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LaboTex

Version 3.0

Texture Analysis Software for Windows



**Texture Analysis
on the Basis of EBSD Data**

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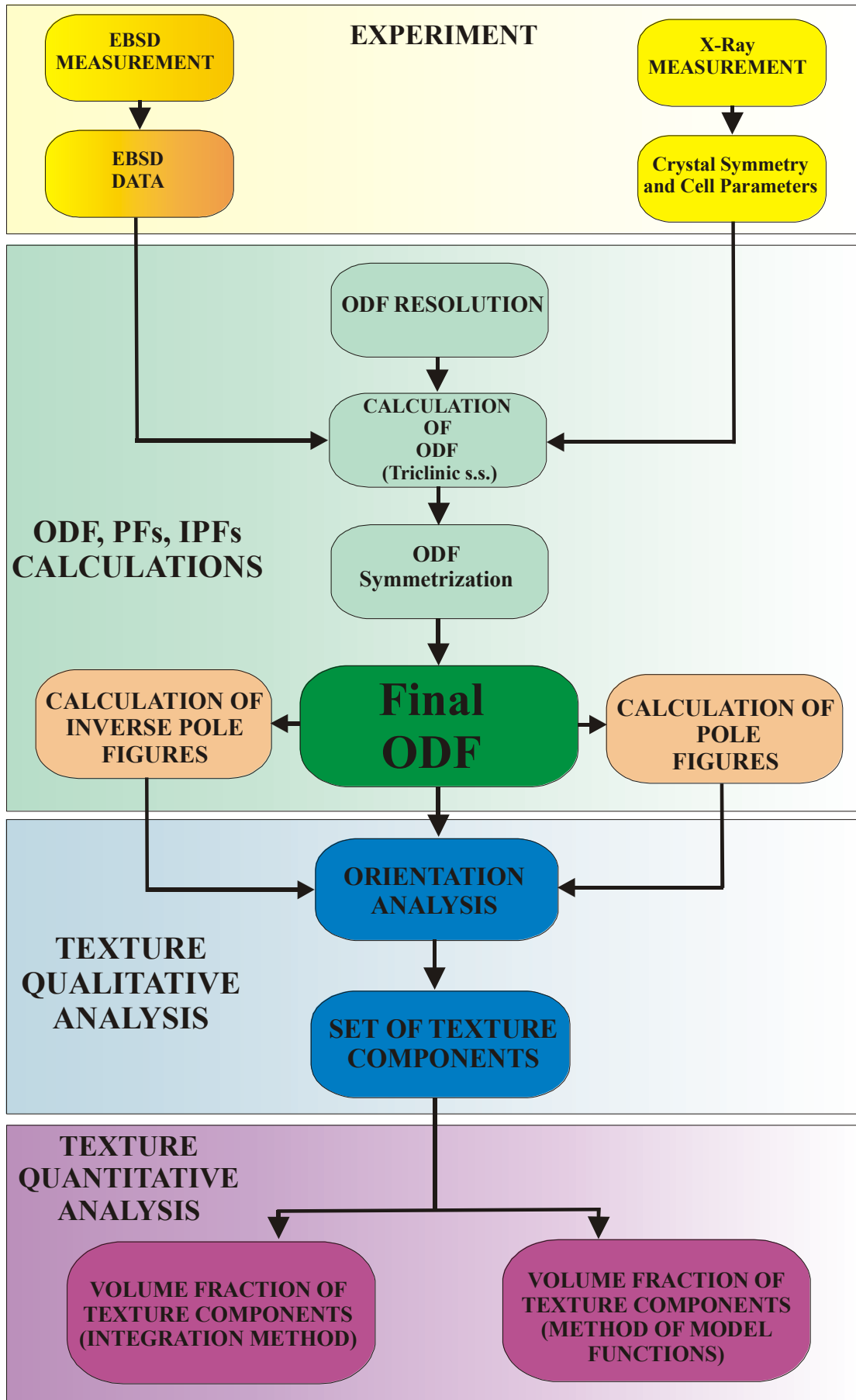


Figure 1. Processing of the EBSD data in LaboTex

1. Format of EBSD data

The input for LaboTex can be the EBSD data or any other data with probabilities of orientations. In the case of the discrete ODF data (a set of probability density data) you should multiply each ODF value by the volume of the element of the orientation space. You cannot input directly ODF values using SOR data format.

1.1 LaboTex format

LaboTex format for the EBSD data is very simple. The LaboTex input files with EBSD data consist of 4 lines heading and the rest is EBSD data. Each element of the EBSD data takes one line which includes 3 Euler angles and, optionally, the statistic weight of its orientation. LaboTex can process the EBSD data files with *.SOR filename extension (*filename.SOR* – Single ORientation File). The table below provides a description of the *filename.SOR* data format:

Line	No of data in line	Description	Type
1 – 2		Arbitrary title	Character
3		Remarks for data in line 4	
4	1	Structure Code (symmetries after Schoenflies): 1 - C ₁ (triclinic) 2 - C ₂ (monoclinic) 3 - D ₂ (orthorhombic) 4 - C ₄ (tetragonal) 5 - D ₄ (tetragonal) 6 - T (cubic) 7 - O (cubic) 8 - C ₃ (trigonal) 9 - D ₃ (trigonal) 10 - C ₆ (hexagonal) 11 - D ₆ (hexagonal)	Integer
4	2	Lattice constant, a (absolute or relative)	Real
4	3	Lattice constant, b (absolute or relative)	Real
4	4	Lattice constant, c (absolute or relative)	Real
4	5	Lattice angle, α in degrees	Real
4	6	Lattice angle, β in degrees	Real
4	7	Lattice angle, γ in degrees	Real
4	8	Step for output ODF (grid cells). Permissible values (deg): 1.0, 1.2, 1.25, 1.5, 2.0, 2.5, 3.0, 3.75, 5.0, 6.0, 7.5, 10.0*	Real
4	9	Weight for data (1 – present, 0 – absent)	Integer
4	10	Angle Unit: 0 – deg, 1 – rad	Integer
4	11	Angle Convention: 0 – Bunge 1 – Roe	Integer
5 to the end	1	ϕ_1	Real
5 to the end	2	Φ	Real
5 to the end	3	ϕ_2	Real
5 to the end	[4]	Weight (optionally) (if parameter <i>weight</i> in line 4 is 1)	Real

Note: Real and integer input data must be separated by one or more space signs.

