Comparison evaluation for the total neutron cross section of ^{250}Cf

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Why ^{250}Cf?

- Not many experimental data
- Connected to the A=250 ENSDF
- Triger projects to generate data using the JRTR

Objective

The purpose of this study is to analyze the Time-Of-Flight cross section data in the Unresolved Resonance Region of ^{250}Cf isotope. Energy-differential cross sections and angular-distribution data are treated in the Unresolved Resonance Region. Theoretical cross sections are generated using the Reich-Moore approximation to R-matrix theory.

SAMMY Code

SAMMY Code (OECD)

- The purpose of the code is to analyze the Time-Of-Flight (TOF) cross section data in the Resolved and Unresolved Resonance Regions (RRR, URR), where the incident particle is either a neutron or a charged particle
- In the RRR, theoretical cross sections are generated using the Reich-Moore approximation to R-matrix theory. The experimental situation is described in which data-reduction parameters (e.g. normalization, background, sample thickness) are included. Several options are available for both resolution and Doppler broadening. Self-shielding and multiple-scattering correction options are available for analysis of capture cross sections. Multiple isotopes and impurities within a sample are handled accurately.

•Cross sections in the URR can also be analyzed using SAMMY. The capability was borrowed from Froehner's FITACS code; SAMMY modifications for the URR include more exact calculation of partial derivatives, normalization options for the data, increased flexibility for input of data, introduction of user-friendly input options.

In general, there is a 5-step method to generate data with good acceptance:

Step 1: Investigate and understand the relevant physics of the data

Step 2: Review the body of the available experimental data

Step 3: Fit the measured data with a physically working theory, or with physically reasonable phenomenological model

Step 4: Test the data set against the presumed theory or model

Step 5: Apply the appropriate statistical techniques; such as minimum variance estimation, to obtain the adopted values for the needed quantities.

The experimental data can then be processed by SAMMY using the well-known Bayes method, and then the output can be validated.

