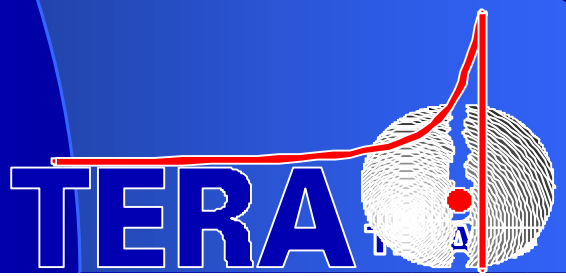
THE C N A

OF THE TERA FOUNDATION

Ugo Amaldi

University of Milano Bicocca and TERA Foundation



- **Purpose: development of hadrontherapy technologies**

Not-for-profit created in 1992

Recognised in 1994 by the Health Ministry

- In 2002: **22 full time employees**

  8 staff researcher (physicists and engineers)

  10 fellows

  3 administratives

  2 administratives for ISE (ARONA)

- TERA has 4 sections: Novara - Geneva - Milan and Genoa

- Collaborations: INFN - CERN - ISS - ENEA - AIRO
- Oncological Institutes and Universities

THE PROGRAMMES OF TERA

~ 0.5 MEuro

TERANET Programme

- **ATLANTIDE:** No-profit portal for scientific research

COMPACT ACCELERATORS Programme

- **IDRA:** Institute for Diagnostics and Radiotherapy Applications
- **LIBO:** LInac BOoster

~ 5 MEuro

CENTRES OF EXCELLENCE Programme

- **CNA:** Centro Nazionale Adroterapia

CAP: Computer Assisted Positioning

MAGIC CUBE & PIXEL CHAMBER

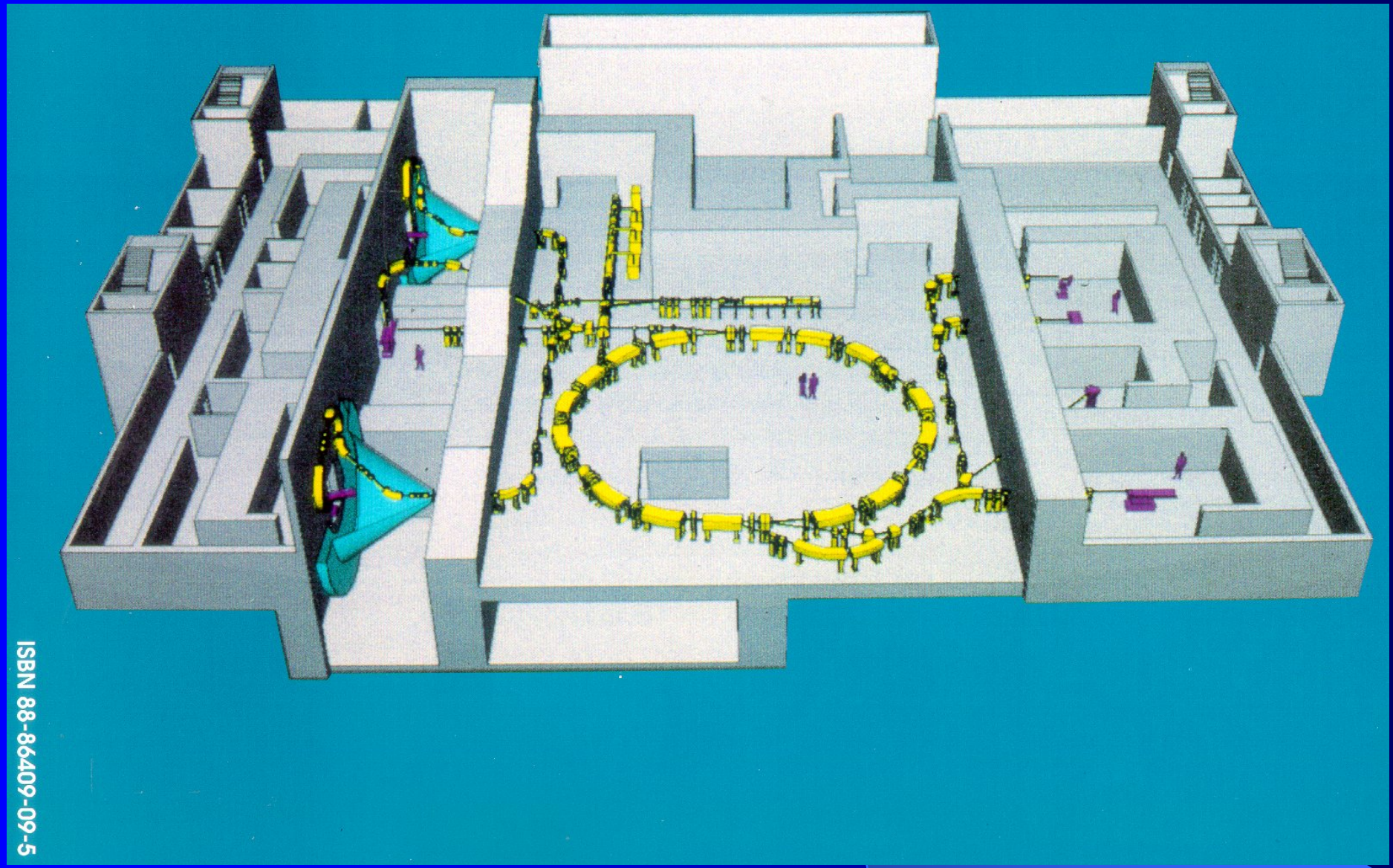
PRASSI: Piani Radioterapici con Adroni e Sistema di Scansione Integrati

~ 50 MEuro

SUCIMA: Silicon Ultra fast Cameras for electron and gamma sources in Medical Applications

TESI: Testata Superconduttrice per Ioni

CNA: VERSION 1995



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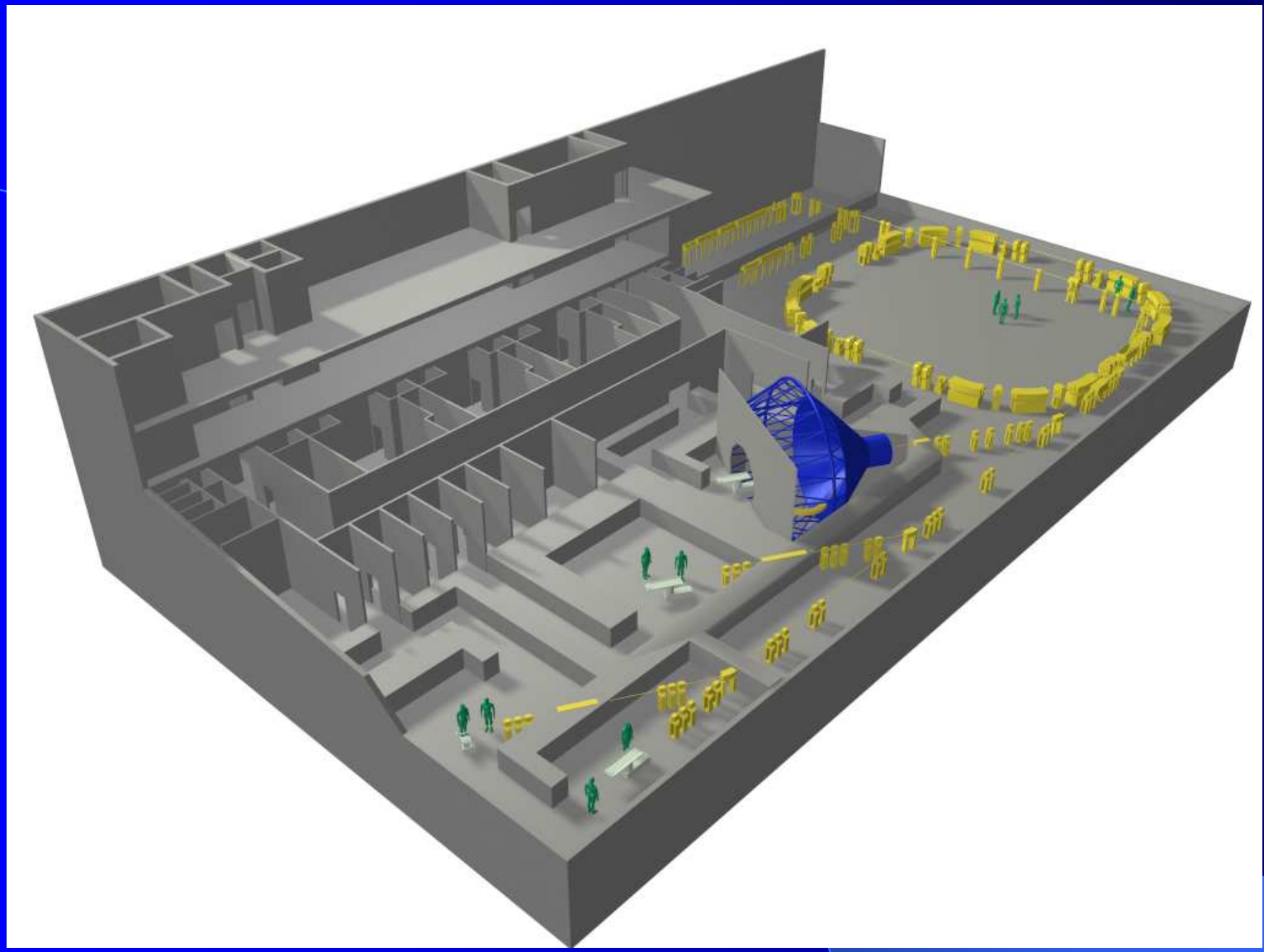
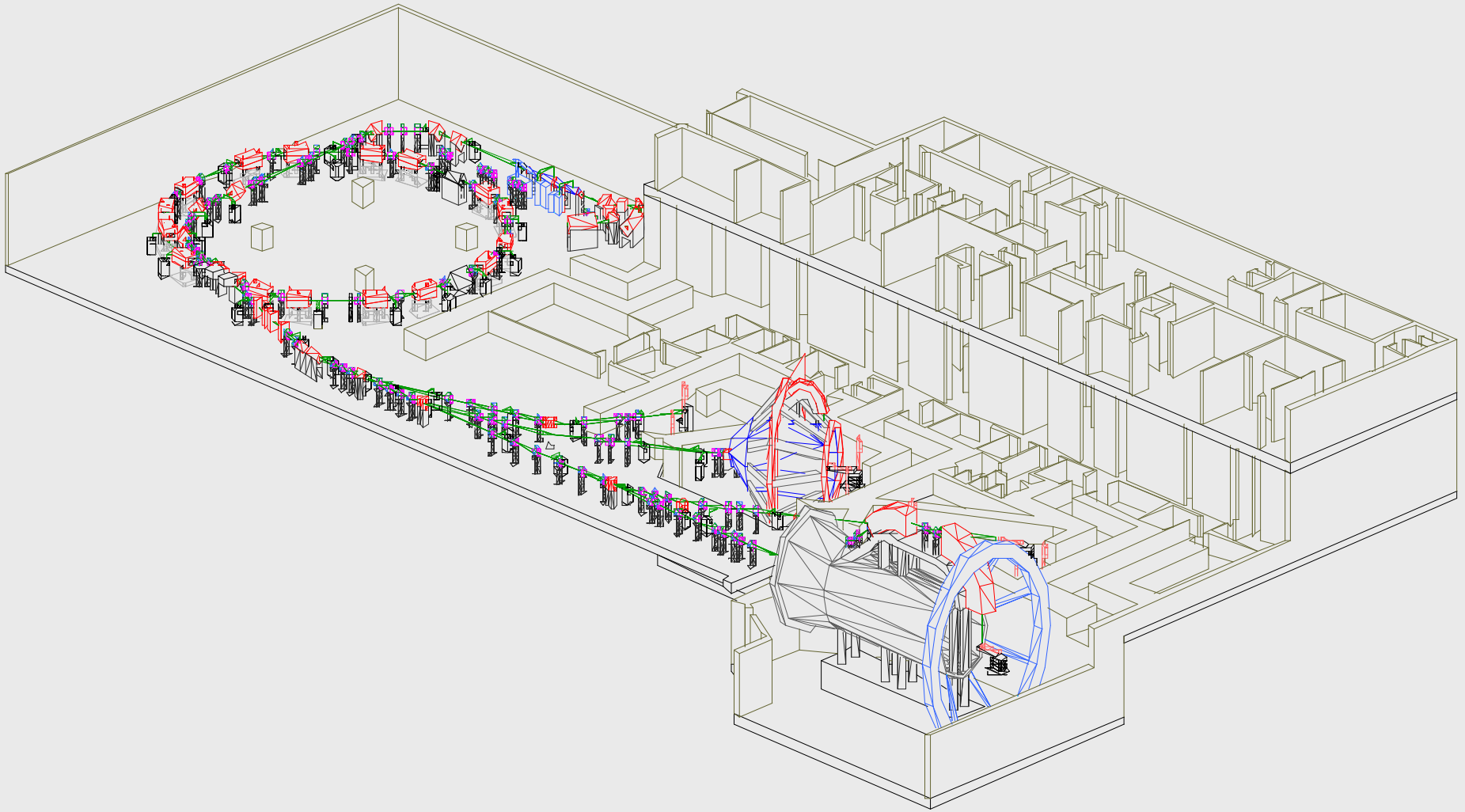
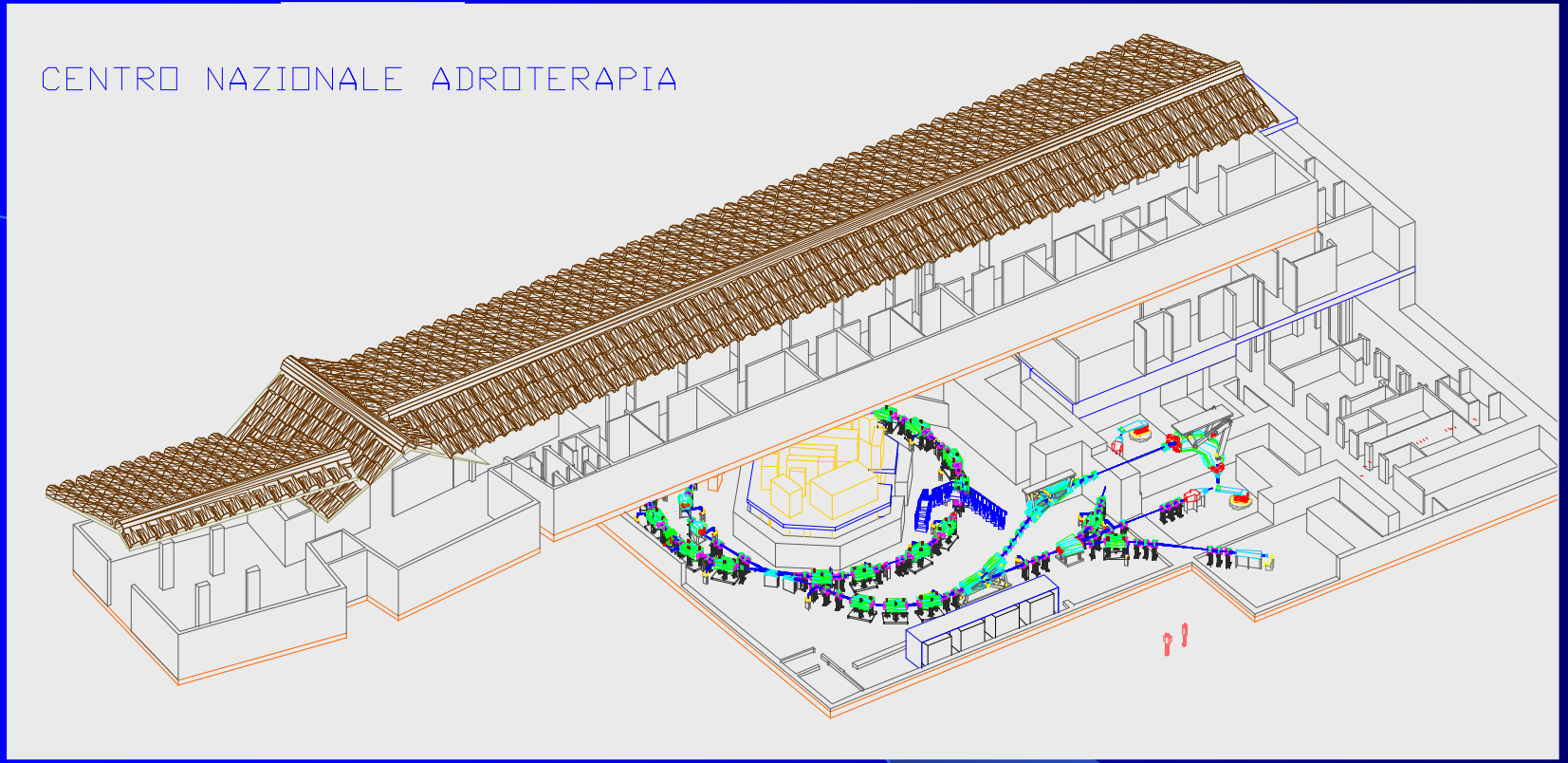
CNA: VERSION 1998



