

# **User's Guide for Hkc\_Pick**

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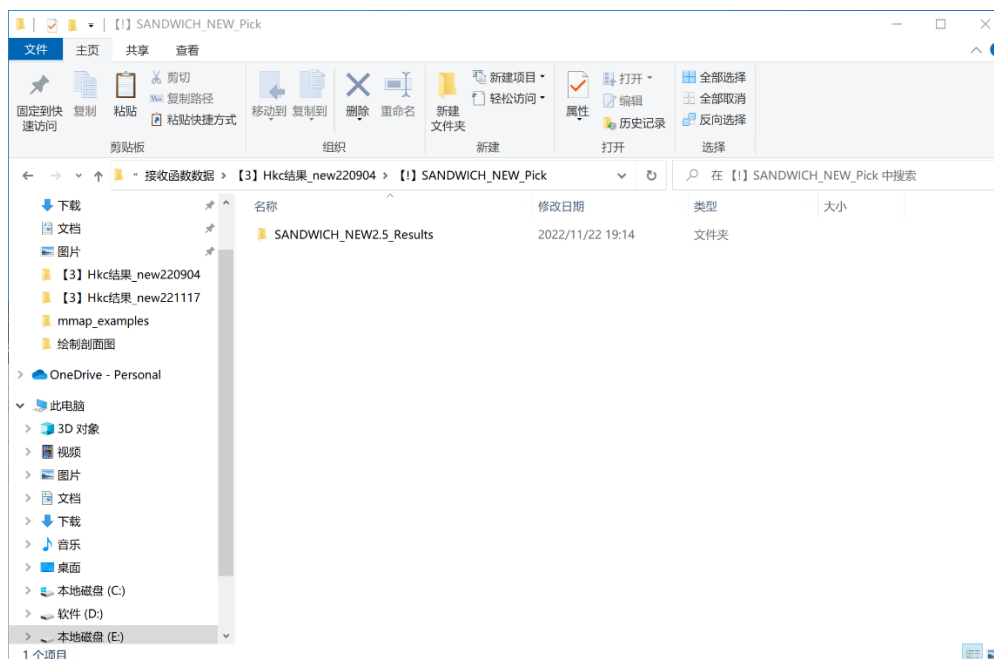
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# 1. Create a new project

## (1) Manage Hkc output using a project directory

To run Hkc\_Pick, you first need to prepare the input data, which should be the output of the Hkc (with stability tests) code. For example, if you have already completed the Hkc analysis of SANDWICH RFs, the Hkc code would output a packaged file named 'SANDWICH\_NEW2.5\_Results.tar'. Unpack the file to obtain the summarized data directory 'SANDWICH\_NEW2.5\_Results', which will serve as the input for Hkc\_Pick.

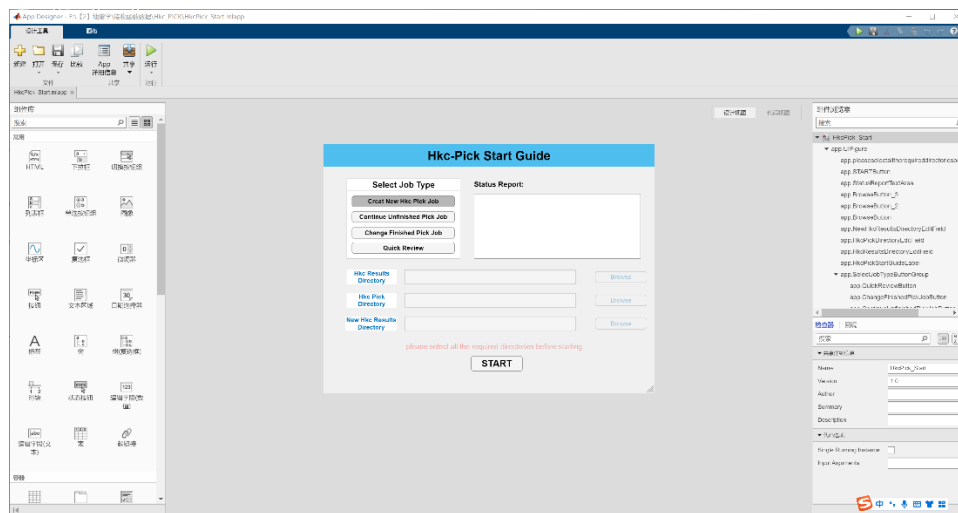
Since it's common to modify the original Hkc results with new Hkc results (e.g., the original harmonic searching range in Hkc may not be suitable for some stations), it's recommended to create a **project directory**. In the example shown below, the project directory is named 'SANDWICH\_NEW\_PICK' (prefix is omitted as it is only a personal preference, not a requirement). This project directory should contain all the Hkc results, including the original Hkc results and any new Hkc results used to modify the original results.



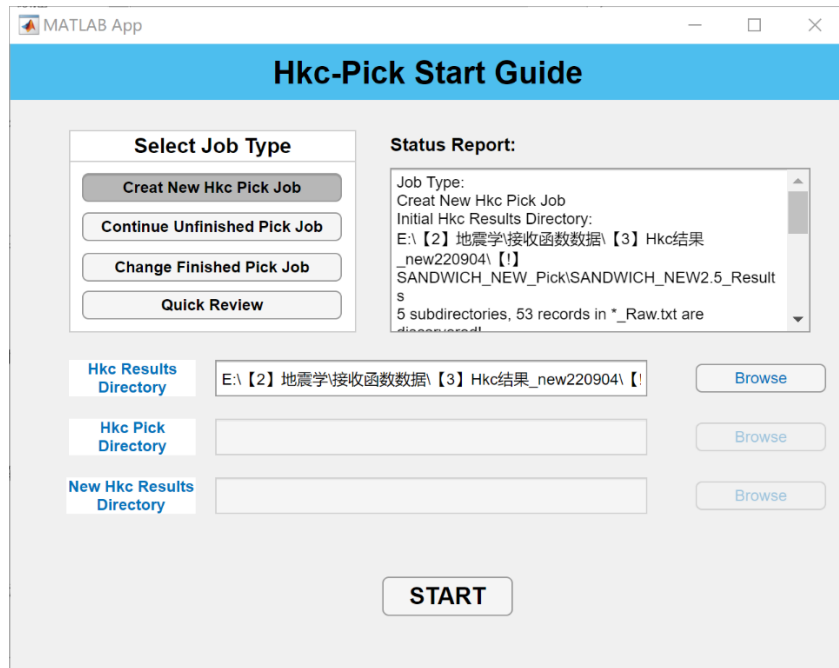
**(2) Run Hkc\_Pick**

Set the MATLAB working directory to the directory where `HkcPick_Start.mlapp` is located. Within MATLAB, double-click on **HkcPick\_Start.mlapp** to open the MATLAB App Designer interface (as shown below).

