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2. Introduction

UPAT_PRINT_LIST accesses, analyses and outputs evaluation data from scans of XtremeCT series. Analysis involves optional matching of common slices between baseline and follow-up measurements, and calculation of percentage variations of evaluation values over time series. Evaluation type and Group code are also matched. The program only extracts results from the database, and does not alter it. The following functionalities are provided:

- List for analysis in spreadsheet
 - Baseline data for one patient or multiple patients
 - Data from multiple measurements for one patient or multiple patients
- Print
 - Baseline data for single patient
 - Data from multiple measurements for single patient
- Show in terminal/web browser
 - Baseline data for single patient
 - Data from multiple measurements for single patient

3. Matching Measurements

Matching procedure involves the definition of

- Baseline measurement, and its `site code`
- Amount of follow-up measurement to include in the output
- Common region of interest
- Evaluation type
- Group code

Advanced options can be used to restrict the dataset to be exported, by using measurement dates, evaluation dates, image quality... (See §8 - "Measurement Selection")

3.1 Slice Matching

The program automatically determines baseline measurements, and their corresponding site codes. When follow-up measurements with the same site code exist, the program determines the common region of interest across all the measurements based on the total cross sectional area of the baseline measurement.

The required slice shift to register areas versus the baseline measurement is interpolated for each measurement. Then results are compared in the determined common region.

This process can be disabled by specifying `-nomatch` on the command line (see §5) or disabling slice matching in advanced mode (see §6.4).

3.2 Evaluation Type Matching

Matching now also accounts for `Evaluation Type`. This parameter allow for coexistence of different sets of results in the database for each measurement. In earlier versions, every repeated analysis would override the existing entry, and only the very last entry would be seen by the program.

With the `Evaluation Type`, it is now possible to have different datasets coming from different evaluations accessible in the database.

- 1 : Disabled
- 2=4 : Direct densities and TbN only, as on XtremeCT I
- 3 : Disabled
- 5 : Direct Trabecular Bone evaluation
- 6 : Direct Cortical Bone evaluation

Addition of new evaluation types may be the object of future updates of the program.

3.3 Group Code Matching

The concept of `Group Code` has been introduced. This code adds one more level of flexibility to the database handling, and the way it is used can be versatile. By default, all evaluation would receive the group code 0.

Here are some examples of how `Group Code` can be used:

- `Group Code` can separate results by studies. Subjects from Study A may be specified to have the `Group Code=1`, on another hand subjects from Study B may have `Group Code=2`. Then to export data from Study A only, `Group Code=1` would be specified, and so on.
- `Group codes` can be used for study involving variations in evaluations, like a study using a different segmentation method for example. `Group Code=0` would stand for standard evaluation, and `Group Code=20` may be set for the results using the alternative method.
- `Group codes` can differentiate scans of the same limb, but done at a different location. By definition the site code is identical, but still distal and proximal scans should not be matched for example. In such a case, evaluations for a standard distal tibia should have `Group Code=0`, when proximal tibia could have `Group Code=10`.

As the Group Code can see different uses, it is the user's responsibility to keep track of the local Group Code definitions.

To use Group Code, it must be specified in the evaluation scripts accessible in the Evaluation Program. One can add a number ahead of the Project Name. Figure 3-1 and 3-2 illustrate how to add/change a Group Code in evaluation scripts. Evaluation scripts with different Group codes should be renamed explicitly and Saved as New scripts.

Figure 3-1 Standard Evaluation script, without Group Code (i.e. Group Code = 0)

