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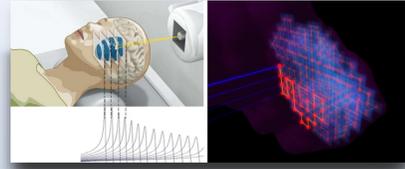
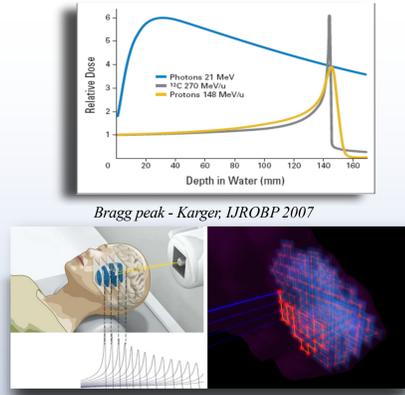
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HADRONTHERAPY

Hadrontherapy is an advanced radiotherapy technique that employs charged particle beams. Hadrontherapy is administered at CNAO with **protons** and **carbon ions** by active scanning. To date, about **2500 patients completed successfully the treatment**.

The tumour is subdivided in iso-range slices in which the dose is delivered by displacing a pencil beam. The number of particles in each 3D position is the result of a **multi-field optimisation** and the number varies considerably with the spot position.



Courtesy of HIT (Heidelberg Ion-Beam Therapy Center)

CNAO

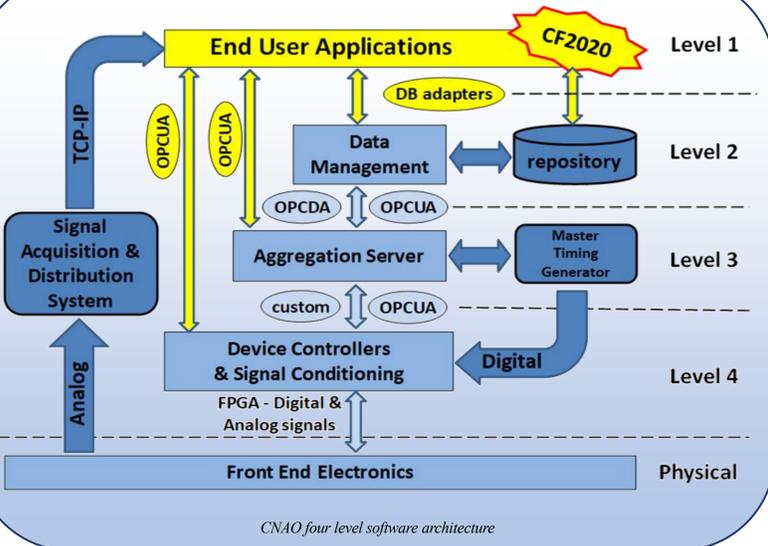
The **CNAO (National Center for Oncological Hadrontherapy)** in Pavia is one of the five centres worldwide in which hadrontherapy is administered with both protons and carbon ions. The center is equipped with **3 treatment rooms** for patients and an **experimental room** in which it will be possible to carry out research activities without interfering with medical activities.

The main accelerator is a **25 m diameter synchrotron** designed to accelerate carbon ions up to an energy of **400 MeV/u** and protons up to an energy of **250 MeV**.



CNAO Layout

CNAO CONTROL SYSTEM

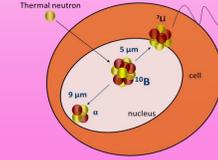


CNAO FUTURE

- Expansion plan for single room facility



- 3rd plasma source to accelerate multiple species (O, He).
- Multi-energy extraction
- Intensity modulation
- Carbon Gantry (collaboration with CERN)
- BNCT



PROJECT GOAL

CNAO Framework **CF2020** is a development kit based on wizards and models that can create end user applications to be used with different operating systems.