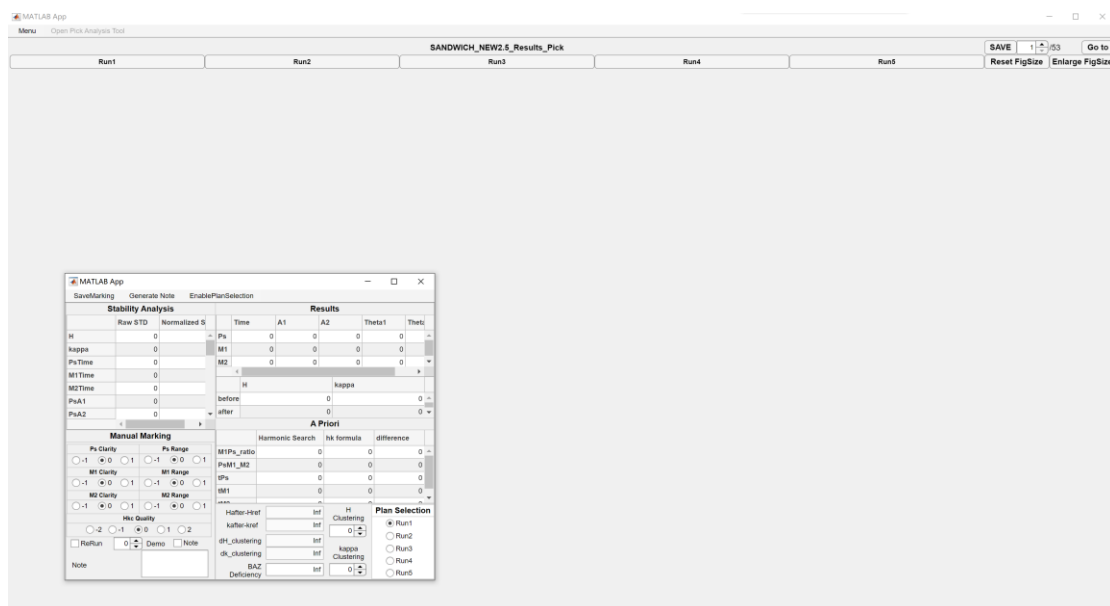
Note that when you start `HkcPick_Start`, the code will automatically run **`HkcPick_AddPath`**, which is located in the same directory as `HkcPick_Start`. You can also run `HkcPick_AddPath` manually beforehand to ensure that all programs and functions of `Hkc Pick` can be found.



To run HkcPick\_Start, click on 'Run' (Green triangle) within the App Designer interface, or run it from the command line. Once HkcPick\_Start has successfully run, a UI panel will be displayed (as shown below). In the UI panel, select 'Create New Hkc Pick Job' as the Job Type. Then, click 'Browse' and select the output folder of the Hkc code (e.g. SANDWICH\_NEW2.5\_Results, as shown in the figure below).



Click 'Start' to start the following process. The initial run may take some time as it involves generating plots. Once the plots have been generated, the interface will automatically switch to the **waiting screen** (as shown below).



Click 'Go to' to start the first station's selection process. The UI panel will be updated and appear as shown below:



MATLAB App
SaveMarking
Generate Note
EnablePlanSelection

### Stability Analysis

	Raw STD	Normalized S
H	7.6954	1.0
kappa	0.0871	1.0
PsTime	0.0172	0.0
M1Time	2.2016	0.0
M2Time	3.0941	1.0
PsA1	0.0224	0.0
PsA2	0.0112	0.0

### Results

	Time	A1	A2	Theta1	Theta2
Ps	9.2837	0.2250	0.6250	140	
M1	28.7678	0.5250	0.7250	150	
M2	37.8115	0.7250	0.4250	345	

	H	kappa
before	67.4660	1.7930
after	66.5010	1.8400

### Manual Marking

Ps Clarity	Ps Range
<input type="radio"/> -1 <input type="radio"/> 0 <input checked="" type="radio"/> 1	<input type="radio"/> -1 <input checked="" type="radio"/> 0 <input type="radio"/> 1
M1 Clarity	M1 Range
<input type="radio"/> -1 <input type="radio"/> 0 <input checked="" type="radio"/> 1	<input type="radio"/> -1 <input checked="" type="radio"/> 0 <input type="radio"/> 1
M2 Clarity	M2 Range
<input type="radio"/> -1 <input type="radio"/> 0 <input checked="" type="radio"/> 1	<input type="radio"/> -1 <input checked="" type="radio"/> 0 <input type="radio"/> 1

Hkc Quality
<input type="radio"/> -2 <input type="radio"/> -1 <input type="radio"/> 0 <input type="radio"/> 1 <input checked="" type="radio"/> 2

☐ ReRun
☐ Demo
☐ Note

SEZA

### A Priori

	Harmonic Search	hk formula	difference
PsM1_M2	0.2400	0	-0.2400
tPs	9.2837	9.2357	-0.0480
tM1	28.7678	28.7808	0.0130
tM2	37.8115	38.0165	0.2050

Hafter-Href	-7.499	H Clustering <input type="text" value="0"/>
kafter-kref	0.1255	
dH_clustering	Inf	kappa Clustering <input type="text" value="0"/>
dk_clustering	Inf	
BAZ Deficiency	55.26	

### Plan Selection

☐ Run1  
☐ Run2  
☒ Run3  
☐ Run4  
☐ Run5

Then, click on 'Save' button in the main UI panel. The selected result will be saved (in essence, the 'currently processed data' will be merged into a summary table used for storing results in the backend of the UI).

