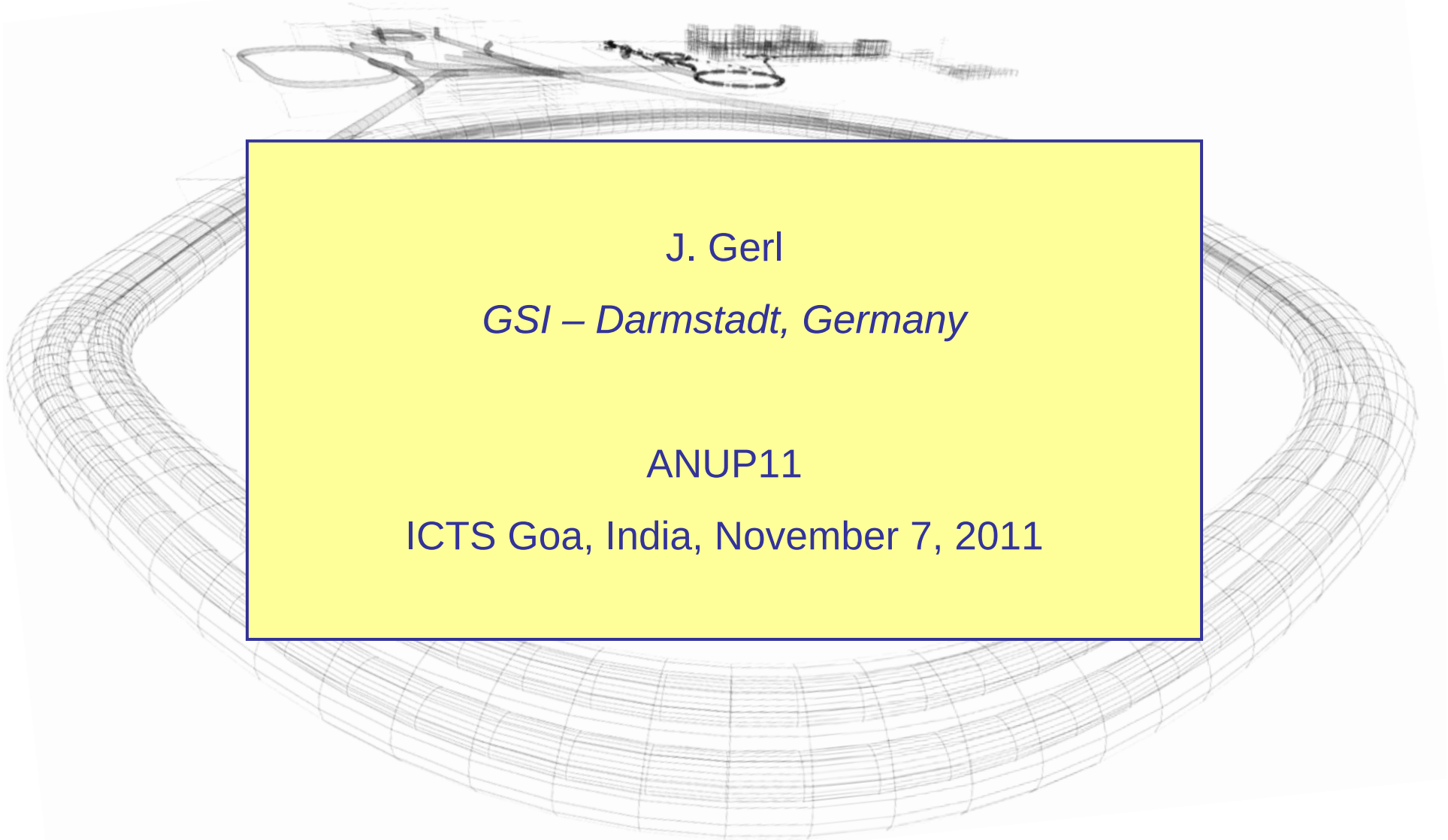
Status and perspectives of FAIR and NUSTAR



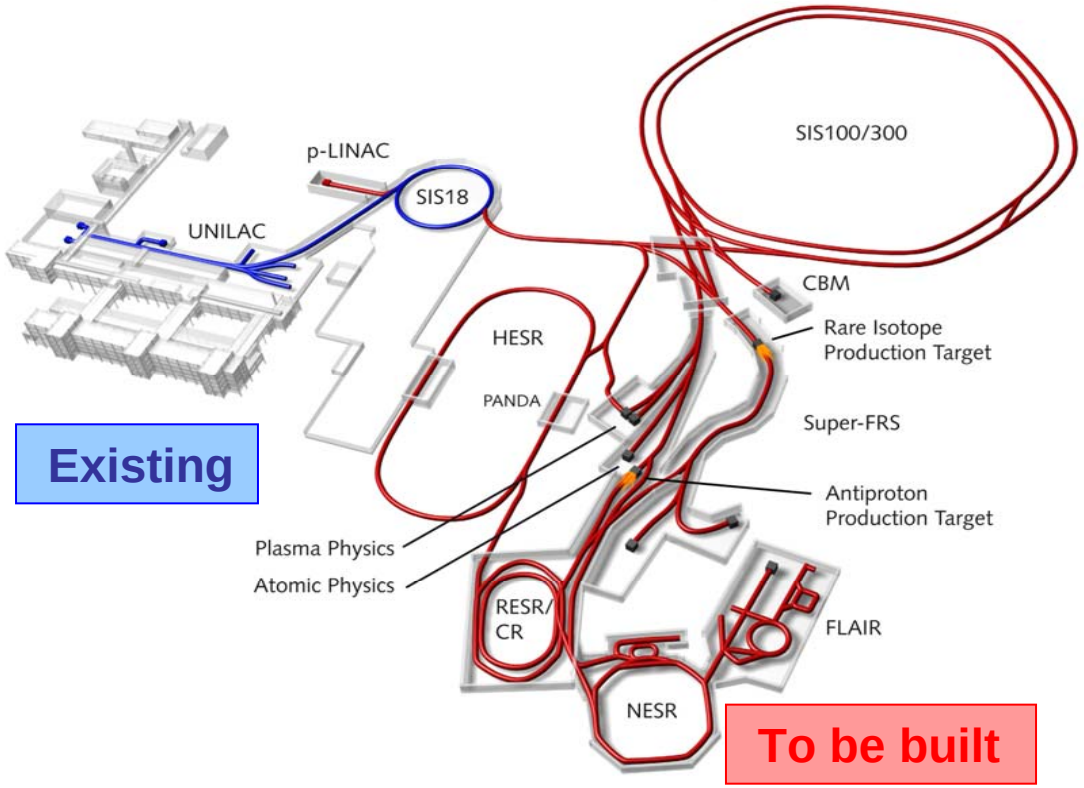
J. Gerl

GSI – Darmstadt, Germany

ANUP11

ICTS Goa, India, November 7, 2011

FAIR – The Facility



Primary Beams

- 10^{12}/s; 1.5-2 GeV/u; $^{238}U^{28+}$
- Factor 100-1000 over present in intensity
- 2(4)x10^{13}/s 30 GeV protons
- 10^{10}/s $^{238}U^{73+}$ up to 25 (- 35) GeV/u

Secondary Beams

- Broad range of radioactive beams up to 1.5 - 2 GeV/u; up to factor 10 000 in intensity over present
- Antiprotons 3 - 30 GeV

