CIELO 1 and 2 C/E impact on selected integral experiments and consistency with current covariance matrices

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Introduction

- **In the last two decades there has been a significant effort by the neutron cross section evaluators in generating new high quality data and in parallel a large effort has been made for producing covariance matrices to be used mainly in uncertainty analyses and data assimilations.**
- **The need for good quality covariance data was expressed, motivated, and quantified by the users especially in view of reductions of safety margins and economical optimization of advanced reactor designs.**
- **We will look first at what is the performance (i. e. impact on measurement/calculations discrepancy) of two of the most recent and reliable evaluate files: CIELO (aka ENDF/B-VIIIβ4) and CIELO-2 (aka JEFF3.3T3).**
- **For sake of brevity the analysis and impact will be limited to 5 of the isotopes of interest for the CIELO project (^{16}O, ^{56}Fe, ^{235}U, ^{238}U, ^{239}Pu), and ^{23}Na because of its impact in integral parameter like the sodium void reactivity.**
- **Then a consistency of these data with two of the current most used covariance data (COMMARA-2.0 and COMACV1) will be shown.**

CIELO – ENDF/B-VII.0

Background information

- The linearity hypothesis was used and the calculated values related to the CIELO isotopes was derived by using sensitivity coefficients: $C' = C(1+S^*\Delta\sigma/\sigma)$
- CIELO isotopes were downloaded from NNDC as ENDF/B-VIIIβ4.
- Reference values in the following are the corresponding isotopes of ENDF/B-VII.0. This file was the one used for calculating with the most accurate tool (i. e. Monte Carlo) the reference C.
- Both set of files were processed in exactly the same way infinite dilution cross sections using the latest (.84) version of NJOY2012.
- An initial large set of 158 experiments was used. This set includes not only criticality and reaction rate (spectral index) measurements but also sample irradiations, reactivity measurements and neutron propagation experiments. Results shown are limited only to the most significant ones and will not include the energy breakdown, even though this information is available.
- Color codes:
  - (blue) large values differences
  - (yellow) compensations
  - (green) both large differences and compensations

LANL Criticals C/E

EXPERIMENT	ENDF/B-VII.0	CIELO	Differ. %
JEZEBEL K_{eff}	0.99986	0.99915	-0.071
JEZEBEL F28/F25	0.97700	0.98921	1.250
GODIVA K_{eff}	0.99983	1.00061	0.078
GODIVA F28/F25	0.95500	0. 96506	1.054
FLATTOP K_{eff}	1.00097	0.99750	-0.346
FLATTOP F28/F25	0.98220	0.99430	1.232
BIGTEN K_{eff}	1.00002	1.00024	0.022
BIGTEN F28/F25	0.94700	0.94535	-0.175
BIGTEN F37/F25	0.96700	0.93536	-3.272

LANL Criticals Breakdown

FLATTOP K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	-0.091	0.198	0.036	-0.488	0.078	-0.042	-0.002	-0.301
^{239}Pu	-0.004	-	-0.060	-	0.089	-0.085	0.016	-0.044
Total	-0.092	0.196	-0.024	-0.488	0.169	-0.128	0.021	-0.346

BIGTEN K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.018	0.072	-0.081	-0.002	0.128	-0.047	-0.302	-0.214
^{238}U	-0.035	0.085	0.232	-0.164	0.229	-0.137	0.027	0.237
Total	-0.017	0.157	0.151	-0.167	0.357	-0.184	-0.274	0.022

BIGTEN F37/F25 Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	-0.016	0.164	0.130	0.011	-0.194	-	-0.748	-0.654
^{238}U	-0.044	-2.120	-0.247	-0.059	-0.020	0.001	-0.130	-2.620
Total	-0.061	-1.956	-0.116	-0.047	-0.214	0.002	-0.878	-3.272

ZPPRs C/E

EXPERIMENT	ENDF/B-VII.0	CIELO	Differ. %
ZPPR-9 K_{eff}	0.99922	0.99822	-0.101
ZPPR-9 F28/F25	0.97100	0.97340	0.247
ZPPR-9 C28/F25	1.00930	0.99678	-1.240
ZPPR-9 STEP 3	1.01920	1.04325	2.359
ZPPR-9 STEP 5	0.97320	1.00802	3.578
ZPPR-10 K_{eff}	1.00015	0.99895	-0.120
ZPPR-10 STEP 2	1.15898	1.19221	2.868
ZPPR-10 STEP 3	1.05639	1.08798	2.991
ZPPR-10 STEP 6	1.03665	1.07358	3.562
ZPPR-10 STEP 9	1.00826	1.05087	4.226
ZPPR-10 Central Control Rod	1.06700	1.06166	-0.500
ZPPR-15 K_{eff}	0.99873	0.99996	0.123

ZPPRs Breakdown

ZPPR-9 K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-	-0.117	-0.116	0.098	-	-	-	-0.134
^{238}U	-0.009	-0.040	0.242	-0.035	0.124	-0.080	0.003	0.205
^{239}Pu	-	-	-0.065	-	0.023	0.075	0.024	-0.094
Total	0.014	-0.156	-0.093	0.064	0.150	-0.156	0.022	-0.101

ZPPR-9 F28/F25 Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-0.001	-0.879	0.204	-0.117	-	-	-	-0.793
^{238}U	0.012	0.136	-0.376	0.015	1.387	-0.002	-0.012	1.159
^{239}Pu	-	-	0.081	-	-0.046	-	0.205	-0.241
Total	-0.150	0.639	0.309	0.005	-0.872	0.003	-0.164	-0.230

ZPPR-9 C28/F25 Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	-	-	-0.003	-	-0.361	-	0.002	-0.362
^{238}U	-0.002	0.026	-0.870	-	-	-	0.006	-0.840
^{239}Pu	-	-	-0.008	-	-0.060	-	-0.008	-0.077
Total	-0.020	0.078	-0.889	-	-0.421	-	-	-1.240

