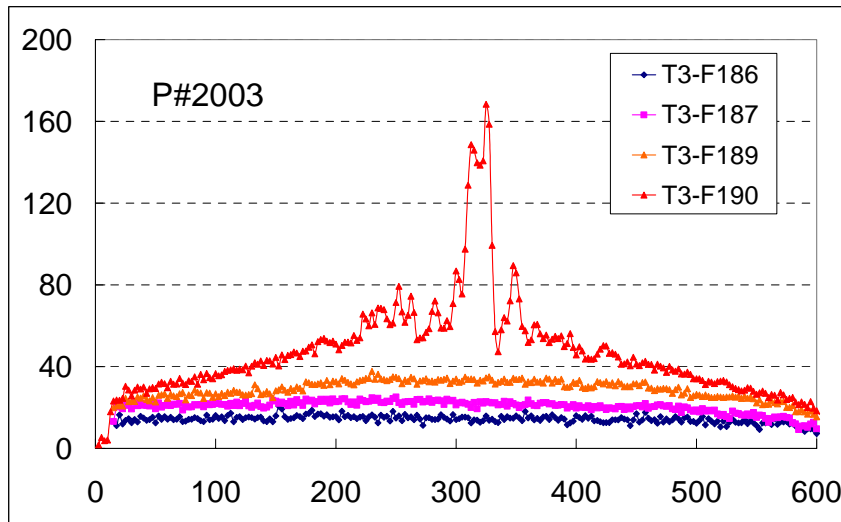
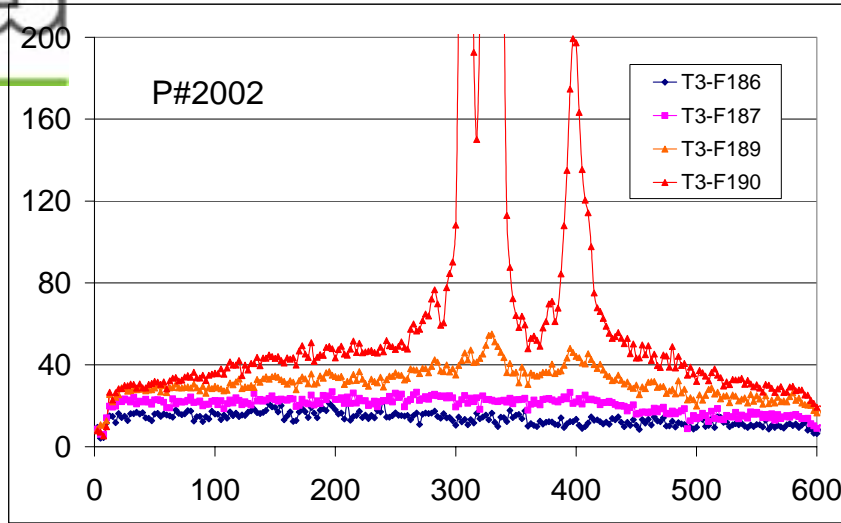




