Costs and Planning and Organizational Structure

1 Cost estimates

These estimates have been made on the basis of in-house experience with and extrapolation from the construction of the SIS/ESR project, the recent industrial bids for the Hadron Therapy project, and consultations with colleagues from CERN and DESY. In addition, the cost estimates for the civil engineering have been established by a reputable company with experience in large projects like HERA.

The present estimate of the **total cost** of the facility is **675 MEuro**. Of these are 225 MEuro for civil construction and infrastructure, 265 MEuro for accelerator components and 185 MEuro for instrumentation and major detectors. These costs include all manpower costs for commercial activities, in particular civil construction and fabrication by industry of various components and sub-systems, including installation, some testing and quality assurance.

The cost does not include redirected manpower from GSI (120 full-time-equivalent positions (FTE) on average for the duration of facility construction) and new (permanent and temporary) staff (140 FTE) for engineering design, procurement, assembly, on-line testing and commissioning and for project management.

SIS18 Upgrade

Vacuum	2.5 M€
Fast ramping mode	7.5 M€
Total	**10 M€**

Cryogenic System

Refrigerator (20-25 kW sufficient to cool also sc-rings if chosen)	10 M€
Distribution only SIS100/SIS200	1.4 M€
Controls	1 M€
Total	**12.4 M€**

SIS100/200 synchrotrons

	SIS100	SIS200
Magnets	14.0 M€	15.8 M€
Power supplies	10.0 M€	6.0 M€
Rf acceleration	17.0 M€	4.5 M€
Rf bunch compression	11.5 M€	-
Rf barrier bucket	1.0 M€	-
Beam injection/extraction	4.4 M€	3.8 M€
Vacuum system	3.6 M€	3.6 M€
Beam diagnostics	2.8 M€	2.3 M€
Controls	5.8 M€	3.6 M€
Total	**70.1 M€**	**39.6 M€**

Collector Ring (CR) (On the basis of normal conducting magnets)

Magnets (normal conducting types)	12.0 M€
Magnet power supplies	8.0 M€
Rf generators and cavities	8.0 M€
Stochastic cooling	6.5 M€
Beam injection/ejection	2.5 M€
UHV components and pipes	3.0 M€
Beam diagnostics	1.5 M€
Controls	3.5 M€
Total	**45.0 M€**

New Experimental Storage Ring (NESR)

Magnets	9.0 M€
Magnet power supplies	7.5 M€
Rf generators and cavities	4.0 M€
Beam injection/ejection	2.5 M€
Electron cooling device (RIB)	3.0 M€
Stochastic cooling (pbar)	5.5 M€
UHV components and pipes	3.0 M€
Beam diagnostics	1.5 M€
Controls	4.0 M€
Total	**40.0 M€**

Electron Ring and Electron Injector

Electron ring	8.0 M€
500 MeV injector	7.0 M€
Total	**15.0 M€**

Proton Linac

Proton linear accelerator and pre-injector	**10.0 M€**

Pbar-Target

Magnets	2.5 M€
Magnet power supplies	1.5 M€
Production target with Li-lens or magnetic horn	1.6 M€
UHV components and pipes	0.6 M€
Beam diagnostics	0.5 M€
Controls	0.2 M€
Total	**6.9 M€**

High Energy Storage Ring (super-conducting magnets)

Magnets (superconducting, incl. liqu. He distribution)	14.5 M€
Magnet power supplies	7.0 M€
Rf generators and cavities	3.0 M€
Beam injection	2.0 M€
Electron cooling	7.0 M€
Stochastic cooling	3.0 M€
UHV components and pipes	3.0 M€
Beam diagnostics	2.0 M€
Controls	3.5 M€
Total	**45.0 M€**

Beamlines

Low energy beamlines (18 Tm)	
Dipole magnets	1.9 M€
Quadrupole magnets	1.0 M€
Power supplies	2.0 M€
UHV-components	0.8 M€
Beam diagnostics	0.8 M€
Controls	0.5 M€
High energy beamlines (100-200 Tm)	
Dipole magnets	3.4 M€
Quadrupole magnets	1.6 M€
Special quadrupole magnets	0.2 M€
Power supplies	3.5 M€
UHV - components	1.7 M€
Beam diagnostics	1.7 M€
Controls	1.0 M€
Beam dump	
Dump	0.4 M€
Vacuum	0.2 M€
Beam diagnostics	0.3 M€
Total	**21.0 M€**

Radiation Monitoring and Safety Systems

Neutron monitors	0.7 M€
Gamma monitors	1.0 M€
Monitoring network	0.5 M€
Central control system(zks)	4.0 M€
Oxygen monitoring system	0.3 M€
Total	**6.5 M€**

