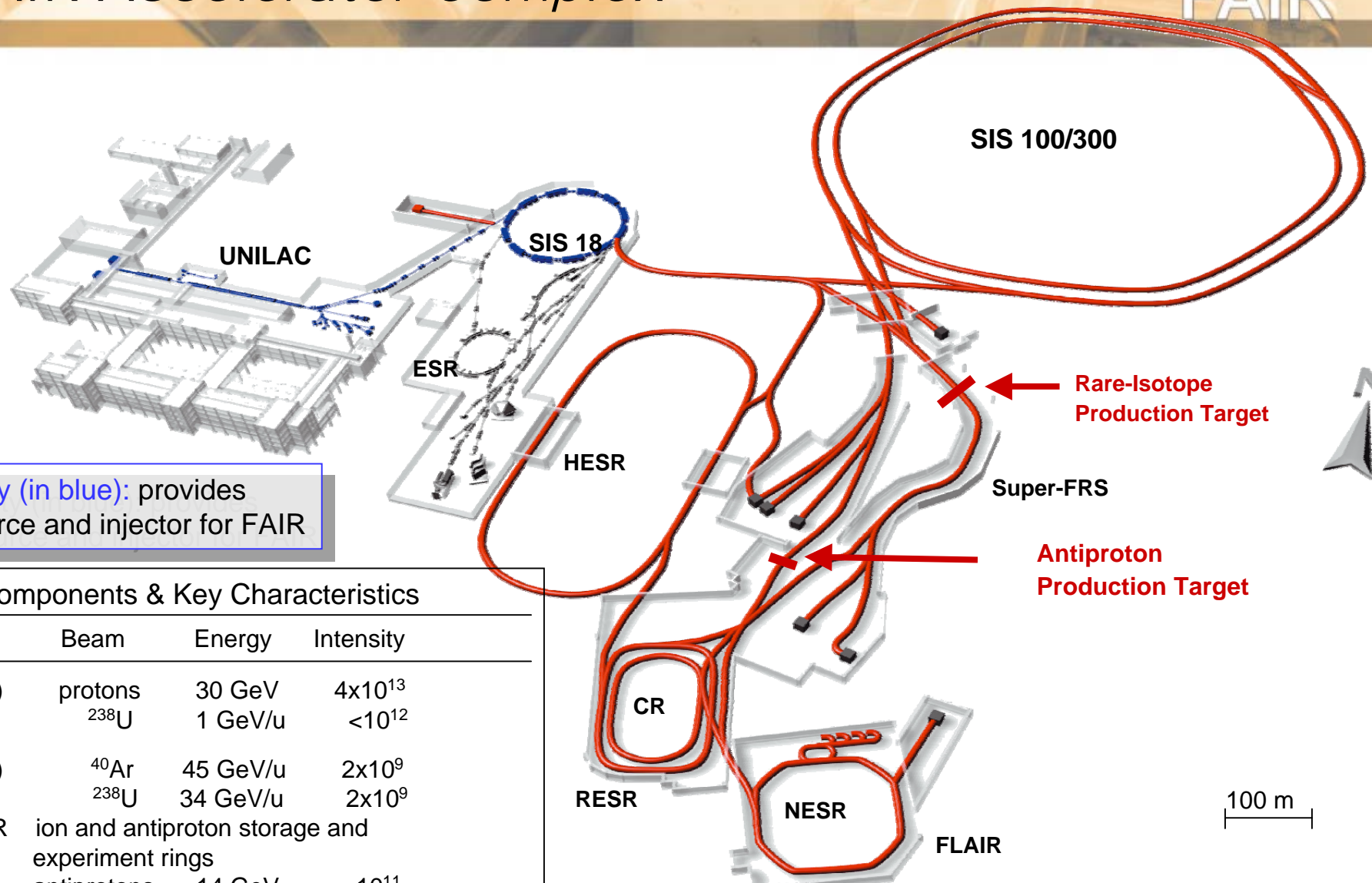




Workpackages and In-Kind Contributions to FAIR

- The FAIR Project
- Preparatory Phase - R&D for FAIR
- Workpackages and In-Kind Contribution

The FAIR Accelerator Complex



Existing facility (in blue): provides ion-beam source and injector for FAIR

Accelerator Components & Key Characteristics

Ring/Device	Beam	Energy	Intensity
SIS100 (100Tm)	protons ^{238}U	30 GeV 1 GeV/u	4×10^{13} $< 10^{12}$
SIS300 (300Tm)	^{40}Ar ^{238}U	45 GeV/u 34 GeV/u	2×10^9 2×10^9
CR/RESR/NESR	ion and antiproton storage and experiment rings		
HESR	antiprotons	14 GeV	$\sim 10^{11}$
SuperFRS	rare-isotope beams	1 GeV/u	$< 10^9$

New future facility (in red): provides ion and anti-matter beams of highest-intensity and up to high energies

The FAIR Baseline Technical Report



More than 3500 pages
ca. 2400 authors

Handed over to ISC in April 2006



Technical Advisory Committee

CORE-A

CORE-E

Locked for more than 5000 individual items, costed them,
Intensive search for forgotten items ...

- | | |
|--------------------|--------------------|
| ● Sept 7 – 8, 2005 | beam diagnostics |
| ● Oct 26 | p-linac |
| ● Oct 27/28 | power supplies |
| ● Oct 31 – Nov 1 | cryogenics |
| ● Nov 3 | warm magnets |
| ● Nov 15 – 16 | cold magnets |
| ● May 2006 | civil construction |



Investment Cost:

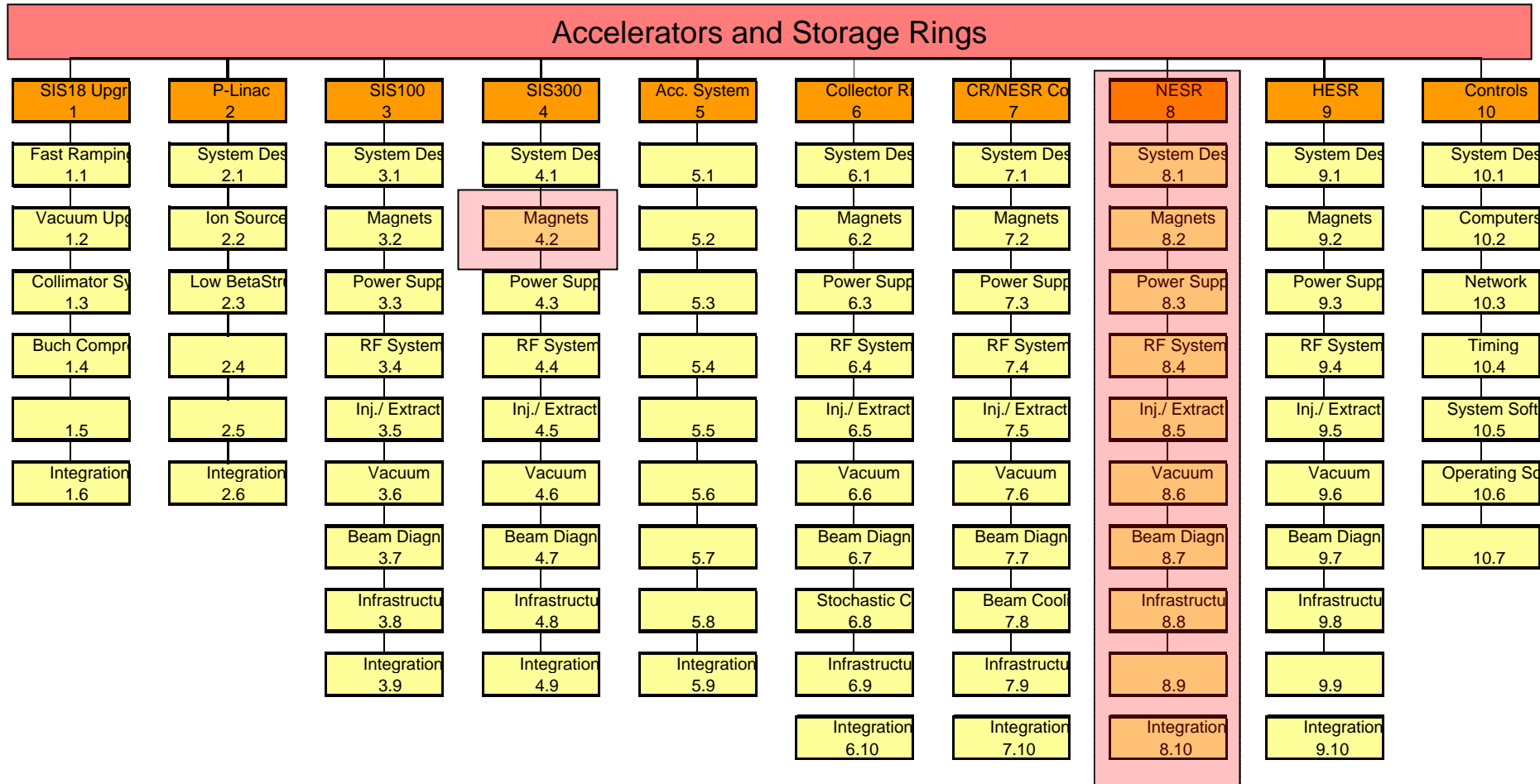
- Accelerators w/o sFRS* 593 M€
- Civil Construction 322 M€
- Experiments incl. sFRS 200 M€

- Manpower 2400 FTE
according to FCI (1 FTE=77k€/y) 185 M€

“The *Costbook* reflects the present status of the estimate. The facility costs are evaluated on a component basis and then aggregated for the sub-systems and finally for the total facility.

This adds up to a total of 1114 M€ in investment cost.”

Supplement to FBTR



Complete R&D of Critical Items within the Preparatory Phase

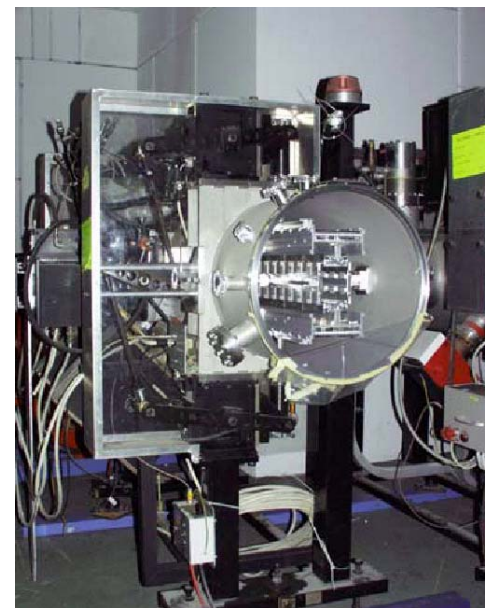
- Rapidly-cycling superconducting magnet technology for synchrotrons
- Superconducting magnets for large aperture devices
- Beam phase-space compression by electron-beam and stochastic cooling
- Cryogenics ...



Superconducting magnet (prototype) for FAIR



Electron Cooler at GSI



Stochastic Cooling Structure

BNL – SIS 300 superconducting ramped dipole

JINR – SIS100 s.c. ramped dipole & quadrupole

IHEP – SIS300 s.c ramped dipole

BINP – SIS100 curved dipole

BNN – SIS100 straight dipole

Toshiba – Super FRS multipole triplet

Spain consortium – NESR magnets, vacuum, power converter

Chinese consortium – CR superconducting dipole

BINP – RF cavity

BINP – fast ramped power converter for ECOOL

BINP – Feasibility studies/ Design studies on

Septa, ER-Electron Ring, Electroncooling, Electron-Target at NESR

ACCEL – Feasibility study on injection/extraction at SIS100/300

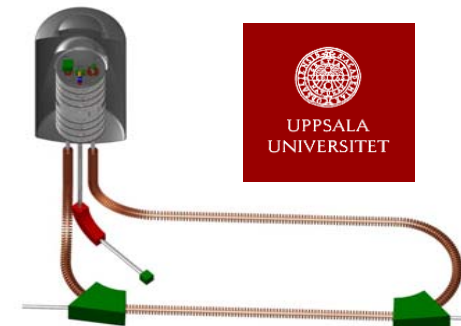


SIS300 magnets



IHEP Protvino

NESR Electron Cooling



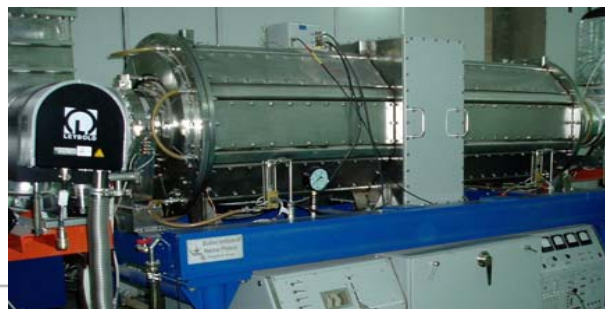
Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft

CNA / CNRS

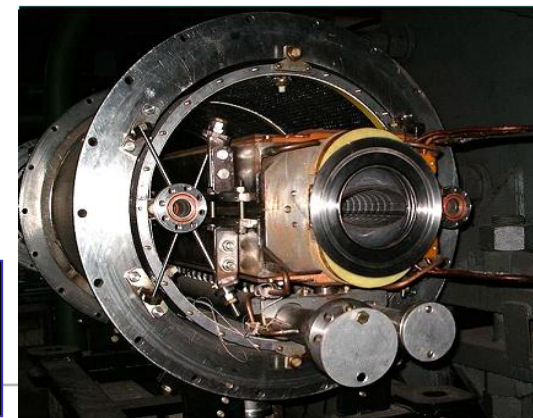
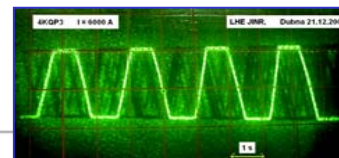