CNA: VERSION 1999



CNA: PRESENT VERSION



Law 348 - 23.12.00 :

CNAO Foundation: Polyclinics of Milan and Pave,
National Neurological Institute, European Institute of Oncology, TERA

10,33 MEuro in 2001

TERA Project Leader: Sandro Rossi

TERA Project group: 7 staff, 7 fellows, 2 consultants (fte)

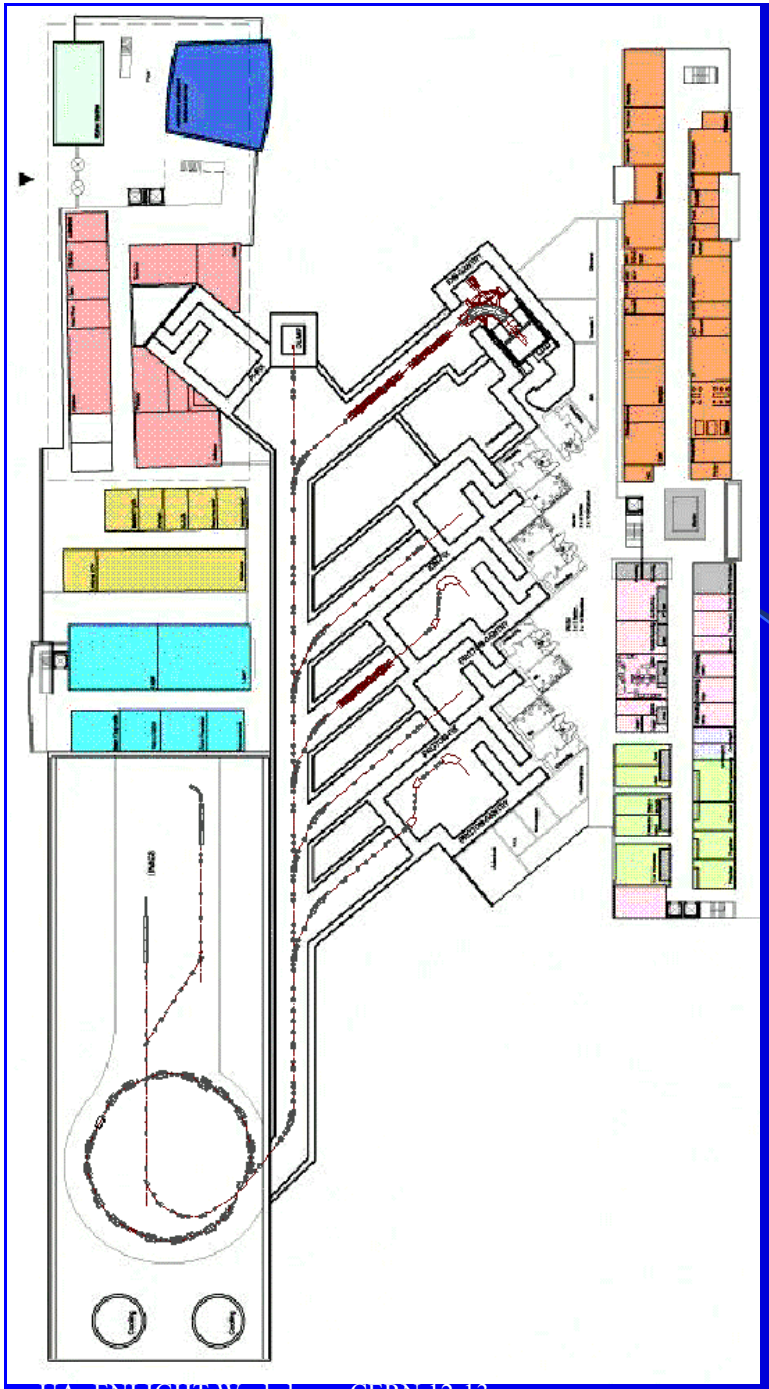
CNAO FOUNDATION

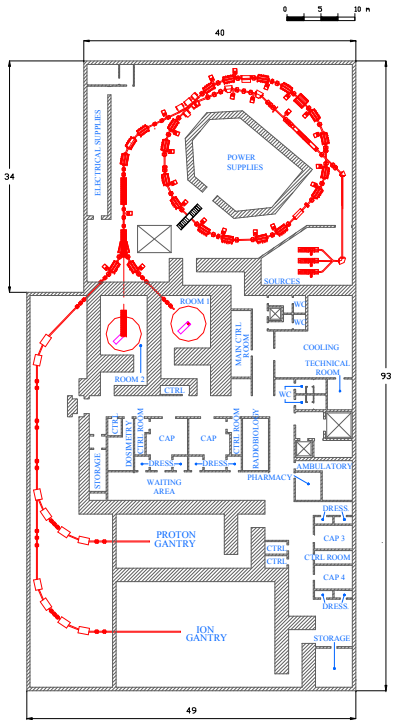
Board:

E. Borloni	**-Ospedale Maggiore**	**President**
G. Arbosti	**-Istituto Neurologico C. Besta**	**Vice-president**
M. Bono	**-European Institute of Oncology**	
G. Azzaretti	**-San Matteo**	
U. Amaldi	**-TERA**	

Letter of the Health Minister to the Board:

1. **Use the available funds to produce a detailed design of CNA**
2. **Acquire further clinical information involving the existing Centres**
3. **Define the technical details of buildings and high-tech components**
4. **Quantify the needed personnel**
5. **Prepare a business plans, based on a 'reasonable' financial plan**