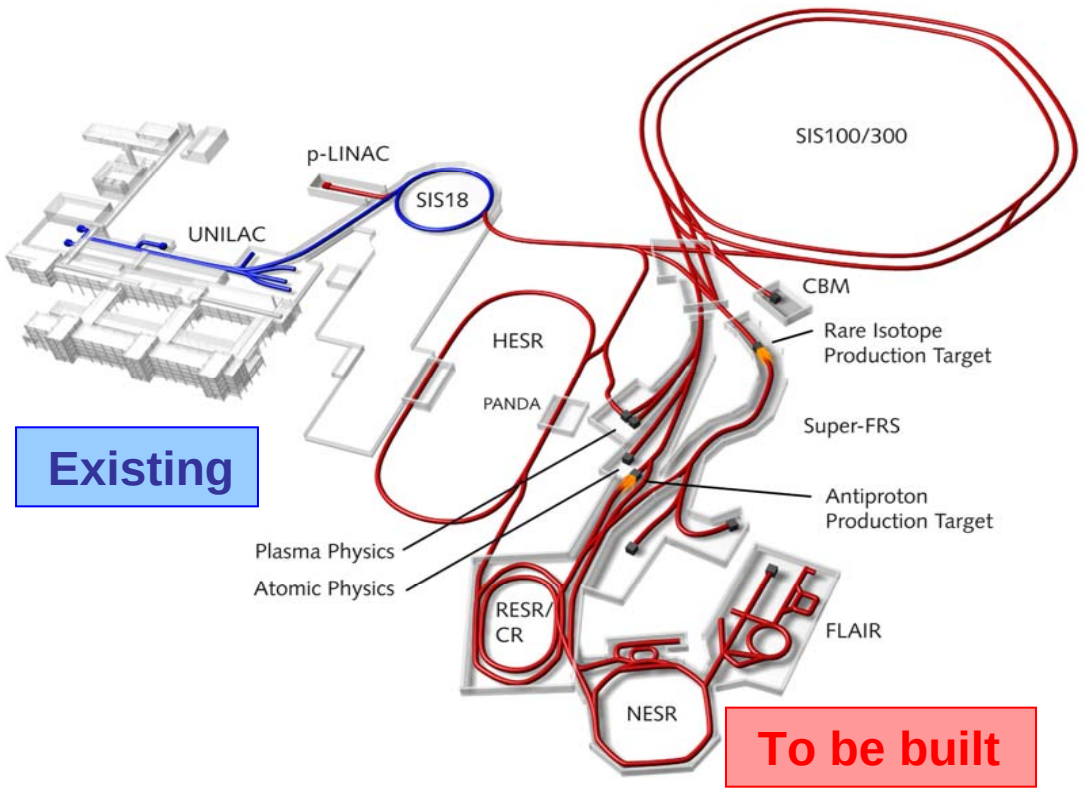
Storage and Cooler Rings

- Radioactive beams
- e – A collider
- 10^{11} stored and cooled 0.8 - 14.5 GeV antiprotons

Key Technical Features

- Cooled beams
- Rapidly cycling superconducting magnets

FAIR – The Science



Plasma Physics with highly Bunched Beams

Bulk matter at very high pressures, densities, and temperatures

Atomic Physics and Applied Science

Highly charged atoms; Low energy anti-protons

Laser cooling

Nuclear Structure Physics and Nuclear Astrophysics with RIBs

Structure of exotic nuclei far off stability;

Nuclear synthesis in stars and star explosions;

Fundamental interactions and symmetries

Hadron Physics with Antiproton Beams

Quark gluon structure and dynamics of "strong" interacting particles;

Origin of the confinement and mass of hadrons

Transversity measurement via polarized antiprotons and pol. protons

Physics of Nuclear Matter with Relativistic Nuclear Collisions

Studies of hadronic matter at high densities;

Phase transitions in quark matter;

Properties of neutron stars

Development of Project Staging

2003	**Recommendation by WissenschaftsRat – FAIR Realisation in three stages**						
2005	**Entire Facility** **Baseline Technical Report**						
2007	**Phase A**						**Phase B** SIS300
2009	**Module 0** SIS100	**Module 1** expt areas CBM/HADES and APPA	**Module 2** Super-FRS fixed target area NuSTAR	**Module 3** pbar facility, incl. CR for PANDA, options for NuSTAR **LEB in HEB**	**Module 4** LEB for NuSTAR, NESR for NuSTAR and APPA, FLAIR for APPA	**Module 5** RESR P+ beam line nominal intensity for PANDA & parallel operation with NuSTAR and APPA	**Module 6** SIS300 BIOMAT Hall HESR cooler EC ring

MSV - Modularized Start Version

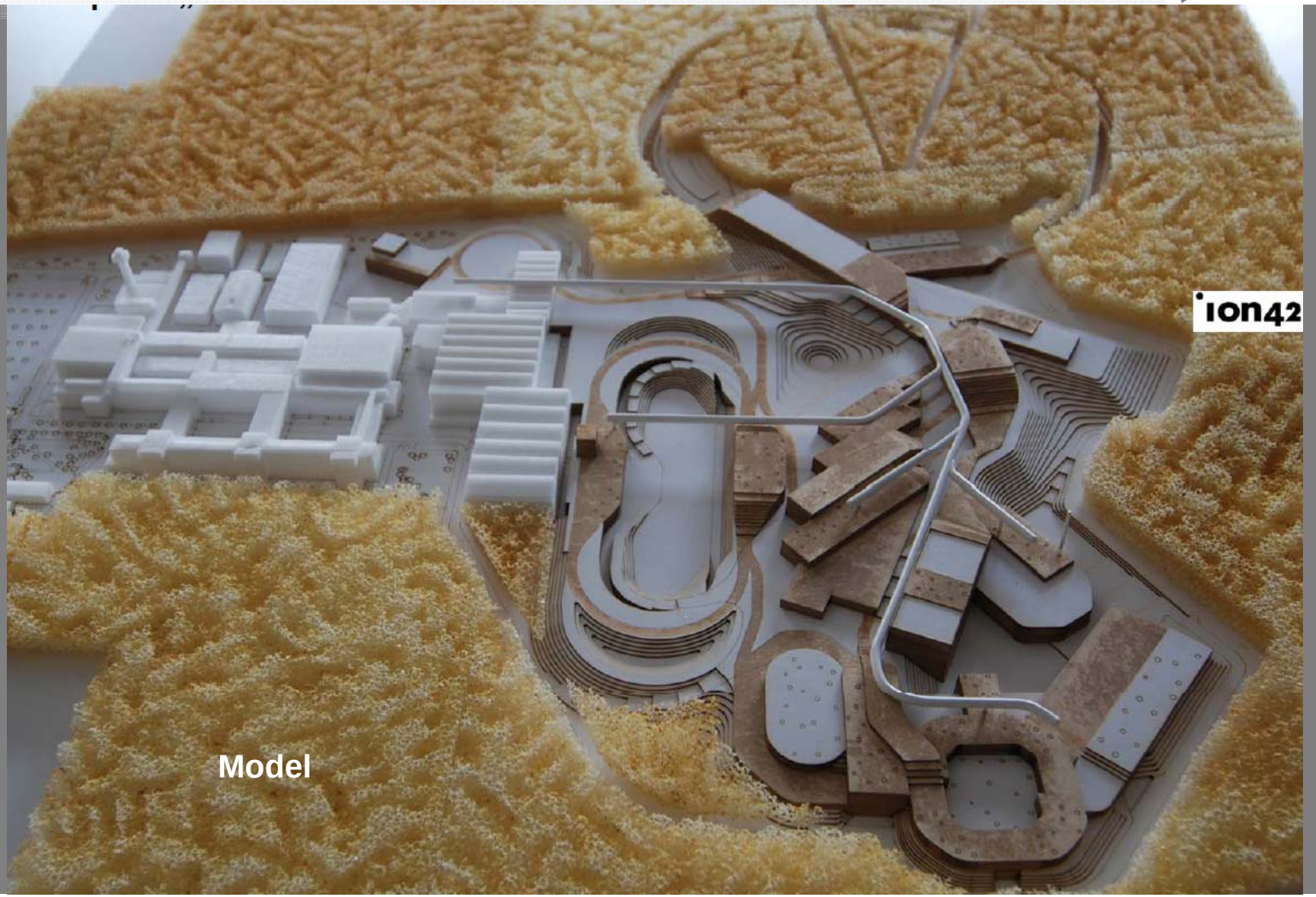
Signing the Application for the Building Permit

Günther Rosner and Boris Sharkow

Construction applications have been submitted to the 13 building authorities in charge, on 31/8/2011 (1400 folders).

First two Test-Pillars Drilled and Casted

How the Construction of Buildings will Proceed?

