



# Resolving Pharmaceutical Polymorphic Perplexities with the PDF-4/Organics 2012 Database and the Accompanying PDF-4+ Data Mining Software

Carbamazepine Polymorphs

This is one of three example-based tutorials for using the data-mining capabilities of the PDF-4+ software that accompanies the PDF-4+ databases. This tutorial covers the following topic:

- **Carbamazepine Polymorphs**
  - a PDF-4/Organics application
  - investigating polymorphic forms of an active pharmaceutical ingredient (API)

Two other similar tutorials for data-mining exist and cover the following topics:

- **CIGS Photovoltaics**
  - solid solution / cell parameter relationship
- **FeO Non-stoichiometric Oxides**
  - sorting out temperature and stoichiometric effects on cell parameters

# Carbamazepine Polymorphs

- An example for the PDF-4/Organics 2012 database that answers the following questions:
  - How many polymorphs are known to exist?
  - How do I distinguish these polymorphs by XRPD?

# Locating Carbamazepine Polymorphs in the PDF-4/Organics 2012 Database

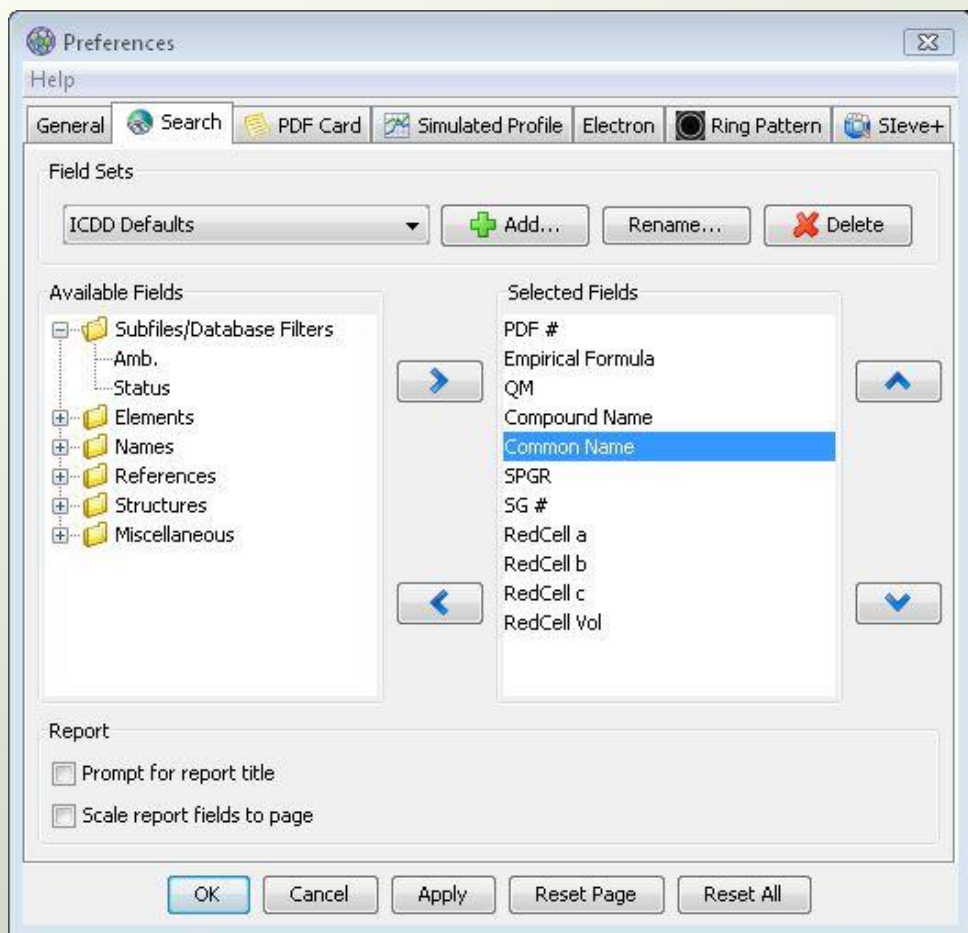
- Information that can be used to search for PDF entries:
  - Empirical Formula:  $C_{15}H_{12}N_2O$ 
    - Note that this is not unique to carbamazepine
  - Name: **carbamazepine**
    - By itself, this name search will also include hydrates, solvates, derivatives
- Taken together (Boolean 'and'), the two criteria above will focus the search results on the entries we want.


# Results Table Preferences

- The 'Results' table can be tailored to provide the useful information needed for sorting out polymorphic forms
- A plot of space group vs. reduced cell volume can often provide relevant groupings for polymorph differentiation
- Another useful plot would be any of the reduced cell edge lengths vs. reduced cell volume
- Suggested fields for results table:

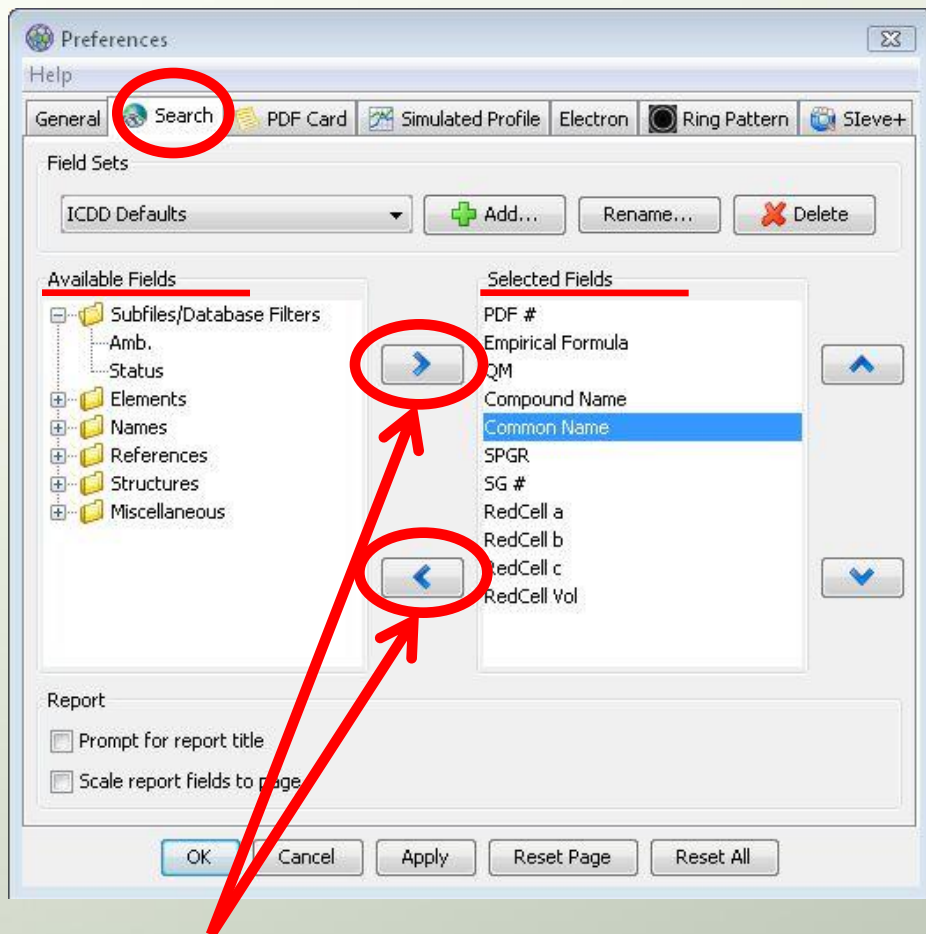
- |                     |                             |
|---------------------|-----------------------------|
| - PDF #             | - International Space Group |
| - Empirical Formula | - Space Group Number        |
| - Quality Mark      | - Reduced cell a            |
| - Compound Name     | - Reduced cell b            |
| - Common Name       | - Reduced cell c            |
|                     | - Reduced cell volume       |

# Specifying Results Table Preferences for Carbamazepine Polymorphs Search



The 'Preferences' window is opened using the 'Preferences' icon on the toolbar - , or clicking 'Preferences. . .' on the 'Edit' drop-down menu.

# Specifying Results Table Preferences for Carbamazepine Polymorphs Search

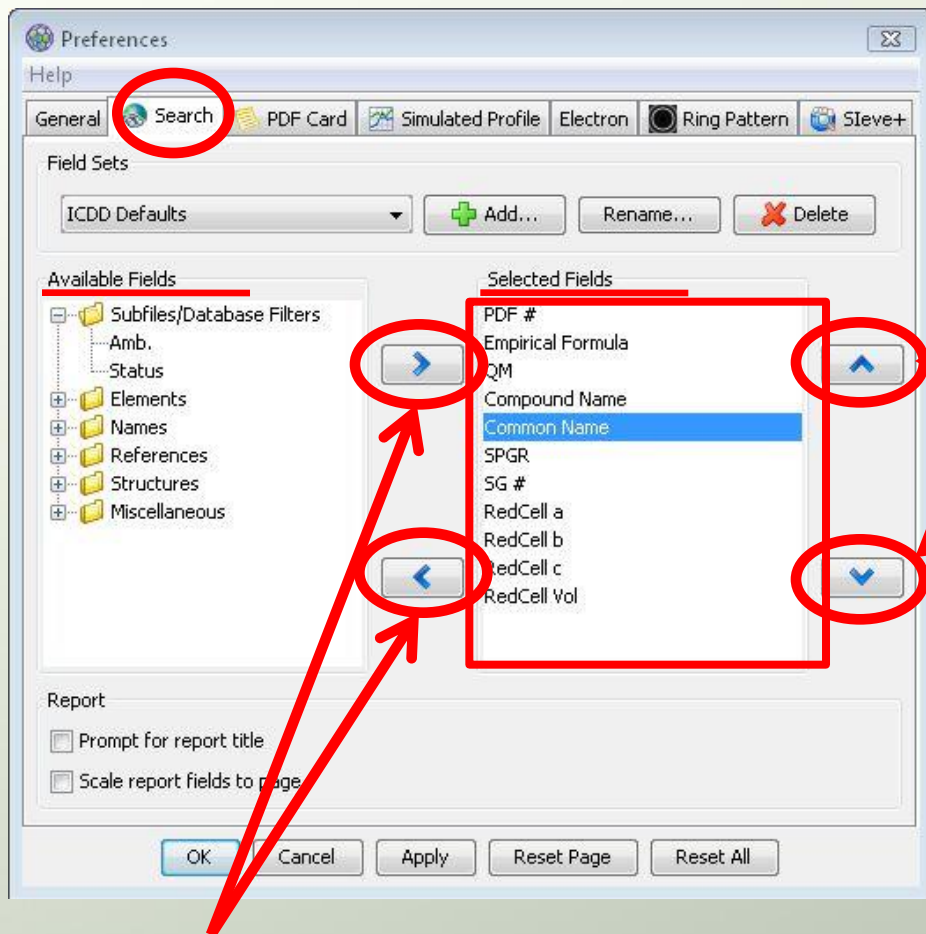


Clicking the 'Search' tab on the 'Preferences' window will display the data fields available and data fields selected for the Search Results Table.