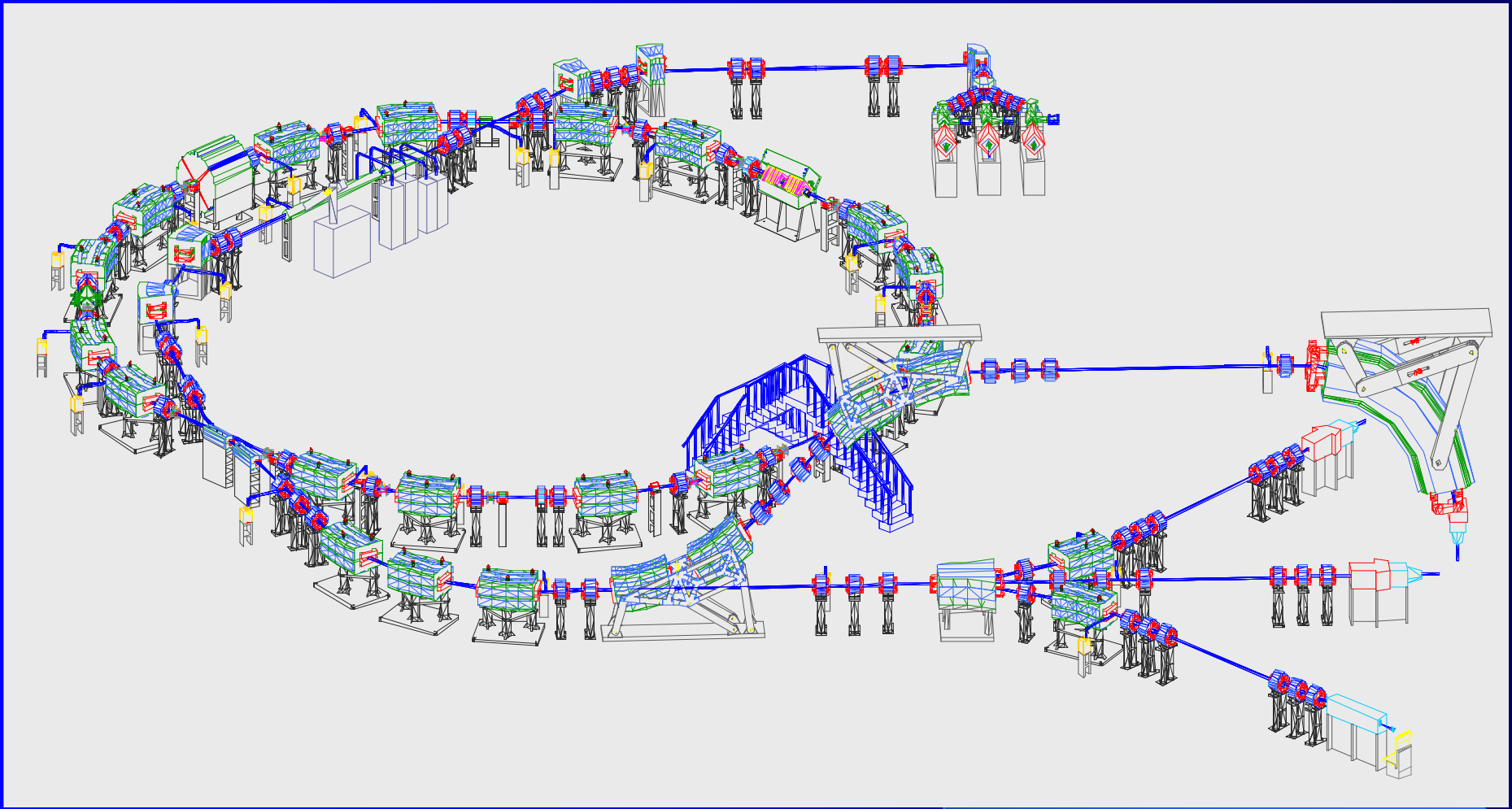




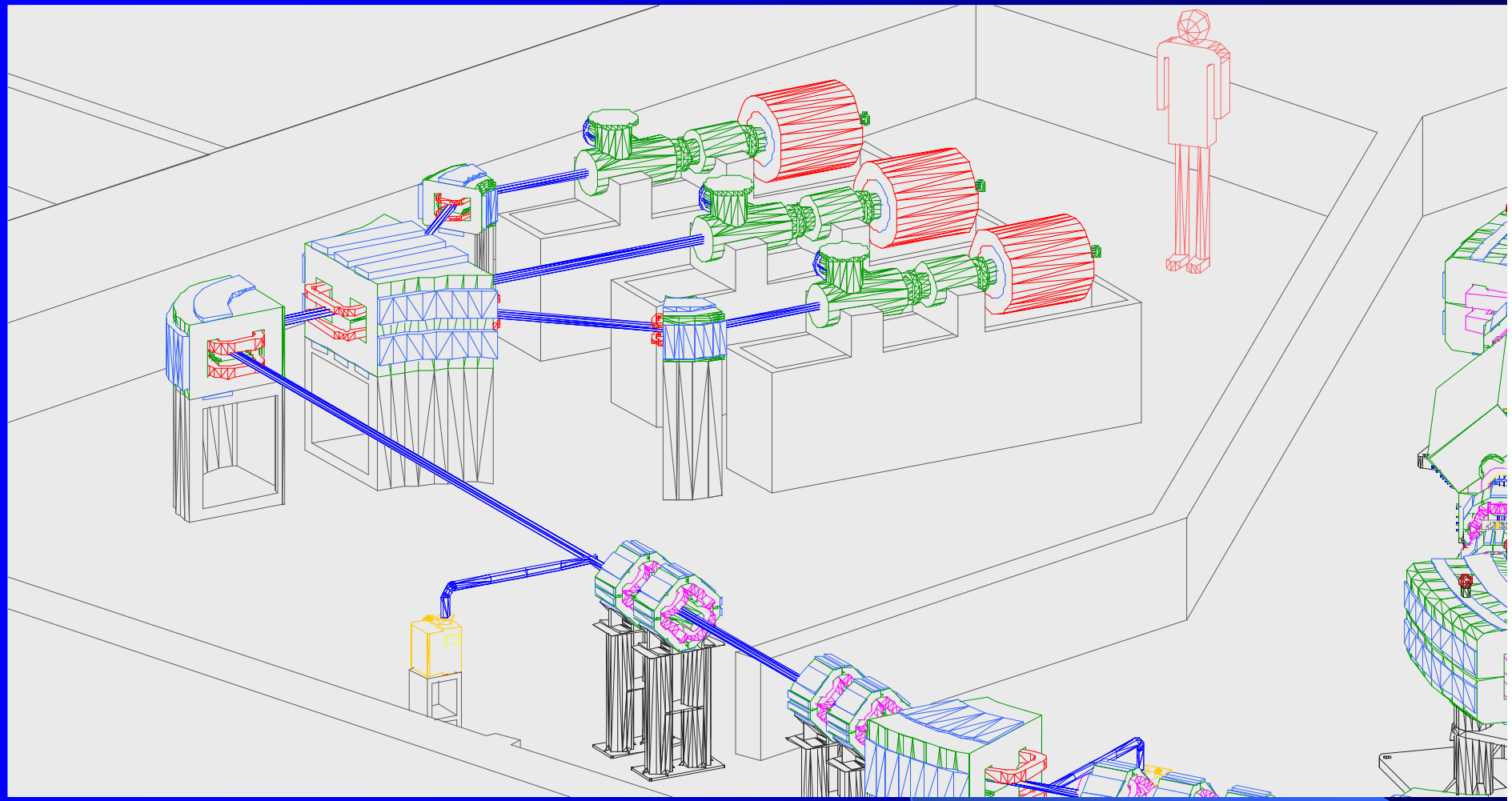
CNA Phase 2 vs PIMMS

- 7 MeV/u injection energy
- Single IH (GSI) linac inside the ring
- Multiturn injection
- Space minimisation (PS inside the ring)
- Integrate functions extraction lines (fan out)
- Isocentric gantries for Phase 2
- CNA Phase 1 : 3200 m²

