



**PRELIMINARY Update on validation test
of Geant4 electron backscattering simulation: investigating
the effects of the Goudsmit-Saunderson model at the
current stage of re-writing**

T. Basaglia¹, M. C. Han², G. Hoff³, C. H. Kim³, S. H. Kim³, M. G. Pia⁴, P. Saracco⁴
¹CERN, ²Hanyang University, Seoul, Korea, ³CAPES, Brasilia, Brazil, ⁴INFN Genova, Italy

CERN/PH/SFT-Simulation meeting
4 August 2015

WORK IN PROGRESS

Preliminary analysis

Production and data analysis

- Production with Geant4 10.2-beta + correction to Goudsmit-Saunderson code (M. Novak, private communication)
- Two (currently hard-coded) options regarding the computation of the screening parameter:
 - computed from Moliere's formula (default)
 - using PWA total elastic and first transport cross sections
- Note: due to a typo in the configuration macros, a test case corresponding to a mistyped electron energy was not included in the productions. The missing productions will be done shortly; the effect of the omission on the whole statistical analysis is negligible.
- Data analysis: as usual, GoF + categorical
 - At this stage automated analysis only, no further detailed investigation yet

Efficiency

Fraction of test cases with $\alpha > 0.01$ from GoF tests (*Anderson-Darling*)

		10.1p02	10.2-beta	Molière	PWA
>20 keV	GS	0.48±0.04	0.01±0.01	0.26±0.04	0.40±0.04
	GSBRF	0.35±0.04	0.01±0.01	0.38±0.04	0.25±0.04
	G4EmStandardPhysicsGS		0.03±0.02	0.26±0.04	0.48±0.04
20-100 keV	GS	0.32±0.04	0.04±0.02	0.39±0.05	0.46±0.05
	GSBRF	0.49±0.05	0.05±0.02	0.34±0.04	0.33±0.04
	G4EmStandardPhysicsGS		0.04±0.02	0.44±0.05	0.42±0.05
>100 keV	GS	0.81±0.05	0.07±0.04	0.67±0.06	0.70±0.06
	GSBRF	0.95±0.03	0.07±0.04	0.70±0.06	0.65±0.06
	G4EmStandardPhysicsGS		0.09±0.04	0.51±0.06	0.60±0.06

Preliminary categorical analysis

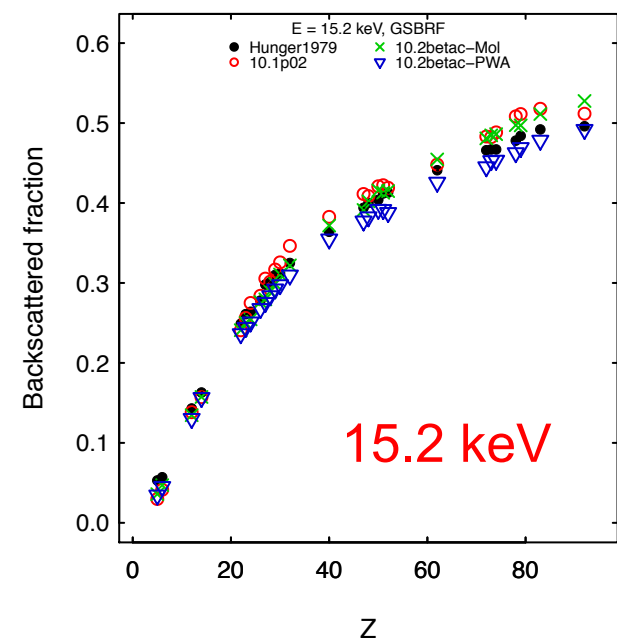
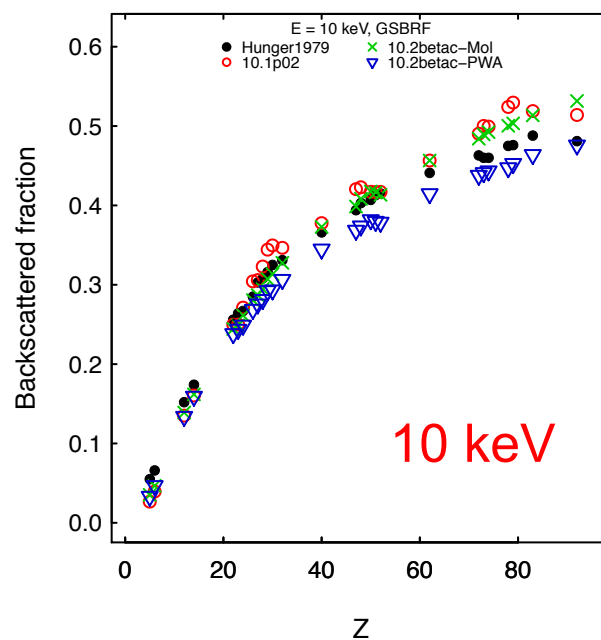
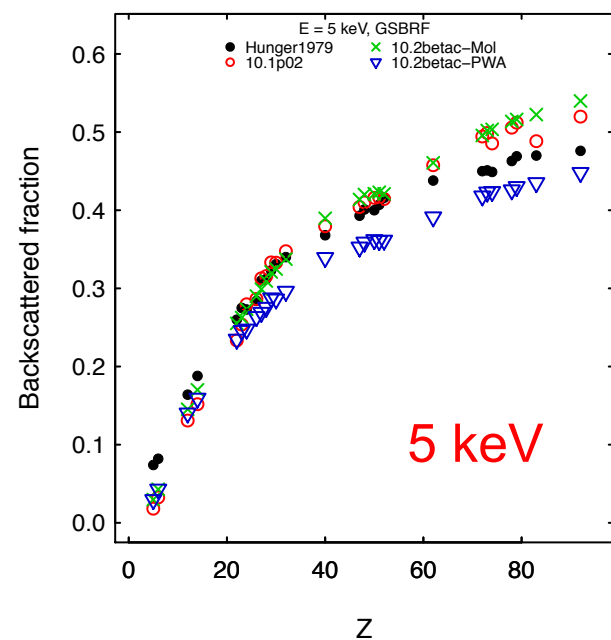
Compatibility with experiment with GS as in 10.1p02 and in 10.2-beta-corrected with Molière and PWA screening options

Two-sided tests, $\alpha = 0.01$

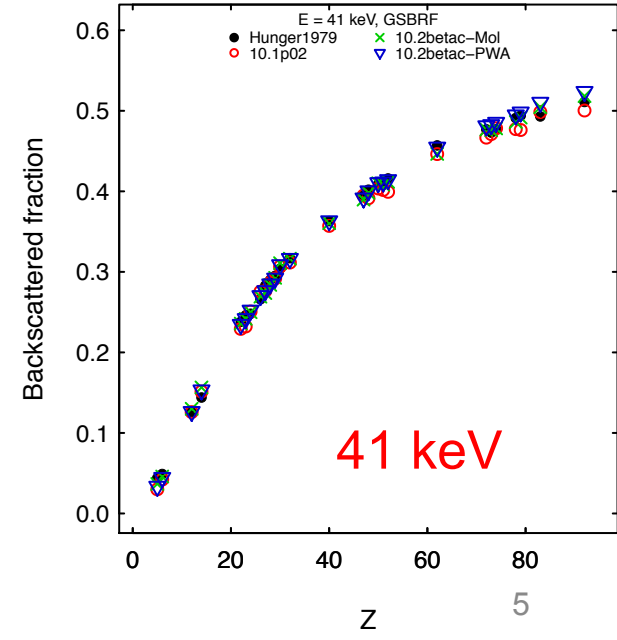
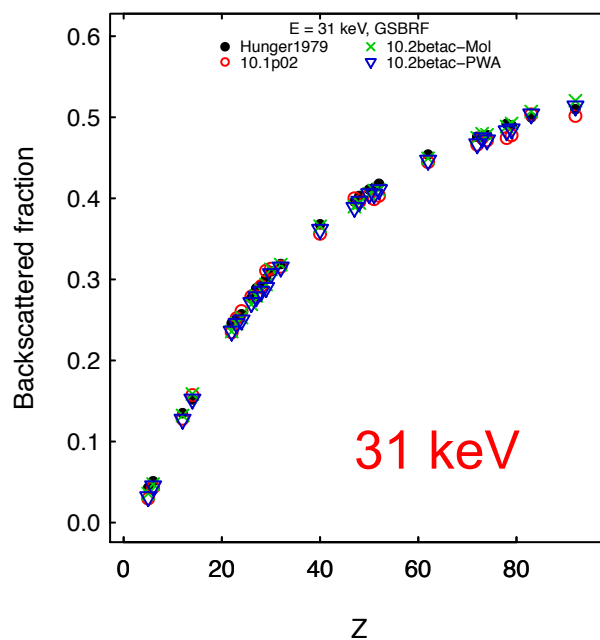
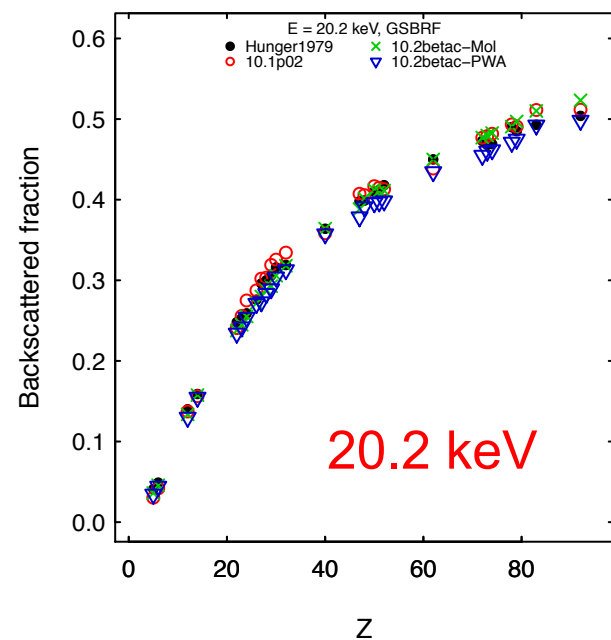
H_0 : equivalent compatibility with experiment in 10.1p02 and 10.2-beta-corrected

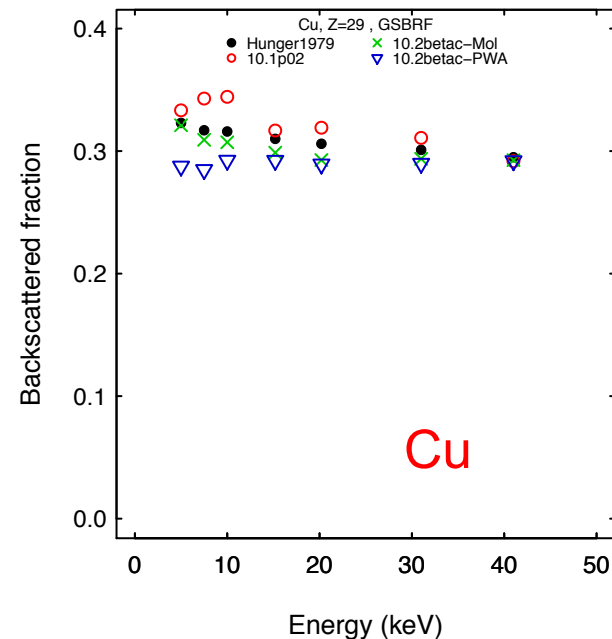
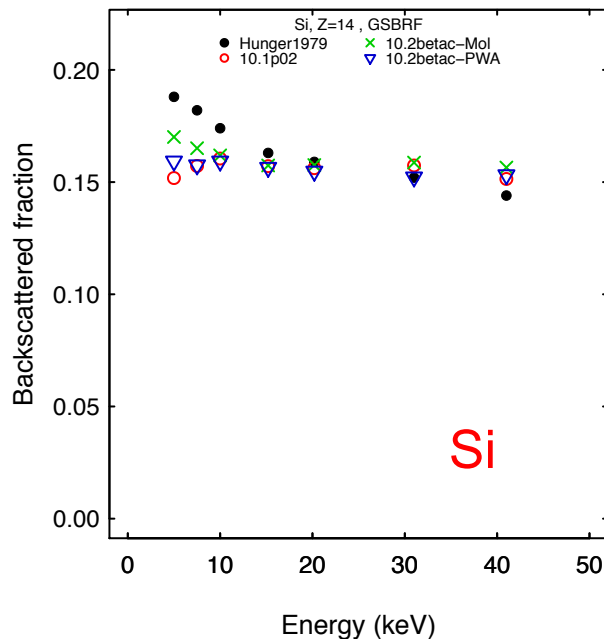
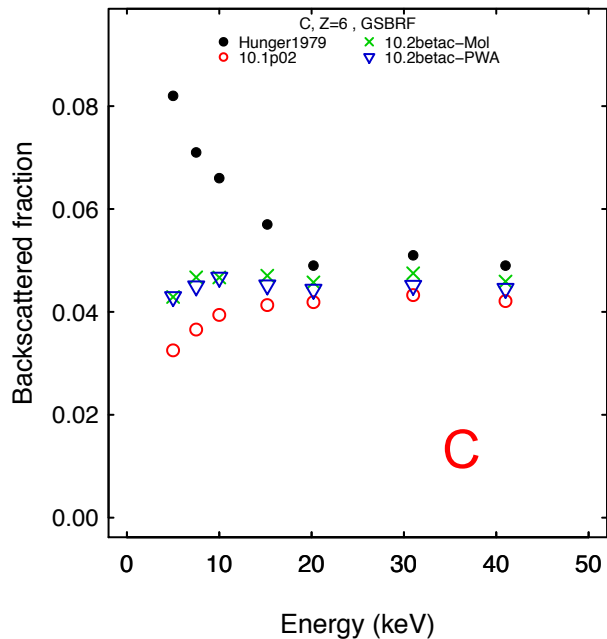
Test (GSBRF, $E > 100$ keV)	p-value Molière	p-value PWA
Fisher	0.0011	0.0010
Z-pooled	0.0007	0.0006
Boschloo	0.0005	0.0005
CSM-approximate	0.0007	0.0007

