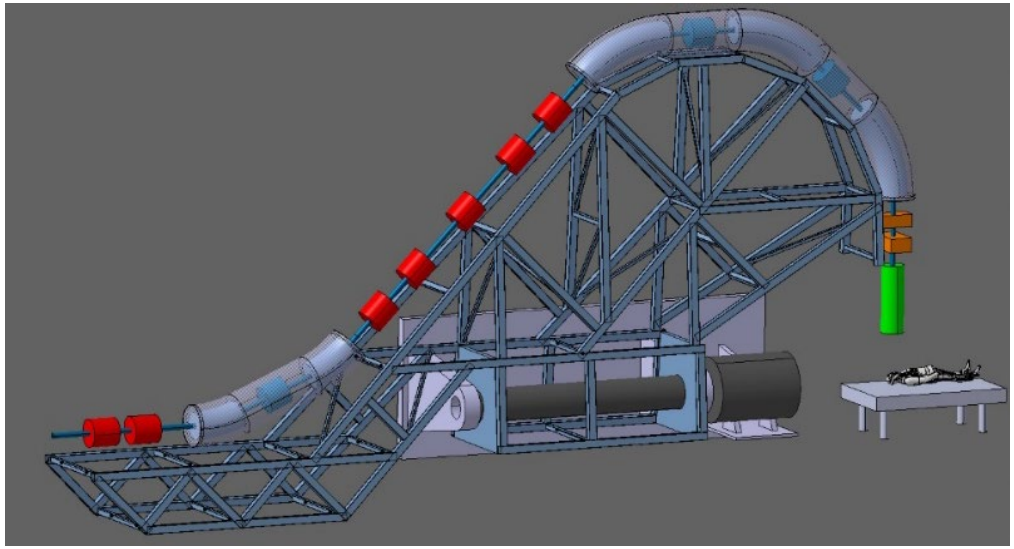
SIG
SUPERCONDUCTING ION GANTRY

The proposal concerns the study and development of the key elements of a novel generation gantry for hadron therapy, optimized for ion beams



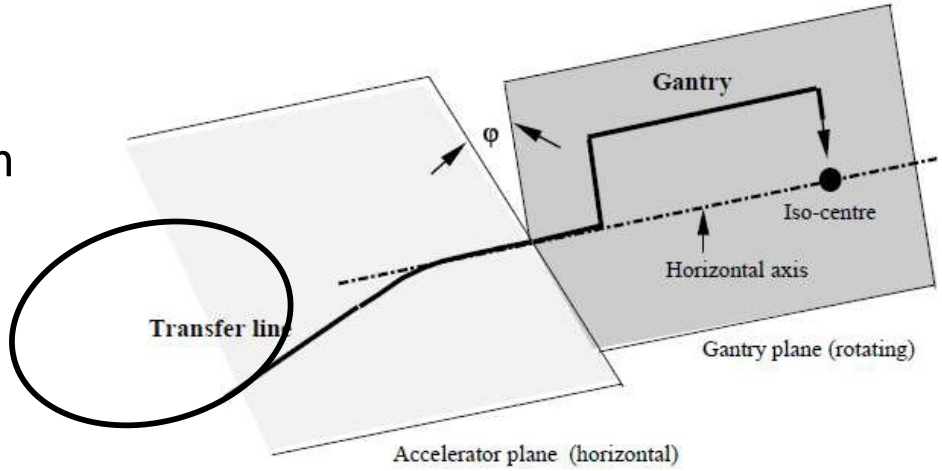
submitted to 2021 csn5 call
areas: accelerators & detectors – interdisciplinary

units: Ge, Mi, To, LNF

national resp.: Lucio Rossi

WHAT IS A GANTRY?