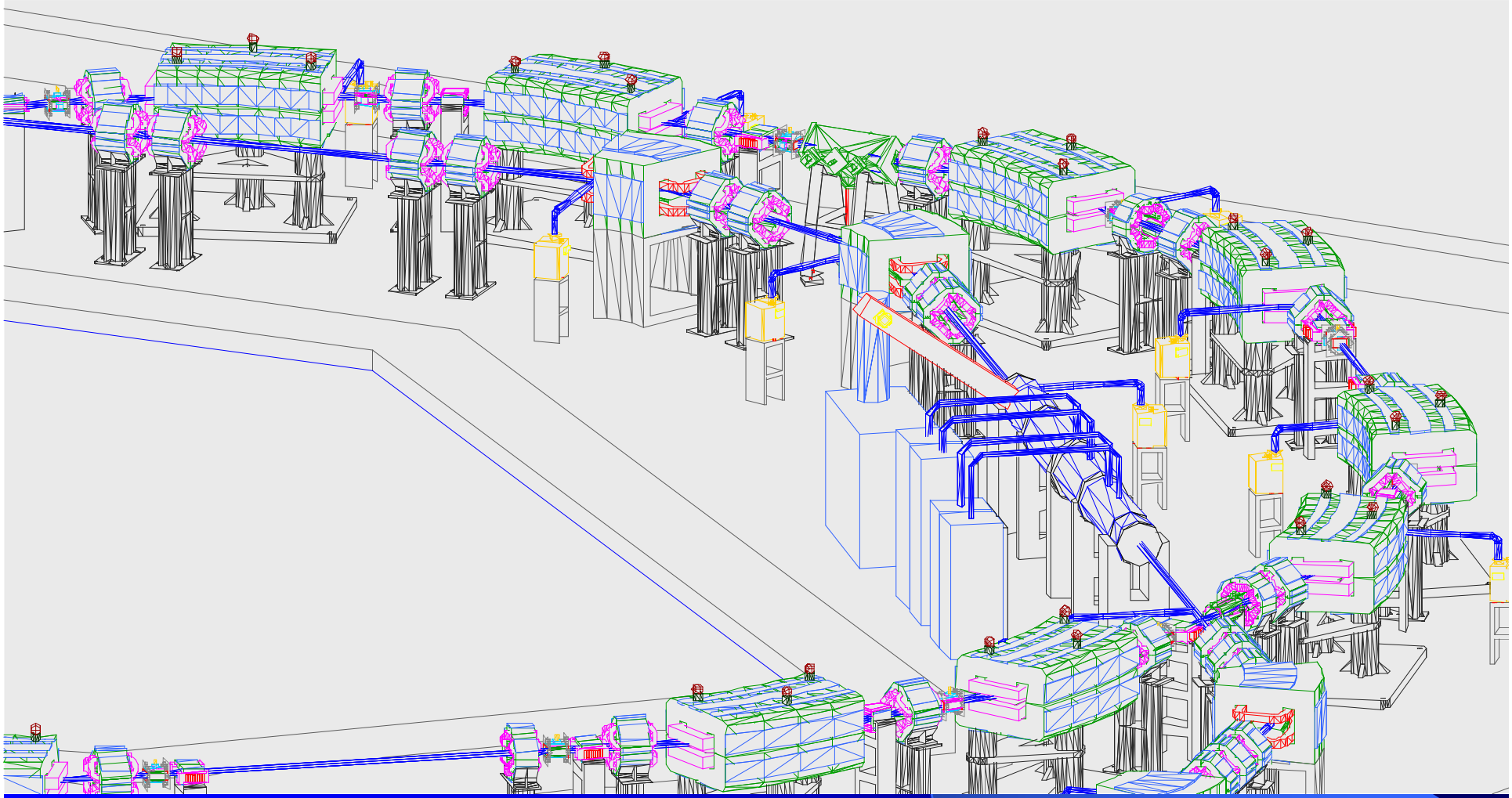
CNA: HIGH TECHNOLOGY



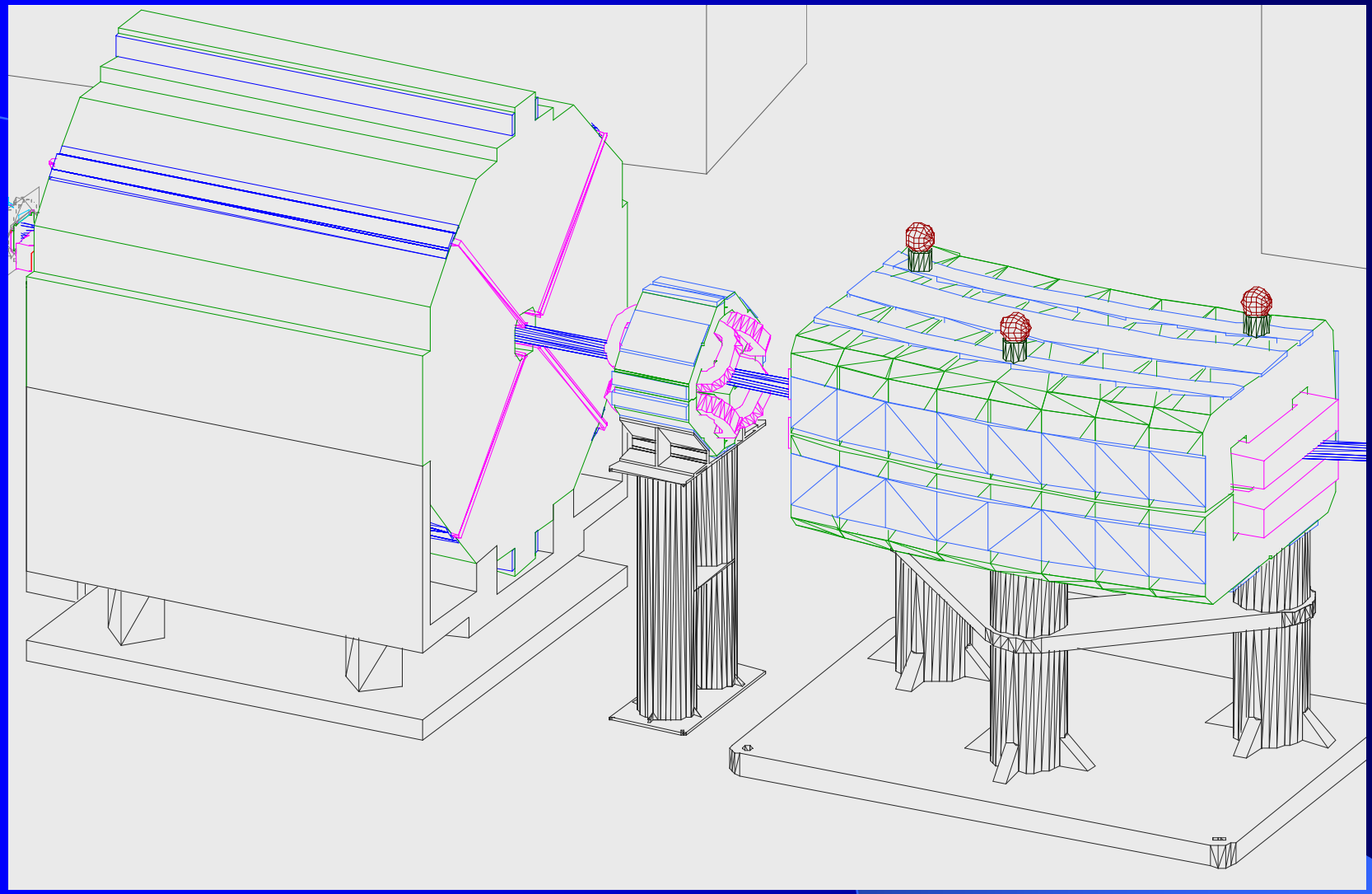
CNA HIGH TECH: SOURCES AND LEBT



CNA HIGH TECH: LINAC AND MEBT



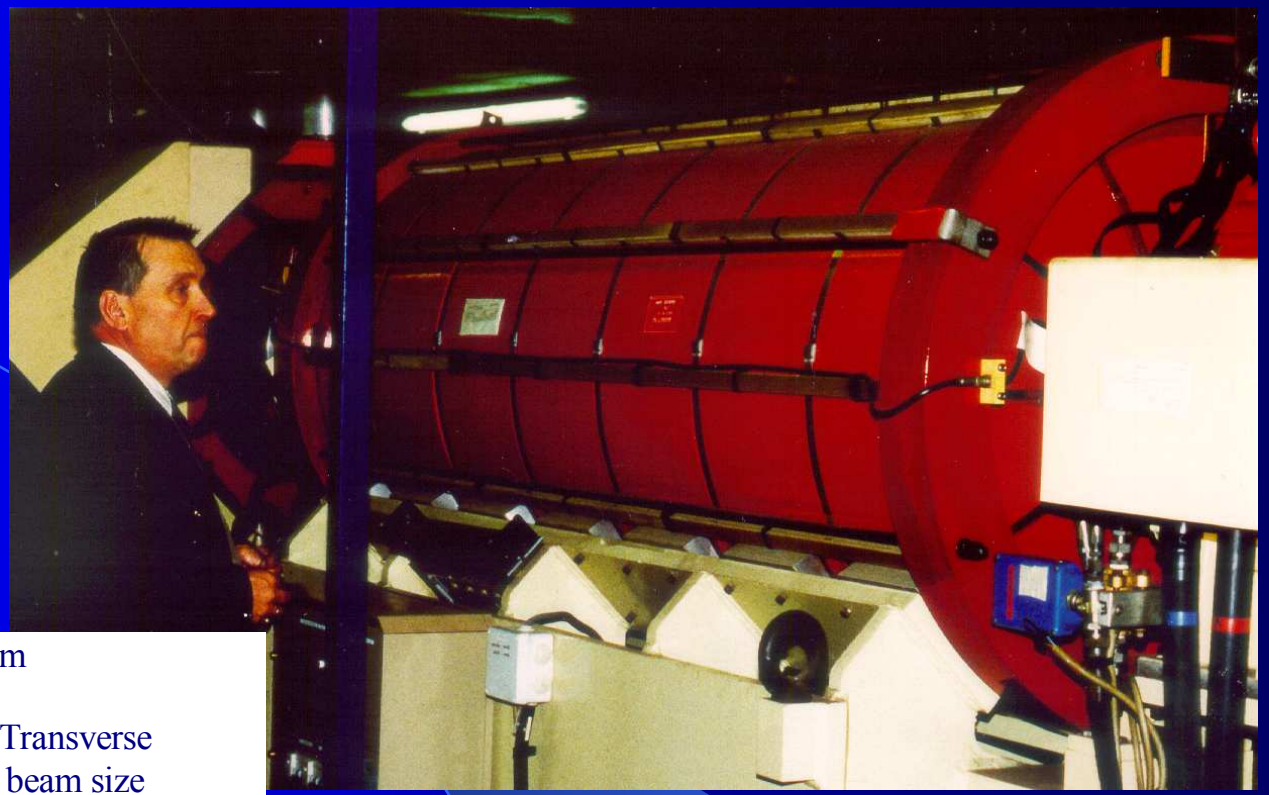
