TXT2NTAB
Generating NEMTAB cross-section libraries from SCALE

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SCALE USERS GROUP WORKSHOP

September 26-28 - ORNL

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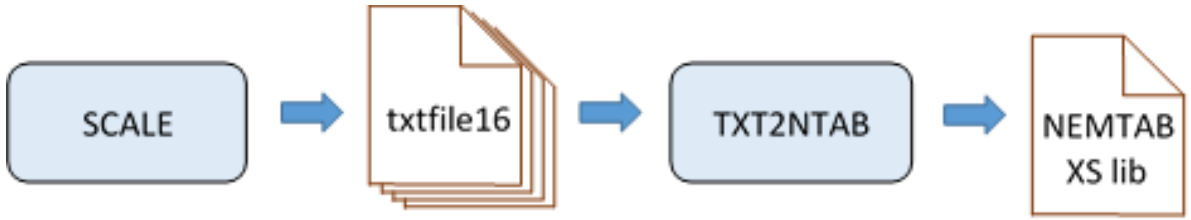
1. INTRODUCTION

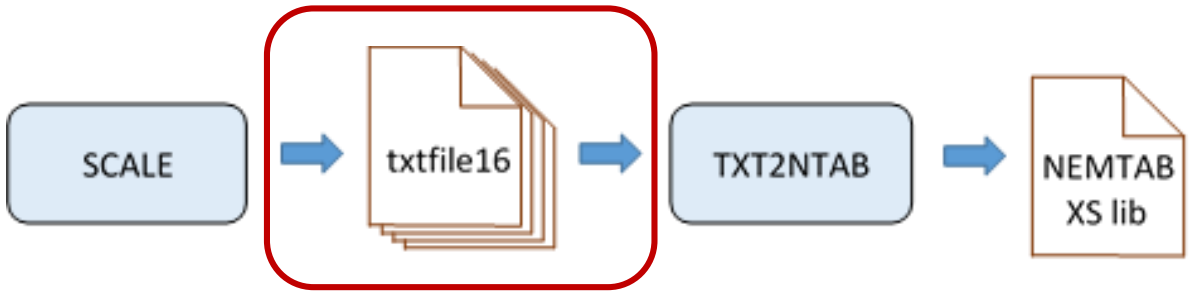
TXT2NTAB is a set of **MATLAB** scripts developed to **convert** cross sections predicted by **SCALE** (**txtfile16** format) into **NEMTAB** formatted cross section libraries (to use with PARCS for example).



The methodology has been **tested** with a **BWR** GE6 within the author's **PhD** thesis and was also **verified** for a fresh fuel simulation with a **code-to-code** comparison with **CASMO**.

1. INTRODUCTION

TXT2NTAB is a set of MATLAB scripts developed to convert cross sections predicted by SCALE (txtfile16 format) into NEMTAB formatted cross section libraries (to use with PARCS for example).



Each reactor **segment** must be run in **SCALE** to provide all ***txtfile16*** needed for a complete core representation.

1. INTRODUCTION

- TXT2NTAB was requested by the **UAM-LWR benchmark** organizers.
- They use it to generate NEMTAB to **distribute** among benchmark participants.
- Developed within the author's **PhD thesis** (UPV).
- It handles **TRITON-NEWT** and **Polaris** modules.
- **Burn-up** dependence feature.
- It is provided with a friendly **user interface** in ASCII format.
- A friendly **manual** is also provided with examples.
- Optionally, it also generates **GEOM** auxiliary file for PARCS.

2. GUIDE

Feedback parameters…

- It is the user **responsibility** to introduce proper feedback parameters.
- These are set using **branches** in SCALE.
- There are three important things to consider.
  - Feedback **parameters** to be included: Tfuel, Dmod, Crod (this is fixed in the NEMTAB format).
  - Number of **points** for each parameter. More accurate library, but more computational time.
  - The **range** for the feedback parameters should cover the range of all possible operational conditions.

2. GUIDE

TRITON-NEWT

There are:

i moderator density points

j fuel temperature points

one *boron* concentration point

two control rod states (*in/out*)

The reactor history is constant for all branches (nominal state).