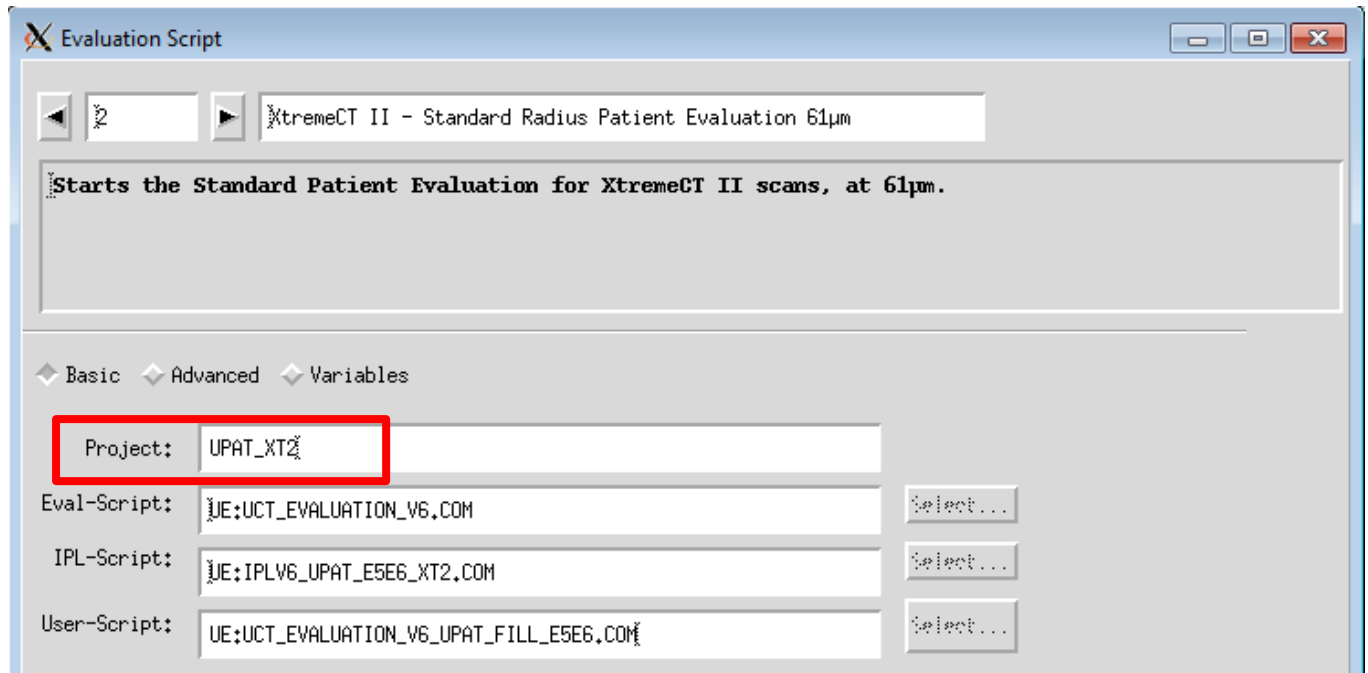
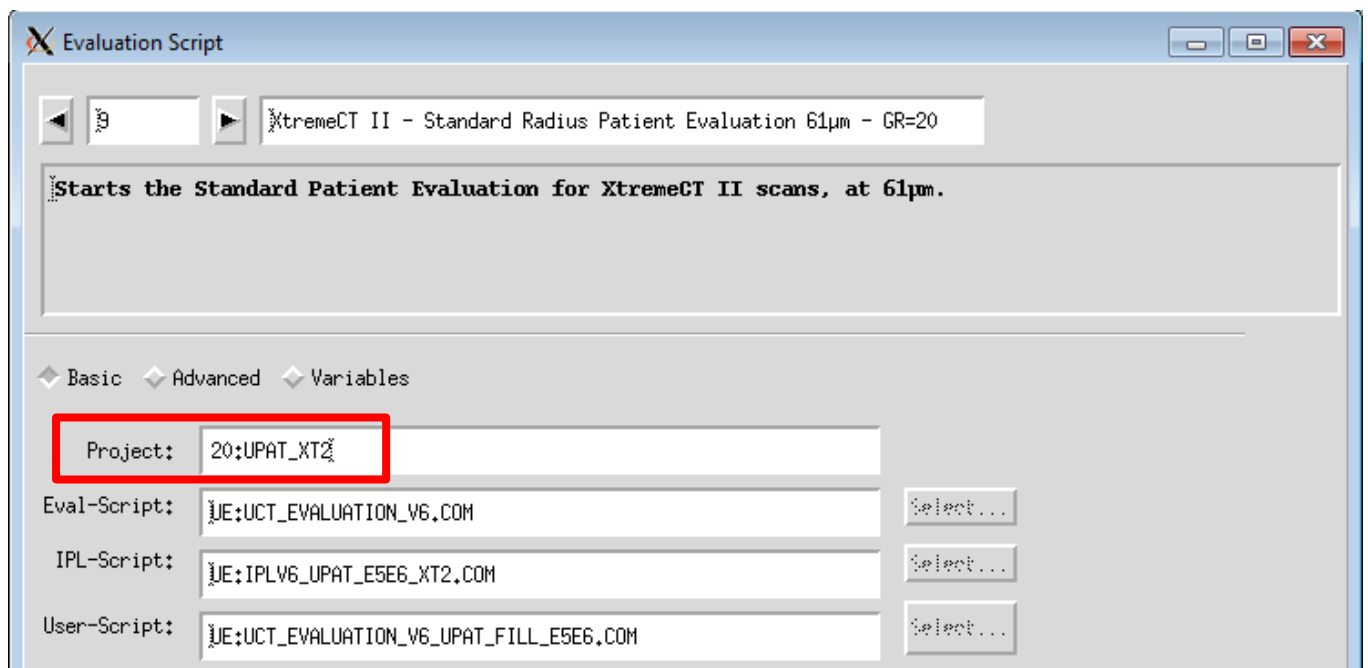


Figure 3-2 Evaluation script with Group Code 20 added in the Project Name.