ZPPRs Breakdown

ZPPR-9 STEP3 Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	0.827	-	0.494	-0.001	-	-	-	0.331
^{56}Fe	-0.024	-0.778	0.549	-0.084	-	-	-	-0.346
^{238}U	0.005	0.553	-1.214	-0.009	0.118	-0.110	-0.018	-1.781
^{239}Pu	0.004	-	0.336	-	3.604	0.298	0.021	4.262
Total	0.802	1.327	-0.892	-0.094	3.679	0.189	0.001	2.359

ZPPR-10 STEP9 Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	0.712	-	-0.569	0.002	-	-	-	0.145
^{56}Fe	-0.056	-0.895	0.896	0.684	-	-	-	0.629
^{238}U	-0.071	-0.500	-1.681	-0.310	0.253	-0.185	-0.013	-2.508
^{239}Pu	0.004	-	-0.462	-	5.219	0.379	0.034	6.098
Total	0.503	-1.391	-0.981	0.375	5.421	-0.194	0.088	4.226

ZPPR-10 Step9 Major Contributions:

^{239}Pu fission: 2.03 kev to 1.23 kev (4.685%) ^{238}U capture: 1.23 kev to 0.749 kev (-1.243%)

ZPRs C/E

EXPERIMENT	ENDF/B-VII.0	CIELO	Differ. %
ZPR6/7 K_{eff}	1.00043	0.99877	-0.166
ZPR6/7 F28/F25	1.00450	1.00601	0.150
ZPR6/7 C28/F25	1.00980	0.99720	-1.247
ZPR6/6A K_{eff}	0.99876	0.99997	0.121
ZPR9-34 Keff	1.00882	1.02879	1.980
ZPR3-53 Keff	1.00923	1.00760	-0.162
ZPR3-54 Keff	1.01202	1.02742	1.522

ZPRs Breakdown

ZPR6/7 K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.001	-0.112	-0.142	0.124	-	-	-	-0.129
^{238}U	-0.014	-0.016	0.225	-0.050	0.111	-0.070	0.004	0.188
^{239}Pu	-	-	-0.070	-	-0.003	-0.077	0.019	-0.125
Total	0.011	0.110	-0.057	0.002	-0.070	0.149	-0.014	-0.166

ZPR9-34 K_{eff} (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.011	0.202	-1.054	2.504	-	-	-	1.662
^{235}U	0.014	0.006	0.140	-0.005	0.154	-0.088	0.089	0.311
Total	0.025	0.207	-0.906	2.498	0.155	-0.088	0.089	1.980

ZPR3-54 K_{eff} (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.007	0.106	-0.194	1.788	-	-	-	1.707
^{238}U	-0.006	0.034	0.101	-0.022	0.045	-0.029	0.005	0.130
^{239}Pu	-0.001	-	-0.136	-	-0.072	-0.110	0.001	-0.317
Total	0.001	0.140	-0.227	1.766	-0.025	-0.139	0.006	1.522

Irradiation Experiments C/E

EXPERIMENT	ENDF/B-VII.0	CIELO	Differ. %
PROFIL-1 ^{235}U Sample	0.94900	0.93796	-1.163
PROFIL-1 ^{238}U Sample	0.97200	0.95944	-1.293
PROFIL-1 ^{239}Pu Sample	0.90600	0.91546	1.045
TRAPU-2 ^{235}U Sample	0.99500	0.99204	-0.297
TRAPU-2 ^{238}U Sample	1.01200	1.01520	0.316
TRAPU-2 ^{239}Pu Sample	0.98400	0.98801	0.408
MANTRA Cd Filter ^{235}U Sample	0.97000	0.98510	1.556
MANTRA Cd Filter ^{238}U Sample	1.03000	1.02730	-0.262
MANTRA Cd Filter ^{239}Pu Sample	1.04000	1.04091	0.088

FCA-IX C/E

EXPERIMENT	ENDF/B-VII.0	CIELO	Differ. %
FCA-IX-1 F42/F49	1.04700	1.03538	-1.110
FCA-IX-1 F51/F49	0.94800	0.93638	-1.225
FCA-IX-1 F53/F49	0.92000	0.90813	-1.290
FCA-IX-6 F42/F49	1.03700	1.02552	-1.111
FCA-IX-6 F51/F49	0.92900	0.91855	-1.125
FCA-IX-6 F53/F49	0.90700	0.89673	-1.132
FCA-IX-7 F42/F49	1.04700	1.01924	-2.651
FCA-IX-7 F51/F49	0.93400	0.91020	-2.548
FCA-IX-7 F53/F49	0.93700	0.91239	-2.626

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FCA-IX Breakdown

FCA-IX-1 F53/F49 Difference (%)								
Isotope/Reaction	**Elast.**	**Inel.**	**Capt.**	**P_1 Elas**	**Fiss.**	**Nubar**	**χ**	**Sum**
^{56}Fe	-0.013	-0.337	0.064	-0.006	-	-	-	-0.297
^{235}U	-0.007	0.535	-0.436	0.005	0.467	-0.005	-1.740	-1.180
^{239}Pu	-	-	-	-	0.206	-	--	0.206
Total	0.005	0.157	-0.427	0.060	0.647	0.009	-1.741	-1.290

FCA-IX-6 F53/F49 Difference (%)								
Isotope/Reaction	**Elast.**	**Inel.**	**Capt.**	**P_1 Elas**	**Fiss.**	**Nubar**	**χ**	**Sum**
^{56}Fe	-0.026	-0.530	-0.001	0.001	-	-	-	-0.556
^{235}U	0.070	1.064	0.050	0.045	0.052	-0.005	-1.364	-0.089
^{238}U	0.019	-0.259	-0.053	0.058	-0.042	0.023	-0.010	-0.264
^{239}Pu	-	-	-	-	-0.222	-	--	-0.222
Total	0.063	0.275	-0.004	0.103	-0.213	0.017	-1.375	-1.132