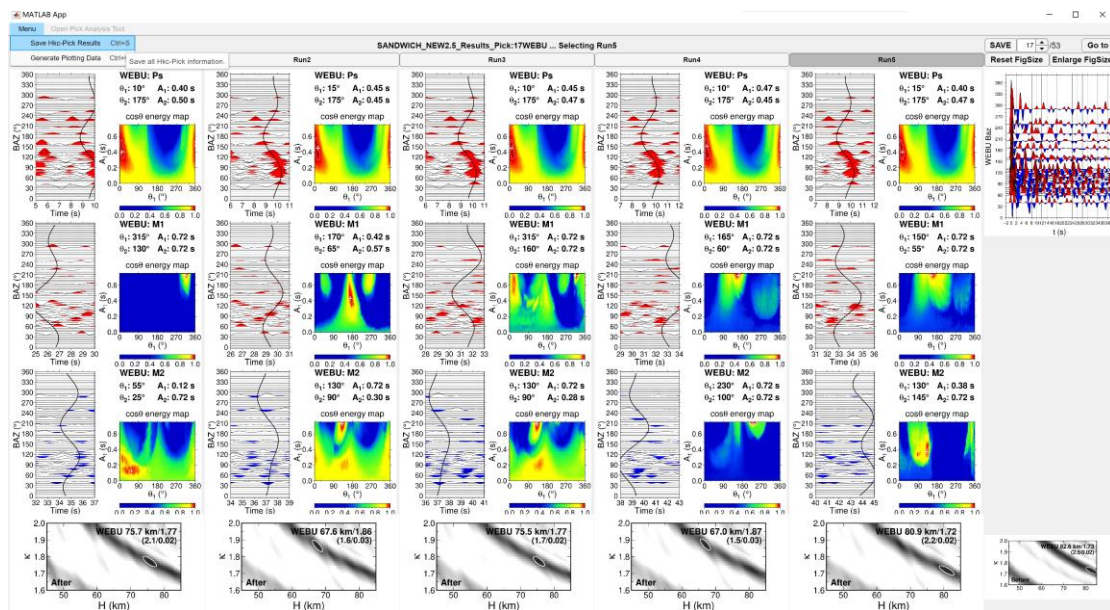






如果中途需要退出程序，请选择 Menu-Save Hkc Pick Results 与 Menu-Generate Plotting Data，然后按右上角关闭按钮，程序正常退出。如果没有保存这些结果，程序会提示用户保存。

If you need to exit the program midway, please select 'Menu => Save Hkc Pick Results' and 'Menu => Generate Plotting Data'. Then click the close button in the upper right corner to exit the UI panel normally. If you have not saved these results, the program will prompt you to do so.



In the HkcPickAppData/ChangeLog.txt file, we can see how many records have been saved (as shown below).

```
ChangeLog.txt - 记事本
文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)
[Start Run] HkcPick_1NewPick at: 22-Nov-2022 20:20:47
16 records generated!
[End Run] HkcPick_1NewPick at: 22-Nov-2022 21:22:51
第 4 行, 第 1 列    100%    Unix (LF)    UTF-8
```

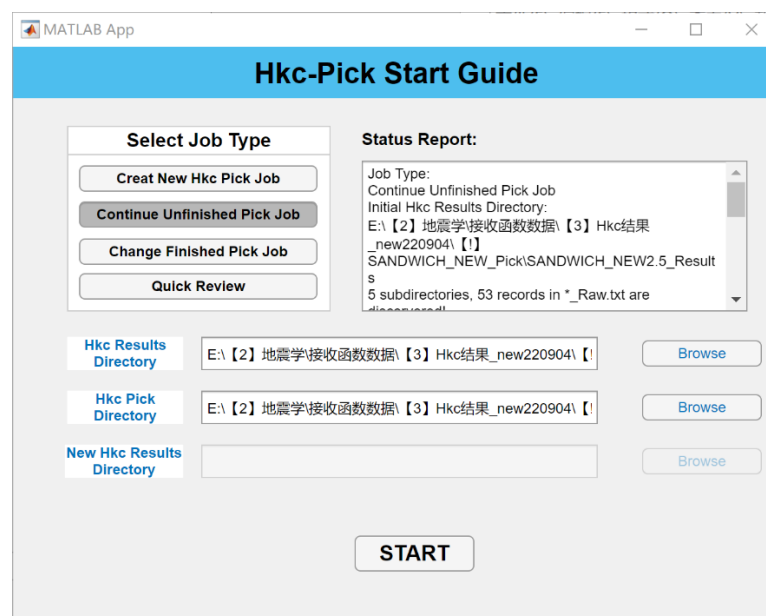
## 2.Continue an unfinished project

Sometimes there are too many stations in a single array to select all of them in one go, and we may need to exit and save our progress using the method described in the

previous section. When we **resume** selecting the remaining stations, we will need to use the method introduced in this section.

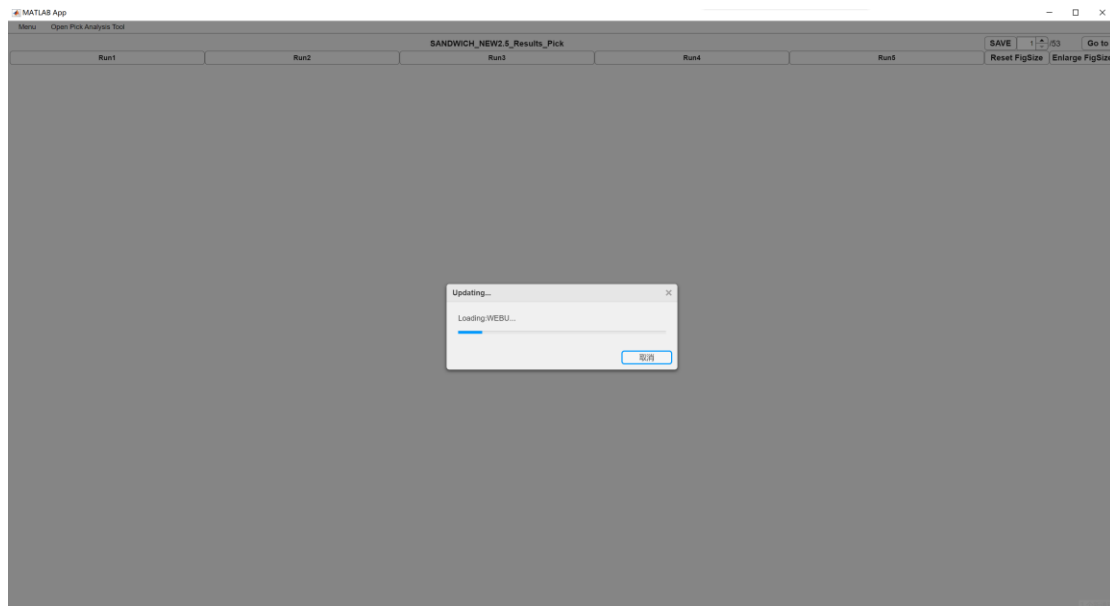
Select '**Continue Unfinished Pick Job**' as the **Job Type**. As in the previous section, we need to select the **data folder**. Additionally, to let the program know how many stations we have already picked, we also need to select the **Hkc Pick folder**. After completing these two selections, click the '**Start**' button to begin the program for continuing the picking process.