*LaboTex allows new grid cell from version 21.006: 1.8x1.8, 2.25x2.5, 3.6x3.6, 4.5x4.5 (exceptions: trigonal, hexagonal crystal lattice symmetry).

1.2 LaboTex format - Example

```

-----
Remark line 1
Remark line 2
Structure  a    b    c  alfa  beta  gamma  grid  weight  deg/rad  Bunge/Roe
      7    1.00  1.00  1.00  90.00  90.00  90.00  5.00    1    0    0
205. 12.  4.  0.2
210. 15. 15. 0.3
215. 20.  2. 0.3
220. 31.  4. 0.2
225. 13.  5. 0.1
200. 13.  5. 0.1
...
-----

```

1.3 Non-LaboTex Formats with EBSD data

LaboTex is compatible with other EBSD data input formats:

- 'CTF' HKL® Single Orientations Files, *.CTF list
- 'SNG' TSL® Single Orientations Files, *.SNG
- 'TXT' HKL® Single Orientations Files, *.TXT
- 'TSV' Single Orientations Files: *.TSV

You can find the current list of the LaboTex compatible data formats at www.labotex.com in the section “Data Formats”.

1.4 User Defined Formats with EBSD data

If your EBSD data format is not compatible with LaboTex, you can adjust LaboTex to accept your EBSD data file. Your file should be in ASCII format. In order to convert your file to the ASCII format you should export your file in the EBSD software to ASCII/TXT. Your file should have the *.txt extension. Once you exported your file, you can try to open it in LaboTex. When opening a file from LaboTex, you will still be able to see files with other extensions but in order to handle the file correctly LaboTex must open it with the *.txt extension. From the main Menu select 'Edit'/'LaboTex Options' and then select the tab 'Data Format'. From the drop down list choose 'TXT' - User Defined Format for EBSD Data. You will see a new window: “TXT Single Orientation Data Files - Details”. Now define the following columns for the data according to their position in your file:

- the data column with Phi1 angles;
- the data column with Phi angles;
- the data column with Phi2 angles;
- the data column with the code of phase (optional);
- the data column with the error code (optional);
- the code of error for the correct data;
- the data column with the weight (optional);
- the data column with the diameter of grains (optional).

The screenshot shows a dialog box titled "TXT - Single Orientation Data Files - Details" with a warning message: "Warning: Please Open *.TXT' File and CheckPosition of Data and Units". The dialog box contains the following sections:

- Euler Angles:** Three columns for Φ_1 , Φ , and Φ_2 . The column numbers are 1, 3, and 2 respectively.
- Code of Phase:** Column No. 0.
- Code for indexed or non-indexed data:** Column No. 0. Radio buttons for "Indexed" and "Non-indexed" are present, with "Non-indexed" selected.
- Weight:** Column No. 4.
- Diameter:** Column No. 0.
- Units:** Radio buttons for "Degrees" and "Radians", with "Degrees" selected.

An "OK" button is located at the bottom of the dialog box.

Important!

Select column '0', if your file does not contain any optional data. You can choose the phase code in the 'New Sample' dialog settings. LaboTex creates ODF for the chosen phase. The user creates ODFs for each phase separately using the 'New Sample' dialog settings within the same file with the relevant phase code.

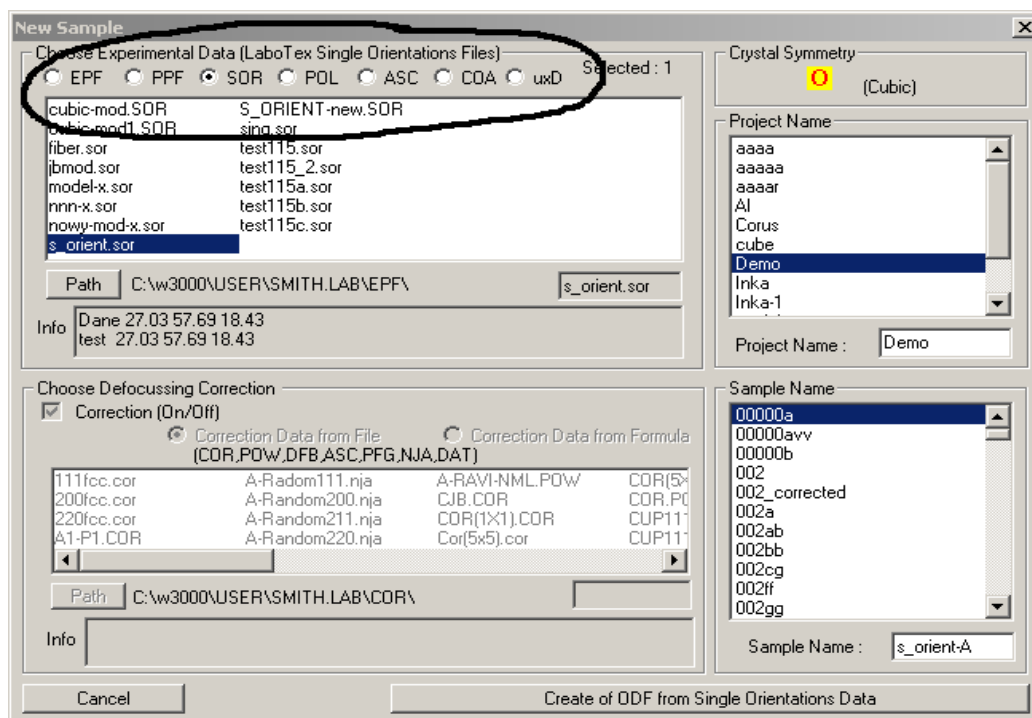
2. Input EBSD data to LaboTex

In this section we will describe how to create the user input EBSD data file(s) using 'New Sample' option.