Motivations:

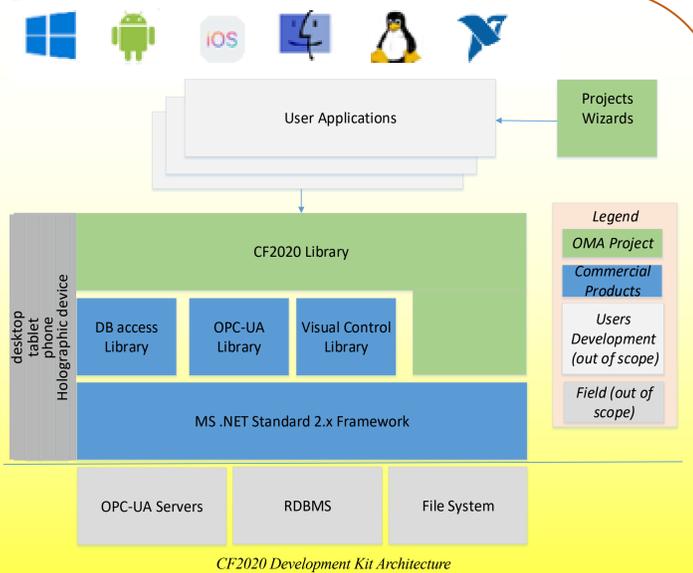
- ensure compatibility and integration among components.
- document the job done for regulatory body validation in quality assurance procedures.
- reduce the amount of work for upgrading the system thanks to automatic code generation and code reuse.
- guarantee security in distributed and open environment applications that run on mobile tools.
- lead the developer along a well-defined path to integrate the business logic of the applications.

CF2020 DEVELOPMENT KIT ARCHITECTURE and TARGETS

The development kit includes:

- **A set of model-based project templates** :
 - Project files that are used to compile and build the final application.
 - C# source files, XAML source files and code snippets that implement the models: these files contain parameters that shall be translated into code by means of the information supplied by the developer when using the project wizards.
 - Run time configuration settings for tuning the application in different target environments.
- **A field class generator** that is able to build C# classes that represent in a suitable way the field objects (i.e. database tables and views and OPC-UA server families).
- **Project wizards**, which are able to build the final project on the base of the chosen model by selecting the suitable files, substituting the parameters inside the files using the information supplied by the developer, generating the code, building the run time configuration files and creating the project directories containing the generated files.
- **A set of libraries** that shall support the implementation of the behaviour defined by the models, the client access to the field and to the ancillary services such as file system access and logging system access and take care of the security aspects. These libraries depend on other widely used support libraries that are open source or commercial.
- The Development Kit is completed by a **set of Web Services** that supply basic functionalities such as access to remote databases and file systems.

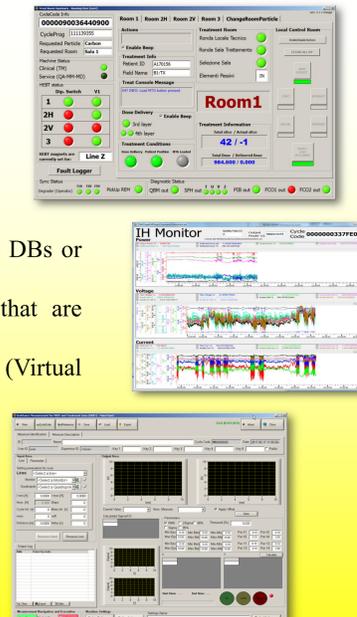
Xamarin in MS Visual Studio was chosen: it allows creating applications in native format, starting from the same source code, on tools that have installed one of the following operating systems: Windows, Android, iOS, MacOS and Linux. Labview APIs were also added for using the kit services in that environment.



CF2020 MODELS

Model Driven Architecture implies a deep understanding of the requirements among applications that address a common domain. A survey of most of the applications presently running in the **CNAO Control and Supervision System** has been done before defining and implementing the tools that generate the application canvases. About 100 applications have been taken into account and grouped in the following categories:

- Applications **managing data** mainly contained in relational DBs or file systems.
- Applications **managing the workflow**, i.e. applications that are aimed to obtain the delivery of the treatments on the patients.
- Applications managing a **single device in a family** (Virtual Instruments).
- Procedures, i.e. **sets of operations** performed on groups of **different devices** with a given **sequence** to obtain a change in the state of the plant.
- Applications to manage **groups of devices** (executing commands in series and displaying summaries indicators).
- Applications to show the status of **scheduled daily activities** (treatments list and patient calls).



CF2020 WIZARDS

The models are implemented by the Development Kit templates that are configured by the **wizards** to lead the developer along the application construction.

