DICOM Services using Orthanc
And
Beth Israel Plugins for Fiji

Quick User Guide

http://petctviewer.org/

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In this user guide we will see how to benefit from a lot of DICOM services such as:

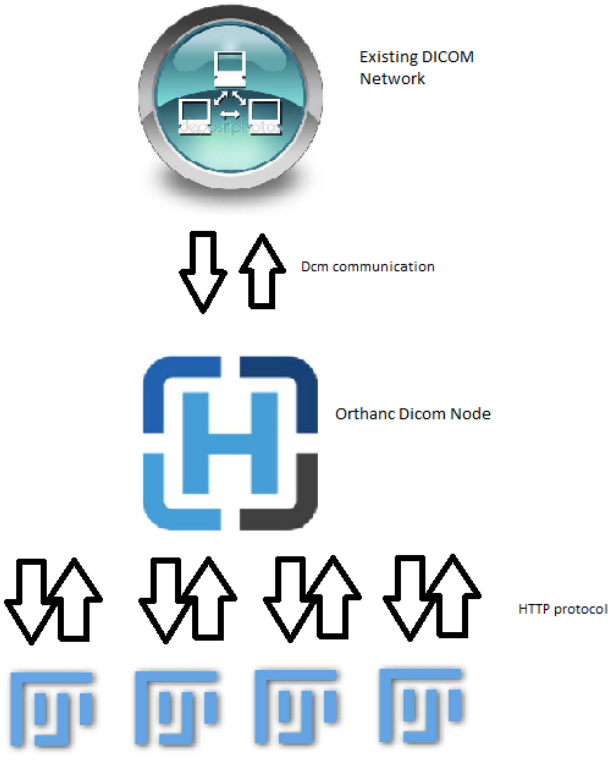
- PACS storage / Dicom Import
- DICOM Anonymization
- DICOM Edition
- Query / Retrieve / DICOM communication
- Clean Export of datasets
- CD/DVD burning and automation with Epson PP100 Disc producer

- Using Fiji and Beth Israel PET/CT viewer, you will be able to transform any computer in a connected PET/CT workstation without any additional setup.

The global architecture has to be understood: the system rely on a DICOM server called Orthanc (http://www.orthanc-server.com/)

Orthanc server will be installed in one of your computer and will handle all requests to receive, query and send DICOM to your existing DICOM node (commercial workstation, PACS…).

Using BIdatabase plugin, you will be to connect Fiji to your Orthanc server to fetch image and review them with the PET/CT viewer. You will be able to connect several Fiji sessions to the same Orthanc server almost without limits.



Global architecture of Networking

I- Run Orthanc Server in your computer

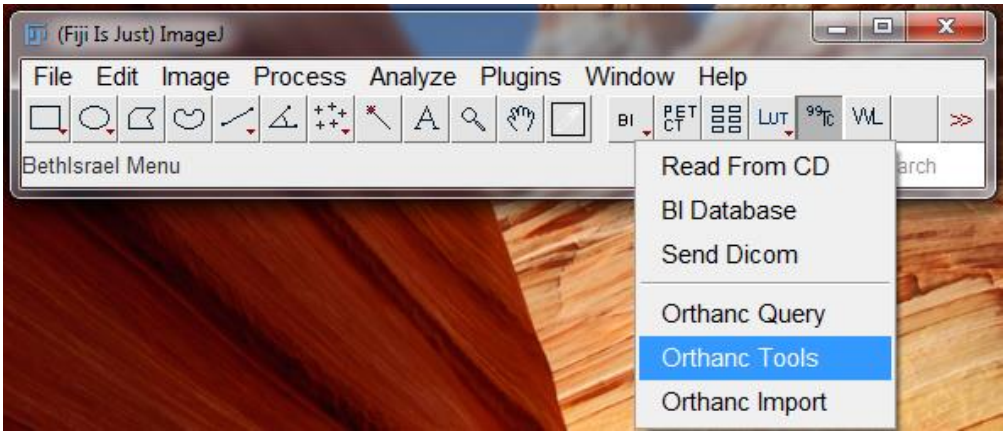
All these services rely on Orthanc Server, a free and open source PACS server that you can install and run in any computer (Windows / MacOS / Linux)

You have 3 ways to run Orthanc Server in your computer:

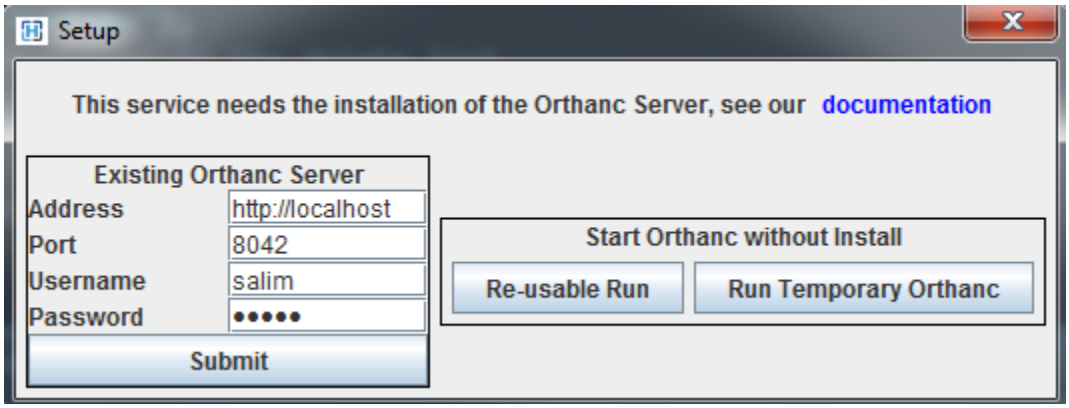
- A regular full install of Orthanc using officials distribution of Orthanc (See appendix : Install Orthanc for your computer)
- A light install of Orthanc directly from Orthanc Tools with 2 options
  - A re-usable run, that will keep in memory your DICOM from one run to another
  - A temporary run that will be auto removed at each exit.

For the light Install:

Open “Orthanc Tools”:



This Prompt will be shown:



Choose one of two options to run Orthanc without install:

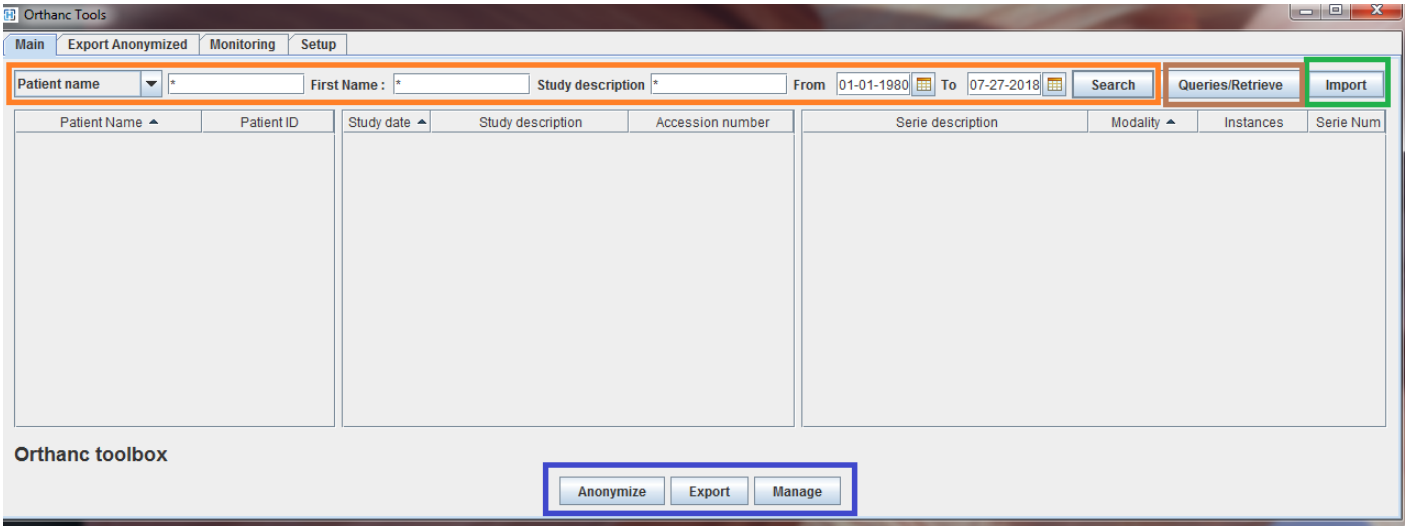
“Re-usable Run” to choose a directory in which Orthanc will stay ready for execution and received DICOM in keept in memory.

“Run Temporary Orthanc” to run a temporary session of Orthanc, once you will exit Orthanc Tool app, the Orthanc server will be destroyed.