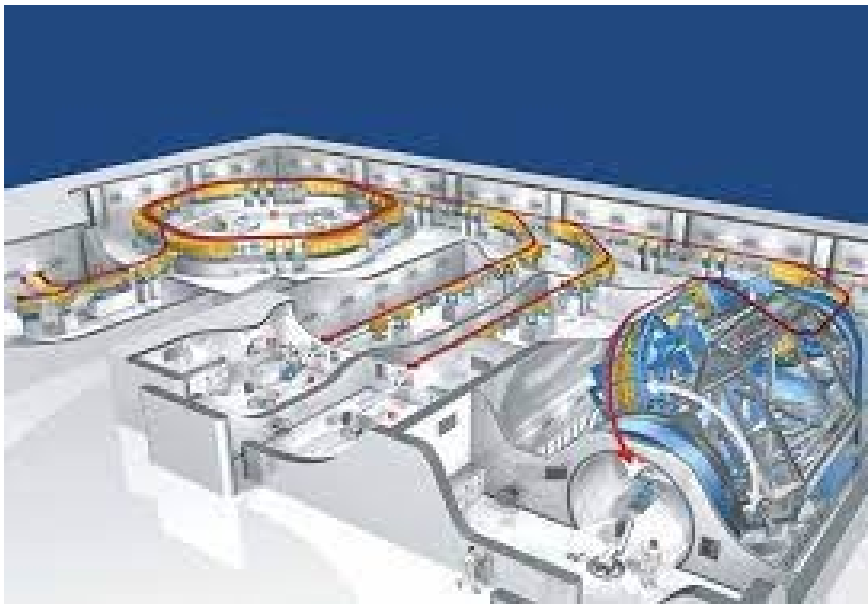
A gantry is a section of beamline that can rotate around the isocenter in order to direct the beam onto the patient from any direction



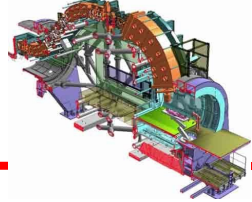
Courtesy M. Pullia, CAS Accelerators for medical applications 2015

Why a gantry?
- To treat patient in supine position, the same in which CT, PET and MRI were acquired
- To provide the maximum flexibility in selecting the the irradiation direction

Proton gantry: Mitsubishi, Hitachi, Iba…
Carbon ion gantry: only two existing (HIT-HIMAC)



ION GANTRIES - STATE OF THE ART



HIT (1° rotating ion gantry)

Heidelberg Ion Therapy

Resistive magnets

L = 25 m, diam = 13 m

600 ton rotating mass

360° rotation

200 x 200 mm2 field

HIMAC-Japan

Heavy Ion Medical Accelerator in Chiba

Superconducting magnets

L = 14 m, diam = 13 m

330 ton

10 magnetic units, increasing aperture, decreasing field (2.88 – 2.37 T)