H_0 is rejected

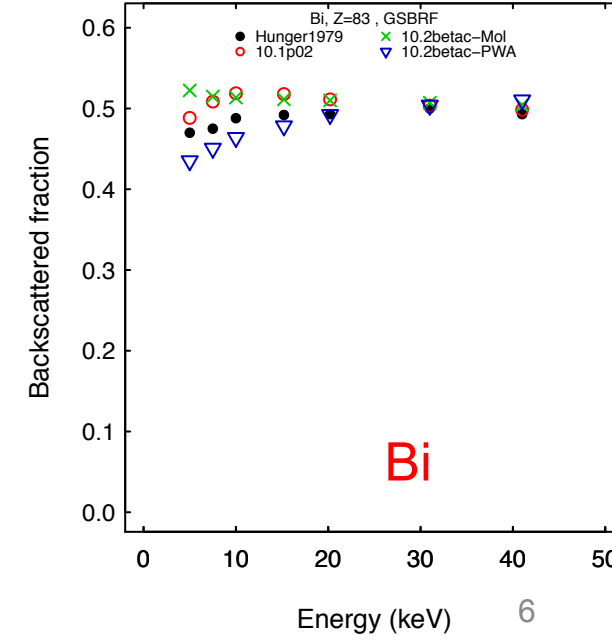
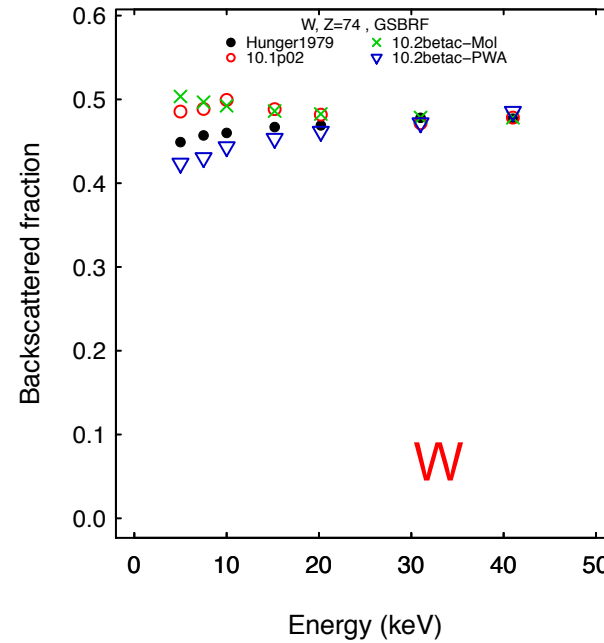
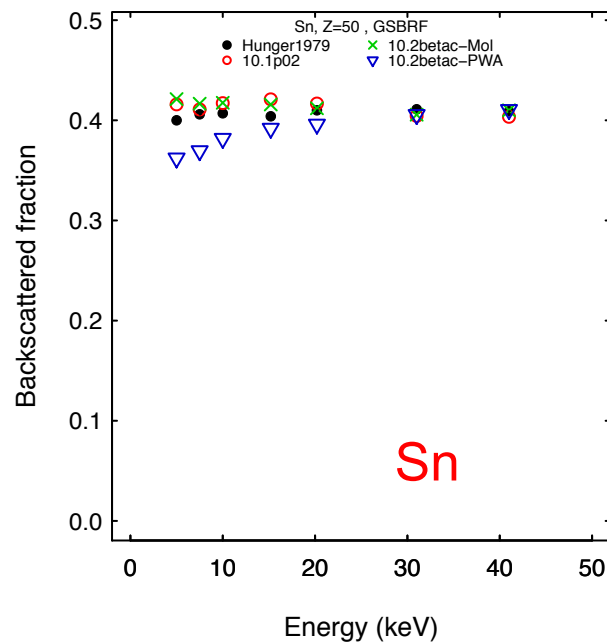


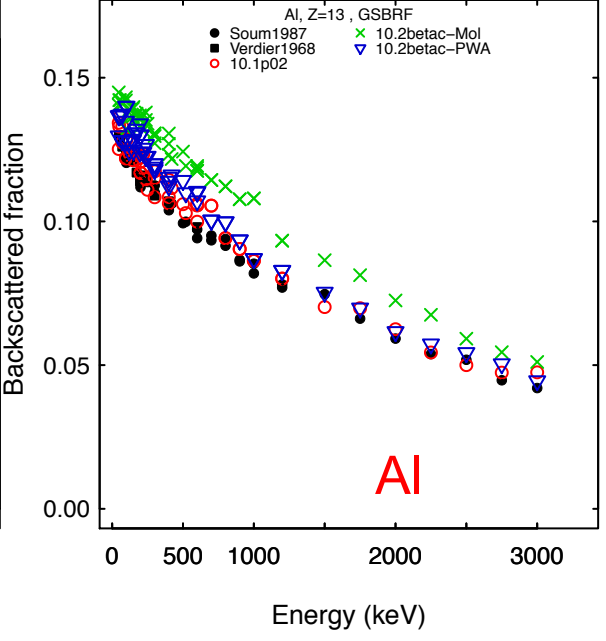
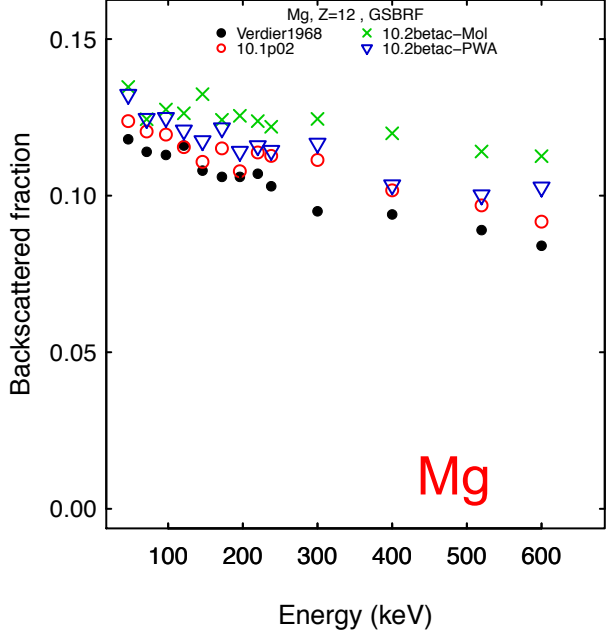
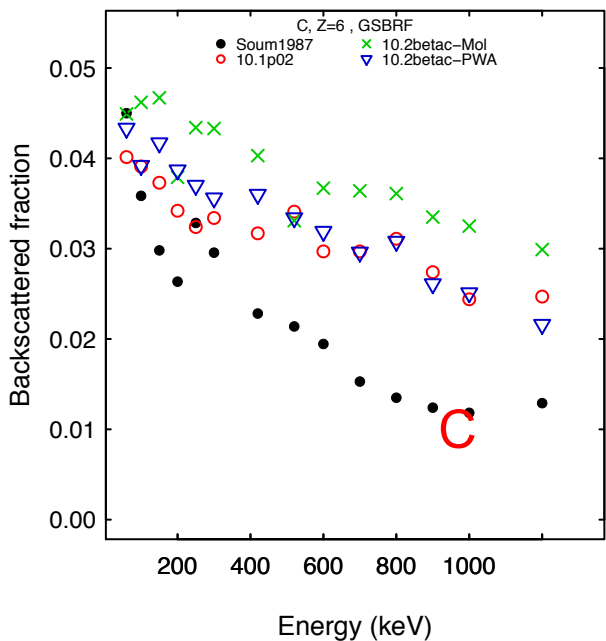
Hunger 1979 experimental data (no error bars in paper)





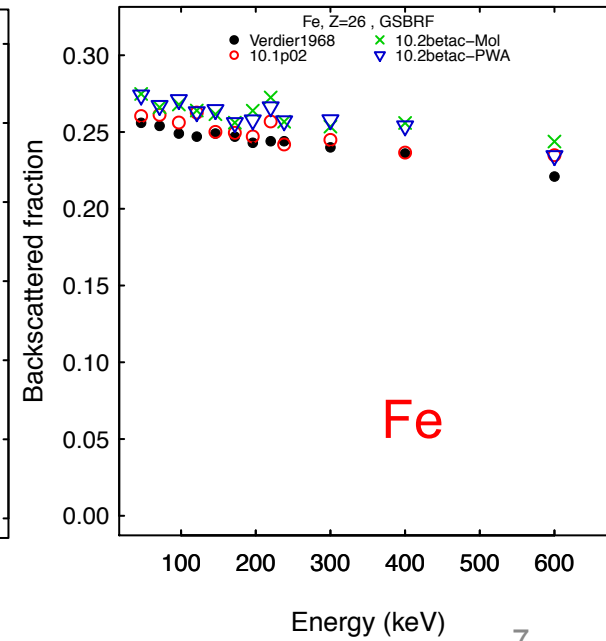
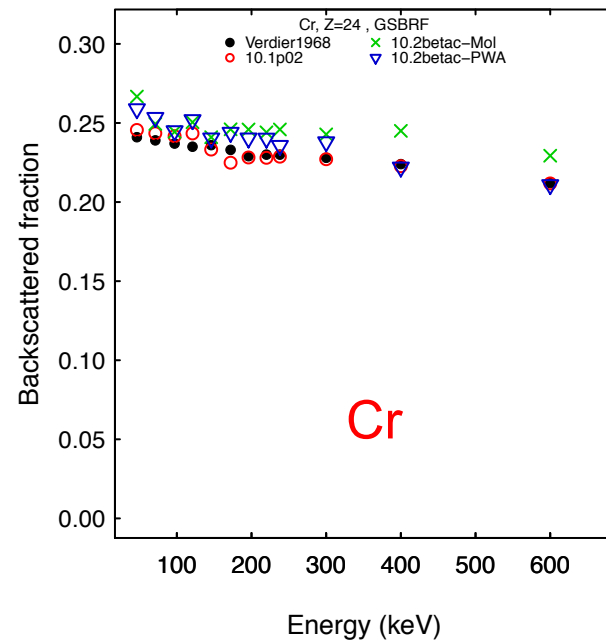
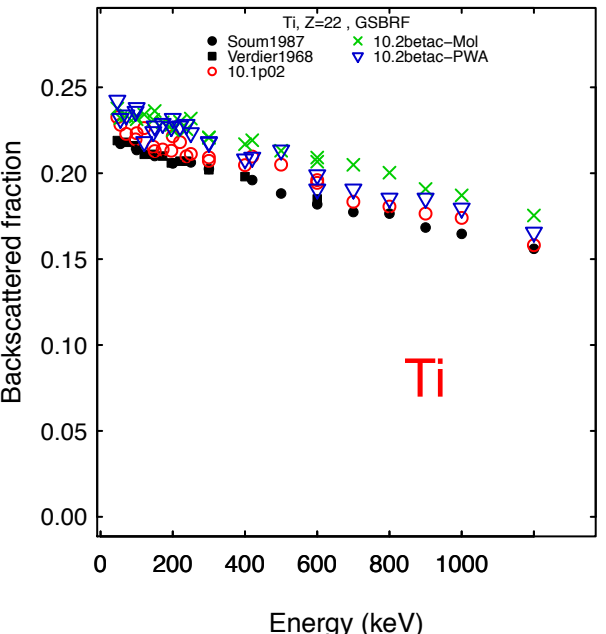
Hunger 1979 experimental data (no error bars in paper)



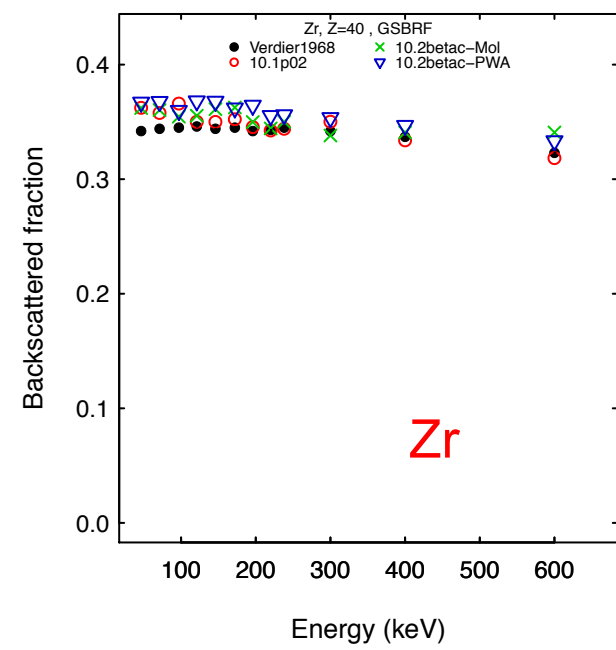
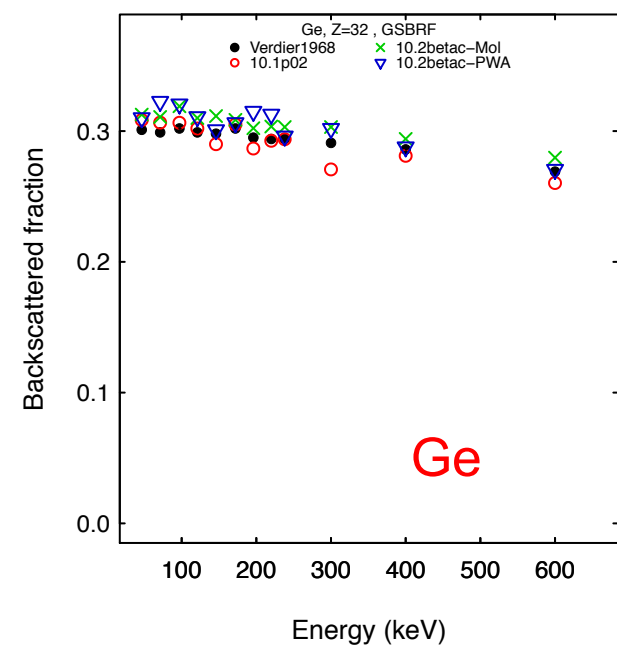
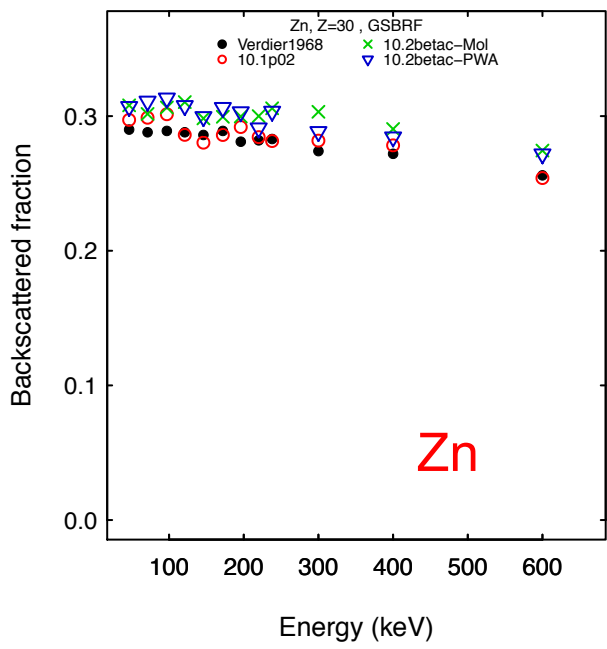
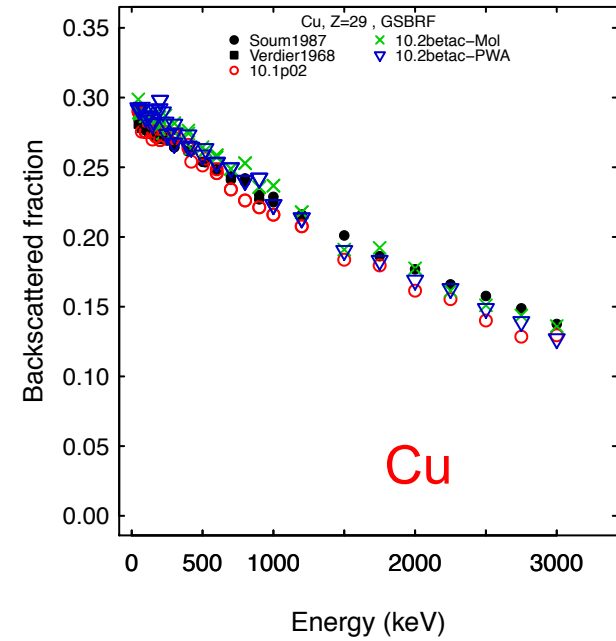
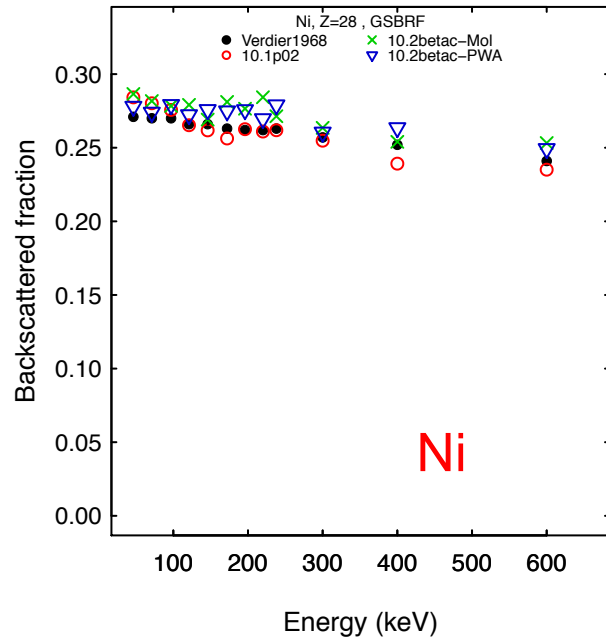
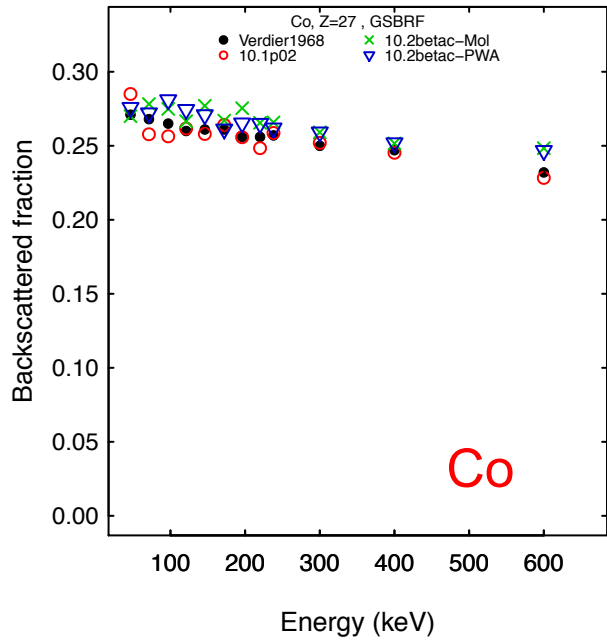