## Available Fields:

Use these buttons to move selected items between the 'Available Fields' list of 88 categorized items and the 'Selected Fields' list of items that will be displayed in the results table

# Specifying Results Table Preferences for Carbamazepine Polymorphs Search



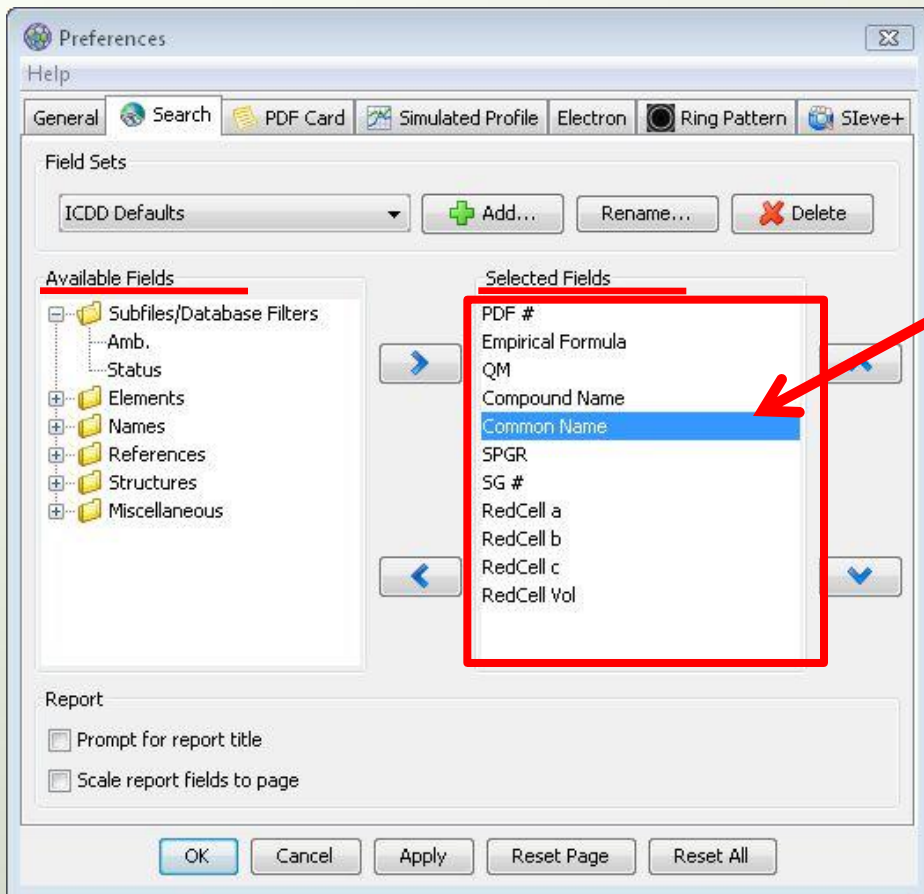
## Selected Fields:

Use these buttons to move a selected item up or down in the listed order for the results table.

## Available Fields:

Use these buttons to move selected items between the 'Available Fields' list of 88 categorized items and the 'Selected Fields' list of items that will be displayed in the results table.

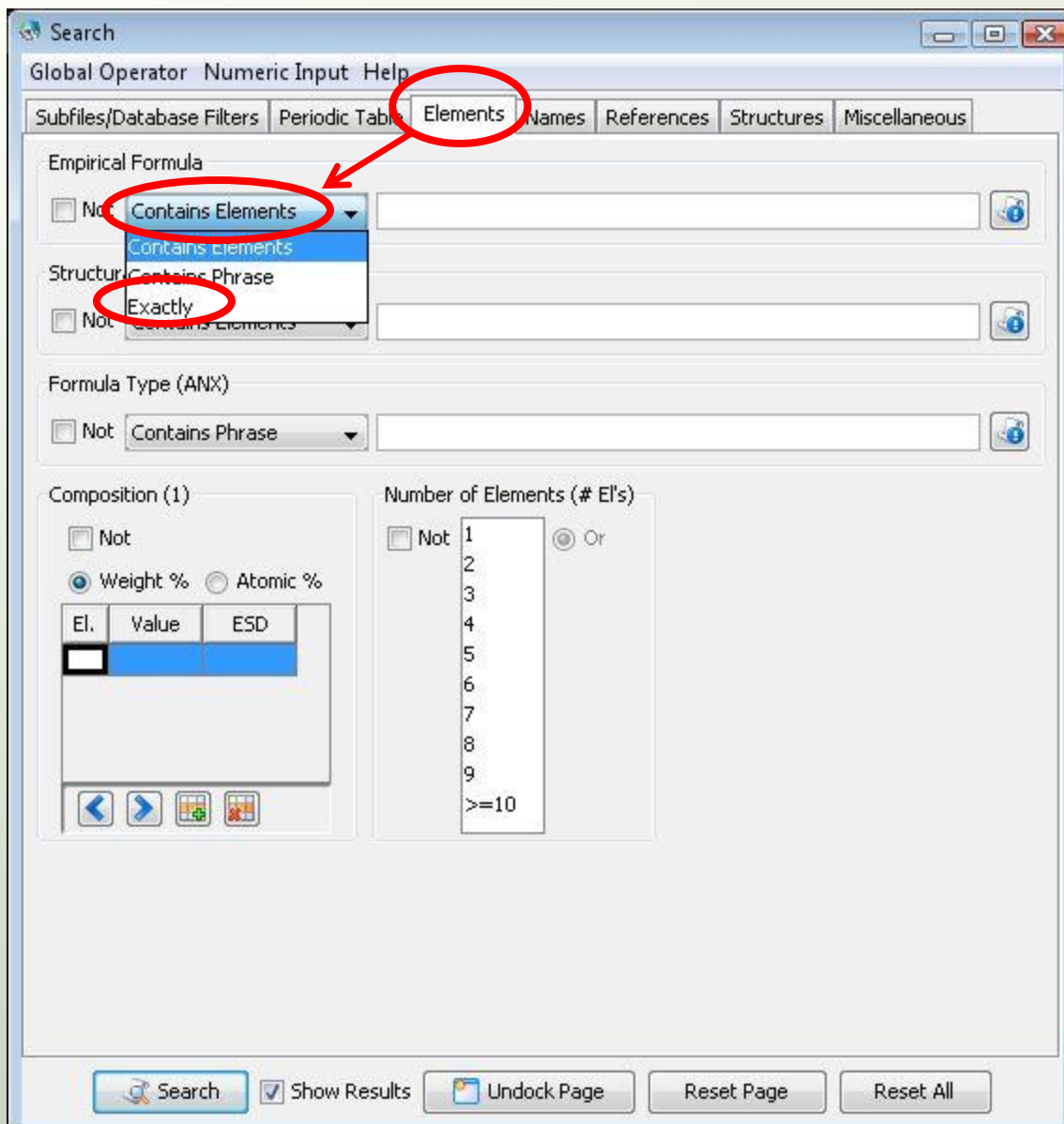
# Specifying Results Table Preferences for Carbamazepine Polymorphs Search



Prepare the 'Selected Fields' list for this exercise as illustrated here. Categories for these items are given below.

<u>Display Field</u>	<u>Category</u>
PDF # . . . . .	Always present
Empirical Formula	Elements
QM . . . . .	Subfiles/ Database Filters
Compound Name	Names
Common Name . .	Names
SPGR. . . . .	Structures
SG # . . . . .	Structures
RedCell params. .	Structures

# Entering the Empirical Formula Search Criterion



Empirical Formula criteria is entered on the 'Elements' tab of the 'Search' window.

To enter a specific Empirical Formula such as 'C<sub>15</sub>H<sub>12</sub>N<sub>2</sub>O', the 'Exactly' choice should be clicked.

# Entering the Empirical Formula Search Criterion

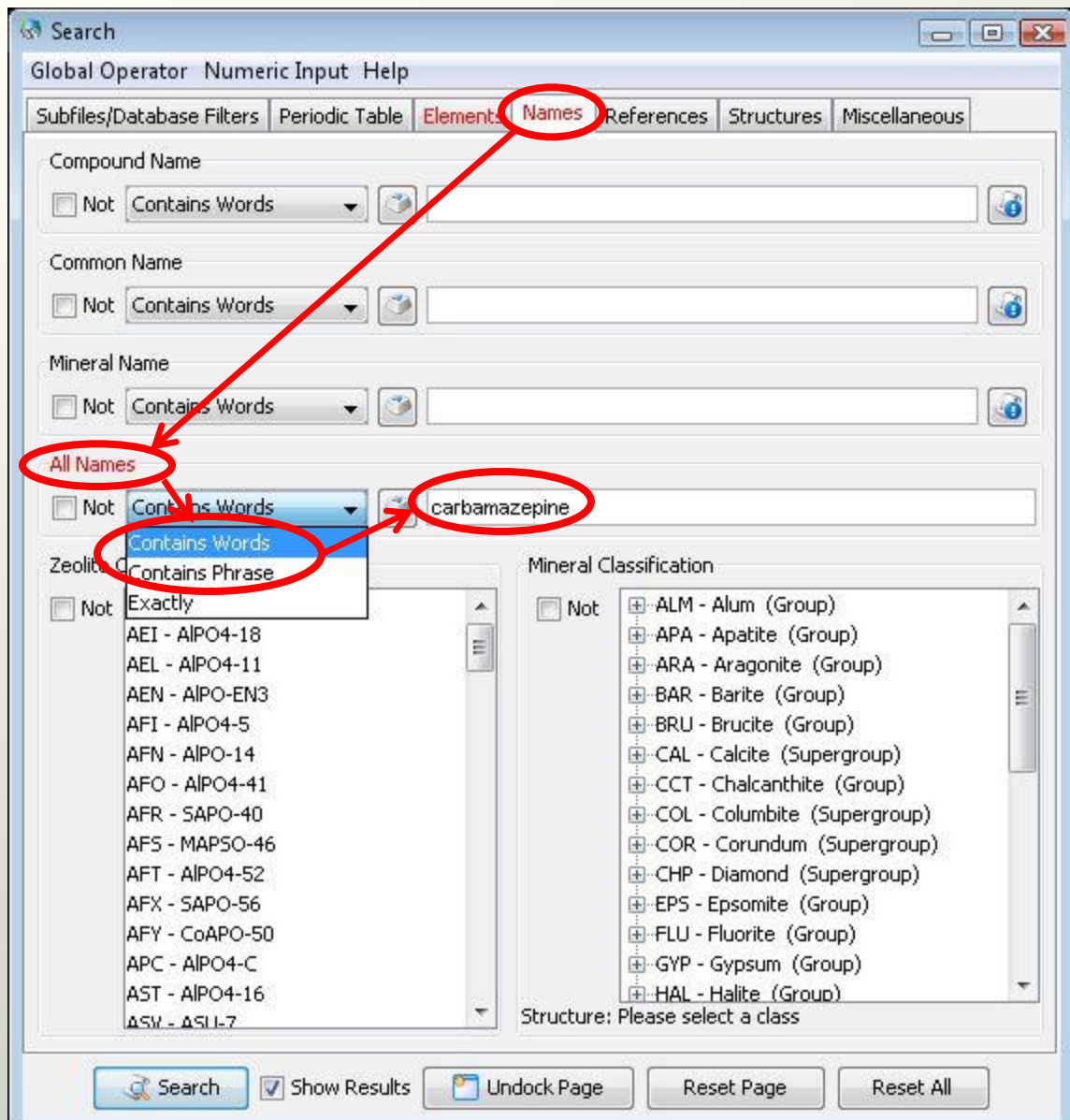
The screenshot shows a software window titled 'Search' with a menu bar (Global Operator, Numeric Input, Help) and a tabbed interface. The 'Elements' tab is active. Under the 'Empirical Formula' section, the 'Not' checkbox is unchecked, and the 'Exactly' radio button is selected. The text input field contains 'C15 H12 N2 O'. Below this are sections for 'Structural Formula' (with 'Contains Elements' selected), 'Formula Type (ANX)' (with 'Contains Phrase' selected), and 'Composition (1)' (with 'Weight %' selected). The 'Number of Elements (# El's)' section has a list of numbers 1-9 and '>=10', with the 'Or' radio button selected. At the bottom are buttons for 'Search', 'Show Results', 'Undock Page', 'Reset Page', and 'Reset All'.

