Ivan Fast i.fast@fz-juelich.de
Yuliya Aksyutina, Holger Tietze-Jaensch
Forschungszentrum Jülich GmbH, IEK-6

ICEM2013 - 96316

JÜLICH FORSCHUNGSZENTRUM

Determination and analysis of the uncertainty bandwidth of the nuclear inventory for assessment of radioactive waste

INTRODUCTION

Waste packages often contain wastes forms of different types of spent fuels and of various operational history, whereas information about secondary reactor parameters may not be available. In this case the so-called characteristic fuel burn-up and cooling time are determined. These values are obtained from a correlations involving key-nuclides (easy-to-measure nuclides). Each correlation is associated with corresponding uncertainty bandwidth. The bandwidth strongly depends on secondary reactor parameters such as initial enrichment, temperature and density of the fuel and moderator, reactor's operational history. The purpose of our investigation is to understand the limitations of the scaling and correlations, to define and verify the range of validity, and to scrutinize the dependencies and propagation of uncertainties that affect the waste inventory declarations and their independent verification. This is accomplished by numerical assessment and simulation of the waste production processes using the widely accepted codes SCALE 6.0 and 6.1 to simulate the cooling time and burn-up of a spent fuel element.

SECONDARY REACTOR PARAMETERS

- Operation history: downtime, power-on time, sp. power
- Moderator: density, temperature, rate of boracic acid
- Fuel: initial enrichment, density, temperature

STUDY of BANDWIDTH - FE 14x14 SIEMENS

- Burn-up: 60 GWd/t_{HM}
- Initial enrichment: 1.5%, 3%, 4.5%
- Fuel temperature: 900 K, 1800 K
- Moderator temperature: 556 K, 586 K
- Fuel density: 90%, 100% respective of the physical fuel density (10.408 g/cm^3)
- Moderator density: 90%, 110% respective of the physical moderator density (0.7283 g/cm^3)

DOWNTIME ANALYSIS - FE 16x16 AFA 3G

- 6 cycles with downtime (DT) 0, 50, 75, 100 and 400 days
- Analyse for cooling time (CT) 0, 1, 3 and 5 year
- For most fission product - operation history without DT is conservative.
- The activities of actinides either independent of DT (e.g. U-235, U-238, Pu-239, Np-237) or underestimated in case of operational history without DT. However, in latter case, significance of DT influence decreases with increasing CT.

Figure I. Build-up of Eu-154 as a function of burn-up (left frame) and corresponding bandwidth (right frame)

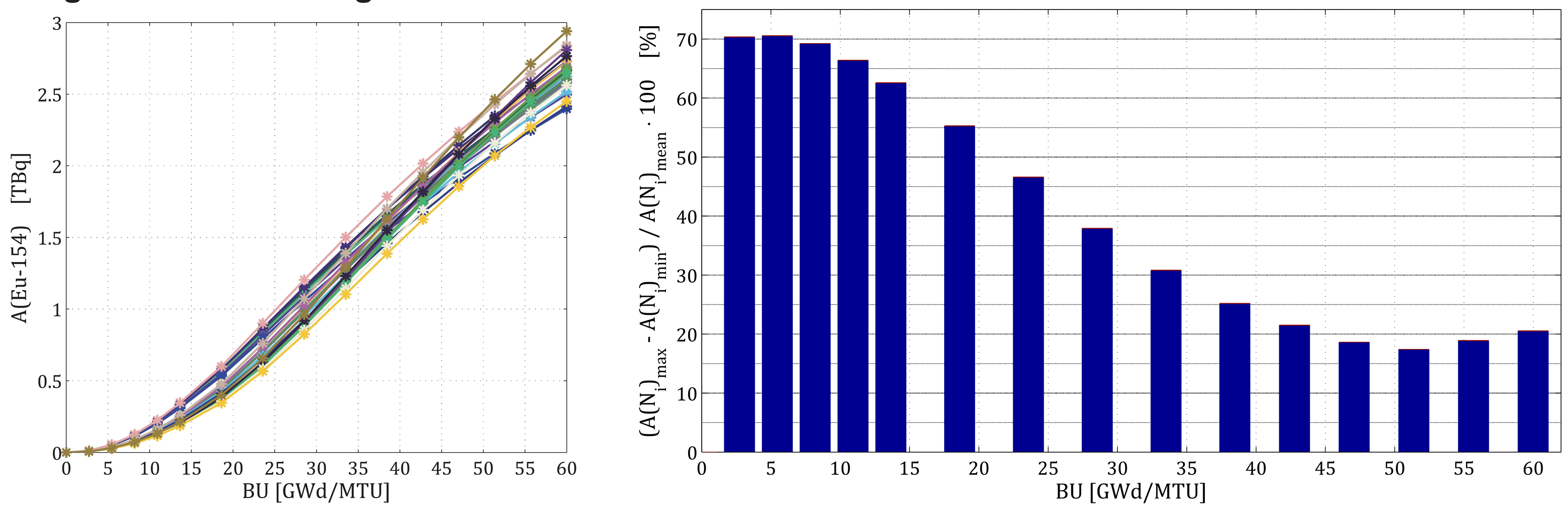


Figure II. Build-up of Cs-134 as a function of burn-up (left frame) and corresponding bandwidth (right frame)