Notice the format : GroupCode:ProjectName



4. Modes

Three modes are supported by UPAT_PRINT_LIST (Table 4-1) to simplify automatic selection of default parameters.

Table 4-1 Run modes

Mode	Features
List	- List matched evaluation data in space-separated text file suitable for import into spreadsheet - Single text file can hold data from multiple patients, multiple measurement sites - Patient number range allows single or multiple patients to be specified - Measurement site can be specified (RL, RR, R*, TL, TR, T*, CU) or all sites (*) exported - Date range for last measurement (evaluation) can be specified to allow listing of only up-dated patient records - Template text file must include \\STARTLIST// and \\ENDLIST// tags to allow listing of data for multiple patients, multiple measurement sites
Print	- Print baseline or matched follow-up data at single measurement site of one patient - Measurement site must be specified (RL, RR, TL, TR, CU) - Multiple copies can be printed - Postscript output also saved in disk file - If data from multiple patients and/or multiple measurement sites is required, program must be run several times (using DCL script) - Selects template file in Postscript format by default, user can select text template manually
Show	- Show baseline or matched follow-up data at multiple measurement sites for multiple patients - Measurement site can be specified (RL, RR, R*, TL, TR, T*, CU) or all sites (*) exported - Output can be saved to disk file - If data from multiple patients and/or multiple measurement sites is required, program must be run several times (using DCL script) - Template in readable text format selected by default, user can select alternative template if desired

These modes are selected either interactively or by using command line switches:

- `-list` for generating output for spreadsheet analysis
- `-print` for generating Postscript output for printing
- `-show` for generating text output for reading in a web browser or terminal

5. Command line arguments

UPAT_PRINT_LIST also recognizes the command line arguments listed in

Table 5-1. If at least one of these arguments is specified, UPAT_PRINT_LIST does not prompt for user input.

Table 5-1 Standard Command Line Arguments

Argument	Description	Default
-b=<pat_id>	Index of first patient in study group	1
-e=<pat_id>	Index of last patient in study group	Depends on mode: in print mode, index of first patient; in list and show modes, index of last patient in database
-s=<site_code>	Measurement site (radius left=RL; radius right=RR; either radius=R*; tibia left=TL; tibia right=TR; either tibia=T*; custom=CU; all=*)	Depends on mode: in print mode, RL; in show and list modes, *
-et=<eval_type>	Type code of evaluation (4=XT I, 5=trabecular, 6=cortical, default = 4)	4
-gr=<group_code>	Group code of evaluation, default = 0 use a unique code (1 to n) to group/select a set of results	0
-mb=<begin_date>	Measurement period, see 8.1. Only data for patients measured during specified time period are exported.	Date of earliest measurement in database
-me=<end_date>		Current date
-f=<#_follow-ups>	Maximum number of follow-up measurements to include during matching. (0 => baseline only)	19 (maximum allowed for matching)
-t=<template_file>	Name of template file as either logical or file spec.	Depends on mode, see 7
-o=<output_file>	Name of output file	Depends on mode
-c=<#_copies>	Number of copies to send to printer (0 => print-to-file only)	0 (list + show modes); 1 (print mode)
-v=<verbosity>	Level of information to display in terminal (silent = 0; normal = 1; debug = 2)	0
-h	Show help and exit	N/A

Table 5-2 Advanced Command Line Arguments

Argument	Description	Default
-eb=<begin_date>	Evaluation period, see 0. Only data for patients evaluated during specified time period are exported.	Date of earliest measurement in database
-ee=<end_date>		Current date
-tb=<begin_date>	Matching period, see 0. Only samples measured during matching period are included in matching.	Date of earliest measurement in database
-te=<end_date>		Current date
-sk=<#to_skip>	Number of measurements to skip during matching. Determines baseline measurement.	0
-m=<meas_list>	Numbered List of measurements to take, e.g. 0,1,2,5,8	0-19
-nomatch	Do not match follow up measurement, just take all slices	N
-nc	Do not check energy, intensity and segmentation parameters	N
-sb	Begin of Slice Range in % to be evaluated	0
-se	End of Slice Range in % to be evaluated	100
-q	Only take evaluations with quality better than (and including) this. If positive number: all scans of better quality (incl. this) as well as all non-graded scans are taken.	100
-qs	Only take Structural evaluations with quality better than (and including) this. Thus: between -qd and -q: only Density results are printed. Parameter is disregarded if -qs >= -q	0
-ut=<code_for_unit_type>	0=>default; 1=>linatt; 2=>mg HA/ccm; 3=>HU	0
-cd=<density>	Density of compact materials.	1200.00

Important: The -nc argument should be used with precaution.