Branch index	Feedback parameters	Comment
0	hdm, htm, htf, hbo, hcr=0	Nominal branch.
1	dm1, tm1, tf1, cb1, cr0	
2	dm2, tm2, tf1, cb1, cr0	
...		
i	dmi, tmi, tf1, cb1, cr0	i branches with dm, tm points.
...		
i·j – i+1	dm1, tm1, tfj, cb1, cr0	Repeat same branches j times with different tf points.
i·j – i+2	dm2, tm2, tfj, cb1, cr0	
...		
i·j	dmi, tmi, tfj, cb1, cr0	
i·j+1	dm1, tm1, tf1, cb1, cr1	Repeat i·j branches with control rod inserted.
i·j+2	dm2, tm2, tf1, cb1, cr1	
...		
i·j+i	dmi, tmi, tf1, cb1, cr1	
...		
2·i·j – i+1	dm1, tm1, tfj, cb1, cr1	
2·i·j – i+2	dm2, tm2, tfj, cb1, cr1	
...		
2·i·j	dmi, tmi, tfj, cb1, cr1	Total number of branches 2 i j +1

2. GUIDE

POLARIS

In order to maintain the analogy with txtfile16 generated by TRITON-NEWT, the first branch specified in Polaris must define the nominal state (or reactor history).

```
state FUEL : temp=htf
state COOL : temp=htm
state COOL : dens=hdm
state COOL : boron=hbo
state BANK : in=false

'branch - instantaneous change
read branch
'      BRANCH:      NOM|  Branch 1| Branch i| Branch ij | Branch ij+i CR| ...
    add FUEL : temp=htf     tf1  ...  tf1  ...  tfj  ...  ... tf1  ...    ...

        COOL : temp=htm     tm1  ...  tmi  ...  tmi  ...  ... tmi  ...    ...

        COOL : dens=hdm     dm1  ...  dmi  ...  dmi  ...  ... dmi  ...    ...

        BANK : in=false    ...  ...  ...  ...  ...  ...  ...  true  ...    ...
end branch
```

2. GUIDE

POLARIS

- File txtfile16 generated by Polaris has some **discrepancies** compared to the **txtfile16** generated by TRITON.

- User must **complete** some information for a couple of data blocks:
  - Block 3: Polaris does not write this block only for fresh fuel conditions.
  - Block 4: user must complete the feedback parameter information.

- This will be **automatized** in a future release of TXT2NTAB.

- More information can be found in the user **guide**.

2. GUIDE

Input files and data.

- **fueltype.dat** contains the **fuel** type **distribution** for the particular reactor (radial mapping).
- **burnup.dat** only provided for burn-up conditions (no fresh fuel), contains the **burn-up distribution** as a 3D map.
- **input.dat** is the input data provided by the **user** to define the reactor dimensions, segment information, parameters, feedback parameters…
  - Define as many fuel assemblies and segments as needed.
  - Option for cross section extrapolation for low moderator densities.
  - Three neutronic composition options.
  - NEMTAB generation for a specific burn-up point.
  - Optionally, generate GEOM auxiliary file for PARCS.

More information can be found in the user **guide**.

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Input.dat example

- **Structured** with variables and cards.
- **Comments** are available with % symbol.
- In-code **checks** to reduce bugs.
- Whole description in user **guide**.
- And more …

