Preliminary Work On Characterizing B Ka in Mg borides

04-06-2011 (Updated 10-31-2011)

I recently attempted to analyze Mg borides using EPMA. I hadn't done much serious work on boron previously and decided to look at the whole ball of wax again. As everyone knows there is a large absorption correction (250 to 300%) for this system and of course the peak shape issues need to be examined.

First I measured the B Ka signal in boron metal, boron nitride and also the unknown samples which were supposedly MgB4 and MgB2 at a number of voltages (5 to 20 keV) to get the MAC for B Ka in B, N and Mg. An empirically measured B Ka in Mg MAC had not been published previously interestingly enough.

Here are the values I obtained using Pouchou's Xmac program running from 5 to 20 keV using a Cameca PC25 LDE crystal:

Emitter	Absorber	MAC	Material
B Ka	B	3068	Boron metal
B Ka	B	2750	Boron nitride (assumed 50:50 composition)
B Ka	Ν	10421	Boron nitride (assumed 50:50 composition)
B Ka	Mg	54251	MgB4 (assumed stoichiometric)
B Ka	Mg	54834	MgB2 (assumed stoichiometric)

By the way, I don't think my BN is quite stoichiometric. I think there is a binder in it, possibly carbon based (oxygen I measured at ~0.4 wt %) but I can't find anyone that has published actual compositions on BN. If anyone knows of empirical measurements on cubic BN for B, N, C and O please let me know. It polishes as a very fine grained sintered material, appears beam stable and fluoresces bright blue under the beam.

I've assumed a (very) rough average B Ka MAC for Mg borides at 54,500 though there may actually be a systematic difference between the compounds due to the Mg L absorption edge moving around with the different bonding though it's not that close.

I also measured the APF factors to deal with the expected peak shift/shape changes and they are significant, at least for the MgB2. Fortunately these materials are all binaries so it's easy to extract the APF factors for use as compound APFs. That is one can easily measure the effect of B Ka in the presence of Mg by measuring for example, a wavescan on boron metal (the "std"), and then wavescans on the MgB4 and MgB2 (the "unkns"). The APF work was done at 15 keV on an SX100 using a PC25 crystal from Cameca which is optimized for boron.

But note: depending on whether you keep the peak position constant for the different materials (and incorporate the peak shift effect in the APF calculation) or use a different peak position for each material (and minimize the peak shift and essentially only correct for peak shape changes, not to mention also improving your counting statistics by staying on the peak), how you calculate the APF is slightly different for the two cases.

In each case one can use the Probe for EPMA Model Background dialog to get the peak and integrated areas on wavescans acquired with sufficient precision. Though one might have to utilize a deconvolution package if there are other extraneous peaks present in other systems. Note that if one clicks the Integrate button the program calculates the Peak and Integrated intensities and also the P/I and I/P intensities. Which ratio you would choose for a given wavescan depends on whether this was the "std" material or the "unk" material for the APF calculation. That is, use the P/I ratio from your standard material and the I/P ratio from your unknown material.

But let's say you wanted to use the same peak position for both the std and the unk and correct for both peak shift and peak shape. Now in the case of say, sulfur, the change between pyrite and anhydrite is almost all peak shift, so you probably wouldn't want to use the same spectrometer position for both materials. But if the spectral change between the two materials is mostly peak shape them you probably would use the same spectrometer positions and just correct for changes in peak shape.

The point is it works either way, but one should think carefully about it. By default, the Probe for EPMA program uses the peak position recorded for each wavescan sample. Now if you are using the same peak position for all samples (and correcting for both peak shift and peak shape changes) that is fine. Multiply the appropriate P/I and I/P ratio from your two materials, edit your EMPAPF.DAT file and you are done.

But if you want to minimize the peak shift effect and use the optimum peak position for each material (and optimize your counting statistics), and only correct for peak shape changes, you should either make sure that each wavescan has the correct on-peak position specified before acquisition. Or you can click one of the peak fit options in the Model Background dialog (usually Maxima or Highest). Then click the Integrate button again and the program will recalculate the P/I and I/P values based on the newly fitted peak position.

Of course in this case, you must use the same optimized peak positions for your actual quantitative standard and unknown acquisitions. The APF values I found doing this (using different optimized peak positions for each material) are (relative to boron metal):

"b"	"ka"	"n"	1.029	"BN/B/PC25/147.6"
"b"	"ka"	"mg"	1.004	"MgB4/B/PC25/147.6"
"b"	"ka"	"mg"	0.928	"MgB2/B/PC25/147.6"

In the case of utilizing a fixed peak position from the boron metal, the APF values are somewhat larger as would be expected to account for the peak shift effects relative to boron metal in addition to peak shape effects as shown here:

"b"	"ka"	"n"	1.214	"BN/B/PC25/147.6"
"b"	"ka"	"mg"	1.017	"MgB4/B/PC25/147.6"
"b"	"ka"	"mg"	0.937	"MgB2/B/PC25/147.6"

Anyway, doing this I get fairly reasonable quant values for these Mg borides, but the stoichiometries are somewhat variable depending on which matrix correction is used (not to mention the totals).

I used the APFs relative to boron metal at the optimized peak position for each material (1.004 for MgB4 and 0.928 for MgB2). One can simply toggle the APF flag in the Analytical Options dialog to turn the APF calculation on or off for each compound. I'm also using the above empirically measured B Ka MACs to override the FFAST MAC values.

The following data was all measured at 6 keV, 30 nA on a Cameca Sx100 using TAP for Mg Ka, PC12 for O ka and PC25 for B Ka. More experimental conditions are listed at the end.

Summary of All Calculated (averaged) Matrix Corrections: Un 11 Mg-B dark phase9 FFAST Chantler (NIST v 2.1, 2005) Elemental Weight Percents: ELEM: Mg B O B TOTAL 1 34.307 67.090 .449 .000 101.846 Armstrong/Love Scott (default) 2 30.786 68.445 .399 .000 99.630 Conventional Philibert/Duncumb-Reed 3 34.289 67.778 .444 .000 102.511 Heinrich/Duncumb-Reed