Verdier 1968 Numerical values Priv. Comm. from P. Verdier and F. Arnal to T. Tabata, 1971

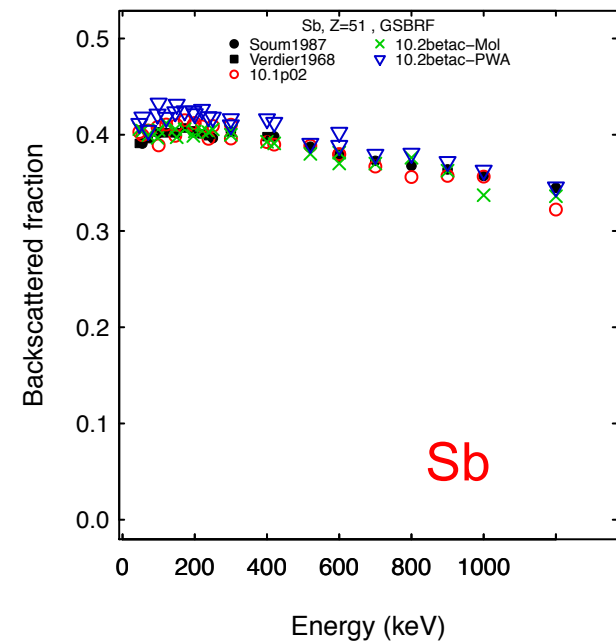
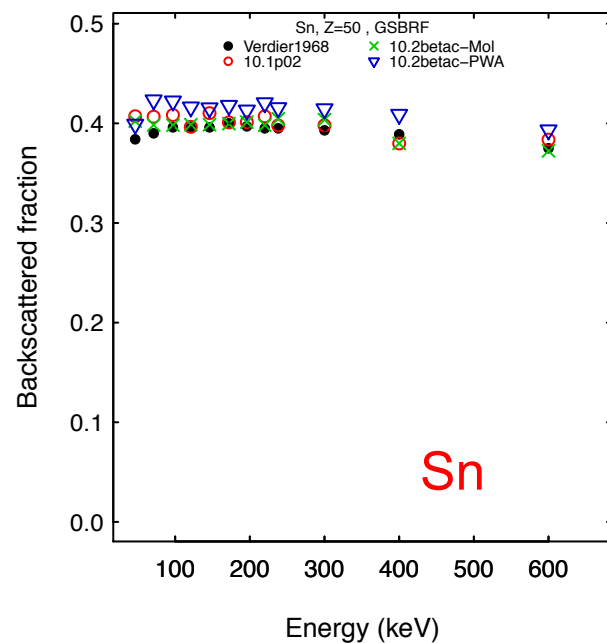
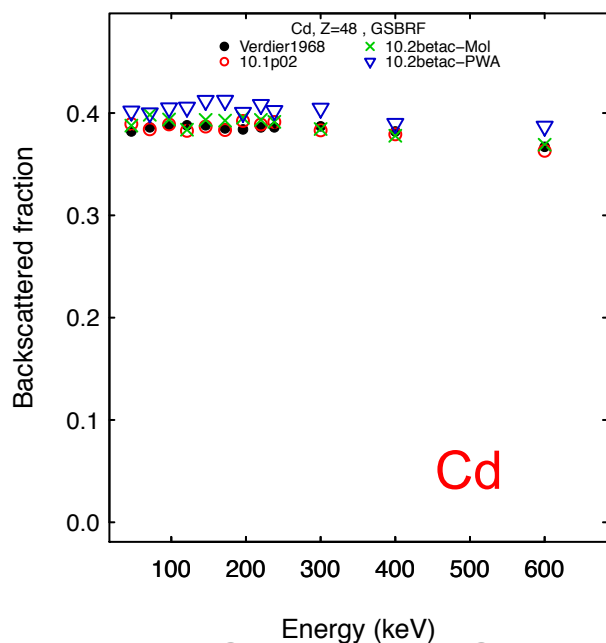
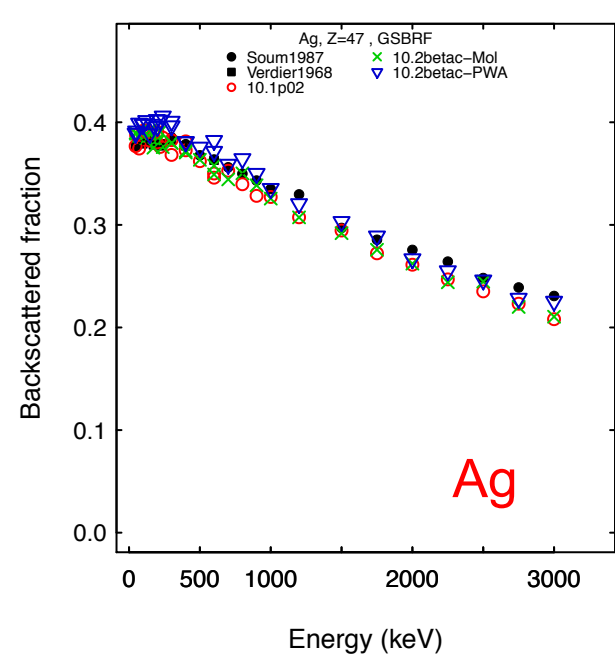
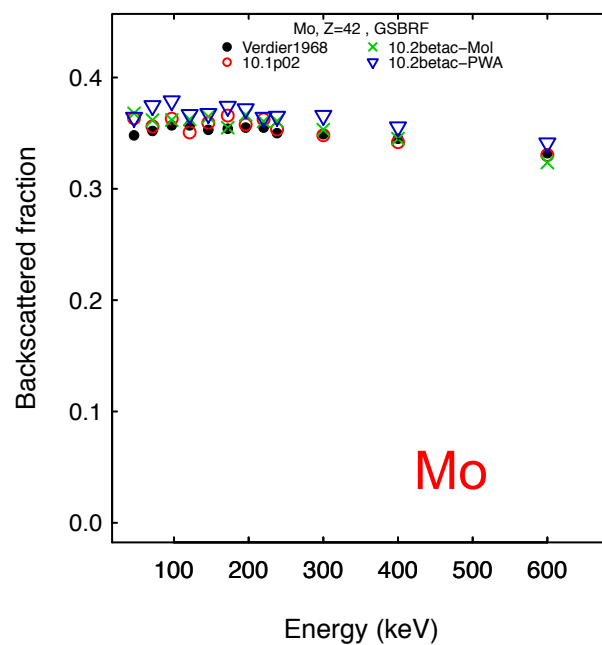
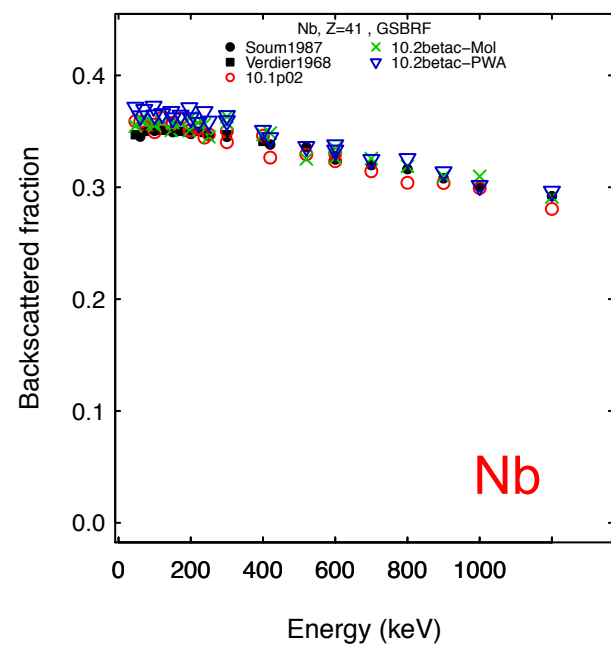
Soum 1987

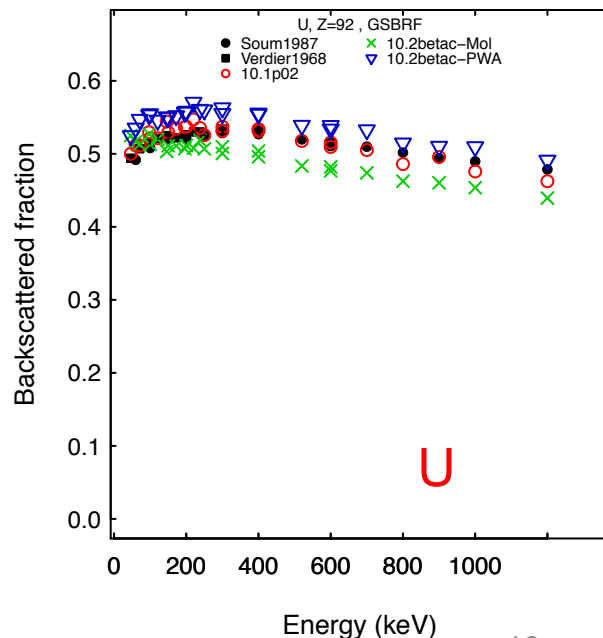
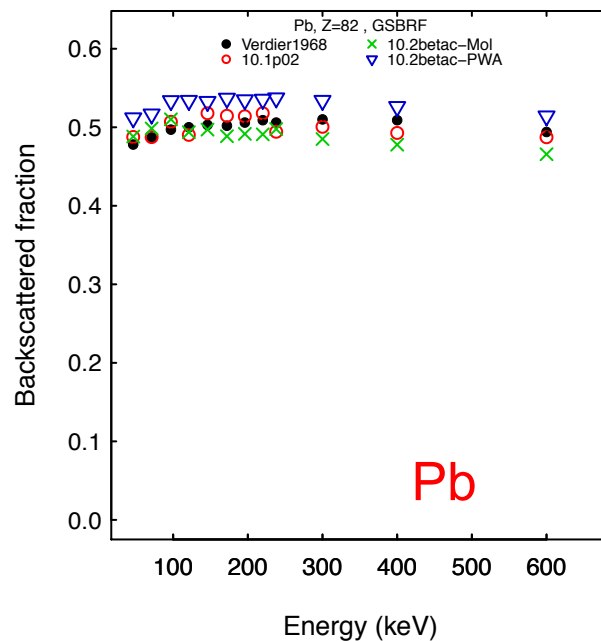
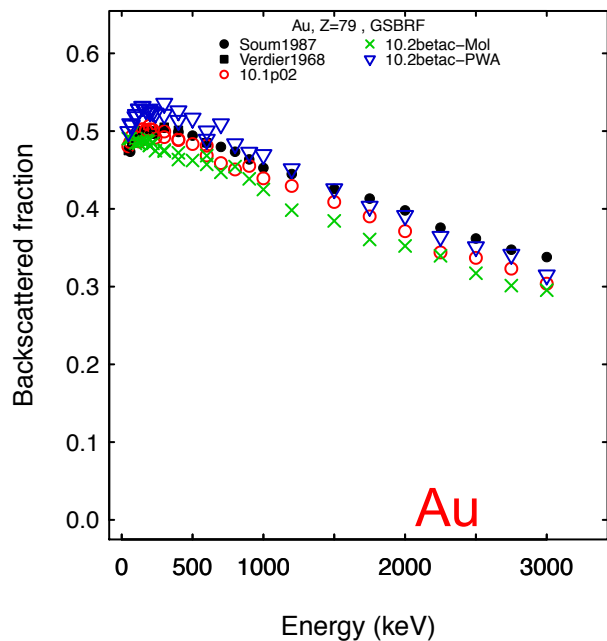
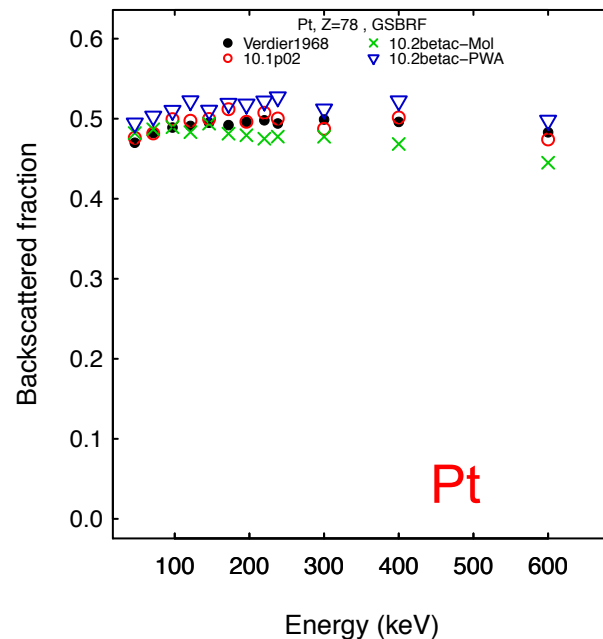
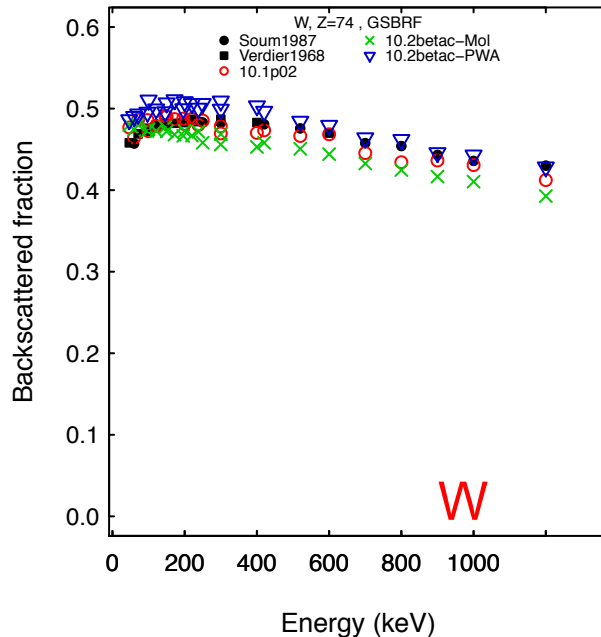
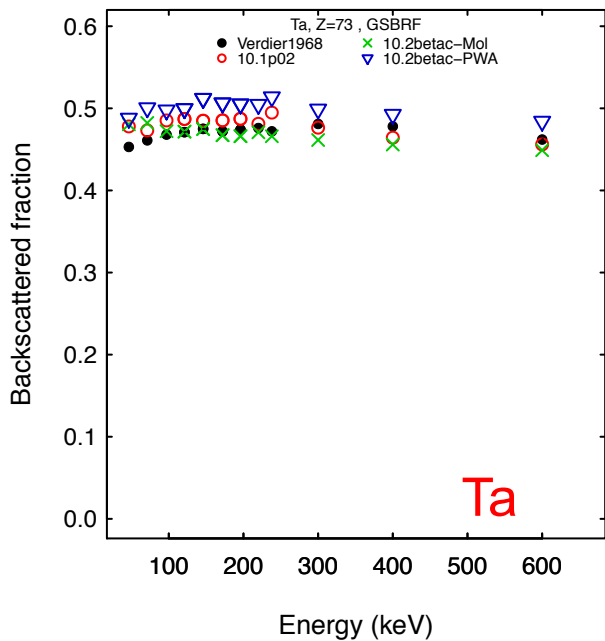