The Empirical Formula can now be entered into the associated text box on this window.

C15 H 12 N2 O

There should be no space between each element and its 'subscript', and one space before entering each subsequent element.

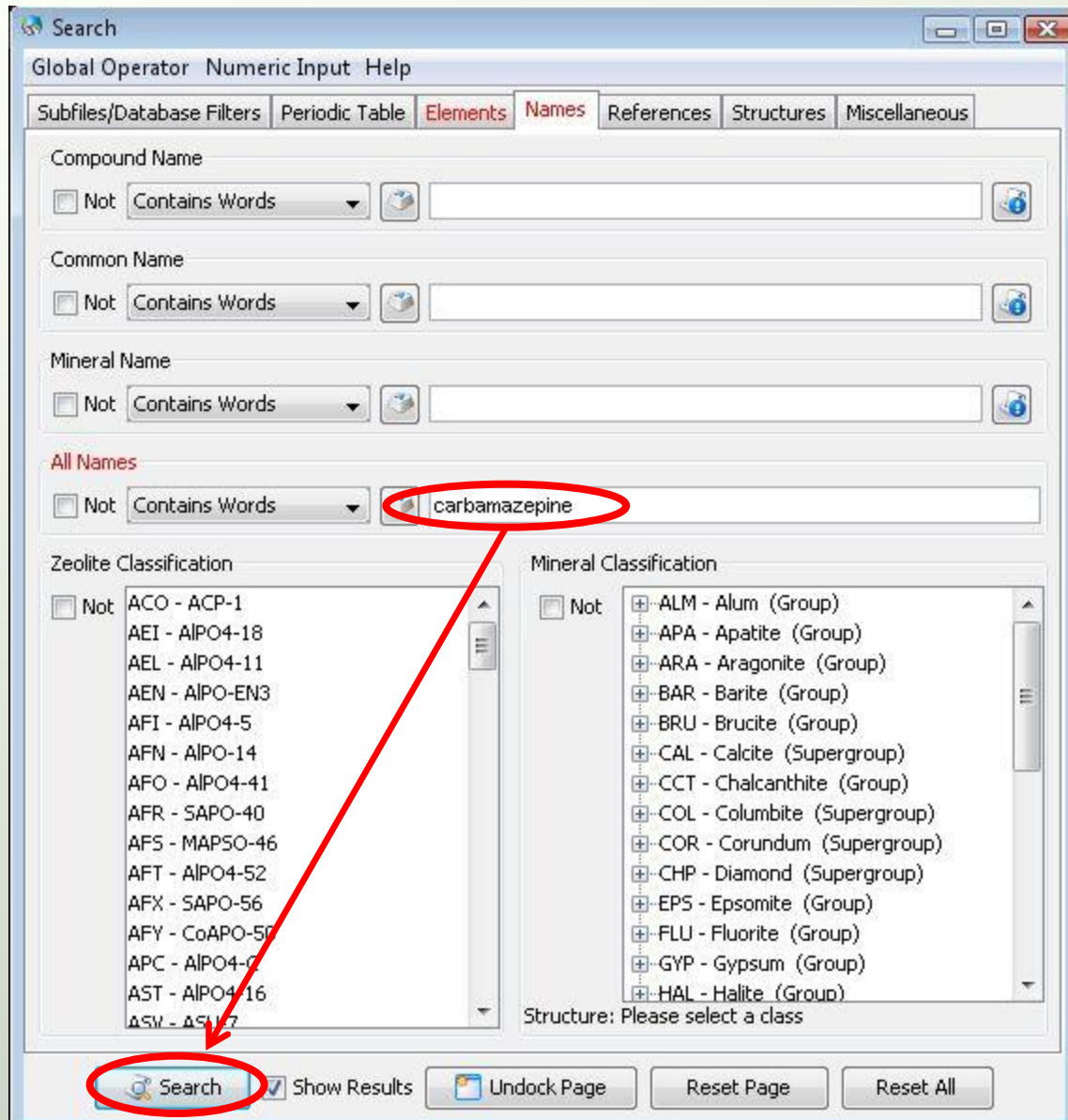
# Entering the 'Carbamazepine' Name Search Criterion



The name criterion is entered on the 'Names' tab.

Since 'carbamazepine' may appear as either a 'Compound Name' or 'Common Name', the criterion is best entered in the 'All Names' category. Because it is a single word, it does not matter if 'Contains Words' or 'Contains Phrase' is selected.

# Entering the 'Carbamazepine' Name Search Criterion



The name 'carbamazepine' should be entered, correctly spelled, in the 'All Names' text box.

The search can now be performed by clicking on the 'Search' button at the bottom of the window.

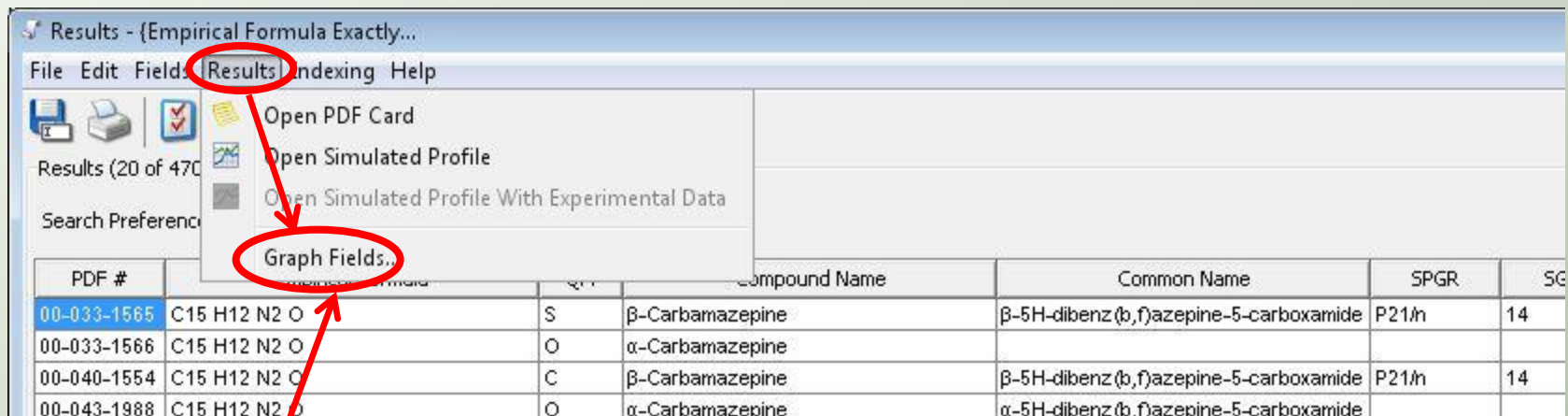
# Carbamazepine Polymorphs

- There are 20 resulting entries found in the PDF-4/Organics 2012 database.
- Of these, 14 have space group and cell parameter information
- Among these 14 entries, there are 5 different reported space groups (1, 2, 14, 15, and 148)

PDF #	Empirical Formula	QM	Compound Name	Common Name	SPGR	SG #	RedCell a	RedCell b	RedCell c	RedCell Vol
00-033-1565	C15 H12 N2 O	S	$\beta$ -Carbamazepine	$\beta$ -5H-dibenz (b,f)azepine-5-carboxamide	P21/n	14	7.543	11.159	13.918	1170.07
00-033-1566	C15 H12 N2 O	O	$\alpha$ -Carbamazepine							
00-040-1554	C15 H12 N2 O	C	$\beta$ -Carbamazepine	$\beta$ -5H-dibenz (b,f)azepine-5-carboxamide	P21/n	14	7.537	11.156	13.912	1168.30
00-043-1988	C15 H12 N2 O	O	$\alpha$ -Carbamazepine	$\alpha$ -5H-dibenz (b,f)azepine-5-carboxamide						
00-043-1989	C15 H12 N2 O	O	$\beta$ -Carbamazepine	$\beta$ -5H-dibenz (b,f)azepine-5-carboxamide						
00-043-1997	C15 H12 N2 O	O	$\beta$ -Carbamazepine	$\beta$ -5H-dibenz (b,f)azepine-5-carboxamide						
00-043-1998	C15 H12 N2 O	O	$\alpha$ -Carbamazepine	$\alpha$ -5H-dibenz (b,f)azepine-5-carboxamide	R-3	148	5.253	20.544	20.544	1906.09
00-046-1813	C15 H12 N2 O	O	Carbamazepine	Benzo (b)(1)benzazepine-11-carboxa...						
00-051-2106	C15 H12 N2 O	S	$\beta$ -Carbamazepine	5H-dibenz (b,f)azepine-5-carboxamide	P21/n	14	7.539	11.156	13.918	1169.22
00-054-2015	C15 H12 N2 O	I	Carbamazepine	5H-dibenz (b,f)azepine-5-carboxamide...	P1	1	5.245	20.520	22.258	2374.48
00-056-1968	C15 H12 N2 O	S	$\gamma$ -Carbamazepine	5H-dibenz (b,f)azepine-5-carboxamide	P-1	2	5.253	20.584	22.294	2388.71
00-057-1449	C15 H12 N2 O	I	Carbamazepine	5H-dibenz (b,f)azepine-5-carboxamide...	P-1	2	5.170	20.574	22.245	2344.82
00-058-1418	C15 H12 N2 O	I	Carbamazepine	Benzo (b)(1)benzazepine-11-carboxa...	R		5.240	20.484	20.484	1890.23
00-058-1419	C15 H12 N2 O	O	Carbamazepine	Benzo (b)(1)benzazepine-11-carboxa...						
02-060-9919	C15 H12 N2 O	S	5H-Dibenz (b,f)azepine-5-carboxamide	Carbamazepine	P21/c	14	7.529	11.148	13.902	1165.34
02-060-9920	C15 H12 N2 O	S	5H-Dibenz (b,f)azepine-5-carboxamide	Carbamazepine	P21/n	14	7.537	11.156	13.912	1168.30
02-064-1948	C15 H12 N2 O	I	5-Carbamoyl-5H-dibenzo (b,f)azepine	Carbamazepine	P21/n	14	7.534	11.150	13.917	1167.55
02-084-2534	C15 H12 N2 O	S	Carbamazepine	5H-Dibenz (b,f)azepine-5-carboxamide	P-1	2	5.170	20.574	22.245	2344.82
02-086-6230	C15 H12 N2 O	S	Carbamazepine		C2/c	15	6.927	13.748	13.957	1210.96
02-093-7847	C15 H12 N2 O	B	5H-Dibenz (b,f)azepine-5-carboxamide	gamma-Carbamazepine	P-1	2	5.186	20.576	22.241	2351.44

# Carbamazepine Polymorphs

- Different space groups do not necessarily correspond to different polymorphs. The same structure can be reported in a space group of lower symmetry. In fact, any structure can be described in the P1 space group, though any higher crystallographic symmetry in the structure will not be expressed.
- To illustrate groupings related to the polymorphic structure among entries given in the results table, the following is performed to create a graph of Reduced Cell Volume vs. Space Group #:



PDF #	Empirical Formula	Space Group	Compound Name	Common Name	SPGR	SC
00-033-1565	C15 H12 N2 O	S	$\beta$ -Carbamazepine	$\beta$ -5H-dibenz(b,f)azepine-5-carboxamide	P21/n	14
00-033-1566	C15 H12 N2 O	O	$\alpha$ -Carbamazepine			
00-040-1554	C15 H12 N2 O	C	$\beta$ -Carbamazepine	$\beta$ -5H-dibenz(b,f)azepine-5-carboxamide	P21/n	14
00-043-1988	C15 H12 N2 O	O	$\alpha$ -Carbamazepine	$\alpha$ -5H-dibenz(b,f)azepine-5-carboxamide		