FCA-IX-7 F53/F49 Difference (%)								
Isotope/Reaction	**Elast.**	**Inel.**	**Capt.**	**P_1 Elas**	**Fiss.**	**Nubar**	**χ**	**Sum**
^{56}Fe	-0.004	-0.119	-	-0.016	-	-	-	-0.139
^{235}U	-0.016	0.628	0.065	0.021	0.055	-0.001	-1.158	-0.406
^{238}U	0.003	-1.589	-0.131	0.011	-0.025	0.005	-0.088	-1.815
^{239}Pu	-	-	-	-	-0.267	-	--	-0.267
Total	-0.017	-1.080	-0.067	0.016	0.237	0.004	-1.246	-2.626

PROTEUS C/E

EXPERIMENT	ENDF/B-VII.0	CIELO	Differ. %
C7 K_{eff}	1.00973	1.00850	-0.122
C7 F25/F49	1.01480	1.0297	1.469
C8 K_{eff}	0.99452	0.99311	-0.142
C8 C28/F49	1.02257	1.01385	-0.853
C8 F28/F49	0.99539	1.00241	0.705
PROTEUS Void	0.57696	0.56835	-1.149

PROTEUS Breakdown

PROTEUS C7 K_{eff} (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	0.037	-	-0.228	-	-	-	-	-0.191
^{238}U	0.005	-0.015	0.184	-0.003	0.074	-0.057	0.008	0.195
^{239}Pu	-0.001	-	-0.095	-	0.119	-0.122	0.017	-0.082
Total	0.039	0.050	-0.170	0.015	0.233	-0.204	0.014	-0.122

PROTEUS C8 F28/F49 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	0.003	-	-0.183	-0.027	-	-	-	-0.206
^{238}U	0.023	0.366	-0.277	0.016	1.340	0.005	-0.001	1.472
^{239}Pu	-0.001	-	0.061	-	-0.268	-0.001	0.146	-0.064
Total	0.020	-0.026	-0.335	0.072	1.077	0.005	0.036	-0.704

PROTEUS Water Void Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	10.099	-	0.866	2.027	-	-	-	12.992
^{56}Fe	-0.064	-4.399	-2.414	-10.370	-	-	-	-17.247
^{235}U	-0.076	0.244	0.507	-0.011	-2.646	1.696	-0.957	-1.244
^{238}U	-0.186	-11.437	4.661	0.037	3.967	-2.707	-0.767	-6.414
^{239}Pu	0.030	-	1.883	-	1.946	6.003	0.575	10.438
Total	9.804	-15.592	5.503	-8.318	-3.267	4.992	-1.149	-1.492

ASPIS C/E

EXPERIMENT	ENDF/B-VII.0	CIELO	Differ. %
ASPIS FE-88 Al (n,α) A7	1.35100	1.14824	-15.001
ASPIS FE-88 S (n,p) A7	0.97900	0.77341	-21.000
ASPIS FE-88 S (n,p) A12	0.93900	0.59465	-36.671
ASPIS FE-88 S (n,p) A14	0.91600	0.52646	-42.526
ASPIS FE-88 In (n,inel) A7	0.97400	0.86890	-10.790
ASPIS FE-88 In (n,inel) A11	0.96800	0.85420	-11.758
ASPIS FE-88 Rh (n,inel) A7	1.05400	0.99919	-5.200
ASPIS FE-88 Rh (n,inel) A14	1.09900	1.04912	4.539
ASPIS FE-88 Au (n,γ) A7	1.00700	0.95060	-5.601
ASPIS FE-88 Au (n,γ) A11	1.02400	0.94939	-7.286
ASPIS FE-88 Au (n,γ) A14	1.05100	0.96495	-8.188

ASPIS Breakdown

ASPIS FE-88 Al (n,α) A7 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	3.247	-16.764	1.138	0.753	-	-	-	-11.626
^{235}U	0.003	0.006	--	-	-	-	-3.392	-3.382
Total	3.250	-16.758	--1.138	0.753	-	-	-3.392	-15.008

ASPIS FE-88 S (n,p) A14 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	5.292	-40.446	0.274	-5.493	-	-	-	-40.372
^{235}U	-	-	--	-	-	-	-2.177	-2.153
Total	5.295	-40.425	0.274	-5.493	-	-	-2.177	-42.526

ASPIS FE-88 In (n,inel) A11 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.060	-11.054	0.331	-	-	-	-	-10.663
^{235}U	-	-	--	-	-	-	-1.110	-1.093
Total	0.061	-11.038	0.331	-	-	-	-1.110	-11.758

ASPIS FE-88 Rh (n,inel) A7 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-0.038	-4.542	0.241	-	-	-	-	-4.366
^{235}U	-	-	--	-	-	-	-0.846	-0.834
Total	-0.037	-4.532	0.215	-	-	-	-0.846	-5.200

ASPIS FE-88 Au (n,γ) A14 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-0.020	-0.092	-8.128	-	-	-	-	-8.240
Total	-0.020	-0.092	-8.128	-	-	-	-	-8.188