IRIS-1 experiment: Plates swelling

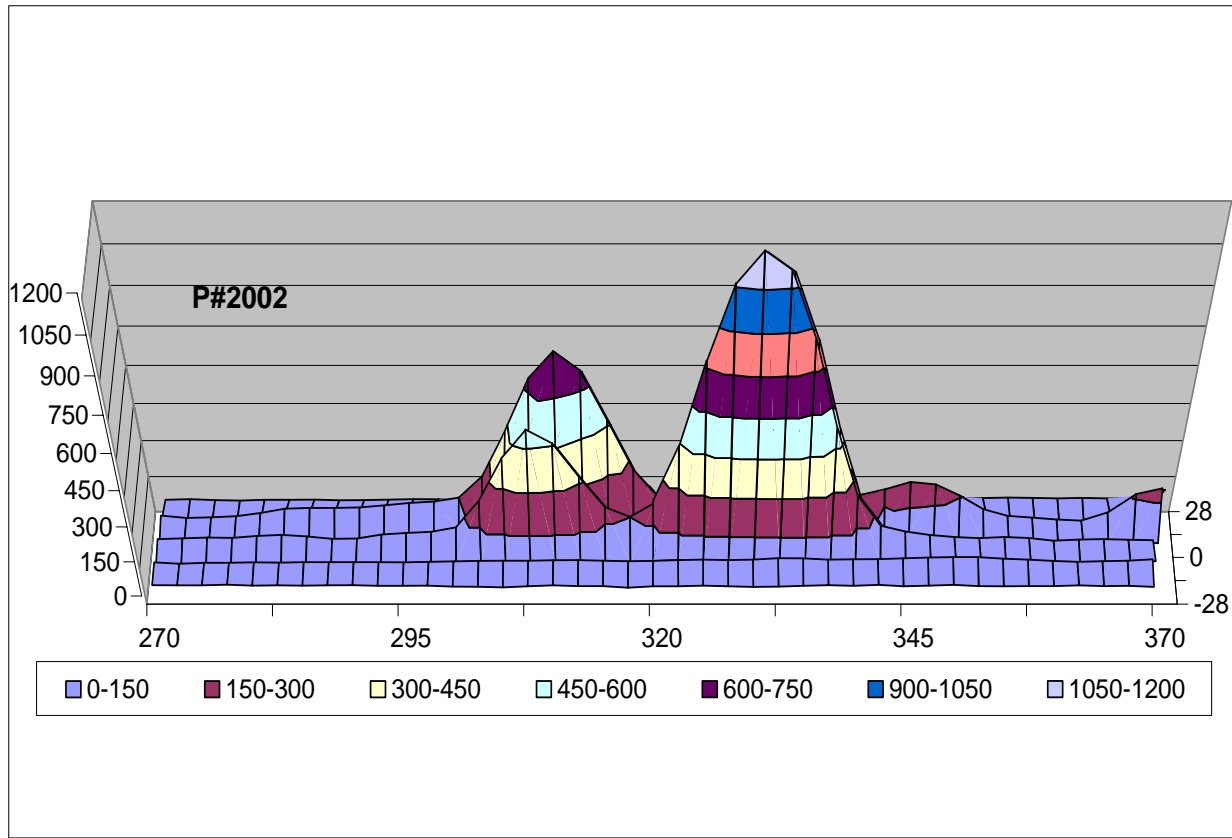


IRIS-2 experiment: Plates pillowing



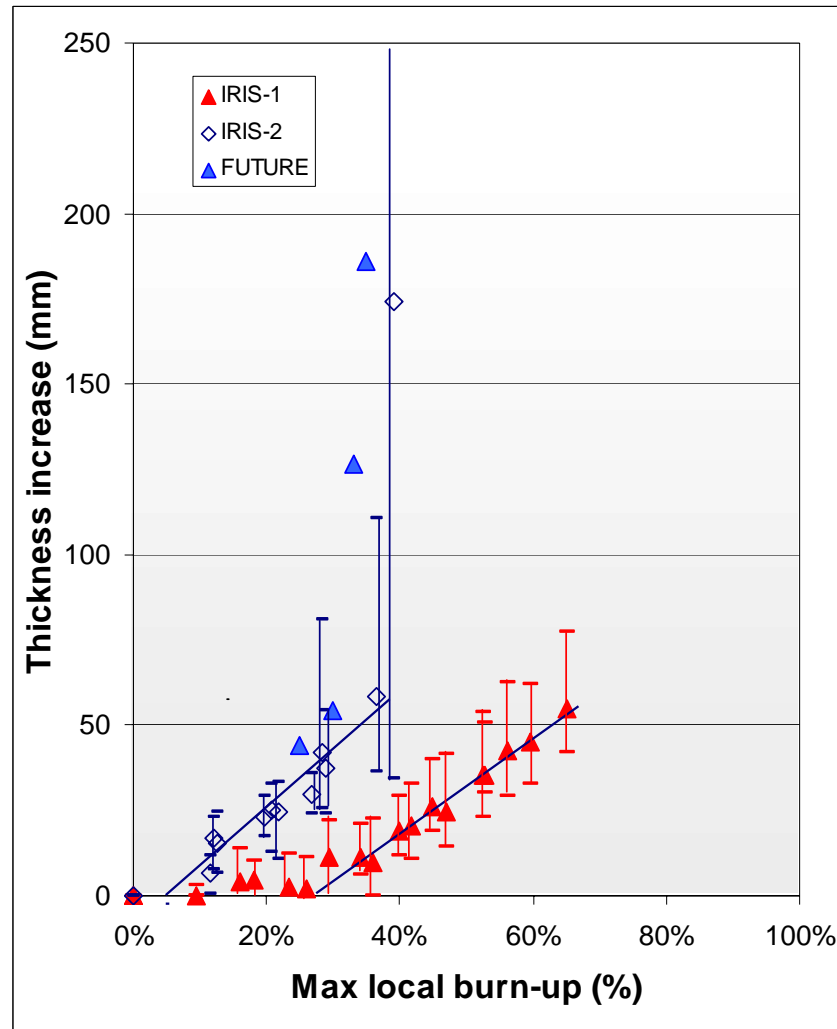


IRIS-2: Pillowing of the Plate U7MT2002