From the main *Menu* select *File > New Sample/Project* or click the icon 'New Sample' from the Icon Menu:

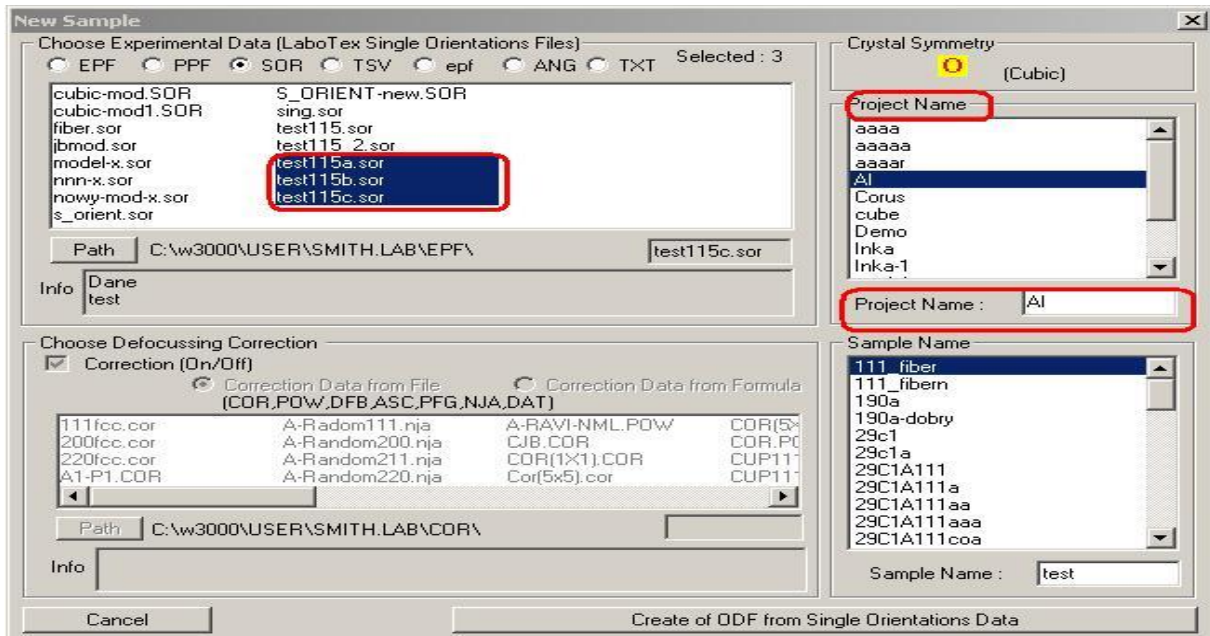


You will see the *New Sample* window.

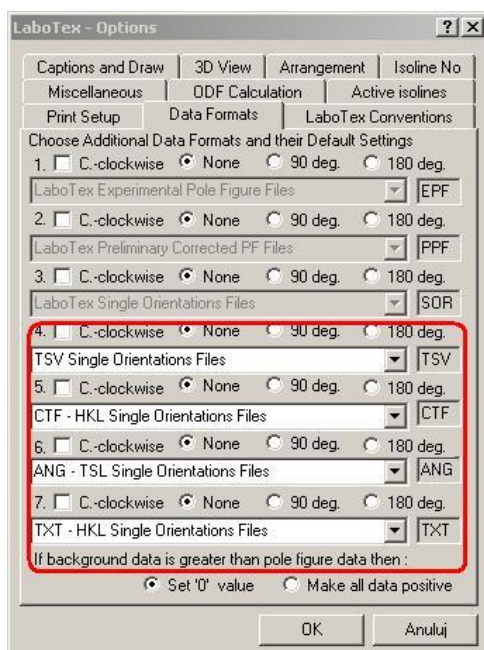


In the top section '*Choose Experimental Data (LaboTex Single Orientations Files)*' you can select the file format. If you choose *SOR*, LaboTex will display only *.sor files in the box below. Below the box with the listed files, you can see the '*Info*' section which will display the remark lines from the selected (highlighted file). If you select files with single orientation data (formats: *SOR*, *CTF*, *SNG*, *TXT*, *TSV*...), the defocussing correction list below will be inactive.

If you want to include more than one file in your project, select the relevant files in the files selection box by holding the Ctrl key on your keyboard and left-clicking the filenames with your mouse. Once you selected the file format, you can choose the name for your project in the box 'Project Name' on your right hand side. You can choose the existing Project Name or define a new name by entering in it the box 'Project Name' below.