After your selection Orthanc Tools will start, providing the full services of Orthanc.

Please note that if you intend to load a lot of DICOM and use it as daily application to store and process DICOM, we strongly recommend you to choose the full Orthanc install with Postgre/MySQL database as explained in the dedicated documentation (with this configuration you can run a full PACS able to store dozen of terabytes of DICOMs)

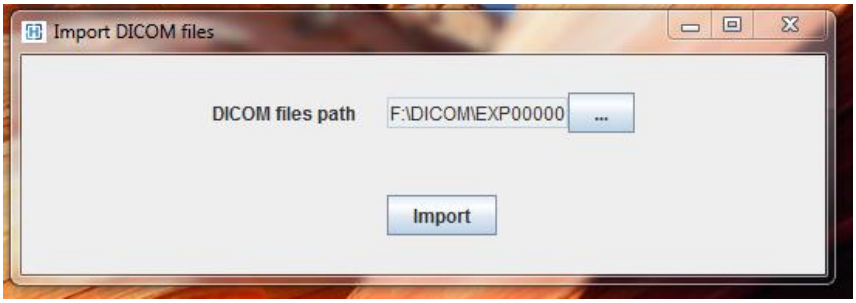
II- Use Orthanc Tools



Main Interface of Orthanc Tools Application

a. Import DICOM

Click on “Import” button to import a dataset of DICOM file. You will be prompted to choose a directory, this directory will be recursively scanned and all DICOM files inside it will be imported into Orthanc.



b. *Search stored DICOM*

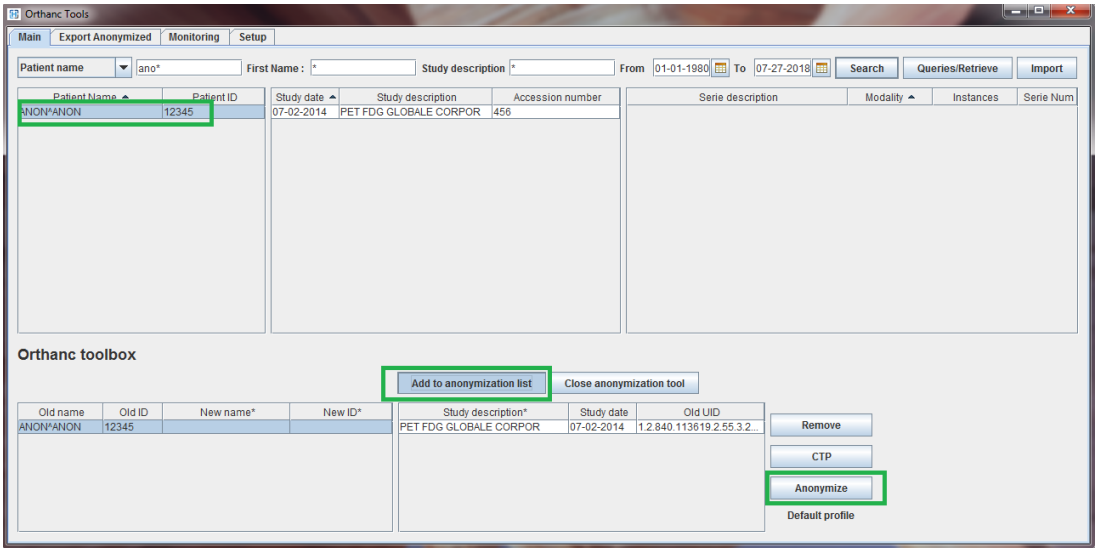
Use the search bar, to find a stored patient in Orthanc.
Use "*" to search for all patient without any filter.

c. *Anonymize*

Open the Anonymization Tool using the "Anonymize button"
Select a Patient or a Study to anonymize and click on "Add to Anoymization List"
You will this way build an anonymization list that will be anonymized by batch.
You can choose the new anonymized name and ID or let the software affect them.

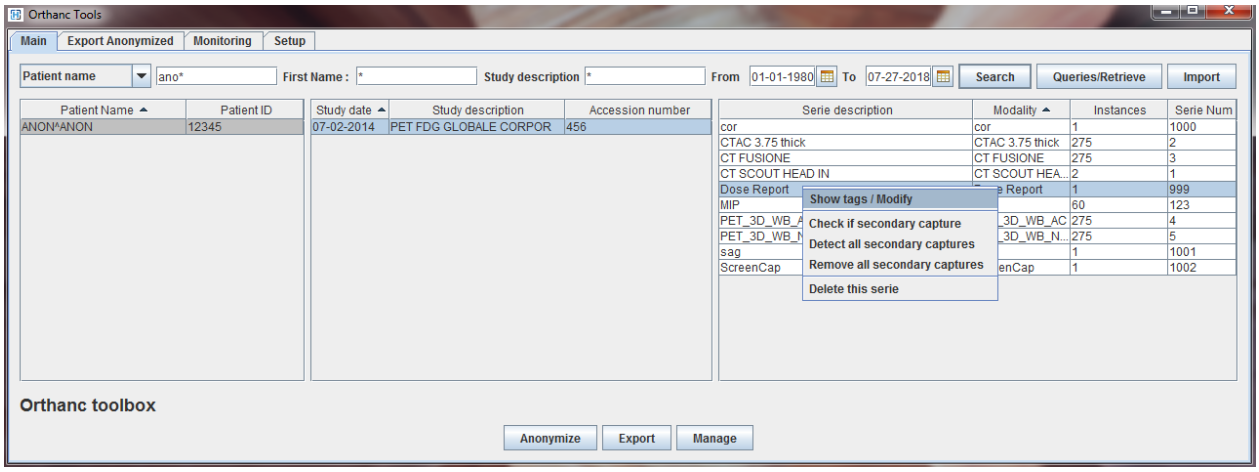
After the anonymization the software will show you the "Export Anonymized" tab in which you will find buttons to locally download the anonymized DICOM or send them to a remote server

For further explanation, [This feature has its own documentation available in our website](#).

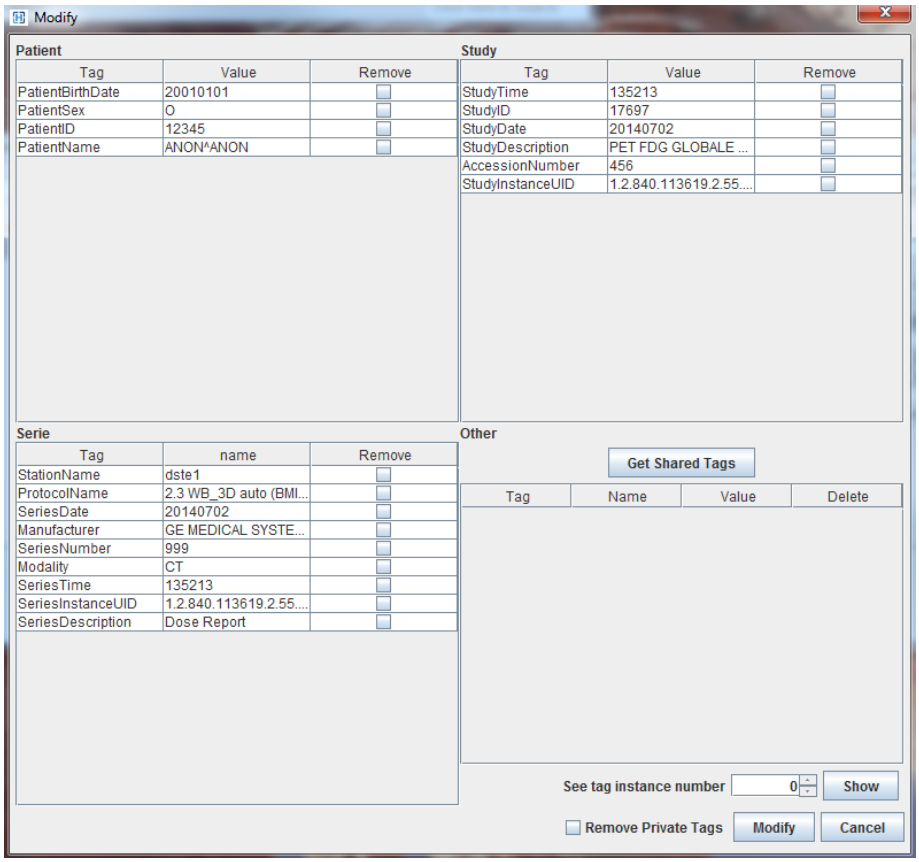


d. *DICOM Edition*

Use Right click on a Patient / Study / Serie to select "Show Tag / Modify"



The Edition panel will appear, you will be able to edit the needed tags and generate new edited DICOM files