4	34.569	65.861	.429	.000	100.860	Love-Scott I
5	34.523	65.603	.425	.000	100.551	Love-Scott II
б	34.959	66.070	.443	.000	101.471	Packwood Phi(pz) (EPQ-91)
7	40.293	67.025	.504	.000	107.821	Bastin (original) Phi(pz)
8	36.085	59.091	.447	.000	95.623	Bastin PROZA Phi(pz) (EPQ-91)
9	36.004	70.083	.456	.000	106.543	Pouchou and Pichoir - Full
10	36.007	69.188	.457	.000	105.652	Pouchou and Pichoir - Simplified
AVER:	35 182	66 623	445	000	102 251	
SDEV:	2.358	3.023	.027	.000	3,613	
SERR:	.746	.956	.009	.000	5.015	
MIN:	30.786	59.091	.399	.000	95.623	
MAX:	40.293	70.083	.504	.000	107.821	
Atomic	Percents	:				
ELEM:	Mq	В	0	В	TOTAL	
1	18.463	81.170	.367	.000	100.000	Armstrong/Love Scott (default)
2	16.618	83.055	.327	.000	100.000	Conventional Philibert/Duncumb-Reed
3	18.304	81.336	.360	.000	100.000	Heinrich/Duncumb-Reed
4	18.861	80.783	.356	.000	100.000	Love-Scott I
5	18.901	80.745	.353	.000	100.000	Love-Scott II
6	18,983	80.652	.365	.000	100.000	Packwood Phi(pz) (EPO-91)
7	21.015	78.586	.399	.000	100.000	Bastin (original) Phi(pz)
, 8	21 277	78 323	400	000	100 000	Bastin PROZA Phi(nz) (EPO-91)
a	18 535	81 108	357	000	100.000	Pouchou and Dichoir - Full
10	18 730	80 909	361	.000	100.000	Pouchou and Pichoir - Simplified
10	10.750	00.909	.501	.000	100.000	rouchou and richorr simprified
AVER:	18.969	80.667	.365	.000	100.000	
SDEV:	1.333	1.354	.022	.000	.000	
SERR:	.422	.428	.007	.000		
MIN:	16.618	78.323	.327	.000	100.000	
MAX:	21.277	83.055	.400	.000	100.000	
Summary	of All	Calculate	d (avera	med) Ma	trix Corr	rections:
Summary Un 14 FFAST	y of All H Mg-B l Chantl	Calculate ight phase er (NIST -	d (averag e9 v 2.1, 20	ged) Ma 005)	atrix Corr	rections:
Summary Un 14 FFAST Element	y of All 4 Mg-B l Chantl cal Weigh	Calculate ight phase er (NIST -	d (averag e9 v 2.1, 20 s:	ged) Ma	atrix Corr	rections:
Summary Un 14 FFAST Element ELEM:	y of All 4 Mg-B l Chantl tal Weigh Mg	Calculate ight phase er (NIST t Percent B	d (averag e9 v 2.1, 20 s: 0	ged) Ma 005) B	atrix Corr TOTAL	rections:
Summary Un 14 FFAST Element ELEM: 1	y of All 4 Mg-B l Chantl tal Weigh Mg 49.046	Calculate ight phas er (NIST t Percent. B 54.731	d (averag e9 v 2.1, 2) s: 0 .536	ged) Ma 005) B .000	TOTAL 104.313	rections: Armstrong/Love Scott (default)
Summary Un 14 FFAST Element ELEM: 1 2	y of All 4 Mg-B l Chantl tal Weigh Mg 49.046 44.941	Calculate ight phas er (NIST t Percent B 54.731 57.511	d (averag e9 v 2.1, 20 s: 0 .536 .505	ged) Ma 005) B .000 .000	TOTAL 104.313 102.956	rections: Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed
Summary Un 14 FFAST Element ELEM: 1 2 3	y of All 4 Mg-B l Chantl tal Weigh 49.046 44.941 48.760	Calculated ight phase er (NIST) t Percent. B 54.731 57.511 54.988	d (averag e9 v 2.1, 20 s: .536 .505 .547	ged) Ma 005) .000 .000 .000	TOTAL 104.313 102.956 104.295	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed
Summary Un 14 FFAST Element ELEM: 1 2 3 4	y of All Mg-B l Chantl cal Weigh Mg 49.046 44.941 48.760 49.155	Calculated ight phase er (NIST) t Percent. 54.731 57.511 54.988 53.045	d (averag e9 v 2.1, 20 s: .536 .505 .547 .531	ged) Ma 005) .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I
Summary Un 14 FFAST Element 2 3 4 5	y of All Mg-B l Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107	Calculated ight phase er (NIST) t Percent. 54.731 57.511 54.988 53.045 53.631	d (averag e9 v 2.1, 20 .536 .505 .547 .531 .527	ged) Ma 005) .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II
Summary Un 14 FFAST Element ELEM: 1 2 3 4 5 6	<pre>v of All 4 Mg-B l Chantl Chantl cal Weigh 49.046 44.941 48.760 49.155 49.107 49.654</pre>	Calculated ight phase er (NIST) t Percent 54.731 54.988 53.045 53.631 53.114	d (averag e9 v 2.1, 20 s: .536 .505 .547 .531 .527 .544	ged) Ma 005) .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91)
Summary Un 14 FFAST Element ELEM: 1 2 3 4 5 6 7	<pre>/ of All 4 Mg-B l Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107 49.654 55.235</pre>	Calculate ight phas er (NIST t Percent 54.731 57.511 54.988 53.045 53.631 53.114 52.819	d (average) v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602	ged) Ma 005) .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz)
Summary Un 14 FFAST Element 2 3 4 5 6 7 8	<pre>/ of All Mg-B l Chantl Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618</pre>	Calculate ight phas er (NIST t Percent 54.731 57.511 54.988 53.045 53.631 53.631 53.114 52.819 44.949	d (average) e9 v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .542	ged) Ma 005) .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91)
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9	<pre>/ of All Mg-B l Chantl Chantl cal Weigh 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630</pre>	Calculate ight phas er (NIST) t Percent. 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589	d (average) e9 v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559	ged) Ma 005) .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10	<pre>/ of All Mg-B l Chantl Chantl cal Weigh 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583</pre>	Calculate ight phas er (NIST t Percent 54.731 57.511 54.988 53.045 53.631 53.631 53.114 52.819 44.949 57.589 56.167	d (average) e9 v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558	ged) Ma 005) .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Dove-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
Summary Un 14 FFAST Element ELEM: 1 2 3 4 5 6 7 8 9 10	<pre>v of All 4 Mg-B l Chantl Chantl cal Weigh 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 40.772</pre>	Calculate ight phas er (NIST) t Percent 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167	d (average) e9 v 2.1, 21 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545	ged) Ma 005) .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER:	<pre>/ of All Mg-B l Chantl Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 49.773 2522</pre>	Calculate ight phas er (NIST) t Percent 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 2 595	d (average) e9 v 2.1, 21 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .245	ged) Ma 005) .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 2.671	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Dove-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