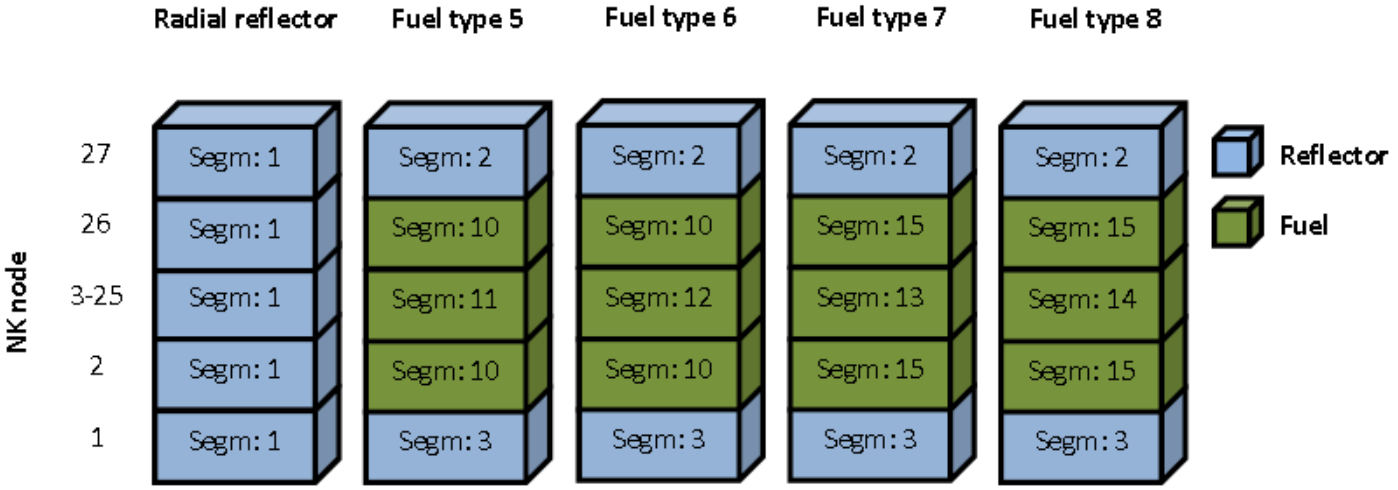
```
%radial reflector
ftyp 1                                  %fuel type for this assembly
segm 1 1 1                              %segment number for this assembly
fuel 0 0 0                              %1 for fuel segments, 0 for reflector segments, nsegm
absz -15.00 0.00 375.00 390.00          %absolute segment height, nsegm+1

%CALCULATION PARAMETERS
pola 1          %optional, 1 if txtfile16 were obtained with Polaris module, 0 otherwise, default is 0 ('
nobu 1          %optional, 1 for fresh fuel, variable burn is then omitted, default is 1
intp linear     %optional, interpolation method accepted by MATLAB: linear or spline, default and recomm
extp 0          %optional, 1 for cross section extrapolation for low moderator densities, default is 0 (:
dlim 0.17075;   %limit for extrapolation, omitted if variable extp is 0
geop 0          %optional, 1 to create GEOM file to be used with PARCS, default is 0
nkop 0          %optional, options are 0, 1 or 2. Option to compute number of neutronic composition, the:

%FEEDBACK PARAMETERS
%to look up in txtfile16
dm16 0.03814 0.17753 0.45632 0.73511 0.84034 0.94281 0.99829 %moderator density, increasing order
tm16 561.4   561.4   561.4   561.4   493     393     293     %moderator temperature for each moderator den:
tf16 293     660.8   879.5   1028.6  1396.5  1764.3  2132.2  %fuel temperature, increasing order
cb16 1935 %scalar only (no variation with boron concentration yet)
```

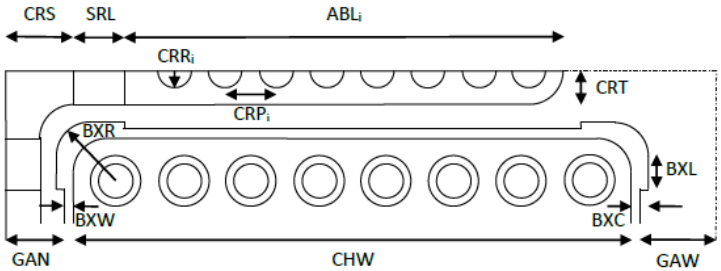
3. EXAMPLE CASE

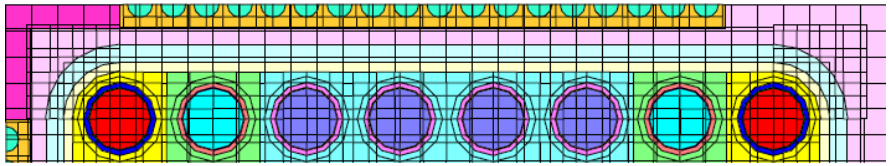
- **Segment information** is given by IBERINCO.
- **Simplified** case to **test** the methodology.
- **Fresh** fuel **conditions** (computational resources).
- 6 fuel segments and 3 reflector segments.
- **Burn-up** conditions **implemented** (interpolation).