Note: **Hkc Pick folder** is the directory for saving all information that HkcPick code needs. It would be **automatically generated** after a new project is created (described in the previous section). The name of Hkc Pick folder is end with '\_Pick' as shown below.



INDEPTH4_C10R2_Results	2023/5/22 9:24
INDEPTH4_Results_Pick => <b>Hkc_Pick folder</b>	2023/3/9 15:45
INDEPTH4_Screenshots	2023/2/21 22:45
INDEPTH4_F17R2_Results	2023/2/21 18:56
INDEPTH4_C12R2_Results	2023/2/21 18:15
INDEPTH4_C11C13R2_Results	2023/2/21 17:54
INDEPTH4_Results => <b>Original Data folder</b>	2023/2/20 22:52

To avoid forgetting which station we previously picked, the program will automatically **add 1** to the **total number of previously picked stations** to determine the current station being picked, and then import previously finished picks (i.e., the information saved in AllHkcPickData.txt). If there were any **omissions** in the previous picking process (i.e., some stations are skipped in the previous section), this step may encounter errors.



The remaining steps (e.g., saving a pick, exiting the program and so on) are the same as those in Section 1 'Create a new project'.

### 3.Modify the finished plan selections

Occasionally, the initial Hkc results may not meet our expectations. For instance, the searching range for harmonic parameters may not be appropriate for certain stations, or the reference crust model may deviate significantly from the actual crust. In such cases, we may need to adjust the relevant settings in the Hkc code and re-run the modified code. Once we have obtained the revised output from the Hkc code, we can **replace the previous plans** with the updated ones.

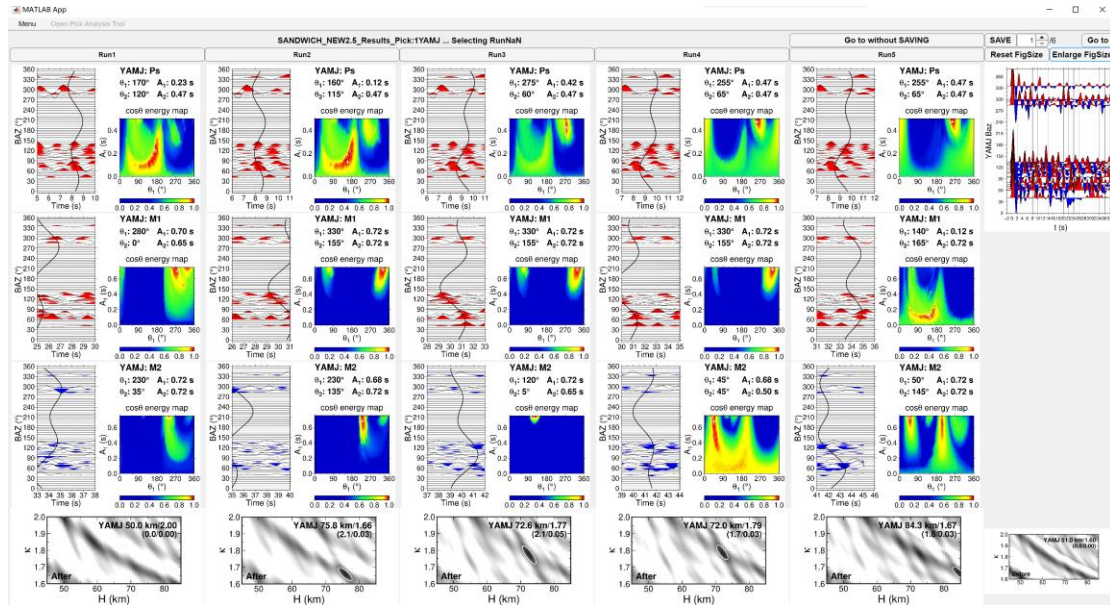
Select **Change Finished Pick Job'** as the **Job Type**. Similar to the previous section, we

need to select the **new data folder** (i.e., the new Hkc results used to substitute the old ones) and **Hkc Pick folder**. Note that we do not need to select the initial data folder in this step.



INDEPTH4_C10R2_Results	2023/5/22 9:24
INDEPTH4_Results_Pick => <b>Hkc_Pick folder</b>	2023/3/9 15:45
INDEPTH4_Screenshots	2023/2/21 22:45
INDEPTH4_F17R2_Results	<b>Substitutional</b> 2023/2/21 18:56
INDEPTH4_C12R2_Results	<b>Data folders</b> 2023/2/21 18:15
INDEPTH4_C11C13R2_Results	2023/2/21 17:54
INDEPTH4_Results => <b>Original Data folder</b>	2023/2/20 22:52