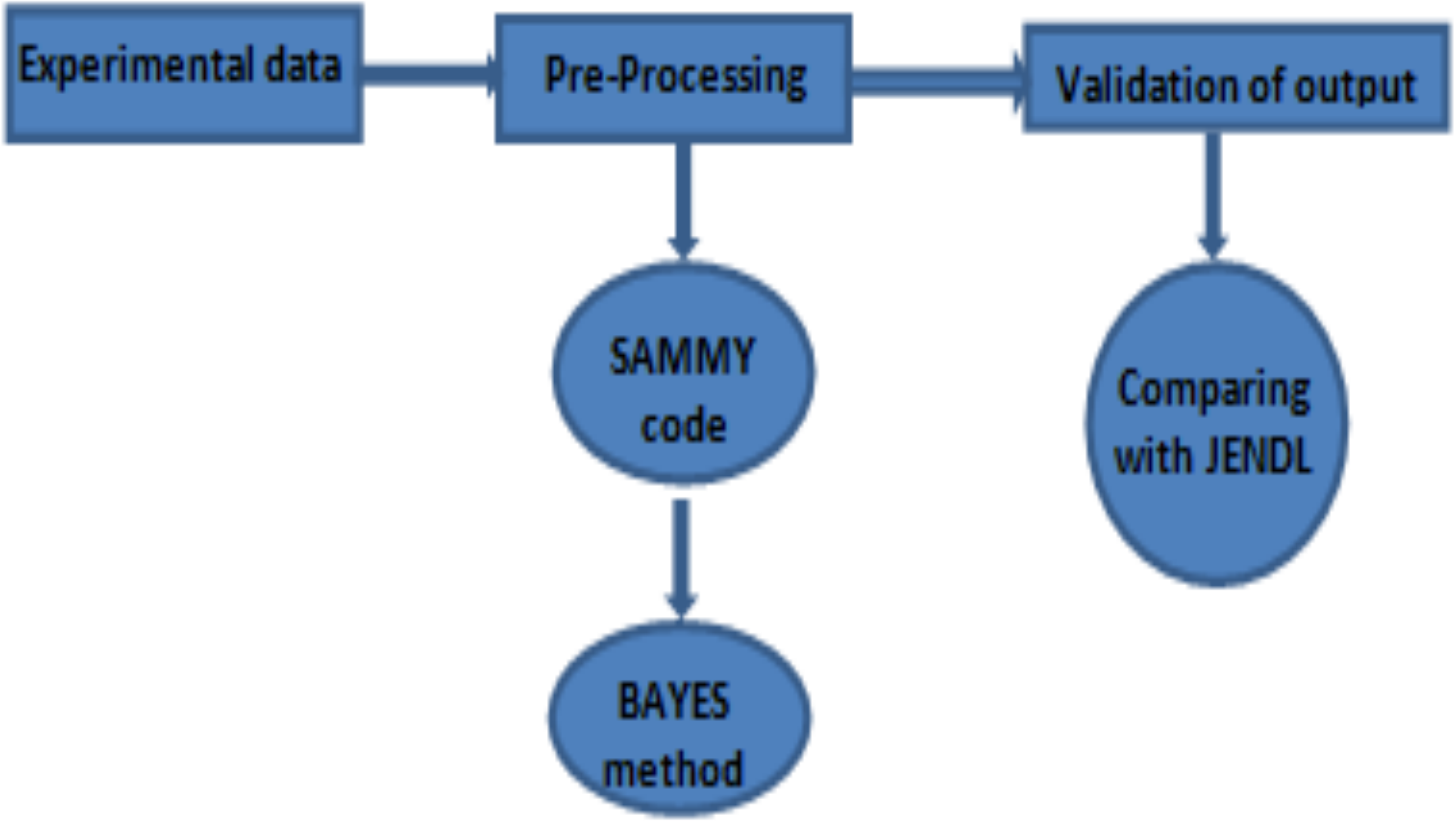


Fig. 1: Flow chart for evaluating experimental nuclear data

Table1. Unresolved resonance parameters for ^{250}Cf (ref. 5)

Quantity	^{250}Cf
Energy range	150 eV- 30 KeV
Scattering radius	9.112 fm
Level spacing	16 eV
S_0	0.0001
S_1	0.0003
Capture width	36.9 MeV
Fission width	0.1 MeV

Table 2. Thermal capture cross sections of ^{250}Cf.

Reference	Capture cross section (barn)
Mugnusson et al.[9]	1500
Folger et al[8]	1500
Halperin et al.[5]	2034 ± 200
Gavrilov et al[6]	1800
This work	1850
Adopted	1730 ± 200

Table 3. Resonance Integrals of radiative capture cross sections of ^{250}Cf

Author	radiative capture cross (barn)
Folger et al.[8]	5300
Halperin et al.[5]	11600
Gavrilov et al.[6]	5000
This work	6300
Adopted	8300 ± 3300

Table 4. Maxwellian-averaged cross sections for the different reactions on ^{250}Cf (barn)

Quantity	JENDL 4.0 [11]	This work
Averaged cross section	208.1	215.3
Total	213.2	210.2
Capture	208.8	209.6
Fission	112.0	109.3
g_t	0.976	0.977
g_c	0.978	0.979
g_f	0.973	0.975

