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PIE - a Need for Future Developments

by

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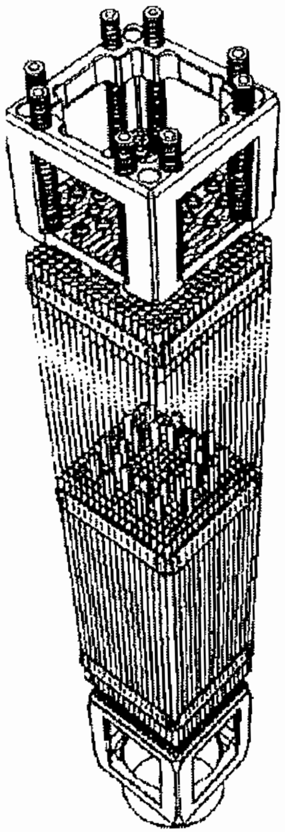
Hot Cell Workshop, Karlsruhe, 13-15 Oct. 1999

PIE - a Need for Future Developments

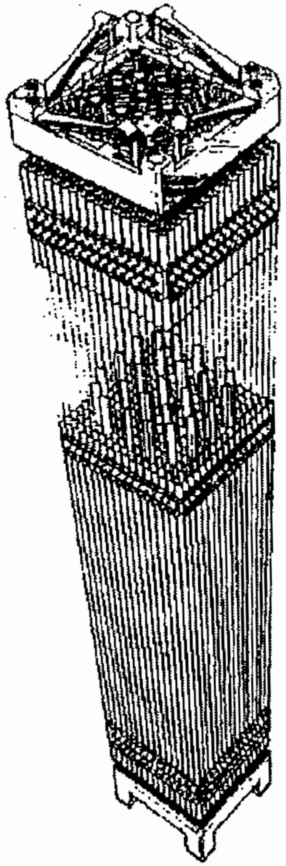
- Introduction
- Hot cell work and development of commercial products
- Examples for industrial applications
  - Fuel
  - Refabrication of rodlets
  - Corrosion
- Future trends
- Conclusions

Fuel Assemblies are the Key Business for Siemens' Nuclear Cycle

PWR

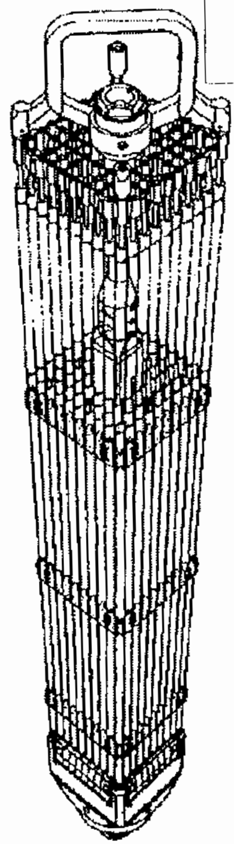


FOCUS



HTP

BWR



ATRIUM → modern 10x10 array with central water channel ↓ result of ~20y of development.