CNA HIGH TECH: BETATRON+QUAD+DIPOLE

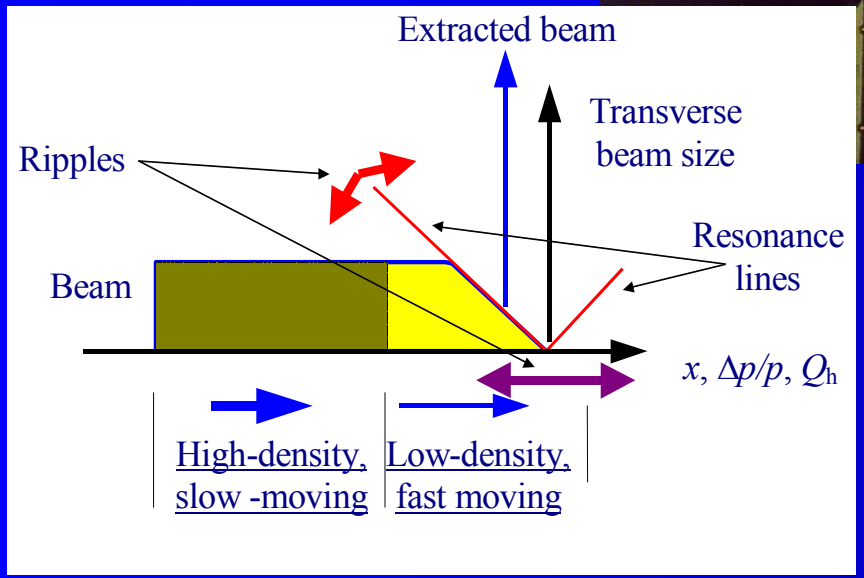


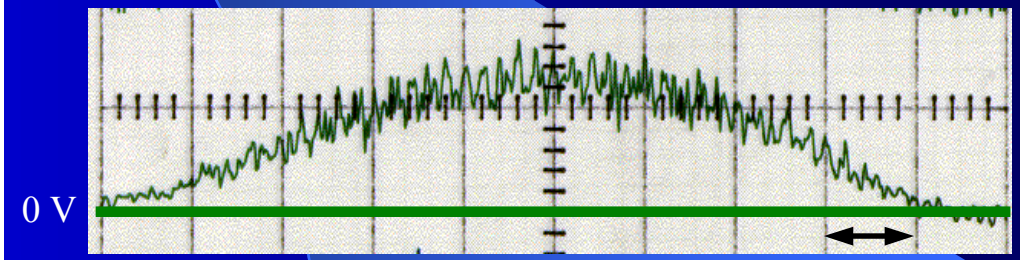
CNA HIGH TECH: THE BETATRON

Gephyrotron

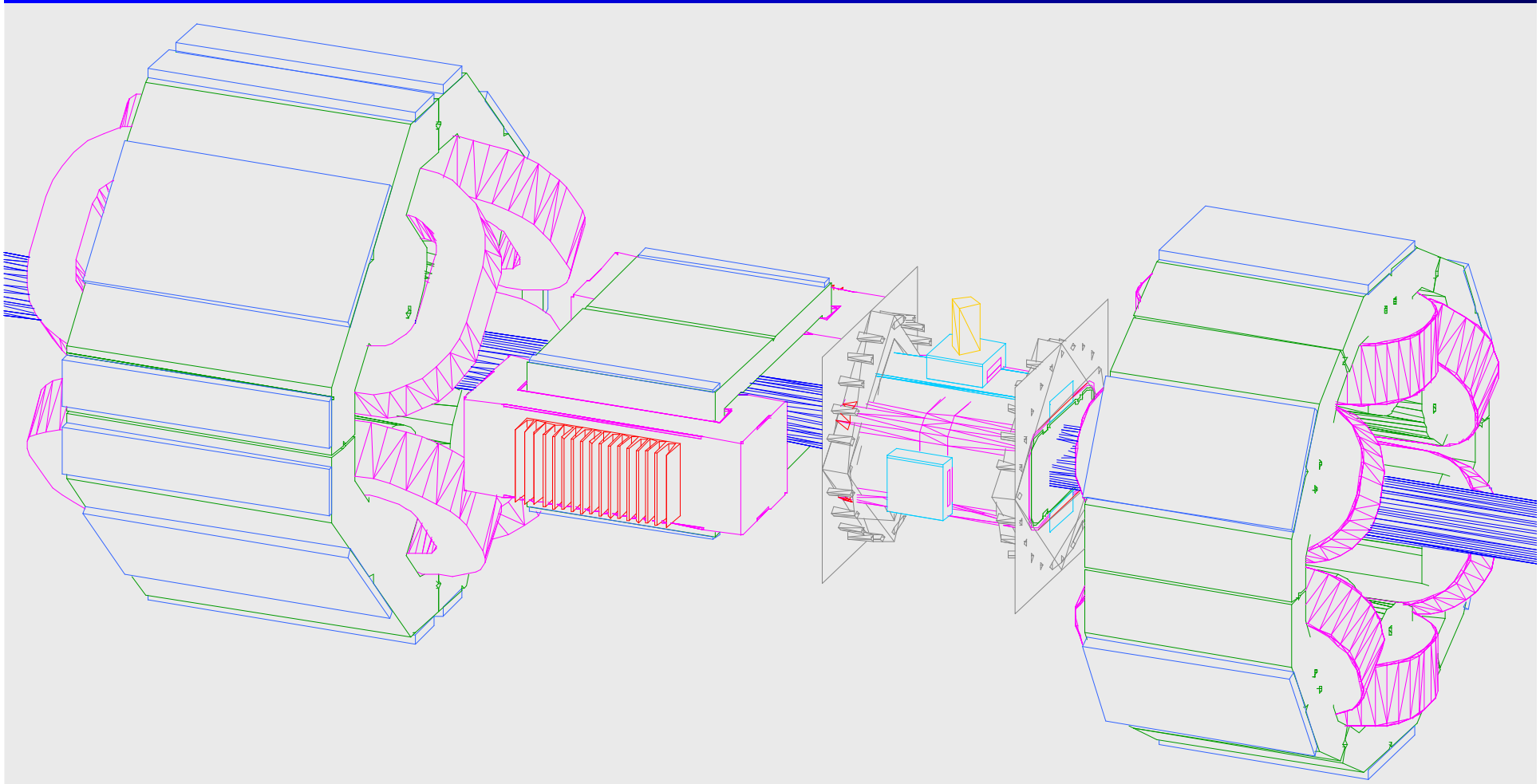
Saturne (Saclay)