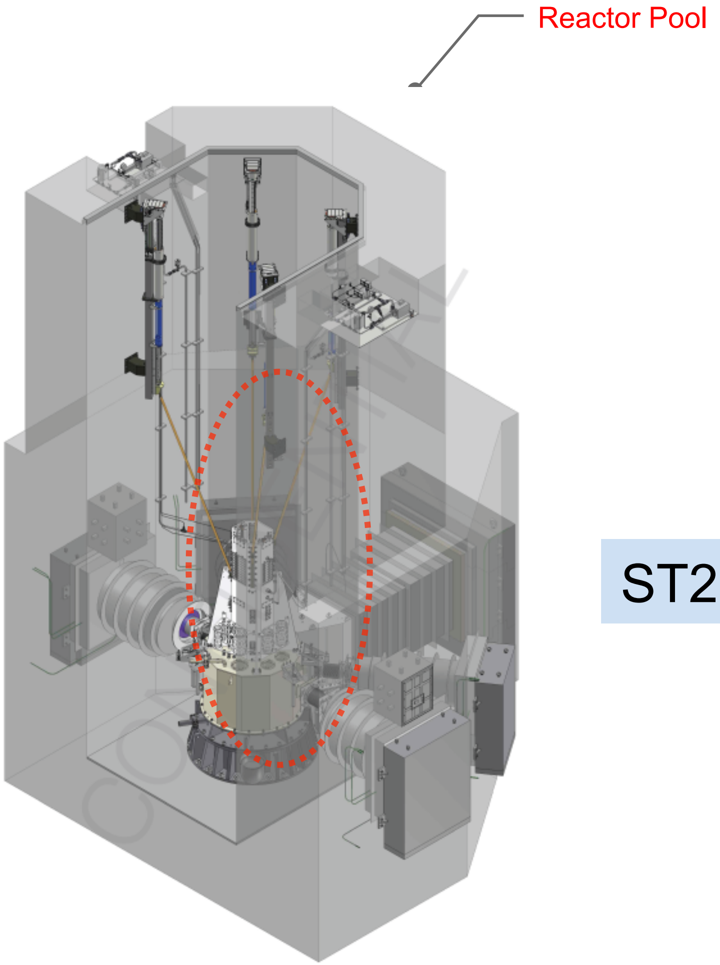
Conclusions

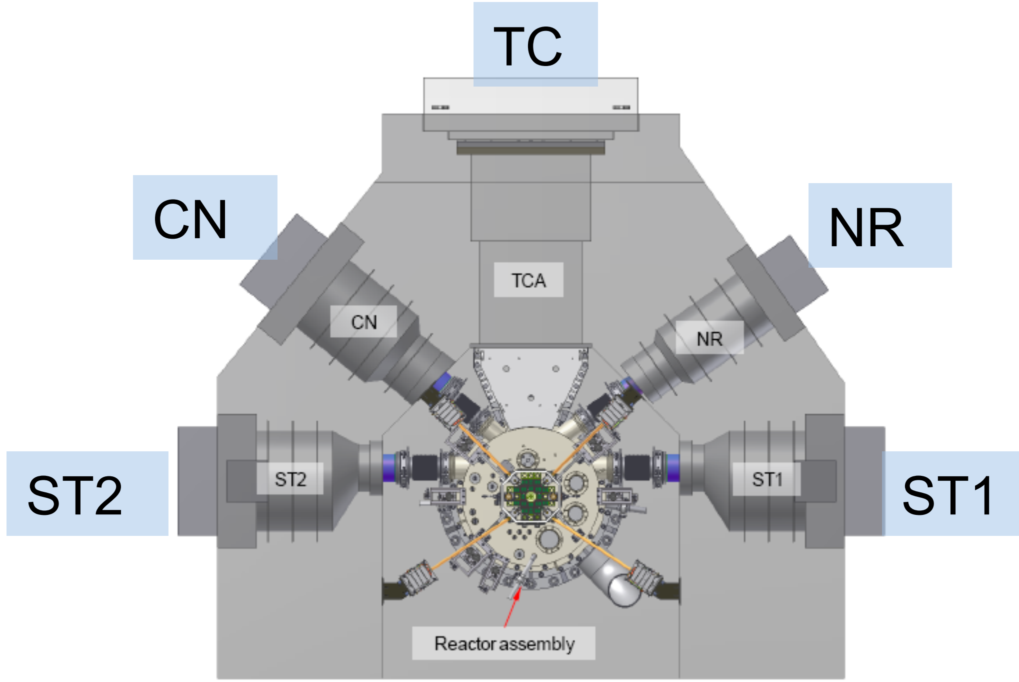
- The evaluation of some important quantities of ^{250}Cf have been investigated
- The thermal capture cross section and the resonance integral capture cross section are in good agreement with the values found in literature
- The thermal benchmark evaluation for the Maxwellian-averaged cross sections of total, capture, and fission reactions along with the Wescott factors are in good agreements with the evaluated values by the Japanese Evaluated Nuclear Data Library.

Jordanian Reactor for Training and Research (JRTR)

Facility Description

Reactor Type	Open Pool
Thermal Power (MW)	5 (upgradable up to 10)
Max. Thermal Neutron Flux ($n/cm^2 \cdot s$)	1.5×10^{14} in the core (central trap) 0.4×10^{14} in the reflector region
Fuel Type & Material	Plate type; 19.75% enriched, U_3Si_2 in Al matrix
Fuel Loading	18 fuel assemblies, 7.0 kg of U^{235} (Equilibrium cycle)♪
Coolant/Moderator Cooling Method	H_2O Downward, forced convection flow
Reflector	Be + D_2O
Utilization	Multipurpose - Neutron beam application (n. science, n. radiography etc.) - Neutron irradiation service (RI production, NAA, NTD, etc.)