DICOM Edition interface

Note the “Get Shared Tags” button that will allow to list all tags common to the selected level and will allow the deepest DICOM tag edition (by default only the main tags are shown)

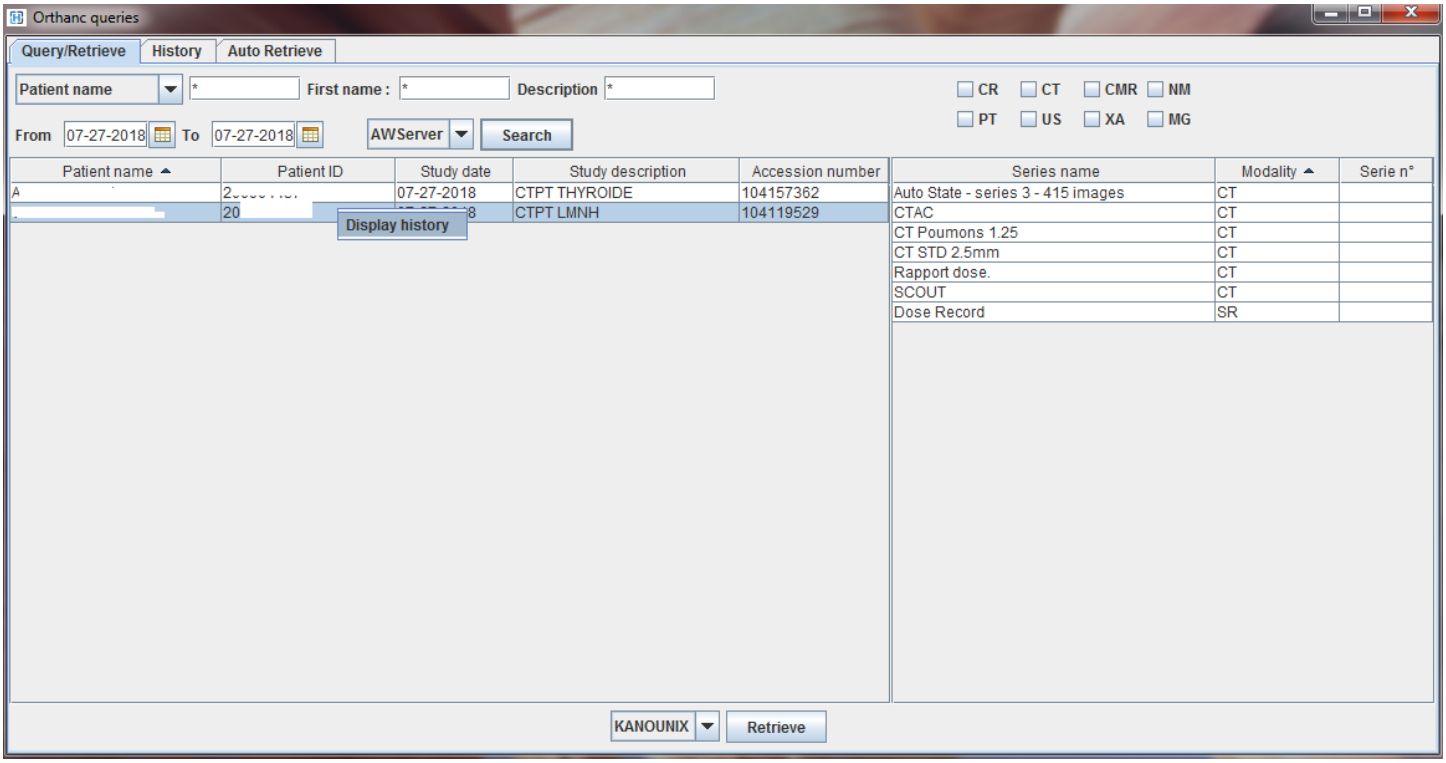
e. Query / Retrieve and automation

Click on the "Query/Retrives" button of the main tab to open the Query interface

i. Query/Retrieve remote DICOM workstations

The Query interface is organized by 3 tabs:

- Query/Retrieve : To simply make a query and Retrieve DICOM from your DICOM network
- The history tab : Right click on a query result and click on "Display History", it gives you the possibility to ask a second query to a second AET (usually the PACS) to show directly the patient's history
- Auto-Retrieve: To define a batch of patient to retrieve and make bulk retrieve of patient's dataset in one single call.



ii. Batch / Auto-Query

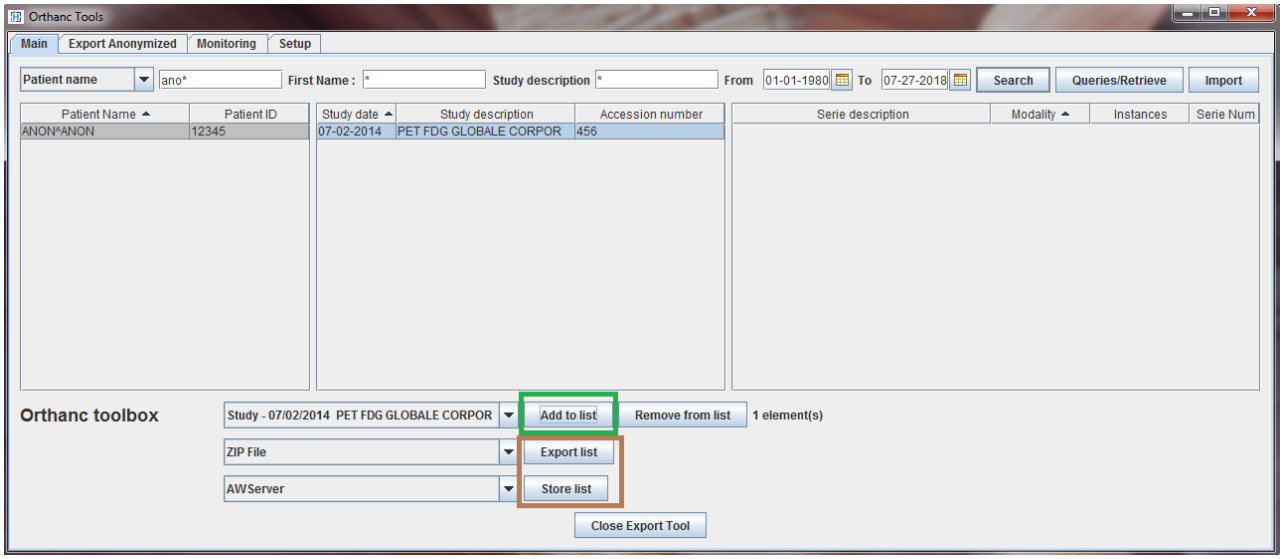
This feature allows you to define a list of patients / studies / series to retrieve from a given DICOM AET and then the software will automatically Query and Retrieve the DICOM into Orthanc without any additional intervention.
You will be also able to schedule the retrieve to make image transfer outside working hours (example start the retrieve of 120 patient's DICOM starting at 10pm).

To learn more about Automatic Retrieve go to "*Appendix 2: Batch / Automatic Retrieve*".

f. Export

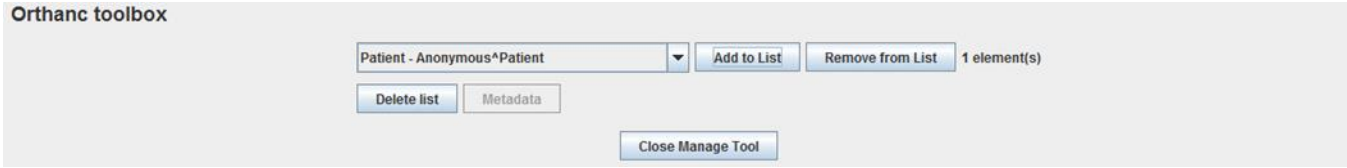
Click on “export” button to open the export Panel.
Add the Patients / Studies / Series you want to add in the list of Export using the “Add to list button”
You will be able to

1. Export in ZIP file with Hierarchical or DICOMDIR structure
2. Generate ready to burn CD/DVD ISO with selected DICOM and ImageJ viewer (in that case you need to first click on “download viewer distribution” in the setup tab).
3. Send the DICOM to one of your declared AET by conventional DICOM transfer



g. Manage

Click on “Manage” button to open the manage panel



Similar to export, you can build a list to do a mass deletion of DICOM stored in Orthanc.
Note that for single deletion of Patients / Study / Series a delete feature is also available using the right click directly in the item you want to delete.

h. CD/DVD Automation with Epson DiscProducer PP100 Device

Orthanc Tools can generate request to the Epson Robot discProducer.