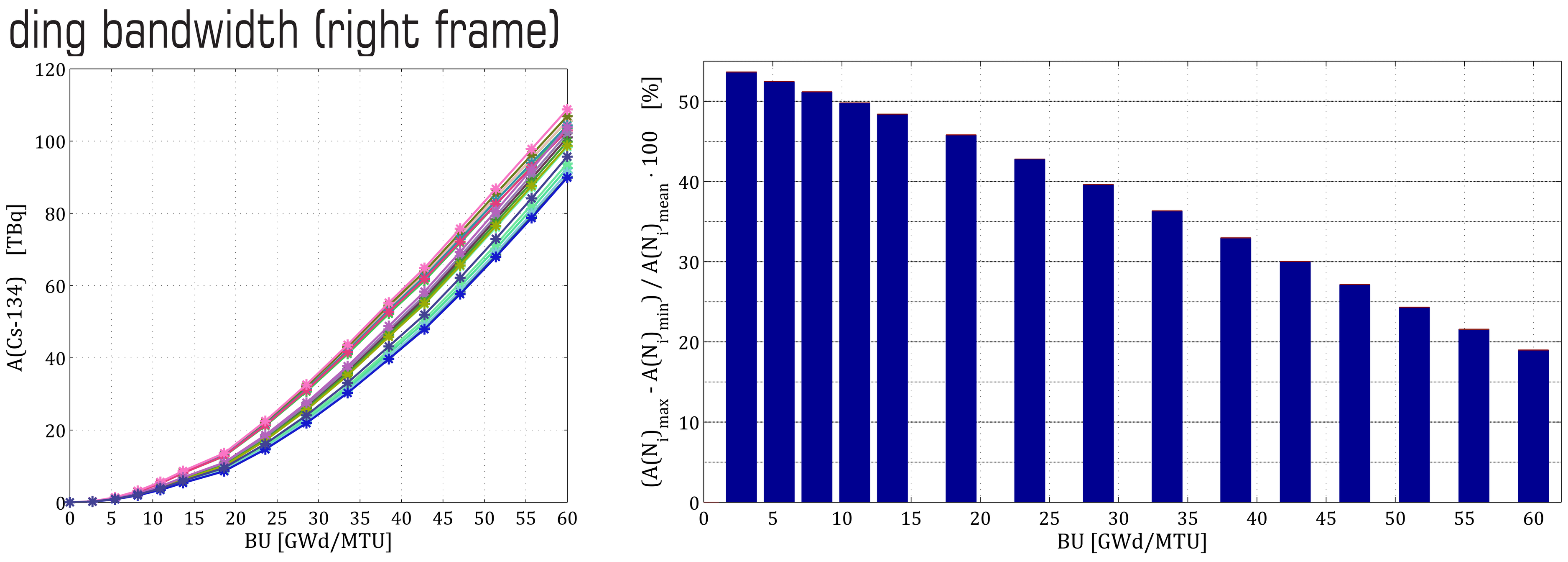
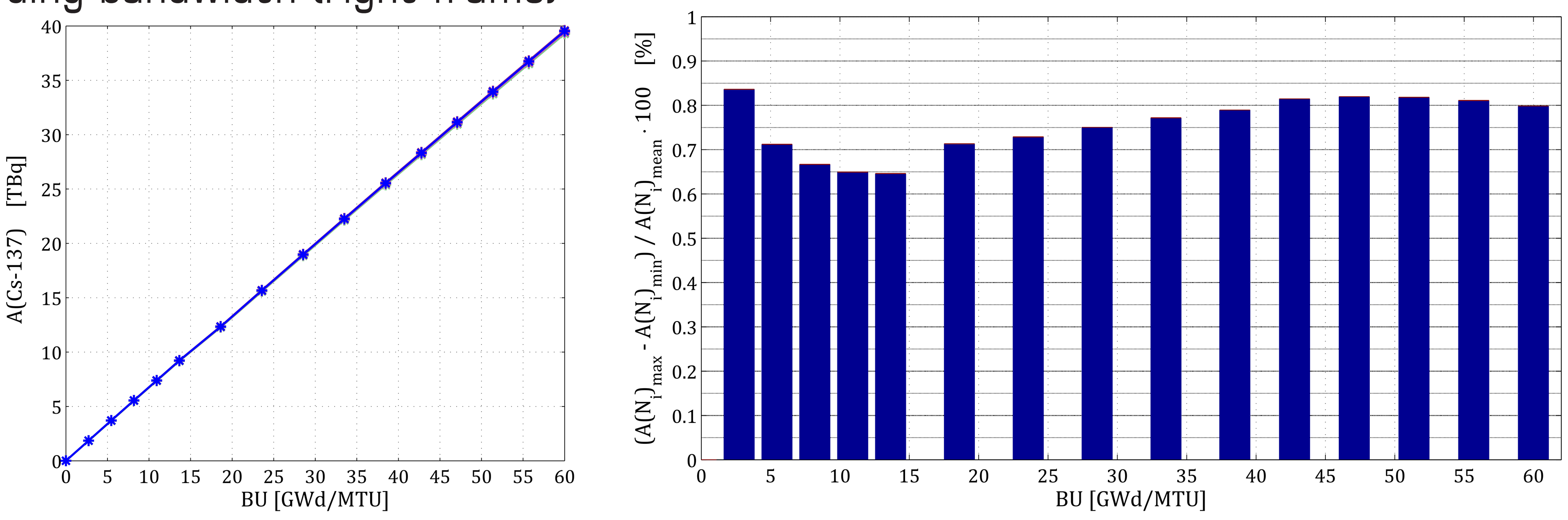