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Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SDEV: SERR: MIN:	<pre>/ of All Mg-B l Chantl Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 57.255</pre>	Calculated ight phase er (NIST) t Percent. 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.500	d (average) e9 v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .558 .545 .026 .008 .505 .505	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
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Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SERR: MIN: MAX: Atomic	<pre>v of All Mg-B l Chantl Chantl Chantl cal Weigh 49.046 44.941 48.760 49.155 49.107 49.654 50.618 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents</pre>	Calculate ight phas er (NIST) t Percent. 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 :	d (average) e9 v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .545 .026 .008 .505 .602	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SDEV: SERR: MIN: MAX: Atomic ELEM:	<pre>v of All Mg-B l Chantl Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg</pre>	Calculate ight phas er (NIST) t Percent. 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 : B	d (average) e9 v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 TOTAL	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Dove-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SDEV: SERR: MIN: MAX: Atomic ELEM: 1	<pre>v of All Mg-B l Chantl Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg 28.381</pre>	Calculate ight phas er (NIST) t Percent. 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 : B 71.147	d (average) e9 v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0 .471	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 TOTAL 100.000	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SDEV: SERR: MIN: MAX: Atomic ELEM: 1 2	<pre>v of All Mg-B l Chantl Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg 28.381 25.690</pre>	Calculate ight phas er (NIST) t Percent. 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 : B 71.147 73.871	d (average) v 2.1, 21 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0 .471 .439	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 TOTAL 100.000 100.000	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed
Summary Un 14 FFAST Element ELEM: 1 2 3 4 5 6 7 8 9 10 AVER: SERR: MIN: MAX: Atomic ELEM: 1 2 3	<pre>v of All Mg-B l Chantl Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg 28.381 25.690 28.169</pre>	Calculate ight phas er (NIST) t Percent. 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 : B 71.147 73.871 71.351	d (average) v 2.1, 21 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0 .471 .439 .480	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 108.778 TOTAL 100.000 100.000	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed
Summary Un 14 FFAST Element ELEM: 1 2 3 4 5 6 7 8 9 10 AVER: SERR: MIN: MAX: Atomic ELEM: 1 2 3 4	<pre>v of All Mg-B l Chantl Chantl Chantl cal Weigh 49.046 44.941 48.760 49.155 59.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg 28.381 25.690 28.169 29.068</pre>	Calculate ight phas er (NIST t Percent 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 : B 71.147 73.871 71.351 70.454	d (average) v 2.1, 21 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0 .471 .439 .480 .477	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 TOTAL 100.000 100.000 100.000	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Dackwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SERR: MIN: MAX: Atomic ELEM: 1 2 3 4 5	<pre>v of All Mg-B l Chantl Chantl Chantl cal Weigh Mg 49.046 44.941 48.760 49.155 59.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg 28.381 25.690 28.169 29.068 28.819</pre>	Calculate ight phas er (NIST t Percent 54.731 57.511 54.988 53.045 53.631 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 : B 71.147 73.871 71.351 70.454 70.711	d (average) v 2.1, 21 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0 .471 .439 .480 .477 .470	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 TOTAL 100.000 100.000 100.000 100.000	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Dove-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SERR: MIN: MAX: Atomic ELEM: 1 2 3 4 5 5 6	<pre>v of All Mg-B l Chantl Chantl Chantl Chantl 49.046 44.941 48.760 49.155 549.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg 28.381 25.690 28.068 28.69 29.068 28.819 29.246</pre>	Calculate ight phas er (NIST 54.731 57.511 54.988 53.045 53.631 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 : B71.147 73.871 71.351 70.454 70.711 70.267	d (average) v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0 .471 .439 .480 .477 .470 .486	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 TOTAL 100.000 100.000 100.000 100.000 100.000	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Dove-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91)
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SERR: MIN: MAX: Atomic ELEM: 1 2 3 4 5 6 7 7 8 9 10	<pre>v of All Mg-B l Chantl Chantl Chantl Chantl Chantl 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg 28.381 25.690 28.169 29.068 28.819 29.246 31.602</pre>	Calculate ight phas er (NIST 54.731 57.511 54.988 53.045 53.631 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 57.589 57.589 : B 71.147 73.871 71.351 70.454 70.711 70.267 67.875	d (average) v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0 .471 .439 .480 .477 .470 .486 .524	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 TOTAL 100.000 100.000 100.000 100.000 100.000	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz)
Summary Un 14 FFAST Element 2 3 4 5 6 7 8 9 10 AVER: SERR: MIN: MAX: Atomic ELEM: 1 2 3 4 5 6 7 8 9 10	<pre>v of All Mg-B l Chantl Chantl Chantl Chantl 49.046 44.941 48.760 49.155 49.107 49.654 55.235 50.618 50.630 50.583 49.773 2.532 .801 44.941 55.235 Percents Mg 28.381 25.690 28.169 29.068 28.819 29.246 31.602 33.219</pre>	Calculate ight phas er (NIST) t Percent. B 54.731 57.511 54.988 53.045 53.631 53.114 52.819 44.949 57.589 56.167 53.854 3.595 1.137 44.949 57.589 57.589 : B 71.147 73.871 71.351 70.454 70.711 70.267 67.875 66.241	d (average) v 2.1, 20 s: 0 .536 .505 .547 .531 .527 .544 .602 .542 .559 .558 .545 .026 .008 .505 .602 0 .471 .439 .480 .477 .470 .486 .524 .540	ged) Ma 005) B .000 .000 .000 .000 .000 .000 .000	TOTAL 104.313 102.956 104.295 102.731 103.264 103.312 108.656 96.110 108.778 107.309 104.172 3.671 96.110 108.778 TOTAL 100.000 100.000 100.000 100.000 100.000 100.000	Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed Heinrich/Duncumb-Reed Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91)