Summary of CIELO – ENDF/B-VII.0

- **Regarding experiments, this exercise has shown that the experiments other than critical masses (e. g. spectral indices, irradiation experiments, reactivity coefficients, and neutron propagation) provide extremely useful information.**
- **Many compensations have been observed among reactions and also energy range (not shown in viewgraphs).**
- **Regarding the 5 isotopes, the major impacts are related to:**
  - **^{16}O: elastic, (n,α), P_1 elastic. Only few experiments are sensitive.**
  - **^{56}Fe: elastic, inelastic, capture, P_1 elastic. Propagation experiments are the most sensitive.**
  - **^{235}U: inelastic, capture, fission, fission spectrum**
  - **^{238}U: inelastic, capture, P_1 elastic, fission, nubar**
  - **^{239}Pu: capture, fission, nubar, fission spectrum (in general lesser impact than the other isotopes)**

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CIELO-2 – CIELO

Background information

- **The linearity hypothesis was used and the calculated values related to the CIELO isotopes was derived by using sensitivity coefficients: C'=C(1+S*$\Delta\sigma/\sigma$)**
- **CIELO-2 isotopes were provided by NEA (Oscar Cabellos) as JEFF3.3T3**
- **Reference values in the following are the corresponding isotopes of ENDF/B-VII.0. This file was the one used for calculating with the most accurate tool (i. e. Monte Carlo) the reference C.**
- **Both set of files were processed in exactly the same way infinite dilution cross sections using the latest (.84) version of NJOY2012.**
- **Color codes:**
  - **large values differences**
  - **compensations**
  - **both large differences and compensations**

LANL Criticals C/E

EXPERIMENT	CIELO-2	CIELO	Differ. %
JEZEBEL K_{eff}	0.99857	0.99915	-0.085
JEZEBEL F28/F25	0.98591	0.98921	-0.317
GODIVA K_{eff}	0.99640	1.00061	-0.405
GODIVA F28/F25	0.96704	0. 96506	0.278
FLATTOP K_{eff}	1.00170	0.99750	0.411
FLATTOP F28/F25	0.98474	0.99430	-0.968
BIGTEN K_{eff}	1.00351	1.00024	0.371
BIGTEN F28/F25	0.91237	0.94535	-3.537
BIGTEN F37/F25	0.95790	0.93536	2.097

LANL Criticals Breakdown

JEZEBEL K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.318	-0.790	0.035	0.228	0.256	-0.040	-0.093	-0.085

FLATTOP K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	0.331	-0.322	0.167	0.364	-0.077	0.044	-	0.508
^{239}Pu	0.125	-0.293	0.037	0.075	0.231	-0.180	-0.083	-0.089
Total	0.457	-0.617	-0.200	0.439	0.153	-0.138	-0.083	0.411

BIGTEN K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.002	0.016	-0.285	-0.002	-0.088	-0.154	-0.039	-0.472
^{238}U	0.231	-0.521	0.967	0.230	-0.204	0.141	-0.001	0.842
Total	0.233	-0506	0.683	0.228	-0.292	-0.013	-0.038	0.371

ZPPRs C/E

EXPERIMENT	CIELO-2	CIELO	Differ. %
ZPPR-9 K_{eff}	1.00717	0.99822	0.743
ZPPR-9 F28/F25	0.94557	0.97340	-2.858
ZPPR-9 C28/F25	0.97243	0.99678	-2.445
ZPPR-9 STEP 3	1.08347	1.04325	3.810
ZPPR-9 STEP 5	1.04646	1.00802	3.502
ZPPR-10 K_{eff}	1.00781	0.99895	0.722
ZPPR-10 STEP 2	1.24222	1.19221	4.162
ZPPR-10 STEP 3	1.13359	1.08798	4.157
ZPPR-10 STEP 6	1.11881	1.07358	4.074
ZPPR-10 STEP 9	1.09551	1.05087	3.987
ZPPR-10 Central Control Rod	1.06085	1.06166	-0.106
ZPPR-15 K_{eff}	1.01221	0.99996	1.007

ZPPRs Breakdown

ZPPR-9 K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.012	0.181	0.105	-0.095	-	-	-	0.204
^{238}U	0.035	0.004	0.571	0.049	-0.130	0.085	0.007	0.621
^{239}Pu	0.004	0.067	0.159	0.005	0.273	-0.661	-0.143	-0.296
Total	0.054	0.317	0.886	0.054	0.146	-0.578	-0.135	0.743

ZPPR-9 F28/F25 Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-0.074	1.524	-0.166	0.101	-	-	-	1.385
^{238}U	-0.051	-0.990	-0.827	-0.059	-1.438	0.003	0.044	-3.319
^{239}Pu	-0.007	0.323	-0.278	-0.006	-0.046	-0.012	-1.127	-0.981
Total	-0.360	1.421	-1.173	-0.063	-1.592	-0.009	-1.081	-2.858

ZPPR-15 K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.028	0.249	0.152	-0.232	-	-	-	0.194
^{238}U	0.082	0.093	0.616	0.095	-0.115	0.068	0.006	0.845
^{239}Pu	0.008	0.077	0.142	0.009	0.281	-0.652	-0.122	-0.257
Total	0.149	0.464	0.893	0.028	0.167	-0.586	-0.114	1.001

ZPPRs Breakdown

ZPPR-9 STEP3 Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	-0.840	-	0.317	0.001	-	-	-	-0.523
^{23}Na	-0.964	-2.772	-0.244	0.014	-	-	-	-3.478
^{56}Fe	-0.035	1.029	-0.084	-0.056	-	-	-	0.853
^{238}U	-0.008	1.066	1.113	-0.020	0.001	0.205	0.053	2.409
^{239}Pu	0.008	0.586	3.143	0.009	-0.089	1.041	-0.114	4.583
Total	-1.841	0.095	4.709	-0.051	-0.109	1.257	-0.060	3.810

ZPPR-10 STEP9 Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	-0.723	-	0.366	-0.005	-	-	-	-0.362
^{23}Na	-1.151	-3.352	0.310	-1.294	-	-	-	-5.487
^{56}Fe	-0.116	1.191	-0.183	-0.794	-	-	-	0.329
^{238}U	0.334	0.820	1.321	0.309	-0.107	0.308	0.068	3.052
^{239}Pu	0.048	0.677	4.556	0.040	-0.037	1.382	-0.170	6.497
Total	-1.377	-0.667	6.342	-1.744	-0.170	1.704	-0.101	3.987