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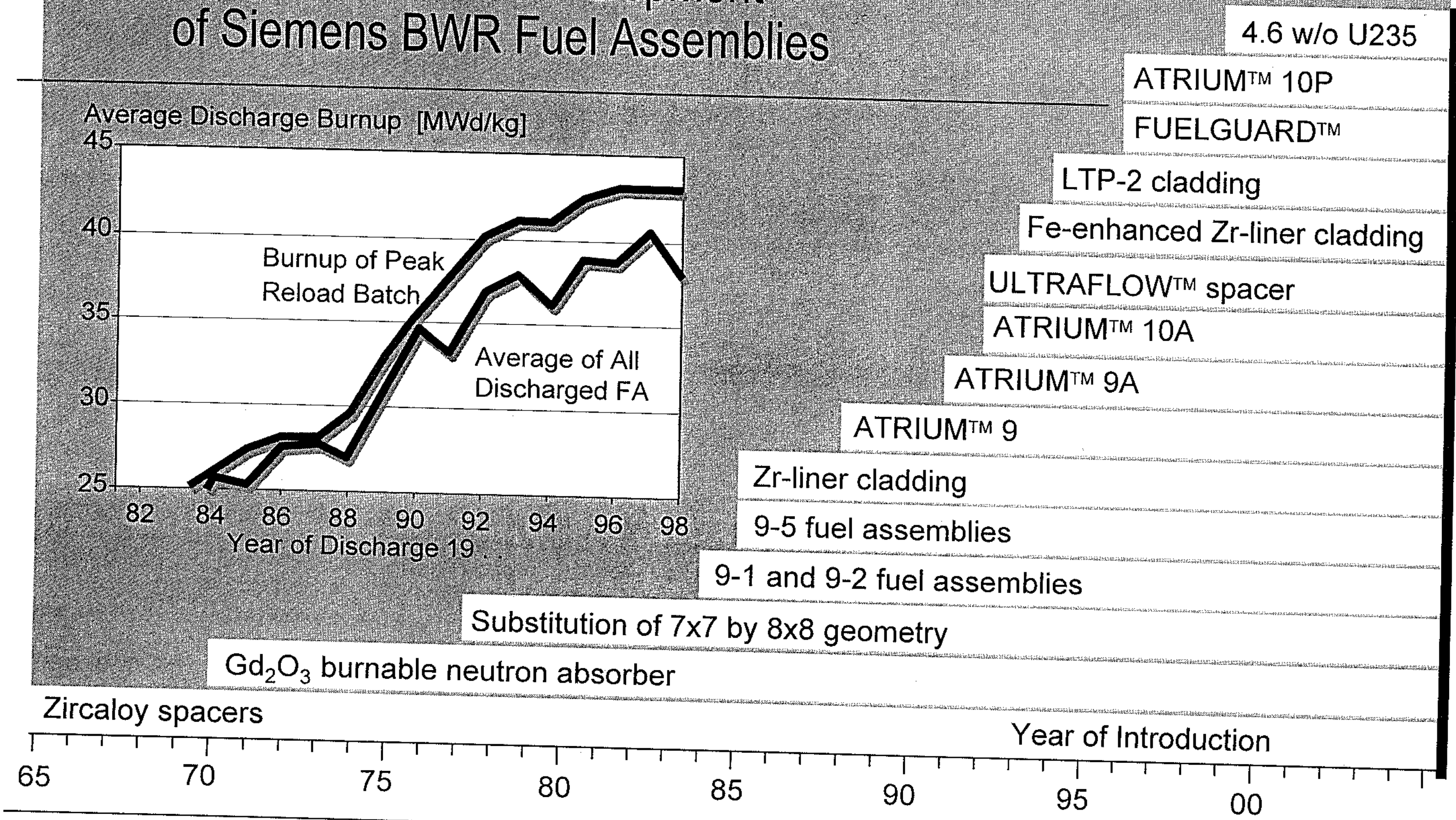
Milestones in the Development of Siemens BWR Fuel Assemblies



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important; * = development of highly corrosion u. stand. cladding.

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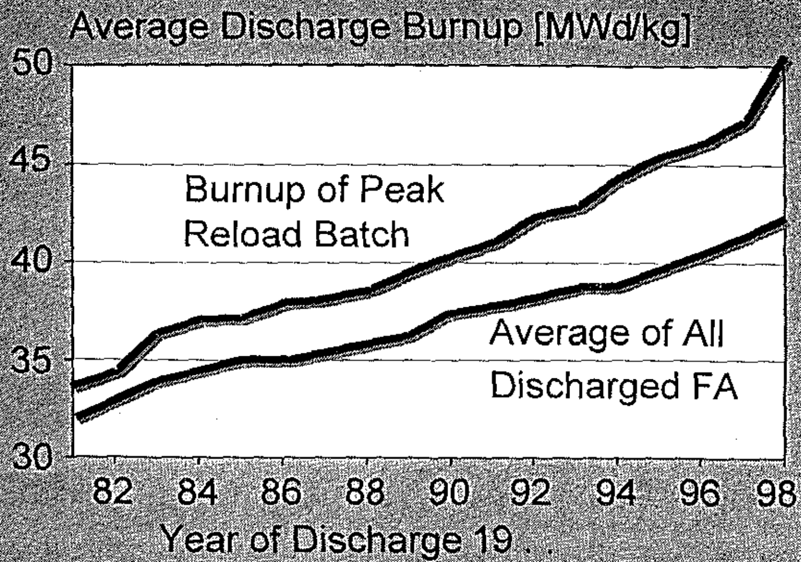
Milestones in the Development of Siemens PWR Fuel Assemblies