R & D for the accelerator facility

High current test injector	1.0 M€
Super-conducting magnets	2.4 M€
Fast electron cooling	0.5 M€
UHV-development	0.8 M€
Stochastic cooling	0.3 M€
Beam diagnostics	0.1 M€
High beam current models	0.1 M€
Total	**5.2 M€**

Civil Engineering and Buildings

Civil engineering (building pits, foundation)	28.0 M€
Construction of the tunnel section	39.0 M€
Building underground structures	17.0 M€
Building above ground structures	80.0 M€
Roads and re-landscaping	6.5 M€
Additional building expenses	17.0 M€
Infrastructure of the SIS100/200	5.0 M€
Electric supply installations	3.0 M€
Hall cranes	2.0 M€
Cooling, ventilation, and air-conditioning	28.0 M€
Total	**225.5 M€**

Super-Fragment Separator (SFRS)

	RB (/ M€)	HEB (/ M€)	LEB (/ M€)	EB (/ M€)	
Magnetic elements	20.2	5.6	3.4	3.6	32.8 M€
Power supplies	2.0	0.5	0.4	0.3	3.2 M€
Vacuum system	1.1	0.3	0.2	0.2	1.8 M€
Diagnostic & Control	1.3	0.3	0.2	0.2	2.0 M€
Power target	0.9				0.9 M€
Total	**25.4**	**6.7**	**4.2**	**5.5**	**40.7 M€**

CBM cost estimates are based on HADES and ALICE:

Superconducting dipole	2.0 M€
Silicon pixel/strip detectors Based on ATLAS, ALICE	8.0 M€
Ring imag. Cerenkov det	3.0 M€
Transition radiation detector Based on ALICE	3.0 M€
Resistive plate chamber array Based on ALICE	4.0 M€
Data acquisition	3.0 M€
Infrastructure	4.0 M€
Total	**27.0 M€**

Technical Infrastructure

Cryo distribution experiments	**3.0 M€**

Computing

Data storage, Grid computing	**7.0 M€**

Cost Estimates for Atomic and applied Physics Research

IS200		
In-ring exp.	Laser system and x-ray spectrometer	0.35 M€
Cave AP	Magnetic charge-state spectrometer	1.25 M€
	Beam-wobbler	0.95 M€
In-ring	Gas-jet target including chamber	1.00 M€
	0-deg. Electron spectrometer	0.45 M€
	Recoil ion spectrometer	0.30 M€
	Second electron target	1.05 M€
	Laser installation shared to ½ with cave a	0.45 M€
Cave A	Magnetic charge-state spectrometer	0.80 M€
	Laser installation shared to ½ with in-ring	0.45 M€
HITRAP	Decelerator and trap facility	1.65 M€
HESR	e^+-e^- spectrometer	1.50 M€
Total		**8.70 M€**

Plasma Physics

Plasma lens	0.8 M€
Superconductive fine focusing	2.0 M€
Petawatt compressor tank	2.3 M€
PHELIX tower and optics (access to cave)	0.7 M€
PHELIX laser beam transport (100 m)	0.8 M€
Target chambers	0.3 M€
Diagnostic equipment	1.0 M€
Cryogenic target system	0.2 M€
Total	**8.0 M€**

Anti Proton Program

TS-Solenoid	2.2 M€
Pellet target Turbo molecular pumps, Cryogenics, Support and workshop time	0.5 M€
MVD Based on the ATLAS pixel detector	2.0 M€
STT 9000 straw chambers, support, electronics. The STT consists of approximately	1.0 M€
TS-MDC and FS-MDC 3200 channels of the MDCs	0.3 M€
DIRC gas-based photon detector	2.0 M€
ACC about 100 liters of aerosol, at $500/liter, about 100,000 readout channels	1.5 M€
TS-electromagnetic Calorimeter $PbWO_4$, estimate on a price of 4.5€/cm^3	13.1 M€
TS- and FS-MuD	0.5 M€
FS-Dipole transport, installation of existing dipole magnet	0.5 M€
FS-Cal Transport and refurbishing of existing calorimeter	0.3 M€
Trigger	1.0 M€
Micro-tracker and TOF	2.0 M€
Infrastructure	1.5 M€
Total	**28.4 M€**