BINP Novosibirsk

Variable Frequency Cavities

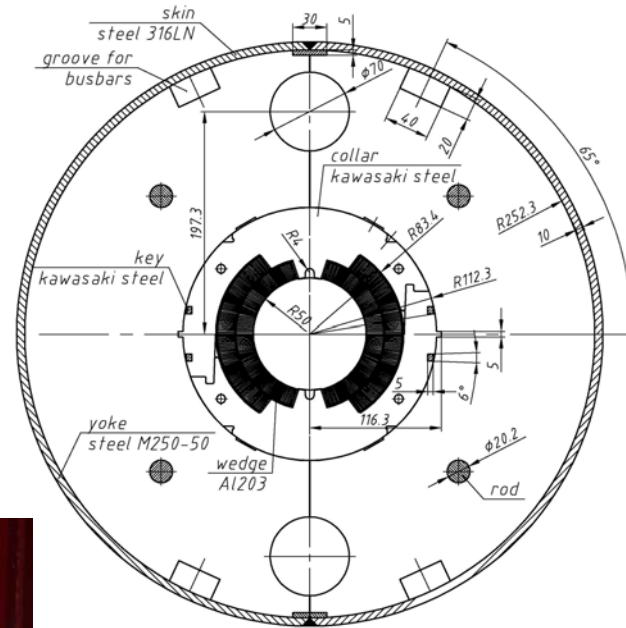


SIS100 rapidly cycling sc magnets



Coil ID, mm	100
Good field diameter, mm	80
Central field, T	6
Field ramp rate, T/s	1
Temperature margin, K	~1
Magnetic length, mm	2909
Field cycle, T	1.6 – 6 – 1.6
Time cycle, s	4.4 – 11 – 4.4

„GSI001“



$B = 4 \text{ T}$, $dB/dt = 1 \text{ T/s}$



IHEP Protvino



Bend prototype dipole
3.7 M€ & ~40 FTE



BINP Novosibirsk

Frequency range	1.1-2.7 MHz
RF voltage	20 kV
Ferrite type	400 NN-2
Number of ferrite for unit	68
Number of unit	29



BINP Cavity built for IHEP (Lanshou)

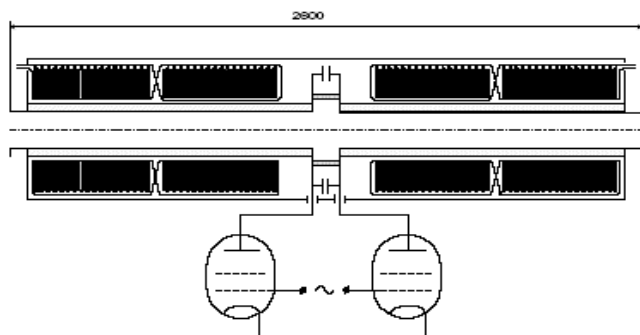
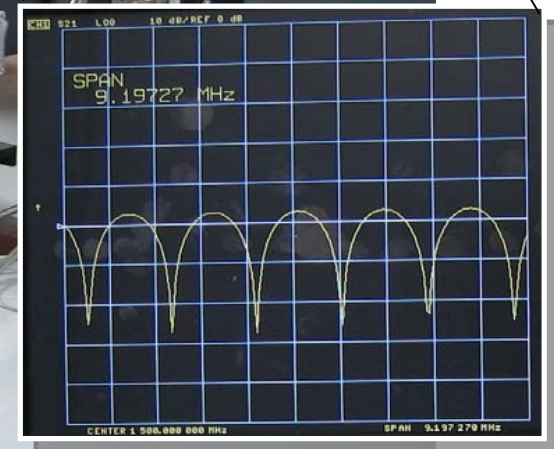
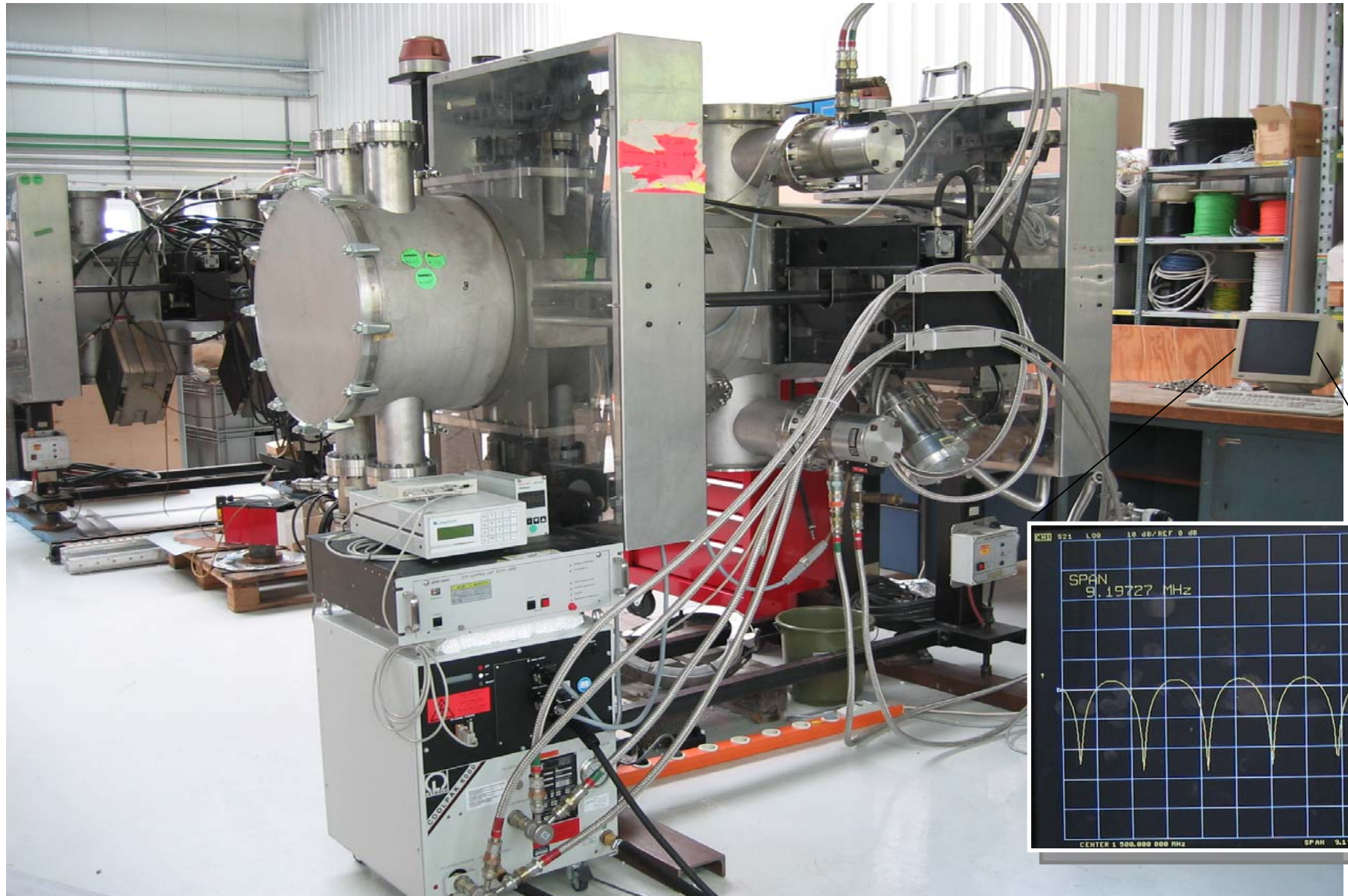


Fig.2.1 Schematic drawing of RF station.