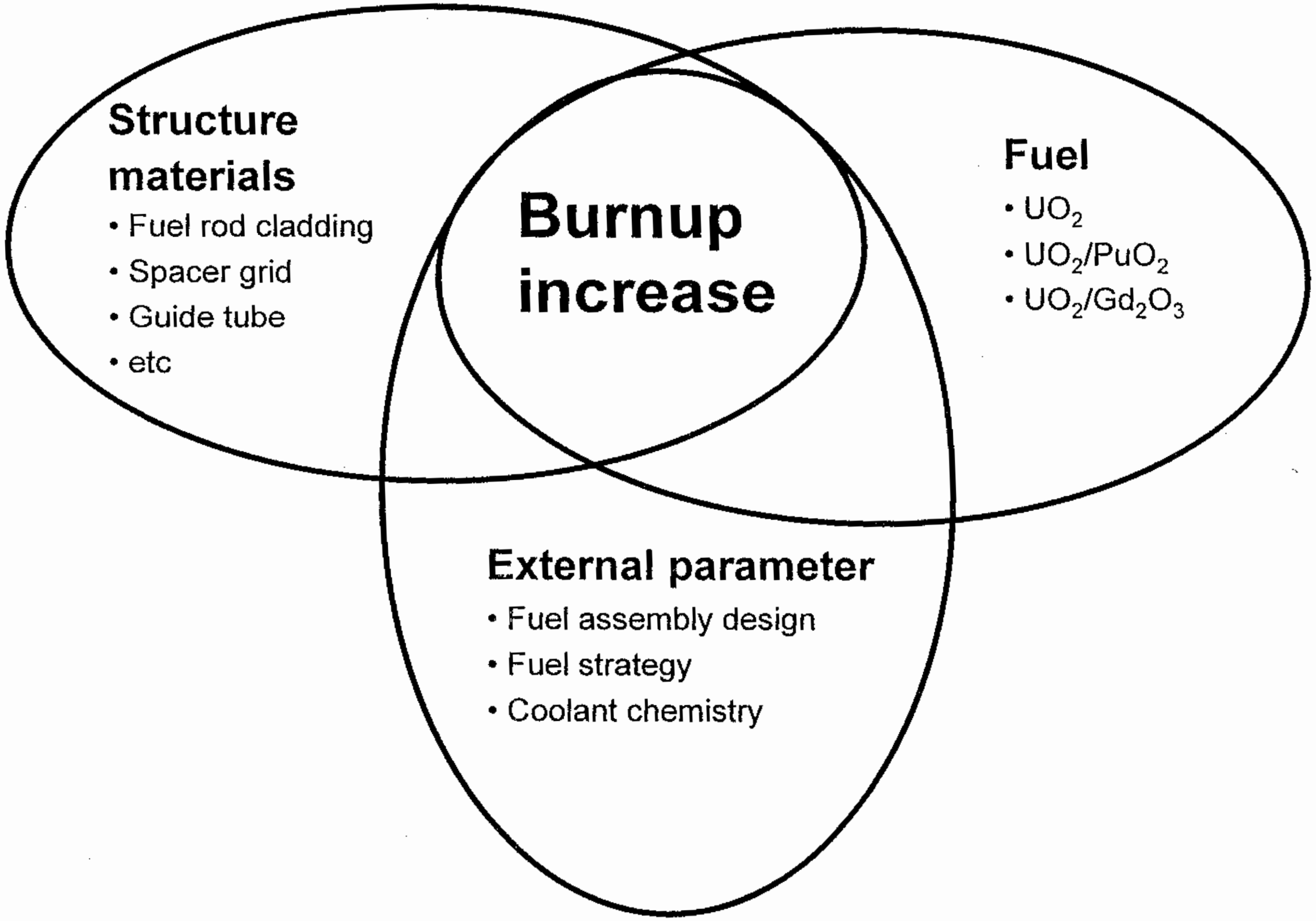
- Advanced MOX Fuel
- Low Gd design
- ERU fuel assemblies
- ZrNb lead assemblies
- 4.4 w/o U235
- Modified Zry 4
- Integrated debris filter
- FUELGUARD™ debris filter
- FOCUS fuel assemblies
- DUPLEX cladding
- Intermediate flow mixers
- 4.0 w/o U235
- Low-tin cladding (PCA-2)
- HTP fuel assemblies
- Gd_2O_3, full low-leakage cores
- Improved MOX fuel assemblies
- 3.6 w/o U235
- Zircaloy spacers and guide tubes
- Partial low-leakage core loadings
- MOX fuel assemblies
- Easily removable upper tie plate
- Removable lower tie plate