2 Planning

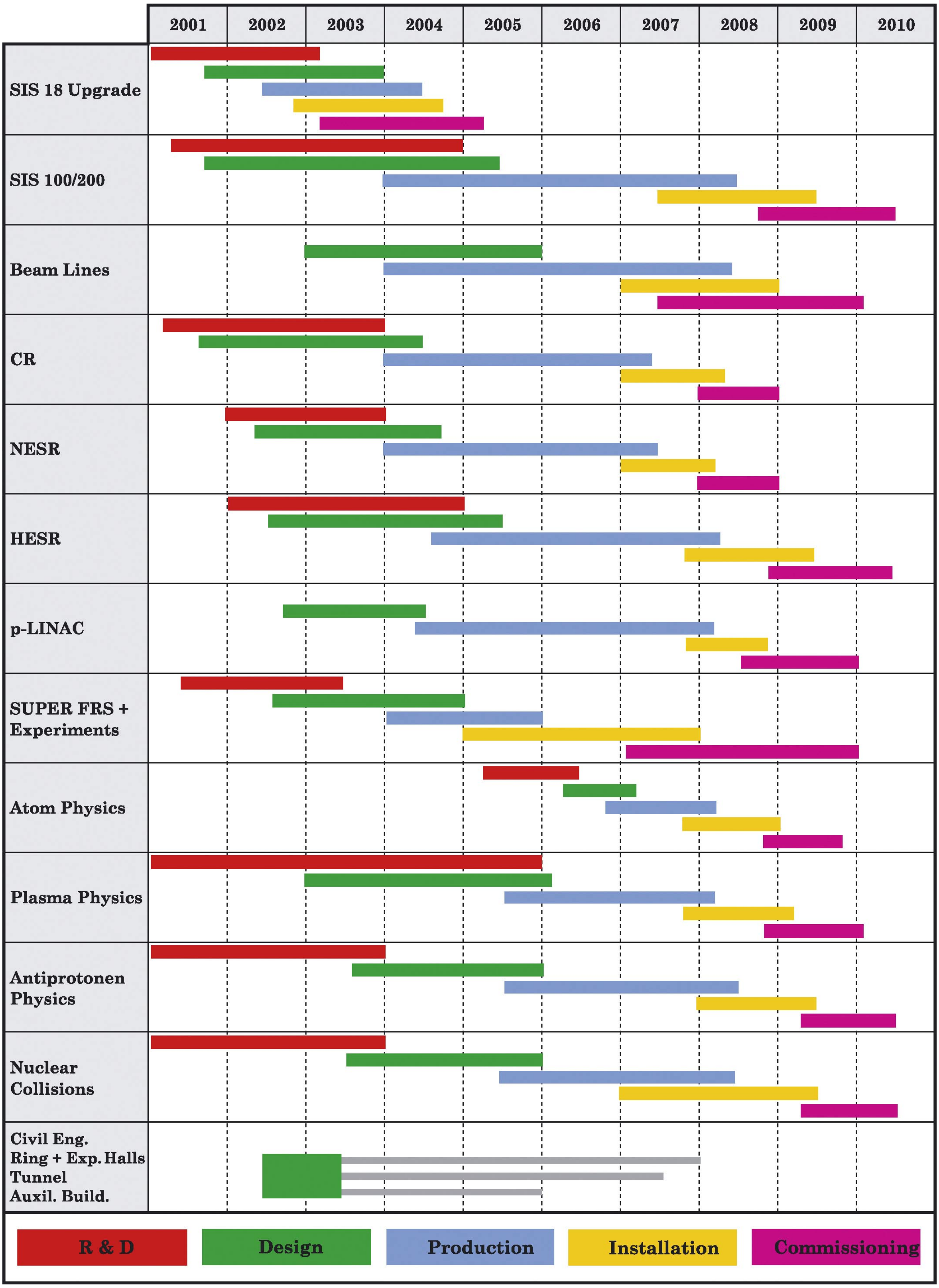
The proposed **schedule for realizing the facility** extends over **8 years**. It consists of 2-3 years of pre-construction research and development (R&D) followed by a 7-year construction phase. Table 6.2-1 illustrates schedules for the main categories of facility planning and construction.

The schedule is determined by the following, partially overlapping phases:

Physical Design and Computer Modelling	1 – 2 years
Design and Prototyping of Components	3 – 4 years
Engineering and Construction	4 – 5 years
Commissioning	1 – 2 years
Total Project Time	8 – 9 years

For all project phases a strong participation of national and international collaborators is needed. Such collaboration has been started on some fields like superconducting magnets. But much more collaborations have to be established and require an appropriate management structure for design, engineering and construction.

For a part of the facility the design of accelerators and experiments is already in an advanced stage. For others development, engineering and prototyping will take another 3 to 4 years. With 4 to 5 years for engineering, procurement and construction of components for the different rings a staged commissioning for radioactive ion beams, antiproton beams, and high energy beams seems natural, as displayed in a tentative schedule in Figure 2.1.