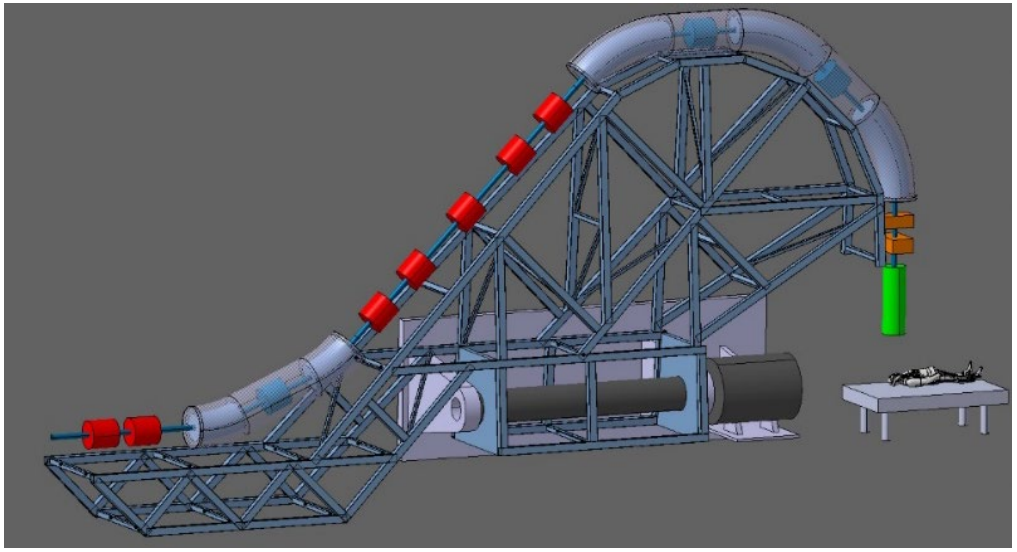
SIG PROPOSAL

GOAL: design a **compact gantry**

L = 12m long

H = 5m

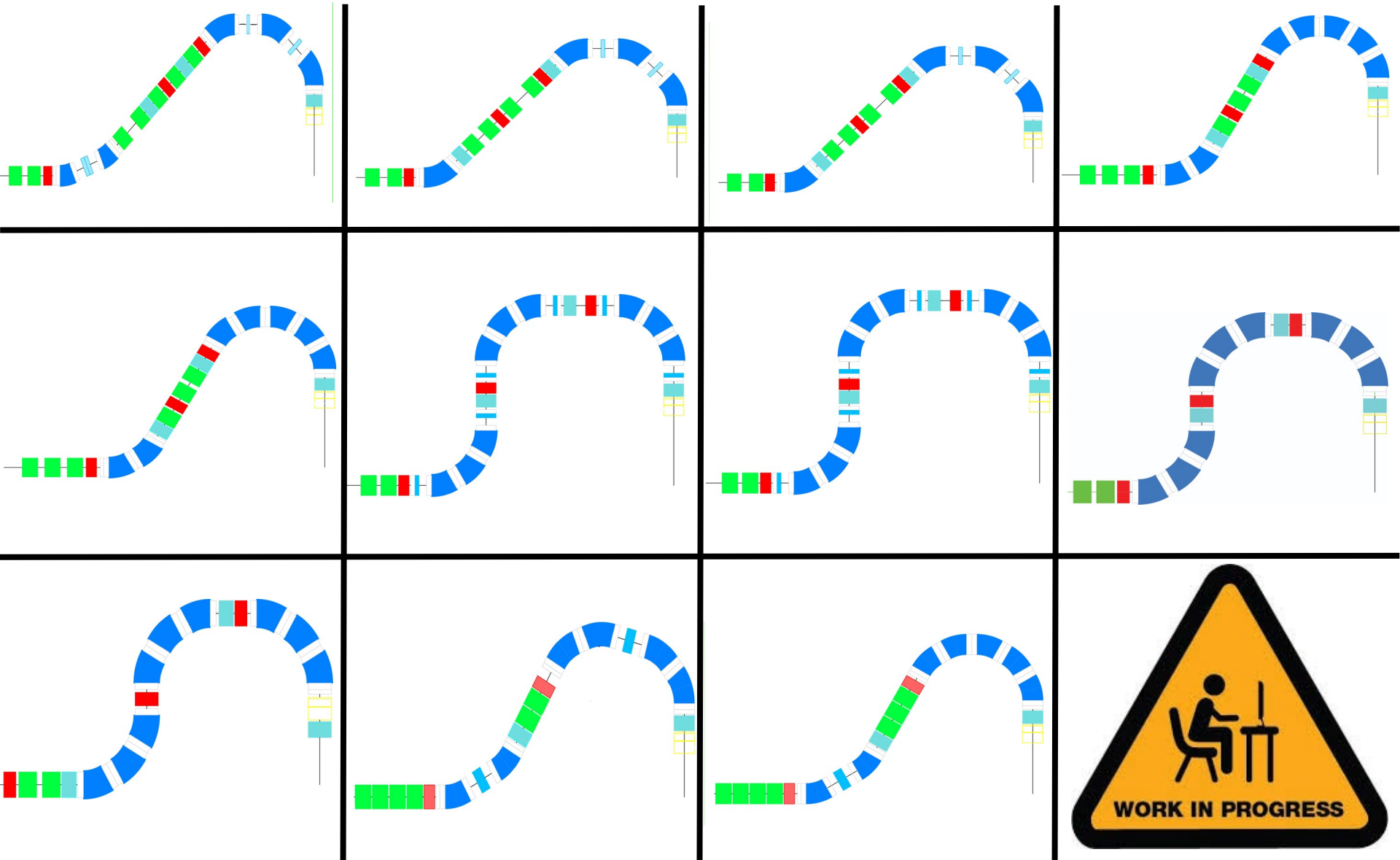
Weight: about 50 tons



Key elements:

- Superconducting bending magnets
- Scanning magnets
- Diagnostics

SIG PROPOSAL



PROJECT ORGANIZATION & BUDGET

	Description of WP	Institution	Coordinator	Budget (k€)
WP1 – PC	Project Coordination and Dissemination	MI	Lucio Rossi	44
WP2 – SMD	Superconducting Magnet Demonstrator	MI + GE	Lucio Rossi	591 (163 Ge + 428 Mi)
WP3 – SMS	Scanning Magnet System study	LNF	Lucia Sabbatini	71
WP4 – DDS	Technologies for Dose Delivery System	TO	Simona Giordanengo	174
WP5 - RVS	Range Verification System	TO	Elisa Fiorina	120
				1000

SIG is integrated in a European effort for ion therapy facility:
Framework agreement between CERN, CNAO, INFN and (prob.) MedAustron

External further financial contribution to the SIG project: 670 k€ (all to WP2)

1. CNAO: 350 k€ (cash)
2. CERN: 250 k€ (components)
3. Previous INFN projects (conductor DISCORAP): 70 k€

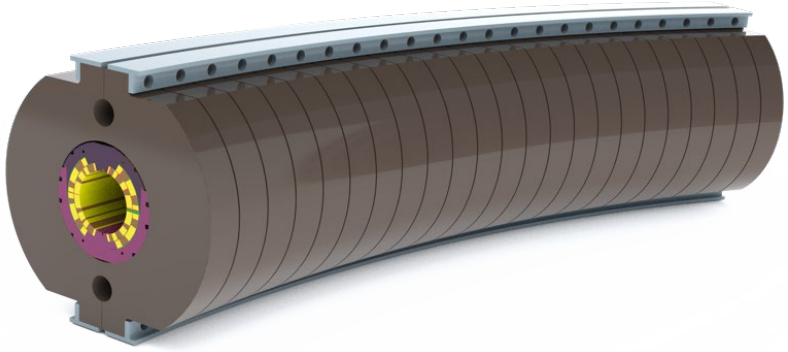
WP2: STUDY, DESIGN, MANUFACTURING AND TEST OF A SUPERCONDUCTING DIPOLE MAGNET DEMONSTRATOR

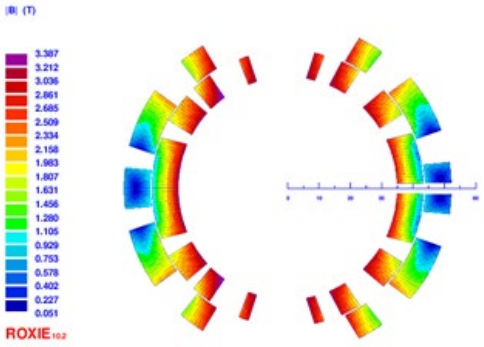
Curved demonstrator magnet: 30° sector dipole

Increasing the field from less than 3 T to 4-5 T (goal: mass and volume reduction)

Possible parameters range between 5 T field with 70 mm bore, 4 T field with 90 mm bore: the parameter set will be frozen at the beginning of the project

Preliminary design, choose of cable layout, stability & quench studies. Detailed engineering design: different winding methods. Special tooling for mock up. Assembly and experimental tests(room temperature and cold test).





MI team: L. Rossi, M. Sorbi, F. Broggi, M. Statera, M. Prioli, E. Dematteis, S. Mariotto + tech.
GE team: R. Musenich, S. Farinon, A. Pampaloni + tech.