French Program on UMo full-sized plates: Results

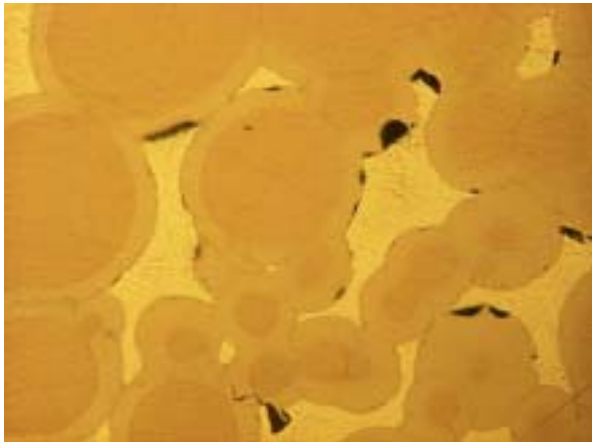




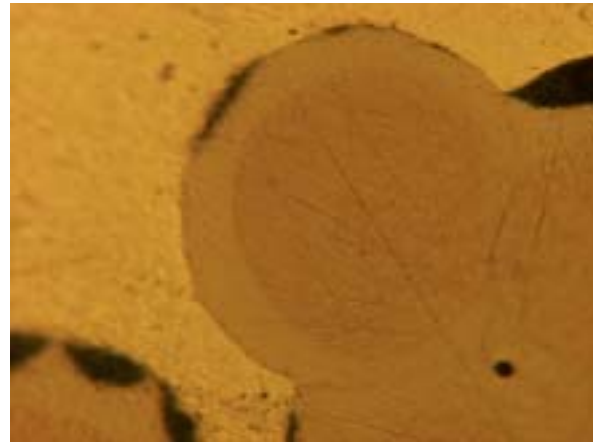
FUTURE experiment: BU=33%; Plate pillowing and porosities in the (UMo)Al_x interaction layer