ZPRs C/E

EXPERIMENT	CIELO-2	CIELO	Differ. %
ZPR6/7 K_{eff}	1.00833	0.99877	0.779
ZPR6/7 F28/F25	0.98358	1.00601	-2.187
ZPR6/7 C28/F25	0.97317	0.99720	-2.419
ZPR6/6A K_{eff}	1.00558	0.99997	0.438
ZPR9-34 Keff	1.03660	1.02879	-0.919
ZPR3-53 Keff	1.00862	1.00760	0.107
ZPR3-54 Keff	1.02438	1.02742	-1.258

ZPRs Breakdown

ZPR6/7 K_{eff} Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.017	0.177	0.127	-0.117	-	-	-	0.204
^{238}U	0.059	0.002	0.529	0.075	-0.114	0.074	0.005	0.629
^{239}Pu	0.005	0.051	0.165	0.007	0.271	-0.675	-0.122	-0.298
Total	0.010	0.290	0.873	0.076	0.159	-0.603	-0.116	0.779

ZPR9-34 K_{eff} (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.108	-0.192	0.919	-1.053	-	-	-	-0.218
^{235}U	-0.005	0.067	-0.683	-0.002	0.087	-0.178	-0.012	-0.724
Total	0.108	-0.125	0.248	-1.048	0.086	-0.178	-0.012	-0.919

ZPR3-54 K_{eff} (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	0.143	-0.143	0.145	-0.974	-	-	-	-0.829
^{239}Pu	0.015	-0.085	-0.064	0.014	0.281	-0.658	-	-0.494
Total	0.173	0.268	0.181	-0.941	0.229	-0.630	-0.002	-1.258

Irradiation Experiments C/E

EXPERIMENT	CIELO-2	CIELO	Differ. %
PROFIL-1 ^{235}U Sample	0.99289	0.93796	5.677
PROFIL-1 ^{238}U Sample	0.94378	0.95944	-1.654
PROFIL-1 ^{239}Pu Sample	0.88081	0.91546	-3.581
TRAPU-2 ^{235}U Sample	1.04660	0.99204	5.398
TRAPU-2 ^{238}U Sample	1.00407	1.01520	-0.475
TRAPU-2 ^{239}Pu Sample	0.97543	0.98801	-1.191
MANTRA Cd Filter ^{235}U Sample	0.97844	0.98510	-0.547
MANTRA Cd Filter ^{238}U Sample	1.02597	1.02730	-0.126
MANTRA Cd Filter ^{239}Pu Sample	1.09001	1.04091	4.671

FCA-IX C/E

EXPERIMENT	CIELO-2	CIELO	Differ. %
FCA-IX-1 F42/F49	1.04150	1.03538	0.587
FCA-IX-1 F51/F49	0.94242	0.93638	0.639
FCA-IX-1 F53/F49	0.91428	0.90813	0.670
FCA-IX-6 F42/F49	1.03069	1.02552	0.440
FCA-IX-6 F51/F49	0.92480	0.91855	0.616
FCA-IX-6 F53/F49	0.90391	0.89673	0.733
FCA-IX-7 F42/F49	1.02781	1.01924	0.651
FCA-IX-7 F51/F49	0.91249	0.91020	0.085
FCA-IX-7 F53/F49	0.91300	0.91239	0.733

PROTEUS C/E

EXPERIMENT	CIELO-2	CIELO	Differ. %
C7 K_{eff}	1.01066	1.00850	0.103
C7 F25/F49	1.01720	1.0297	-1.156
C8 K_{eff}	1.00211	0.99311	0.823
C8 C28/F49	0.98832	1.01385	-2.616
C8 F28/F49	0.96114	1.00241	-4.254
PROTEUS Void	0.88962	0.56835	58.196

PROTEUS Breakdown

PROTEUS C7 K_{eff} (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.004	0.018	-0.739	-	0.940	-0.258	-0.092	-0.103

PROTEUS C8 K_{eff} (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-0.004	0.132	0.044	0.064	-	-	-	0.235
^{238}U	-0.011	0.077	0.716	-0.007	-0.117	0.108	0.014	0.781
^{239}Pu	-0.001	0.076	0.271	-0.001	0.205	-0.513	-0.150	-0.113
Total	-0.181	-0.284	1.141	0.026	0.097	-0.412	-0.131	0.823

PROTEUS Water Void Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	-10.267	-	0.787	-2.396	-	-	-	-11.876
^{56}Fe	-0.196	6.362	1.782	5.441	-	-	-	13.387
^{235}U	-0.045	-0.170	-2.983	-0.034	-0.528	-0.969	0.219	-4.509
^{238}U	-0.567	13.342	46.625	-0.640	-3.030	2.997	1.240	60.038
^{239}Pu	-0.497	4.677	82.465	-0.129	-60.371	-20.358	-4.596	11.899
Total	-11.573	24.210	128.71	2.240	-63.929	-18.329	-3.136	58.197

ASPIS C/E

EXPERIMENT	CIELO-2	CIELO	Differ. %
ASPIS FE-88 Al (n,α) A7	1.29722	1.14824	10.079
ASPIS FE-88 S (n,p) A7	1.03803	0.77341	24.851
ASPIS FE-88 S (n,p) A12	1.05876	0.59465	46.034
ASPIS FE-88 S (n,p) A14	1.05569	0.52646	54.167
ASPIS FE-88 In (n,inel) A7	0.98768	0.86890	11.181
ASPIS FE-88 In (n,inel) A11	0.97560	0.85420	11.445
ASPIS FE-88 Rh (n,inel) A7	1.05439	0.99919	4.810
ASPIS FE-88 Rh (n,inel) A14	1.08774	1.04912	3.218
ASPIS FE-88 Au (n,γ) A7	1.01528	0.95060	3.728
ASPIS FE-88 Au (n,γ) A11	1.02975	0.94939	4.654
ASPIS FE-88 Au (n,γ) A14	1.05423	0.96495	5.145