WP4 - STUDY AND DEVELOPMENT OF A BEAM MONITORING PROTOTYPE

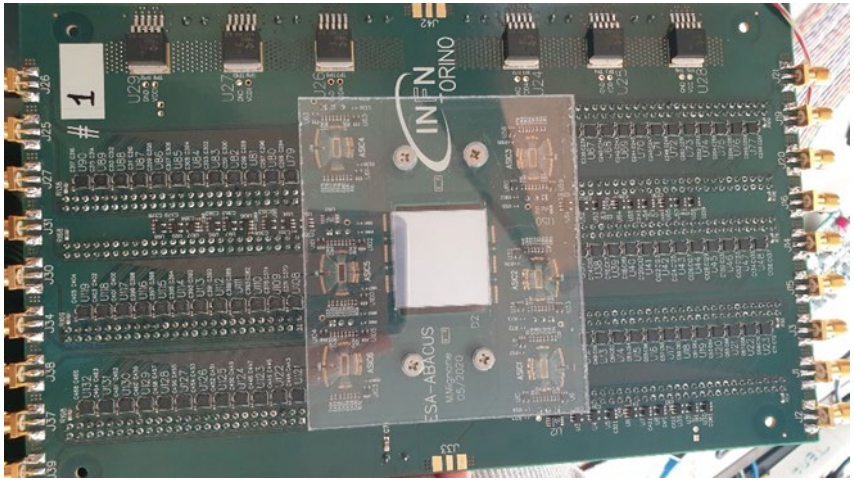
Silicon detector for DDS (dose delivery system)

Originality: direct measurement of the crossing time and position of each particle of the beam delivered to the patient: from beam tracking (based on gas detectors) to ***single particle tracking*** based on solid state detector technology.

Frontend readout with timing capabilities.

Test campaign with ion beams.

Collaboration with GSI.



TO team: S. Giordanengo, R. Sacchi, R. Cirio, F. Milian, S. Garbolino + technicians

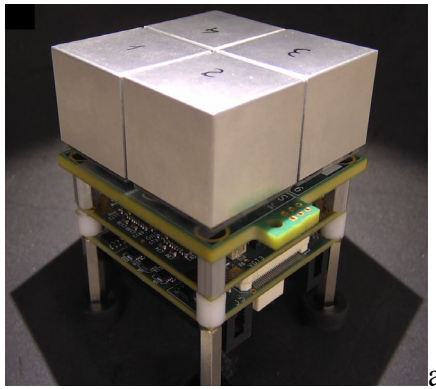
WP5 - STUDY, DESIGN AND TEST OF THE BASIC ELEMENT FOR A NEW CONCEPT OF RANGE MONITORING FOR IONS

Detectors for RVS (range verification system)

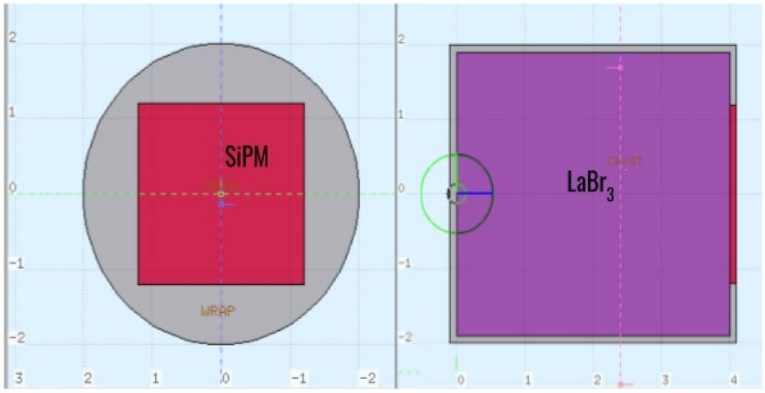
Studying the solution for ions treatment considering both annihilation photons from fast decaying positron emitters and prompt photons (PGT: Prompt Gamma Timing technique, based on the TOF distribution, correlated to the primary particle range).

Test with ion beams.