3. EXAMPLE CASE

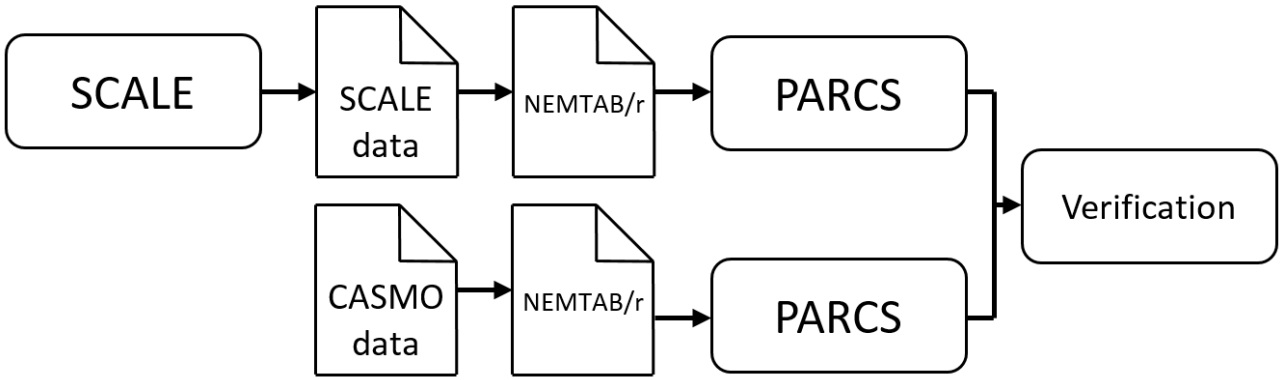
- **Verification** with a code-to-code comparison with **CASMO**.
- CASMO outputs are given by **IBERINCO**.
- A **MATLAB** tool was developed to **translate CASMO** inputs into **SCALE** models.