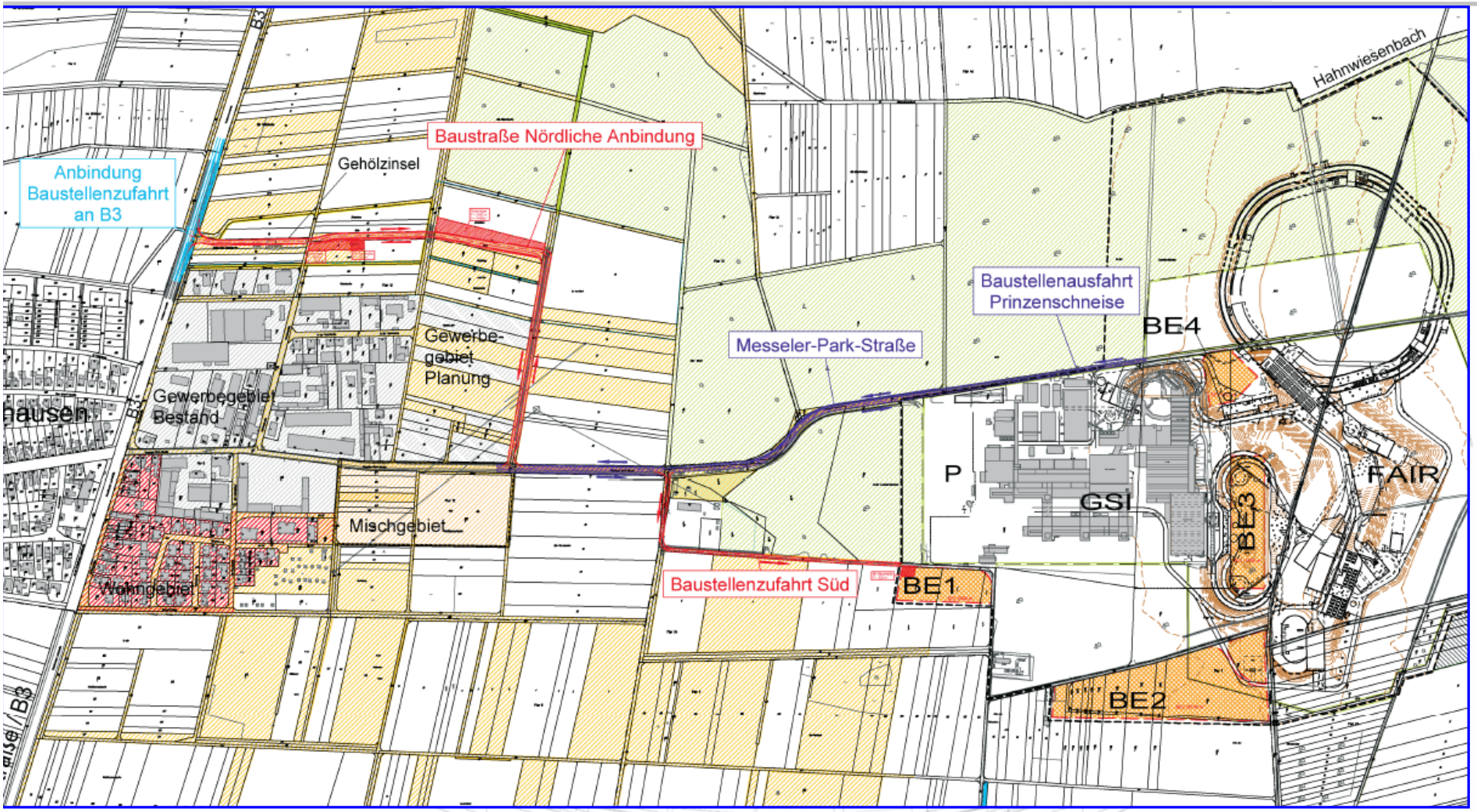


Key Figures from Civil Construction

Type			Mass (t)	Fraction
Sum			5.835.000	100%
Soil out	1.154.000	m3	2.077.200	**36%**
Soil in	1.078.000	m3	1.940.400	**33%**
Concrete	519.000	m3	1.283.400	22%
Steel for concrete	34.000	t	34.000	0,6%
Other	500.000	t	500.000	9%

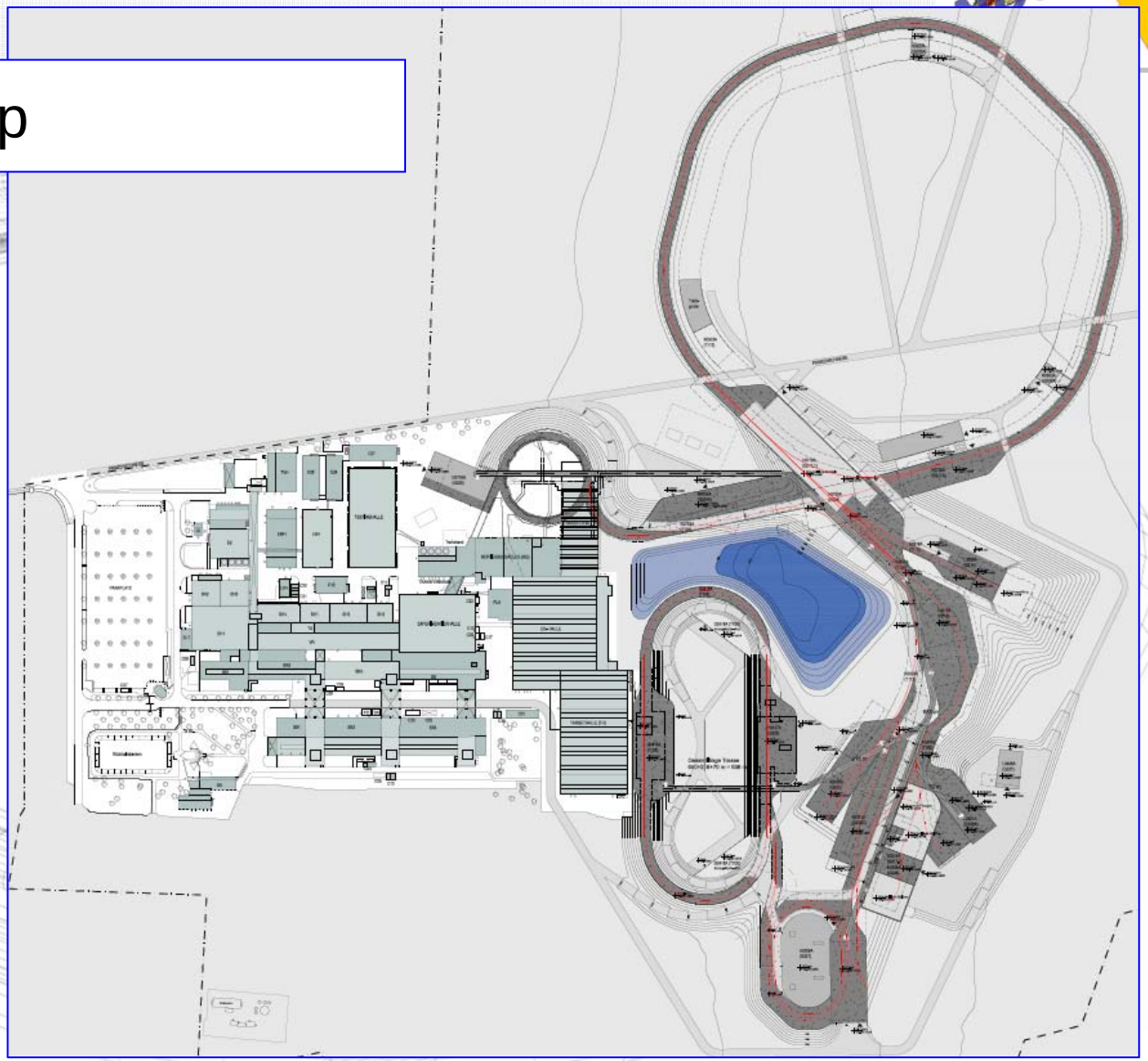
In order to optimize time and costs logistics is an item
-> professional construction logistics company is contracted