The program is usually checking that the parameters used during the evaluation are consistent over all measurements. If one or more parameters are inconsistent, the program produces an error.

There is one typical case where one can wish to bypass those consistency checks: that is when a user has measurements for the same subject from both XtremeCT I and XtremeCT II collected in the same database, and wishes to compare them as follow-up measurement.

6. Interactive

If none of the command line arguments listed in

Table 5-1 (with the exceptions of `-h` and `-v`) is specified, UPAT_PRINT_LIST runs interactively.

If the mode was not specified on the command line, the user is prompted for a selection. The default option is list mode.

```
Program: upat_print_list V2.0
Started: 15-JUL-2015 13:39:23.66
Mode (1 = list, 2 = print, 3 = show) [1]:
```

6.1 List mode

In list mode, the user can select multiple patients and multiple measurement sites.

```
$ upat_list
Program: upat_print_list V2.0
Started: 15-JUL-2015 13:39:23.66
Mode (1 = list, 2 = print, 3 = show) [1]: 1First patient # (found 1-120) [1]:
Last patient # (found 1-120) [120]:
Site (RL RR R* TL TR T* CU *) [*]:
Evaluation type (1-6) [4]:
Group Code [0]:
Start of measurement period [13-MAY-2004]:
End of measurement period [24-MAR-2005]:
Start of evaluation period [13-MAY-2004]:
End of evaluation period [24-MAR-2005]:
Start of matching period [13-MAY-2004]:
End of matching period [24-MAR-2005]:
# measurements to skip (min=0) [0]:
Maximum # of follow-ups (0-19) [19]:
List of Meas. of Follow-Ups (list with either comma or dash) [0-19]:
Disable slice matching (y/n) [n]:
Disable consistency checks (y/n) [n]:
Unit type (0=default, 1=linatt, 2=mg HA/ccm, 3=Hounsfield) [0]:
Compact density in mg HA/ccm [1200.000]:
Quality grading cut-off (neg. to exclude also non-graded scans) [100]:
Quality grading for Structure cut-off [0]:
Begin of Evaluated Slice Range in Percent [0.000]:
End of Evaluated Slice Range in Percent [100.000]:
Template file [UPAT_LIST_SHEET]:
Output filename [SYS$SCRATCH:UPAT_PATS_E4_1_TO_120_ALL_SITES.TXT]:
```

- User can select alternative template files to customize data listed.
- Output files are written into SYS\$SCRATCH unless user specifies an alternative directory.

6.2 Print mode

In print mode, the user can only select one patient and measurement site.

```
$ upat_list
Program: upat_print_list V2.0
Started: 15-JUL-2015 13:46:16.98
Mode (1 = list, 2 = print, 3 = show) [1]: 2
Patient # (found 1-120) [1]:
Site (found RL RR TL TR CU) [RL]:
Evaluation type (1-6) [4]:
Group Code [0]:
Start of matching period [13-MAY-2004]:
End of matching period [24-MAR-2005]:
# measurements to skip (min=0) [0]:
Maximum # of follow-ups (0-19) [19]:
List of Meas. of Follow-Ups (list with either comma or dash) [0-19]:
Disable slice matching (y/n) [n]:
Disable consistency checks (y/n) [n]:
Quality grading cut-off (neg. to exclude also non-graded scans) [100]:
Quality grading for Structure cut-off [0]:
Begin of Evaluated Slice Range in Percent [0.000]:
End of Evaluated Slice Range in Percent [100.000]:
Unit type (0=default, 1=linatt, 2=mg HA/ccm, 3=Hounsfield) [0]:
Compact density in mg HA/ccm [1200.000]:
Template file [default]:
Output filename [SYS$SCRATCH:UPAT_PAT_E4_1_RL.PS]:
# copies [1]:
```

- Only single patient, single site supported.
- Default template selection is based on number of follow-up measurements found (see 7.1).
- User can select alternative template files to customize data printed. The template should be matched to the number of measurements.
- Output file is written into SYS\$SCRATCH by default, user can select new path at prompt. PostScript output is saved to file regardless of number of copies requested.
- Specified number of copies sent to default printer (SYS\$PRINT). If number of copies greater than 0, Postscript files will be deleted after printing.