It will act as a CD/DVD burner automation, for each DICOM Study received by Orthanc, Orthanc Tools will automatically send the received DICOM and send a burning request to Epson DiscProducer.
Of course you will have to own a Espon Burner DiscProducer device

For details go to *"Appendix 4: Automatize CD/DVD burning with Epson PP100"* of this manual.

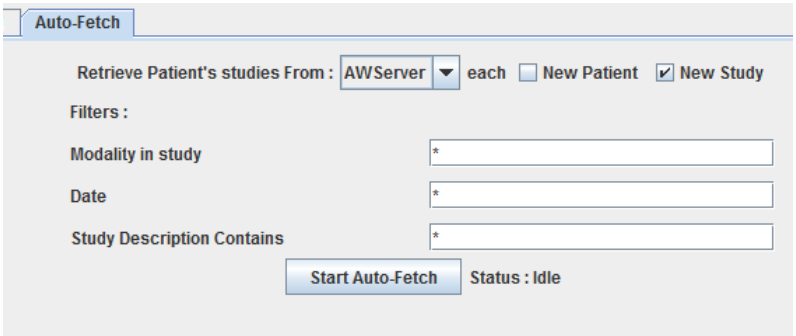
i. Monitoring services

i. Tag Monitoring :

This feature allows automatically extraction of DICOM Tags from incoming DICOMs and store them in a database for mass data analysis.
In short each time Orthanc will receive a new Patients/Study/Instance, Orthanc Tools will retrieve a list of predefined tags and store them in a MySQL database.
See "*Appendix 4: DICOM Tag monitoring for database collection*" for a detailed description.

ii. Auto-Fetch:

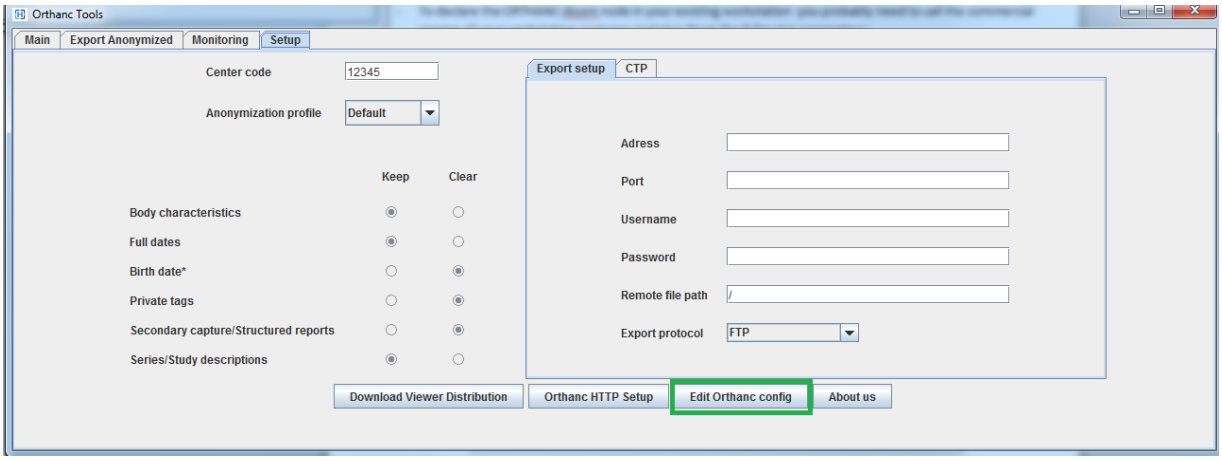
To automatically retrieve from a PACS the image history of a patient, for each new patient/study received by Orthanc, the software will make a retrieve operation to the PACS to download all patient history (+-filters) in Orthanc.
This way when you will read a study, all history will be already downloaded.



j. Orthanc JSON config editor / Declare your DICOM network

Orthanc Tools provides a GUI to edit Orthanc's configuration file.

Go to “Setup” Tab and click “Edit Orthanc config”

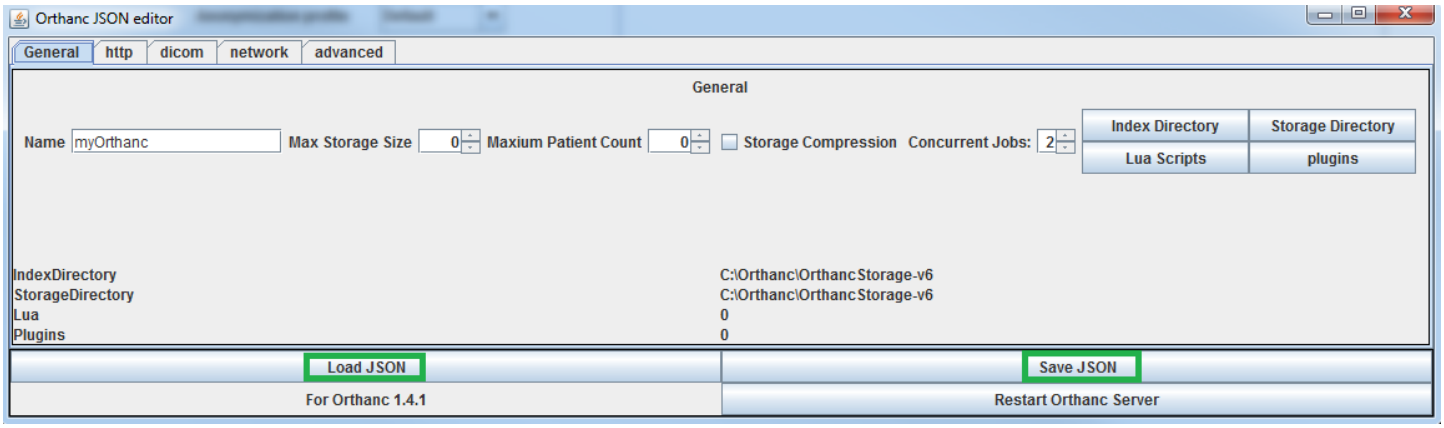


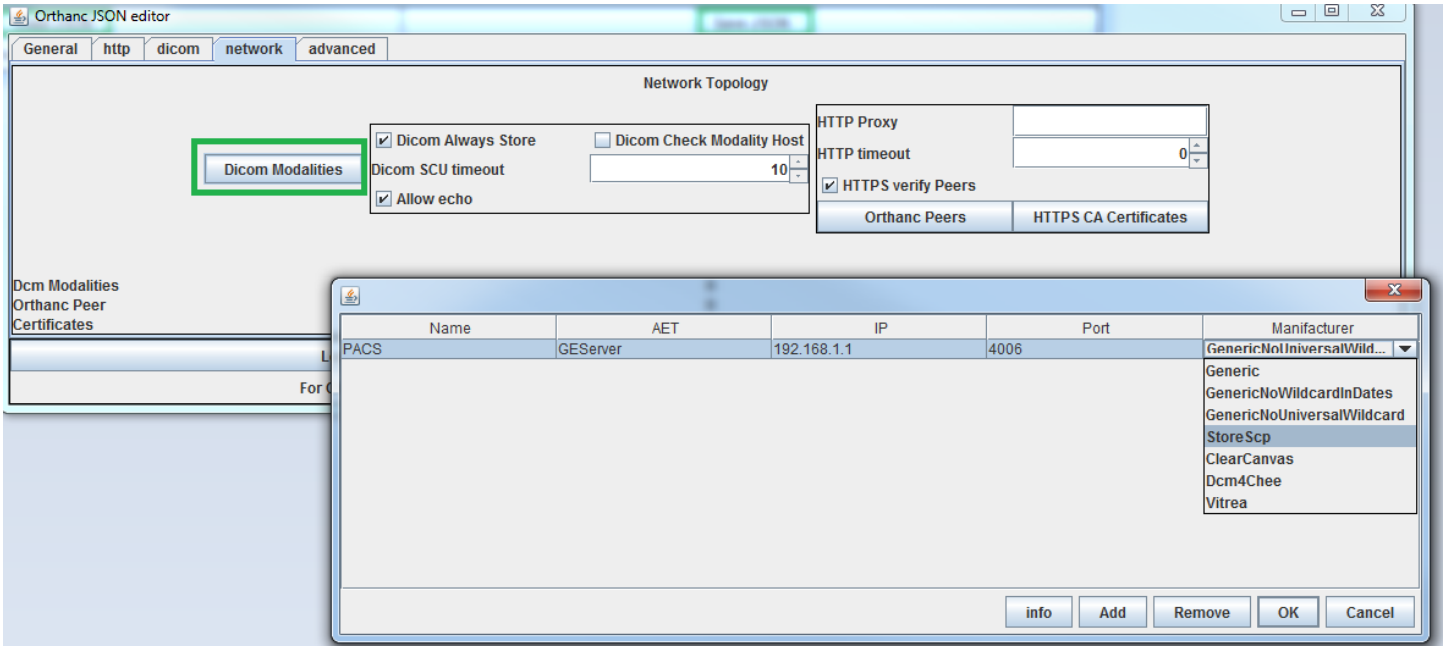
The application open with the default settings or Orthanc, you will find almost all settings of Orthanc server in the GUI