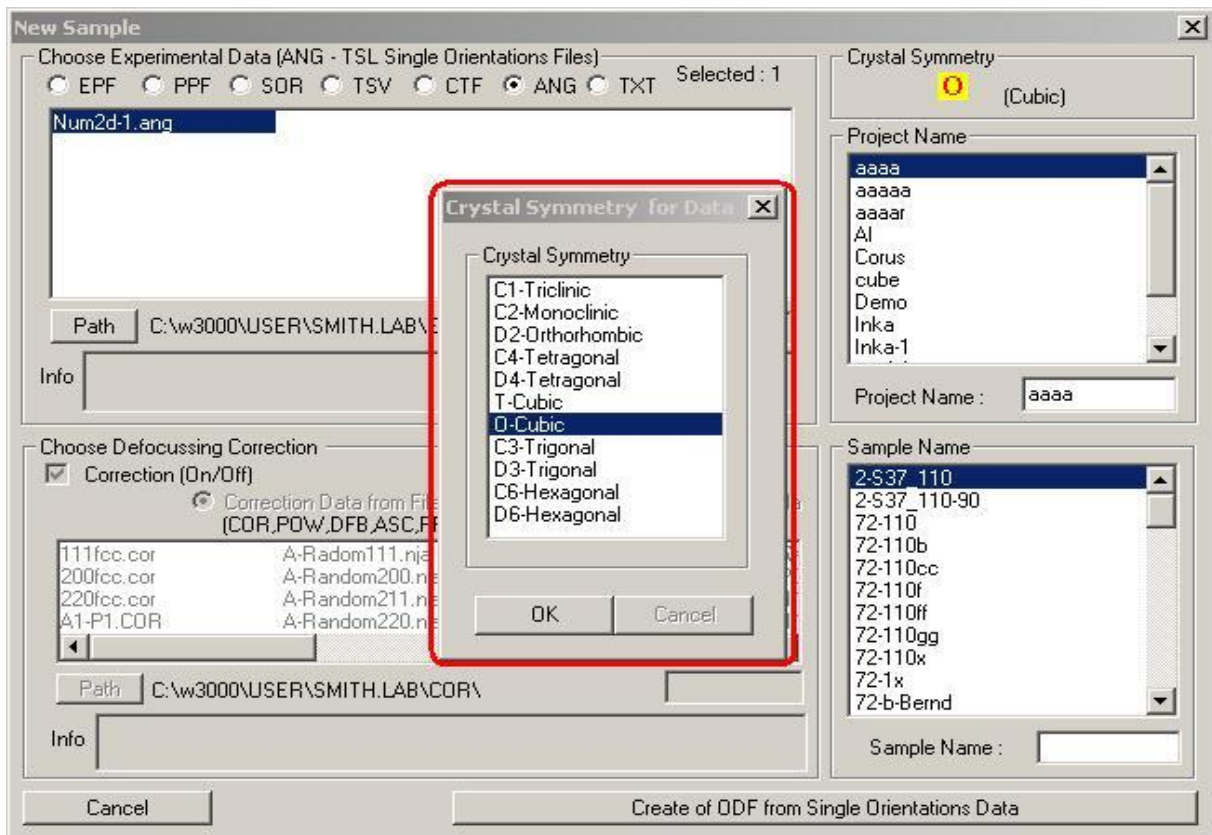


LaboTex is compatible with 30 different input data formats. However, only up to 7 data formats can be selected at the same time. You will see that LaboTex will show up to 7 active data formats to choose from. For example, in the above screenshot you can see the following data formats available for selection: EPF, PPF, SOR, TSV epf (popLA), ANG and TXT. The first three data formats are default and will always be displayed. You can change the remaining four formats. In order to do that select 'Edit' > 'LaboTex Options' and then the tab 'Data Formats'. The first three formats (EPF, PPF, SOR) are preselected and fixed out but you can change formats 4 to 7 using the drop down list (see the screenshot below).



The settings: 'C-clockwise', '90 deg.' and '180 deg.' are non-active for the single orientations data (SOR).

Please remember that only 'SOR' files contain information about crystal symmetry of sample. If you input data in other data format than 'SOR', LaboTex will ask you for crystal symmetry of your sample (see on the figure below).

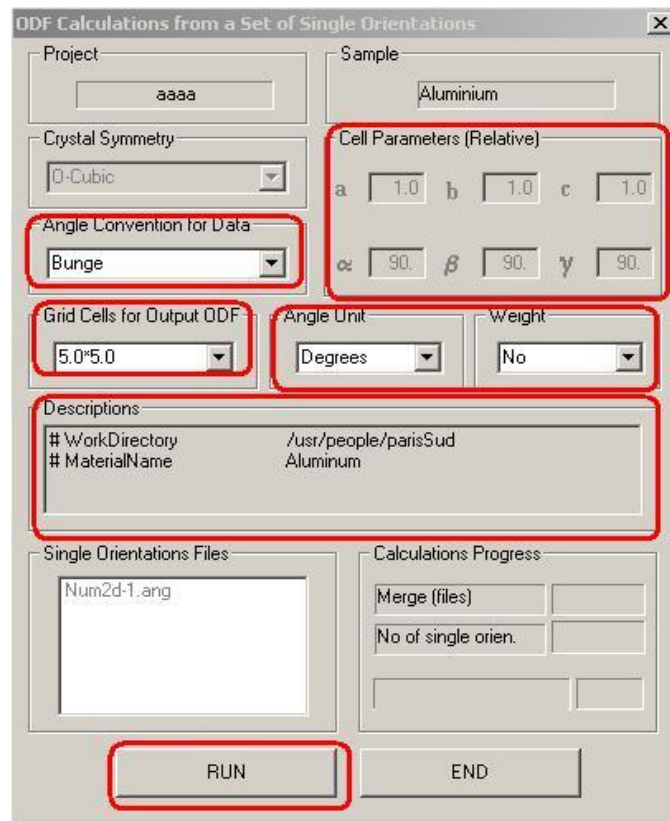


Once you completed all the steps: selecting all files with single orientation data for your sample, choosing the project name, the sample name and the crystal symmetry for your sample, click '*Create of ODF from Single Orientation Data*'.