Reactor Pool


TC
CN
NR
TCA
CN
NR
ST2
ST2
ST1
ST1
Reactor assembly

Reactor Utilization

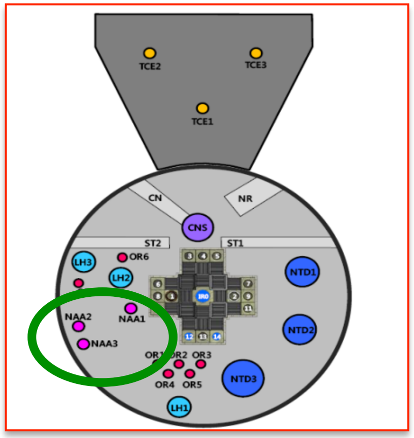
Existing capabilities of JRTR
- Training and Education
- Radioisotopes production
- NAA

Potential capabilities of JRTR
- Cold Neutron
- Neutron Scattering
- Neutron radiography
- Neutron Transmutation Doping

NAA → 15 inner region holes / 7 outer region holes / 3 large irradiation holes

Isotope production → Ir-192: 100,000Ci/year / I-131, 2,000Ci/year / Mo-99/Tc-99m: 1,000Ci/year

Education and Training → Training students , physicists and engineers



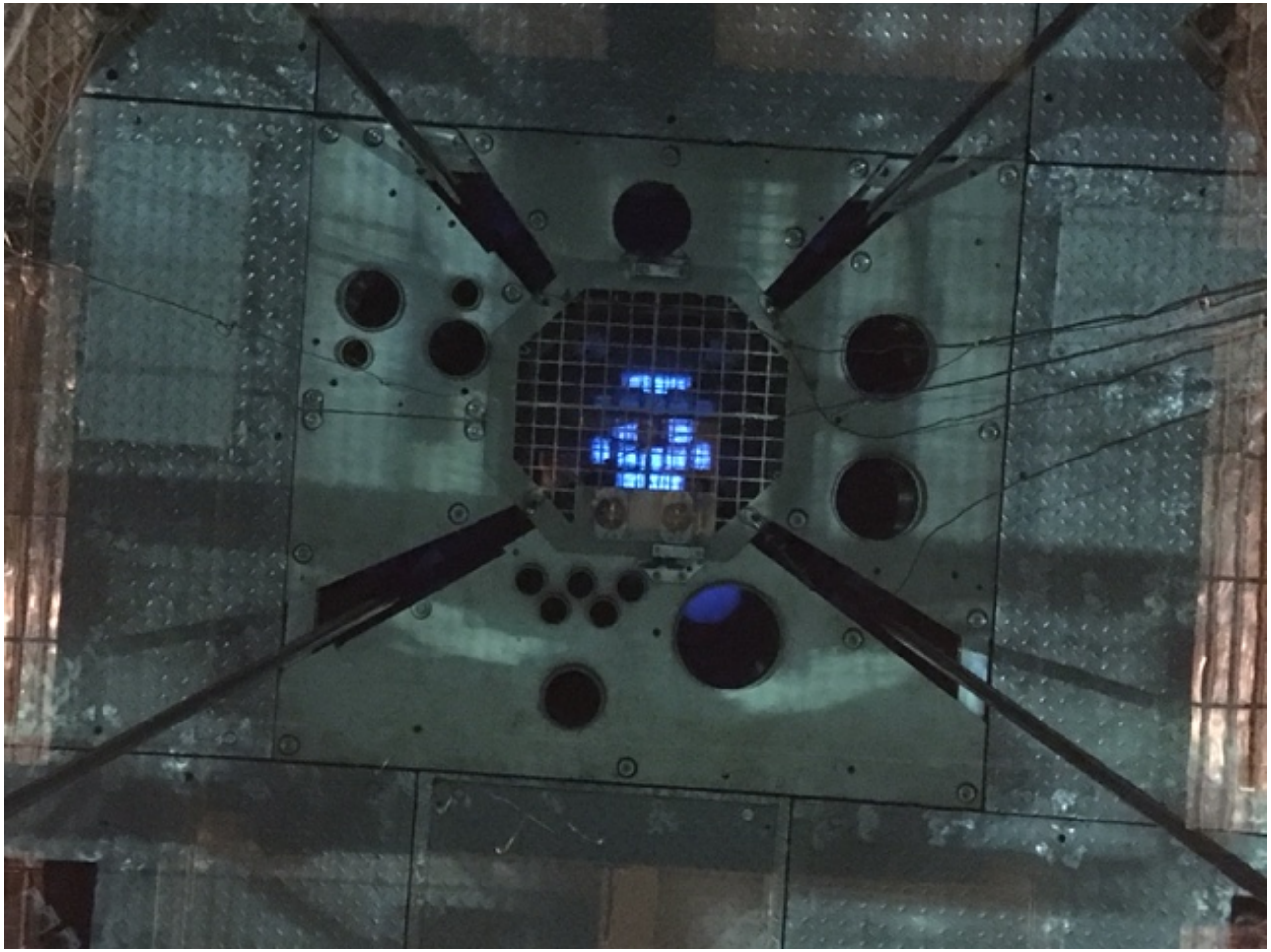
Where are we now?