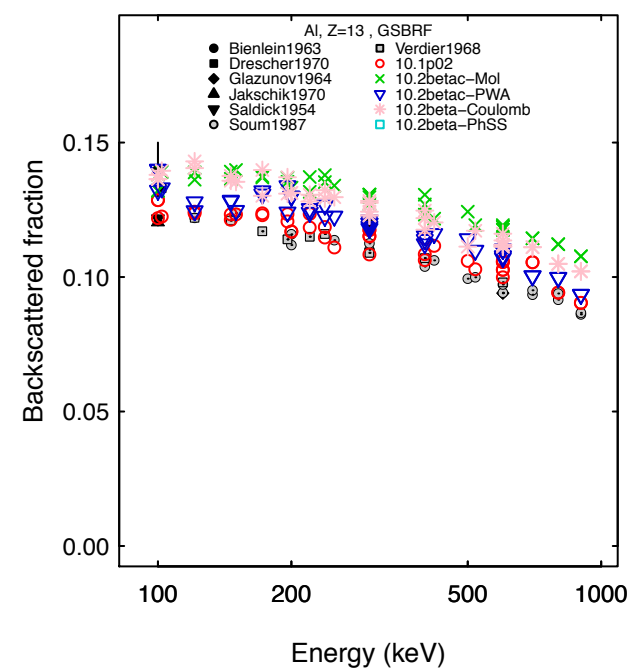
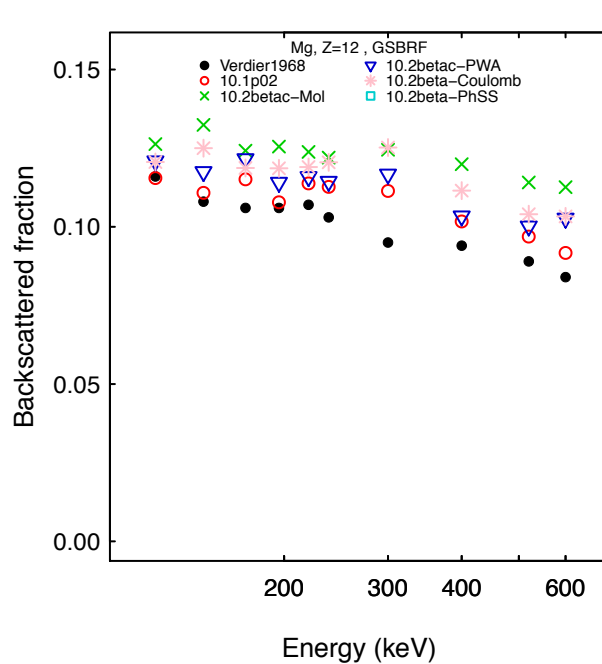
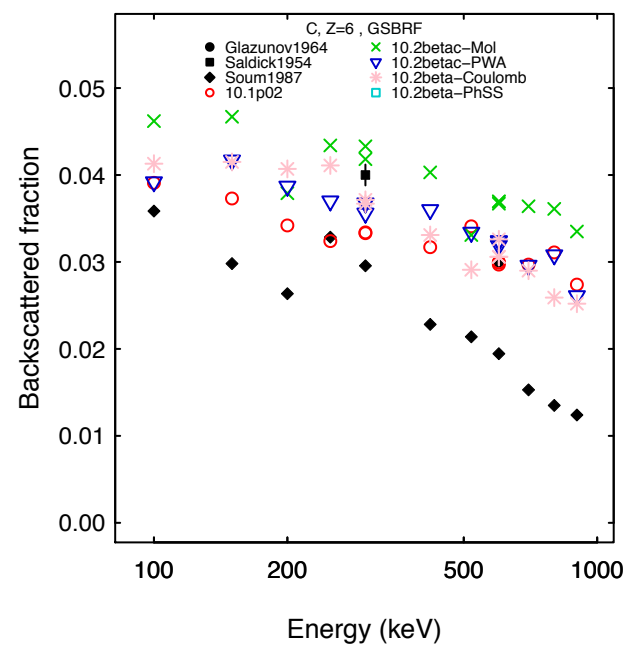
Light: green systematically above red



Light to intermediate: from green systematically above red to similar green and red

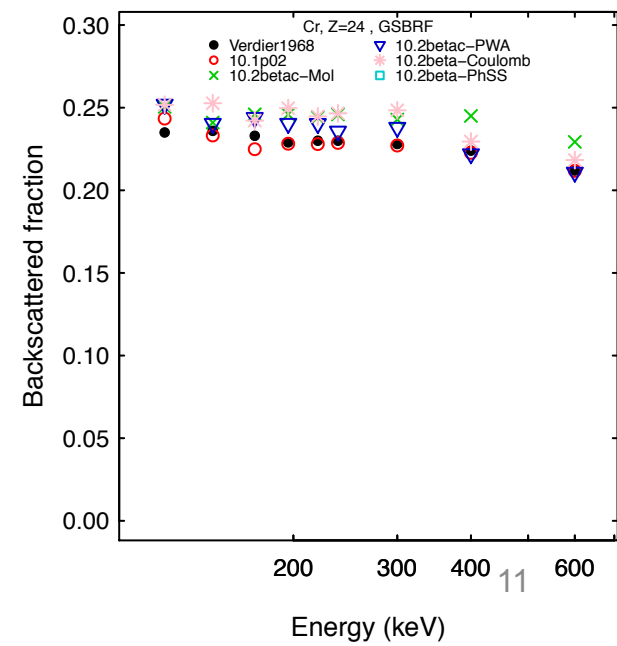
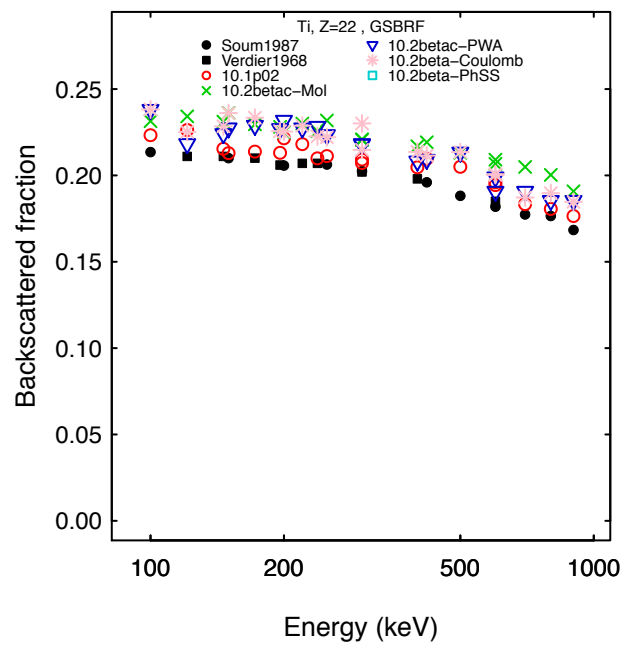
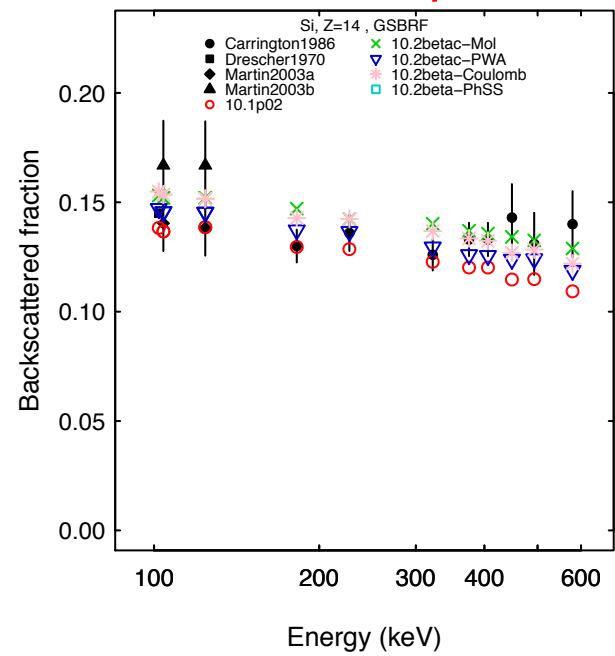


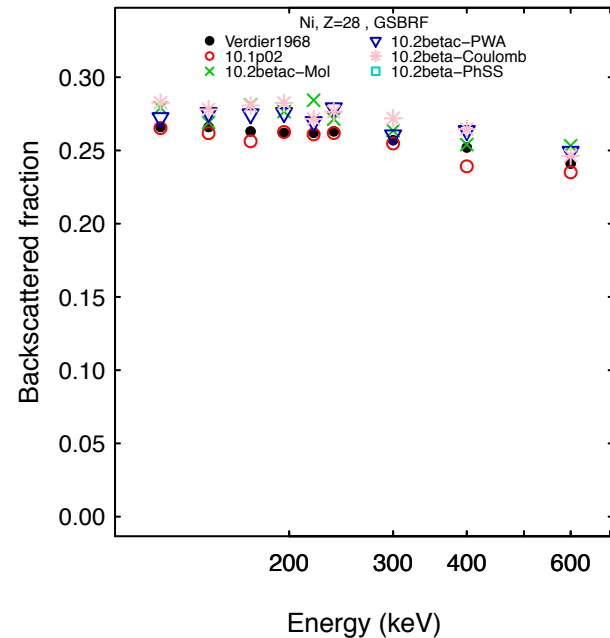
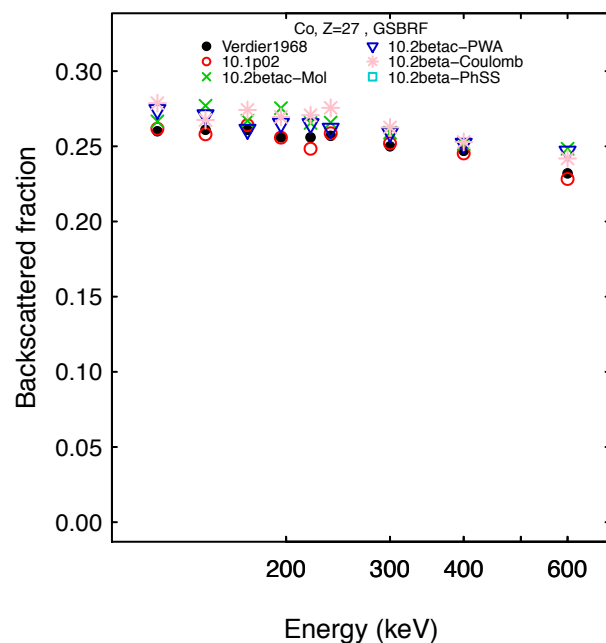
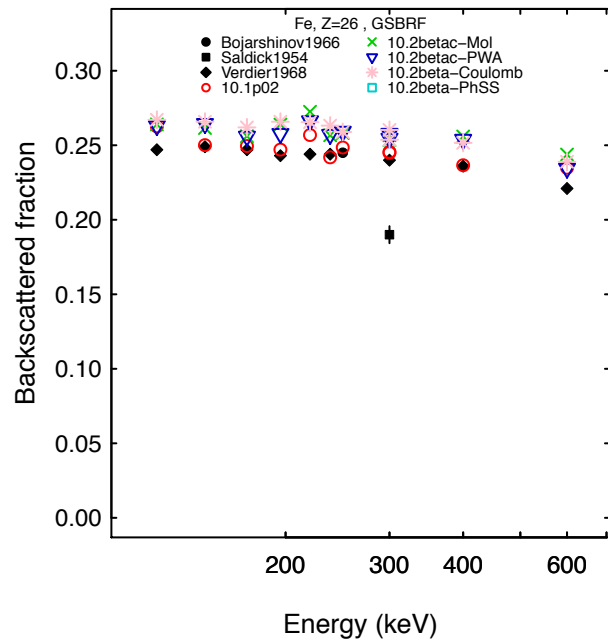