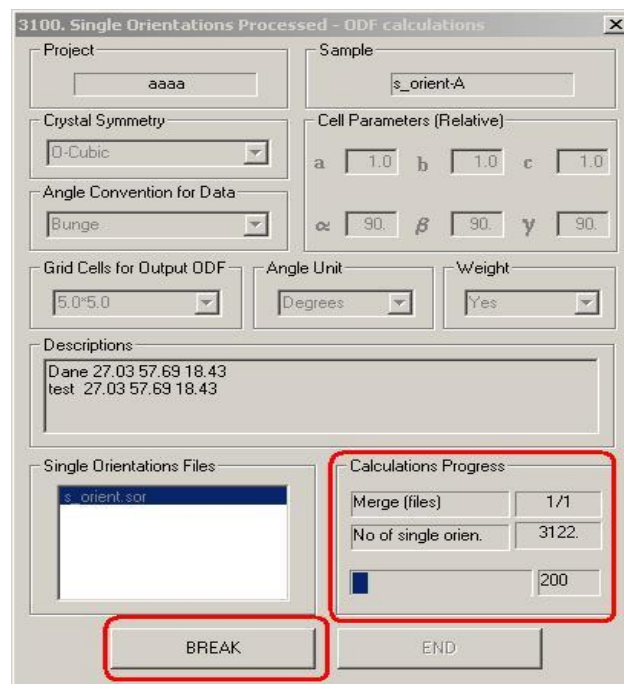
You will see a new dialog window which displays information about your data. If you use other formats for single orientation data than 'SOR', you will be asked to complete additional information essential for proper processing of your data:

- Euler angle convention for your data: you can choose 'Bunge' or 'Roe' convention;
- Cell parameters (only in the case of samples with crystal symmetry lower than cubic). Cell parameters have to be entered in the right sequence. For more details please see our Report: "*Pole Figures: Registration and Plot Conventions*" (available in PDF on www.labosoft.com.pl);
- Angle unit: you can choose 'degrees' or 'radians';
- Weight (weights of measurements): you can choose 'yes' or 'no'. If your file contains three Euler angles and weight for each measurement, select 'yes'.
- Grid cells for output ODF. You can choose from the following grids: 1., 1.2 ,2. ,1.25 ,1.5, 2. ,2.5 ,3. ,3.75 ,5. ,6. ,7.5 ,10. degrees.

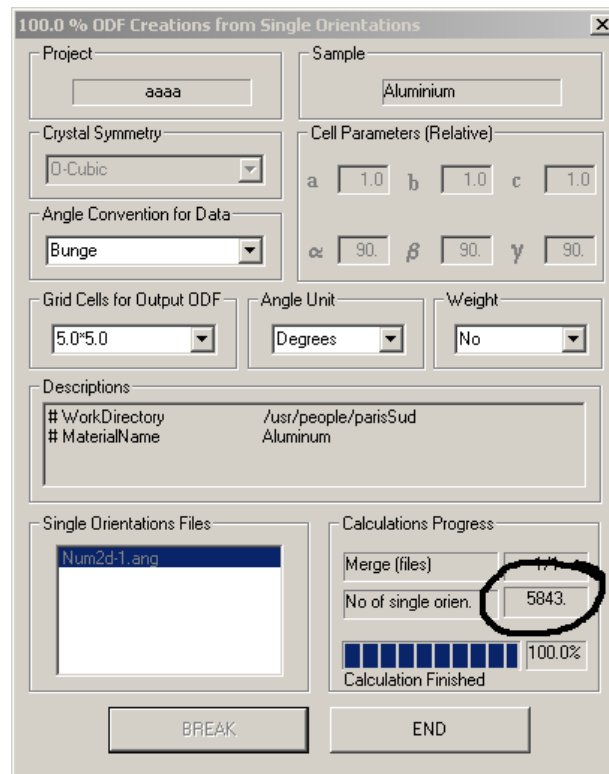
For some formats you can also add descriptions (remarks) for your data. Once you enter all the requested information, click "Run".




LaboTex will start ODF calculation showing you the progress of the calculation. You can stop calculation at any moment by clicking the 'BREAK' button. LaboTex will also displays the current number of processed orientations.

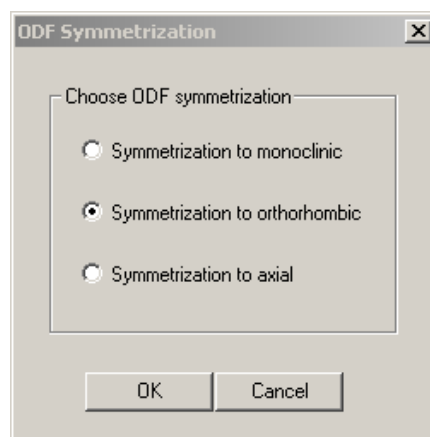


Once the ODF calculations are finished, LaboTex will display a message '*Calculation Finished*'. You can also monitor the number of single orientations processed during ODF calculation (see the screenshot below) and the names of files which were used (merged) during the calculation. When you click the '*End*' button, LaboTex will open your new ODF.

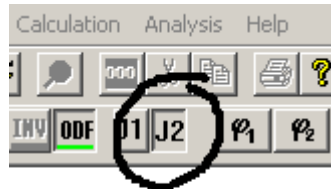


3. ODF Symmetrization

When calculations are made from single orientations data, LaboTex always calculates ODF in triclinic sample symmetry. If your ODF has higher sample symmetry, you should conduct ODF symmetrization. Open the dialog window for symmetrization from the main Menu '*Calculation*' > '*ODF symmetrization*' or directly from toolbar clicking the icon . In the *ODF Symmetrization* window you will be able to select the type of ODF symmetrization:

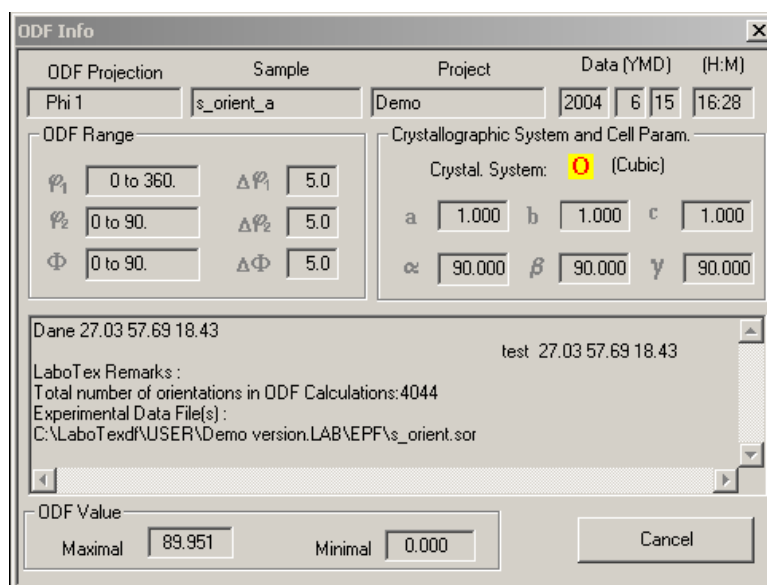


When you select the ODF symmetrization, a new ODF for your data will be created and placed as the job nr 2. Every time you conduct a new ODF symmetrization, its resulting ODF will be placed in the subsequent job. The original ODF is always can placed in the job nr 1. The maximal number of jobs is 9 (see the screenshot below).




When you click the right mouse button on the projection of the ODF, LaboTex will display details about the ODF ('ODF Info' dialog) which includes:

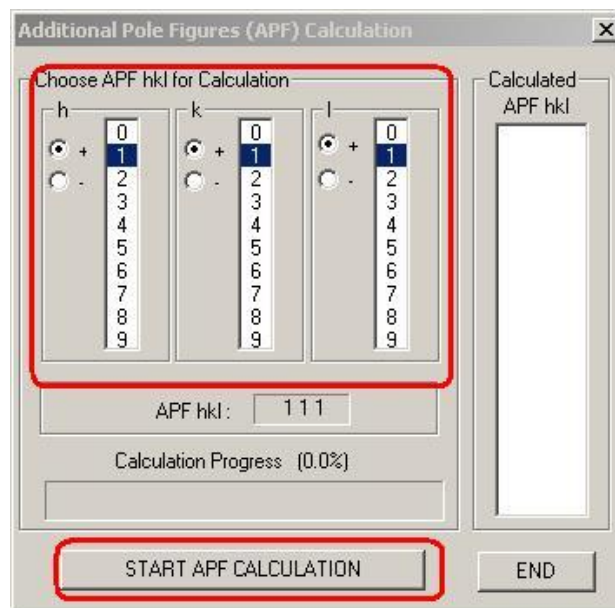
- ODF Projection (i.e. the name of the projection which is current displayed by LaboTex);
- Name of project and name of sample;
- Date and time of ODF creation;
- ODF range and grid;
- Crystal system;
- Cell parameters;
- Maximal and minimal ODF value;
- Description of ODF or sample (from remarks the lines of the SOR file);
- Number of orientations used in the ODF calculation;
- Names of all the files with single orientations data used in the ODF calculation (there are also path to these files);



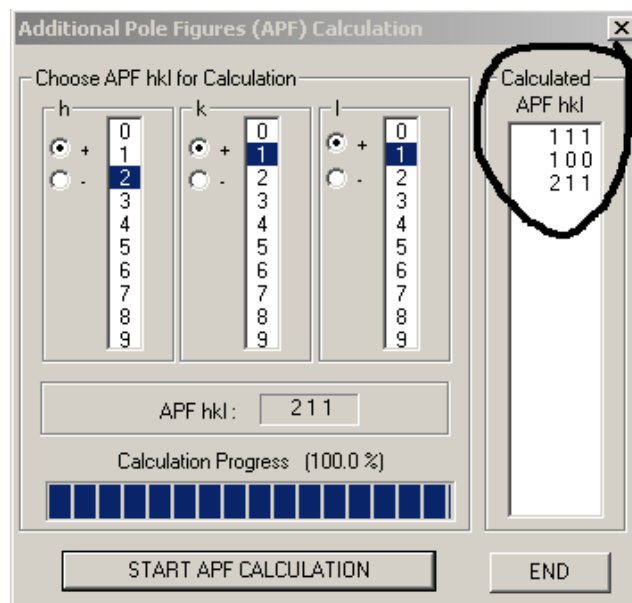
4. Pole Figures and Inverse Pole Figures calculations

After finishing the ODF calculations you can make calculations of pole figures. From the menu 'Calculation' select one of the options: 'ODF to APF' or 'ODF to INV'. You can also click directly on the icon  to start dialog window for calculation of pole figures.

In the 'ODF to APF' dialog window you can make the calculation of the normal pole figures. You only have to choose miller indices h, k, l for pole figure which you want create and the click on the button 'START APF CALCULATION'.



Miller indices for the calculated pole figures are displayed in the list on the right hand side.