R&D on Stochastic Cooling: Test tank for cryogenic measurements



Technical negotiations between GSI/FAIR and partner institutes

China	-	CR superferric bending magnets	Oct. 2004
India	-	VECC on sc magnets	Dec. 2005
Italy	-	INFN on SIS300 bending magnets	Jan. 2006
France	-	CNRS-CEA on SIS300 multipole magnets and ECR for p-Linac	Feb. 2006
UK	-	RAL on cryogenics	Feb. 2005
Russia	-	JINP, IHEP, ITEP, BINP	May 2006
Spain	-	CIEMAT on NESR magnets, vacuum etc.	May 2006

Non of these activities of the preparatory phase imply a decision who finally will procure the components!

All partners will be free to propose their in-kind contribution.

Following the structure of WBS and Costbook
94 Workpackages have been defined

Assumption: due to legal regulation Germany procures all buildings (~300 M€)
~ 186 M€ for man-power (to be financed by GSI)
Consortium KFZ Jülich, TSL and GSI procure HESR (~100 M€)

i.e. ~ 300 M€ for Germany and ~ 300 M€ for the partners
for in-kind contributions

Having ~100 WPs \Rightarrow typical value 6 M€/WP, i.e. 0,5% of total sum

Compatible with 1% as minimum share for FAIR-shareholders.

Definition of 94 Workpackages

FAIR WPs

		WBS 2.3 HEBT	2.4 Supere FRS	2.5 CR	2.6 NESR	2.7 p-lianc	2.8 SIS100	2.9 pbar-target	2.10 RESR	2.11 HESR	2.12 SIS300	2.13 ER	2.14 Com. Sys.	3.0 Civ. Constr.	1.0 Experiments
CostBook 3.0 (M€)		79,2	72,9	37,8	23,4	13,5	81,9	4,5	20,7	59,4	95,4	11,7	104,4	289,8	108
TS-2	Magnets Cost Who	Bend 12,2	Bend 15 China	Bend 9 China	Bend 4 Es	Bend 0,22	Bend 7 Rus	Bend 0,7	Bend 4	Bend S & G	Bend 24 RUS & I	Bend	GSI		
		Quad 14	Quad 23	Quad 2,2	Quad 2,7 Es	Quad 0,7	Quad 8 Rus	Quad 0,7	Quad 2,6	Quad	Quad 19 Rus & F	Quad			
			Sextupoles 8	Sextupoles 0,5	Sextupoles 0,4 Es		Sextupoles 1,1 Rus			Sextupoles	Multipoles 7 RUS & I	Sextupoles			
		Other 3	Other 3,3	Other 1,5	Other 0,4		Other 1,3 Rus		0,4	Other	Other 0,6 Rus	other			
TS-3	Power Converter	Power Conve 16	Power Conve 3	Power Conve 2,4	Power Conve 2,3 Es	Power Conve 2,3	Power Conve 5	Power Conve 1,1	Power Conve 2,4	Power Conve 0,1 GSI	Power Conve 5,2	Power Conve			
TS-4	RF-System			RF 4,4	RF 3,8	RF 7 Ind./Rus/G	RF 31 Rus		RF 0,1 GSI	RF	RF 6,8 Rus	RF			
TS-5	Inj/Extraction			Inj/Extr. 3,5	Inj/Extr. 2		Inj/Extr. 6 Rus		Inj/Extr. 3	Inj/Extr.	Inj/Extr. 7 Rus	Inj/Extr.			
TS-6	Diagnostics	Diagnostics 10	Diagnostics 4,5	Diagnostics 2	Diagnostics 1,8	Diagnostics 1,3	Diagnostics 5,5	Diagnostics 0,3	Diagnostics 1,8	Diagnostics	Diagnostics 5,4	Diagnostics			
TS-7	Vacuum	Vacuum 12	Vacuum 5,4	Vacuum 3,4	Vacuum 3,4 Es	Vacuum 0,7	Vacuum 8	Vacuum 0,7	Vacuum 2,9	Vacuum	Vacuum 8	Vacuum			
TS-8	Part. Sources					EZR 0,7 F						Linac			
TS-9	ECOOOL				ECOOOL 2,7 Rus					ECOOOL					
TS-10	St. Cooling			St. Cool 6 GSI					St. Cool 3,8 GSI	St. Cool					
TS-11	Special inst.	Special 0,1	Special 5,5			Special 0,3	Special 2	Special 0,8							
TS-12	Local Cryo	Local Cryo 12	Local Cryo 6,3	Local Cryo 3,1			Local Cryo 6,8				Local Cryo 12		Refrigerator 49 GSI		
TS-14	Common System												Controls/Interfaces 24 GSI		
													Quench Detection 2,1		
													Magnet QC 7,2 GSI		
													Alignment 5,5 GSI		
													El. Power 16 GSI		