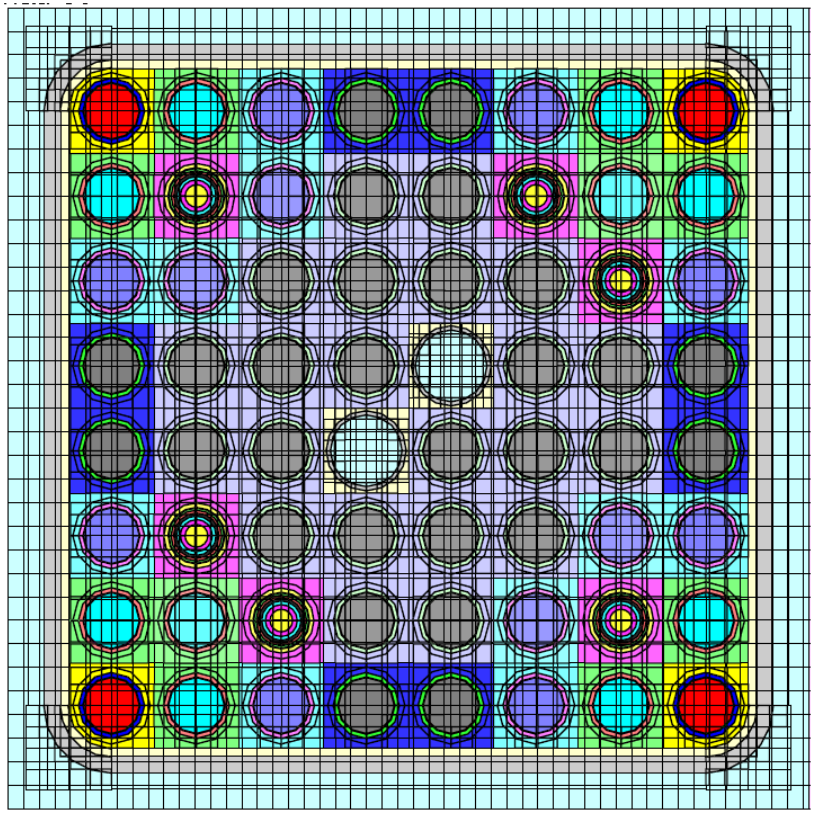
3. EXAMPLE CASE

- **Verification** with a code-to-code comparison with **CASMO**.
- CASMO outputs are given by **IBERINCO**.
- A **MATLAB** tool was developed to **translate CASMO** inputs into **SCALE** models.
- **NEMTABs** can be **obtained** out of CASMO results and out of SCALE results.
- The same **PARCS model** can be run with both NEMTAB sets.
- Results comparison is used to **verify** the process.



3. EXAMPLE CASE

- Example of lattice model translated from CASMO and obtained with MATLAB tool.
- Represents only one segment of the core.



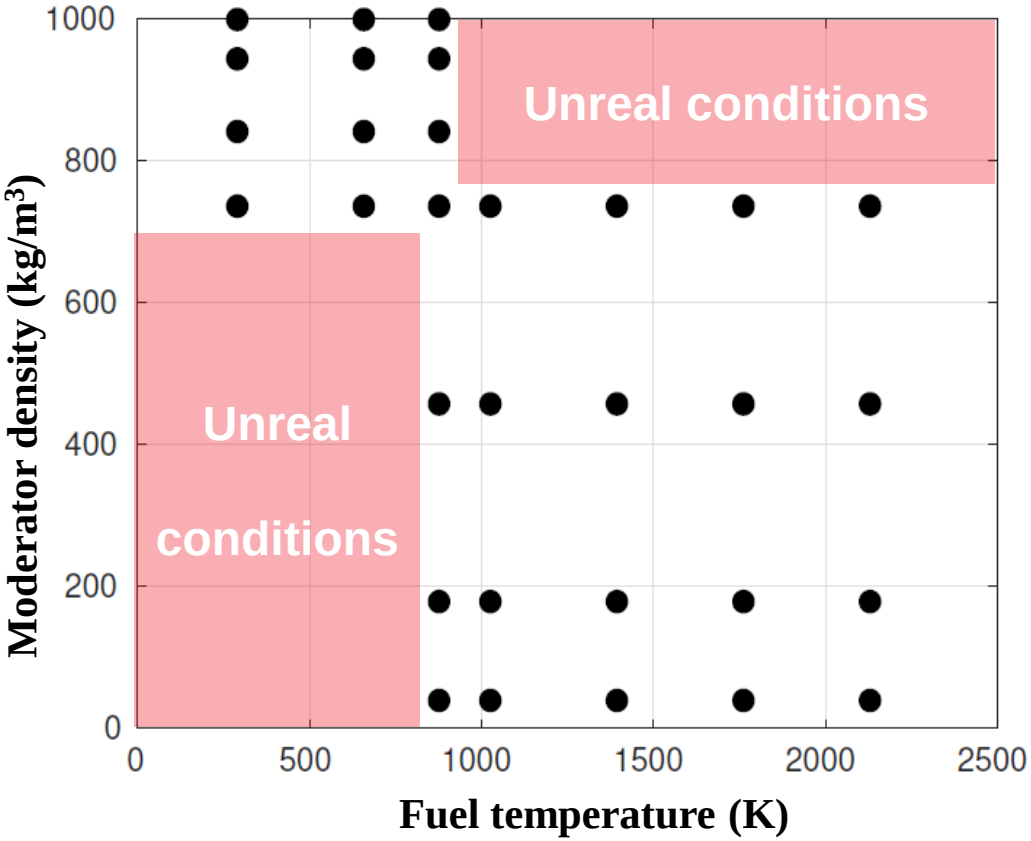
- TRITON-NEWT is used.
- 5 different UO_2 pin types.
- 1 Gd pin type.
- Two water rods.