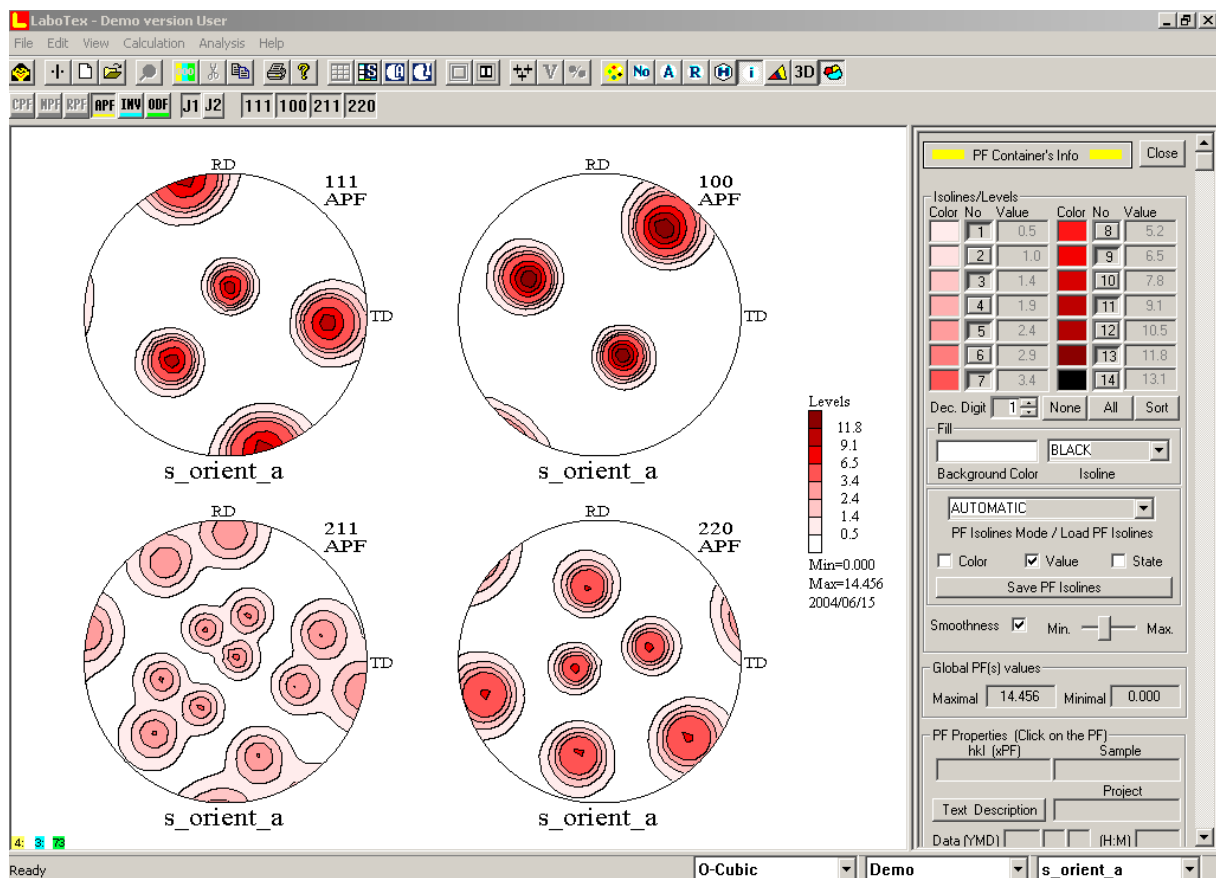


Once you finished the calculation of pole figures, click 'END'. All your calculated pole figures can be accessed by choosing the *APF* (Additional Pole Figures) icon on the toolbar.

Clicking the '111', '100', '211' icons displays one or more pole figures. If you want to display pole figures from the job number 2, first click the button 'J2' and then select 'APF' icon. Finally, click the pole figures icons.

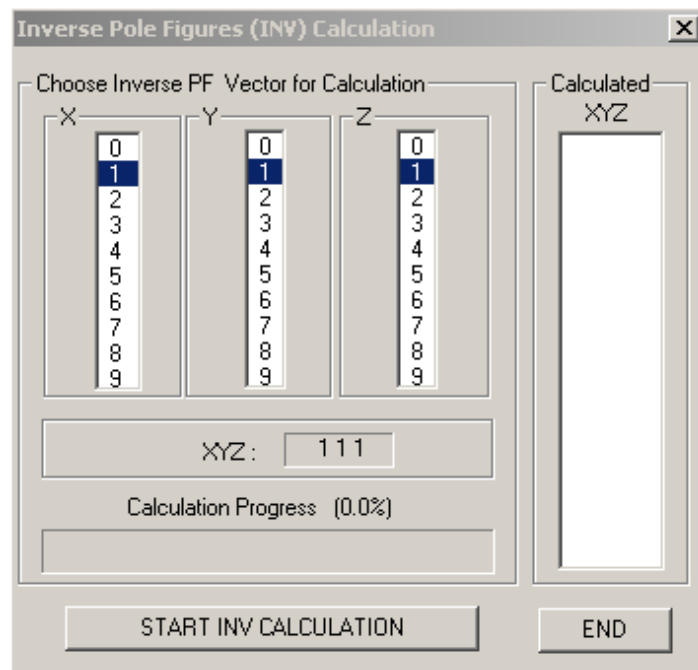


Please note: The pole figures for each job are calculated on the basis of the ODF from this job.

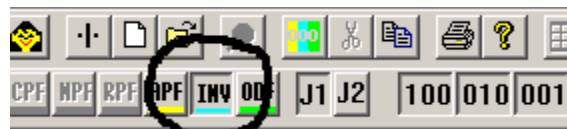


You can create the inverse pole figure ('Calculations' > 'ODF to INV') in the similar way. In this case you need to choose the vector components: X, Y, Z for which LaboTex calculates the orientation distribution on the stereogram (see the screenshot below). The most popular are directions of axis: 001 (ND direction), 010 (TD direction) and 100 (RD/LD