10	28.482	71.040	.478	.000	100.000	Pouchou and Pichoir - Simplified
AVER: SDEV: SERR:	29.067 2.053 .649	70.449 2.081 .658	.484 .029 .009	.000 .000 .000	100.000	
MIN: MAX:	25.690 33.219	66.241 73.871	.439 .540	.000	100.000 100.000	

So then I decided to try measuring integrated intensities to avoid any APF issues (and the seemingly small but possibly significant crystallographic effect I observed on the APFs when measuring different grains) (though acquisition is slow!). The calculations below are using all 10 matrix corrections (note the new feature which also calculates atomic percents for all 10 matrix corrections if specified by the user- nice for comparing stoichiometry).

Summary of All Calculated (averaged) Matrix Corrections: Un 2 MgB4-1 FFAST Chantler (NIST v 2.1, 2005) Elemental Weight Percents: O TOTAL ELEM: Mg в 1 35.413 66.591 .507 102.511 Armstrong/Love Scott (default) .468 100.347 Conventional Philibert/Duncumb-Reed 2 31.654 68.225 .520 103.070 Heinrich/Duncumb-Reed 3 35.207 67.344 .503 101.319 .503 101.319 Love-Scott I .498 101.016 Love-Scott II 4 35.493 65.323 5 35.445 65.073 6 35.894 65.582 .519 101.995 Packwood Phi(pz) (EPQ-91) 41.274 66.220 .589 108.083 Bastin (original) Phi(pz) 7 .523 95.807 8 36.984 58.299 Bastin PROZA Phi(pz) (EPQ-91) 9 36.942 69.591 .534 107.067 Pouchou and Pichoir - Full 10 36.943 68.686 .535 106.165 Pouchou and Pichoir - Simplified 36.125 66.094 AVER: .519 102.738 SDEV: 2.377 3.126 .031 3.629 .752 .989 .010 SERR: 31.654 58.299 .468 95.807 MIN: MAX: 41.274 69.591 .589 108.083 Atomic Percents: ELEM: Mg В O TOTAL 1 19.050 80.534 .415 100.000 Armstrong/Love Scott (default) .383 100.000 Conventional Philibert .422 100.000 Heinrich/Duncumb-Reed 17.042 82.575 Conventional Philibert/Duncumb-Reed 2 3 18.788 80.791 4 19.383 80.199 .418 100.000 Love-Scott I .415 100.000 Love-Scott II .428 100.000 Packwood Phi(pz) (EPQ-91) 5 19.422 80.163 19.495 80.077 6 7 21.605 77.926 .469 100.000 Bastin (original) Phi(pz) 8 21.904 77.624 .471 100.000 Bastin PROZA Phi(pz) (EPQ-91) 19.022 80.560 .418 100.000 9 Pouchou and Pichoir - Full 10 19.224 80.353 Pouchou and Pichoir - Simplified .424 100.000 AVER: 19.493 80.080 .426 100.000 .000 SDEV: 1.386 1.411 .026 SERR: .438 .446 .008 17.042 77.624 .383 100.000 MIN: .471 100.000 21.904 82.575 MAX: Summary of All Calculated (averaged) Matrix Corrections: Un 3 MgB2-1 FFAST Chantler (NIST v 2.1, 2005) Elemental Weight Percents: ELEM: Mq в 0 TOTAL 1 53.042 54.432 .617 108.091 Armstrong/Love Scott (default) 2 48.798 57.240 3 52.733 54.645 .585 106.623 Conventional Philibert/Duncumb-Reed .629 108.007 Heinrich/Duncumb-Reed

4 5 7 8 9 10	53.160 53.110 53.682 59.417 54.491 54.663 54.608	52.692 53.376 52.840 52.282 44.272 57.243 55.845	.612 106.464 .608 107.093 .625 107.147 .689 112.388 .622 99.385 .643 112.549 .642 111.095	Love-Scott I Love-Scott II Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
AVER: SDEV: SERR:	53.770 2.604 .824	53.487 3.703 1.171	.627 107.884 .028 3.792 .009	
MIN:	48.798	44.272	.585 99.385	
MAX:	59.417	57.243	.689 112.549	
Atomic	Percents	:		
ELEM:	Mg	В	O TOTAL	
1	30.081	69.387	.532 100.000	Armstrong/Love Scott (default)
2	27.361	72.141	.498 100.000	Conventional Philibert/Duncumb-Reed
3	29.874	69.584	.542 100.000	Heinrich/Duncumb-Reed
4	30.812	68.648	.539 100.000	Love-Scott I
5	30.521	68.948	.531 100.000	Love-Scott II
б	30.958	68.494	.548 100.000	Packwood Phi(pz) (EPQ-91)
7	33.384	66.028	.589 100.000	Bastin (original) Phi(pz)
8	35.167	64.222	.610 100.000	Bastin PROZA Phi(pz) (EPQ-91)
9	29.658	69.811	.530 100.000	Pouchou and Pichoir - Full
10	30.152	69.310	.539 100.000	Pouchou and Pichoir - Simplified
AVER:	30.797	68.657	.546 100.000	
SDEV:	2.129	2.160	.032 .000	
SERR:	.673	.683	.010	
MIN:	27.361	64.222	.498 100.000	
MAX:	35.167	72.141	.610 100.000	

So far it appears the MgB4 is fairly stoichiometric, but the MgB2 seems a little light heavy on the boron side. I then calculated them all just doing boron by difference as a sanity check:

Summary	y of All Ca	alculated	l (aver	aged) Ma	atrix Cor	rections:
Un 11	L Mg-B dai	ck phases)			
FFAST	Chantler	c (NIST v	7 2.1,	2005)		
Element	al Weight	Percents	3:			
ELEM:	Mg	В	0	В	TOTAL	
1	34.479	.000	.432	65.089	100.000	Armstrong/Love Scott (default)
2	30.782	.000	.399	68.819	100.000	Conventional Philibert/Duncumb-Reed
3	34.275	.000	.443	65.283	100.000	Heinrich/Duncumb-Reed
4	34.564	.000	.429	65.007	100.000	Love-Scott I
5	34.519	.000	.425	65.056	100.000	Love-Scott II
6	34.951	.000	.442	64.607	100.000	Packwood Phi(pz) (EPQ-91)
7	39.959	.000	.497	59.543	100.000	Bastin (original) Phi(pz)
8	36.163	.000	.449	63.387	100.000	Bastin PROZA Phi(pz) (EPQ-91)
9	35.896	.000	.453	63.651	100.000	Pouchou and Pichoir - Full
10	35.911	.000	.454	63.634	100.000	Pouchou and Pichoir - Simplified
AVER:	35.150	.000	.442	64.408	100.000	
SDEV:	2.270	.000	.025	2.294	.000	
SERR:	.718	.000	.008	.726		
MIN:	30.782	.000	.399	59.543	100.000	
MAX:	39.959	.000	.497	68.819	100.000	
Atomic	Percents:					
ELEM:	Mq	В	0	В	TOTAL	
1	19.002	.000	.362	80.636	100.000	Armstrong/Love Scott (default)
2	16.542	.000	.326	83.132	100.000	Conventional Philibert/Duncumb-Reed
3	18.864	.000	.370	80.766	100.000	Heinrich/Duncumb-Reed
4	19.060	.000	.359	80.581	100.000	Love-Scott I
5	19.029	.000	.356	80.616	100.000	Love-Scott II