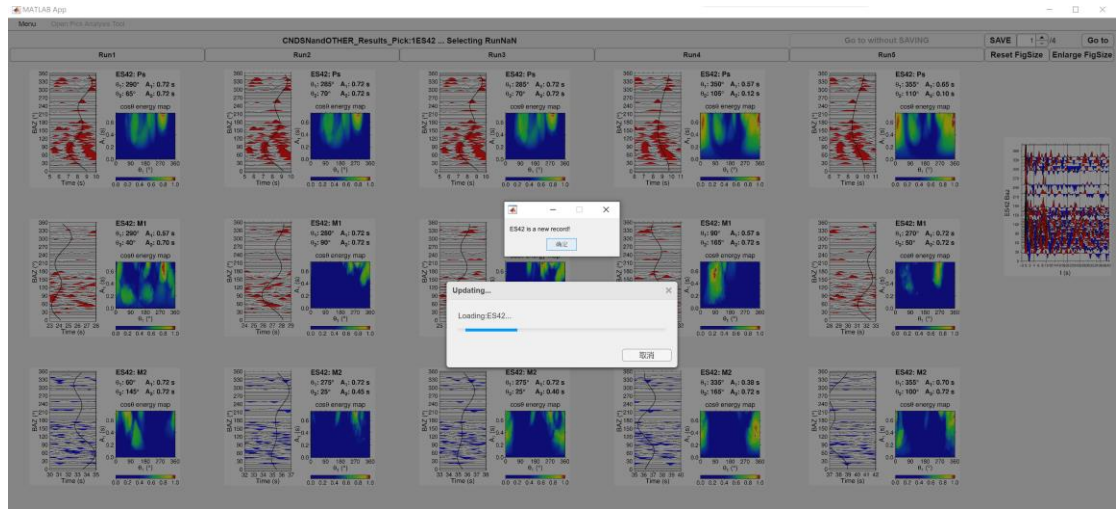
This UI panel is nearly identical to the "New Project" UI panel. If you think that the alternate results are still unsatisfactory and wish to proceed to another station without saving, select **"Go to without SAVING"**.



Please note that in this mode, the current results are **not** automatically integrated into the table. This could result in the current Pick not being included in the final results, if you forget to click "**SAVE**" (particularly when modifying only one station). To ensure that the current selection is included in the results, click "**SAVE**" in the upper right corner to integrate the current Pick into the table **first**, and **then** click "Save Results" under the MENU directory to save the table as a txt file. If you click "Save Results" without clicking "**SAVE**" first, the new results will **not** be integrated into the final AllHkcPickData.txt file.

Additionally, this mode allows for the **integration of new data** with the existing data.

In this case, a prompt will appear for the new data:

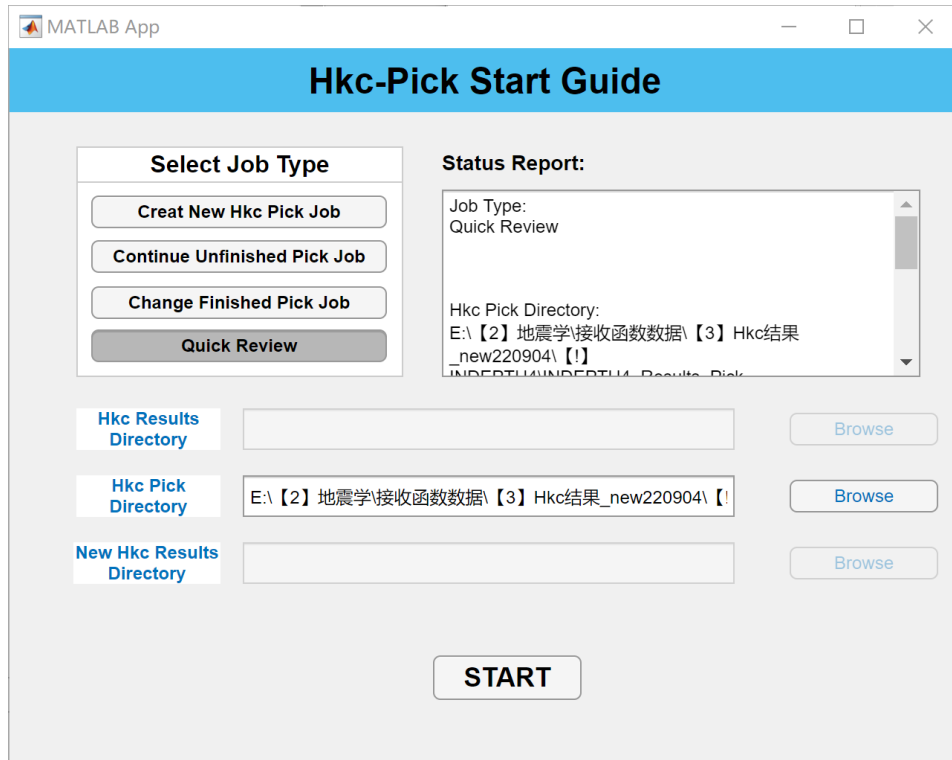


This feature should be used with caution. I have only tested the integration of a small amount of completely new data with existing data to ensure proper code functionality. I have not tested whether the code can properly integrate new data that contains both completely new data and changes to old data.

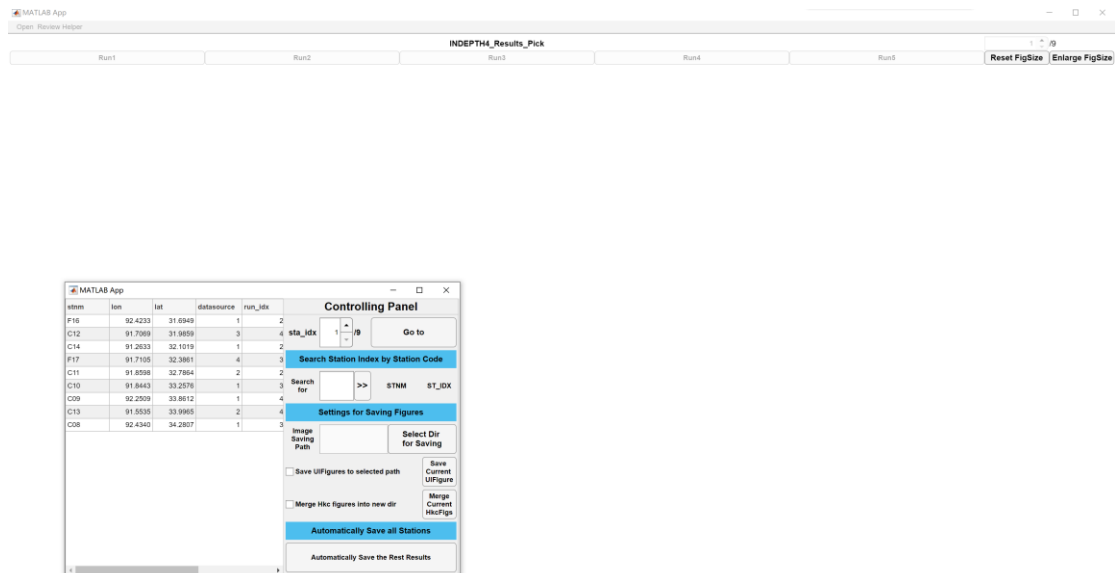
## 4. Quick review and generate plots

After successfully selecting Hkc solutions for all stations using Hkc\_Pick, we can use the functionality in this section to generate figures suitable for publication.