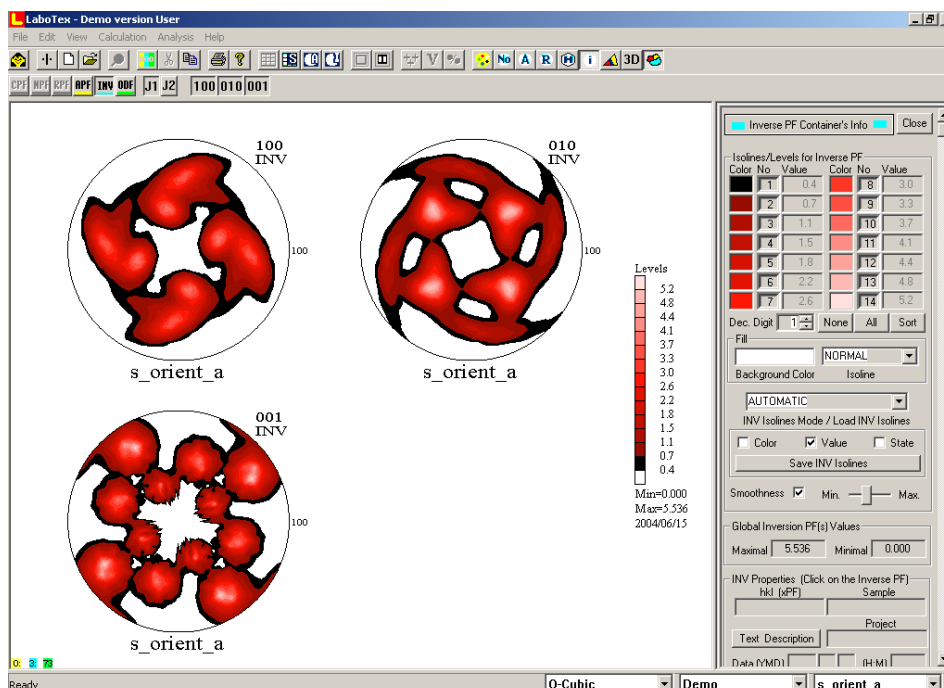
direction). You can find more details in our Report: *"The Nomenclature of Inverse Pole Figures Use in LaboTex"* (available on our website <http://labotex.com>).



All your inverse pole figures can be accessed by clicking the INV (*IN*verse *po*le *fi*gures) icon on the toolbar:



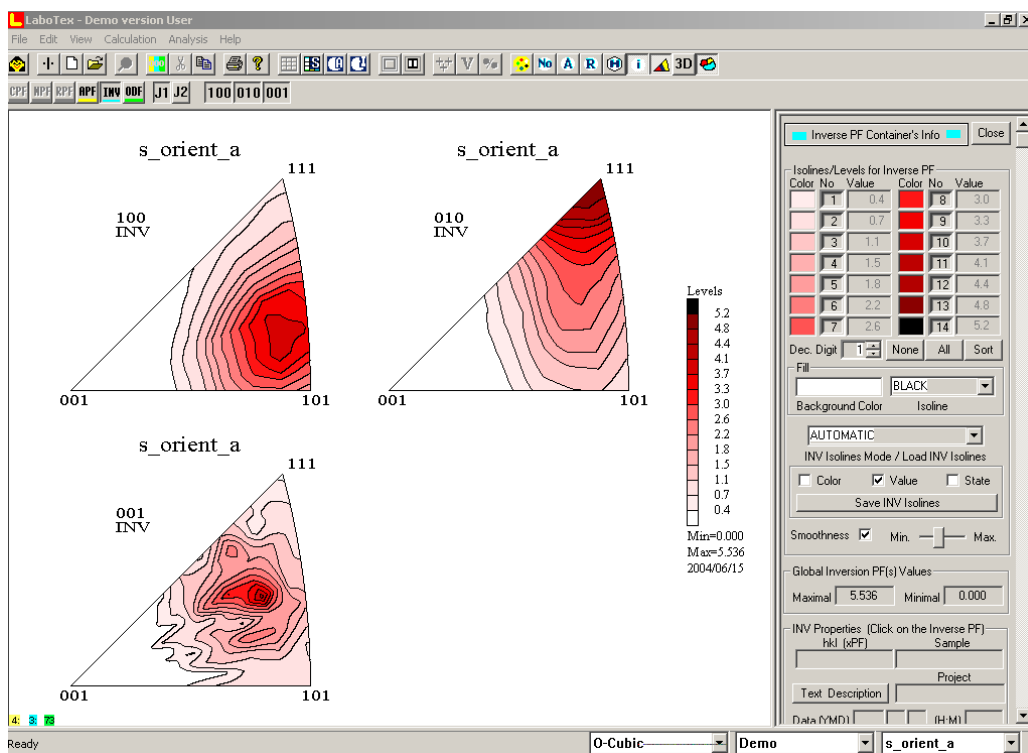
When you click the '001', '100', '010' icons, LaboTex will display one or more complete inverse pole figures:



To display partial inverse pole figures (orientations distribution of a sample axis on a standard stereographic triangle), click the icon with a triangle or select 'View' > 'Basic Region'.



LaboTex will display partial inverse pole figures replacing the complete inverse pole figures:



Please note: once the icon for basic region has been clicked, the analysis icons become inactive (grayed out).

5. Texture qualitative and quantitative analysis

After calculating the ODF, pole figures and inverse pole figures, you may perform the qualitative and quantitative analysis. The execution of these analyses is similar to other samples from X-Ray, neutron or synchrotron measurements. You can find more details in our reports available in PDFs on the LaboTex website <http://www.labotex.com>:

- 1) Introduction to LaboTex 3.0
- 2) Menu Guide to LaboTex
- 3) Determination of Volume Fraction of Texture Components Using LaboTex - Integration Method
- 4) Determination of Volume Fraction of Texture Components Using LaboTex - Model Functions Method
- 5) Nomenclature of Inverse Pole Figures Use in LaboTex
- 6) Pole Figures: Registration and Plot Conventions
- 7) LaboTex: Modeling of ODF, Pole Figures and Inverse Pole Figure
- 8) Texture Analysis on the Base of the EBSD Data
- 9) "Device-independent" pole figures for quantitative texture analysis (Techniques: PIM and IM)
- 10) Fundamentals of 3-D Texture Analysis. Symmetry aspects of 3-D texture analysis
- 11) Hexagonal Axes: Conventions & Conversions
- 12) LaboTex – The Texture Analysis Software - Getting Started
- 13) LaboTex: Modelling of ODF, Pole Figures and Inverse Pole Figure
- 14) LaboTex: Skeleton Lines and Misorientation Diagrams

**If you have any queries or comments,
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