Year of Introduction

65 70 75 80 85 90 95 00

main driving force for developments (end of fuel cycle ≈ 2/3 of total cycle cost)

Burnup Increase is a Result of Many Parameter



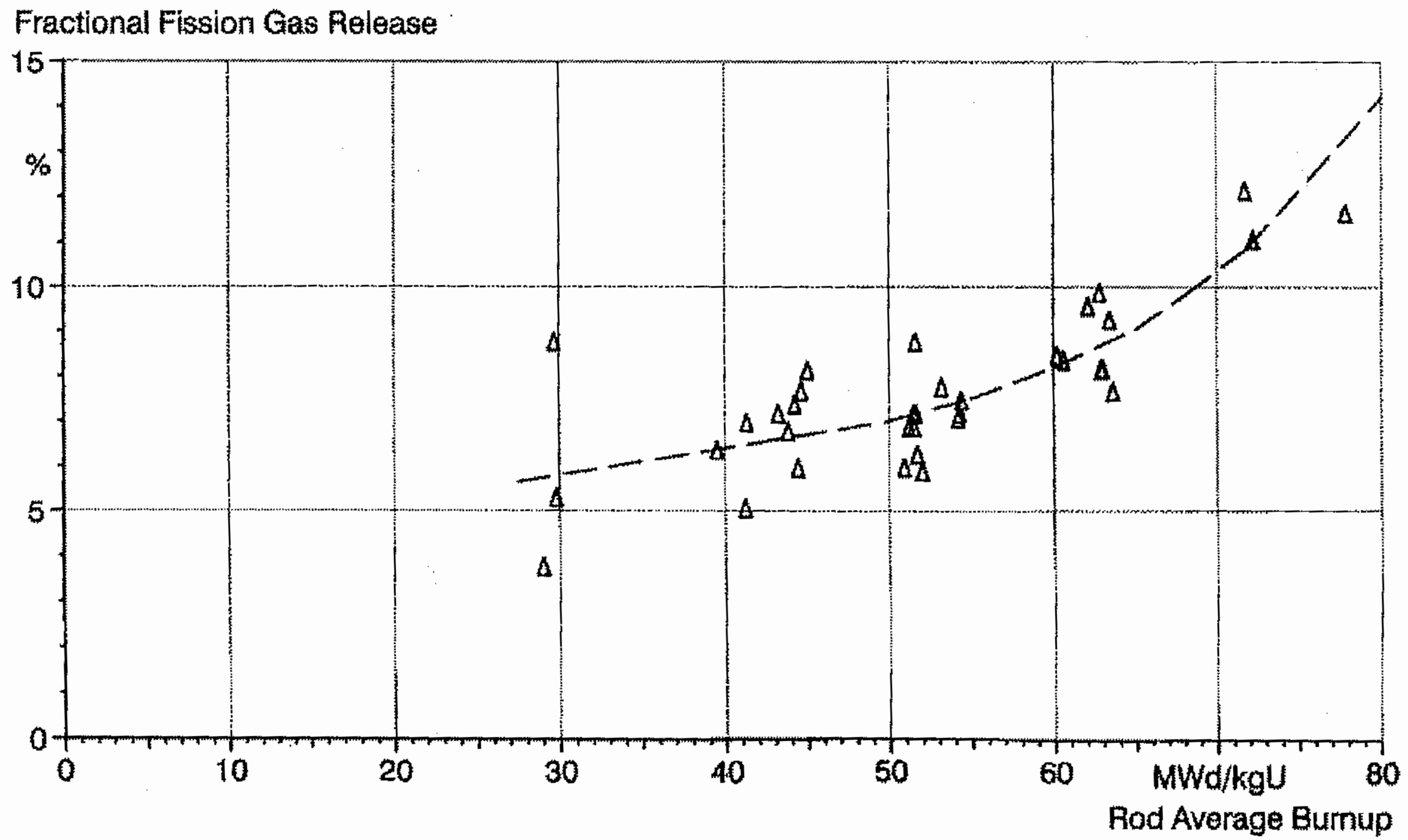
Different Kinds of Hot Cell Work

- More detailed measurements already performed in the FA-pool of the plant.