3. EXAMPLE CASE

- User must decide what **feedback parameters** (branches) to include for each segment.

- Some **branches** can be **discarded** to save computational time.

- However, there is no problem if the user wants to simulate **all branches.**



3. EXAMPLE CASE

Data shown hereafter are full core results obtained with **PARCSv3.2**, either with NEMTABs out of SCALE (with TXT2NTAB) or with NEMTABs out of CASMO.

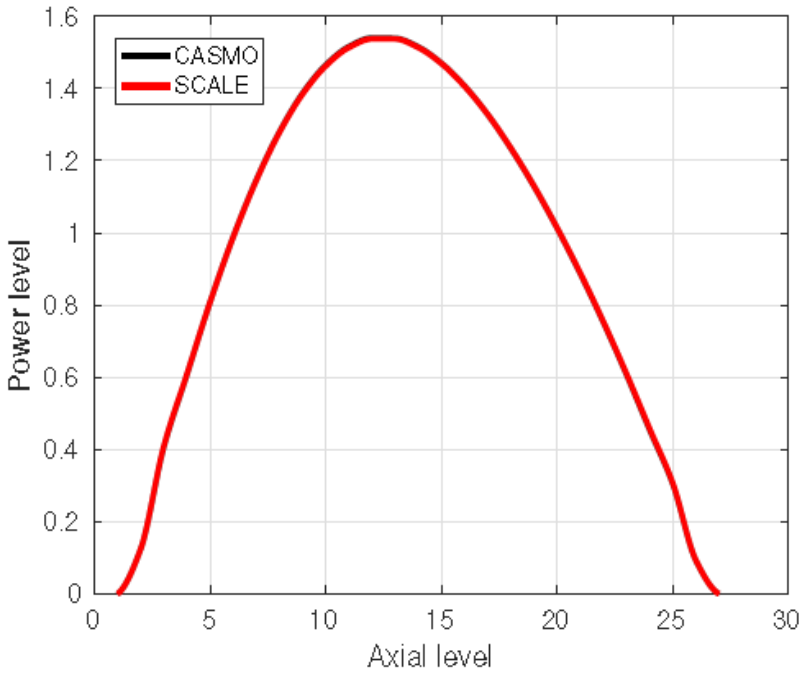
ARO	CASMO	SCALE v7-56		SCALE v7-252	
		Default	MCDANCOFF	Default	MCDANCOFF
k_{eff}	1.03171	1.03601	1.03417	1.03533	1.03416
Error (pcm)	-	429.5	246.0	362.1	**244.9**

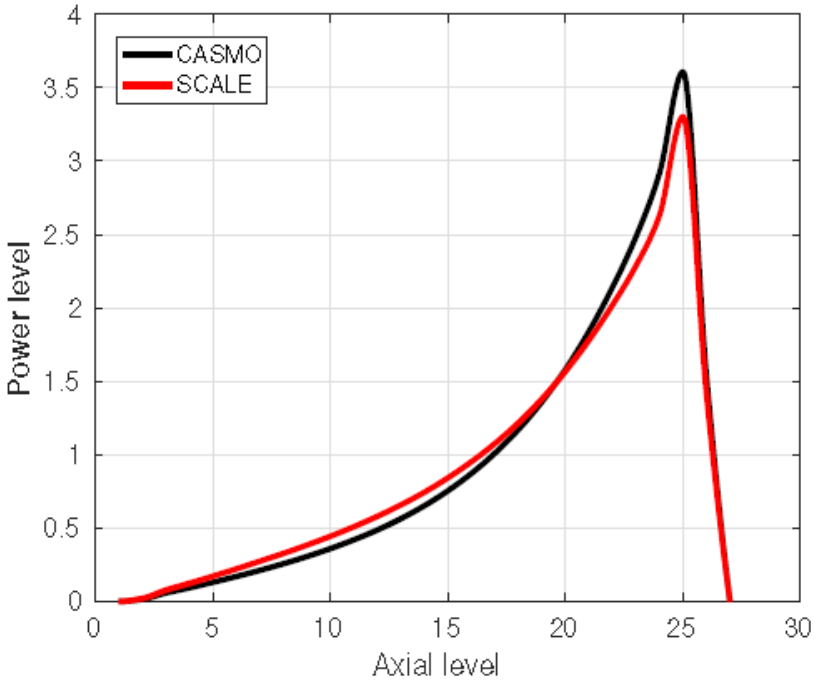
ARI	CASMO	SCALE v7-56		SCALE v7-252	
		Default	MCDANCOFF	Default	MCDANCOFF
k_{eff}	0.79702	0.80023	0.79893	0.80011	0.79925
Error (pcm)	-	321.1	**191.5**	308.9	223.3