New Road to Build – Application Issued



Construction Cycle I

2012: Site set-up

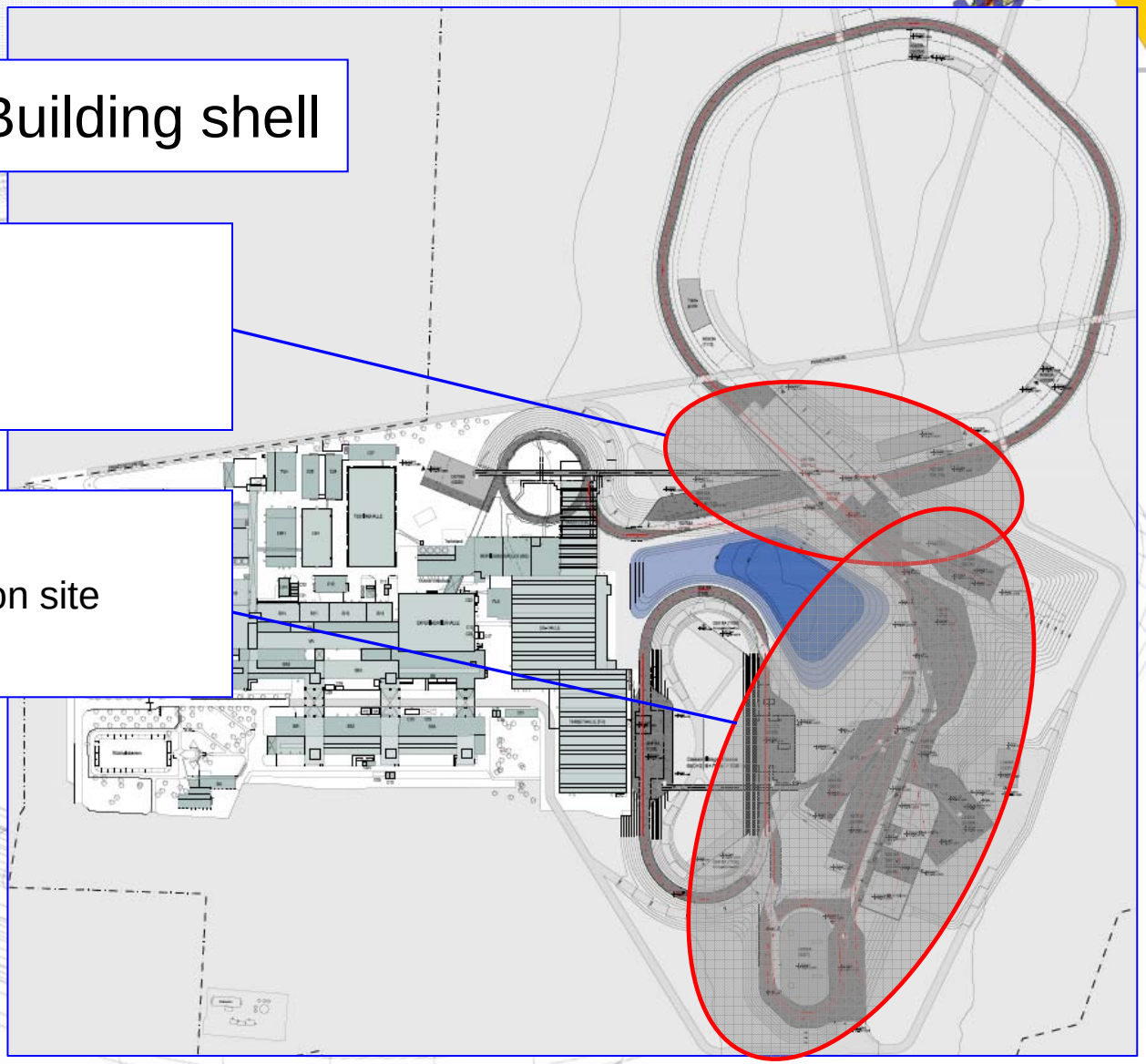


Construction Cycle II

2013 – 2014: Building shell

1. <u>Cross-way building:</u>
- dewatering
- excarvation pit
- cross-way building

2. <u>Bored piles:</u>
- southern construction site
- cross-way building



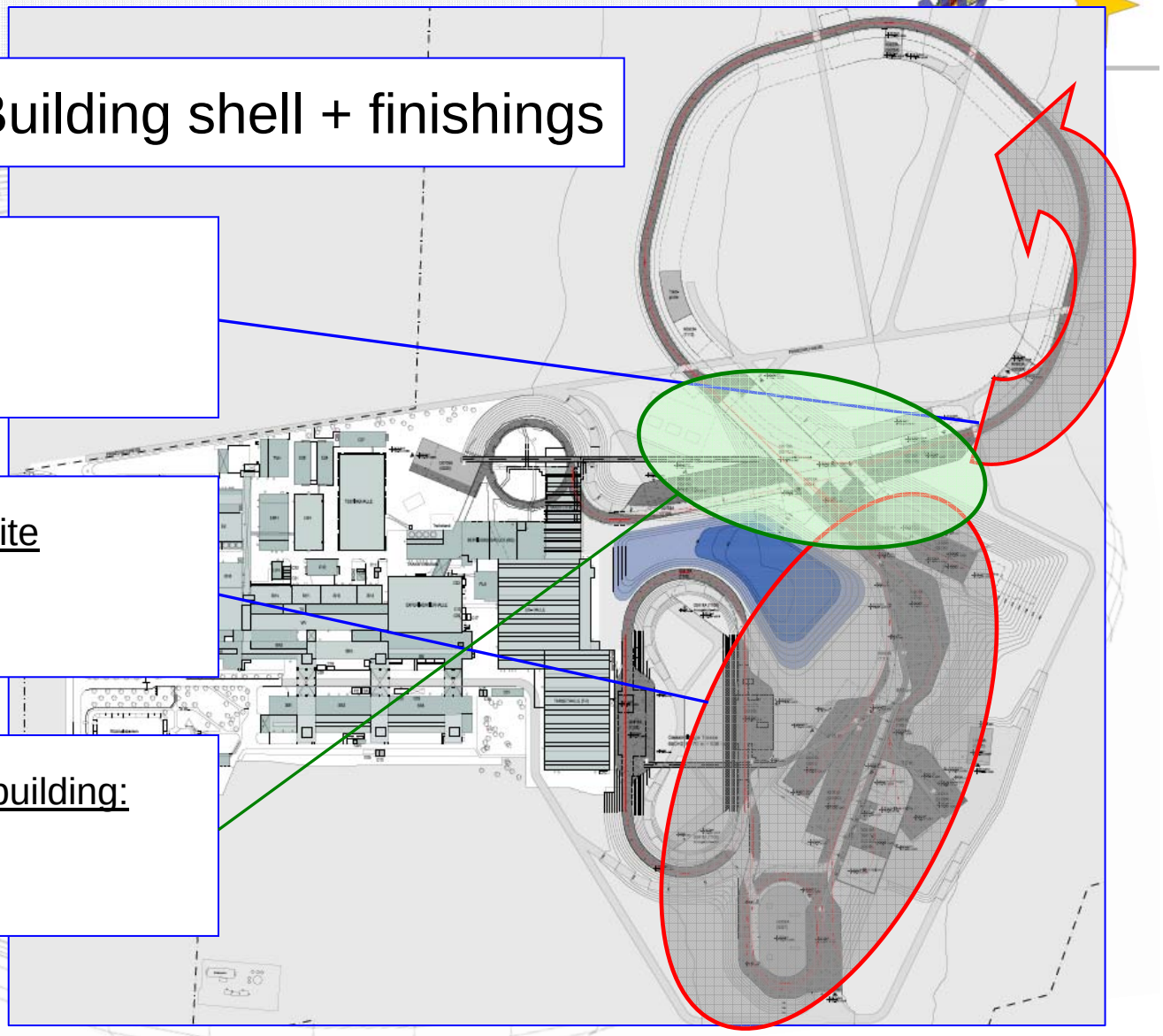
Construction Cycle III

2015 – 2016: Building shell + finishings

3. <u>Syncrotron tunnel:</u>
- excarvation pit
- tunnel
- dewatering

4. <u>Buildings southern site</u>
- buildings
- <u>cross-way building</u>

5. <u>finishing cross-way building:</u>
- building services
- terrain modelling



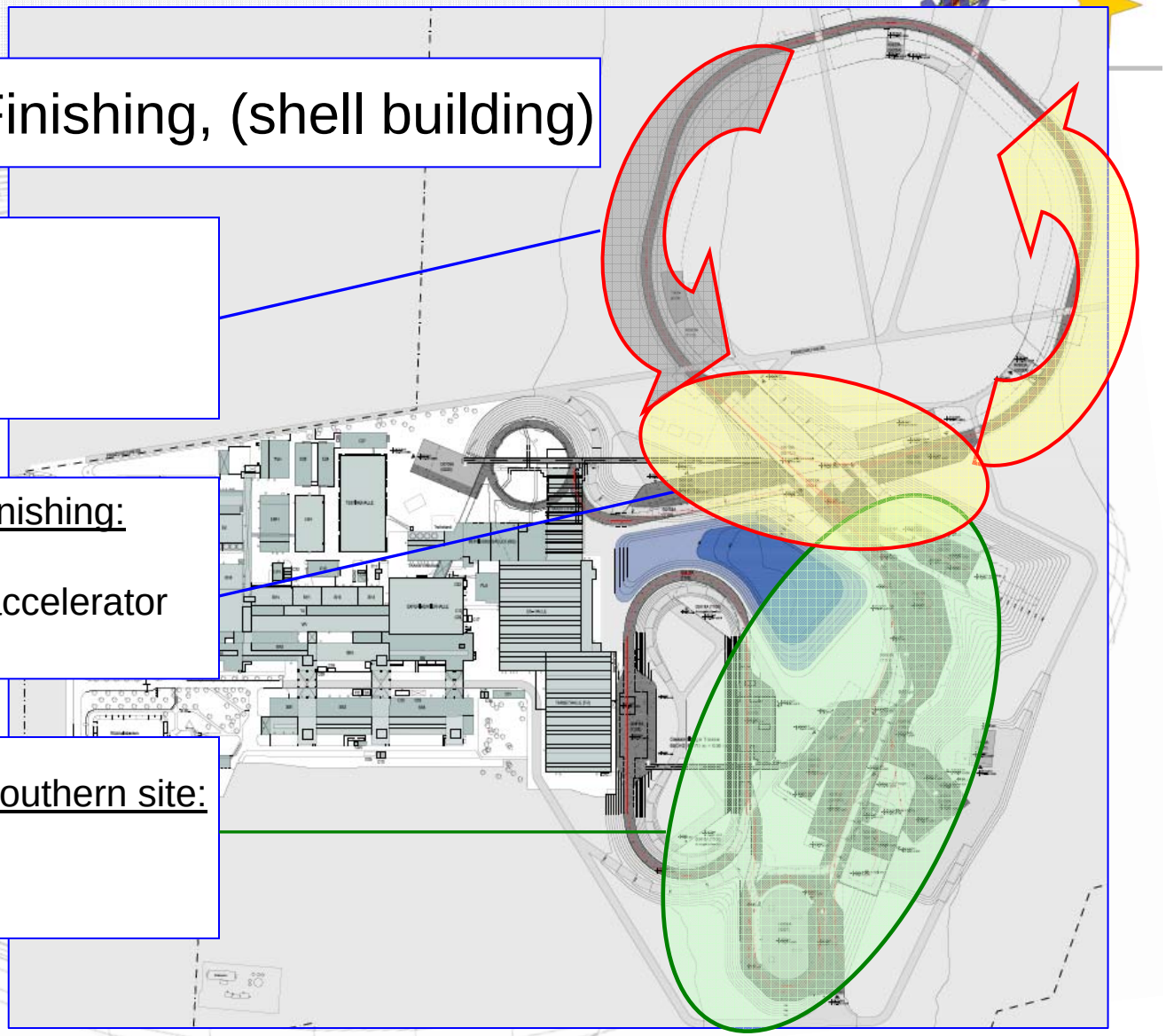
Construction Cycle IV

2016 – 2017: Finishing, (shell building)