- Contribution to the design data base or modelling of irradiation behaviour by destructive examinations
  e.g. fission gas release, fuel density, EPMA, ceramography etc.

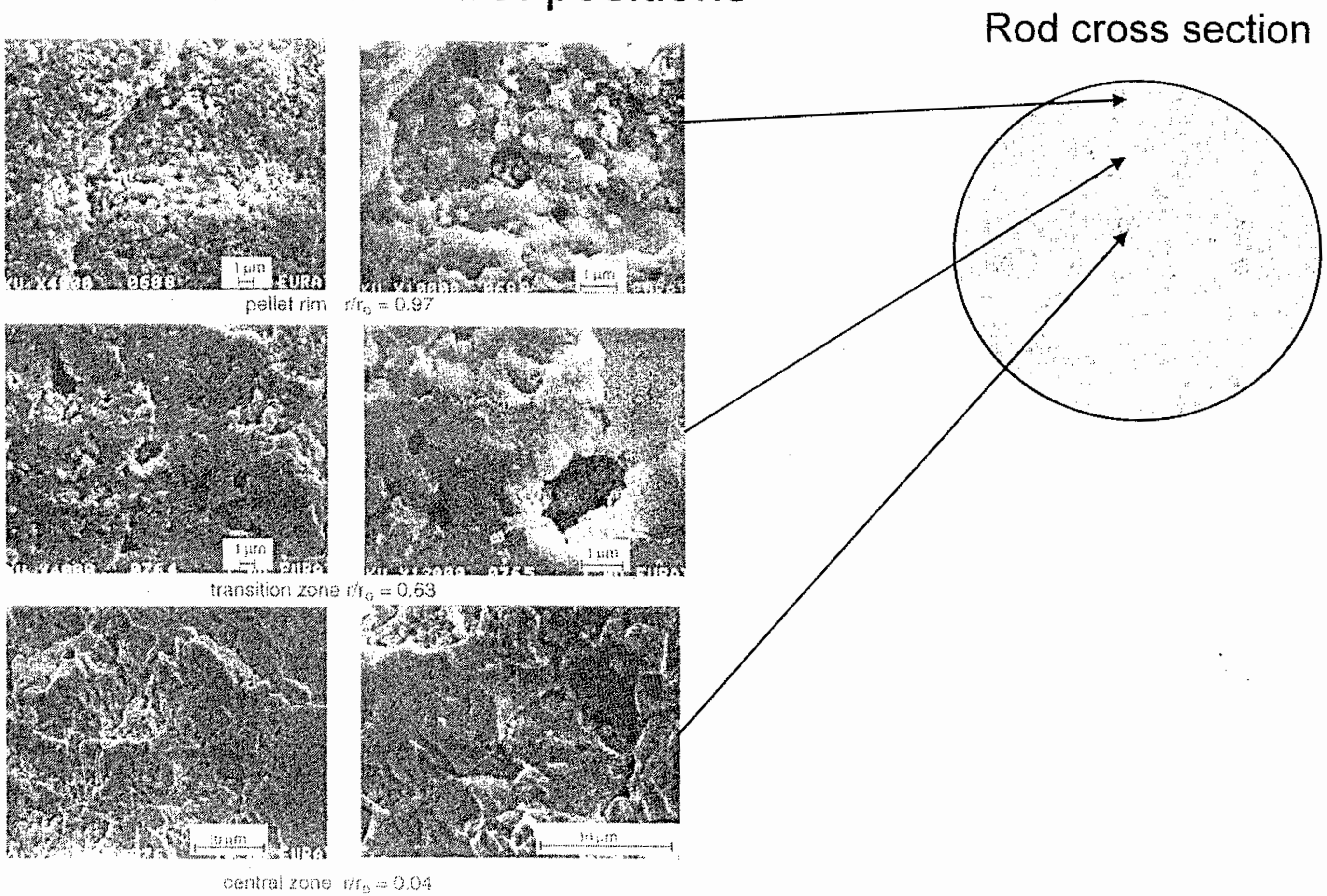
- Examination of special cases
  e.g. new or unexpected phenomena.
  → e.g. rod failure.