-Click “Load JSON” to load an existing JSON configuration File, the file will be read and the GUI updated to you JSON file settings

- Select your options (for example to declare AET go to

- Click “Save JSON” to save the defined settings, we recommand you to replace the existing Orthanc.json file and click “restart Orthanc Server” to restart Orthanc and take account of the new settings



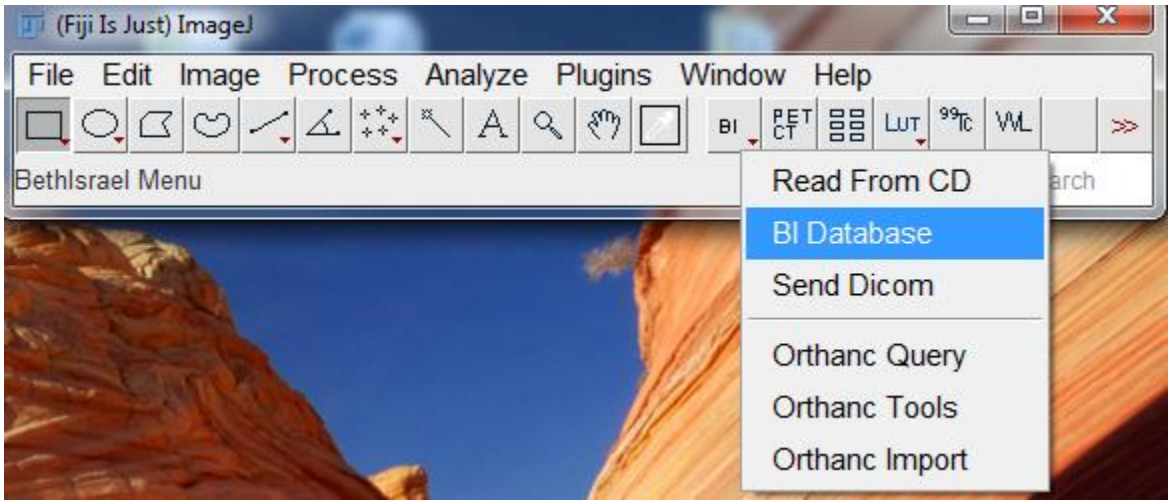


Dicom Declaration interface to add AET of your network. We recommend you to use “GenericNoUniversalWildcard” as it seems to be the most compatible parameter with usual workstations.

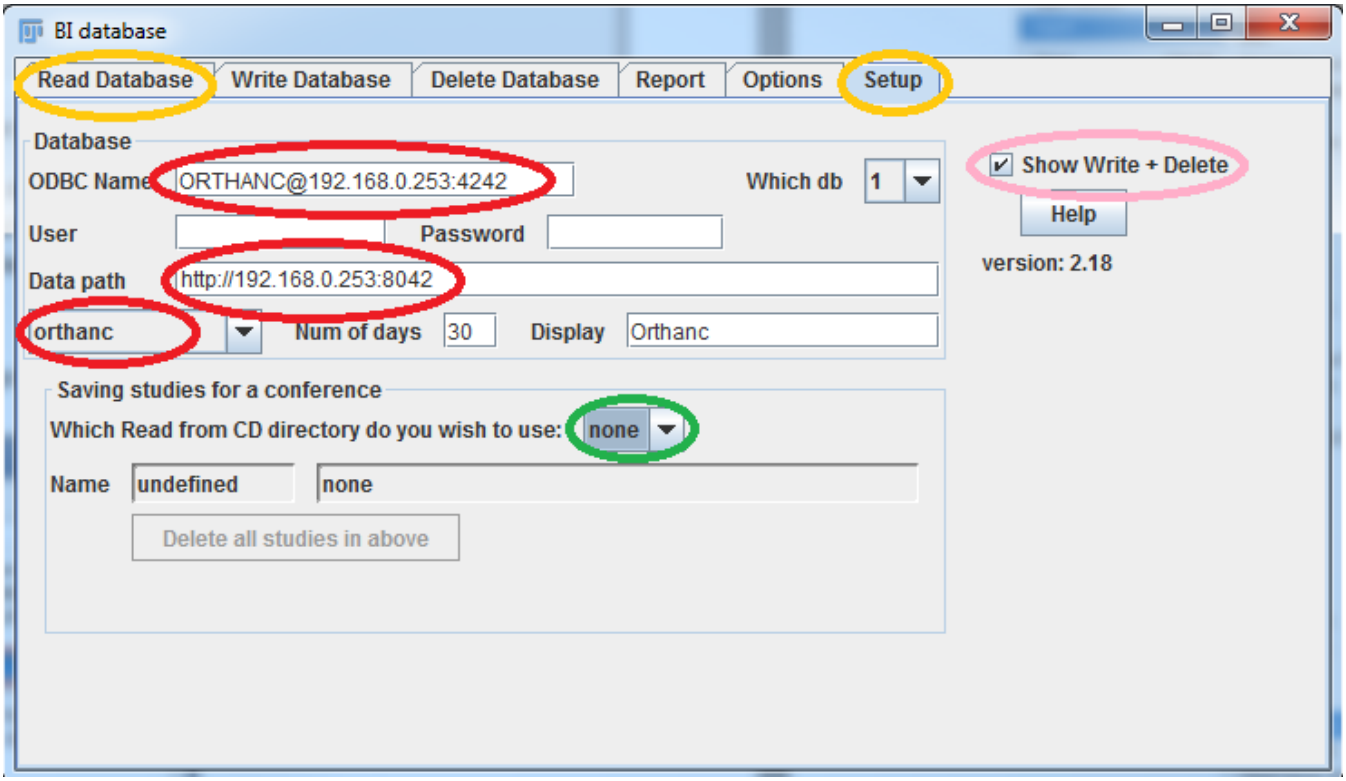
III - Using Orthanc with Fiji and the PET/CT Viewer

a. Connecting Fiji to Orthanc Server

- Open Fiji and BIdatabase



- Go to the setup tab of BI database plugin :



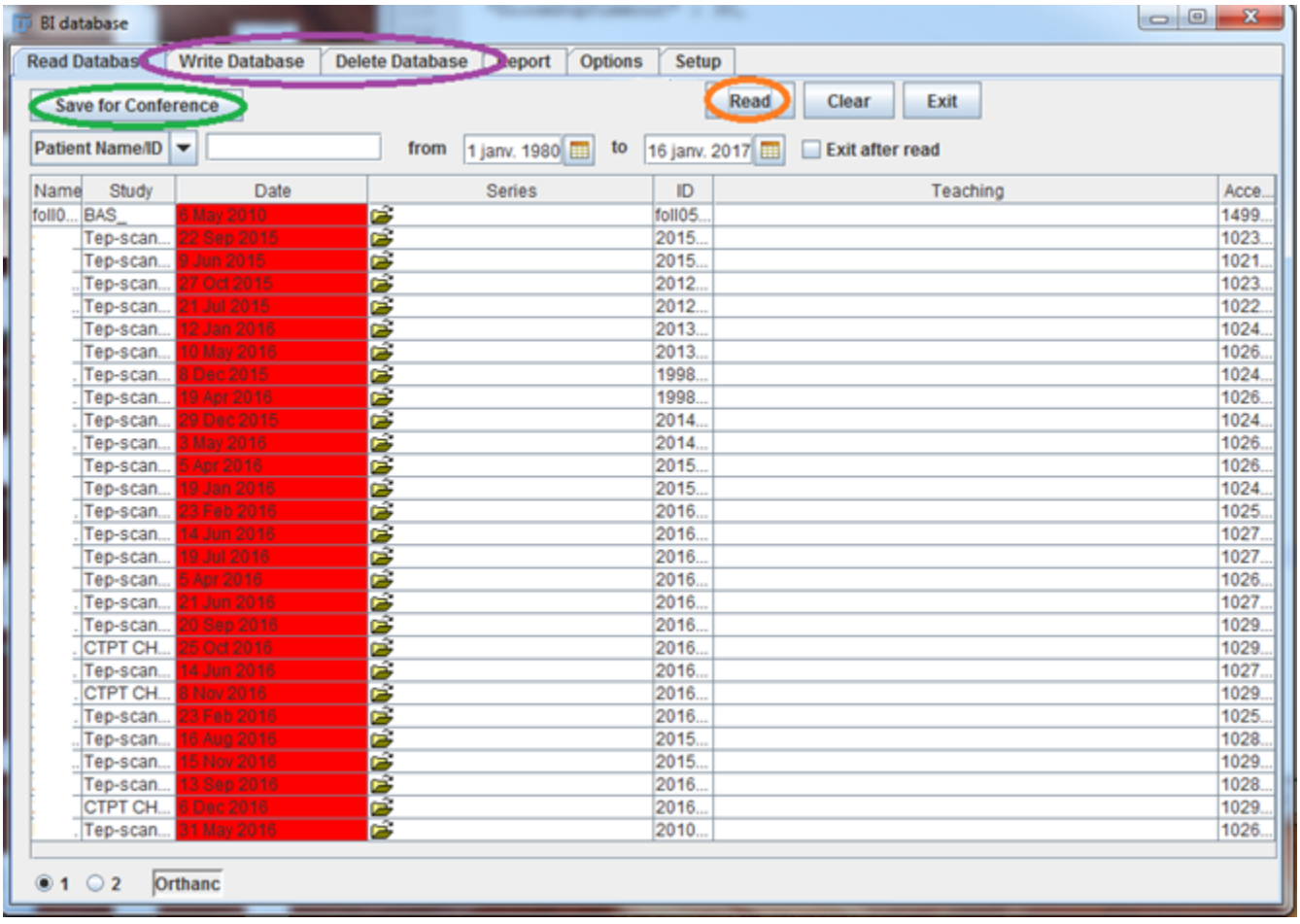
- In ODBC Name (Red), you have to declare the location of the orthanc dicom server following the syntax AET@IP:Port