6.3 Show mode

In show mode, the user can select multiple patients and measurement sites.

```
$ upat_list
Program: upat_print_list V1.2
Started: 24-MAR-2005 13:41:39.05
Mode (1 = list, 2 = print, 3 = show) [1]: 3
First patient # (found 1-120) [1]:
Last patient # (found 1-120) [120]:
Site (RL RR R* TL TR T* CU *) [*]:
Evaluation type (1-6) [4]:
Group Code [0]:
Start of measurement period [13-MAY-2004]:
End of measurement period [24-MAR-2005]:
Start of evaluation period [13-MAY-2004]:
End of evaluation period [24-MAR-2005]:
Start of matching period [13-MAY-2004]:
End of matching period [24-MAR-2005]:
# measurements to skip (min=0) [0]:
Maximum # of follow-ups (0-19) [19]:
List of Meas. of Follow-Ups (list with either comma or dash) [0-19]:
Disable slice matching (y/n) [n]:
Disable consistency checks (y/n) [n]:
Quality grading cut-off (neg. to exclude also non-graded scans) [100]:
Quality grading for Structure cut-off [0]:
Begin of Evaluated Slice Range in Percent [0.000]:
End of Evaluated Slice Range in Percent [100.000]:
Unit type (0=default, 1=linatt, 2=mg HA/ccm, 3=Hounsfield) [0]:
Compact density in mg HA/ccm [1200.000]:
Template file [UPAT_SINGLE]:
Output filename [SYS$OUTPUT]:
```

- User can select alternative template files to customize data shown.
- Output is written to SYS\$OUTPUT, user can specify new path if desired.
- Verbose output is suppressed by default.

6.4 Advanced options

Advanced options, shown above in grey, are enabled when `-advanced` is specified on the command line. `-advanced` is ignored when other command line arguments (0) are supplied (with the exception of `-v`).

7. Template selection

If the template file is not specified directly, the template is selected based on both the specified mode, and the evaluation type.

7.1 List mode

List mode uses a single template that supports export of baseline + 19 follow-ups for multiple patient records (VMS logical: upat_list_sheet).

7.2 Print mode

Print mode templates support export of matched data for a single patient record. The number of valid measurements for a patient record is counted and the template selected to accommodate the measurements. See Table 7-1.

Table 7-1 Automatic template selections in print mode

Number of measurements	Template (VMS logical)
$n \leq 1$	Baseline and 3D image (upat_eval_sheet_baseline)
$2 \leq n \leq 5$	Baseline + 4 follow-ups (upat_eval_sheet05)
$6 \leq n \leq 10$	Baseline + 9 follow-ups (upat_eval_sheet10)
$11 \leq n \leq 15$	Baseline + 14 follow-ups (upat_eval_sheet15)
$16 \leq n \leq 20$	Baseline + 19 follow-ups (upat_eval_sheet20)

7.3 Show mode

Show mode uses a single template that supports export of baseline + 19 follow-ups for a single patient record (VMS logical: upat_single). However, the template is text only and can be written repeatedly into a single output file.

8. Measurement selection

By default, all evaluated measurements for each patient record (1 record per patient + measurement site) are matched and exported. The following options allow control of record and measurement selection.

8.1 Limiting number of follow-up measurements

The number of follow-up measurements matched to the baseline can be limited explicitly by setting the maximum number of follow-up measurements. Once the maximum number of follow-up measurements has been matched for a patient record, remaining measurements are ignored. See Figure 8-1Error! Reference source not found..

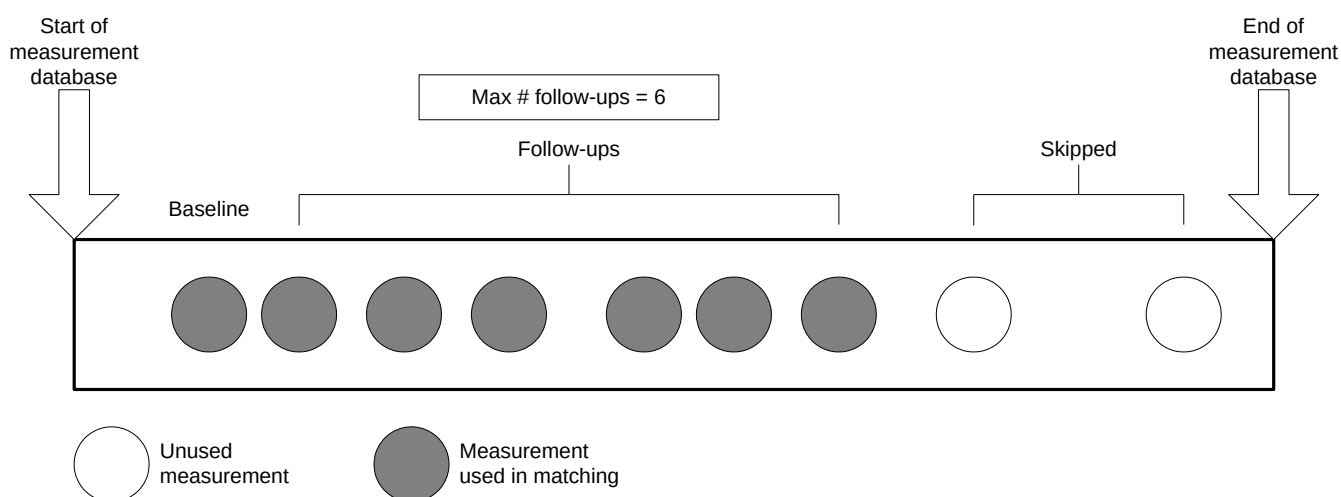


Figure 8-2 Setting the maximum number of follow-up measurements limits the number of measurements matched to the baseline.