3. <u>Syncrotron tunnel:</u>
- excarvation pit
- tunnel
- dewatering

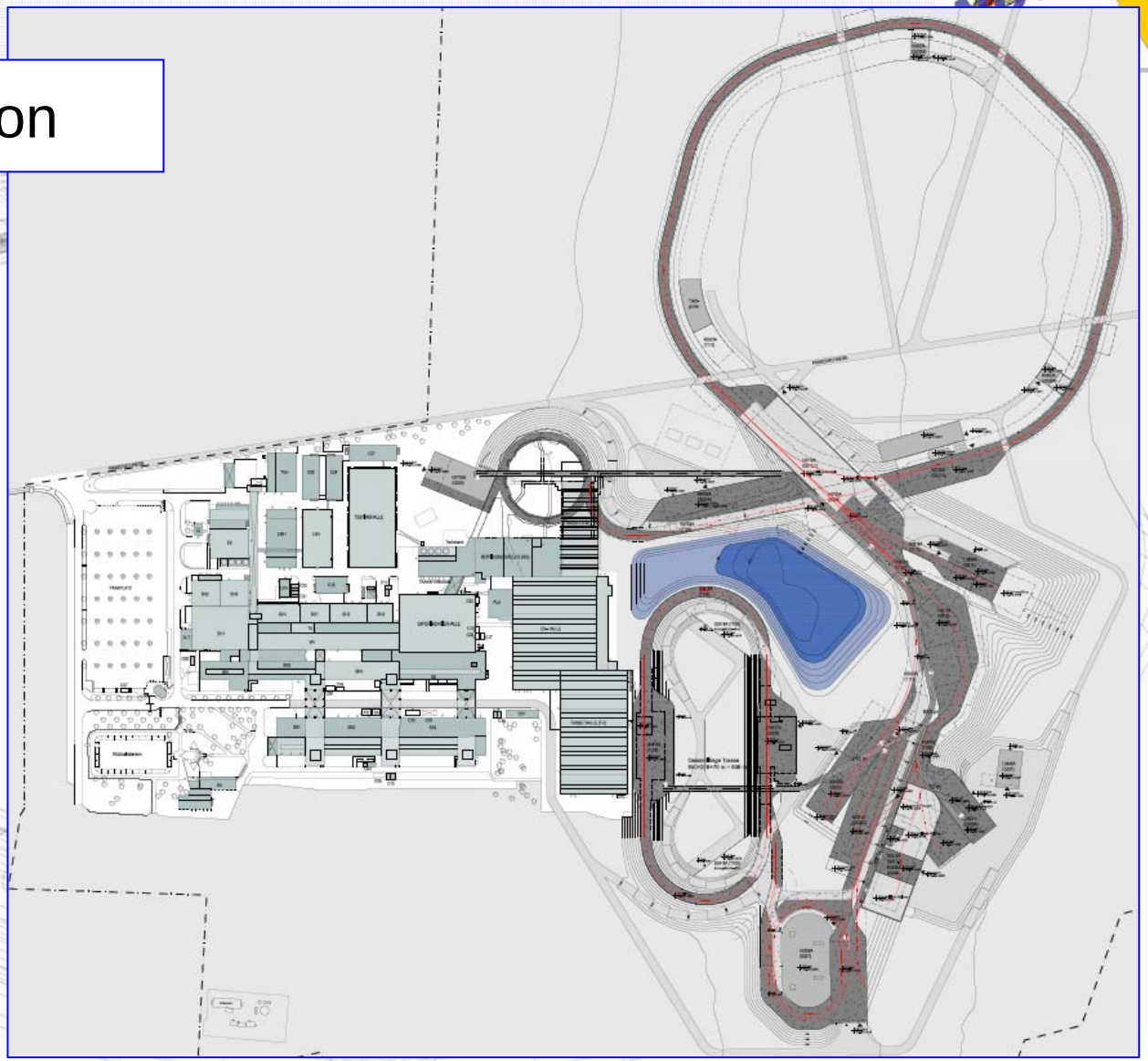
6. <u>Syncrotron tunnel finishing:</u>
- building services
- Start installation of accelerator components

7. <u>Finishing buildings southern site:</u>
- building services
- terrain modelling



Construction Cycle V

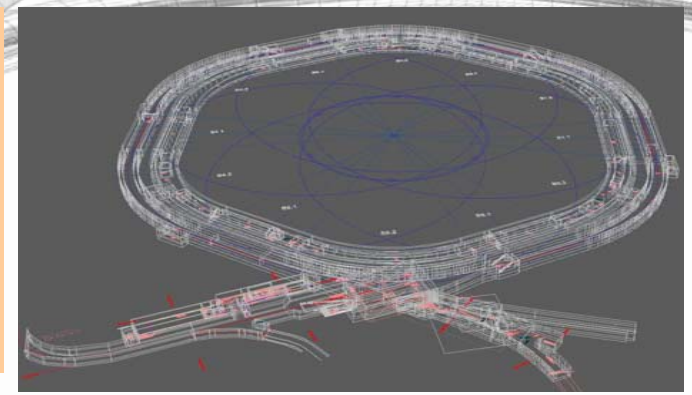
2018 Completion

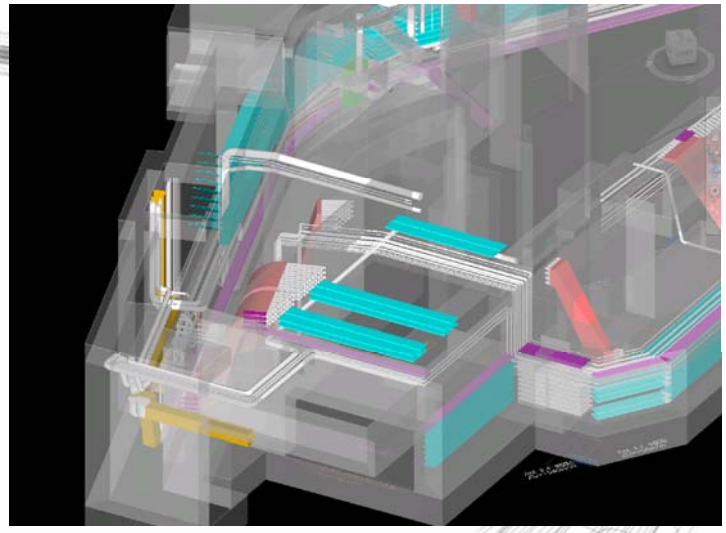


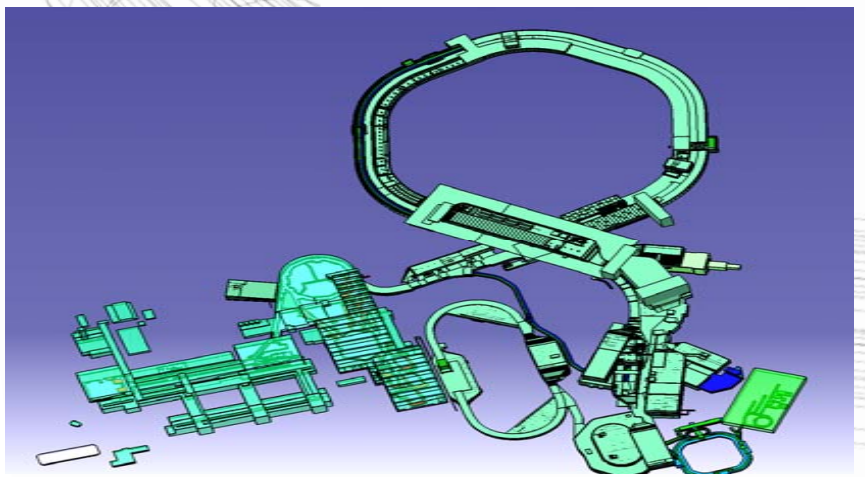
Digital Mock Up

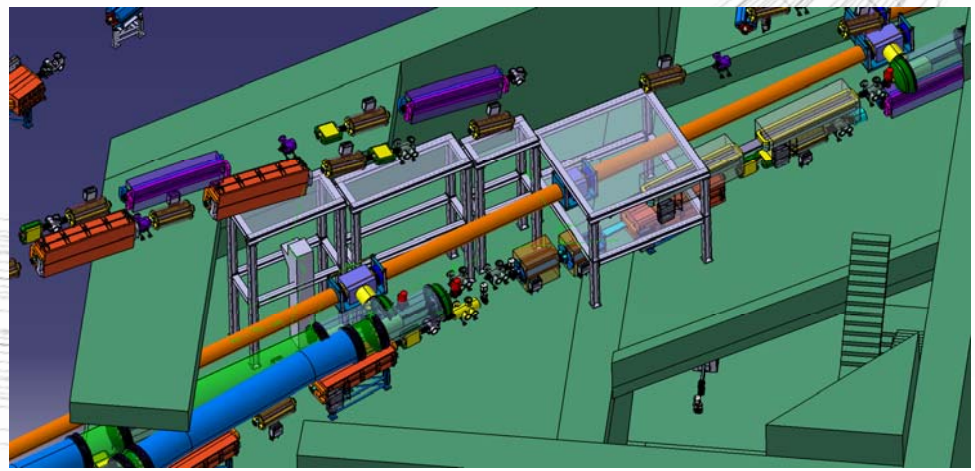
All buildings, and existing accelerator and detector components included

Valuable tool for studying various details as collision-, installation-, service or maintenance- and space aspects.