On the Hkc-Pick Start Guide interface, select "**Quick Review**" as the Job Type, and then choose the **Hkc Pick Directory**. Click "Start". Wait for the app to open. The resulting UI panel will look like the image below:



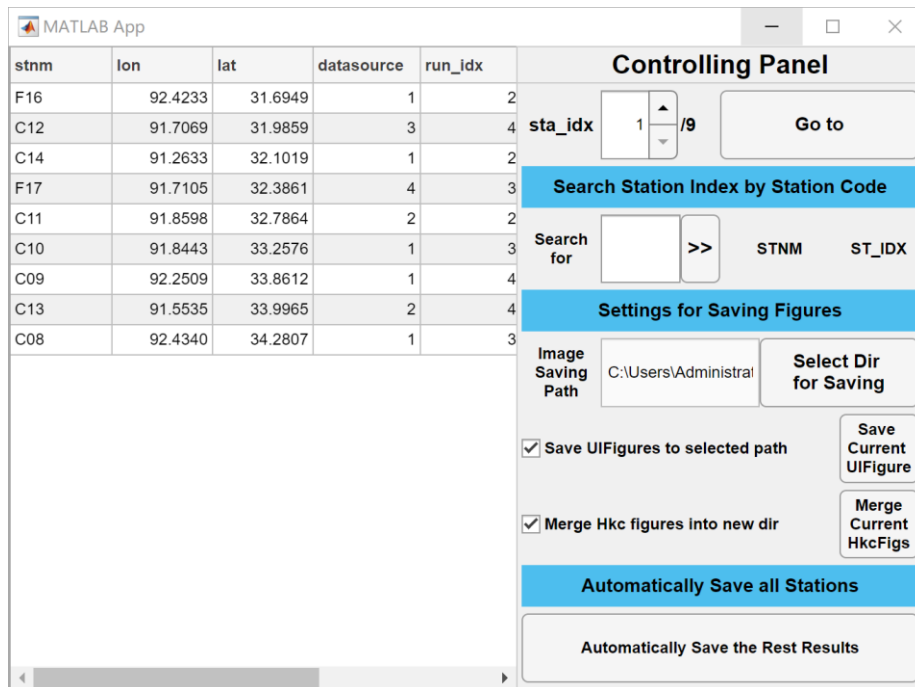
Most of our main operations are carried out in the small **dialogue UI panel**, while the large main UI panel is mainly used for display purposes.

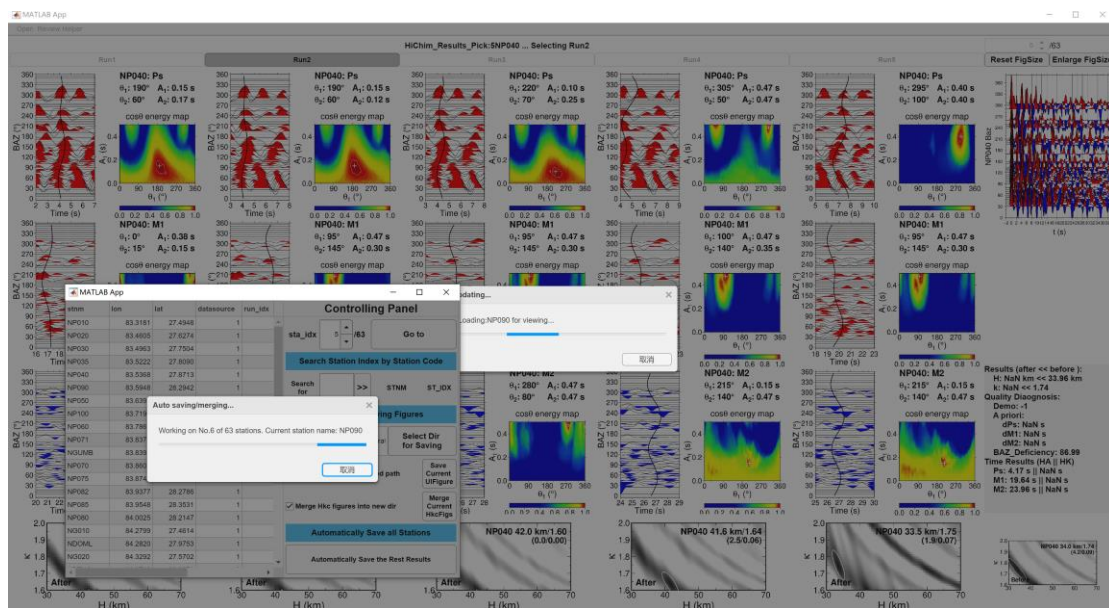
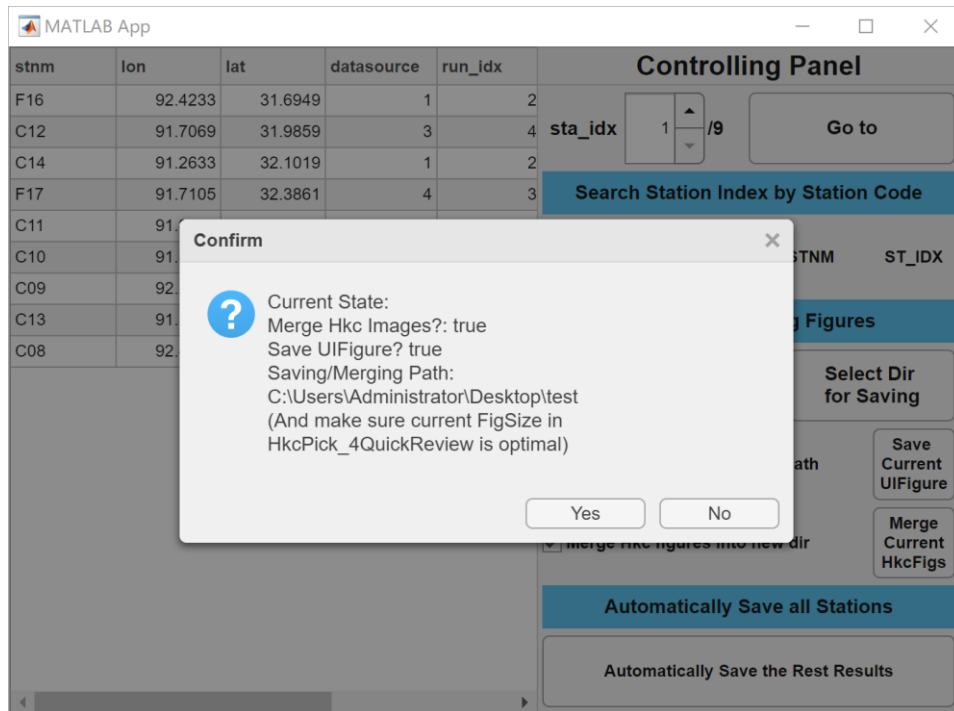
- (1) If you only need to **check** the picks of various plans in this app, you do not need to select the two checkboxes in "Settings for Saving Figures". Use the **spinner** and