WP for discussion

Intension to take WP

Indication to Take Over WPs

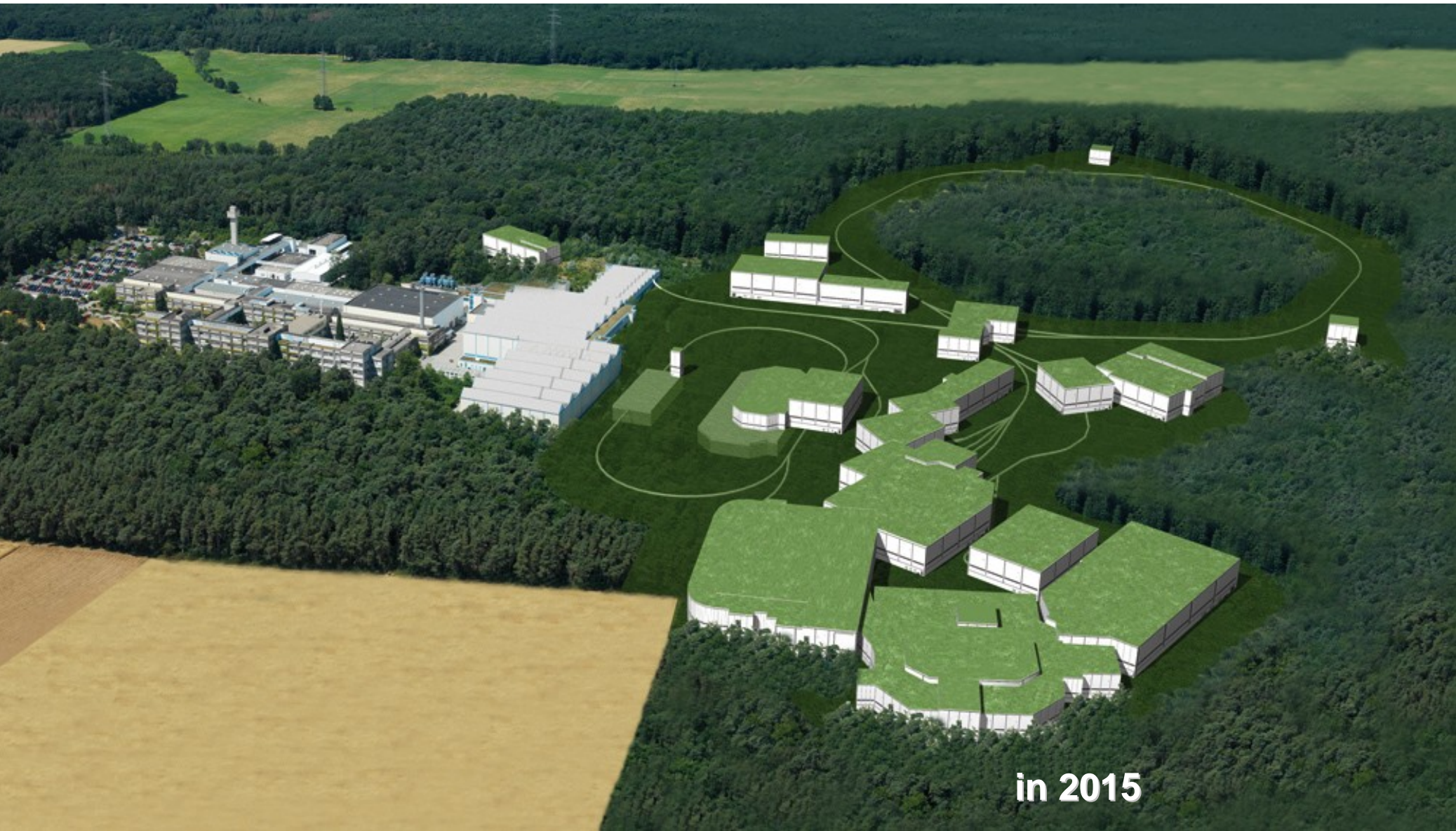
FAIR WPs

		WBS 2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11	2.12	2.13	2.14	3.0	1.0
		HEBT	Supere FRS	CR	NESR	p-Jiang	SIS100	pbar-target	RESR	HESR	SIS300	ER	Com. Sys.	Civ. Constr.	Experiments
CostBook 3.0 (M€)		88	81	42	26	16	81	6	23	66	106	13	116	322	120
TS-2	Cost	Bend 13,5	Bend 14	Bend 10	Bend 4,6	Bend 0,25	Bend 7,7	Bend 0,8	Bend 4,5	Bend S & G	Bend 27	Bend		GSI	
	Magnets		China	China	Es		Rus			S & G	RUS & I				
	Who	Quad 15,4	Quad 26	Quad 2,5	Quad 3	Quad 0,8	Quad 8,7	Quad 0,8	Quad 2,9	Quad Jülich	Quad 21	Quad			
			Sextupoles 9	Sextupoles 0,6	Sextupoles 0,4		Sextupoles 1,2			Sextupoles	Multipoles 8	Sextupoles			
	Other 3,3	Other 3,6	Other 1,7	Other 0,5		Other 1,4		0,4		Other	Other 0,7	other			
TS-3	Power Converter	Power Converter 18	Power Converter 3,4	Power Converter 2,6	Power Converter 2,6	Power Converter 2,7	Power Converter 5,5	Power Converter 1,2	Power Converter 2,6	Power Converter	Power Converter 5,7	Power Converter			
TS-4	RF-System			RF 4,9	RF 4,2	RF 7,8	RF 34		RF 0,1	RF	RF 7,6	RF			
TS-5	Inj/Extraction			Inj/Extr. 3,8	Inj/Extr. 2,2		Inj/Extr. 7		Inj/Extr. 3	Inj/Extr.	Inj/Extr. 8	Inj/Extr.			
TS-6	Diagnostics	Diagnostics 11	Diagnostics 5	Diagnostics 2,2	Diagnostics 2	Diagnostics 1,4	Diagnostics 6	Diagnostics 0,3	Diagnostics 2	Diagnostics	Diagnostics 6	Diagnostics			
TS-7	Vacuum	Vacuum 13	Vacuum 6	Vacuum 3,7	Vacuum 3,7	Vacuum 0,8	Vacuum 9	Vacuum 0,8	Vacuum 3,2	Vacuum	Vacuum 9	Vacuum			
TS-8	Part. Sources					EZR 0,8						Linac			
TS-9	ECOOOL				ECOOOL 3					ECOOOL					
TS-10	St. Cooling			St. Cool 6,6					St. Cool 4,2	St. Cool					
TS-11	Special inst.	Special 0,1	Special 6			Special 0,3	Special 2,2	Special 0,9							
TS-12	Local Cryo	Local Cryo 13,5	Local Cryo 7	Local Cryo 3,4			Local Cryo 7,5				Local Cryo 13				
TS-14	Common System											Refrigerator 54			
												Controls/Interfaces 26,5			
												Quench Detection 2,3			
												Magnet QC 8,1			
												Alignment 6			
												El. Power 18			

WP for discussion
 Intention to take WP

- Refrigerator
54
GSI
- Controls/Interfaces
26,5
GSI
- Quench Detection
2,3
- Magnet QC
8,1
GSI
- Alignment
6
GSI
- El. Power
18
GSI

FAIR – an Unprecedented Research Facility



in 2015

Staging of the Project

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Stage I	Unilac Super FRS CR NESR	[Gantt chart for Stage I: Construction (red) from 2007 to 2011, Commissioning (yellow) in 2011-2012, Operation (green) from 2012 to 2017]									
Stage II	p-linac SIS100 p_bar target RESR HESR	[Gantt chart for Stage II: Construction (red) from 2008 to 2014, Commissioning (yellow) in 2014-2015, Operation (green) from 2015 to 2017]									
Stage III	SIS300 ER	[Gantt chart for Stage III: Construction (red) from 2008 to 2014, Commissioning (yellow) in 2014-2015, Operation (green) from 2015 to 2017]									

Construction
 Commissioning
 Operation
 Based on Civil Construction Schedule

Project Master Schedule



Nr.	Vorgangname	Anfang																												
			5	2006	2007	2008	2009	2010	2011	2012	2013	2014	2																	
			3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
1	MASTER SCHEDULE FAIR	Die 14.03.06																												