AVER: 19.485 .000 .372 80.143 100.000 SDEV: 1.573 .000 .027 1.600 .000 SDEV: 1.573 .000 .027 1.600 .000 MAX: 22.891 .000 .433 83.132 100.000 Summary of All Calculated (averaged) Matrix Corrections: Un 14 Mg-B light phase9 FPAST Charler (NIST V 2.1, 2005) Elemental Weight Percents: ELEM: Mg B 0 B TOTAL 1 48.995 .000 .533 50.471 100.000 Armstrong/Love Scott (default) 2 45.039 .000 .555 54.456 100.000 Conventional Philibert/Duncumb-Reed 4 49.121 .000 .544 50.746 100.000 Love-Scott II 5 49.069 .000 .526 50.495 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .553 49.100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .554 44.653 100.000 SERV: 2.344 .000 .554 44.653 100.000 Armstrong/Love Scott (default) 10 50.345 .000 .554 44.653 100.000 Bastin (original) Phi(pz) (EPC-91) 9 50.566 .000 .554 44.653 100.000 Armstrong/Love Scott (default) 10 50.345 .000 .554 44.653 100.000 Bastin (original) Phi(pz) (EPC-91) 9 50.564 .000 .552 44.656 100.000 Armstrong/Love Scott (default) 10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .553 49.331 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .554 44.653 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 3 29.831 .000 .503 69.666 100.000 Heinrich/Duncumb-Reed 4 30.177 .000 .488 69.330 100.000 Love-Scott II 5 30.133 .000 .488 69.330 100.000 Love-Scott II 5 30.133 .000 .518 68.250 100.000 Bastin PROZ Phi(pz) (EPC-91) 9 31.232 .000 .518 68.250 100.000 Bastin PROZ Phi(pz) (EPC-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERV: 2.009 .000 .303 2.039 .000 SERV: 2.009 .000 .531 72.717 100.000	6 7 8 9 10	19.325 22.891 20.165 19.980 19.990	.000 .000 .000 .000 .000	.371 .433 .381 .383 .384	80.303 76.676 79.454 79.637 79.626	100.000 100.000 100.000 100.000 100.000	Packwood Phi(pz) (EPQ-91) Bastin (original) Phi(pz) Bastin PROZA Phi(pz) (EPQ-91) Pouchou and Pichoir - Full Pouchou and Pichoir - Simplified
<pre>MIN: 16.542 .000 .326 76.676 100.000 MAX: 22.891 .000 .433 83.132 100.000 Summary of All Calculated (averaged) Matrix Corrections: Un 14 Mg-B light phase9 FFAST Chantler (NIST v 2.1, 2005) Elemental Weight Percents: ELEM: Mg B 0 B TOTAL 1 48.995 .000 .533 50.471 100.000 Armstrong/Love Scott (default) 2 45.039 .000 .505 54.456 100.000 Conventional Philibert/Duncumb-Reed 4 49.121 .000 .530 50.349 100.000 Love-Scott II 6 49.597 .000 .526 50.405 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .542 49.861 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .542 49.861 100.000 Bastin (PC2 PH) 9 50.356 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .553 49.102 100.000 Bastin PROZA Phi(pz) (EPQ-91) 10 50.345 .000 .555 44.853 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 50.345 .000 .555 44.853 100.000 Bastin PROZA Phi(pz) (EPQ-91) 10 50.345 .000 .555 44.853 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 2 226.829 .000 .454 72.717 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 2 226.829 .000 .555 44.851 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .494 69.434 100.000 2 276.829 .000 .557 64.451 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 44.56 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 44.56 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 64.455 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 64.455 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 64.455 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 64.56 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 64.455 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 64.6520 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.71 .000 .555 64.6520 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.77 .000 .555 64.6520 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.222 .000</pre>	AVER: SDEV: SERR:	19.485 1.573 .497	.000 .000 .000	.372 .027 .009	80.143 1.600 .506	100.000	
Summary of All Calculated (averaged) Matrix Corrections: Un 14 Mg-B light phase9 FFAST Chantler (NIST v 2.1, 2005) Elemental Weight Percents: ELEMM: Mg B 0 B TOTAL 1 48.995 .000 .533 50.471 100.000 Armstrong/Love Scott (default) 2 45.039 .000 .544 50.746 100.000 Heinrich/Duncumb-Reed 4 49.121 .000 .530 50.349 100.000 Love-Scott I 5 49.069 .000 .526 50.405 100.000 Love-Scott I 6 49.597 .000 .542 49.861 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .546 48.706 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .553 49.102 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 50.345 .000 .553 49.091 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .552 44.853 100.000 SERR: .741 .000 .007 .748 MIN: 45.039 .000 .505 44.853 100.000 Atomic Percents: ELEMM: Mg B 0 B TOTAL 1 30.071 .000 .494 69.434 100.000 Atomic Percents: ELEMM: Mg B 0 B TOTAL 1 30.071 .000 .494 69.331 100.000 Atomic Percents: ELEMM: Mg B 0 B TOTAL 1 30.071 .000 .494 69.331 100.000 Atomic Percents: ELEMM: Mg B 0 B TOTAL 1 30.073 .000 .503 69.666 100.000 Atomic Percents: ELEM: Mg B 0 B TOTAL 1 30.071 .000 .503 69.666 100.000 Atomic Percents: ELEM: Mg B 0 B TOTAL 1 30.771 .000 .503 69.666 100.000 Atomic Percents: ELEM: Mg B 0 B TOTAL 1 30.773 .000 .503 69.666 100.000 Atomic Percents: ELEM: Mg B 0 B TOTAL 1 30.773 .000 .503 69.666 100.000 Atomic Percents: ELEM: Mg B 0 B TOTAL 1 30.271 .000 .503 69.666 100.000 A Armstrong/Love Scott [6 30.583 .000 .504 68.913 100.000 Love-Scott I 6 30.583 .000 .504 68.913 100.000 Bastin PROZA Phi(pz) (EPQ-91) 7 34.976 .000 .573 64.451 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.222 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified	MIN: MAX:	16.542 22.891	.000 .000	.326 .433	76.676 83.132	100.000 100.000	
Elemental Weight Percents: ELEM: Mg B O B TOTAL 1 48.995 .000 .535 54.456 100.000 Armstrong/Love Scott (default) 2 45.039 .000 .544 50.746 100.000 Heinrich/Duncumb-Reed 4 49.121 .000 .530 50.349 100.000 Love-Scott I 5 49.069 .000 .526 50.405 100.000 Dastin (Original) Phi(pz) 7 54.555 .000 .552 44.853 100.000 Bastin (Original) Phi(pz) 8 50.748 .000 .546 48.706 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.091 100.000 SERR: .741 .000 .553 49.091 00.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 2 26.829 .000 .553 64.455 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 2 26.829 .000 .553 64.465 100.000 Armstrong/Love Scott (default) Conventional Philibert/Duncumb-Reed 4 30.177 .000 .494 69.434 100.000 3 29.831 .000 .505 64.853 100.000 Heinrich/Duncumb-Reed 4 30.177 .000 .494 69.331 100.000 Love-Scott I 5 30.133 .000 .504 68.933 100.000 Love-Scott I 5 30.133 .000 .513 69.066 100.000 Bastin (PROZ) (PPC-91) 7 34.976 .000 .513 67.917 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.250 100.000 Bastin (original) Phi(pz) (EPC-91) 8 31.571 .000 .518 68.250 100.000 Bastin (original) Phi(pz) (EPC-91) 8 31.571 .000 .518 68.250 100.000 Bastin (PROZ Phi(pz) (EPC-91) 8 31.571 .000 .518 68.250 100.000 Bastin (PROZ Phi(pz) (EPC-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERR: .635 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .518 68.250	Summary Un 14 FFAST	of All C Mg-B li Chantle	alculated ght phase r (NIST v	d (aver 9 7 2.1,	aged) Ma	atrix Cori	rections:
ELEM: Mg B 0 B TOTAL 1 48.995 .000 .505 54.456 100.000 Armstrong/Love Scott (default) 2 45.039 .000 .544 50.746 100.000 Heinrich/Duncumb-Reed 4 49.121 .000 .526 50.459 100.000 Love-Scott I 5 49.069 .000 .526 50.405 100.000 Bastin (original) Phi(pz) 7 54.555 .000 .522 44.853 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .546 48.706 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 50.356 .000 .553 49.102 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .555 44.853 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 49.804 100.000 SERR: .741 .000 .007 .748 MIN: 45.039 .000 .555 44.853 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 2 2 6.829 .000 .454 64.51 100.000 Heinrich/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Armstrong/Love Scott (default) C averstoal Philibert/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .557 64.451 100.000 Love-Scott I 6 30.583 .000 .573 64.451 100.000 Love-Scott I 6 30.583 .000 .573 64.451 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Love-Scott I 6 30.583 .000 .573 64.451 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .573 64.451 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .573 64.451 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .573 64.451 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .573 64.451 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .507 64.51 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .573 77.717 7100.000	Element	al Weight	Percents	3:			
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2 45.039 .000 .505 54.456 100.000 Conventional Philibert/Duncumb-Reed 3 48.709 .000 .544 50.746 100.000 Heinrich/Duncumb-Reed 4 49.121 .000 .530 50.349 100.000 Love-Scott I 5 49.069 .000 .542 49.861 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .542 49.861 100.000 Bastin (original) Phi(pz) 9 50.356 .000 .553 49.091 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.091 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .553 49.102 100.000 SERR: .741 .000 .023 2.366 .000 SERR: .741 .000 .007 .748 MIN: 45.039 .000 .555 44.853 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 4 30.177 .000 .593 69.380 100.000 Love-Scott I 5 30.133 .000 .503 69.666 100.000 Love-Scott I 6 30.583 .000 .503 69.743 100.000 Love-Scott I 6 30.583 .000 .503 69.771 000 Love-Scott I 6 30.583 .000 .503 69.666 100.000 Love-Scott I 6 30.583 .000 .503 69.666 100.000 Love-Scott I 6 30.583 .000 .503 69.666 100.000 Love-Scott I 6 30.583 .000 .504 68.913 100.000 Love-Scott I 6 30.583 .000 .513 67.917 100.000 Bastin Philibert/Duncumb-Reed 1 31.571 .000 .513 67.917 100.000 Bastin (original) Phi(pz) 7 34.976 .000 .513 67.917 100.000 Bastin Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .556 64.451 100.000 Pouchou and Pichoir - Simplified MIN: 26.829 .000 .454 64.451 100.000	1	48.995	.000	.533	50.471	100.000	Armstrong/Love Scott (default)
3 48.709 .000 .544 50.746 100.000 Heinrich/Duncumb-Reed 4 49.121 .000 .526 50.495 100.000 Love-Scott I 6 49.597 .000 .526 50.405 100.000 Packwood Phi(pz) (EPQ-91) 7 54.555 .000 .592 44.853 100.000 Bastin (original) Phi(pz) (EPQ-91) 9 50.356 .000 .553 49.091 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .552 44.853 100.000 Pouchou and Pichoir - Simplified MIN: 45.039 .000 .552 44.853 100.000 Pouchou and Pichoir - Simplified Atomic Percents: ELEM: Mg B O TOTAL Armstrong/Love Scott (default) 2 2.6829 .000 .454 72.717 0.000 Conventional Philibert/Duncumb-Reed 4 30.177 .000 .503 69.666 100.000 Love-Scott I </td <td>2</td> <td>45.039</td> <td>.000</td> <td>.505</td> <td>54.456</td> <td>100.000</td> <td>Conventional Philibert/Duncumb-Reed</td>	2	45.039	.000	.505	54.456	100.000	Conventional Philibert/Duncumb-Reed
 4 49.121 .000 .530 50.349 100.000 Love-Scott I 5 49.669 .000 .526 50.405 100.000 Love-Scott II 6 49.597 .000 .542 49.861 100.000 Packwood Phi(pz) (EPQ-91) 7 54.555 .000 .592 44.853 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .546 48.706 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 49.804 100.000 SDEV: 2.344 .000 .023 2.366 .000 SERR: .741 .000 .007 .748 MIN: 45.039 .000 .505 44.853 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 Conventional Philiper/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott II 5 30.133 .000 .503 64.651 00.000 Love-Scott II 6 30.583 .000 .504 68.913 100.000 Love-Scott II 6 30.583 .000 .513 67.917 100.000 Packwood Phi(pz) (EPQ-91) 7 34.976 .000 .513 67.917 100.000 Packwood Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Packwood Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Packwood Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 64.451 100.000 MAX: 26.829 .000 .454 64.451 100.000 MAX: 26.829 .000 .454 64.451 100.000 	3	48.709	.000	.544	50.746	100.000	Heinrich/Duncumb-Reed
 5 49.069 .000 .526 50.405 100.000 Love-Scott II 6 49.597 .000 .542 49.861 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .546 48.706 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 50.356 .000 .553 49.091 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 49.804 100.000 SERR: .741 .000 .007 .748 MIN: 45.039 .000 .505 44.853 100.000 MAX: 54.555 .000 .592 54.456 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 Love-Scott I 2 6.829 .000 .454 72.717 100.000 Love-Scott II 6 30.583 .000 .503 69.666 100.000 Love-Scott II 6 30.583 .000 .504 68.913 100.000 Love-Scott II 6 30.583 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 8 31.571 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.250 100.000 Pouchou and Pichoir - Full MIN: 26.829 .000 .533 2.039 .000 SERR: .635 .000 .534 4.451 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full MIN: 26.829 .000 .454 64.451 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified MAX: 34.976 .000 .573 72.717 100.000	4	49.121	.000	.530	50.349	100.000	Love-Scott I
6 49.597 .000 .542 49.681 100.000 Bastin (original) Phi(pz) 8 50.748 .000 .546 48.706 100.000 Bastin (original) Phi(pz) (EPQ-91) 9 50.356 .000 .553 49.091 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 49.804 100.000 Pouchou and Pichoir - Simplified SER: .741 .000 .023 2.366 .000 SER: .741 1 30.071 .000 .592 54.456 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 3 29.831 .000 .503 69.666 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Love-Scott I 6 30.583 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (5	49.069	.000	.526	50.405	100.000	Love-Scott II
A 34:333 100:00 Bastin (Original) Pin(pz) 8 50.748 000 .553 49.091 100.000 Bastin PCZA Phi(pz) (EPQ-91) 9 50.356 .000 .553 49.102 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 49.804 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 29.804 100.000 Pouchou and Pichoir - Simplified MIN: 45.039 .000 .505 44.853 100.000 Armstrong/Love Scott (default) Acomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 Conventional Philibert/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .544 68.913 100.000 Bastin PROZA Phi(pz) (EPQ-91) 7 34.976	0 7	49.597	.000	.542	49.801	100.000	Packwood Phi(pz) (EPQ-91) Pactin (original) Dhi(pz)