"Go to" button to navigate to the desired result. If you do not know the station code of the station you want to check, you can **search** for it under "**Search Station Index by Station Code**" (enter the station name in the text box and click the ">>" button to display the search results).

- (2) If you want to **summarize figures** of all the results, select the two **checkboxes** in "**Settings for Saving Figures**" and **choose a folder** to store the summarized results. Before summarizing, check that the **image size** in the large main UI panel is optimal. By pressing "**Automatically Save the Rest Results**" button, we can let the program automatically summarize all the results.

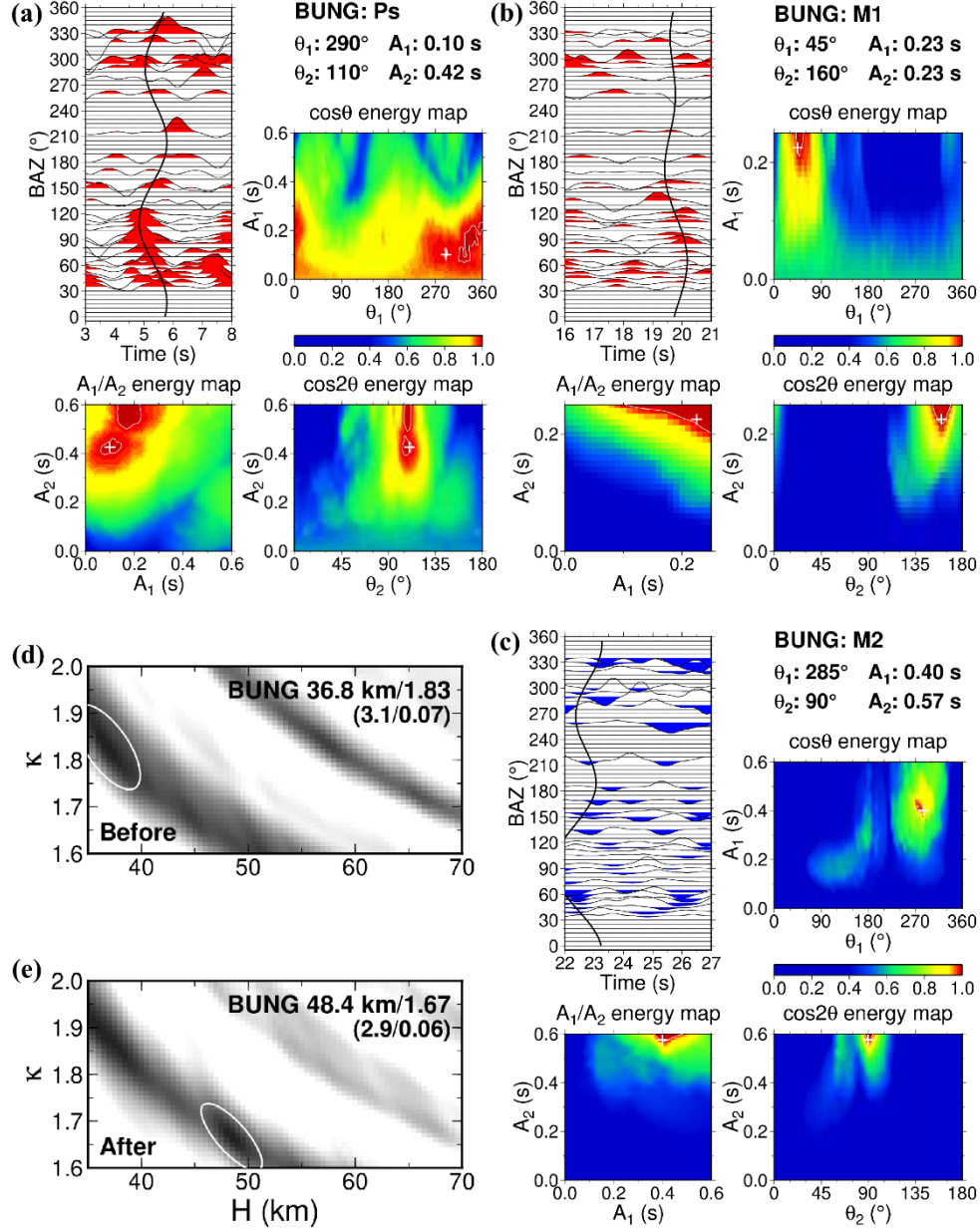




The results collected by the program are shown below, including screenshots of the Hkc-Pick UI panel (.png files), images of the selected Hkc results (stored in a folder), and a list of stations that were not collected successfully (the error message can be viewed with Matlab errordlg).