Adapted to Bung Civil Construction Schedule

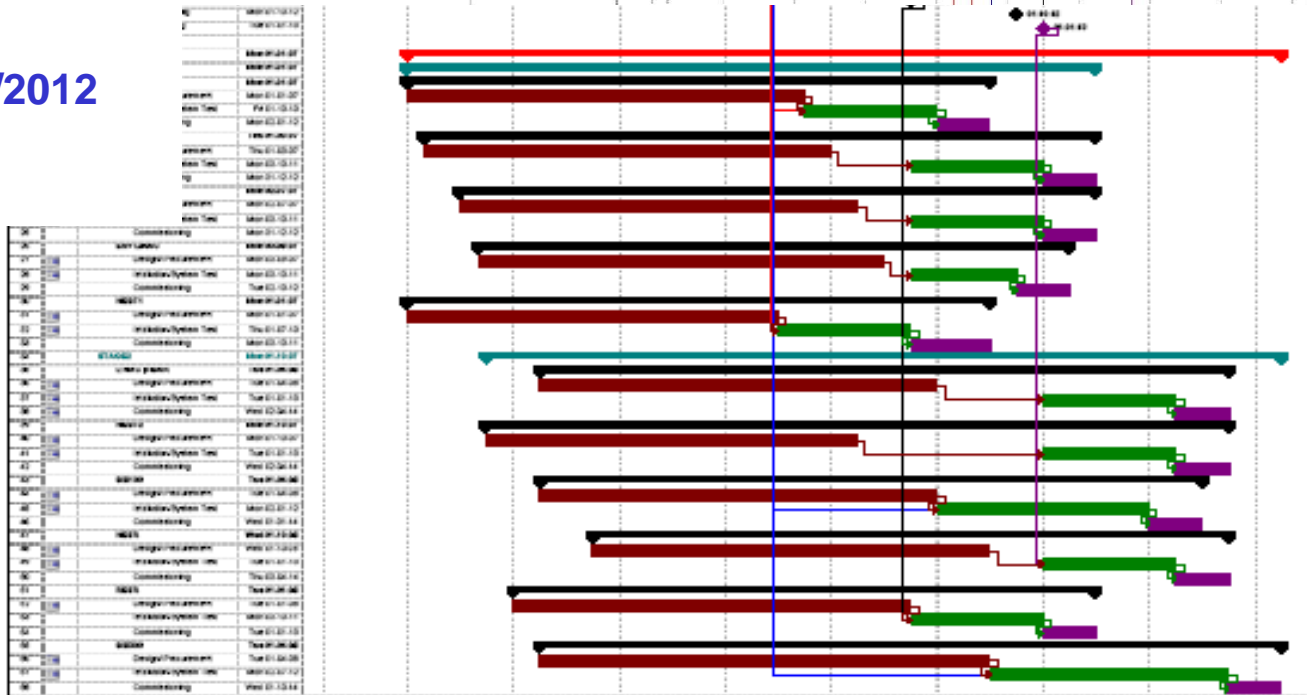
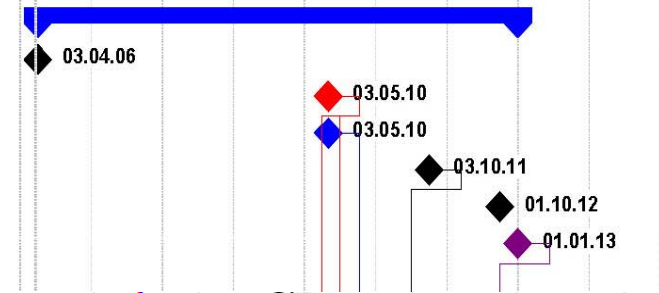
Critical Path:

Availability of buildings to start installations

Actual planning allows for:

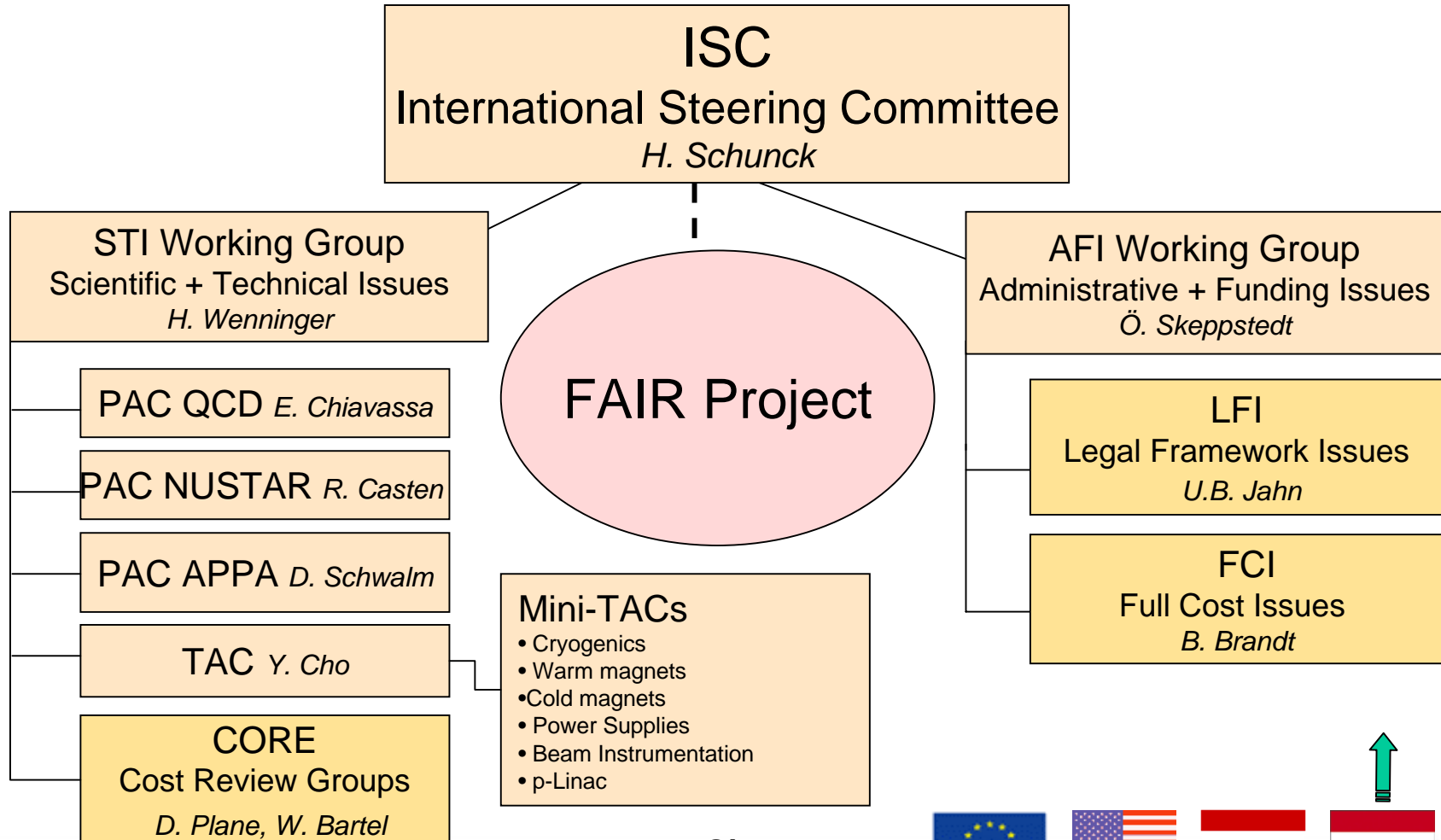
- First experiments at sFRS 2011/2012
- Project end 2014/2015