- ***Commissioning:*** The process during which the performance of reactor components and systems is verified to be in accordance with the design assumptions and meet the operational requirements.
- The commissioning stages of the JRTR are summarized as follows
  1. Stage A1: Construction Acceptance Tests (CATs).
  2. Stage A2:Flushing and System Performance Tests (SPTs).
  3. Stage A3: Integrated System Tests (ISTs).
  4. Stage B: Fuel Loading and Low Power Tests.
     (criticality reached on April 25, 2016)
  5. Stage C: Power Ascension and Full Power Tests.

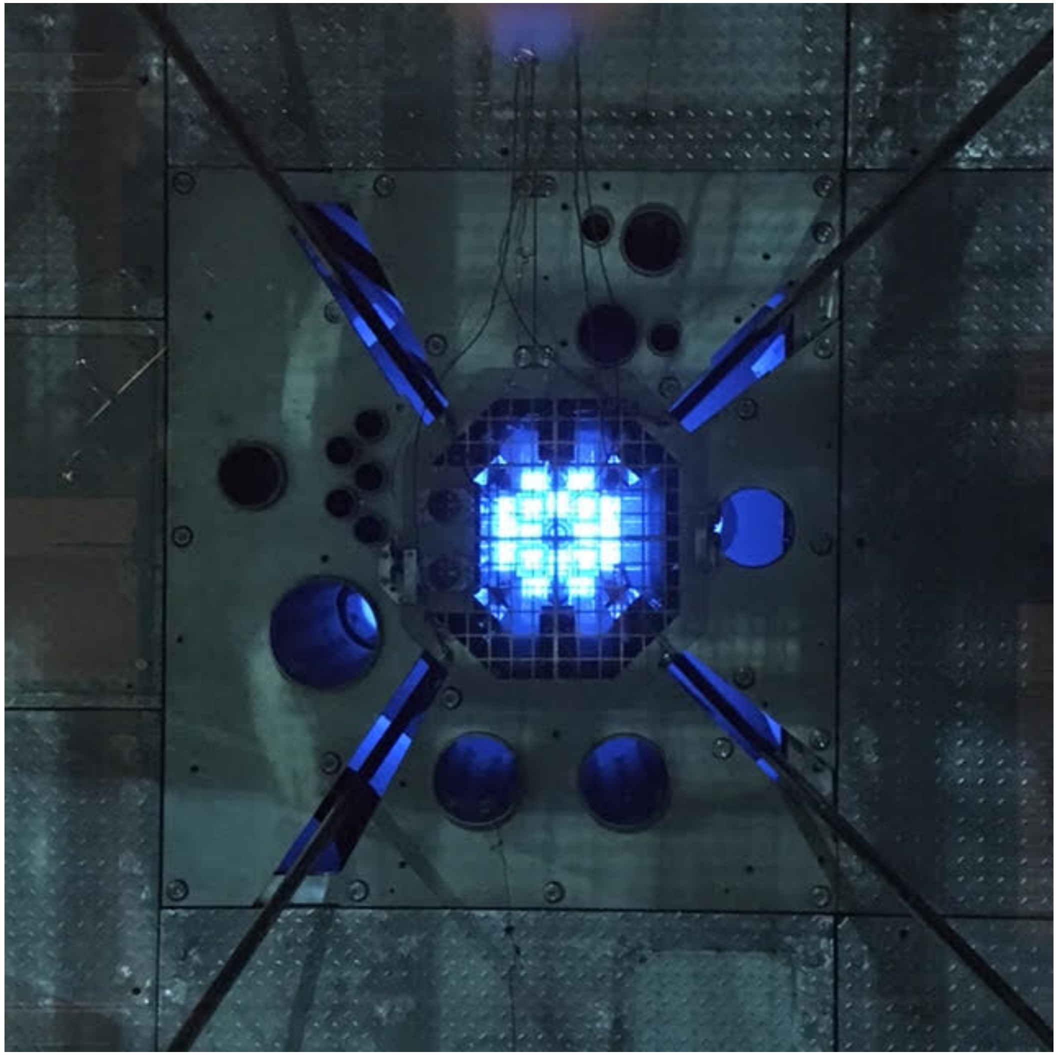
We are currently at this stage!