8.2 Measurement period

Only data for patient records measured within the specified measurement period are exported. In this context, patient record refers to a single measurement site for a single patient. With all other parameters at their default values, all measurements are matched for records updated within the update period. See Figure 8-3. The measurement period is only relevant when selecting data from multiple patient records.

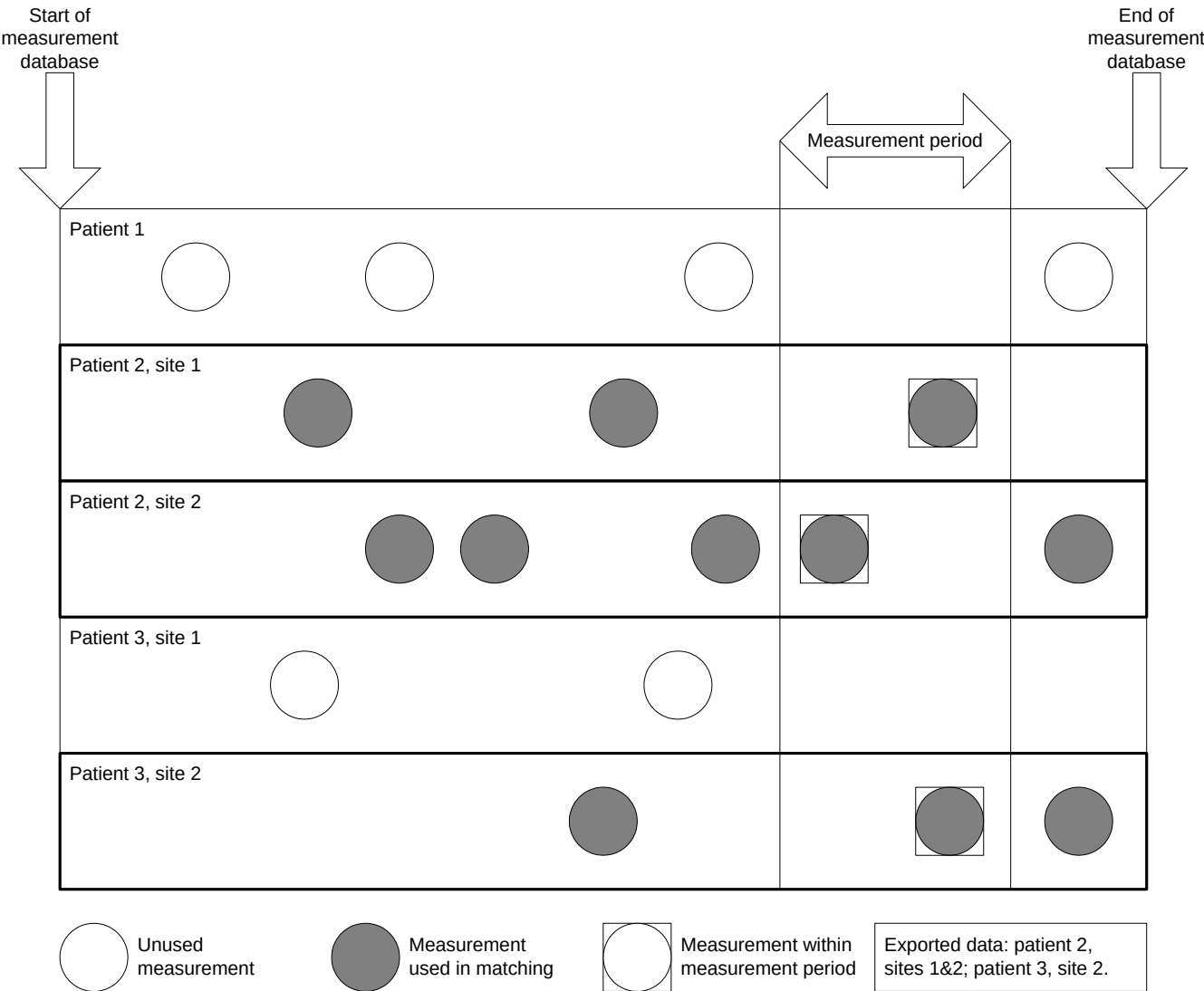


Figure 8-3 Only patient records with measurements made during the measurement period are matched. Both measurement sites for patient 2 and site 2 for patient 3 were remeasured, and the data for all measurements in these records are matched. The records for patient 1, for whom only a single site is measured, or site 1 for patient 3 were not measured, and no matching is performed for these records.