9 50.356 .000 .553 49.091 100.000 Pouchou and Pichoir - Full 10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 49.804 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 49.804 100.000 Pouchou and Pichoir - Simplified AVER: 2.344 .000 .023 2.366 .000 SERR: .741 .000 .007 .748 MIN: 45.039 .000 .505 44.853 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I I 5 30.133 .000 .513 67.917 100.000 Bastin (original) Phi(pz) (EPQ-91) 7 34.976 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000	, 8	50 748	.000	546	48 706	100.000	Bastin PROZA Phi(nz) (EPO-91)
10 50.345 .000 .553 49.102 100.000 Pouchou and Pichoir - Simplified AVER: 49.654 .000 .542 49.804 100.000 SDEV: 2.344 .000 .023 2.366 .000 SER: .741 .000 .007 .748 MIN: 45.039 .000 .592 54.456 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 Conventional Philibert/Duncumb-Reed 3 29.831 .000 .503 69.666 100.000 Love-Scott I 5 30.137 .000 .494 69.331 100.000 Love-Scott II 6 30.583 .000 .513 67.917 100.000 Bastin (original) Phi(pz) 7 34.976 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .518 68.322 100.000 Pouchou and Pichoir - Simplified	9	50.356	.000	.553	49.091	100.000	Pouchou and Pichoir - Full
AVER: 49.654 .000 .542 49.804 100.000 SDEV: 2.344 .000 .023 2.366 .000 SERR: .741 .000 .007 .748 MIN: 45.039 .000 .505 44.853 100.000 MAX: 54.555 .000 .592 54.456 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 3 29.831 .000 .503 69.666 100.000 Heinrich/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Love-Scott II 6 30.583 .000 .504 68.913 100.000 Packwood Phi(pz) (EPQ-91) 7 34.976 .000 .513 67.917 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.250 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	10	50.345	.000	.553	49.102	100.000	Pouchou and Pichoir - Simplified
SDEV: 2.344 .000 .023 2.366 .000 SERR: .741 .000 .007 .748 MIN: 45.039 .000 .505 44.853 100.000 Atomic Percents:	AVER:	49.654	.000	.542	49.804	100.000	
SERR: .741 .000 .007 .748 MIN: 45.039 .000 .505 44.853 100.000 Atomic Percents: .000 .592 54.456 100.000 Atomic Percents: .000 .494 69.434 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .504 68.913 100.000 Love-Scott II 6 30.583 .000 .513 67.917 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.822 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Picho	SDEV:	2.344	.000	.023	2.366	.000	
MIN: 45.039 .000 .505 44.853 100.000 Atomic Percents: ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 3 29.831 .000 .503 69.666 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Love-Scott II 6 30.583 .000 .573 64.451 100.000 Bastin (original) Phi(pz) (EPQ-91) 7 34.976 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Semplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified MIN: 26.829 .000 <td>SERR:</td> <td>.741</td> <td>.000</td> <td>.007</td> <td>.748</td> <td></td> <td></td>	SERR:	.741	.000	.007	.748		
<pre>MAX: 54.555 .000 .592 54.456 100.000 Atomic Percents: ELEM: Mg B 0 B TOTAL 1 30.071 .000 .494 69.434 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Love-Scott II 6 30.583 .000 .504 68.913 100.000 Packwood Phi(pz) (EPQ-91) 7 34.976 .000 .573 64.451 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000</pre>	MIN:	45.039	.000	.505	44.853	100.000	
Atomic Percents: ELEM: Mg B 0 B TOTAL 1 30.071 .000 .494 69.434 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 3 29.831 .000 .503 69.666 100.000 Heinrich/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Packwood Phi(pz) (EPQ-91) 7 34.976 .000 .573 64.451 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	MAX:	54.555	.000	.592	54.456	100.000	
ELEM: Mg B O B TOTAL 1 30.071 .000 .494 69.434 100.000 Armstrong/Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 3 29.831 .000 .503 69.666 100.000 Love-Scott I 5 30.133 .000 .492 69.331 100.000 Love-Scott I 6 30.583 .000 .504 68.913 100.000 Bastin (original) Phi(pz) (EPQ-91) 7 34.976 .000 .573 64.451 100.000 Bastin (original) Phi(pz) (EPQ-91) 8 31.571 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SerRe: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 Max: 3	Atomic	Percents:	2	0	5		
1 30.071 .000 .454 100.000 Affiltering/ Love Scott (default) 2 26.829 .000 .454 72.717 100.000 Conventional Philibert/Duncumb-Reed 3 29.831 .000 .503 69.666 100.000 Heinrich/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Love-Scott II 6 30.583 .000 .504 68.913 100.000 Bastin (original) Phi(pz) 7 34.976 .000 .573 64.451 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.832 100.000 Serrer SDEV: 2.009 .000 .030 2.039 .000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 <	ELEM: 1	Mg	B	104	60 121 B	100 000	Armstrong (Lovo Caott (dofoult)
3 29.831 .000 .503 69.666 100.000 Heinrich/Duncumb-Reed 4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Love-Scott I 6 30.583 .000 .504 68.913 100.000 Packwood Phi(pz) (EPQ-91) 7 34.976 .000 .573 64.451 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	2	26 829	.000	454	72 717	100.000	Conventional Philibert/Duncumb-Reed
4 30.177 .000 .492 69.331 100.000 Love-Scott I 5 30.133 .000 .488 69.380 100.000 Love-Scott II 6 30.583 .000 .504 68.913 100.000 Packwood Phi(pz) (EPQ-91) 7 34.976 .000 .573 64.451 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	3	29.831	.000	.503	69.666	100.000	Heinrich/Duncumb-Reed
5 30.133 .000 .488 69.380 100.000 Love-Scott II 6 30.583 .000 .504 68.913 100.000 Packwood Phi(pz) (EPQ-91) 7 34.976 .000 .573 64.451 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	4	30.177	.000	.492	69.331	100.000	Love-Scott I
6 30.583 .000 .504 68.913 100.000 Packwood Phi(pz) (EPQ-91) 7 34.976 .000 .573 64.451 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	5	30.133	.000	.488	69.380	100.000	Love-Scott II
7 34.976 .000 .573 64.451 100.000 Bastin (original) Phi(pz) 8 31.571 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Serre: .635 .000 .030 2.039 .000 SERR: .635 .000 .010 .645 .645 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000 .000	6	30.583	.000	.504	68.913	100.000	Packwood Phi(pz) (EPQ-91)
8 31.571 .000 .513 67.917 100.000 Bastin PROZA Phi(pz) (EPQ-91) 9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Serre: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	7	34.976	.000	.573	64.451	100.000	Bastin (original) Phi(pz)
9 31.232 .000 .518 68.250 100.000 Pouchou and Pichoir - Full 10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SDEV: 2.009 .000 .030 2.039 .000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	8	31.571	.000	.513	67.917	100.000	Bastin PROZA Phi(pz) (EPQ-91)
10 31.222 .000 .518 68.260 100.000 Pouchou and Pichoir - Simplified AVER: 30.663 .000 .506 68.832 100.000 SDEV: 2.009 .000 .030 2.039 .000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	9	31.232	.000	.518	68.250	100.000	Pouchou and Pichoir - Full
AVER: 30.663 .000 .506 68.832 100.000 SDEV: 2.009 .000 .030 2.039 .000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	10	31.222	.000	.518	68.260	100.000	Pouchou and Pichoir - Simplified
SDEV: 2.009 .000 .030 2.039 .000 SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	AVER:	30.663	.000	.506	68.832	100.000	
SERR: .635 .000 .010 .645 MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	SDEV:	2.009	.000	.030	2.039	.000	
MIN: 26.829 .000 .454 64.451 100.000 MAX: 34.976 .000 .573 72.717 100.000	SERR:	.635	.000	.010	.645		
	MIN: MAX:	26.829 34.976	.000	.454	64.451 72.717	100.000 100.000	