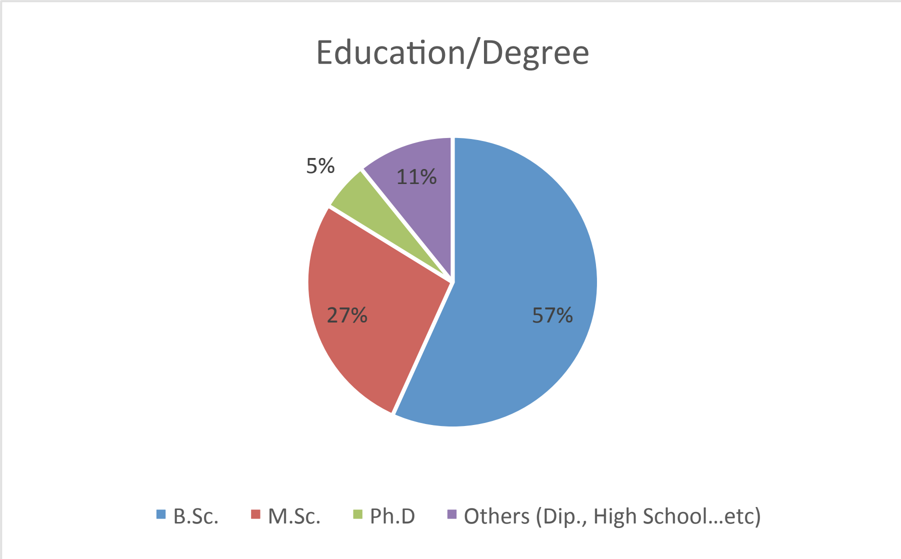
First Cherenkov radiation from the JRTR

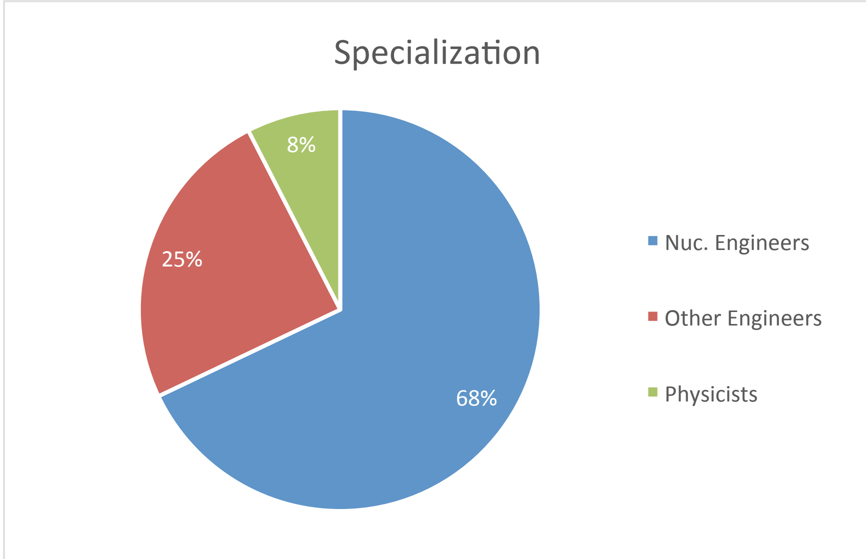
4 am, September 5, 2016



2MW, TUESDAY SEPTMBER 13







Degree	No.
B.Sc.	42
M.Sc.	20
Ph.D.	4
Others (Dip. High school...etc)	8
Total	74

Specialization	No.	Place of Training
Nuc. Engineers	36	(28) Korean trained
Other Engineers	13	(7) Korean trained
Physicists	4	USA & China

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