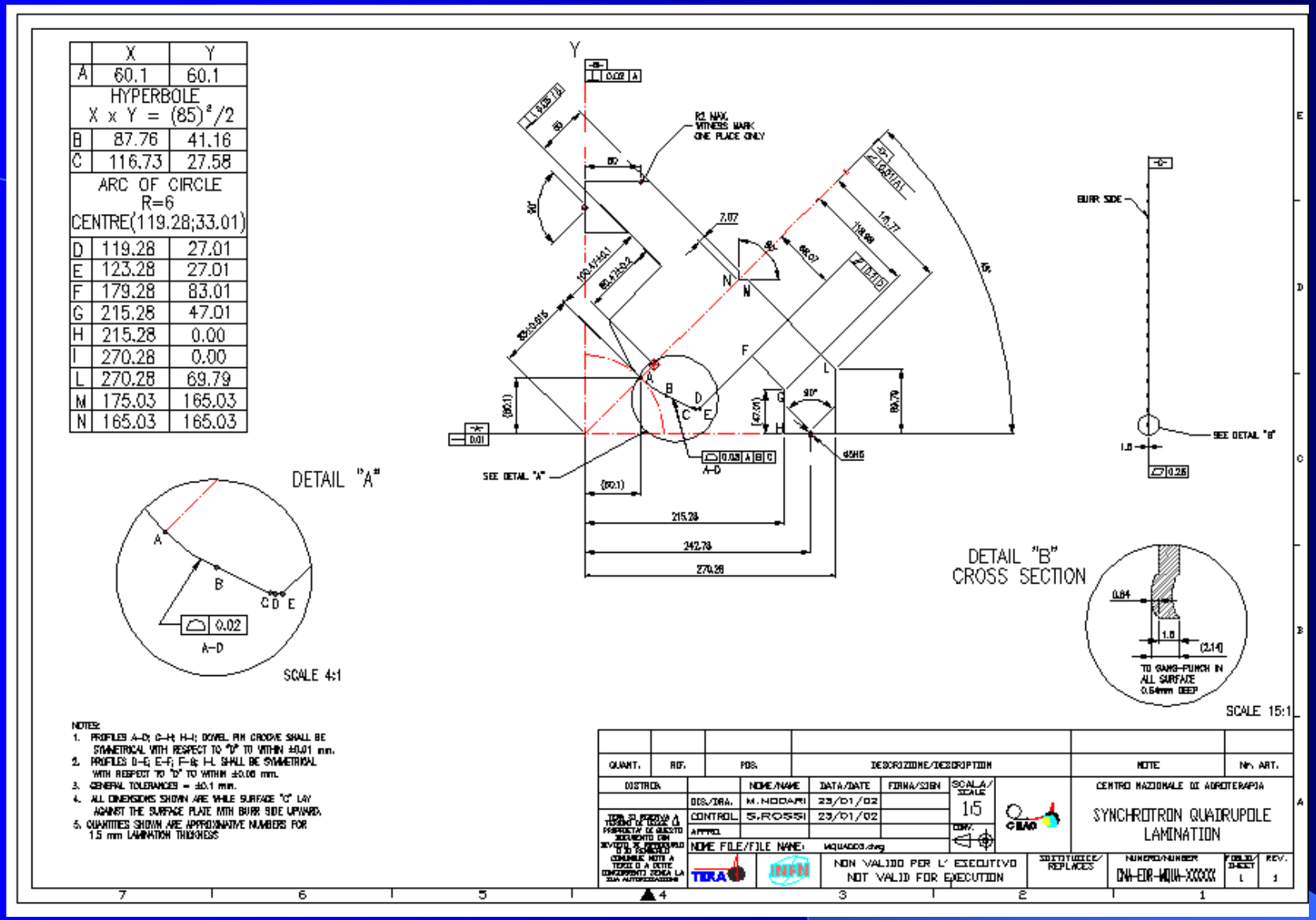




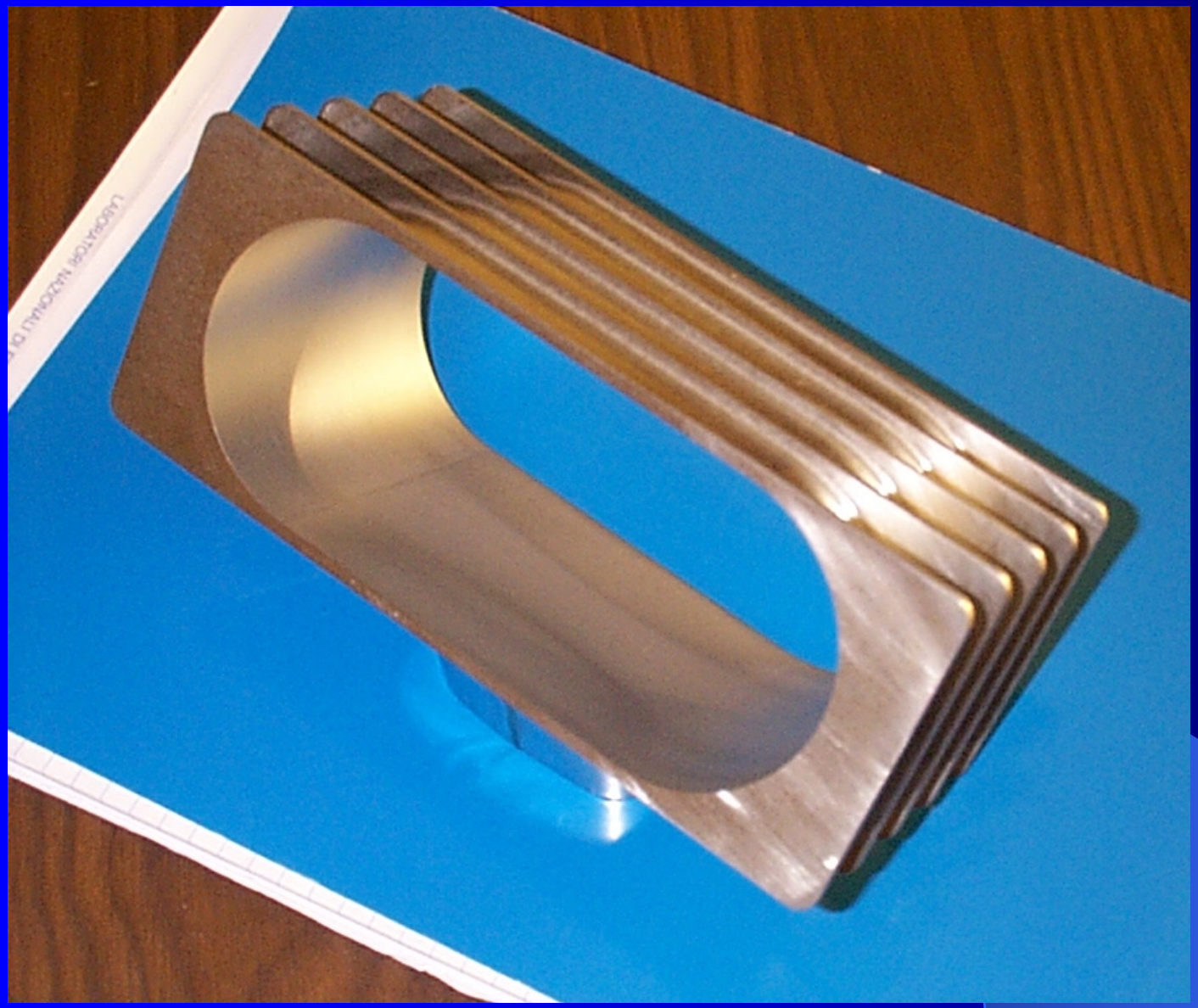
CNA HIGH TECH: QUAD+COR+PU+SEXT



CNA HIGH TECH: SPECS (QUAD) PREPARATION



CNA HIGH TECH: DIPOLE CHAMBER PROTOTYPE

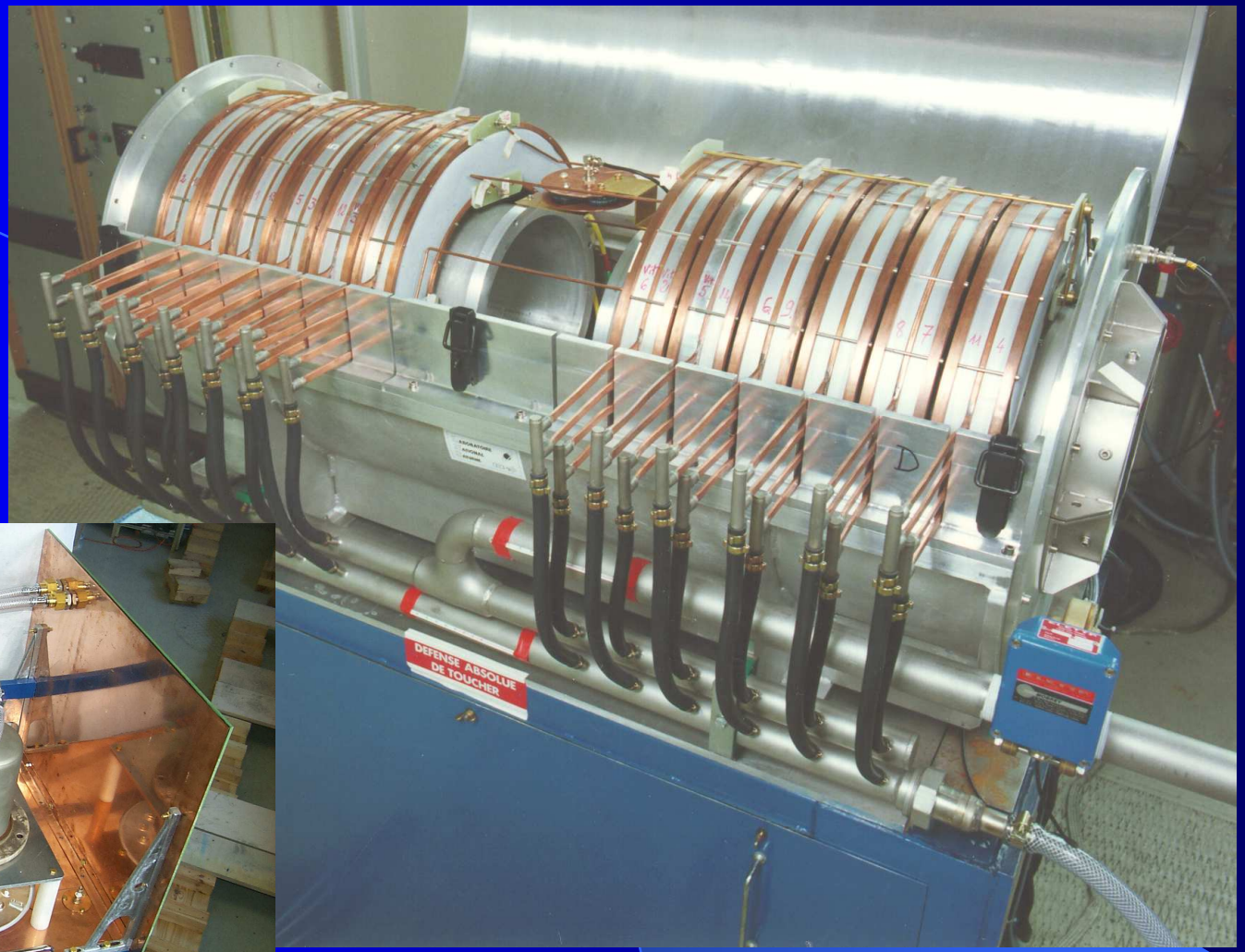


CNA HIGH TECH: VITROVAC RF CAVITY

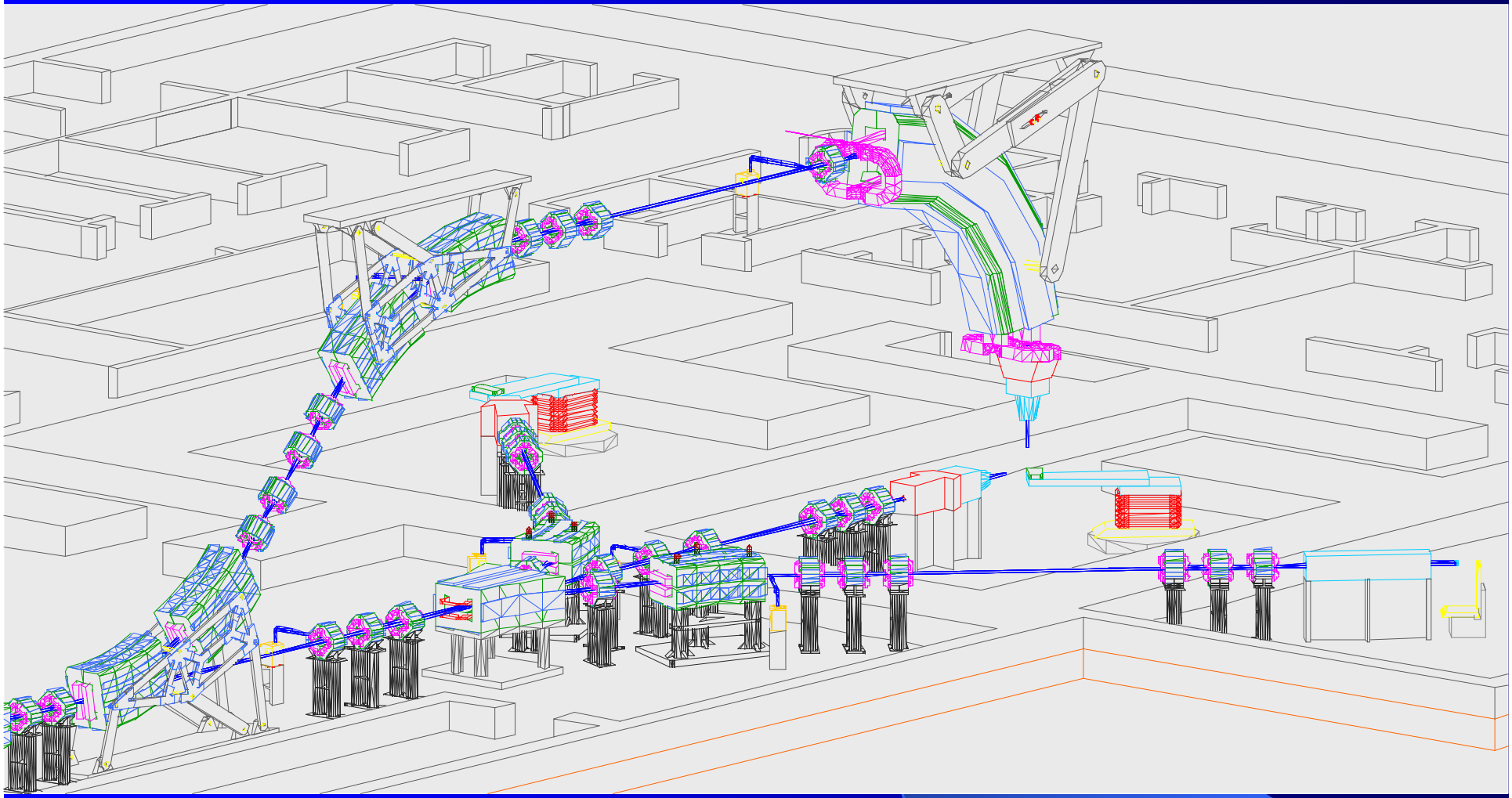
Bought from

Saclay

(Saturne)