Click the 'Graph Fields...' item on the 'Results' drop-down menu

# Carbamazepine Polymorphs

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- To illustrate groupings related to the polymorphic structure among entries given in the results table, the following is performed to create a graph of Reduced Cell Volume vs. Space Group #:

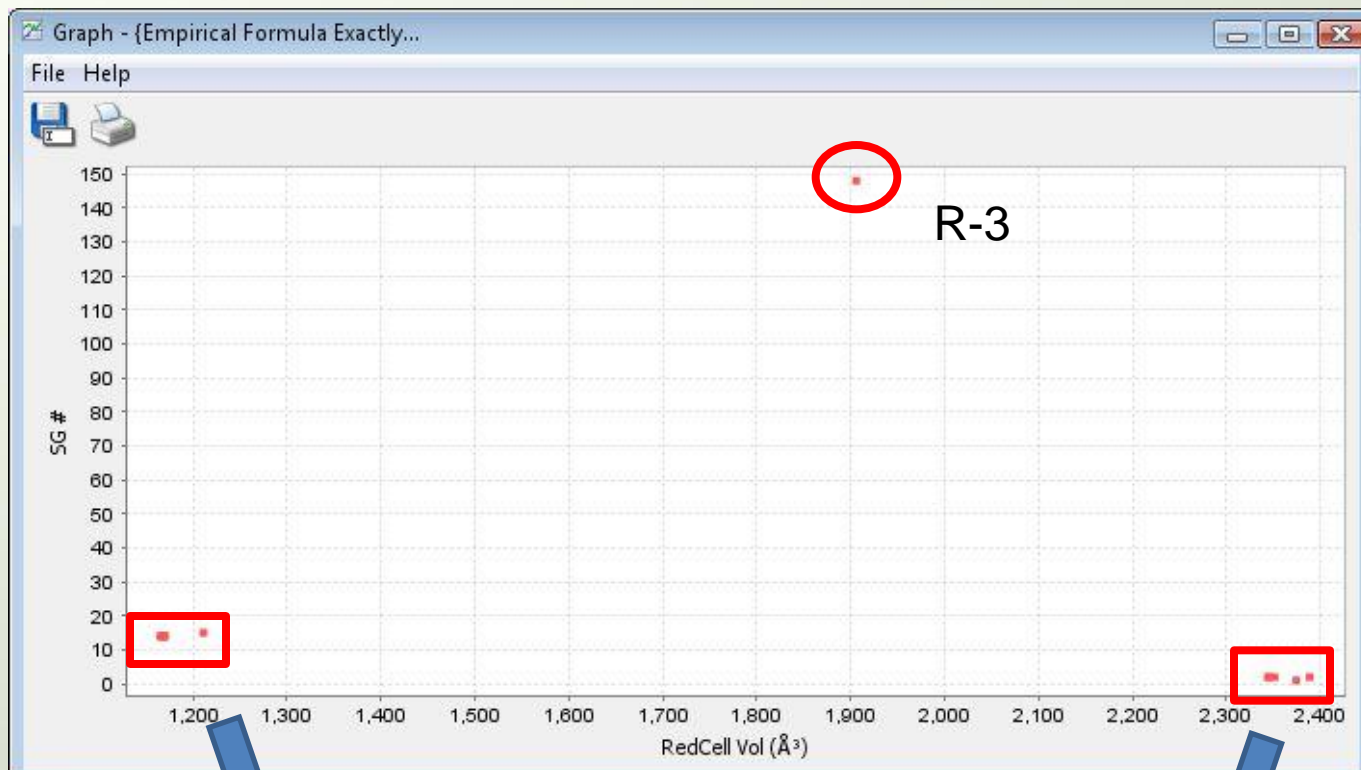
The screenshot shows a software window titled 'Results - {Empirical Formula Exactly...}' with a menu bar (File, Edit, Fields, Results, Indexing, Help) and a toolbar. Below the toolbar is a table with columns for PDF #, Empirical Formula, Space Group, and Compound Name. The table contains four rows of data for Carbamazepine polymorphs. A 'Graph Fields' dialog box is open in the foreground, with 'RedCell Vol' selected for the X-Axis and 'SG #' selected for the Y-Axis. Red circles and arrows highlight these selections.

PDF #	Empirical Formula	Space Group	Compound Name
00-033-1565	C15 H12 N2 O	S	β-Carbamazepine
00-033-1566	C15 H12 N2 O	O	α-Carbamazepine
00-040-1554	C15 H12 N2 O	C	β-Carbamazepine
00-043-1988	C15 H12 N2 O	O	α-Carbamazepine

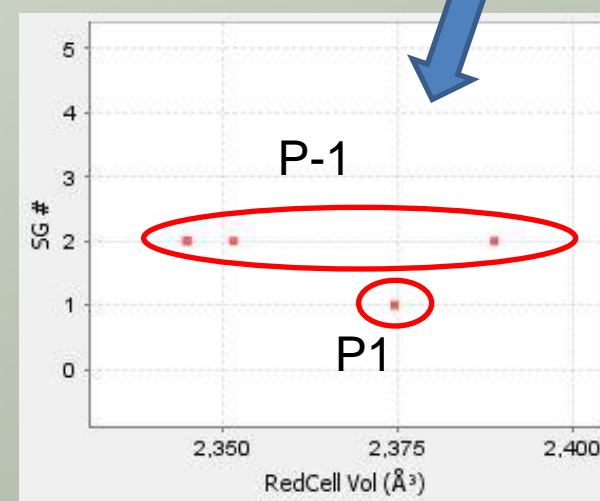
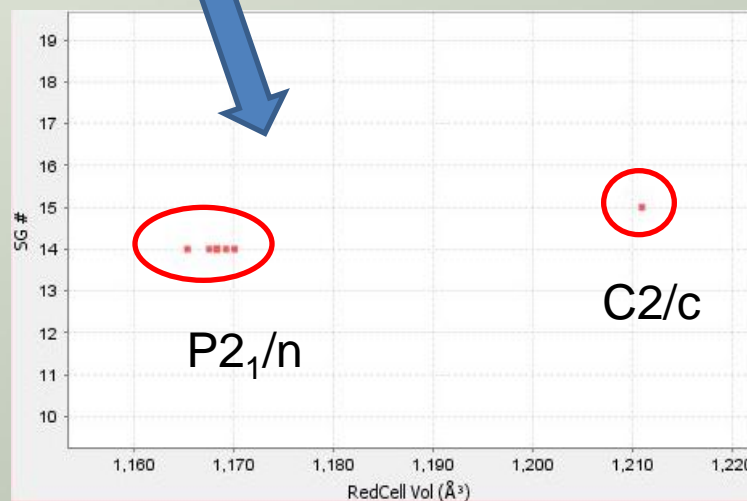
Now select the 'RedCell Vol' item for the X-Axis and the 'SG #' item for the Y-Axis.

# Space Group # / Reduced Cell Volume Groupings for 14 Carbamazepine PDF Entries

Note the groupings have an approximate 2:3:4 'Reduced Cell Volume' ratio (1200 / 1900 / 2400). The Z-values for the unit cells in each group (i.e., molecules per unit cell) will almost assuredly have the same ratio.

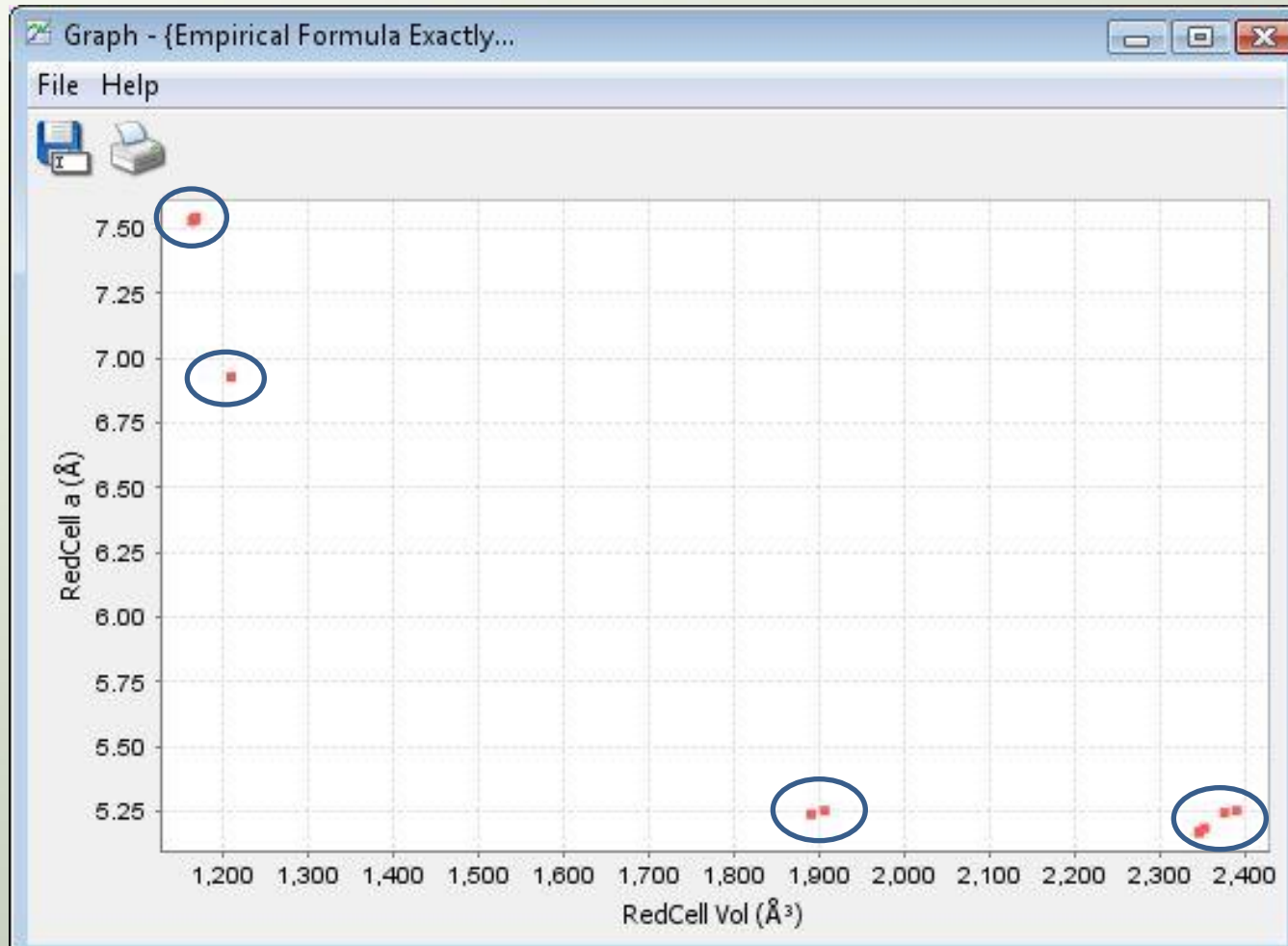


The groupings suggest that the likely number of known polymorphs for carbamazepine is 3, 4, or 5.