    - The IP is the value we have found in the end of the chapter II, in this example it is 192.168.0.253.
    - The default AET and Port are ORTHANC and 4242.
        - For now we didn't modify it, so you have to use these default values. We will see in chapter VI how to modify them if you need to (You can stay safely with the default parameters otherwise).
    - If you secured your server with login and password in orthanc's settings you will have to enter you login/password in the box under the ODBC name.
- In "data path" : we are going to declare the http link of Orthanc. The syntax is http://IP:Port
    - You should use the default http port is 8042, so in this example the link should be http://192.168.0.253:8042
- Select "Orthanc" in the menu (third box in red in the screen capture)
- Check "Show Write + Delete" (pink) to enable writing and deletion feature (import DICOM and erase stored DICOM in Orthanc).

The connection is made: the "Read Database" tab will now show you what is stored in Orthanc.
At this stage your Orthanc server should be empty so it is normal to have an empty list, you can go to http://localhost:8042/app/explorer.html#upload to upload DICOM to Orthanc and you should then see the data you have uploaded into the "Read Database" tab.

b. BI database for Reading

To read DICOMs stored in Orthanc simply use "BI database" software shown earlier.



- The Read button (in orange) is for finding studies and opening series
    - You can use a filter by Name / ID/ Date and then find you patient by pressing Read
    - Once you found you patient, select the series you want to open and press Read
        - If you selected PET + CT series the viewer should come automatically.
- The write and delete tab allows you to send DICOM files to Orthanc or delete studies
- Please note that all that features are not limited to the computer where you installed Orthanc
    - You can setup several computers running Fiji that will access your Orthanc server (just repeat chapter IV for each computer you want to connect).

Additional features:

- Export DICOM function : The “Save for conference” button is an export function that will copy the DICOM you are reading to an export folder (Go to the setup tab to choose the export folder, the destination folder proposed to you are the folder you defined in the Read From CD plugin)
    - You can press it before opening study (the button remain pressed) : In that case all study you are going to open will be stored in the folder destination you have specified in the setup tab
    - You can press it after opening studies of interest: In that case all already opened studies in Fiji will be stored in the destination folder (one shot export).
- Autostart BIdatabase at Fiji startup
    - If you want to auto-start the BIdatabase plugin at Fiji startup go to Fiji menu: Plugin => Nuclear Medicine=>Choose startup program.

Appendix 1: Install Orthanc Server in your computer

Some terms have to be understood before setting the network:

Dicom Node: Is a DICOM server, you have already several DICOM nodes installed in your department. A DICOM Node is defined by 3 parameters: AET which is a name (ex: “XELERIS”), IP (ex : 192.168.0.10) and a port (ex : 4242).

IP: Is an address in a Local Area Network (LAN). Each computer connected in your department has a specific IP (ex: 192.168.0.10) that allows other computer to reach it. IP could be static (always the same address) or dynamic (changing at each computer startup). To set the Orthanc server, we will need to have a computer with a static IP (see further).

- ***Installing Orthanc Server***

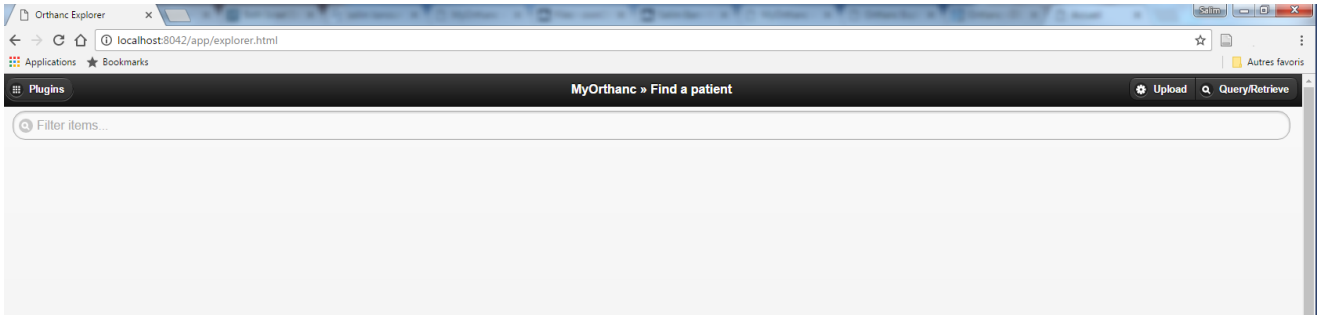
Choose a computer that will become the Orthanc server, you can choose any computer you want but since the server will store many images we recommend you to choose a computer with a decent hard disk space.

- To install Orthanc Server go to : http://www.osimis.io/fr/download.html and select the installer for your distribution.
- Install Orthanc on your computer using the installer you downloaded.

Once installed Orthanc will run automatically in your computer without even noticing it.

- To check that Orthanc is correctly installed, open you web-browser and go to : http://localhost:8042/

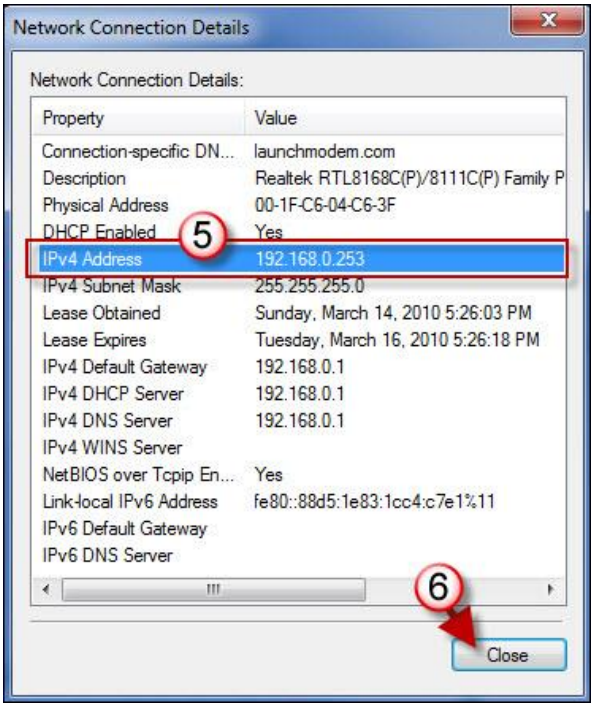
You should see the Orthanc Web server as follow:



If you see this web-page your Orthanc Server is properly installed.