8.3 Advanced: Evaluation period

If an evaluation period is specified, only matched data from patient records evaluated during the specified period are exported. The evaluation period allows exporting results of newly evaluated patient records.

8.4 Advanced: Matching period

Only measurements made within the specified matching period are considered for matching, i.e. the measurement was made between the start and end dates of the period. The matching period is specified using date strings in VMS (e.g. 01-JAN-2005). Measurements made on the specified days are considered to be within the measurement period. See Figure 8-4.

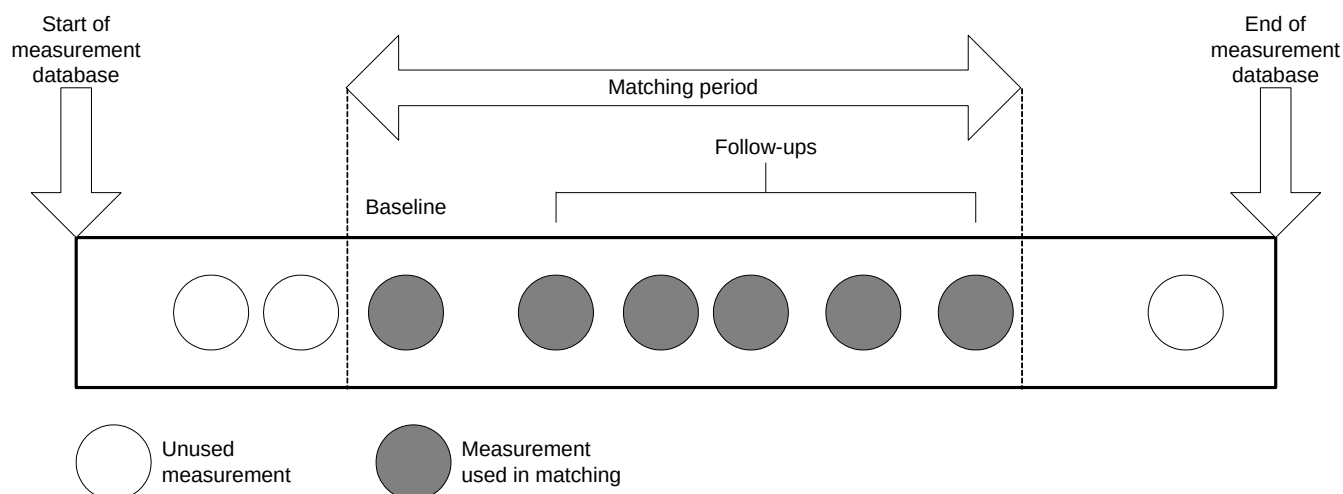


Figure 8-4 Only measurements within the matching period are matched

8.5 Advanced: Skipping measurements

The measurement used as baseline during matching can be explicitly offset by setting the number of measurements to skip. Skipped measurements are not matched. See Figure 8-5.

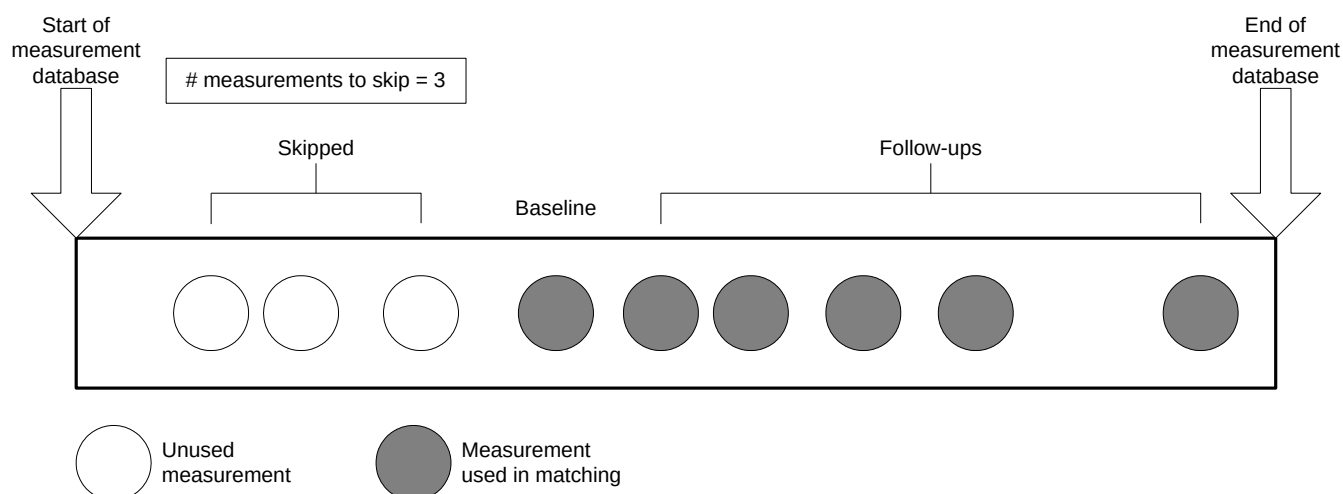


Figure 8-5 Explicitly skipping measurements discards older measurements, offsetting the baseline used during matching.