Figure III. Build-up of Cs-137 as a function of burn-up (left frame) and corresponding bandwidth (right frame)



BURN UP CORRELATION Eu-154/Cs-137

- Not defined for burn-ups highter than ~ 45 GWd/t_{HM}

Figure IV. Burn-up as a function of the ratio Eu-154/Cs-137 (left frame) and the corresponding bandwidth (right frame).

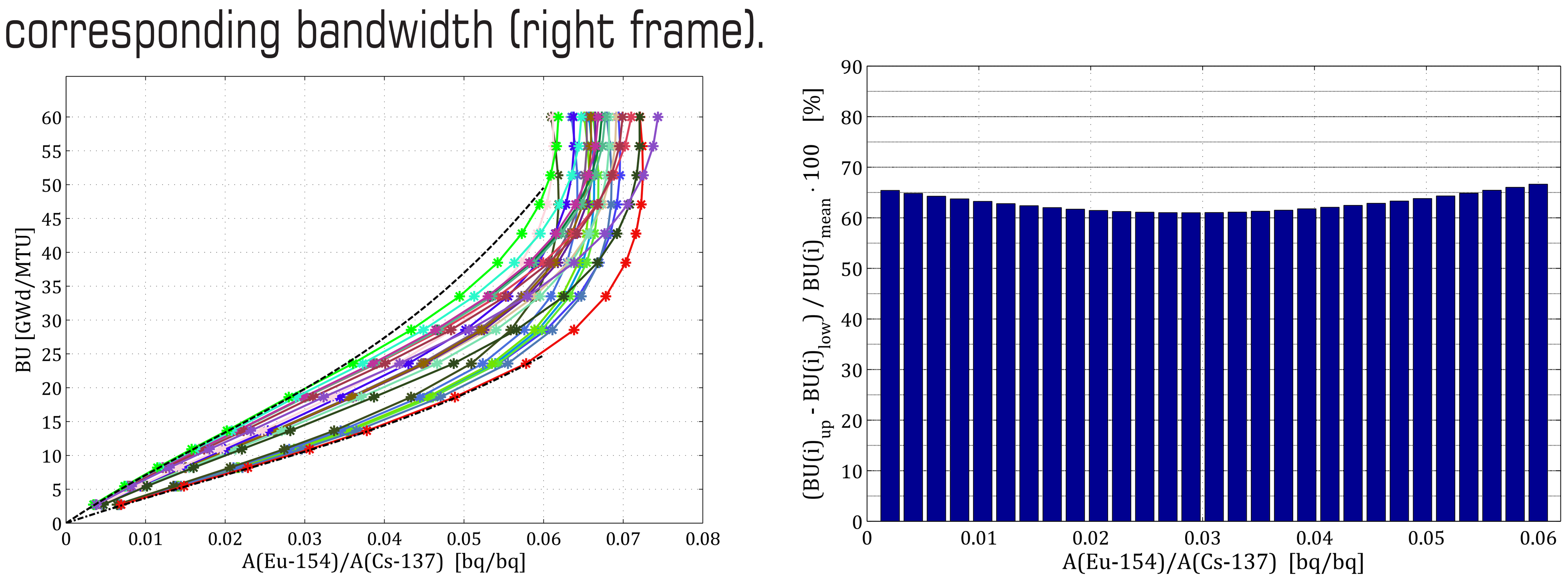


Figure V. Build-up of Cs-134 as a function of burn-up without correction for CT (left frame), build-up of Am-241 as a function of burn-up without correction for CT (middle frame) and build-up of Am-241 as a function of burn-up corrected for CT of 5 years (right frame).