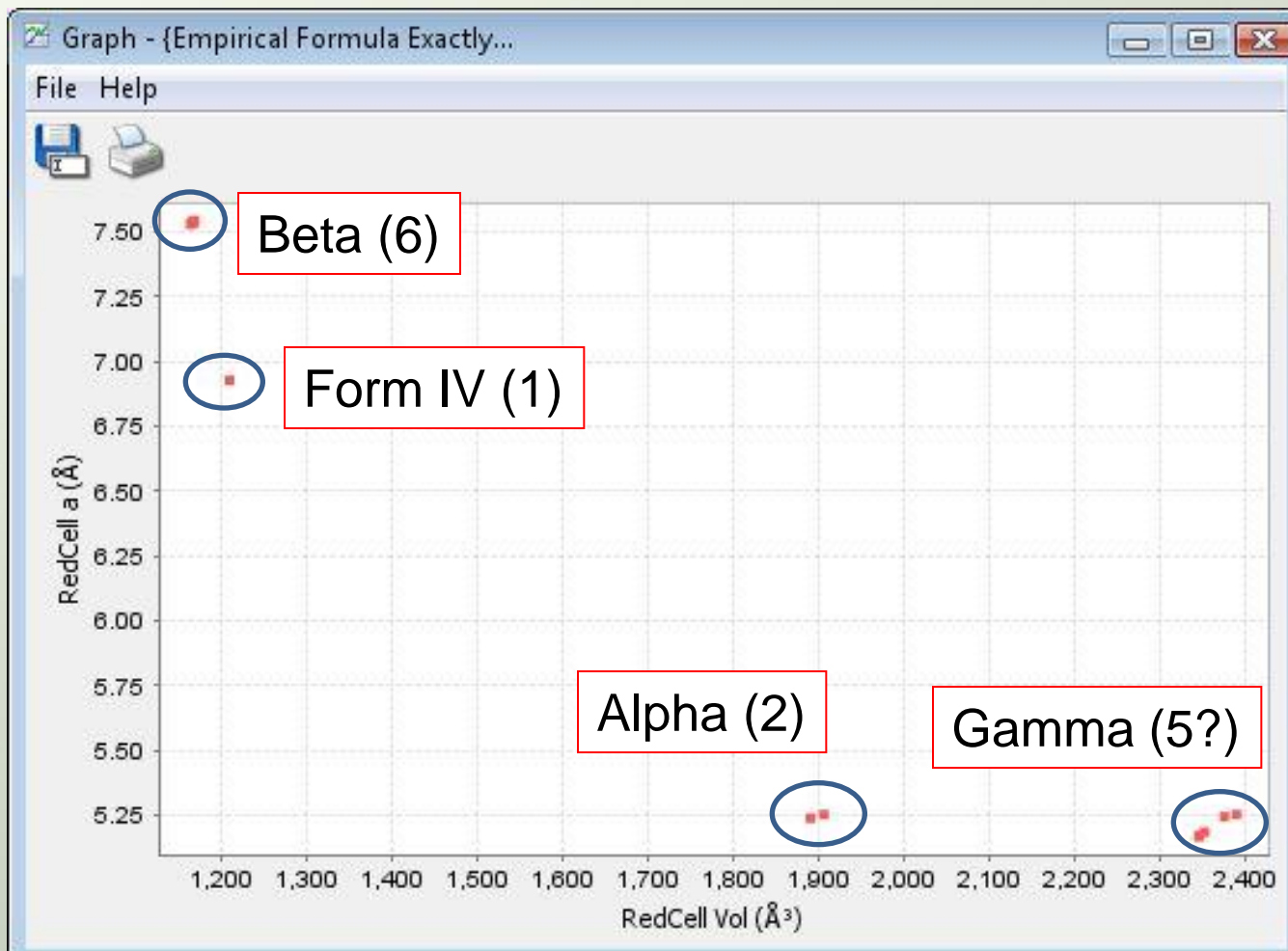
# Carbamazepine – Another View: A-axis Length vs Reduced Cell Volume

From the results table, another chart can be prepared, using the Reduced Cell Volume and Reduced Cell A-axis, to show potential polymorph 'clusters'.




# Carbamazepine – Another View: A-axis Length vs Reduced Cell Volume

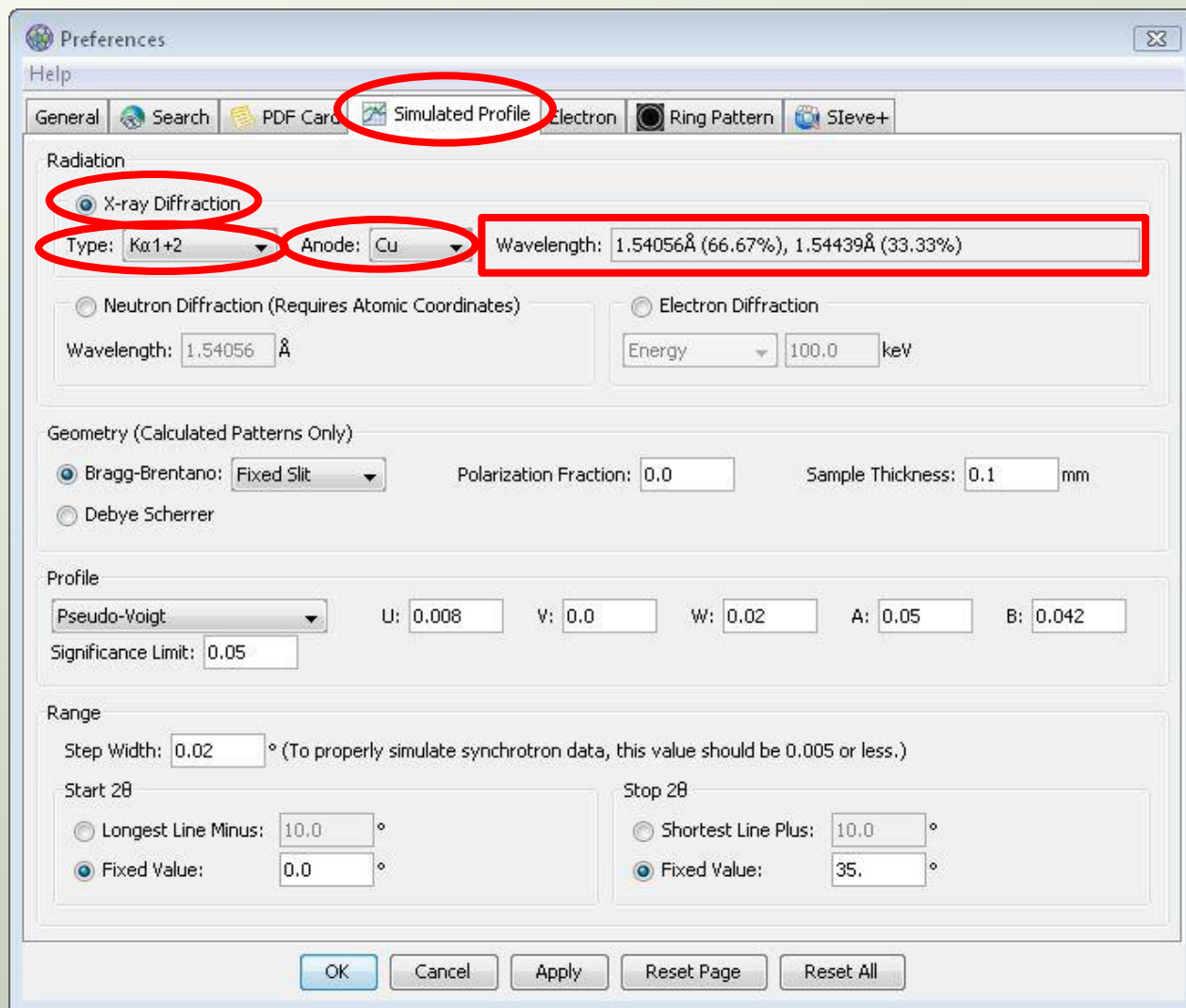
Here, the groupings have been labeled based on information from the 'Compound Name' or 'Comments' field from at least one member of the group. Polymorph designations can differ within a group and some entries do not have designations. The X-ray powder diffraction patterns themselves can be used to disambiguate the designations.



# X-ray Pattern Simulation Preferences

To compare the X-ray powder diffraction patterns for these entries, wavelengths, profile parameters, and 2-theta ranges must be set. The next 3 slides will illustrate this. The 'Preferences' icon  is used to bring up the 'Preferences' window.

On the 'Simulated Profile' tab, the 'Radiation' is set to 'X-ray Diffraction'. Then the 'Type' is set to 'K $\alpha$ 1+2', and the 'Anode' is set to 'Cu'.



# X-ray Pattern Simulation Preferences

On the same 'Simulated Profile' Tab, the 'Profile' type is set to 'Pseudo-Voigt', and the values for U, V, W, A, B, and Significance Limit are set as shown here

The screenshot shows the 'Preferences' dialog box with the 'Simulated Profile' tab selected. The 'Profile' section is highlighted with a red box, and a red arrow points from the text on the left to it. The 'Profile' section contains the following settings:

- Profile: Pseudo-Voigt
- U: 0.008
- V: 0.0
- W: 0.02
- A: 0.05
- B: 0.042
- Significance Limit: 0.05

Other settings visible in the dialog include:

- Radiation: X-ray Diffraction (selected), Type: K $\alpha$ 1+2, Anode: Cu, Wavelength: 1.54056Å (66.67%), 1.54439Å (33.33%)
- Geometry (Calculated Patterns Only): Bragg-Brentano: Fixed Slit, Polarization Fraction: 0.0, Sample Thickness: 0.1 mm
- Range: Step Width: 0.02 °, Start 2 $\theta$ : Fixed Value: 0.0 °, Stop 2 $\theta$ : Fixed Value: 35.0 °

# X-ray Pattern Simulation Preferences

Finally, the range is set to simulate patterns over a fixed 2-theta range of 0.0° to 35.0°

Preferences

Help

General Search PDF Card **Simulated Profile** Electron Ring Pattern Sieve+

Radiation

X-ray Diffraction

Type:  Anode:  Wavelength:

Neutron Diffraction (Requires Atomic Coordinates)  Electron Diffraction

Wavelength:  Å Energy:  keV

Geometry (Calculated Patterns Only)

Bragg-Brentano:  Polarization Fraction:  Sample Thickness:  mm

Debye Scherrer

Profile

U:  V:  W:  A:  B:

Significance Limit:

Range

Step Width:  ° (To properly simulate synchrotron data, this value should be 0.005 or less.)