ASPIS Breakdown

ASPIS FE-88 Al (n,α) A7 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-1.643	12.949	0.662	-1.011	-	-	-	9.633

ASPIS FE-88 S (n,p) A14 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-17.000	62.804	-0.276	8.683	-	-	-	54.210

ASPIS FE-88 In (n,inel) A11 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-3.059	13.579	0.695	-	-	-	-	11.215

ASPIS FE-88 Rh (n,inel) A7 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-1.399	5.589	0.385	-	-	-	-	4.574

ASPIS FE-88 Au (n,γ) A14 (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-0.262	0.174	5.190	-	-	-	-	5.102

Summary of CIELO-2 – CIELO

- As general observation from the point of view of an user, one can say that we are far away from reaching a consensus.
- The case of the JEZEBEL critical mass is emblematic. The large compensations among the different reactions (elastic, inelastic, P_1, and fission) yields the same critical mass. The user is disoriented: where is the truth?
- Regarding the 5 isotopes, the major impacts are related to:
  - ^{16}O: elastic, (n,α), P_1 elastic.
  - ^{56}Fe: elastic, inelastic, capture, P_1 elastic.
  - ^{235}U: inelastic, capture, fission, nubar, fission spectrum
  - ^{238}U: inelastic, capture, P_1 elastic, fission, nubar, fission spectrum
  - ^{239}Pu: capture, fission, P_1 elastic, nubar, fission spectrum

Consistency with current covariance matrices

Background information

- The two covariance matrices used in the analysis are COMMARA-2.0 and COMACV1 (provided by CEA).
- Even if the covariance matrix is available for CIELO-2, this one has not been used because it includes an adjustment including an integral experiment (JEZEBEL). The fact of using only one experiment could completely skew the covariance data.
- Both covariance matrices originally do not include the P1 elastic data. The matrices were, therefore, completed using the corresponding JENDL-4 P_1 data.
- This is a significant missing in view of the large impact in many kind of experiments.
- The users expects that also the secondary energy distribution for inelastic scattering covariance data would have a significant impact on uncertainty analysis.
- A significant impact can be expected when cross correlations among isotopes will be included (today only one exists related to ^{235}U fission.

Background information (cont.)

- The analysis look at two main consistencies:
  - the consistency between the individual (E-C)/E of the two evaluated files and the associated uncertainties calculated with the two covariance matrices
  - the consistency between the differences (impact on the C/E) between the two evaluated files and the corresponding uncertainties.
- For this latter case also we look at the differences between the uncertainties obtained with the two covariance matrices of individual isotopes and, among others, at the impact of correlations.
- Color codes when comparing to individual(E-C)/E:
  - [blue] large values differences between uncertainties of the two covariance matrices
  - [orange] insufficient uncertainty compared with (E-C)/E
- Color codes when comparing to differences between CIELO-2 and CIELO for single isotopes:
  - [blue] large values differences
  - [orange] large differences between the uncertainties (in particular different impact of correlation)

LANL Criticals C/E

EXPERIMENT	CIELO-2 (C-E)/E	CIELO (C-E)/E	COMM. Uncert.	COMAC Uncert.
JEZEBEL K_{eff}	-0.143	-0.085	0.646	1.211
JEZEBEL F28/F25	-1.409	-1.079	3.677	3.709
GODIVA K_{eff}	-0.360	0.061	1.003	1.197
GODIVA F28/F25	-3.296	-3.494	4.376	5.168
FLATTOP K_{eff}	0.070	-0.250	0.861	1.318
FLATTOP F28/F25	-1.526	-0.570	3.078	3.618
BIGTEN K_{eff}	0.351	0.024	2.582	1.718
BIGTEN F28/F25	-8.673	-5.465	13.058	5.219
BIGTEN F37/F25	-4.210	-6.464	6.975	4.536

The strange case of JEZEBEL

JEZEBEL K_{eff} CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.318	-0.790	0.035	0.228	0.256	-0.040	-0.093	-0.085

JEZEBEL K_{eff} COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.188	0.396	0.036	0.068	0.237	0.065	0.878	1.0145

JEZEBEL K_{eff} COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	-0.415	0.640	0.079	0.149	0.343	0.082	0.162	0.646

JEZEBEL K_{eff} COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.031	0.068	0.015	0.068	0.435	0.135	0.896	1.0103

JEZEBEL K_{eff} COMAC Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.109	-0.188	0.154	0.149	1.156	0.210	0.249	1.211

GODIVA K_{eff}

GODIVA K_{eff} CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.076	-0.232	-0.159	0.066	-0.100	-0.136	-0.009	-0.416

GODIVA K_{eff} COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.118	0.255	0.259	0.213	0.114	0.058	1.510	1.577

GODIVA K_{eff} COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	-0.172	0.464	0.719	0.406	0.262	0.078	0.247	1.002

GODIVA K_{eff} COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.120	0.258	0.325	0.213	0.115	0.151	1.507	1.0103

GODIVA K_{eff} COMAC Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.077	0.459	0.923	0.406	0.262	0.272	0.232	1.197

BIGTEN F28/F25

BIGTEN F28/F25 CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	-0.346	-1.427	-1.271	0.281	-1.247	-0.002	-0.089	-4.485

BIGTEN F28/F25 $_f$ COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	0.175	7.693	0.183	0.153	0.302	0.002	1.073	7.779