1 mm



50 μm

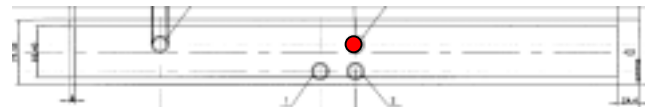
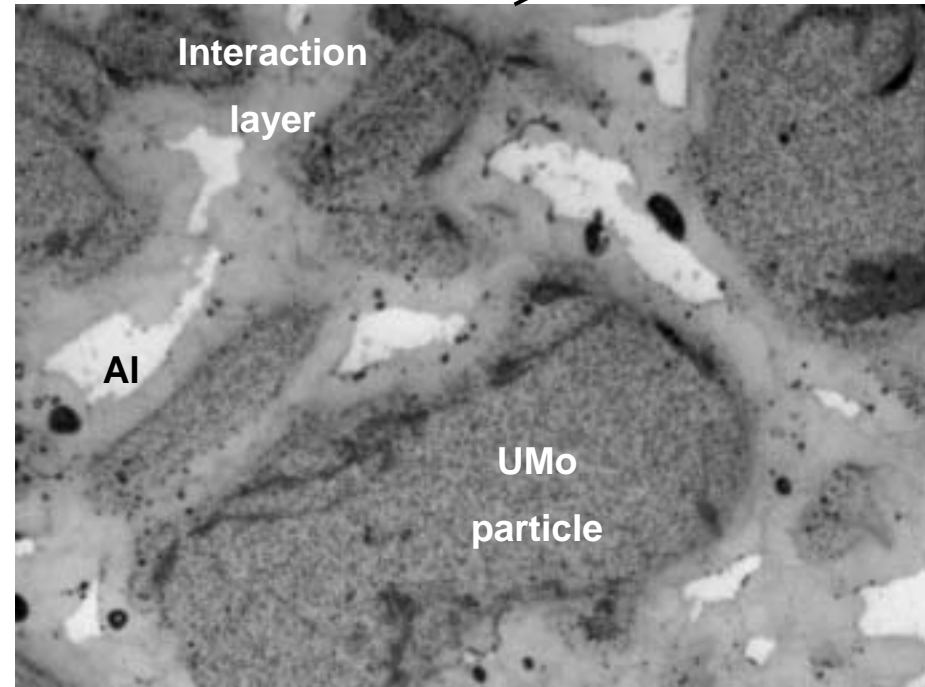
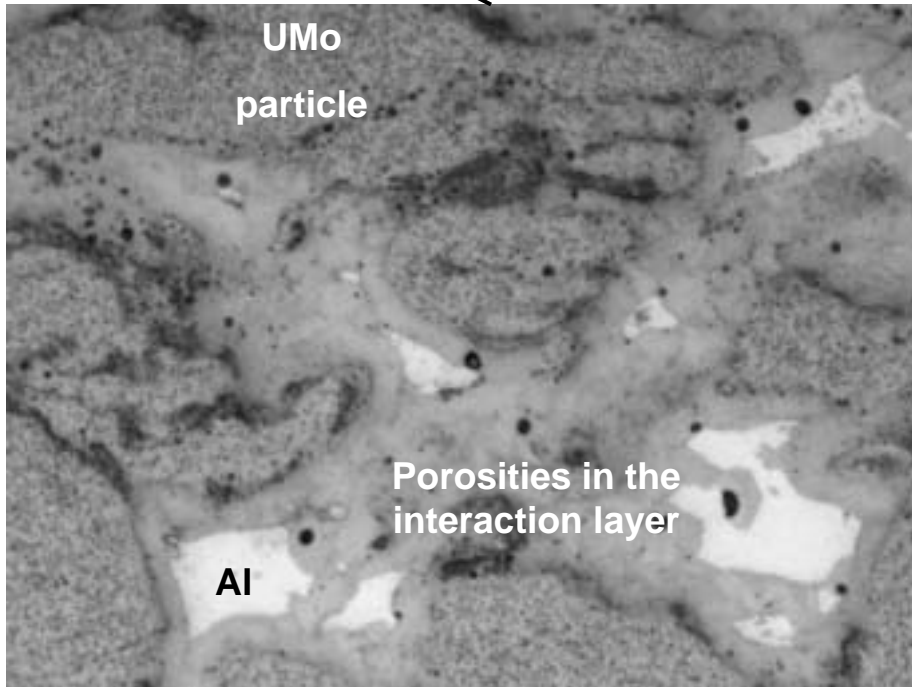
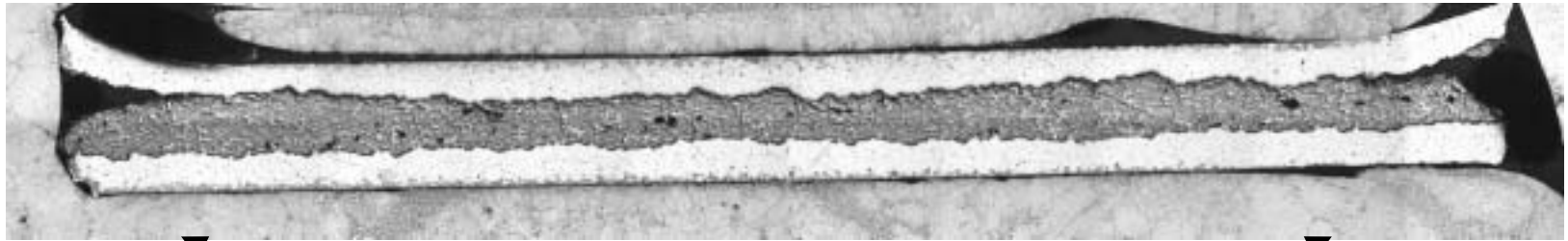