Start 2θ

Longest Line Minus:  °

Fixed Value:  °

Stop 2θ

Shortest Line Plus:  °

Fixed Value:  °

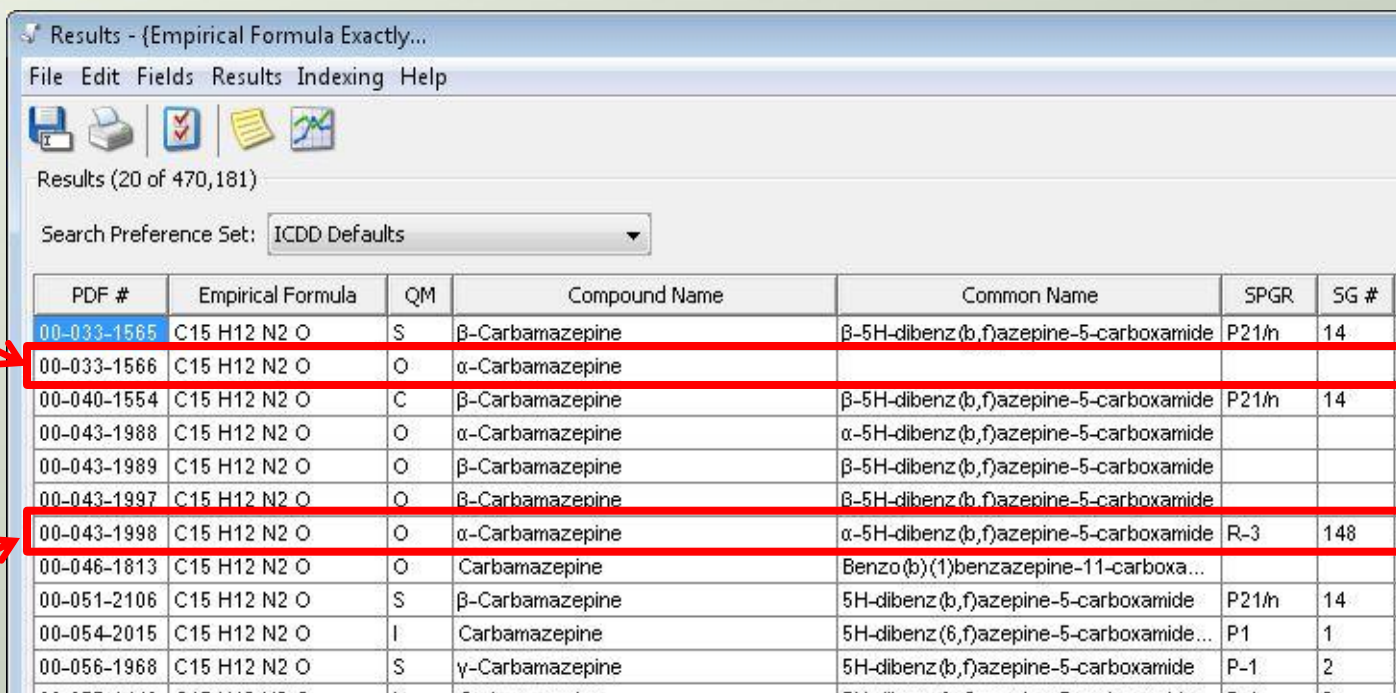
OK Cancel Apply Reset Page Reset All

# Carbamazepine – Comparing XRD Data

- To sort out all the entries, including those without unit cell information, the X-ray powder diffraction (XRPD) patterns themselves can be used
- With the PDF-4+ software, the user can overlay simulated XRPD patterns based on individual PDF entry data
- Example – overlay simulated XRPD patterns for entry 00-033-1566 (reported as alpha form but without cell parameters) and entry 00-043-1998 (reported as alpha form with cell parameters included)

We can select two patterns for comparing simulated X-ray powder diffraction patterns as follows:

- Click on the first entry (00-033-1566) for which a simulated pattern is desired.
- Then, holding the 'Ctrl' key, click on one or more additional entries (00-043-1998) for pattern overlay.
- Now right-click on either of these entries and select 'Open Simulated Profile'.



Results - {Empirical Formula Exactly...}

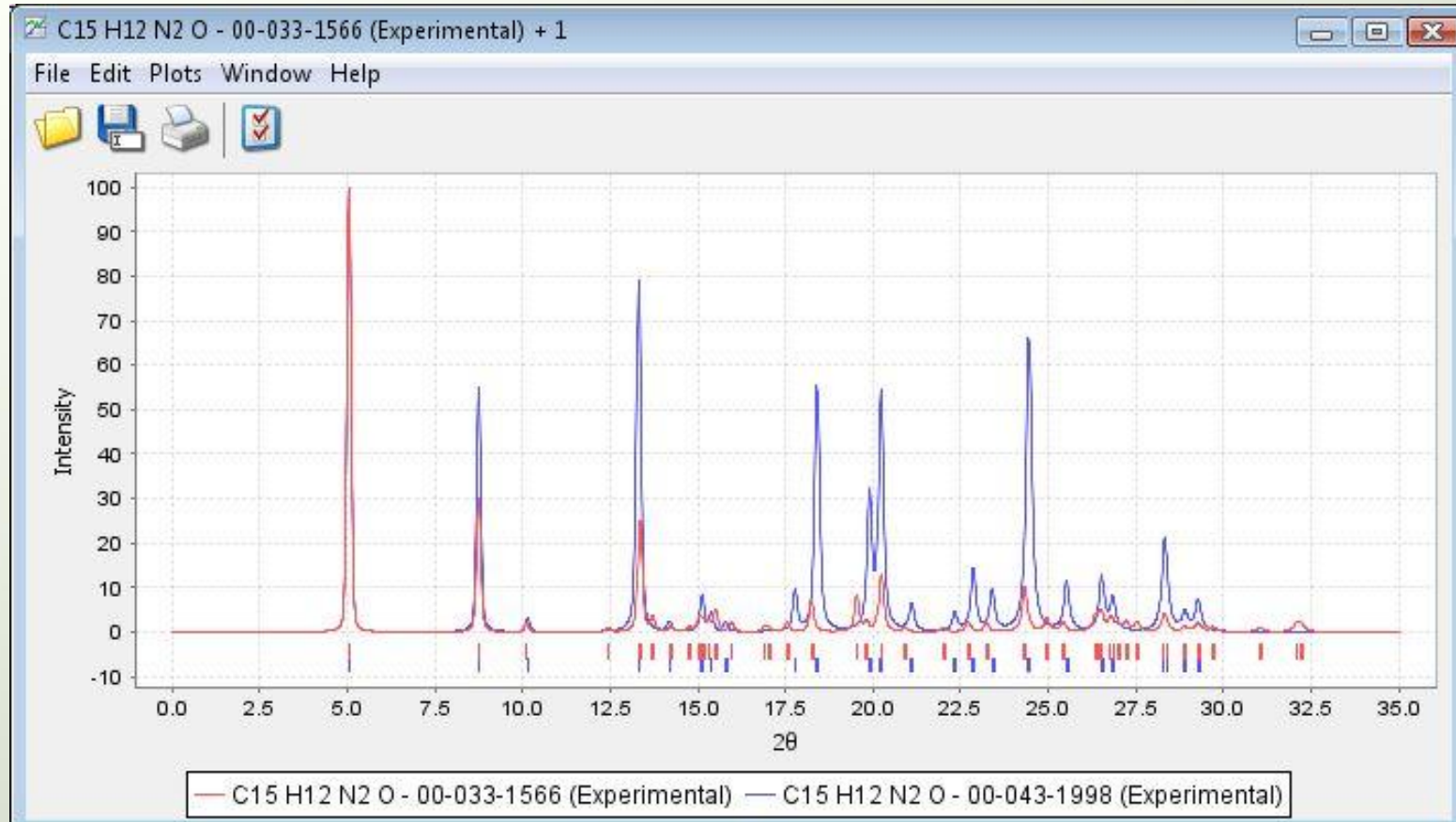
File Edit Fields Results Indexing Help

Results (20 of 470,181)

Search Preference Set: ICDD Defaults

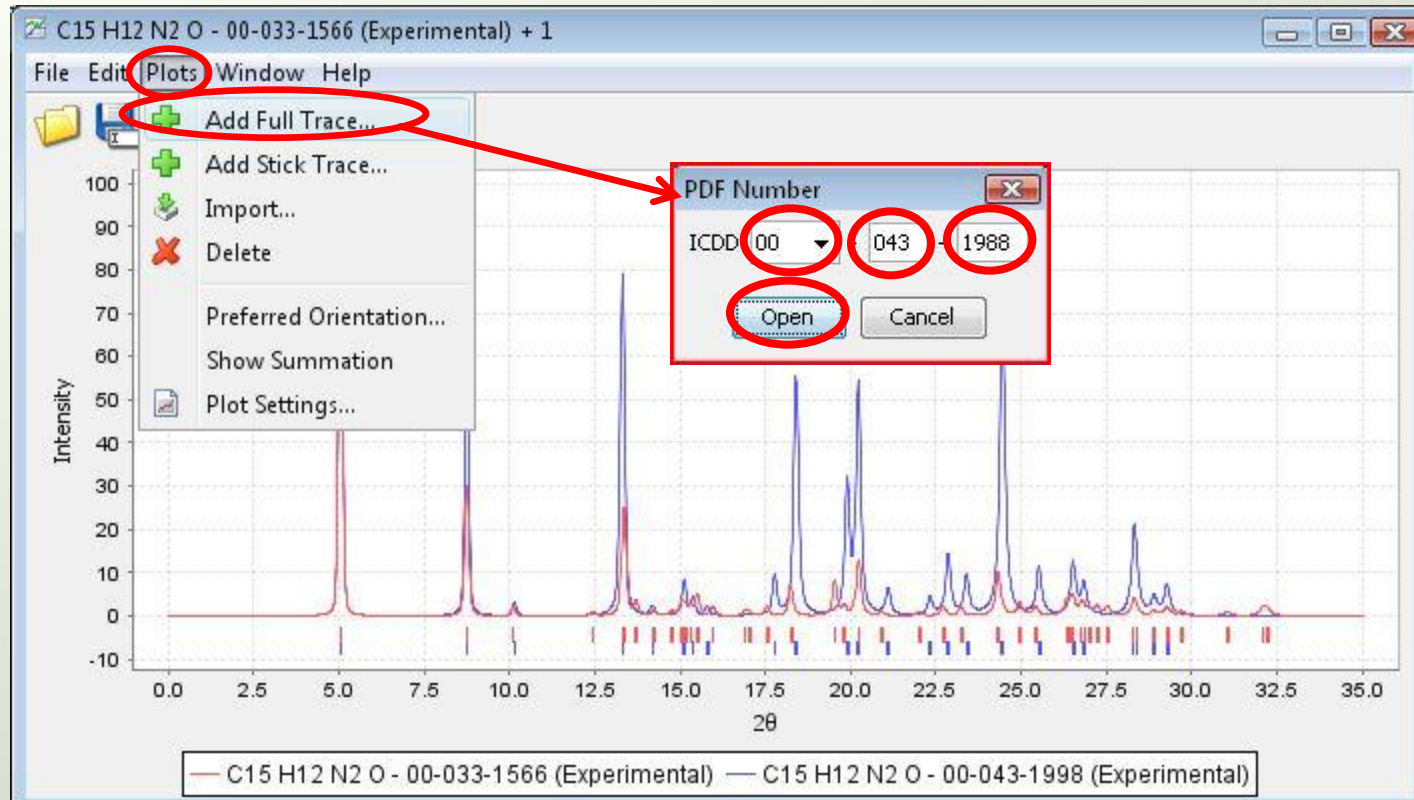
PDF #	Empirical Formula	QM	Compound Name	Common Name	SPGR	SG #
00-033-1566	C15 H12 N2 O	S	β-Carbamazepine	β-5H-dibenz(b,f)azepine-5-carboxamide	P21/n	14
00-033-1566	C15 H12 N2 O	O	α-Carbamazepine			
00-040-1554	C15 H12 N2 O	C	β-Carbamazepine	β-5H-dibenz(b,f)azepine-5-carboxamide	P21/n	14
00-043-1988	C15 H12 N2 O	O	α-Carbamazepine	α-5H-dibenz(b,f)azepine-5-carboxamide		
00-043-1989	C15 H12 N2 O	O	β-Carbamazepine	β-5H-dibenz(b,f)azepine-5-carboxamide		
00-043-1997	C15 H12 N2 O	O	β-Carbamazepine	β-5H-dibenz(b,f)azepine-5-carboxamide		
00-043-1998	C15 H12 N2 O	O	α-Carbamazepine	α-5H-dibenz(b,f)azepine-5-carboxamide	R-3	148
00-046-1813	C15 H12 N2 O	O	Carbamazepine	Benzo(b)(1)benzazepine-11-carboxa...		
00-051-2106	C15 H12 N2 O	S	β-Carbamazepine	5H-dibenz(b,f)azepine-5-carboxamide	P21/n	14
00-054-2015	C15 H12 N2 O	I	Carbamazepine	5H-dibenz(b,f)azepine-5-carboxamide...	P1	1
00-056-1968	C15 H12 N2 O	S	γ-Carbamazepine	5H-dibenz(b,f)azepine-5-carboxamide	P-1	2
00-057-1440	C15 H12 N2 O	I	Carbamazepine	5H-dibenz(b,f)azepine-5-carboxamide	P-1	2

# Overlaying Simulated XRPD Patterns for Comparison



The tick marks beneath the patterns show the reported peak positions. These patterns are fairly similar, with differences being attributable to unreported weak peaks, or accuracy in reported peak position, or intensity vs 2-theta where it appears 00-043-1998 was collected using a variable slit (theta-compensating) and 00-33-1566 was collected using fixed slits. (An alternate explanation would be that the pattern for 00-033-1566 was collected on an ultra-thin sample and 00-043-1998 was a thicker sample.) The comments show that entry 00-033-1566 is marked 'deleted' and replaced by 00-043-1998.