BIGTEN F28/F25 COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	-1.241	13.057	0.404	0.221	0.492	0.004	2.472	13.248

BIGTEN F28/F25 $_f$ COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	0.079	2.597	0.382	0.153	1.398	0.001	0.322	2.996

BIGTEN F28/F25 COMAC Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	-0.297	3.842	0.903	0.221	-0.723	0.002	0.861	3.971

ZPPRs C/E

EXPERIMENT	CIELO-2 (C-E)/E	CIELO (C-E)/E	COMM. Uncert.	COMAC Uncert.
ZPPR-9 K_{eff}	0.717	-0.178	1.220	1.183
ZPPR-9 F28/F25	-5.443	-0.266	8.017	3.285
ZPPR-9 C28/F25	-2.757	-0.322	1.546	1.399
ZPPR-9 STEP 3	8.347	4.325	7.638	6.065
ZPPR-9 STEP 5	4.646	0.802	9.881	8.053
ZPPR-10 K_{eff}	0.781	-0.105	1.135	1.171
ZPPR-10 STEP 2	24.222	19.221	7.006	6.189
ZPPR-10 STEP 3	13.359	8.798	7.070	6.324
ZPPR-10 STEP 6	11.881	7.358	7.952	7.146
ZPPR-10 STEP 9	9.551	5.087	9.058	8.218
ZPPR-10 Central Control Rod	6.085	6.166	1.611	1.948
ZPPR-15 K_{eff}	1.221	-0.004	0.985	1.242

ZPPR-15 K_{eff}

ZPPR-15 K_{eff} CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.008	0.077	0.142	0.009	0.281	-0.652	-0.122	-0.257

ZPPR-15 K_{eff} COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.005	0.037	0.110	0.002	0.150	0.060	0.769	0.794

ZPPR-15 K_{eff} COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.038	0.091	0.246	0.003	0.248	0.076	0.185	0.415

ZPPR-15 K_{eff} COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.011	0.006	0.0049	0.002	0.326	0.084	0.781	1.0103

ZPPR-15 K_{eff} COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.025	-0.086	0.275	0.003	1.058	0.146	0.248	1.132

ZPPR-10 STEP9

ZPPR-10 STEP9 CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.048	0.677	4.556	0.040	-0.037	1.382	-0.170	6.497

ZPPR-10 STEP9 COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.034	0.324	0.941	0.009	1.176	0.489	1.412	2.147

ZPPR-10 STEP9 COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.205	0.785	0.642	0.016	0.210	0.606	0.336	2.444

ZPPR-10 STEP9 COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	0.009	0.048	1.500	0.009	3.047	0.759	1.292	3.712

ZPPR-10 STEP9 COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{239}Pu	-0.149	-0.196	2.788	0.016	6.191	0.840	0.434	6.853

ZPPR-10 STEP9

ZPPR-10 STEP9 CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	0.334	0.820	1.321	0.309	-0.107	0.308	0.068	3.052

ZPPR-10 STEP9 COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	0.203	3.479	1.738	0.191	0.070	0.319	2.396	4.588

ZPPR-10 STEP9 COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	1.370	6.363	2.953	0.247	0.116	0.493	1.740	7.378

ZPPR-10 STEP9 COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	0.072	1.264	1.800	0.191	0.376	1.513	0.737	2.363

ZPPR-10 STEP9 COMAC Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{238}U	-0.132	2.744	2.638	0.247	0.236	0.244	0.484	3.858

ZPRs C/E

EXPERIMENT	CIELO-2 (C-E)/E	CIELO (C-E)/E	COMM. Uncert.	COMAC Uncert.
ZPR6/7 K_{eff}	0.833	-0.123	0.994	1.153
ZPR6/7 F28/F25	-1.642	0.601	6.474	3.167
ZPR6/7 C28/F25	-2.683	-0.280	1.512	1.381
ZPR6/6A K_{eff}	0.558	-0.003	1.605	2.306
ZPR9-34 Keff	3.660	2.879	2.404	3.033
ZPR3-53 Keff	0.862	0.760	1.734	1.102
ZPR3-54 Keff	2.438	2.742	1.069	1.244

ZPR9-34 K_{eff}

ZPR9-34 K_{eff} CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	-0.005	0.067	-0.683	-0.002	0.087	-0.178	-0.012	-0.724

ZPR9-34 K_{eff} COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.008	0.037	0.600	0.009	0.132	0.070	1.459	1.582

ZPR9-34 K_{eff} COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.135	0.074	1.854	0.018	0.226	0.110	0.097	1.880

ZPR9-34 K_{eff} COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.009	0.037	0.920	0.009	0.180	0.125	1.456	1.737

ZPR9-34 K_{eff} COMAC Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{235}U	0.208	0.072	2.879	0.018	0.266	0.187	0.097	2.907

Irradiation Experiments C/E

EXPERIMENT	CIELO-2 (C-E)/E	CIELO (C-E)/E	COMM. Uncert.	COMAC Uncert.
PROFIL-1 ^{235}U Sample	0.711	-6.204	14.820	23.092
PROFIL-1 ^{238}U Sample	5.622	-4.056	2.178	2.529
PROFIL-1 ^{239}Pu Sample	-11.919	-8.454	4.646	3.244
TRAPU-2 ^{235}U Sample	4.660	0.976	1.783	2.559
TRAPU-2 ^{238}U Sample	0.407	1.520	0.550	0.525
TRAPU-2 ^{239}Pu Sample	-2.547	-1.490	1.367	0.792
MANTRA Cd Filter ^{235}U Sample	-2.156	-1.199	1.050	1.360
MANTRA Cd Filter ^{238}U Sample	2.597	2.730	1.547	1.107
MANTRA Cd Filter ^{239}Pu Sample	9.001	4.091	0.879	3.735