Collaboration of Lubeck University.



a)



b)

TO team: E. Fiorina, F. pennazio, P. Cerello, V. Ferrero, A. Patera, R. Wheadon

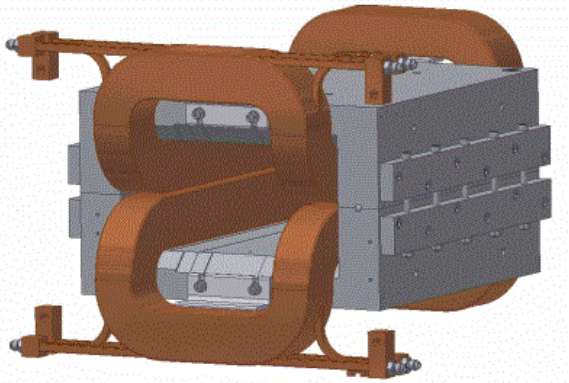
WP3 - STUDY AND DESIGN OF HIGH FIELD SCANNING MAGNET SYSTEM

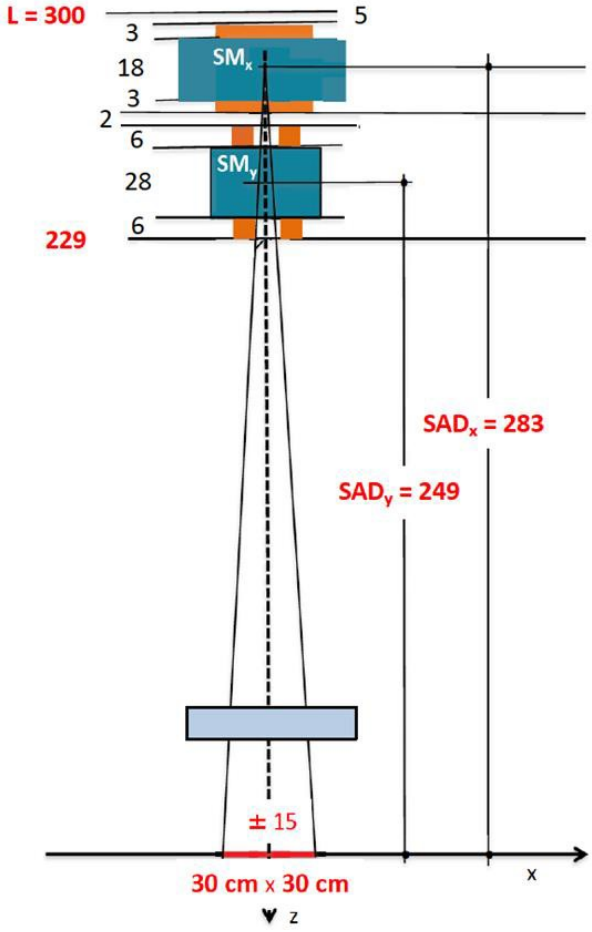
Design of scanning magnet system:

challenging from electromagnetic point of view (large aperture, field quality, longitudinal size, settling time…)

scanning area @ isocenter: 30 cm x 24 cm

settling time: down to 100 µs





Studies for alternative layouts:

special configurations with variable aperture along the length (tapering) as well as combined function (XY coupling)