100 keV -1 MeV

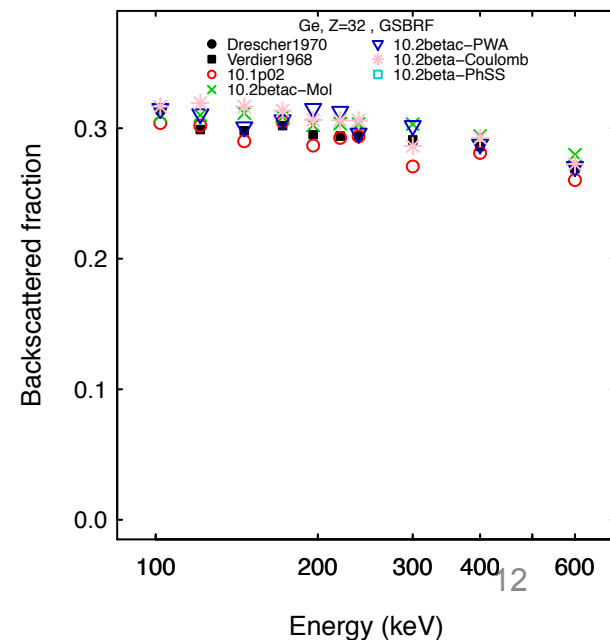
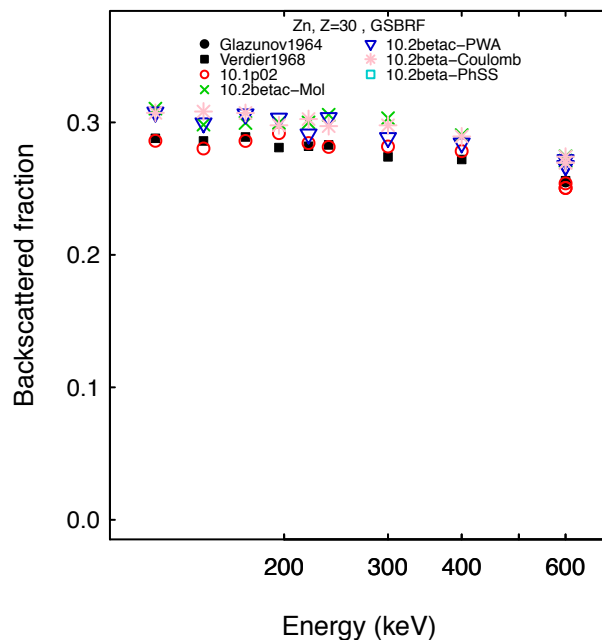
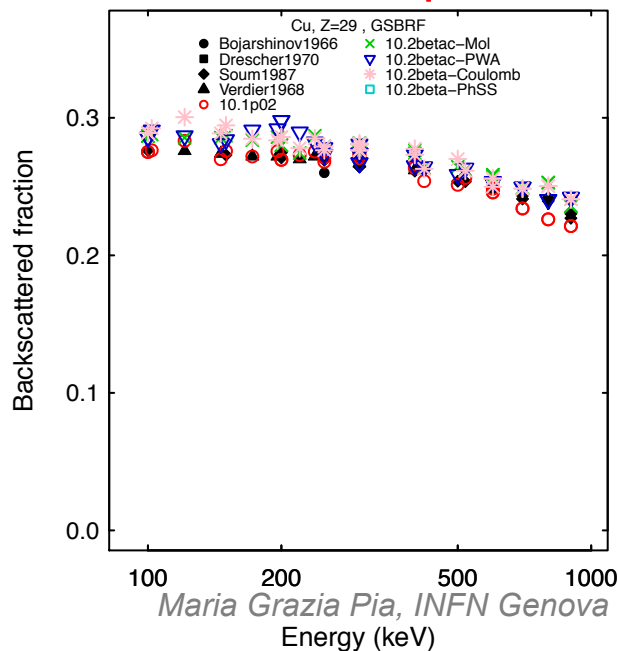
GSBRF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb

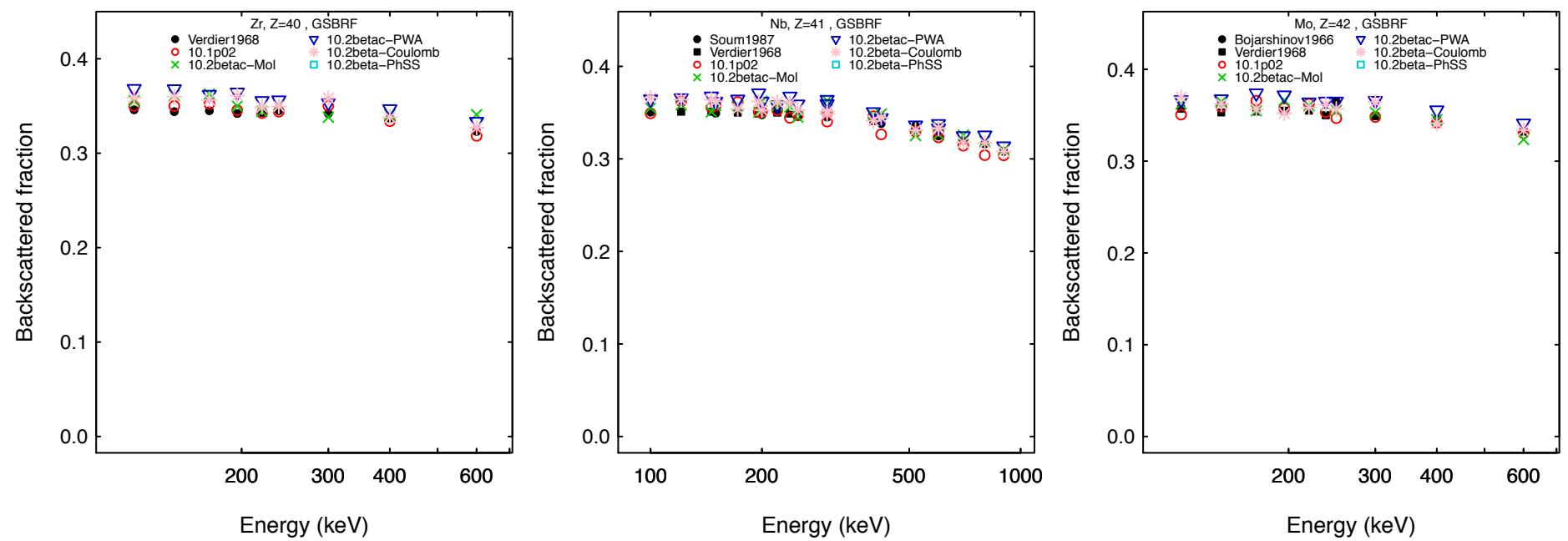




100 keV -1 MeV

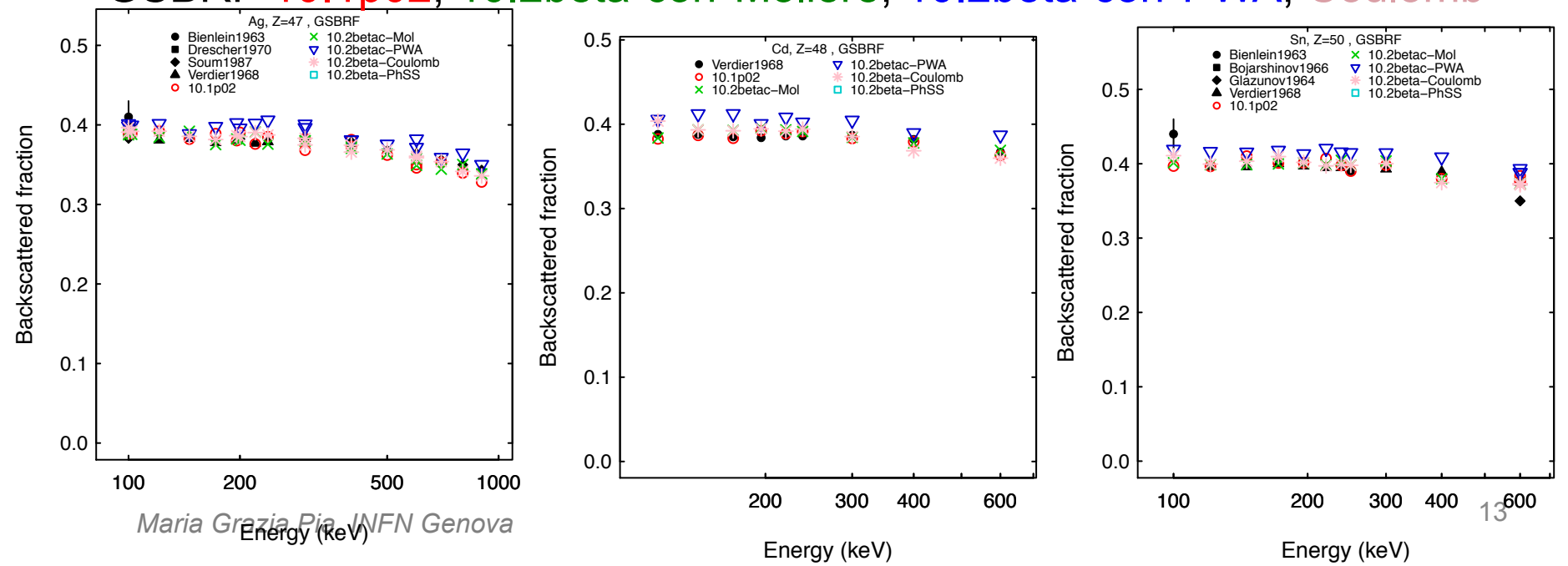
GSBRF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb

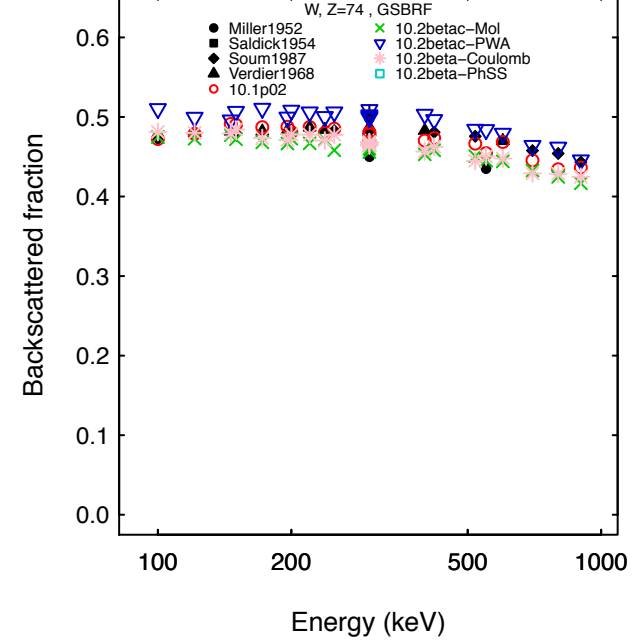
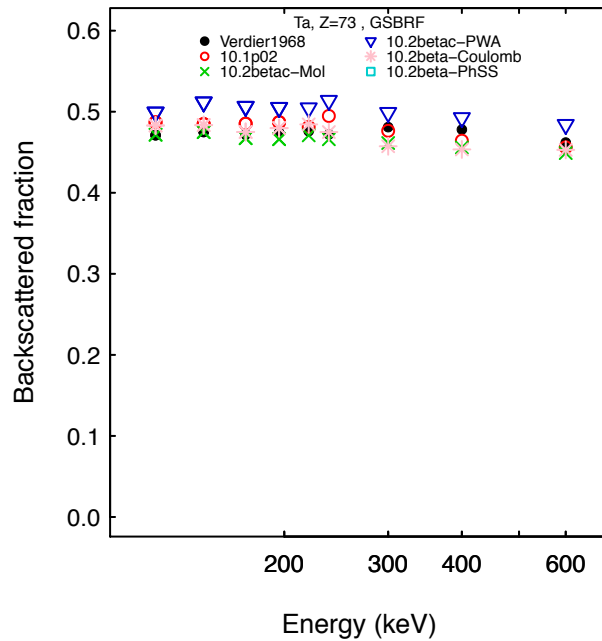
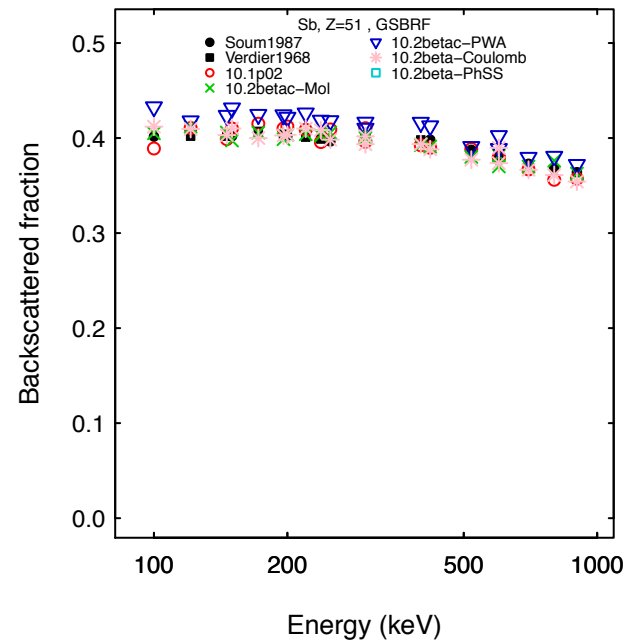




100 keV -1 MeV

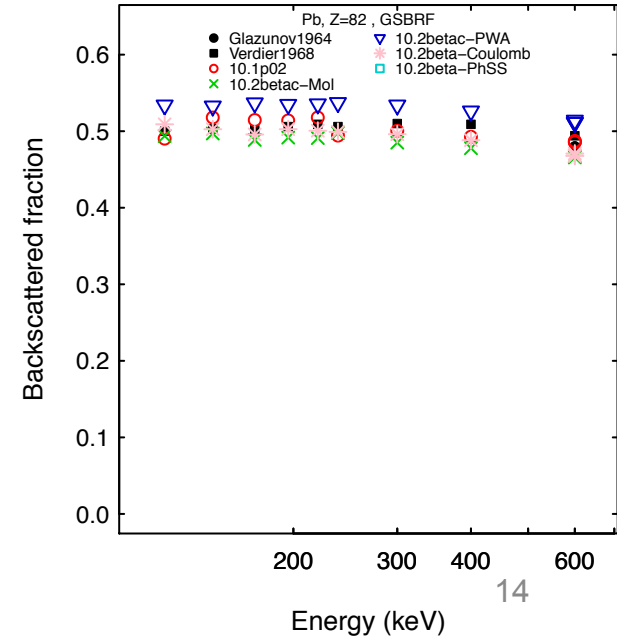
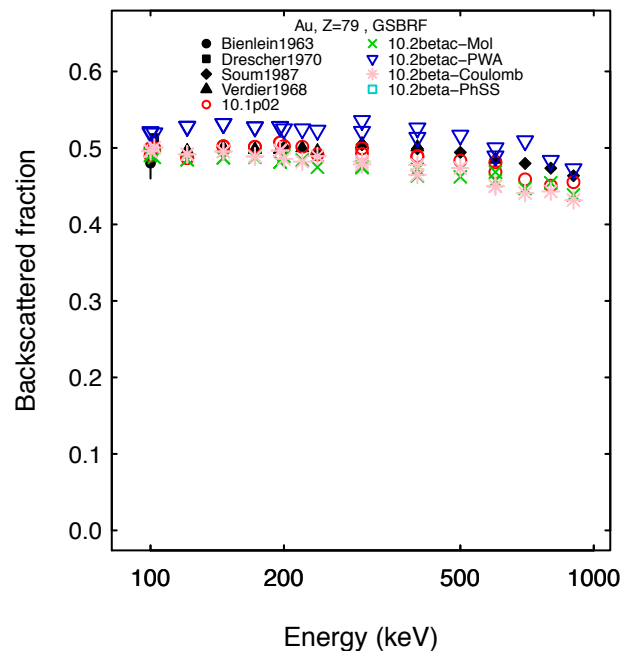
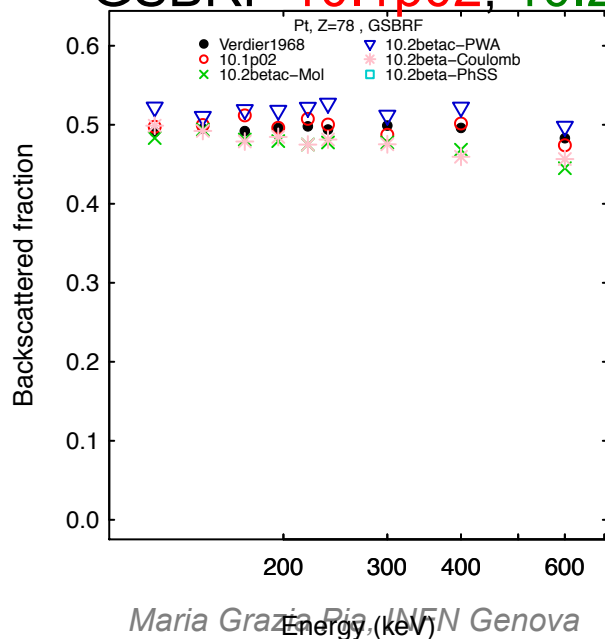
GSBRF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb

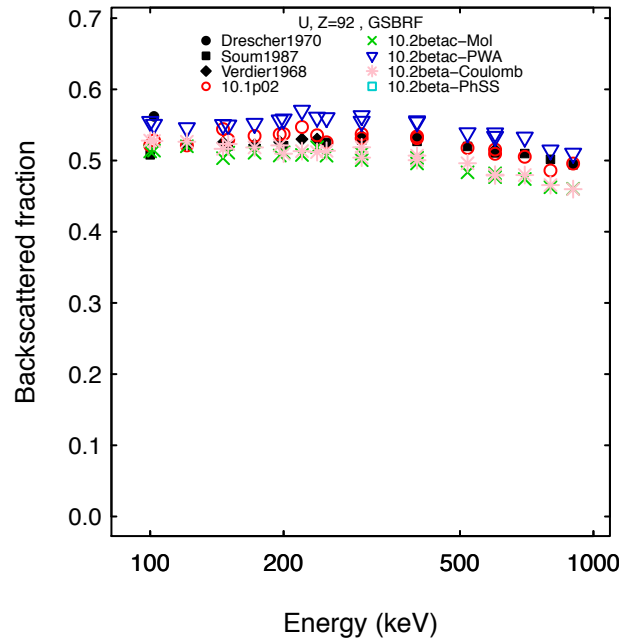
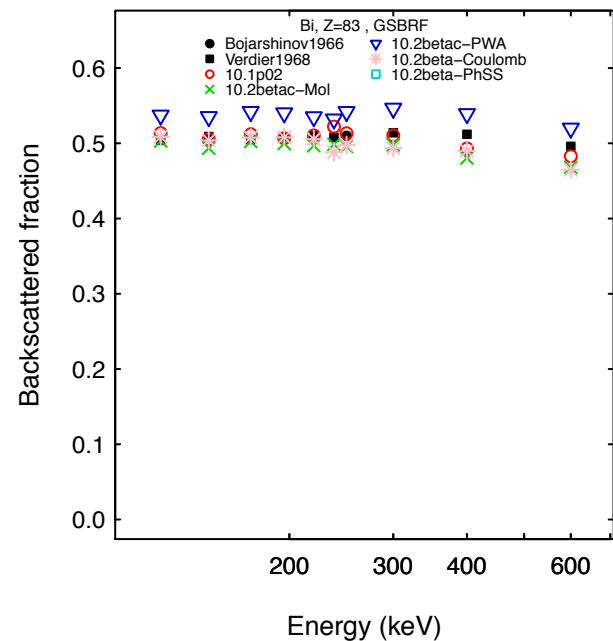




100 keV -1 MeV

GSBRF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb





100 keV -1 MeV
GSBRF 10.1p02,
10.2beta-corr Molière,
10.2beta-corr PWA,
Coulomb

Efficiency $E \geq 100$ keV

Simulation Configuration	10.1p02	10.2-beta	Molière	PWA
Coulomb	0.81±0.05	0.81±0.05		
G4EmStandarPhysicsSS	0.82±0.05	0.89±0.05		
GS	0.81±0.05	0.07±0.04	0.67±0.06	0.70±0.06
GSBRF	0.95±0.03	0.07±0.04	0.70±0.06	0.65±0.06
G4EmStandardPhysicsGS		0.09±0.04	0.51±0.06	0.60±0.06

Preliminary categorical analysis

Two-sided tests, $\alpha = 0.01$

H_0 : equivalent compatibility with experiment of **GSBRF** in 10.1p02 and 10.2-beta-corrected

Test	p-value Molière	p-value PWA
Fisher	0.0011	0.0010
Z-pooled	0.0007	0.0006
Boschloo	0.0005	0.0005
CSM-approximate	0.0007	0.0007

H₀ is rejected

H_0 : equivalent compatibility with experiment of simulations with

Coulomb / G4EmStandardPhysicsSS in 10.2-beta and GSBRF in 10.1p02

Test	p-value Coulomb	p-value G4EmStandardPhysicsSS
Fisher	0.0427	0.4897
Z-pooled	0.0235	0.3257
Boschloo	0.0308	0.3994
CSM-approximate	0.0620	1

H₀ is not rejected

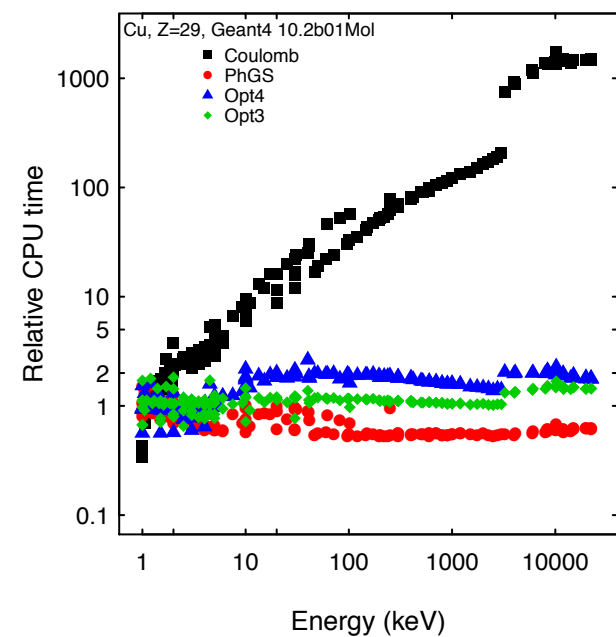
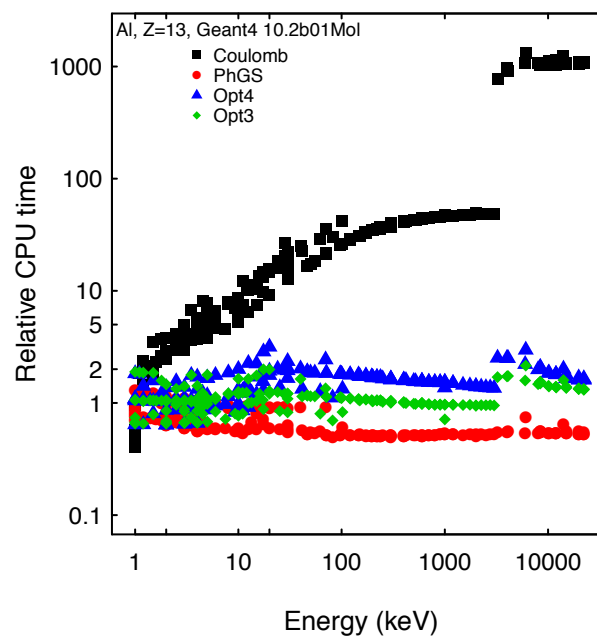
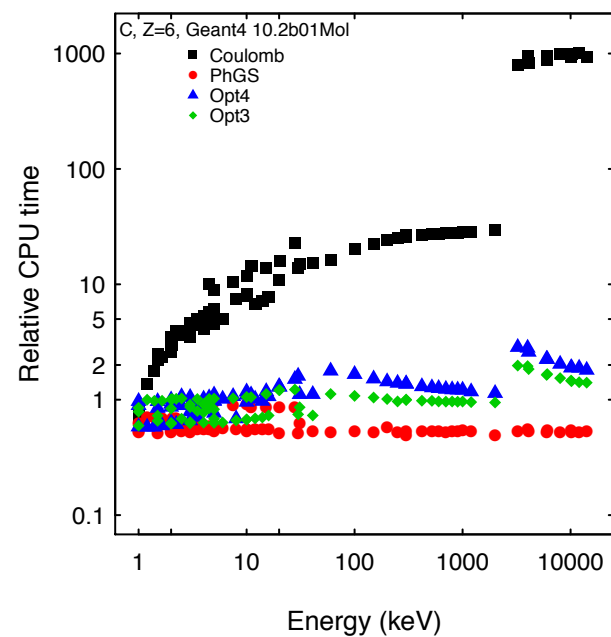
Curiosity...

H_0 : equivalent compatibility with experiment of simulations with **UrbanBRF** and **GSBRF** in 10.2-beta-corrected

Two-sided tests, $\alpha = 0.01$

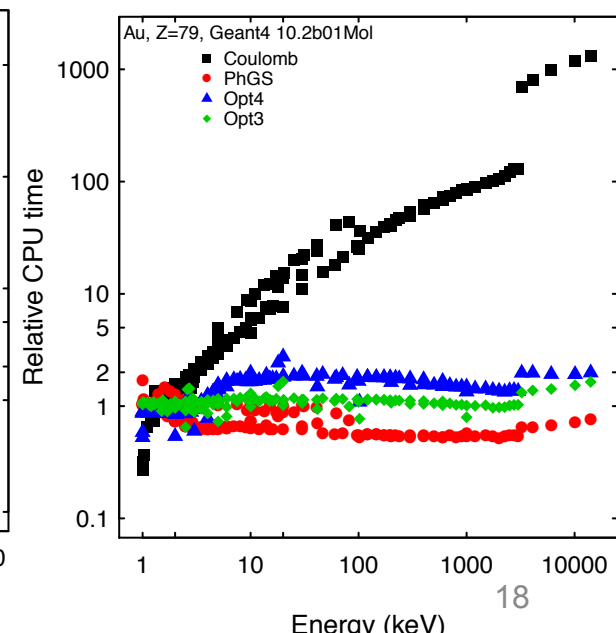
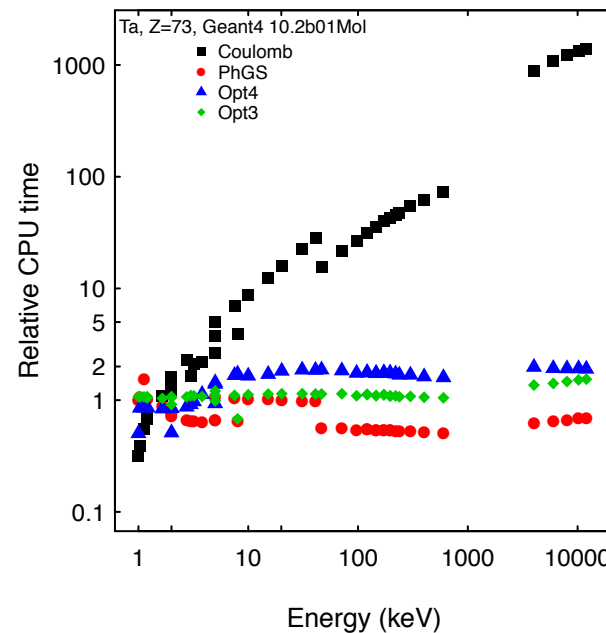
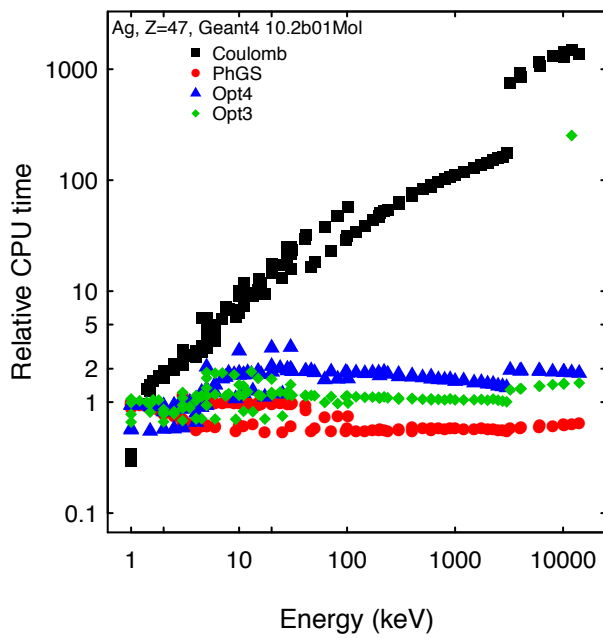
Test	p-value Molière	p-value PWA
Fisher	1	0.8427
Z-pooled	0.9087	0.7515
Boschloo	1	0.7453
CSM-approximate	0.9562	0.8060