INGINEERING	Mon 03.04.06
jektbewilligung	Mon 03.04.06
stufe 1a bezugsfähig	Mon 03.05.10
stufe 1b bezugsfähig	Mon 03.05.10
stufe 1c bezugsfähig	Mon 03.10.11
stufe 1d bezugsfähig	Mon 01.10.12
stufe 2 bezugsfähig	Die 01.01.13



01	Commissioning	Mon 01.01.13
02	Commissioning	Mon 01.01.13
03	Commissioning	Mon 01.01.13
04	Commissioning	Mon 01.01.13
05	Commissioning	Mon 01.01.13
06	Commissioning	Mon 01.01.13
07	Commissioning	Mon 01.01.13
08	Commissioning	Mon 01.01.13
09	Commissioning	Mon 01.01.13
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16	Commissioning	Mon 01.01.13
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100	Commissioning	Mon 01.01.13

The International Committee Structure



Observers:

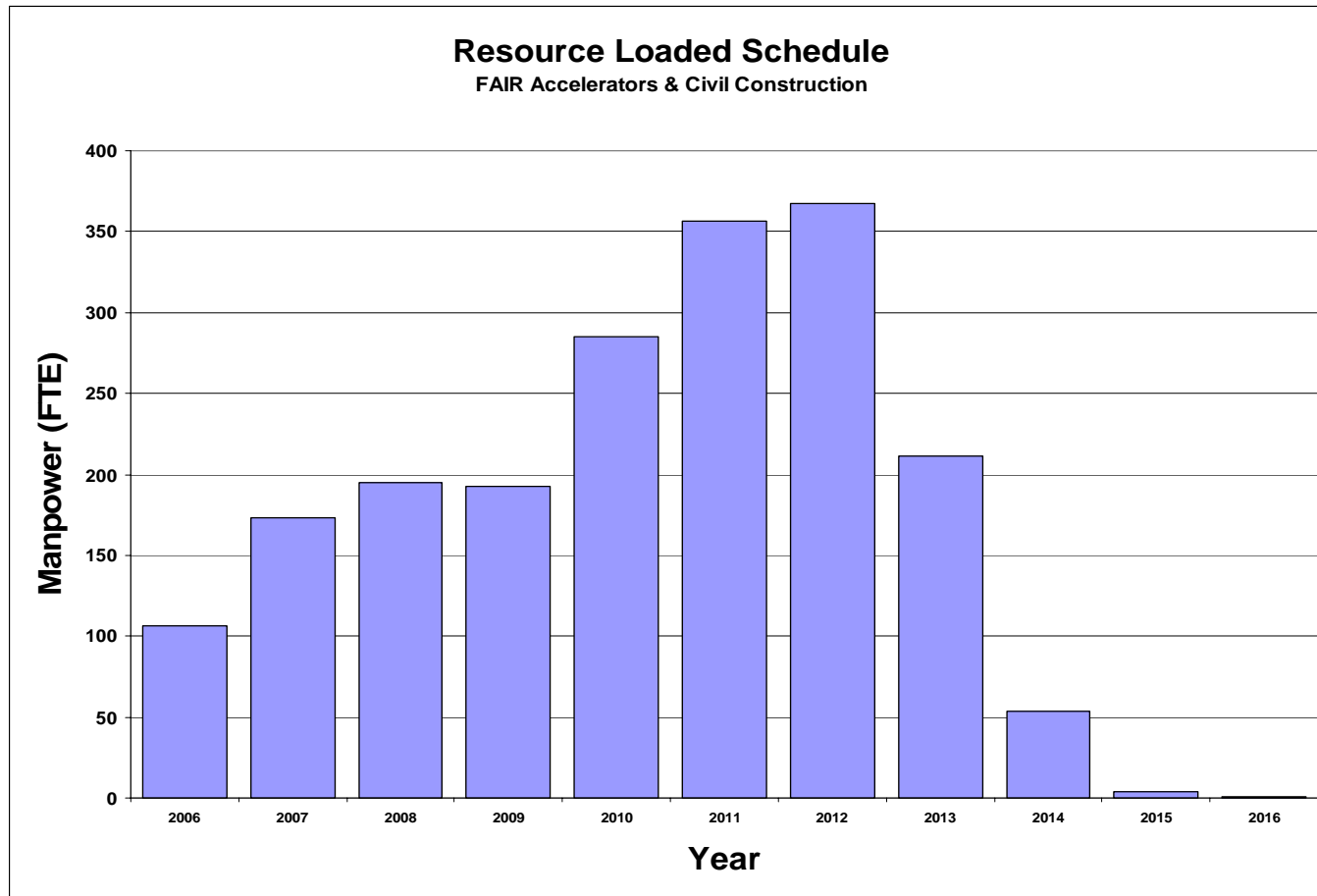


Acc-sections

Techn. systems

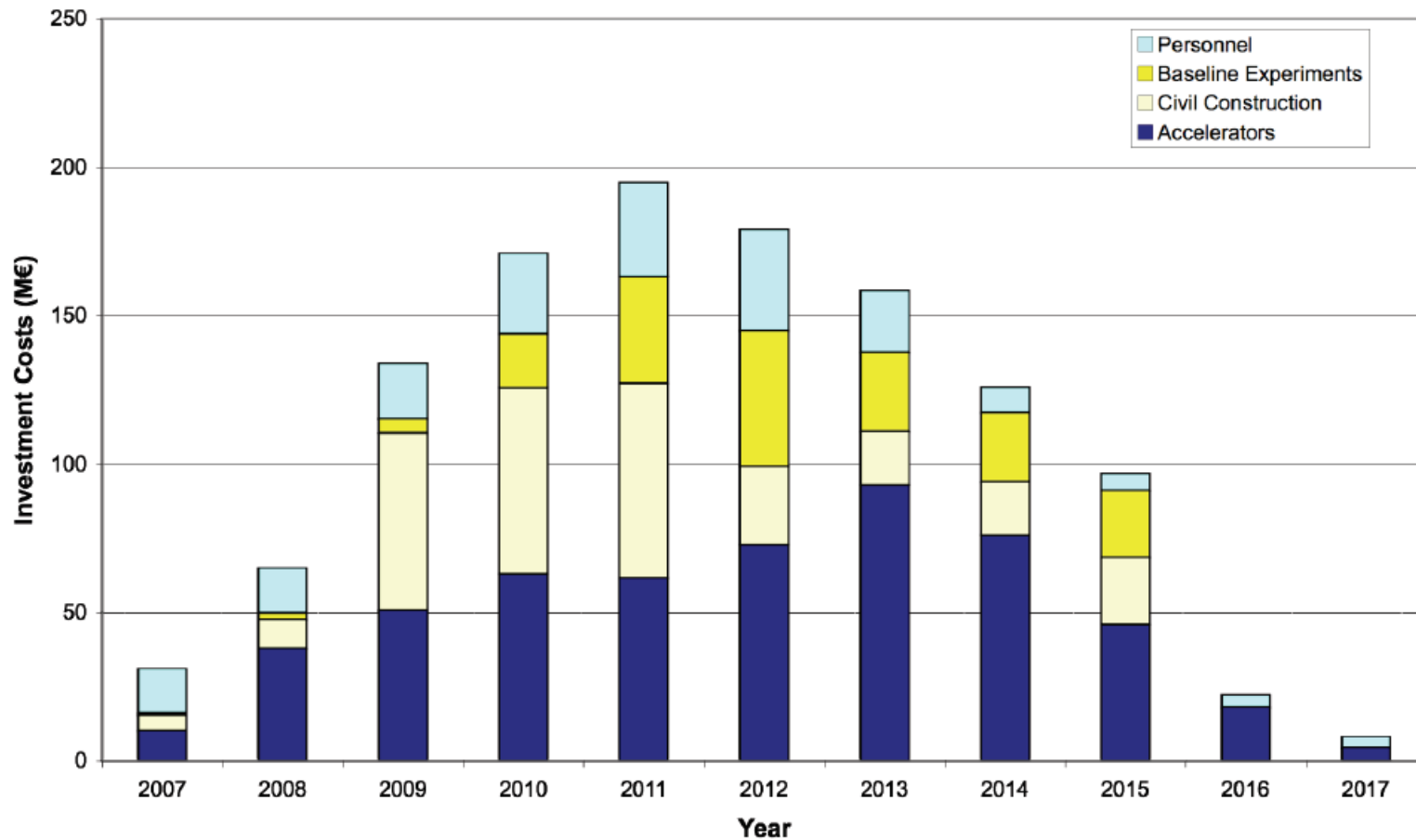
WBS-E2.1	UNILAC Upgrade
WBS-E2.2	SIS18 Upgrade
WBS-E2.3	HEBT
WBS-E2.4	Super FRS
WBS-E2.5	CR
WBS-E2.6	NESR
WBS-E2.7	p-LINAC
WBS-E2.8	SIS100
WBS-E2.9	pBar TARGET
WBS-E2.10	RESR
WBS-E2.11	HESR
WBS-E2.12	SIS300
WBS-E2.13	ER
WBS-E2.14	Common Systems

TS-2	Magnets
TS-3	Power Supplies
TS-4	RF Systems
TS-5	Injection / Extraction
TS-6	Beam Diagnostics
TS-7	Vacuum
TS-8	Particle Sources
TS-9	Electron Cooling
TS-10	Stochastic Cooling
TS-11	Special Installations
TS-12	Local Cryogenics
TS-14	Common Systems



FAIR Accelerators and Civil Construction: 2400 man-years in total incl. FAIR GmbH

Annual incidences of expenditure for construction



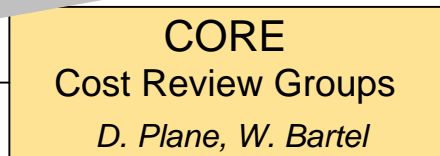
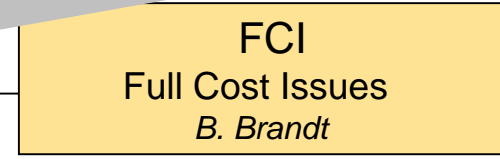
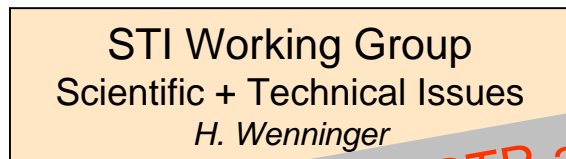
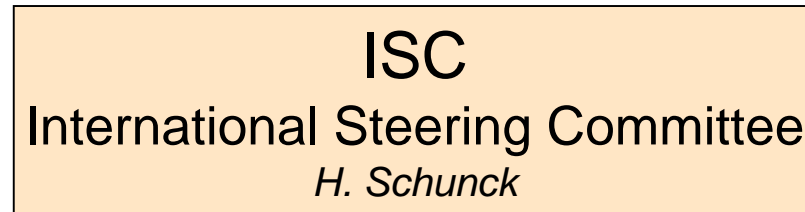
FAIR Baseline Technical Report

Table of Contents



Volume 1	Executive Summary