Fission Gas Release Measurements are Used to Predict the Inner Rod Pressure at High Burnup



A Porous Structure is Formed at the Fuel Rim at High Burnup

SEM at different radial positions



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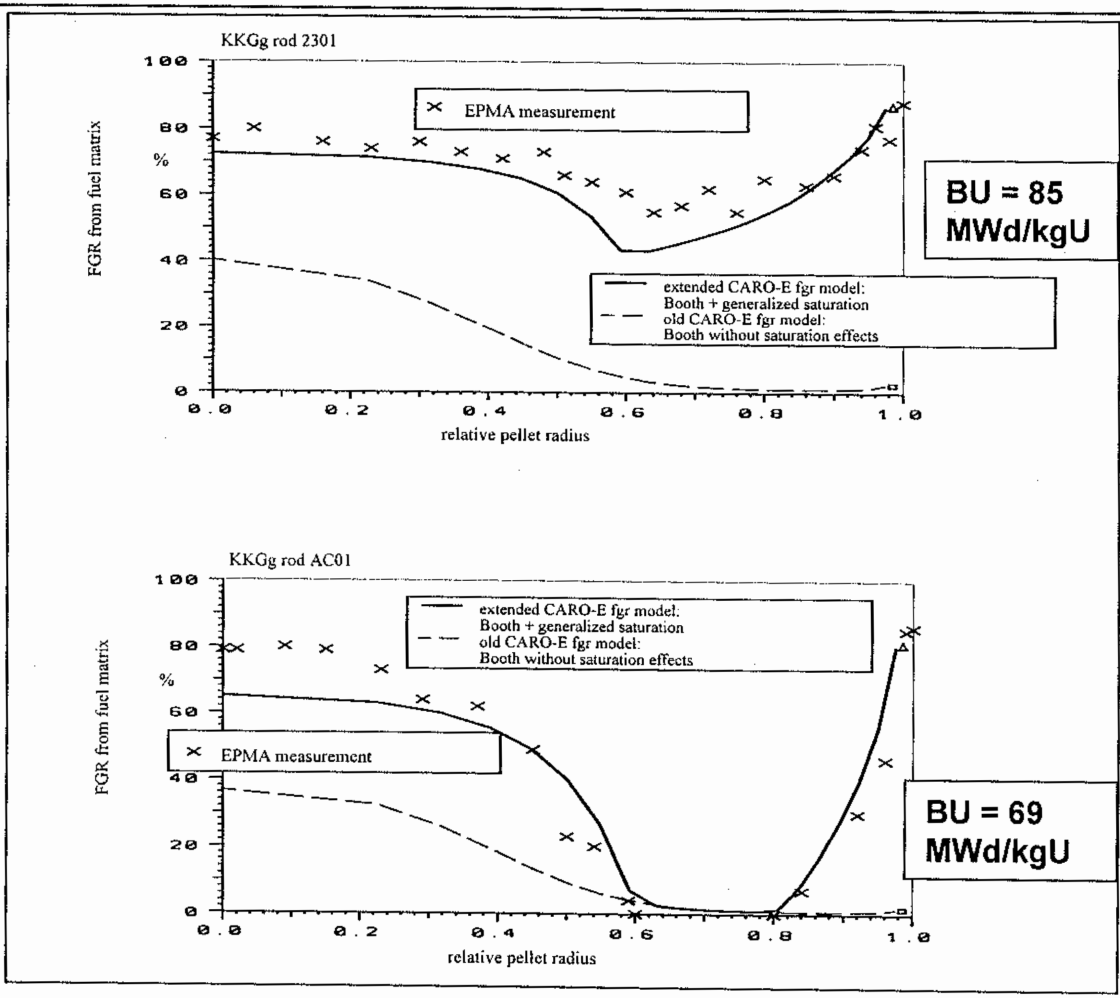
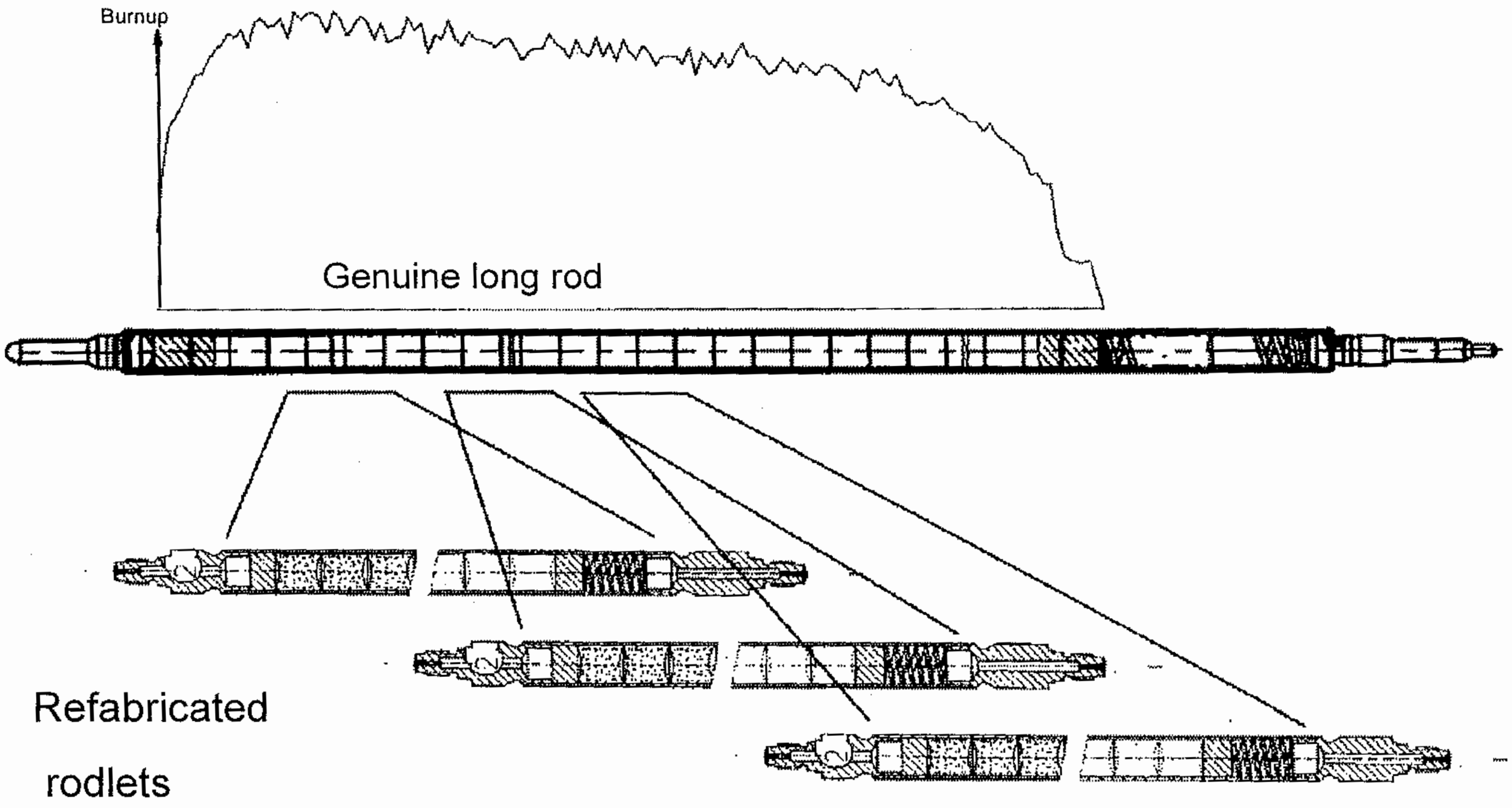
Xe Release Profiles (Matrix) Calculated with CARO-E in Comparison to EPMA Measurements