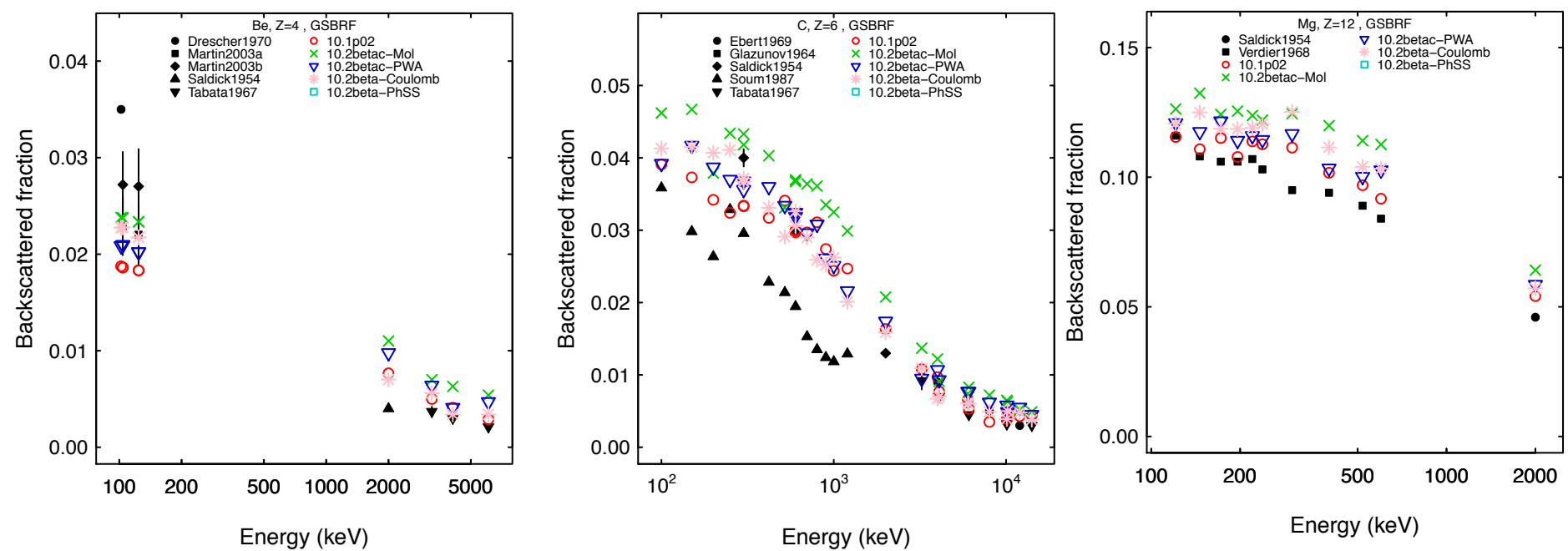
H_0 is not rejected



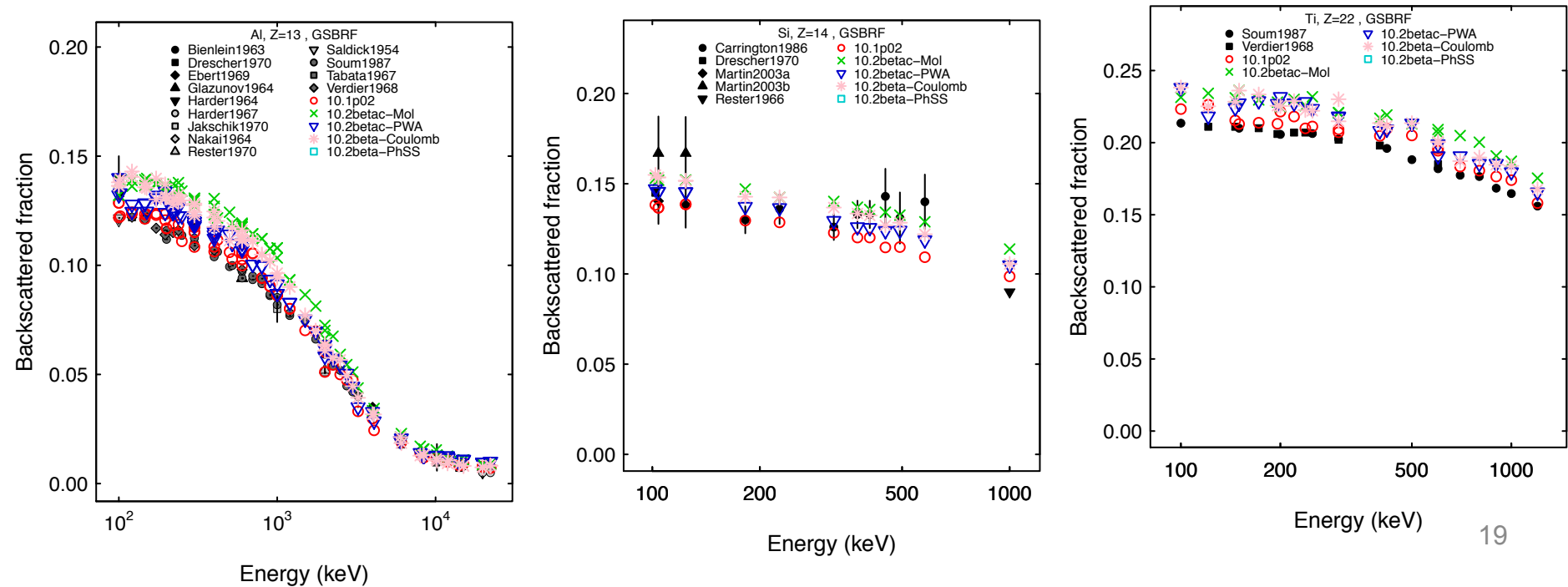
Time ratio w.r.t. simulation with G4EmStandardPhysics

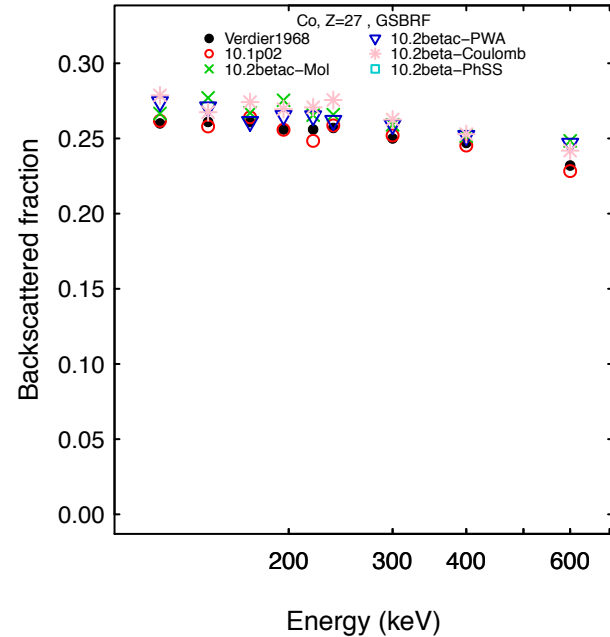
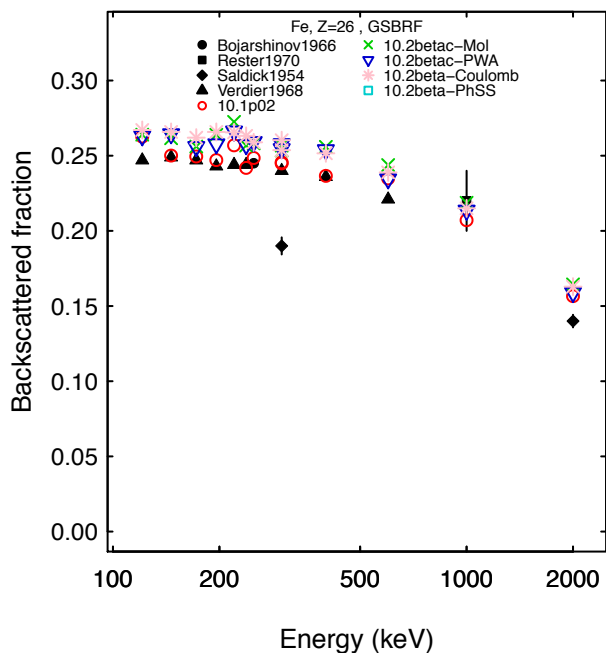
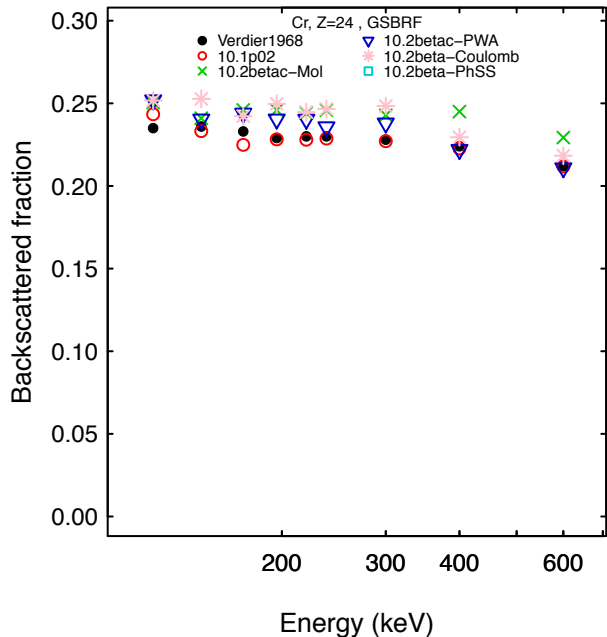
Beware: only qualitative indication due to characteristics of the production



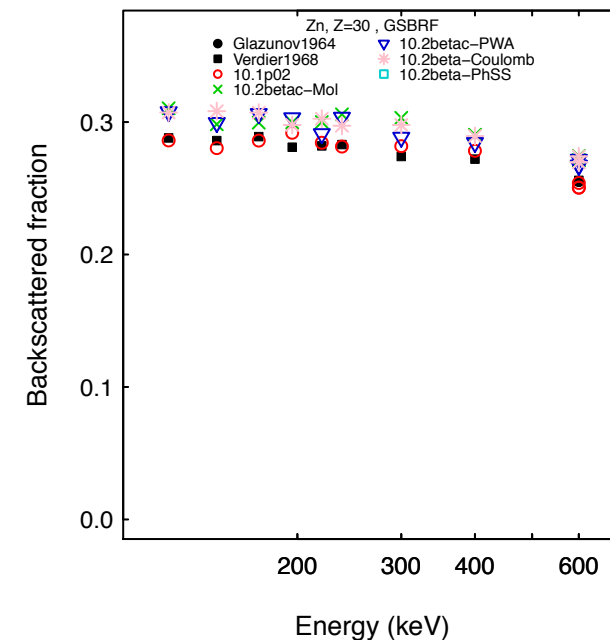
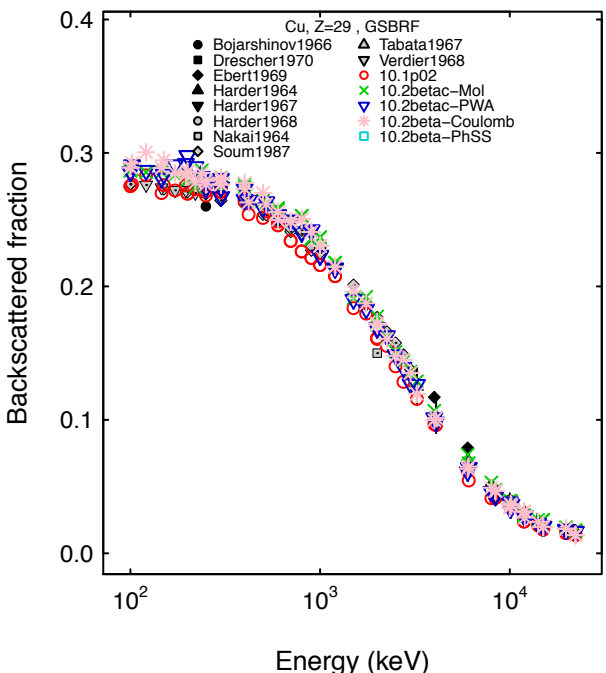
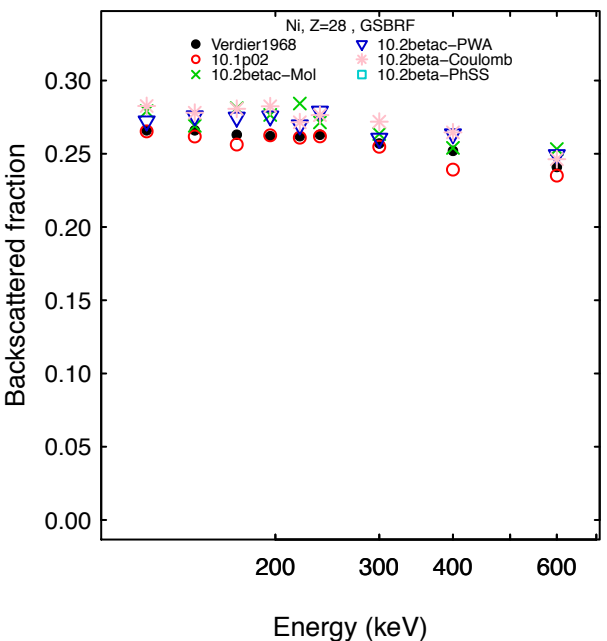


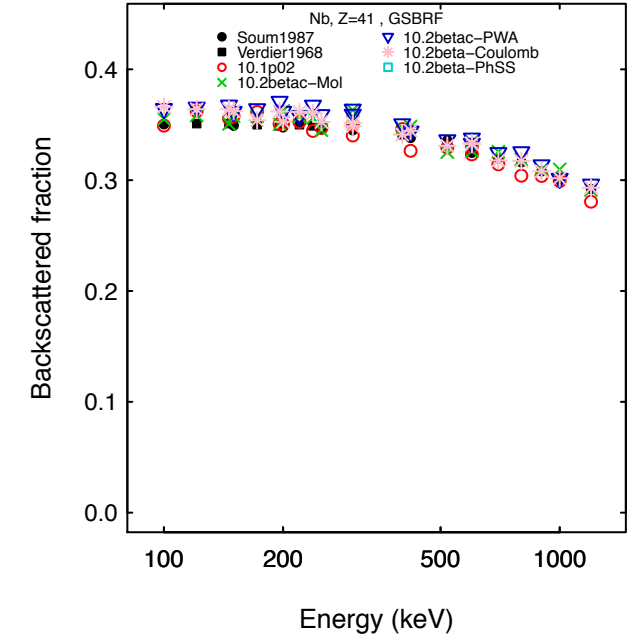
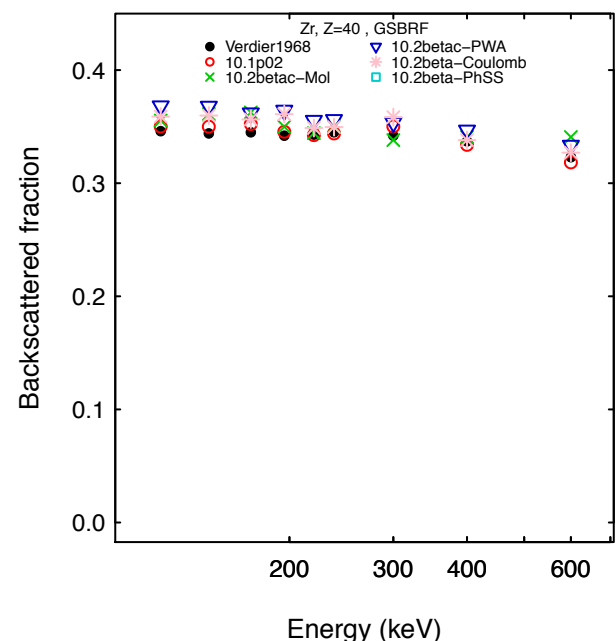
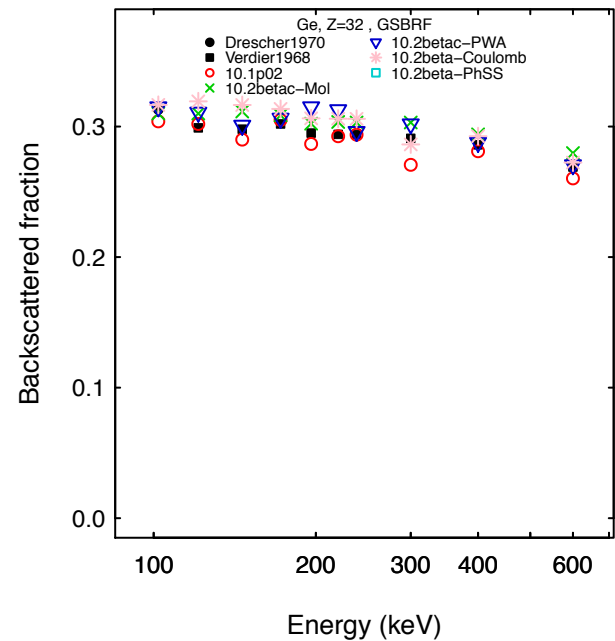
≥ 100 keV - GSBFRF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb



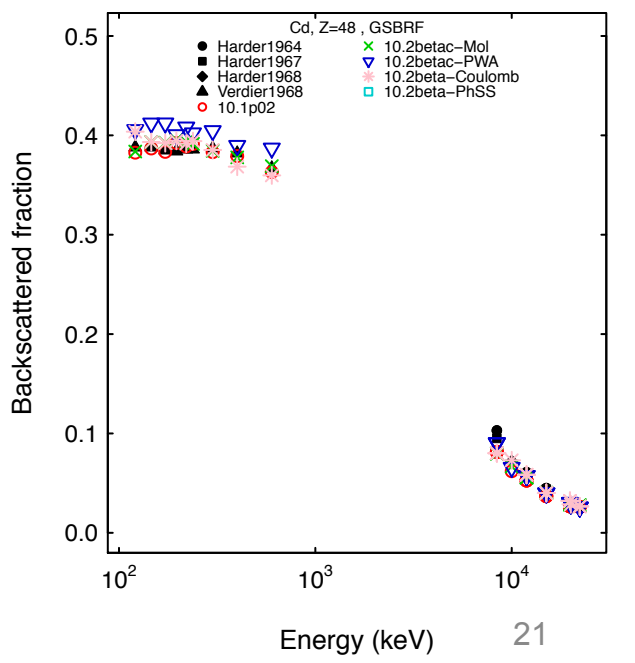
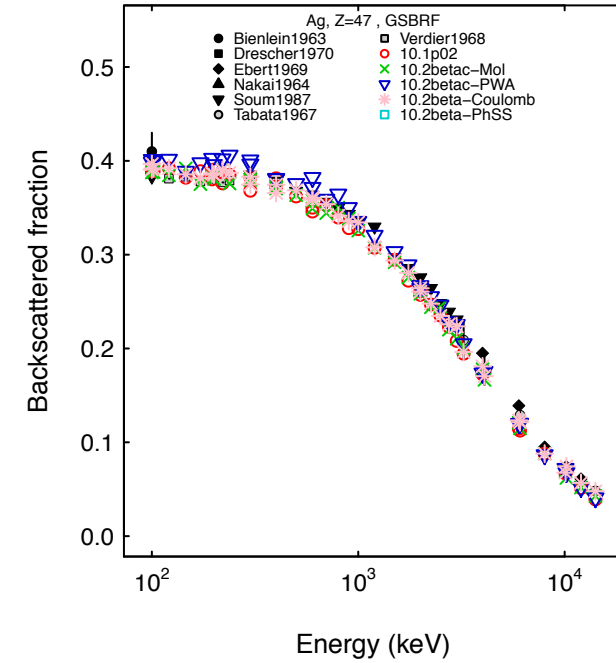
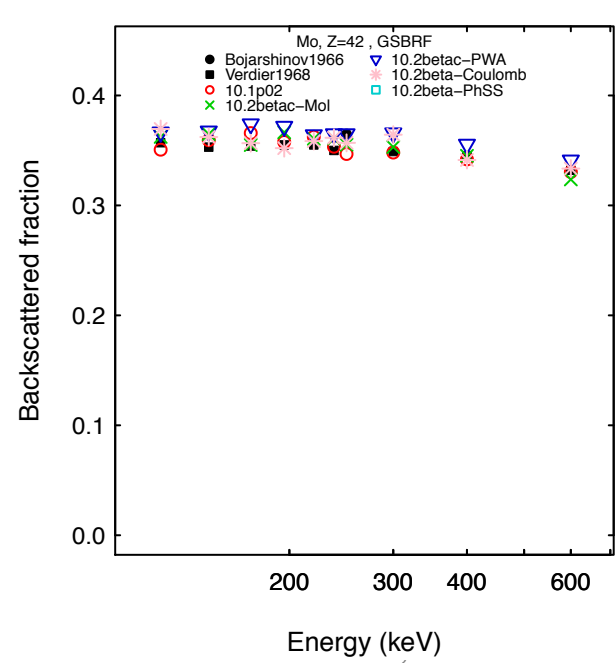


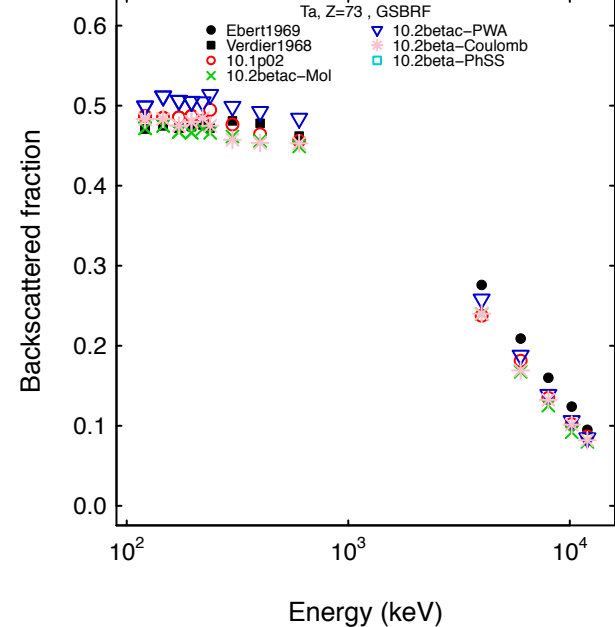
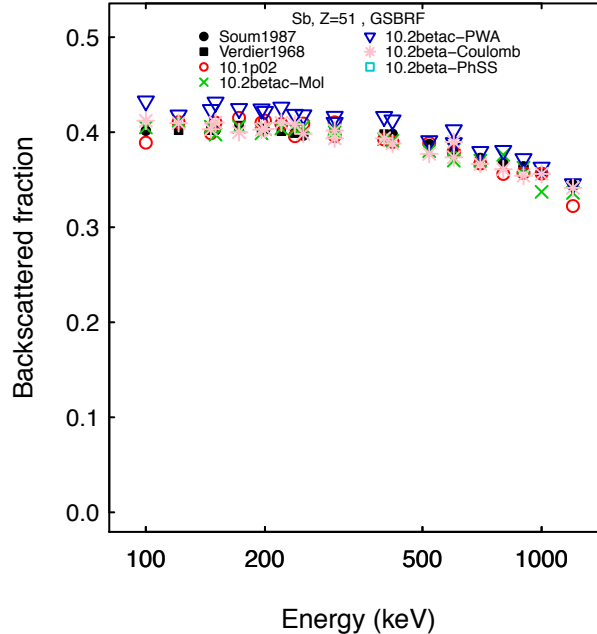
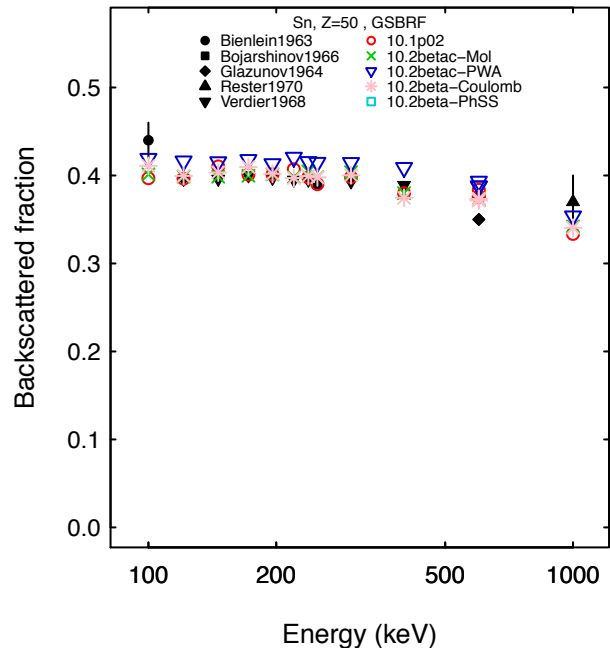
≥ 100 keV - GSRBF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb



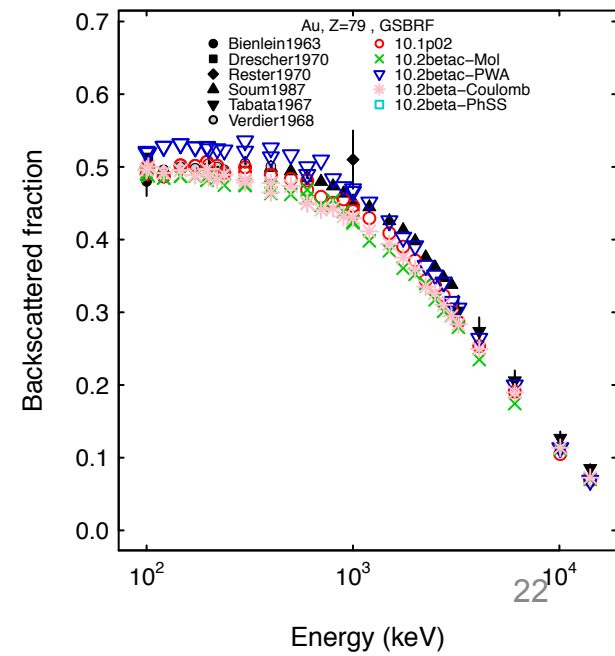
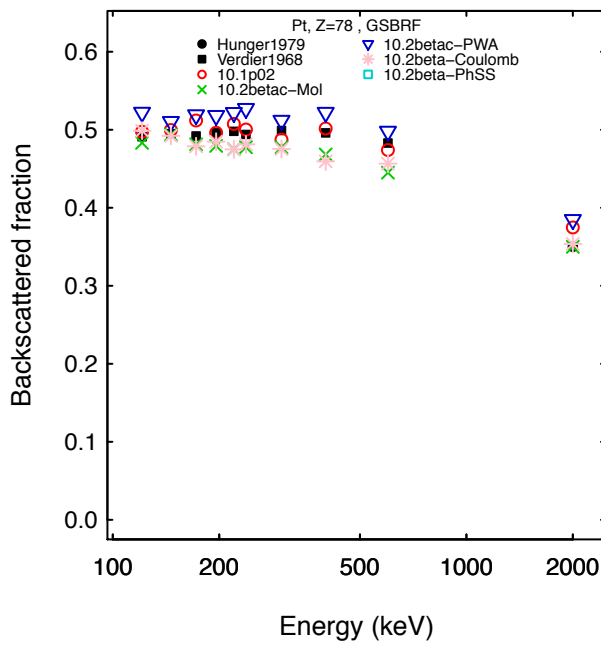
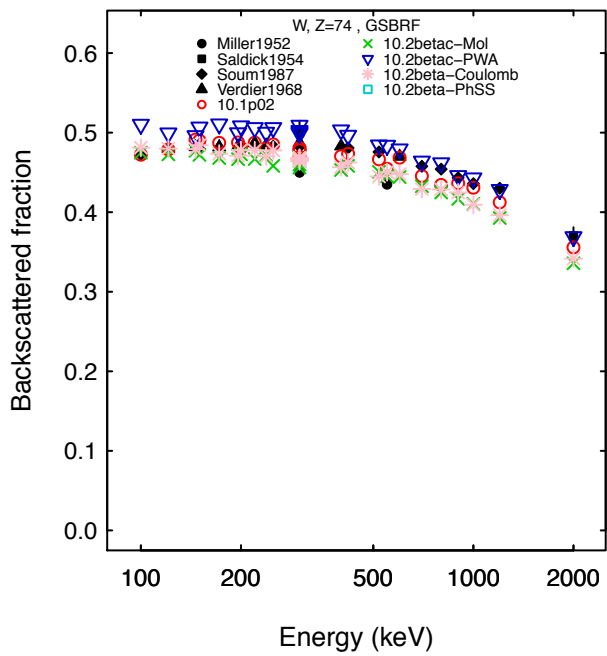


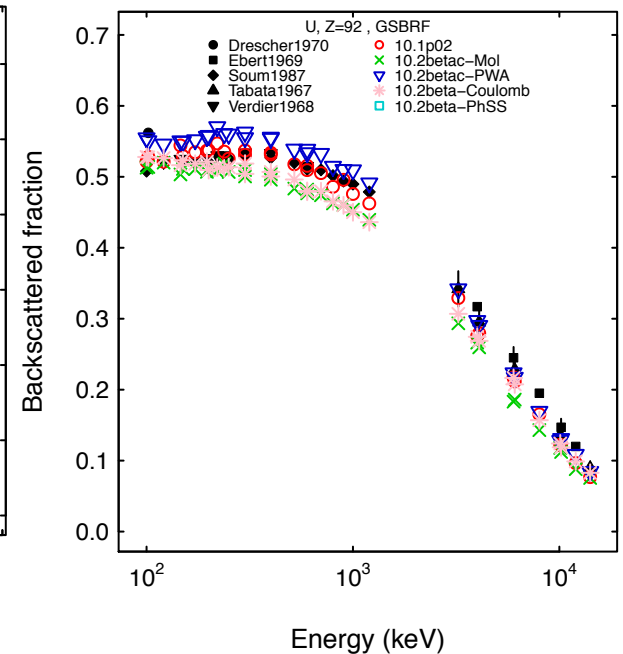
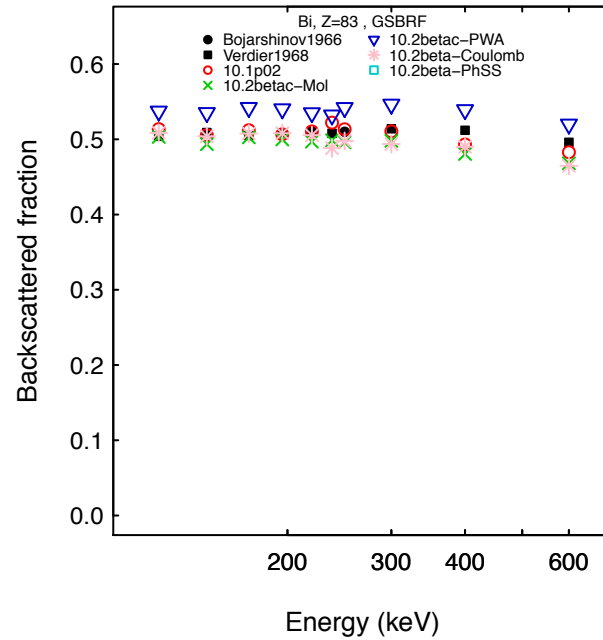
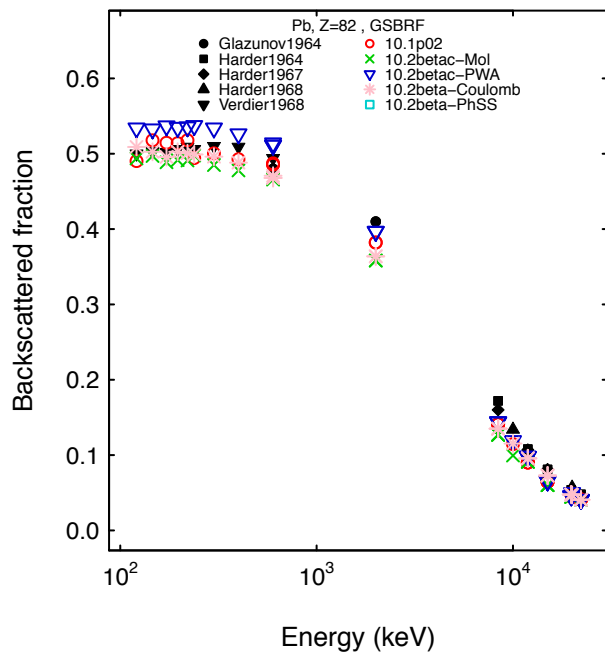
≥ 100 keV - GSBRF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb





≥ 100 keV - GSRBF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb





≥ 100 keV - GSBRF 10.1p02, 10.2beta-corr Molière, 10.2beta-corr PWA, Coulomb