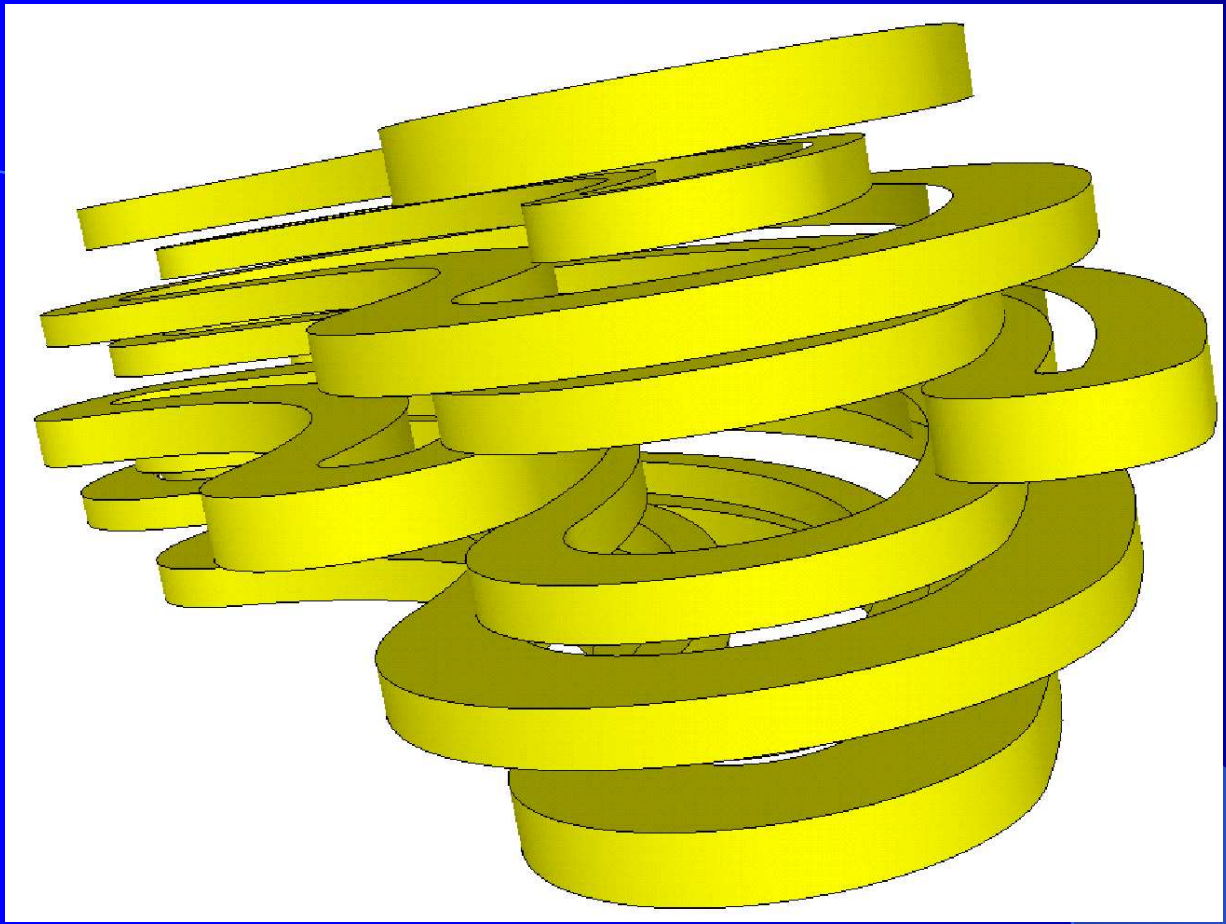
CNA HIGH TECH: 3 HORIZ+1 VERT



3 treatment rooms with protons and carbon – 4 beamlines: 3h + 1v

Active scanning and beam FWHM variation (4 -10 mm) at the isocentre

TESI: THE LIGHT ION GANTRY

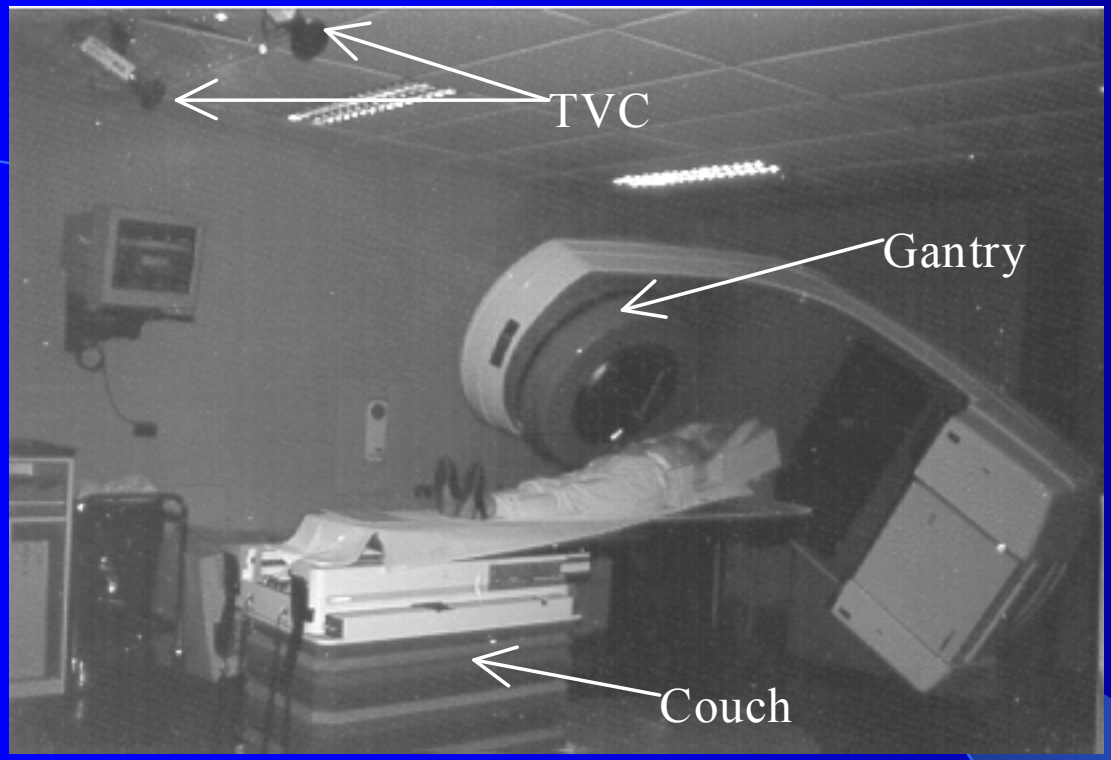


B field = 4 T

Lightweight = simplified mechanics

Cryogenic-free superconductor = low power

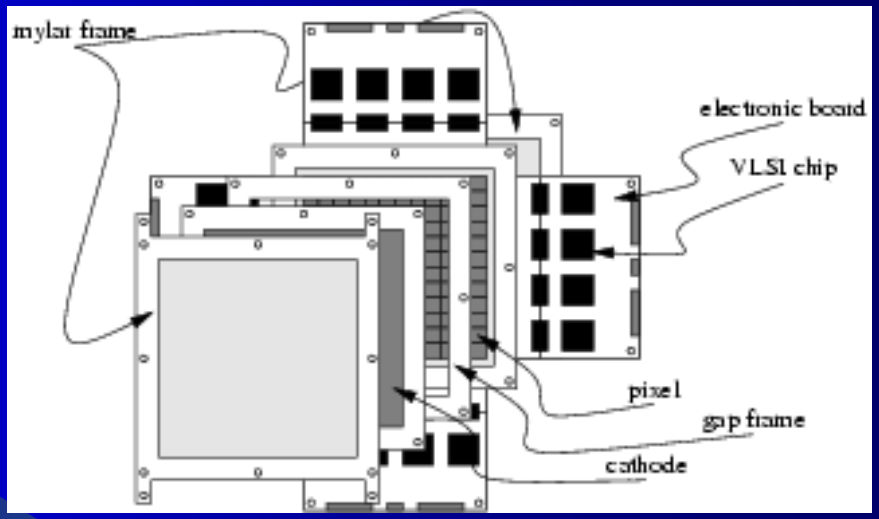
CAP: PATIENT POSITIONING

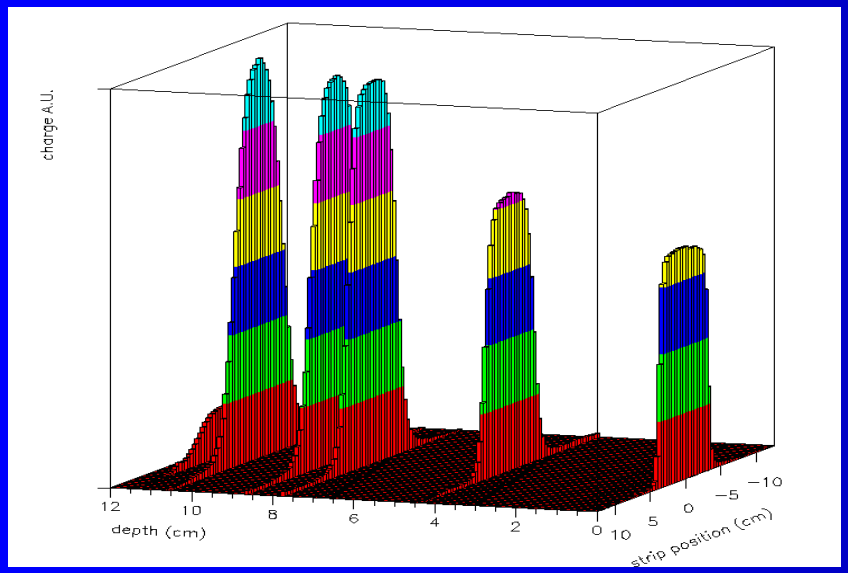


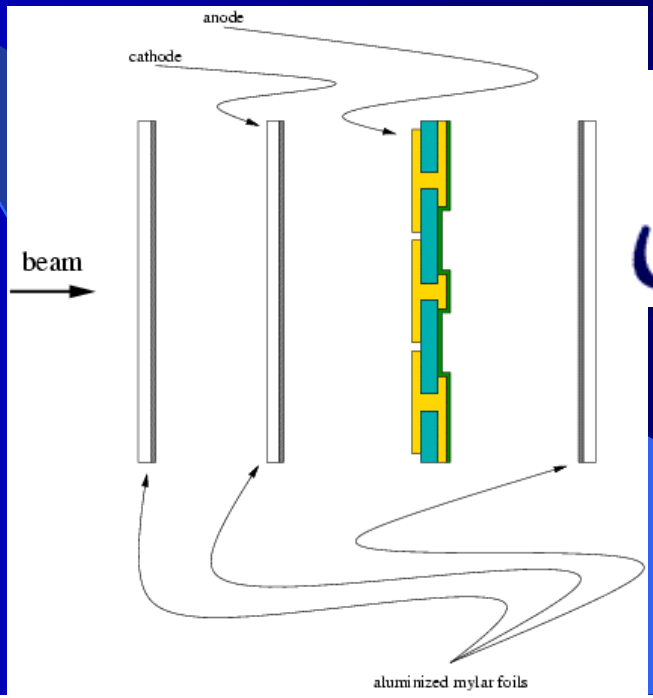
Istituto Europeo di Oncologia

- **2 TV Cameras**
- **100 Hz** sample rate
- **5 mm** markers
- **2 real-time acquisitions**: at each irradiation (immediately before and during the irradiation)
- **5 patients**
- **global 3-D accuracy** in marker localisation: **0.34± 0.11** [mm] *(N=4)*