FCA-IX C/E

EXPERIMENT	CIELO-2 (C-E)/E	CIELO (C-E)/E	COMM. Uncert.	COMAC Uncert.
FCA-IX-1 F42/F49	4.150	3.538	2.794	3.641
FCA-IX-1 F51/F49	5.758	-6.362	3.099	3.856
FCA-IX-1 F53/F49	-8.572	-9.187	1.384	4.003
FCA-IX-6 F42/F49	3.069	2.552	1.888	2.581
FCA-IX-6 F51/F49	-7.520	-8.145	2.286	2.861
FCA-IX-6 F53/F49	-9.609	-10.327	2.488	3.013
FCA-IX-7 F42/F49	2.781	1.924	5.812	3.606
FCA-IX-7 F51/F49	-8.751	-8.980	7.287	3.991
FCA-IX-7 F53/F49	-8.700	-8.761	7.906	4.167

PROTEUS C/E

EXPERIMENT	CIELO-2 (C-E)/E	CIELO (C-E)/E	COMM. Uncert.	COMAC Uncert.
C7 K_{eff}	1.066	0.850	0.858	0.935
C7 F25/F49	1.720	0.297	0.684	1.473
C8 K_{eff}	0.211	-0.689	2.126	1.209
C8 C28/F49	-1.168	1.385	1.927	2.202
C8 F28/F49	-3.886	0.241	9.621	3.116
PROTEUS Void	-11.038	-43.165	113.293	94.967

PROTEUS VOID

PROTEUS VOID CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	-10.267	-	0.787	-2.396	-	-	-	-11.876

PROTEUS VOID COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	6.909	0.168	0.704	5.442	-	-	-	8.796

PROTEUS VOID COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	12.652	0.162	0.082	5.864	-	-	-	13.946

PROTEUS VOID K_{eff} COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	3.884	0.141	0.613	5.442	-	-	-	6.715

PROTEUS VOID K_{eff} COMAC Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{16}O	6.571	0.127	0.723	5.864	-	-	-	8.837

ASPIS C/E

EXPERIMENT	CIELO-2 (C-E)/E	CIELO (C-E)/E	COMM. Uncert.	COMAC Uncert.
ASPIS FE-88 Al (n,α) A7	29.722	14.824	31.655	30.060
ASPIS FE-88 S (n,p) A12/A7	16.215	-19.130	10.587	12.389
ASPIS FE-88 S (n,p) A14/A7	21.039	-26.549	15.455	16.885
ASPIS FE-88 In (n,inel) A11/A7	-0.337	-1.560	1.838	1.735
ASPIS FE-88 Rh (n,inel) A14/A7	2.640	4.990	14.627	6.499
ASPIS FE-88 Au (n,γ) A11/A7	2.338	-0.309	2.556	1.602
ASPIS FE-88 Au (n,γ) A14/A7	6.285	2.089	6.108	3.567

ASPIS FE-88 S (n,p) A14

ASPIS FE-88 S (n,p) A14/A7 CIELO-2 – CIELO Difference (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	-10.557	33.237	-0.164	6.681	-	-	-	29.201

ASPIS FE-88 S (n,p) A14/A7 COMMARA Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	9.950	15.162	0.141	1.009	-	-	-	18.164

ASPIS FE-88 S (n,p) A14/A7 COMMARA Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	7.042	13.698	-0.043	1.113	-	-	-	15.442

ASPIS FE-88 S (n,p) A14/A7 COMAC Unc. No Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	10.311	7.268	0.350	1.009	-	-	-	12.661

ASPIS FE-88 S (n,p) A14/A7 COMAC Unc. with Correlation (%)								
Isotope/Reaction	Elast.	Inel.	Capt.	P_1 Elas	Fiss.	Nubar	χ	Sum
^{56}Fe	14.017	9.315	0.486	1.113	-	-	-	16.873

Summary of consistency with current covariance matrices

- **There are severe differences between the two covariance matrix data.**
- **In many instances the calculated uncertainties would not cover the C/E spread of the experiments, at least at the one sigma level.**
- **Of specific interest is the effect of the correlation. In many cases the differences leads to a different sign in the contribution: what can explain this completely different behavior?**
- **Regarding specific differences between the two covariance matrices related the 5 isotopes, the major impacts are associated to:**
  - **^{16}O: elastic, (n,α).**
  - **^{56}Fe: elastic, inelastic, capture.**
  - **^{235}U: elastic, capture.**
  - **^{238}U: elastic, inelastic, capture, fission, nubar, fission spectrum**
  - **^{239}Pu: elastic, inelastic, capture, fission.**

General Conclusions

- Even though there has been a significant effort by the neutron cross section evaluators in generating new high quality neutron cross section data and in producing associated covariance matrices, the state of affairs is far from being settled.
- The user is puzzled by many inconsistencies among evaluated cross sections and corresponding covariance data that in many cases fail to explain current discrepancies between measurements and calculations.
- Among other issues, it would be of interest to understand the current contradictions at the level of correlations.
- Among recommendations that can be done from an user point of view:
  - Generate covariance data at the same time and consistently with the cross section evaluation.
  - Provide the missing data in covariance matrix: P1 elastic, secondary energy distribution for inelastic cross sections (multigroup transfer matrix), cross correlations (reactions and isotopes), delayed data (nubar and fission spectra). Finer energy grid and eigenvalue decomposition of the covariance matrix will be welcome for use in Monte Carlo.
  - In integral testing look also if the observed C/E discrepancy is consistent with covariance data.
- When covariance will be available for CIELO isotopes, more relevant feedback could be provided through data assimilation using PIA strategy (trying to avoid compensations) and careful choice among available experiments.