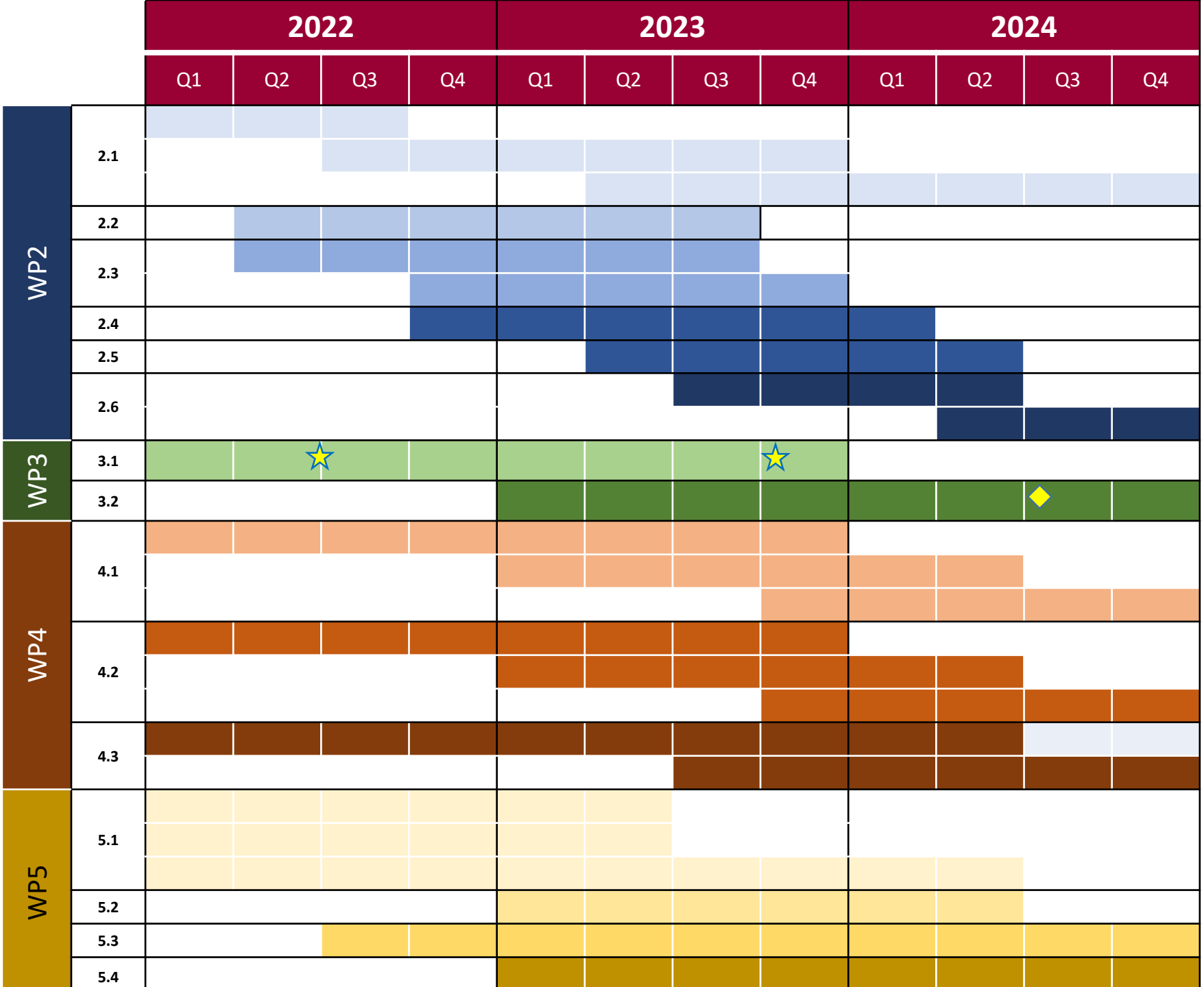
LNF team: L. Sabbatini, A. Vannozzi, L. Pellegrino

LNF: MILESTONES, TEAM AND BUDGET

Milestones:

MS3.1	Conceptual design of the scanning magnets	(M6)
MS3.2	Detailed design (magnetic, electric and mechanical structure)	(M22)
DLV3.1	Complete technical specifications of the scanning magnets	(M32)

Team	**2022**	**2023**	**2024**	**TOT**
WP3 – SMS	**FTE**	**FTE**	**FTE**	**FTE-y**
Lucia Sabbatini	0,3	0,3	0,2	0,8
Alessandro Vannozzi	0,5	0,5	0,5	1,5
Luigi Pellegrino	0,1	0,1	0,1	0,3
Fellow (under recr.)	0,2	0,2	0,2	0,6
New temp position (AR tecnologo junior)	1	1	0	2
	2,1	2,1	1	5,2
Budget (k€)	**2022**	**2023**	**2024**	**TOT**
Licenza software	5	5	5	15
Missioni	2	2	2	6
AR tecnologo junior	25	25		50
WP3 TOT	32	32	7	71


2022
2023
2024
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WP3
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WP4
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WP5
5.1
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