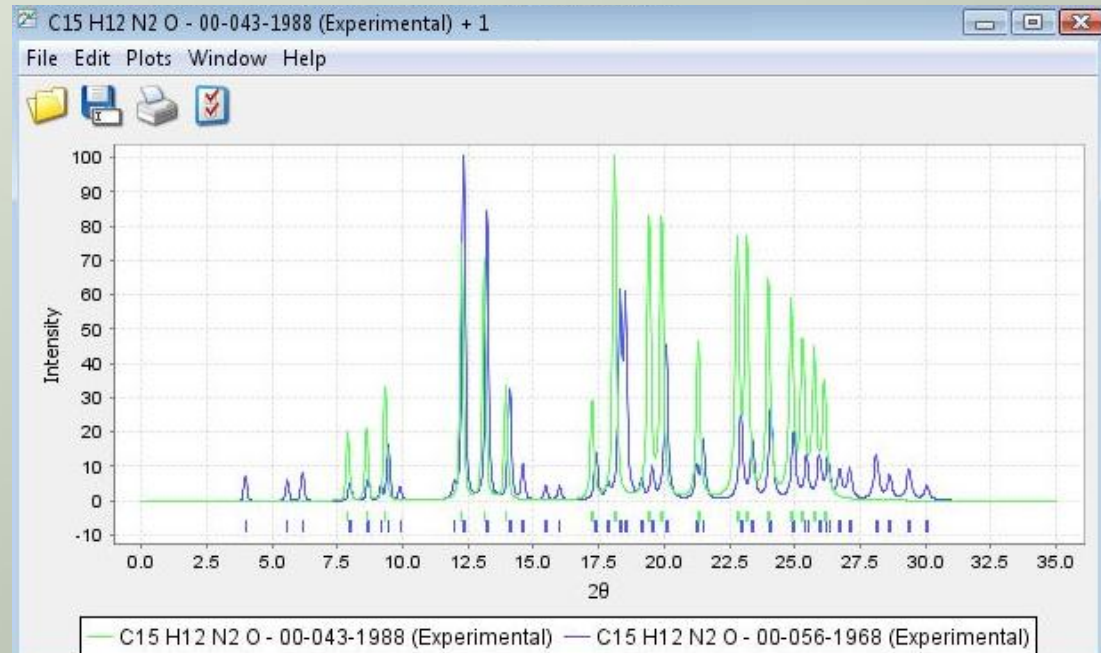
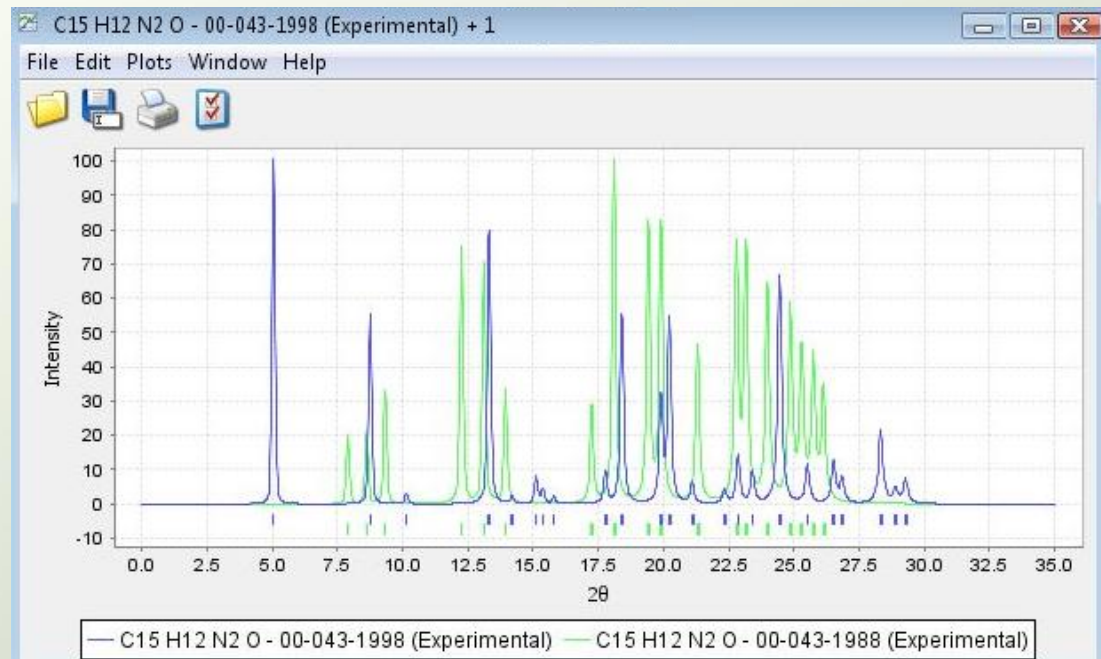
# Overlaying Simulated XRPD Patterns for Comparison



Additional XRPD patterns can be overlaid using the 'Plots'/'Add Full Trace ...' option

# Mis-assigned Polymorphic Form

Entry 00-043-1988 (green pattern) was also labeled as the  $\alpha$ -form by its author. However, one can see from the comparison with a known  $\alpha$ -form pattern (top graph – blue) and a known  $\gamma$ -form pattern (bottom graph – blue), that this entry was mis-characterized by the author and is actually a  $\gamma$ -carbamazepine.



# Overlaying Many XRPD Patterns

Using 'Ctrl-Click', one can select multiple entries from the 'Results' window and overlay their XRPD patterns on one graph. Here, all the experimental  $\beta$ -form entries have been selected.

A 'Right-Click' on one of these selected entries brings up the menu shown here. The 'Open Diffraction Pattern' choice will prepare the desired graph of overlaid patterns.

Results (20 of 470,181)

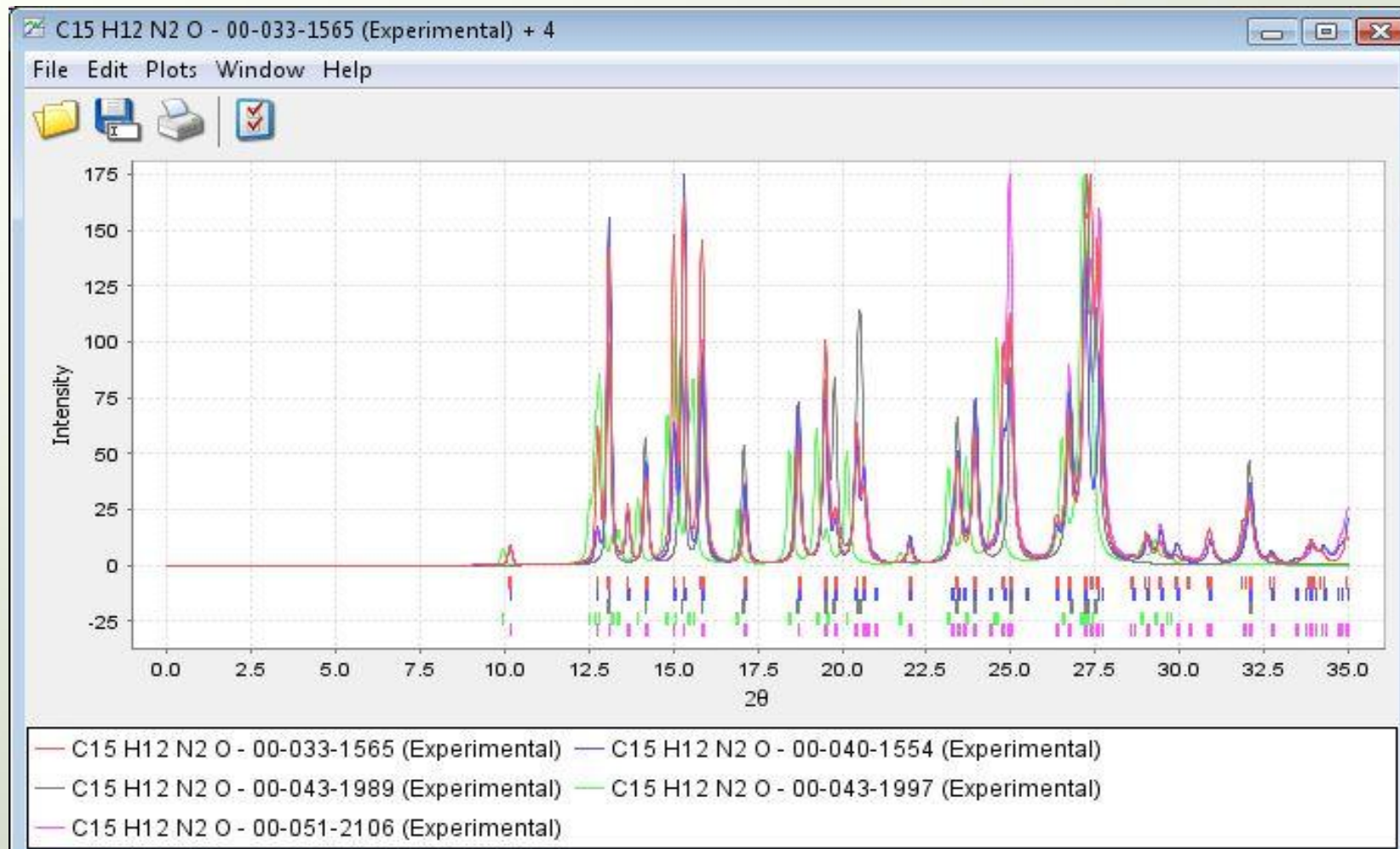
Search Preference Set: ICDD Defaults

PDF #	Empirical Formula	QM	Compound Name	Common Name	SPGR	SG #	RedCell a	RedCell b	RedCell c	RedCell Vol
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00-043-1997	C15 H12 N2 O	O	$\beta$ -Carbamazepine	$\beta$ -5H-dibenz (b,f)azepine-5-carboxamide						
00-043-1998	C15 H12 N2 O	O	$\alpha$ -Carbamazepine	$\alpha$ -5H-dibenz (b,f)azepine-5-carboxamide	R-3	148	5.253	20.544	20.544	1906.09
00-046-1813	C15 H12 N2 O	O	Carbamazepine	Benzo (b) (1) benzazepine-11-carboxa...						
00-051-2106	C15 H12 N2 O	S	$\beta$ -Carbamazepine	5H-dibenz (b,f)azepine-5-carboxamide	P21/h	14	7.539	11.156	13.918	1169.22
00-054-2015				5H-dibenz (b,f)azepine-5-carboxamide...	P1	1	5.245	20.520	22.258	2374.48
00-056-1968				5H-dibenz (b,f)azepine-5-carboxamide	P-1	2	5.253	20.584	22.294	2388.71
00-057-1449				5H-dibenz (b,f)azepine-5-carboxamide...	P-1	2	5.170	20.574	22.245	2344.82
00-058-1418				Benzo (b) (1) benzazepine-11-carboxa...	R		5.240	20.484	20.484	1890.23
00-058-1419				Benzo (b) (1) benzazepine-11-carboxa...						
02-060-9919				Carbamazepine	P21/c	14	7.529	11.148	13.902	1165.34
02-060-9920				Carbamazepine	P21/h	14	7.537	11.156	13.912	1168.30
02-064-1948				Carbamazepine	P21/h	14	7.534	11.150	13.917	1167.55
02-084-2534				5H-Dibenz (b,f)azepine-5-carboxamide	P-1	2	5.170	20.574	22.245	2344.82
02-086-6230					C2/c	15	6.927	13.748	13.957	1210.96
02-093-7847				gamma-Carbamazepine	P-1	2	5.186	20.576	22.241	2351.44

Search Description: {Empirical Formula Exactly 'C15 H12 N2 O'} And {All Names Contains Words 'carbamazepine'}

Calculations: Mean: [ ] Median: [ ] ESD: [ ]

# Overlay of Experimental $\beta$ -Carbamazepine Patterns on One Graph



Note the similarity between these five patterns. The most noticeable differences are that several weaker peaks were not reported in entry 00-043-1989 and 00-043-1997 shows a noticeable 2-theta shift.