25 μm



100 μm

IRIS-1 experiment: Sample #2 ; BU= 58 %

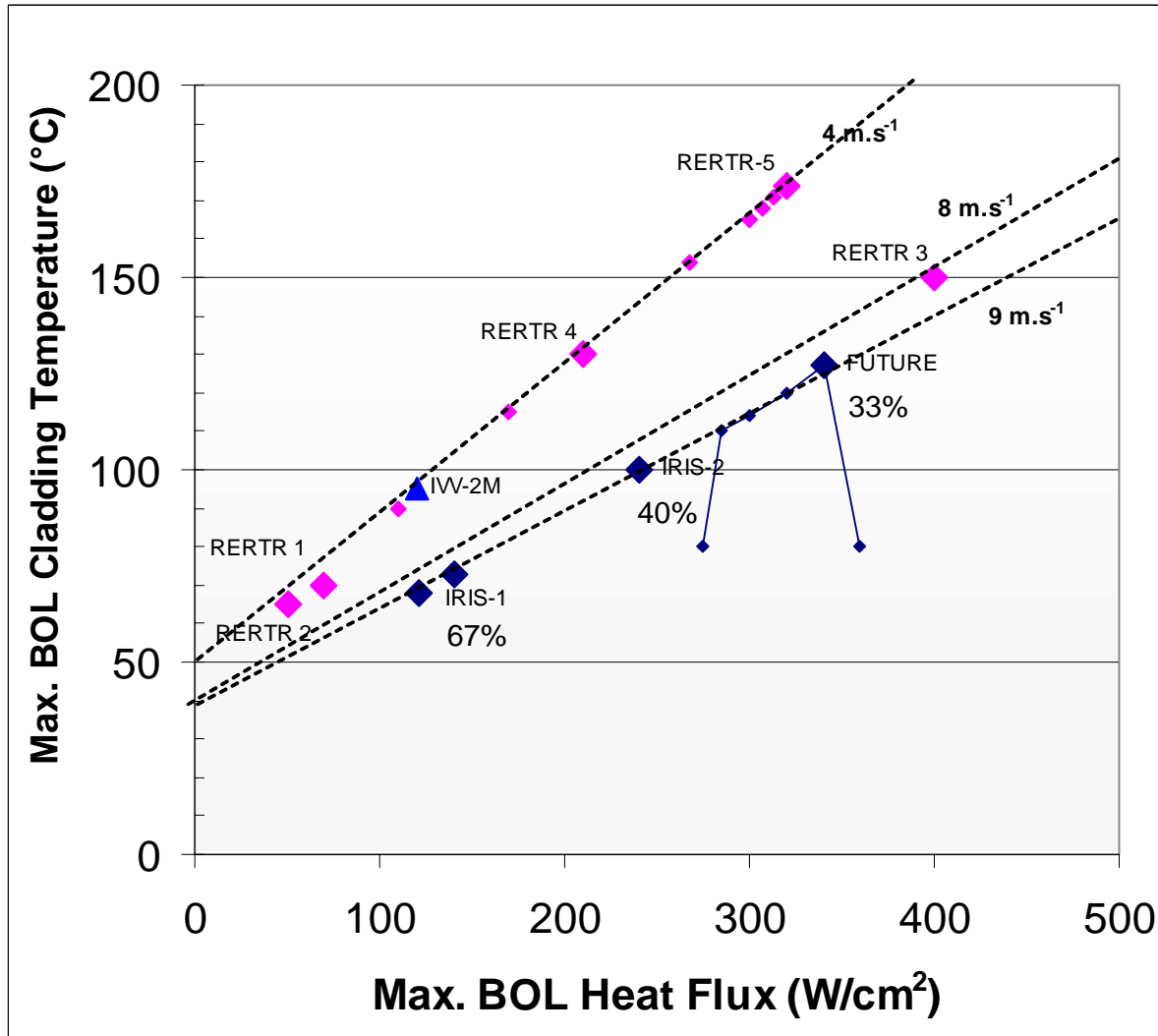




Synthesis

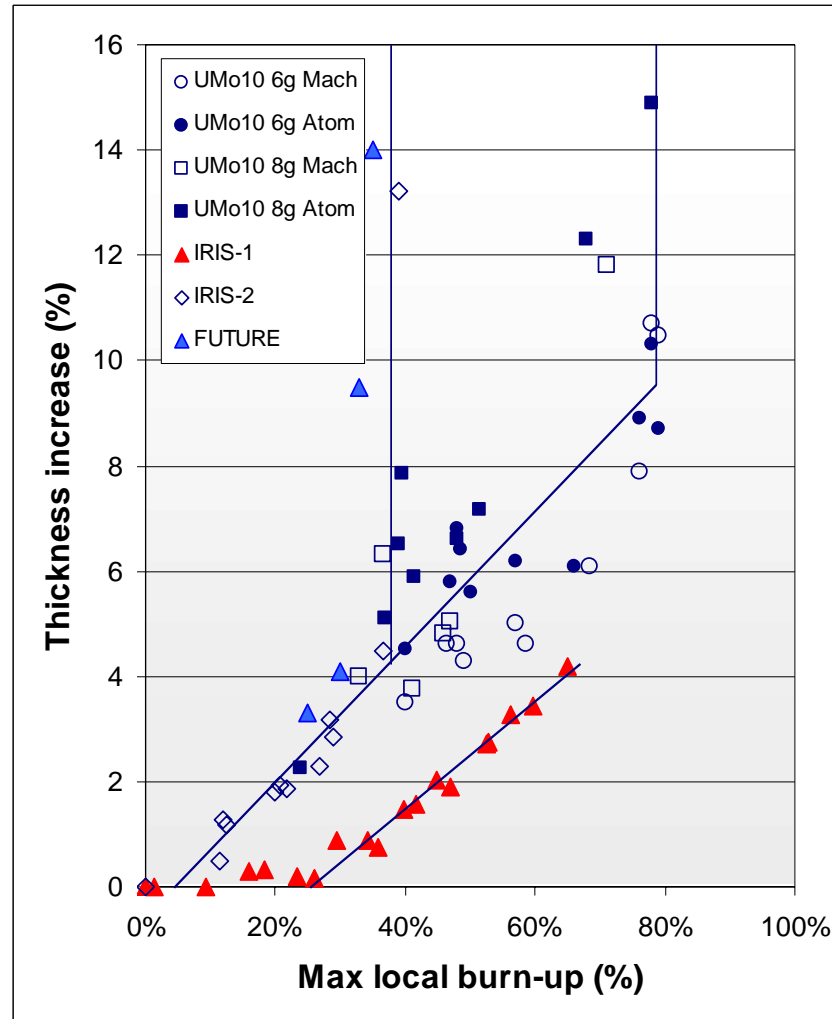


UMo/Al plate-type dispersion fuel irradiations



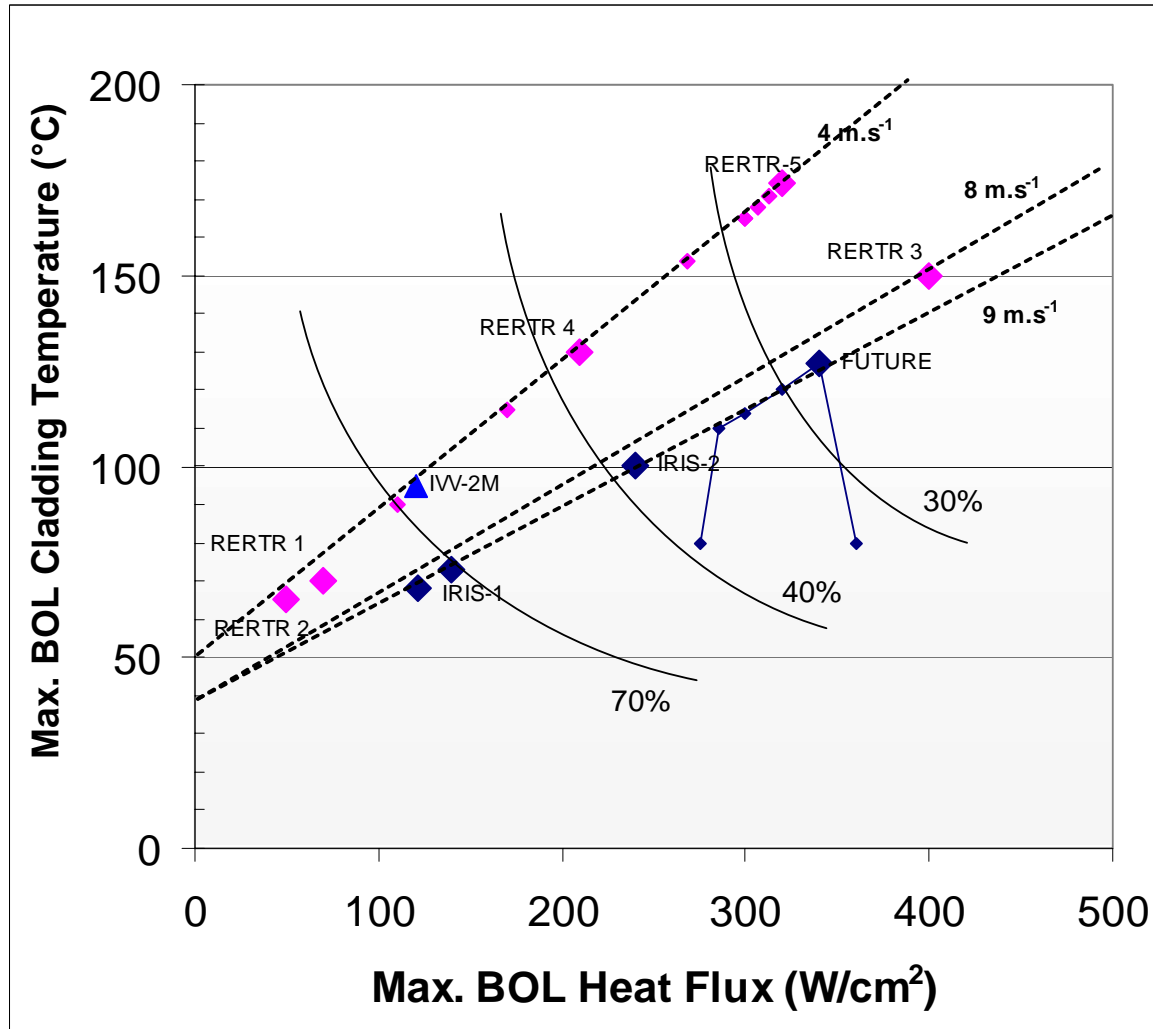


French plates and US miniplates Results





Burn-up limits for UMo plate-type dispersion fuels





Conclusions

- **UMo/Al dispersion fuel shown evident limitations in burn-up performance due to excessive plate swelling or pillowing**
- **The origin of these limitations is the excessive formation of (UMo)Al_x interaction layer, unable to retain fission gas as small and stable bubbles**
- **The forthcoming activities will investigate solutions to reduce drastically this interaction, as:**
 - **the modification of the composition of the Al matrix,**
 - **the coating the UMo particles to create a diffusion barrier,**
 - **the suppression of the Al matrix (UMo monolithic)**
- **These developments are the subject of the next presentations**
- **The irradiation qualification of these alternative solutions clearly needs hard work for at least 5 years more.**