 SIND	2023/3/9 19:04	文件夹	
 SSAN	2023/3/9 19:05	文件夹	
 SUKT	2023/3/9 19:04	文件夹	
 THAK	2023/3/9 19:04	文件夹	
 TUML	2023/3/9 19:06	文件夹	
 XIXI	2023/3/9 19:04	文件夹	
 auto_fail.txt	2023/3/9 19:04	文本文档	1 KB
 BIRA.png	2023/3/9 19:06	PNG 文件	727 KB
 BUNG.png	2023/3/9 19:04	PNG 文件	803 KB
 DINX.png	2023/3/9 19:05	PNG 文件	722 KB
 GAIG.png	2023/3/9 19:05	PNG 文件	728 KB
 HILE.png	2023/3/9 19:06	PNG 文件	794 KB
 ILAM.png	2023/3/9 19:06	PNG 文件	769 KB
 JANA.png	2023/3/9 19:05	PNG 文件	593 KB
 JIRI.png	2023/3/9 19:05	PNG 文件	760 KB
 LAZE.png	2023/3/9 19:06	PNG 文件	720 KB
 MAZA.png	2023/3/9 19:06	PNG 文件	696 KB
 MNBU.png	2023/3/9 19:05	PNG 文件	647 KB
 NAIL.png	2023/3/9 19:05	PNG 文件	645 KB
 NAMC.png	2023/3/9 19:05	PNG 文件	525 KB
 NBIRA.png	2023/3/9 19:06	PNG 文件	613 KB

Afterwards, the **HkcPick\_GetMergedImagesForPublishing\_ALL.m** code in the **HkcPickTools** directory can be used to merge the separated figures into an integrated figure that is suitable for publication. If you are not satisfied with the merging effect, you can adjust it using **HkcPick\_GetMergedImagesForPublishing\_ONETESTING.m**. This code is for merging figures at a single station. Therefore, it is much more suitable for testing.



## S1. Hkc\_Pick Tools

A subdirectory HkcPickTools is in the Hkc\_Pick package. It provides some useful tools while you are handling the results of Hkc\_Pick. Here is the brief introduction to these tools:

### (1) HkcPick\_CalculateMeanForObservationsAtTheSameStation.m

This code is used for calculating the mean value if the same station presents multiple times in your final result. To examine whether two records are at the

same station, this code checks both location and station code.

(Sometimes, the GMT module blockmean may be more convenient in handling such situation.)

**(2) HkcPick\_ChangePickByCommand.m**

This code changes the Picks of previous results by command. To use this code, copy it to the folder that contains AllHkcPickData.txt and then run it.

**(3) HkcPick\_GetMergedImagesForPublishing\_ALL.m**

This code generates batch figures for publication. The summarized figures, as described in Section 4, are needed. To run this code, set the InputPath to be the path that containing all summarized figures. Be sure that all subdirectories in InputPath need to be the output of Section 4, and no additional subdirectories exist in that folder to avoid Bugs.

**(4) HkcPick\_GetMergedImagesForPublishing\_ONETESTING.m**

The same as HkcPick\_GetMergedImagesForPublishing\_ALL.m, but only plot one summarized figure for the first station. If you want to plot specific station, you can directly set variable one\_dir in this code to be the path of the expected station.

**(5) HkcPick\_hk2ttLineCalculation.mlapp**

Note: you need to run HkcPick\_AddPath.m before running this app.

A Matlab app that calculates variation of  $t_{PS}$ ,  $t_{M1}$  and  $t_{M2}$  with respect to Hk solutions. This app is designed to check the reason for multiple local extrema in Hk energy map, by locating their corresponding energy source in Receiver Function. However, this app is less used in my practice, because I find that using HkcPick\_TimeSeperation.m directly is much easier.

**(6) HkcPick\_MergeHkcResults.m**

This code extracts and summarizes Hkc results from multiple Hkc projects. To run this code, you need to set variables fileloc to be the path of Hkc result file, i.e., the AllHkcPickData.txt in each project.

You can set the output format to make it more suitable for postprocessing.

**(7) HkcPick\_TimeSeperationCalculation.mlapp**

Note: you need to run HkcPick\_AddPath.m before running this app.

An UI interface for HkcPick\_TimeSeperation.m

It may be more convenient to run HkcPick\_TimeSeperation.m in the command line directly.

**(8) HkcPick\_tt2hkCalculation.mlapp**

This app can be executed independently without running HkcPick\_AddPath.m.

This is because built-in time separation calculating functions already exist in this app. However, if you want to change reference  $Vp$  or ray parameter  $p$ , you need to change them in Matlab app designer, as well.

This app calculates energy strips for given times. It is useful in determining the reference crust model according to Receiver Function waveform, if too many local extrema occur in Hk energy map.

**(9) m\_map\_CheckPsTime.m**

Note: you need to install m\_map in advance before running this code.

This code is an example code for identifying  $t_{PS}$  outliers by calculating the difference between  $t_{PS}$  from Receiver Function and  $\tilde{t}_{PS}$  from interpolation.

**(10) m\_map\_GetHkcDiscussStations.m**

Note: you need to install m\_map in advance before running this code.

This code is designed for manual checking of Picks. It filters data by user-defined criteria, and then plot stations on the map.

## **S2. Possible Bugs**

**(1) Figure size and figure enlargement:**

I have tested the Matlab apps on my PC, which has a resolution of  $3840 \times 2160$ . However, it is possible that the display of figures may not be optimal on other PCs. To

achieve the best visualization on your PC, you can adjust the figure clip parameters (i.e. UP, DW, LF, RF, UPhk, etc.) and figure enlargement parameters in the EnlargeHA and Enlargehk functions until a satisfactory display is achieved.

Note: you can find these parameters in Matlab App Designers.

**(2) Absence of Hkc outputs:**

Occasionally, the Hkc code may fail when running certain stations. In this case, blank records for these stations will be summarized in the outputs, while the station list still includes these stations. When Hkc\_Pick encounters this situation, it may not run successfully. However, you can check these stations separately and merge them into the main results using the methods described in Section 3.

**(3) Multiple txt file in data directory:**

The Hkc\_Pick apps require the station list file to obtain basic information. The file that records the station list is formatted as  $\{\text{HkcProjectName}\}_{\text{Raw.txt}}$ . However, in the early stages of designing Hkc\_Pick, I only filter the station list file by the .txt suffix. This can cause errors if multiple .txt files exist in the data directory, as Hkc\_Pick may not read the file list correctly.

**(4) Matlab version:**

Hkc\_Pick is developed and tested in Matlab R2021a.