8.6 Advanced: Combining measurement selection parameters

Figure 8-6 shows the effect of combining measurement selection parameters.

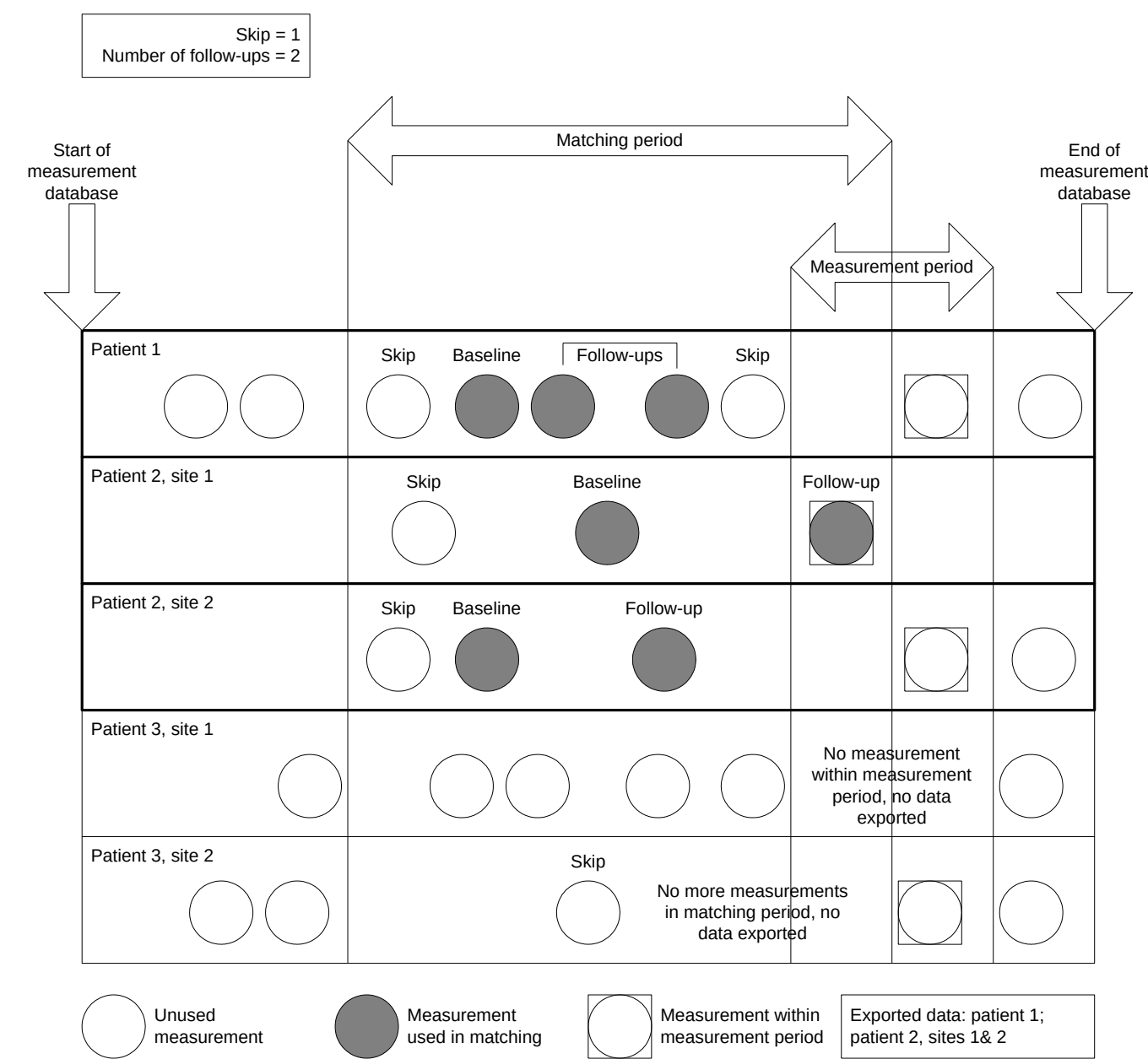


Figure 8-6 Measurement selection parameters can be combined to provide precise selection of matched measurements.