So even just calculating boron by difference from Mg and O (which should be no big deal as the absorption correction for Mg is small, ~7%) we still see that the MgB2 is a little low in Mg and too high in boron (The MgB4 looks excellent). I think this consistent result between all three methods is therefore real, so far as I can tell.

Experimental Conditions (based on MgB2)

Un 26 Mg-B light phase11 TakeOff = 40.0 KiloVolt = 6.0 Beam Current = 30.0 Beam Size = 2 Column Condition Method Specified (1), Column Condition String =C:\UserData\Bohnenstiehl\03-2011\6 keV, 4, 0.pcc(Magnification (analytical) = 40000),Beam Mode = Analog Spot(Magnification (default) =400, Magnification (imaging) = 3632)Image Shift (X,Y):0, 0

Compositional analyses were acquired on an electron microprobe (Cameca SX100 (TCP/IP Socket)) equipped with 5 tunable wavelength dispersive spectrometers. Operating conditions were 40 degrees takeoff angle, and a beam energy of 6 keV. The beam current was 30 nA, and the beam diameter was 2 microns.

Elements were acquired using analyzing crystals LTAP for Mg ka, PC1 for O ka, and PC25 for B ka.

The standards were MgO synthetic for Mg ka, O ka, and Boron metal for B ka. The counting time was 60 seconds for all elements. The off peak counting time was 30 seconds for all elements. The off peak correction method was Exponential for all elements.

Unknown and standard intensities were corrected for deadtime. Standard intensities were corrected for standard drift over time.

Empirical Mass Absorption Coefficients were utilized to correct x-ray intensities for matrix corrections.

See Bastin, G.F. and Heijligers, H.J.M (1991) Quantitative electron probe microanalysis of ultralight elements (boron - oxygen), in Electron Probe Quantitation, ed K.F.J. Heinrich and D.E. Newbury, Plenum Press, NY, 145-161

Also Bastin, G.F. and Heijligers, H.J.M. (1992) Present and future of light element analysis with electron beam instruments, Microbeam Analysis, 1, 61-73.

Current Mass Absorption Coefficients From: FFAST Chantler (NIST v 2.1, 2005)

Z-LINE X-RAY Z-ABSOR MAC Ma ka Ma 4.4533e+02 B 5.7871e+02 Mg ka Mq O 2.3871e+03 ka Mg ka B 5.7871e+02 В ka Mg 5.4500e+04 * В B 3.0680e+03 * ka В O 1.3696e+04 ka В B 3.0680e+03 * ka Mg 4.3851e+03 0 ka 0 B 6.8087e+03 ka 0 O 1.1204e+03 ka 0 ka B 6.8087e+03 * indicates empirical MAC

Empirical Mass Absorption Coefficients From: C:\Probe Software\Probe for EPMA\EMPMAC.DAT

Z-LINE X-RAY Z-ABSOR MAC B ka Mg 5.4500e+04 Donovan (2011) B ka B 3.0680e+03 Donovan (2011) B ka B 3.0680e+03 Donovan (2011) Area Peak Factors were utilized to correct x-ray intensities for wavelength peak shift and/or shape changes for compound compositions by summing binary APF values.

See G. F. Bastin and H. J. M. Heijligers, Quantitative Electron Probe Microanalysis of Carbon in Binary Carbides, Parts I and II, X-Ray Spectr. 15: 135-150, 1986

Empirical Area Peak Factors From: C:\Probe Software\Probe for EPMA\EMPAPF.DAT

Z-LINE X-RAY Z-ABSOR APF B ka Mg .9280 MgB2/B/WSi/59.8

Results are the average of 10 points and detection limits ranged from .016 weight percent for Mg ka to .040 weight percent for B ka.

Analytical sensitivity (at the 99% confidence level) ranged from .103 percent relative for Mg ka to 3.020 percent relative for O ka.

The exponential or polynomial background fit was utilized.

See John J. Donovan, Heather A. Lowers and Brian G. Rusk, Improved electron probe microanalysis of trace elements in quartz, American Mineralogist, 96, 274-282, 2011

The matrix correction method was ZAF or Phi-Rho-Z calculations and the mass absorption coefficients dataset was FFAST Chantler (NIST v 2.1, 2005).

See J. T. Armstrong, Quantitative analysis of silicates and oxide minerals: Comparison of Monte-Carlo, ZAF and Phi-Rho-Z procedures, Microbeam Analysis--1988, p 239-246