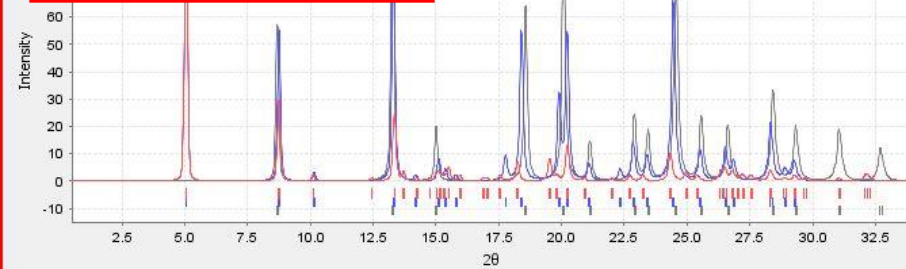
One can use this technique to determine which XRPD patterns among the 17 entries are similar, including those without polymorphic form or space group designations. Results of such a determination are shown on the next slide.

# Grouping of Similar XRPD Patterns for 20 Carbamazepine PDF Entries

One can overlay the simulated patterns for all 20 PDF entries to establish four groups of similar patterns. Note: Several entries with no space group or polymorphic form information have been reasonably assigned to one of these four groups.

**3 entries**  
 2 reported as  $\alpha$ -form  
 1 reported as form II

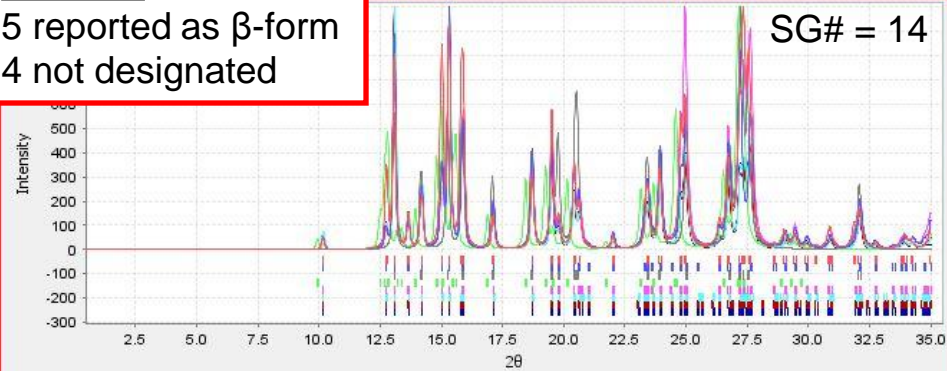
SG# = 148



— C15 H12 N2 O - 00-033-1566 (Experimental) — C15 H12 N2 O - 00-043-1998 (Experimental)  
 — C15 H12 N2 O - 00-058-1418 (Experimental)

**9 entries**  
 5 reported as  $\beta$ -form  
 4 not designated

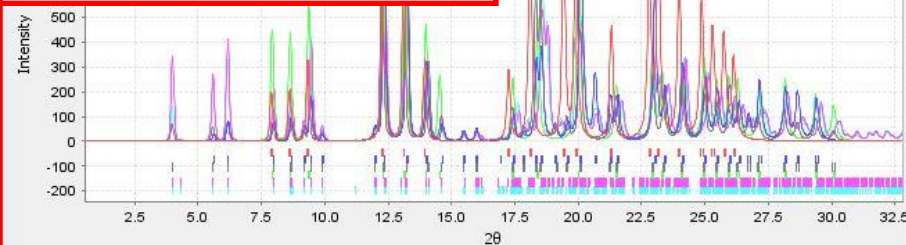
SG# = 14



— C15 H12 N2 O - 00-040-1554 (Experimental) — C15 H12 N2 O - 00-043-1989 (Experimental)  
 — C15 H12 N2 O - 00-043-1997 (Experimental) — C15 H12 N2 O - 00-051-2106 (Experimental) — C15 H12 N2 O - 02-060-9919 (Calculated)  
 — C15 H12 N2 O - 02-060-9920 (Calculated) — C15 H12 N2 O - 02-064-1948 (Calculated)

**6 entries**  
 2 reported as  $\gamma$ -form/form I  
 2 reported as form I  
 1 mis-reported as  $\alpha$ -form

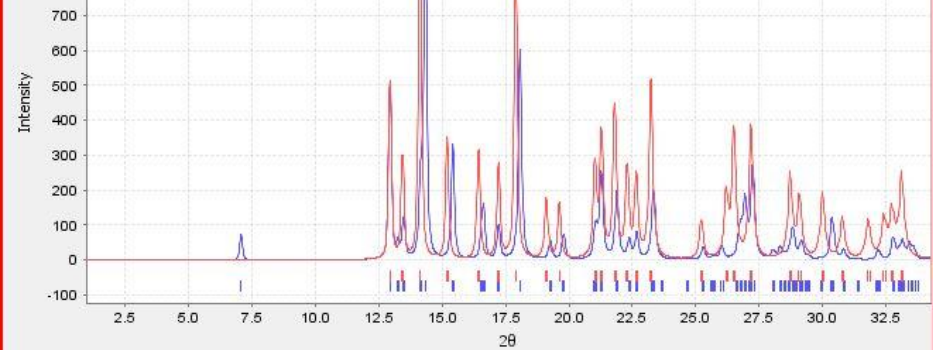
SG# = 1 or 2



— C15 H12 N2 O - 00-043-1988 (Experimental) — C15 H12 N2 O - 00-054-2015 (Experimental)  
 — C15 H12 N2 O - 00-056-1968 (Experimental) — C15 H12 N2 O - 00-057-1449 (Experimental)  
 — C15 H12 N2 O - 02-084-2534 (Calculated) — C15 H12 N2 O - 02-093-7847 (Calculated)

**2 entries**  
 2 reported as Form IV

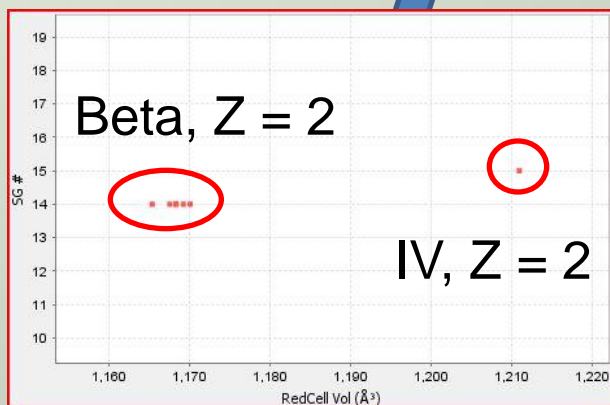
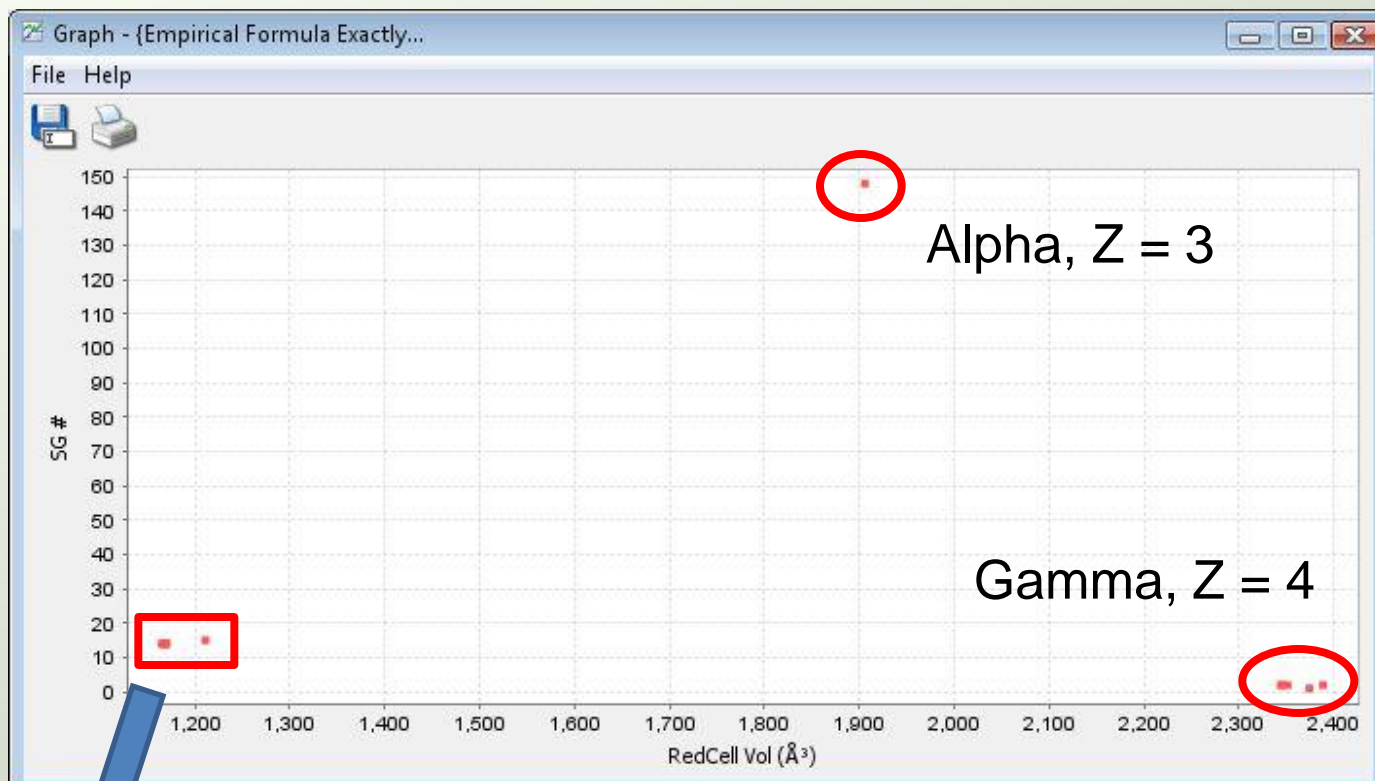
SG# = 15



— C15 H12 N2 O - 00-058-1419 (Experimental) — C15 H12 N2 O - 02-086-6230 (Calculated)

# Carbamazepine – Cell Volume vs Space Group

20 PDF Entries (14 Experimental, 6 Calculated from Single Crystal data)



Revisiting the 'Cell vs Space Group' graph, all 20 entries can be assigned to one of these four groupings, based on similarity of their XRPD patterns.

# Carbamazepine Polymorphs

- Crystallographic and powder diffraction data suggest 4 known polymorphic forms.
- Data mining and display capabilities of the PDF-4+ software and databases give users the ability to categorize the database entries into specific polymorphic groupings.
- The user's own pattern can be compared with the known polymorph patterns to ascertain polymorphic form.



Thank you for viewing our tutorial.

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web site ([www.icdd.com](http://www.icdd.com)).

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