2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
SIS 18 Upgrade
SIS 100/200
Beam Lines
CR
NESR
HESR
p-LINAC
SUPER FRS +
Experiments
Atom Physics
Plasma Physics
Antiprotonen
Physics
Nuclear
Collisions
Civil Eng.
Ring + Exp. Halls
Tunnel
Auxil. Build.
R & D
Design
Production
Installation
Commissioning

Figure 2.1

3 Organizational Structure

The project will be of international scope with substantial contributions from outside of Germany. An adequate institutional structure must allow the various partners to find themselves well represented in such an International Research Center. At the present stage obviously no final management structure could be defined. However, we have considered a range of possibilities and present here a possible solution for discussion. We would exclude a structure like CERN or a structure like a GmbH, since the first introduces the concept of an "international employee" which would require an associated, special pension system, and the second one does not allow to include manpower from institutions in other countries into the project without forcing these employees to leave their system.

There is, however, a structure in Europe, which has both on a national and on a European level already been exploited with very good success: the Economical Interest Group EIG or the European Economical Interest Group EEIG. Such a structure allows the different partners to bring their staff into the Center without the need of creating new labor, administrative or retirement structures. On the other hand, this structure of an EEIG allows to manage the project in a very direct way, independent of a large administrative overhead from each country. The EIG is, for example, the structure of GANIL in France where scientists from two different funding agencies with two different 'cultures' are working together in the laboratory at CAEN under one management; the EEIG was also the structure of AIRBUS Industries before it became a shareholder company. In such an EEIG, e.g. GSI would assign most of its staff and of its facilities to this company structure, the French CNRS and the French CEA could assign, respectively, a certain number of positions to the project, as well as the INFN from Italy, etc. Salary structures and benefits would remain under the control of each partner for his own staff. Otherwise the EEIG would function autonomously with its Directorate supervised adequately by Administrative and Scientific Councils, similar to a GmbH.

The project management and its structure has also to take into account the fact that in addition to contributions that will come from the partner institutes, there may be contributions from institutes and funding agencies outside of the EEIG. The budget from the different funding partners is managed by the International Center according to the rules of an EEIG. Other participating institutes are managing their funds related to the joint project according to a memorandum of collaboration established between them and the Center. A large fraction of these outside contributions will most likely be spent in the collaborating laboratories themselves for the production of experimental and technical components of the facility.

The strong coupling of accelerator structures and experiments suggests to work with a very flat project hierarchy, to guarantee a rapid flow of information among experts. The project is under the responsibility of the Project Leader (PL) (and deputies), who is heading the Management Board (MB). The Management Board defines the project in agreement with the Directorate of the EEIG and the User group, manages the project and its planning as a whole, from scientific- to financial- and to international aspects, etc. The Management Board contains a selected group of sub-project leaders, the integration coordinator, the administration and financial coordinator and some outside members who are representing the interests of contributing institutions other than the consortium partners.

The size of the project requires a breakdown into several sub-projects, which are lead by sub-project leaders and coordinators (and their deputies). All sub-project leaders are members of the Technical Board, headed by a Technical Coordinator (with deputies), who reports to the project leader. The Project Leader and the Technical Coordinator are in charge of building the international facility within the budget and on-time to the specifications outlined and defined by the Management Board. The Technical Board monitors and steers the progress of the project and assures horizontal communication between the sub-projects themselves and with the technical divisions and services.

The structuring of the sub-projects will be done appropriately by the sub-project leaders who are fully responsible for their project. Thus, some parts of the project can be produced entirely outside the EEIG. The project leader and the sub-project leaders are responsible for their individual project budget. The budget is managed by the administrative coordinator in each sub-project. A controlling group (Controlling) monitors the money flow.

The Directorate is assisted by outside advisory and evaluation boards, like the present External Scientific Advisory Committee (ESAC) or the External Technical Advisory Committee (ETAC). ESAC and ETAC provide advice on the scientific, technical and financial matters of the project and will evaluate all proposed major project modifications. They will appoint referees who will undertake regularly in-depth reviews of the project and its sub-projects. Controlling and Safety are part of the supervising structure of GSI for any project.

Quality assurance procedures will be implemented in all stages of the project, e.g., in planning, design, hardware and software production. (GSI, for example, is implementing a quality assurance procedure already in the design of the future Ion Cancer Therapy Facility for Heidelberg). Special attention must be paid to sub-projects from outside the partner consortium.

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