3. EXAMPLE CASE

ARO	RMS_{axial} (%)	
	V7-56	V7-252
Default	0.24	**0.21**
MCDANCOFF	0.24	**0.21**

ARI	RMS_{axial} (%)	
	V7-56	V7-252
Default	11.98	**11.53**
MCDANCOFF	12.09	11.56



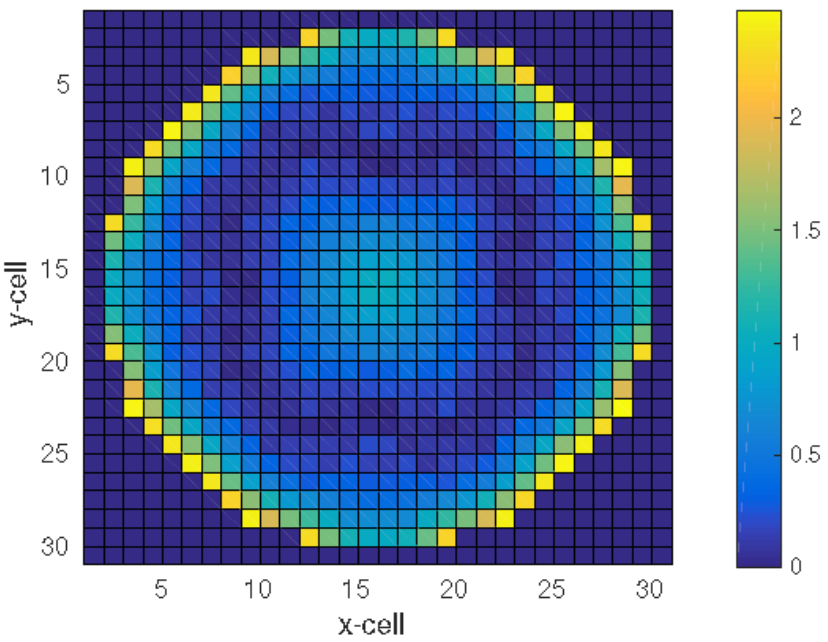


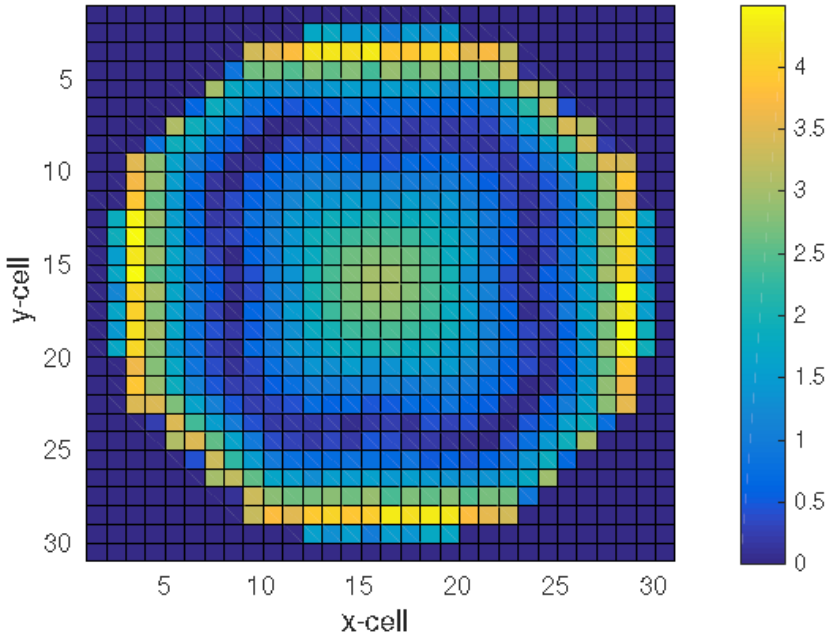
3. EXAMPLE CASE

ARO	RMS_{radial} (%)	
	V7-56	V7-252
Default	0.53	0.53
MCDANCOFF	0.53	0.53

ARI	RMS_{radial} (%)	
	V7-56	V7-252
Default	1.75	1.73
MCDANCOFF	1.74	**1.72**

Absolute radial error (%)





3. EXAMPLE CASE

- With **accurate Dancoff** factors the **k_{eff}** difference is **reduced** almost 50%.
- Their influence over the axial and radial **power** profiles is **negligible**.
- It was found that when accurate Dancoff factors are used, an unexpected **increase** in **memory** was required by **SCALE**.

ARO	k_{eff} (pcm)		RMS_{axial} (%)		RMS_{radial} (%)	
	V7-56	V7-252	V7-56	V7-252	V7-56	V7-252
Default	429.5	362.1	0.24	0.21	0.53	0.53
MCDANCOFF	246.0	244.9	0.24	0.21	0.53	0.53

ARI	k_{eff} (pcm)		RMS_{axial} (%)		RMS_{radial} (%)	
	V7-56	V7-252	V7-56	V7-252	V7-56	V7-252
Default	321.1	308.9	11.98	11.53	1.75	1.73
MCDANCOFF	191.5	223.3	12.09	11.56	1.74	1.72

3. EXAMPLE CASE

- The **master library** has an effect over the k_{eff} (20 – 70 pcms).
- But it is almost **irrelevant** to the power **profiles**.
- In general, the k_{eff} difference is smaller when the **v7-252** is used.

ARO	k_{eff} (pcm)		RMS_{axial} (%)		RMS_{radial} (%)	
	V7-56	V7-252	V7-56	V7-252	V7-56	V7-252
Default	429.5	362.1	0.24	0.21	0.53	0.53
MCDANCOFF	246.0	244.9	0.24	0.21	0.53	0.53