MAGIC CUBE & PIXEL CHAMBER

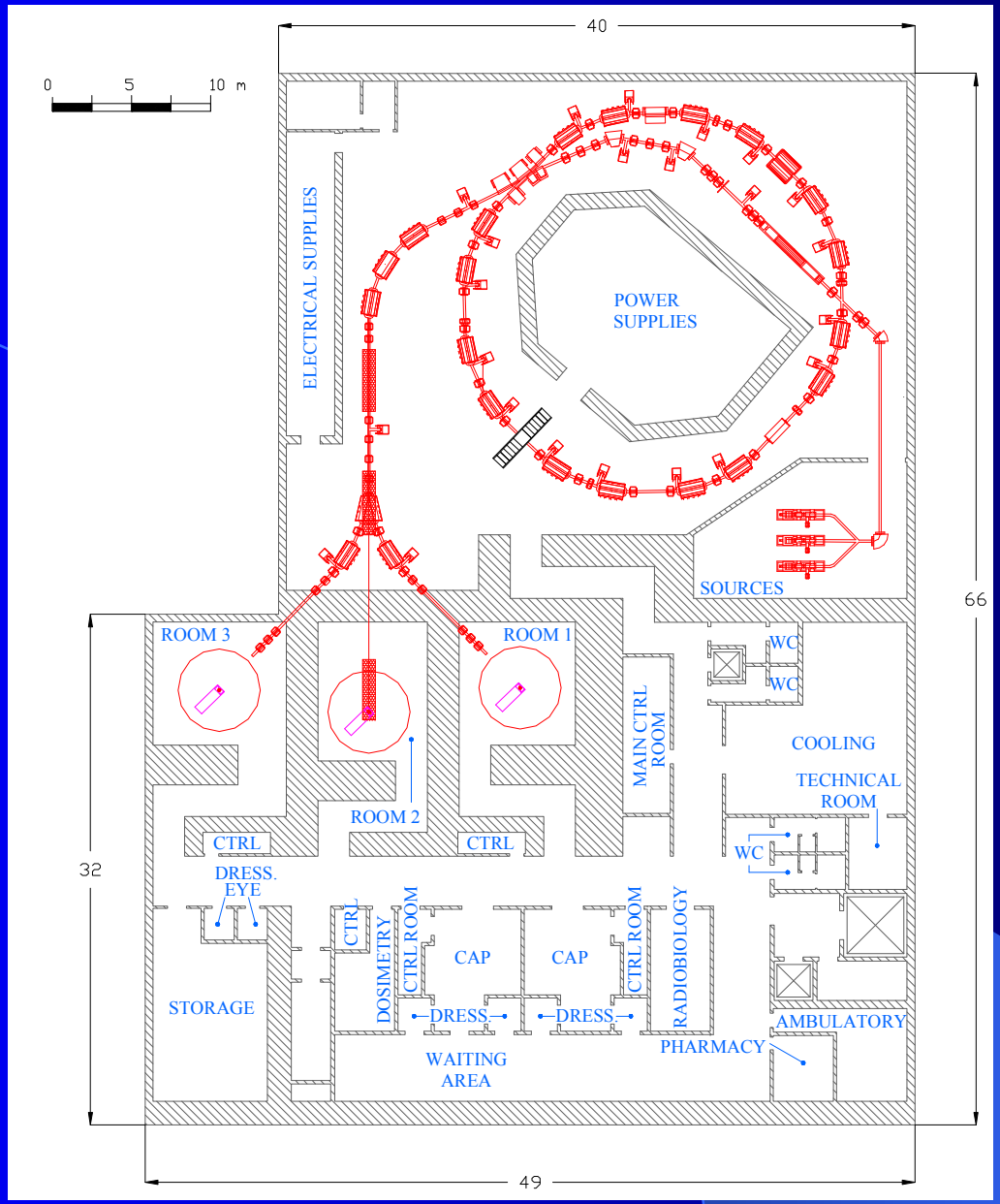




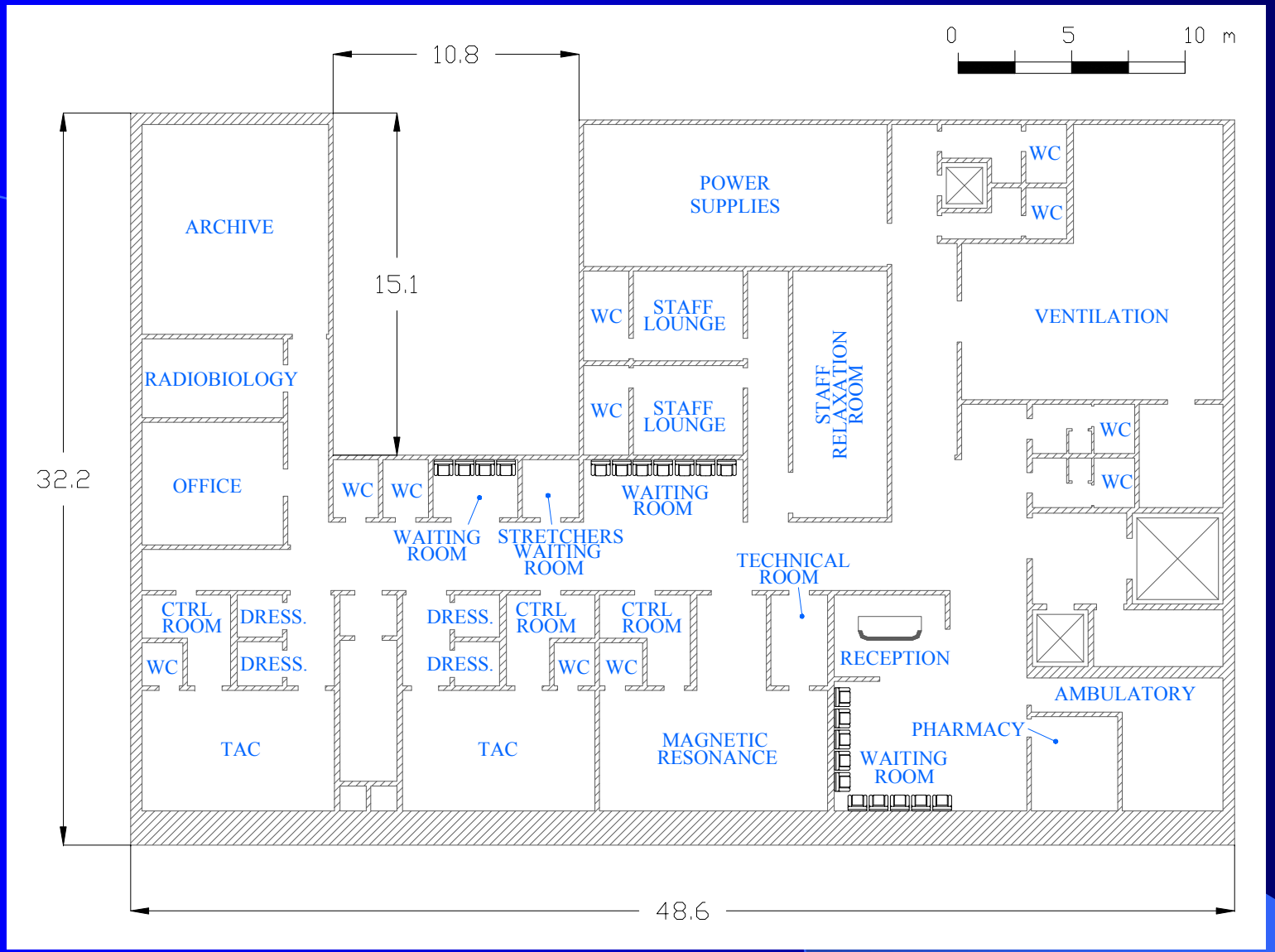


INFN

CNA LAYOUT: TREATMENT LEVEL (-2)



CNA LAYOUT: DIAGNOSTICS LEVEL (-1)

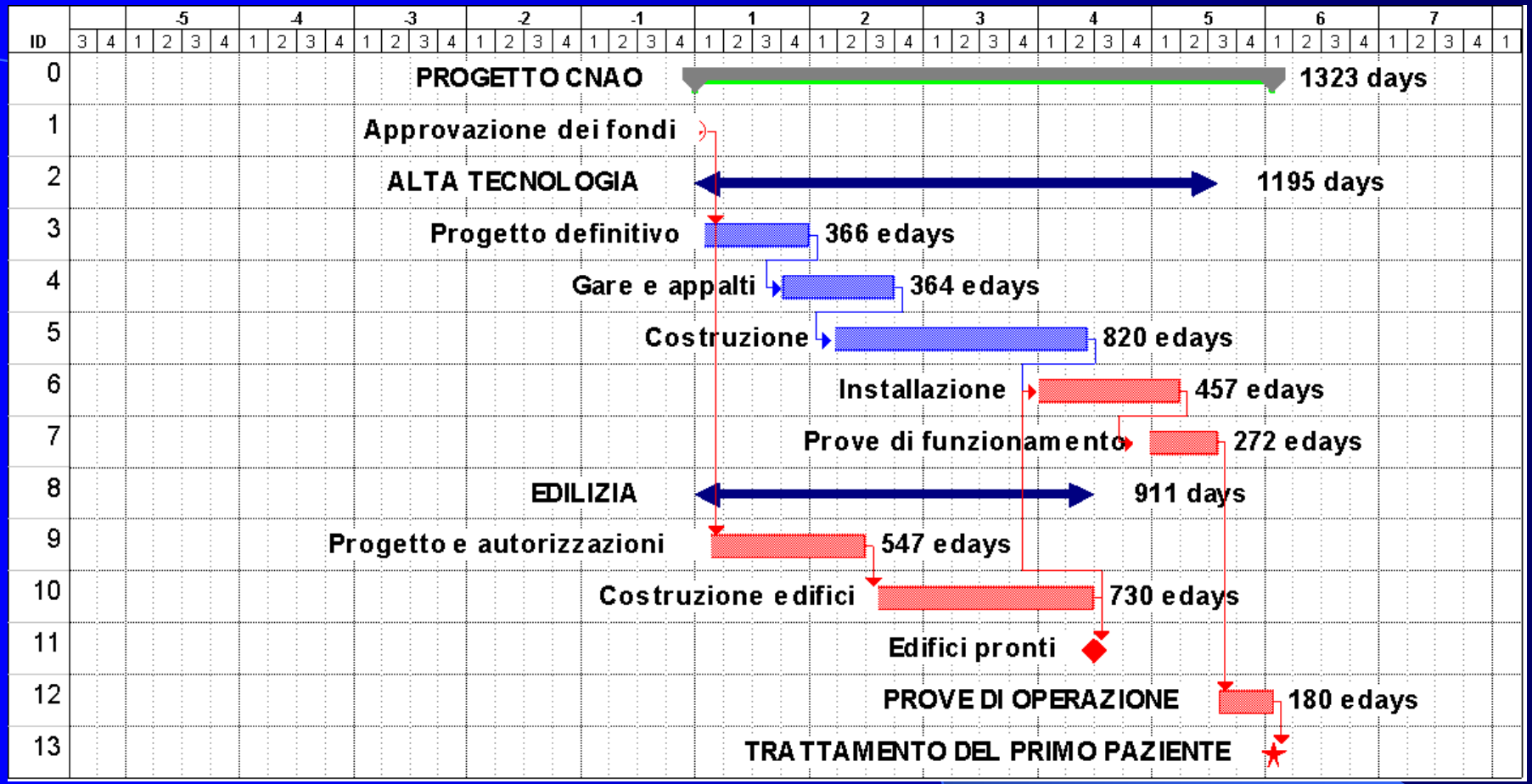


CNA SURFACE BUILDING

CNA COSTS

CNA GLOBAL COSTS IN MEuro	
High-tech and Diagnostics	31.2
Accelerator, beam lines, delivery and auxiliary systems	*24.8*
Treatment monitoring, patient positioning and planning	*4,2*
Medical equipment for diagnostics	*2,2*
Buildings and conventional plants	10.1
Personnel for project management, installation and commissioning	9.3
Services and running costs during installation and commissioning	2.7
VAT	7.2
Contingency	5.2
Total cost	**65.7**

CNA: CONSTRUCTION TIMETABLE



CNA: USEFUL NUMBER - 1

Running conditions and number of patients in Phase 1

Year of running	1	2	3	4 R
Working hours per day	7	7	7	7
Working days per week	5	5	5	5
Equivalent weeks per year	44	44	44	44
Protons				
Equivalent treatment rooms	2	2	2	2
Patient treated per year	**200**	**400**	**548**	**548**
Number of sessions per year	**3370**	**6740**	**9234**	**9234**
Carbon ions				
Equivalent treatment rooms	1	1	1	1
Patient treated per year	**100**	**200**	**350**	**385**
Number of sessions per year	**800**	**1600**	**2800**	**3080**
Totals				
Patient treated per year	**300**	**600**	**898**	**933**
Number of sessions per year	**4170**	**8340**	**12034**	**12314**

CNA: USEFUL NUMBER - 2

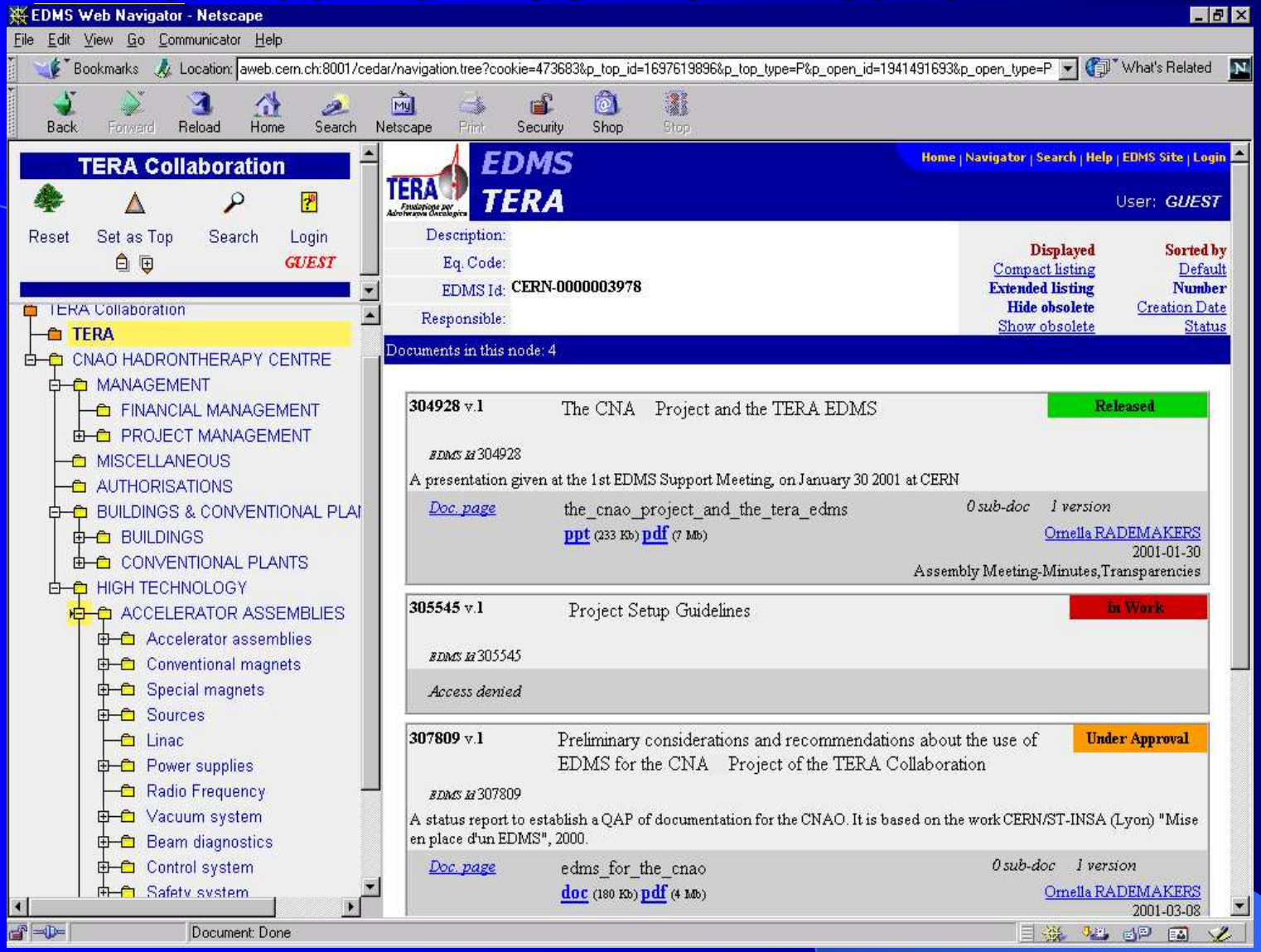
Personnel of CNAO

Year of running	1	2	3	4R
Administration	5	5	5	5
Medical Department	24	28	34	35
Physics Department	21	24	26	26
Total	**50**	**57**	**65**	**66**

Fees per session [Euro]

	Ocular melanoma	Deep seated tumours
CNAO	**1'211**	**670**
Mean in USA		2'120
Mean in Europe	1'960	
Mean in European projects		930

EDMS: A USEFUL TOOL FOR PROJECT MANAGEMENT



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