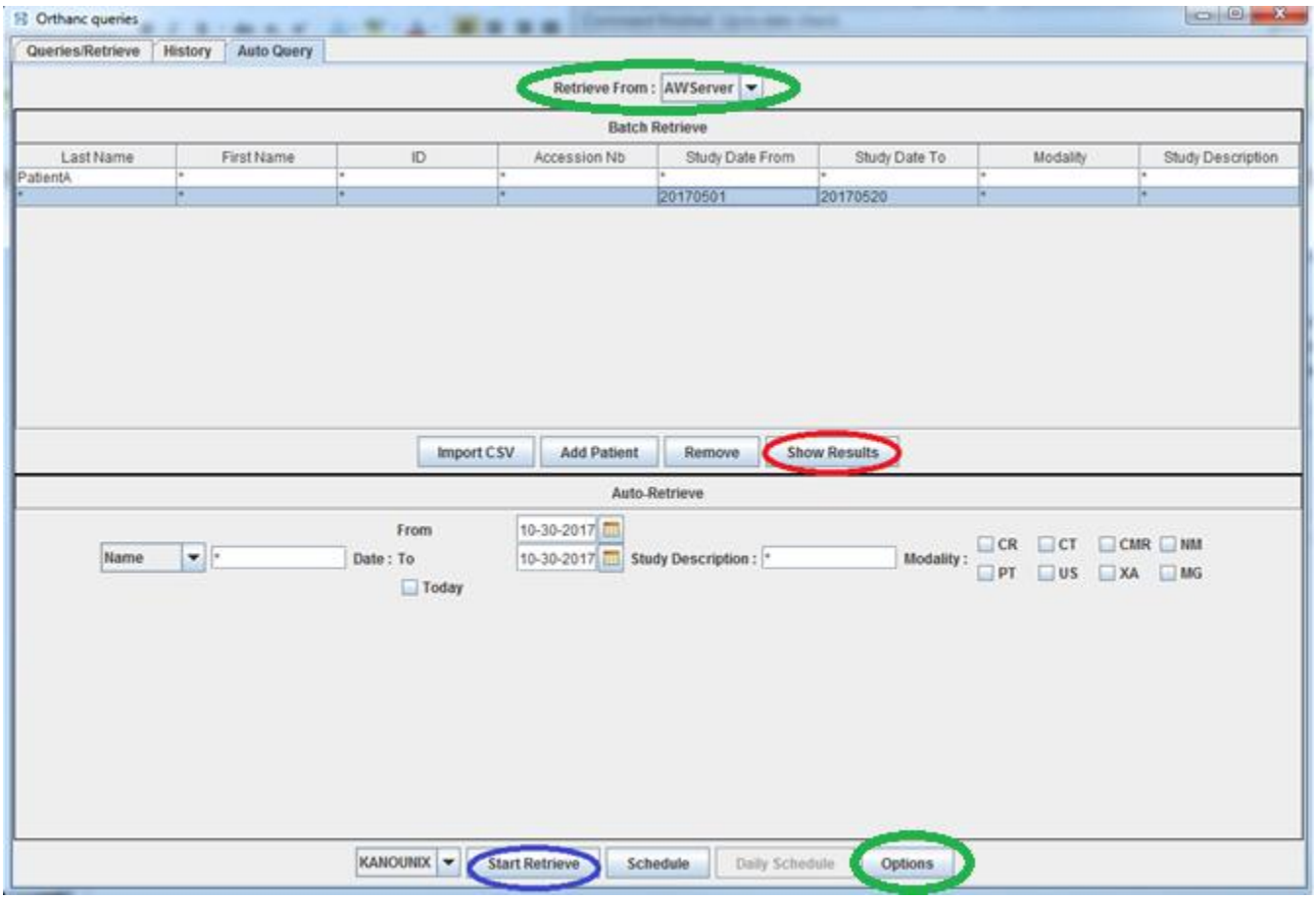
- You have now to verify that you have a static IP address in you LAN.
    - If you don’t know how to do, call you Network manager, this is a trivial operation that every LAN manager will able to address.

- Identify and note your IP address
    - Ask your network manager or go to the network connection detail of your OS (here for windows)



- In this example your IP address would be “192.168.0.253”
  Note this IP address, it will be important to connect Fiji to Orthanc.

Appendix 2: Batch / Automatic Retrieve



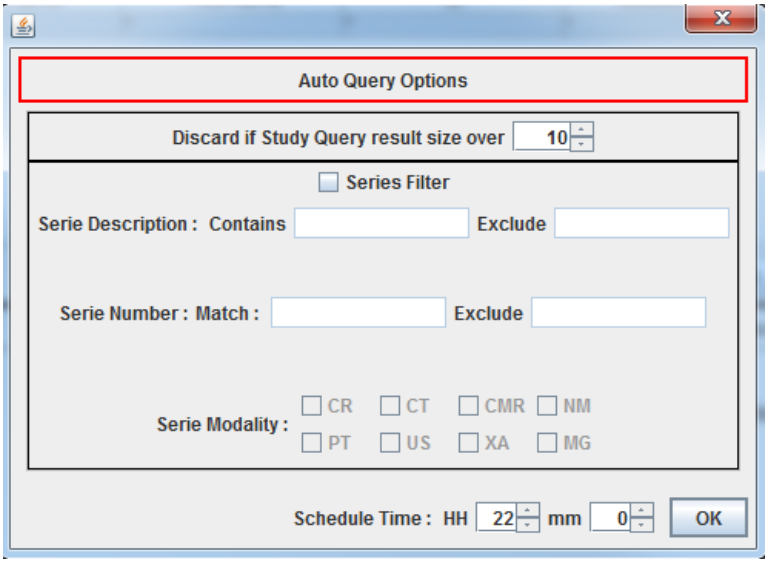
Two Features are provided:

- Batch Retrieve:
    - List every patient your need (by name, or date, modality…) the list will be retrieved one by one.
        - Click on “Add patient” to create a new line
            - Note the date format YYYYMMDD and the Modality format (each modality separated by “//” ; Example : ”CT//MRI”)
        - You can display the Query Result without retrieving the DICOM : Click on “Show Results”
            - All the matching studies will be shown and correspond to all study that will be downloaded If you click on “Start Retrieve”
            - You will be able to edit this list in the software or dump the shown result to a CSV file to edit it manually and re-import it using the “Import CSV” button

- “Auto-Retrieve”: This panel allows you to define 1 Query that will be repeated each day (Example : each end of day retrieve all studies of the working day from the acquisition console to store them in Orthanc as PACS). Start the process using “Start Retrieve”, this feature will be applied only if the “Batch Retrieve” list is empty.

To make a Retrieve:

- Select the AET you want to retrieve data from in the upper selector
- Fill either your batch list or your recurrent retrieve
- Set the Options :
    - Series Filtering : To download in the found studies only some matching series number or series description (otherwise the full study will be retrieved)
    - A study Query result size limit (default = 10), if your query criteria is not specific enough (ex: selecting only firstname “John”, you will retrieve too much data that will overload your hard-disk, so queries returning results over this limit will be discarded to avoid result overload.
    - The Schedule Time allows to define an hour to start the retrieve process



- Start the retrieve process
    - Immediately : by pressing “Start Retrieve” button
    - At the scheduled hour: by pressing “Schedule”, the retrieve will start at the requested hour (let the program opened).

Appendix 3: Automatize CD/DVD burning with Epson PP100

1) Download Epson's Software

Go to Epson website to download Epson's software to manage CD/DVD creation. (https://download.epson-biz.com/modules/dp/index.php?page=prod&pcat=1&pid=2);

You will need to install:

- Epson Total Disc Maker
- Epson TD Bridge

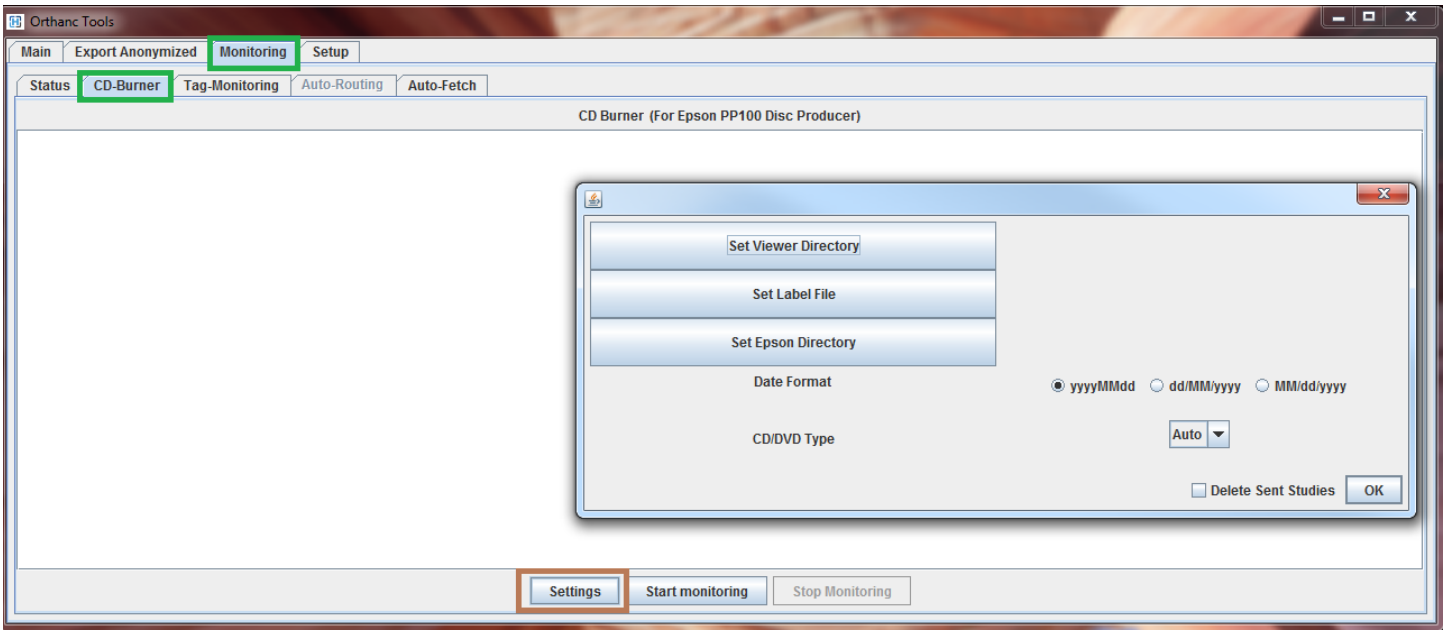
Download and install these two software in your computer

Use Epson Total Disc Maker to generate your CD/DVD printing and save it (will generate a .tdd file) you can Include the tags "{patientName}", "{patientId}", "{patientDate}", "{studyDescription}" to automatically print their respective value in the label.