ARI	k_{eff} (pcm)		RMS_{axial} (%)		RMS_{radial} (%)	
	V7-56	V7-252	V7-56	V7-252	V7-56	V7-252
Default	321.1	308.9	11.98	11.53	1.75	1.73
MCDANCOFF	191.5	223.3	12.09	11.56	1.74	1.72

4. CONCLUSIONS

- ✓ TXT2NTAB program is developed to fill the **gap** between SCALE and a core simulator.
- ✓ Problem-dependent cross section libraries in NEMTAB format can be obtained from **TRITON** or **Polaris**.
- ✓ The choice of **feedback parameters** is the user responsibility.
- ✓ Significant **computational time** could be needed with TRITON models (use of Polaris).
- ✓ A **friendly** ASCII user **interface** is used to introduce the data with ease.
- ✓ A user **guide** is provided.

5. ONGOING WORK

TXT2NTAB is actively being updated…

- ✓ For **U&S** analysis. Process **SAMPLER** perturbed txtfile16 to generate…
  - One set of NEMTAB/r with the **average** response.
  - One set of NEMTAB/r with their **standard deviation**.
- ✓ Handle **branches** of **Polaris** without the user intervention.
- ✓ Generate NEMTABs for different **reactor histories**.

THANK YOU!

You can forward any **question** or **comment** to …

cmesado@iqn.upv.es

Besides you can download **TXT2NTAB User Guide**

and the author PhD Thesis here …

goo.gl/nbmxNp

C. Mesado (2017). "*Uncertainty Quantification and Sensitivity Analysis for Cross Sections and Thermohydraulic Parameters in Lattice and Core Physics Codes. Methodology for Cross Section Library Generation and Application to PWR and BWR.*" PhD thesis, Universitat Politècnica de València (UPV).