Volume 2	Accelerator and Scientific Infrastructure
Volume 3A	Experiment Proposals on QCD Physics
	3.1 CBM
Volume 3B	Experiment Proposals on QCD Physics
	3.2 PANDA
	3.3 PAX
	3.4 ASSIA
Volume 4	Experiment Proposals on Nuclear Structure & Astro Physics (NUSTAR)
	4.1 LEB-SuperFRS
	4.2 HISPEC/DESPEC
	4.3 MATS
	4.4 LASPEC
	4.5 R3B
	4.6 ILIMA
	4.7 AIC
	4.8 ELISe
	4.9 EXL
Volume 5	Experiment Proposals on Atomic, Plasma & Applied Physics (APPA)
	5.1 SPARC
	5.2 HEDgeHOB
	5.3 WDM
	5.4 FLAIR
	5.5 BIOMAT
Volume 6	Civil Construction and Safety

The International Committee Structure



- Cryogenics
- Warm magnets
- Cold magnets
- Power Supplies
- Beam Instrumentation
- p-Linac

ISC accepted the FBTR as 'The Project' to perform
 ISC took note of the project cost of 1186 Mio. €
 ISC asked its members to discuss the legal documents (convention, AoA ..)
 - Aiming for signature to the legal documents in early 2007
 - Creation of FAIR GmbH as the project owner
 that will hand over all operative tasks to GSI.

Observers:



Core Groupe "A" for Accelerators and Infrastructure

- **David Plane, chair (ex CERN)** experiments, beam lines, project management
 - **Y. Cho, Argonne (ex officio, TAC chair)** accelerators, costing
 - **K. Blasche (ex GSI)** accelerators
 - **T. Taylor (ex CERN)** magnets, sc magnets
 - **E. Weisse (ex CERN)** accelerator systems, safety, infrastructure
 - **G. Stevenson (ex CERN)** safety, infrastructure
 - **W. Erdt (ex CERN)** cryo systems
 - **P. Strubin (CERN)** vacuum
 - **I. Gardner (CCLRC)** accelerators systems
 - **L. Miralles (Synchr. Lab Spain)** accelerators, ATLAS, engineering
 - **D. Krämer (BESSY II)** Accelerators, infrastructure
- **First Meeting on July 26/27th, 2005, last meeting 8-10th November 2005**