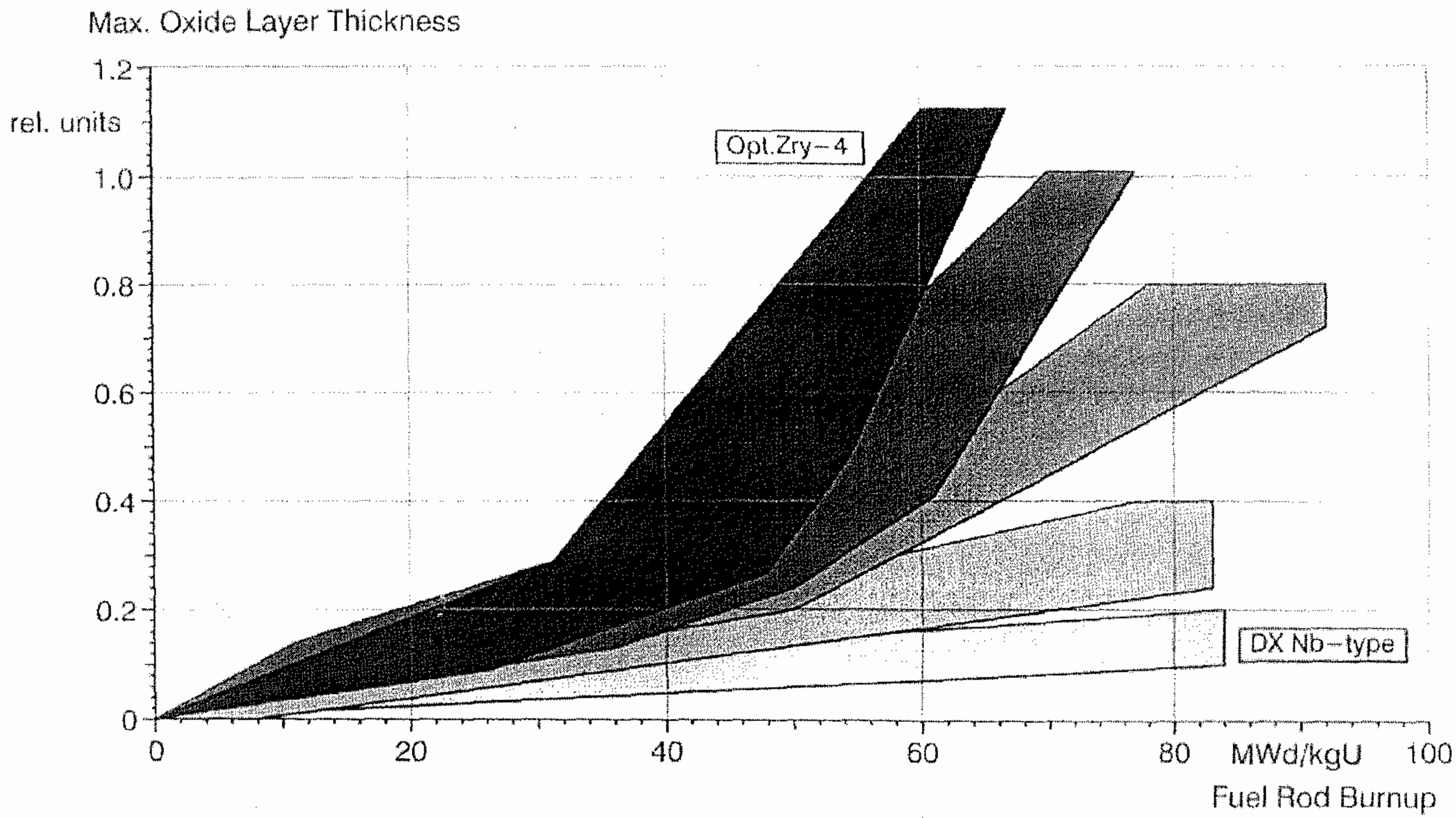


Presented at the EHPGM
Loen-Norway, May 24-29, 1999
by F. Sontheimer

Refabrication of Rodlets of Irradiated Long Rods



A Wide Spectrum of Corrosion Resistant Cladding Materials are Available Today



Future Trends in PIE work

- Support of further burnup increase. Fuel and structural material related questions will receive more attention.
- Growing importance of effects of coolant chemistry on corrosion.
- Refabrication of rodlets with high burnup.
- Shorter response times on materials' behaviour.

PIE - a Need for Future Developments - CONCLUSIONS-

- Up to now, hot cell work has improved the knowledge on the materials' behaviour, contributed to their development and provided a lot of data for licensing purposes.
- In future, hot cell work is needed on an even broader basis, since the spectrum of components to be optimised by different techniques will become larger.
- To meet shorter response times, key techniques should also be time optimised.