2) In Orthanc Tools: Go to the "Monitoring" and "CD Burner tab"

Go to option and set the following settings:

- The Viewer directory: Containing the viewer distribution you want to add to the CD/DVD along with DICOM, you can use Fiji as viewer (Free) or Radiant (commercial).
    - To Use Fiji Viewer simply unzip in a directory of your choice the viewer distribution that you can download from the setup tab.
- The label file: It is the label image file that you generate with Epson software (.tdd file)
- The Epson directory: The directory monitored by Epson TD Bridge to receive burning instruction.



Click 'start monitoring' to run the service.
The settings will be kept in memory for the future run or Orthanc Tools

Don't hesitate to ask for assistance to setup this automated CD/DVD burning service.

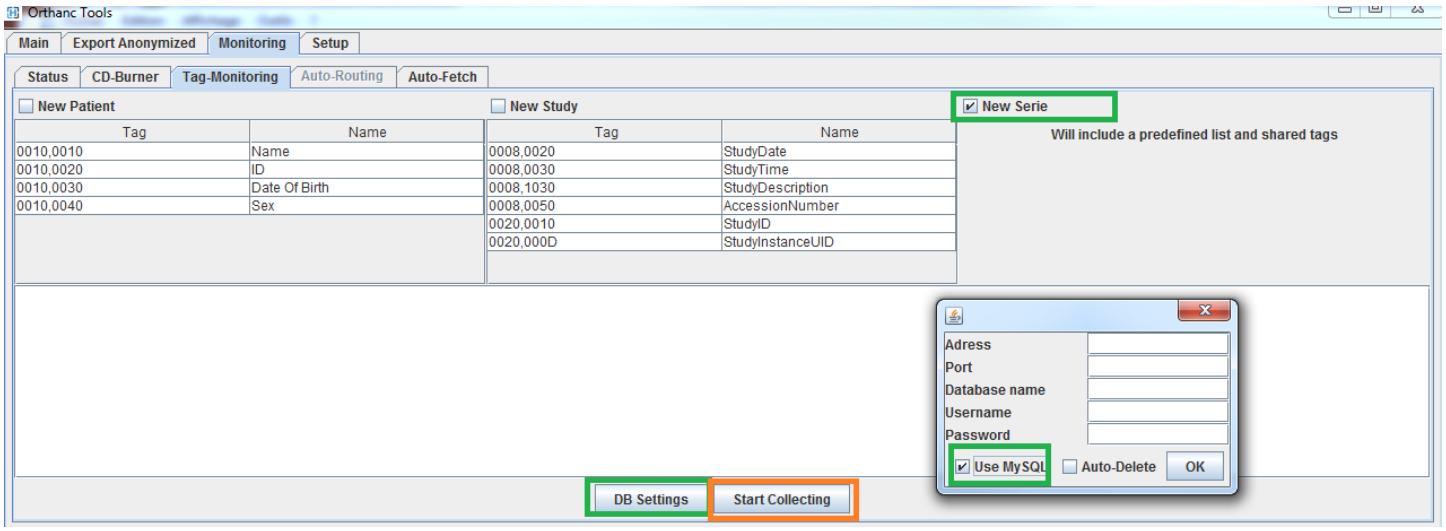
Appendix 4: DICOM Tag monitoring for database collection

For this feature you will need to access to a MySQL server, install a database with the database structure available here: https://github.com/salimkanoun/Orthanc_Tools/blob/master/src/org/petctviewer/orthanc/monitoring/monitoring.sql

The Database that will receive Tags data is structured in 3 tables: Patients, Study and Series.

To setup the database collection in Orthanc Tools:

- Go to Tab “Monitoring” => “Tag Monitoring”



- Select the Level to monitor (The series level will give the most detailed tags collection)
- Click on “DB Settings” and enter you MySQL connexion parameter, check “Use MySQL” to enable database storage (otherwise the tags will be only displayed in the monitoring console)
    - You can also check “Auto-Delete” if you want the DICOM be erased after tag collection (only monitoring with no storage, all incoming dicom will be Tag extracted and then deleted)
- Click “Start Collecting” to start the DICOM monitoring (each new DICOM in Orthanc will be tag Collected)

Collected tags for Tag monitoring, by level (incremental, series Level will collect Patients+Study+Series) :

```
/*
              Patients
              0010,0020 = Patient ID
              0010,0010 = Patient Name
              0010,0040 = Patient's Sex
              0010,0030 = Patient Date of birth

              Study
              0008,0020 = StudyDate
              0008,0030 = StudyTime
              0010,1020 = Patient's Size
              0010,1010 = Patient's Age
              0010,1030 = Patient Weight
              0008,1030 = Study Description
              0008,0050 = Accession Number
              0020,000d = Study Instance UID
              0020,0010 = Study ID

              Series
              0008,0070= Manifacturer
              0008,1090 = Manifacturer Model
              0008,1050 = Performing Physician Name
              0008,103E = Series Description
              0008,1010 = Station Name
              0008,0023 = Content Date
              0008,0033 = Content Time
              0018,1030 = Protocol Name
              0020,000e = Series Instance UID
              0040,0310 = Comment Radiation Dose
              0054,0016 = Radiopharmaceutical sequence
              0018,0031 = Radiopharmaceutical
              0018,1072 = RadiopharmaceuticalStartTime
              0018,1074 = RadionuclideTotalDose
              0018,1075 = RadionuclideHalfLife
              0018,1076 = RadionuclidePositronFraction

              0040,030e (Radiation Dose Module) (tag 0018,9345 (CTDIvol))
              */
```

Appendix 5: Questions and Troubleshooting

- I can't connect to Orthanc
  - Go to your Orthanc PC and check that http://localhost:8042/ is responding
    - If not, you have a trouble in your Orthanc Server (go back to Chapter II and III)
    - If it is OK
      - Try to access http://IP:8042/ in a remote computer inside your institution (in this example : http://192.168.0.253:8042)
        - If you can't connect it should be a firewall issue that is closing the access, check your firewall settings and add an exception for Orthanc service (open 8042 http port and 4242 dicom port).
  - DICOM reading is slow
    - Usually the reading process shouldn't be much longer than reading local file with the Read From CD plugin, if the reading time is really long (>1 minute for a serie) it is probably due to a slow network, ask your network assistance for that.

- How many studies can I store on Orthanc ?
  - By following this guide you made the default installation of Orthanc which is designed to handle properly 50 000 DICOM files, and this allow you to store safely 50 to 70 studies
    - You can store more but you might face performance decrease (slower reading)
  - You can remove that limit by extending your Orthanc installation with Postgre database, it will remove all limitation for DICOM storage (except you hard disk size limit of course)
    - It is a free procedure, we wrote another guide to help you extend your Orthanc installation with Postgre database.
      - Follow this guide :
        - http://petctviewer.org/images/Extending_Orthanc_with_PostgreDB.pdf

- I have questions about Orthanc
  - Orthanc is an Open Source software provided by the university of Liege (Belgium).
  - The project is in active developpement, Orthanc provides a lot of capabilities that are not described here.
  - If you need to reach the Orthanc team here are the most important links :
    - Website : http://www.osimis.io and http://www.orthanc-server.com/
    - Documentation (manual, Dicom conformance statement…) : http://www.orthanc-server.com/static.php?page=documentation
    - Forum : https://groups.google.com/forum/#!forum/orthanc-users

- If you still face problems, feel free to contact us (Salim.kanoun@gmail.com, Ilan.tal@gmail.com)