NUclear STructure Astrophysics and Reactions

What are the limits for existence of nuclei?

- Where are the proton and neutron drip lines situated?
- Where does the nuclear chart end?

How does the nuclear force depend on varying proton-to-neutron ratios?

- What is the isospin dependence of the spin-orbit force?
- How does shell structure change far away from stability?

How to explain collective phenomena from individual motion?

- What are the phases, relevant degrees of freedom, and symmetries of the nuclear many-body system?

How are complex nuclei built from their basic constituents?

- What is the effective nucleon-nucleon interaction?
- How does QCD constrain its parameters?

Which are the nuclei relevant for astrophysical processes and what are their properties?

- What is the origin of the heavy elements?

NUSTAR - The Project

DESPEC	γ-, β-, α-, p-, n-decay spectroscopy
ELISE	elastic, inelastic, and quasi-free e^--A scattering
EXL	light-ion scattering reactions in invere kinematics
HISPEC	in-beam γ spectroscopy at low and intermediate energy
ILIMA	masses and lifetimes of nuclei in ground and isomeric states
LASPEC	Laser spectroscopy
MATS	in-trap mass measurements and decay studies
R3B	kinematically complete reactions at high beam energy
Super FRS	RIB production, identification and spectroscopy

The Approach

Complementary measurements leading to consistent answers

The Collaboration

> 900 scientists

148 institutes

38 countries

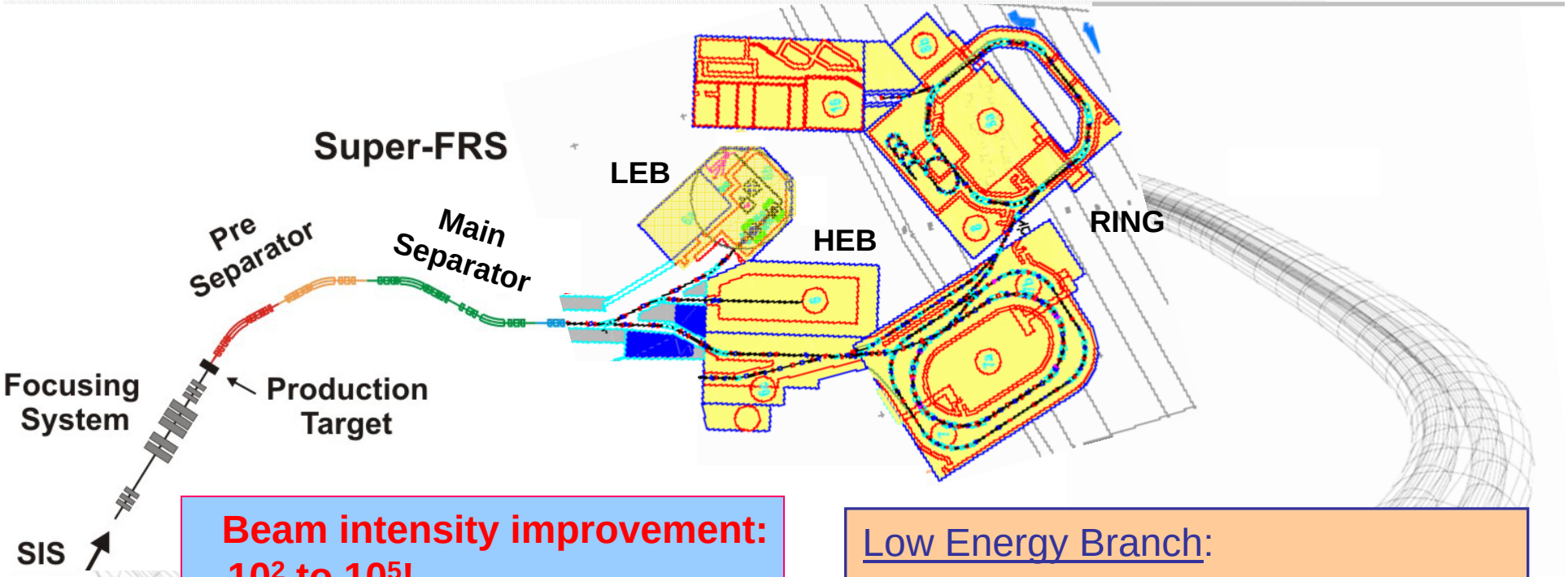
Database update started

The Investment

82 M€ Super FRS

73 M€ Experiments

NUSTAR - The Facility



Beam intensity improvement: 10^2 to 10^5!

Low Energy Branch:

HISPEC, DESPEC, MATS, LASPEC

High Energy Branch:

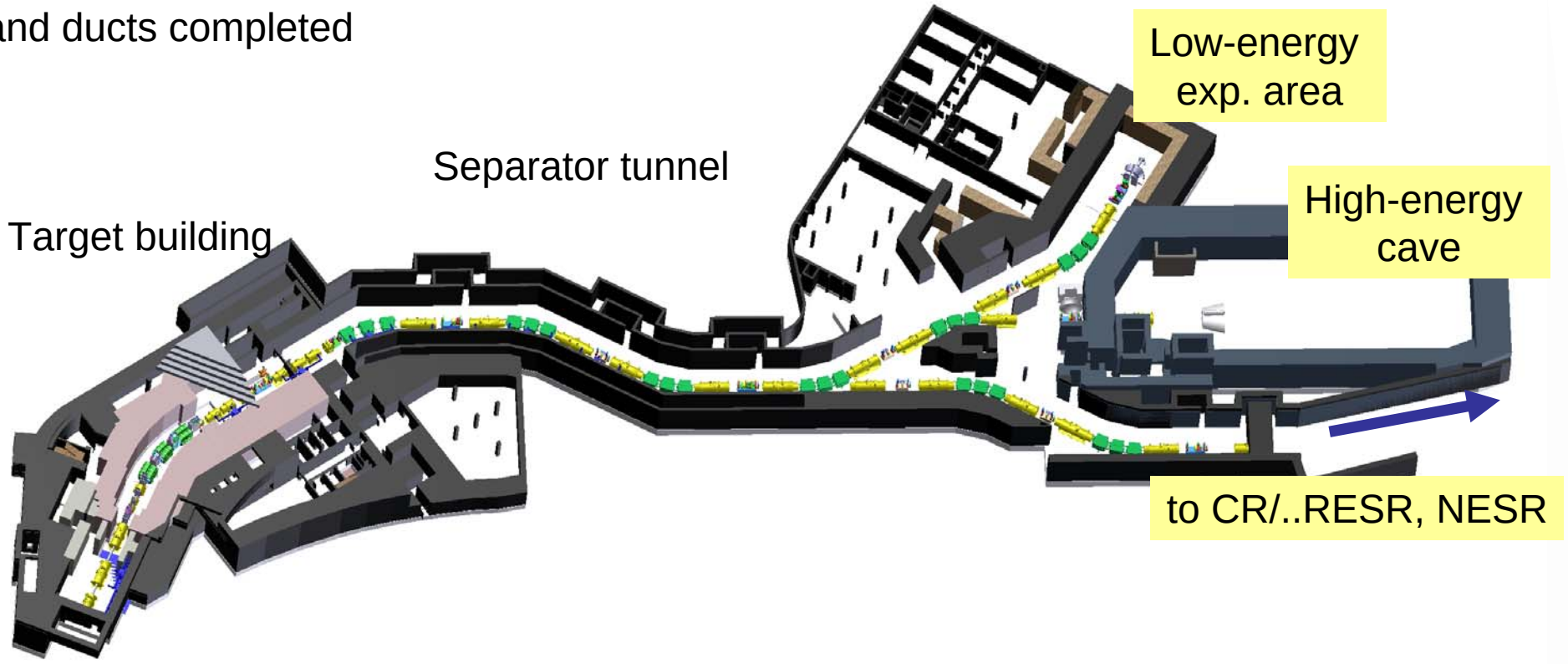
R3B

Ring Branch:

EXL, ILIMA, ELISE

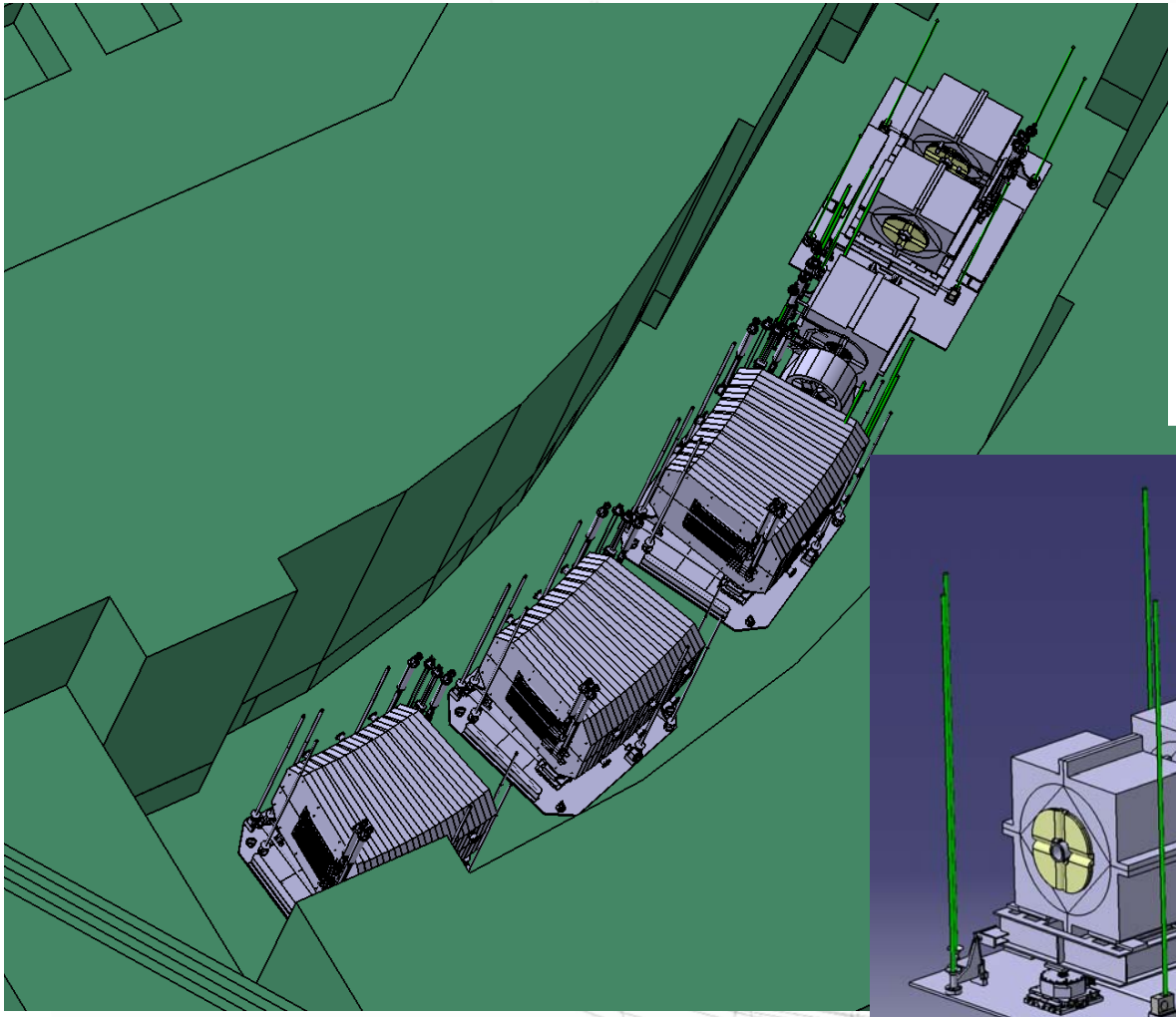
The Super-FRS

- Basic evaluation completed
- Preliminary planning completed
- Approval planning including maze and ducts completed

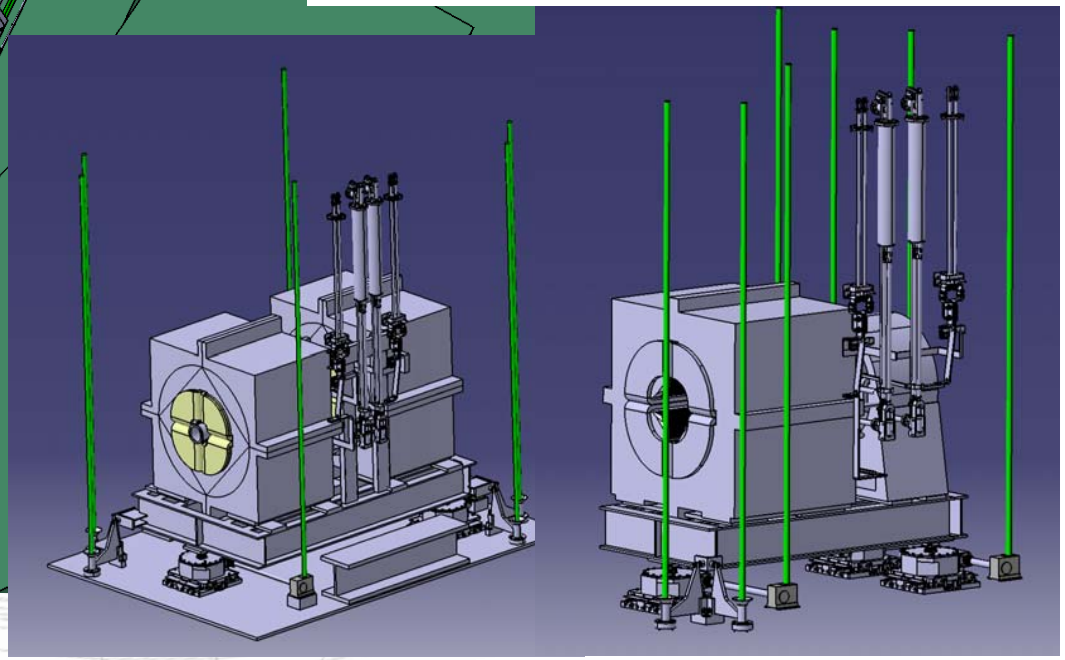


from SIS18/SIS100 synchrotrons

The Super-FRS in Digital Mock Up



- Cross check of ion optical layout and civil construction planning
- Definition of installation space
- Definition of assembly strategy



… and real life?

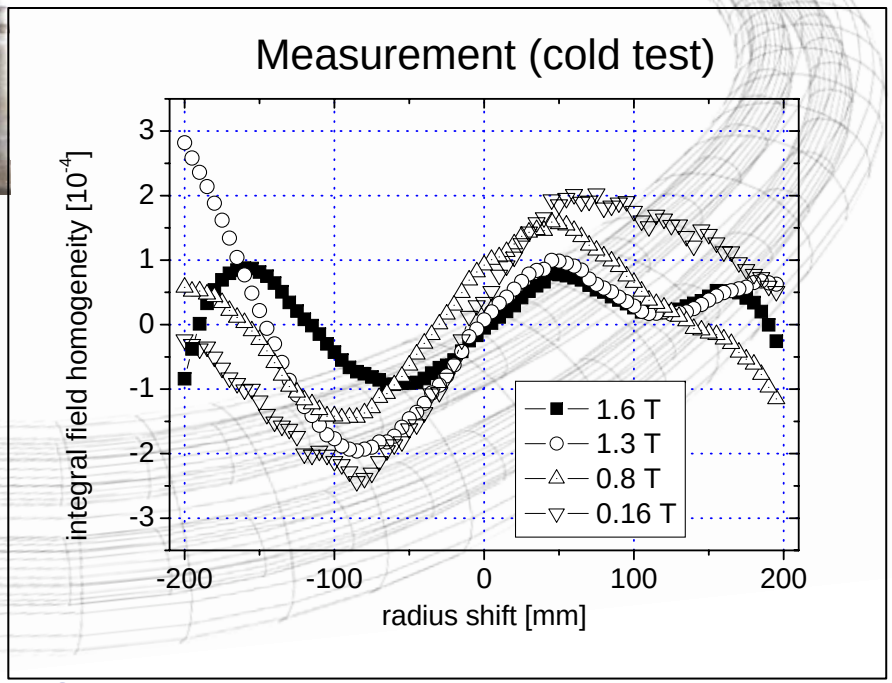
Superferric Dipole for the S-FRS

Magnetic flux:

B_{max} = 1.6 T @ I = 233 A
(design value: I = 230 A)

Required field quality:

DB/B = $\pm 3 \times 10^{-4}$
(over ±190 mm, 5 mm steps)

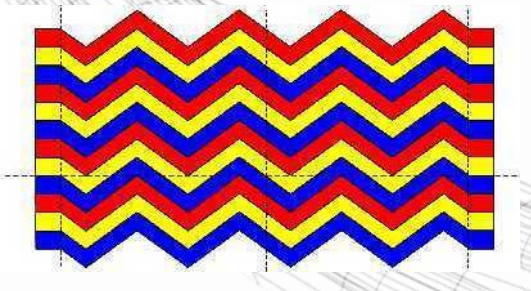


- field quality tests successful
- quench tests successful
- no part of outer cryostat-wall ≤ 0° C
- heat load @ 4.2 K ≈ 5 W
- stored energy ≈ 400 kJ

Production: CEA and CIEMAT as IKC

Heavy Ion tracking

GEM TPC development

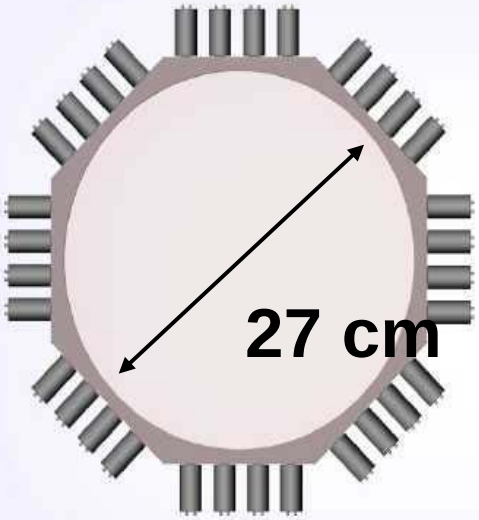


Chevron shaped electrode

$\sigma_x \approx 400\ \mu m \quad \sigma_y \approx 300\ \mu m$

B. Sitar(Bratislava)

Ultra-Fast timing



R. Hoischen (Lund/GSI)

More PMTs ->
Cover more solid angle
+ Less "dead spots"

Set-up:
32 PMTs on BC-420
CFDs+TDC (25ps/bin)

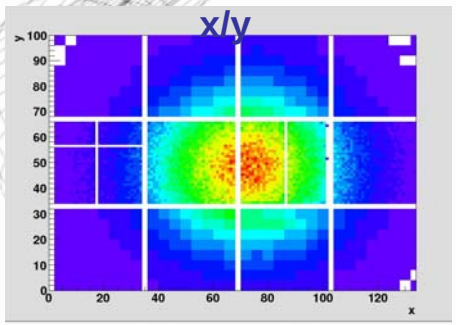
σ~15 ps

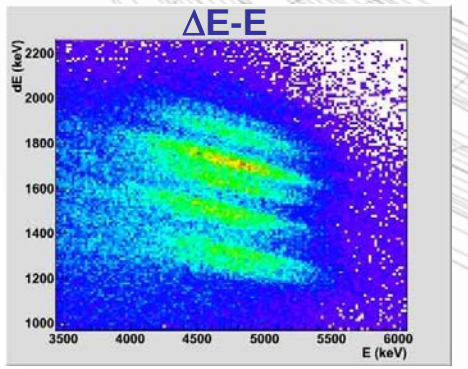
HISPEC Detector LYCCA in use

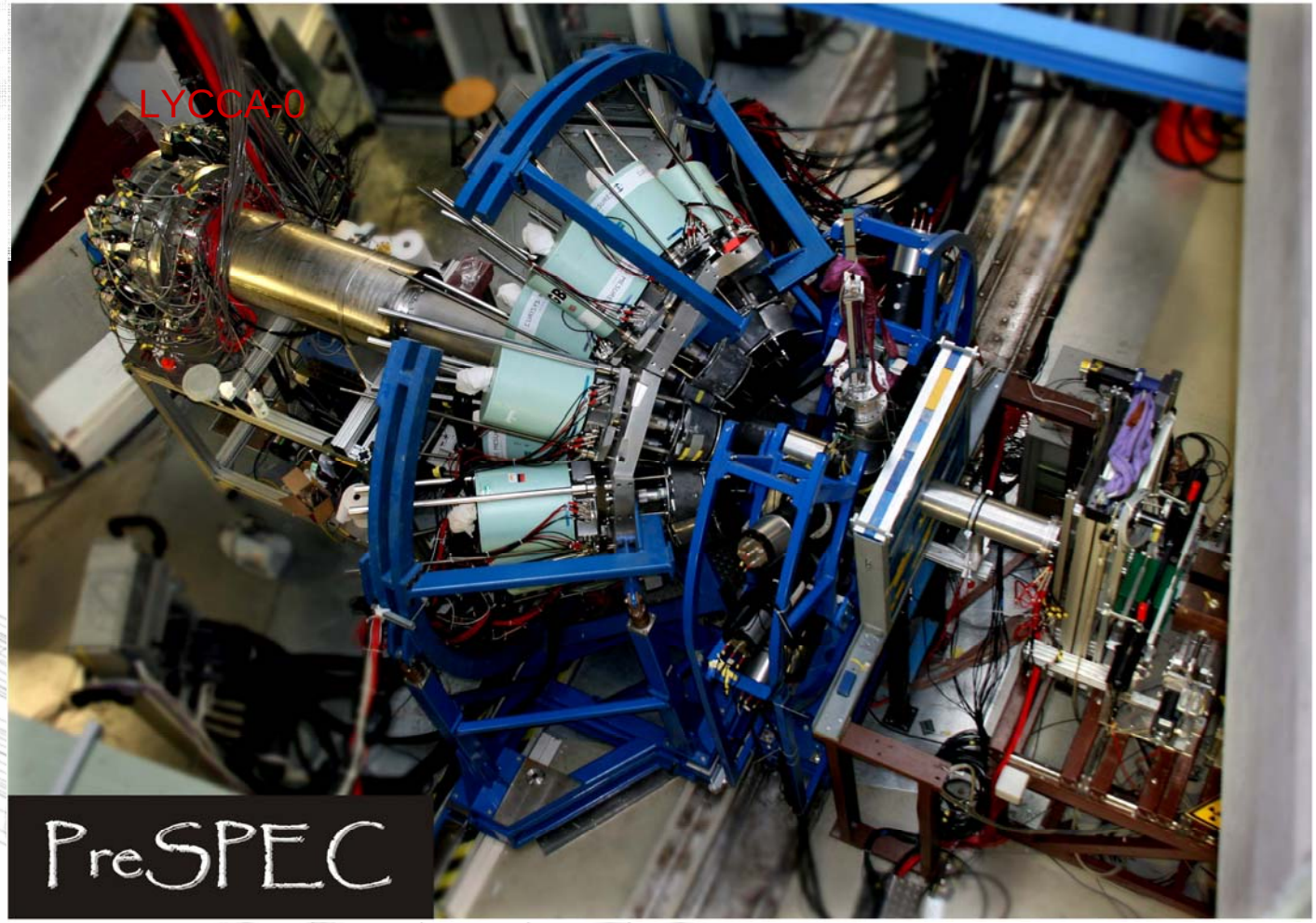
Position sensitive
ΔE-E-ToF calorimeter

Commissioned in 9.2011

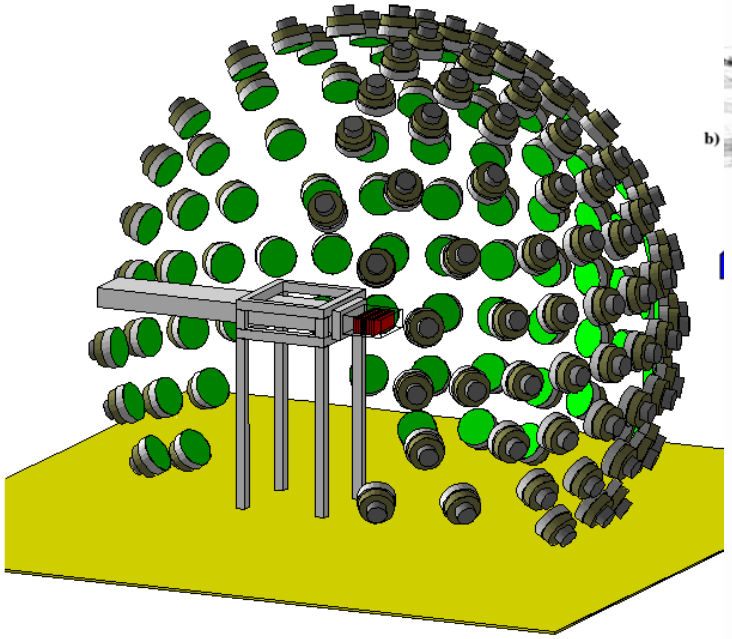
In use since 10.2011

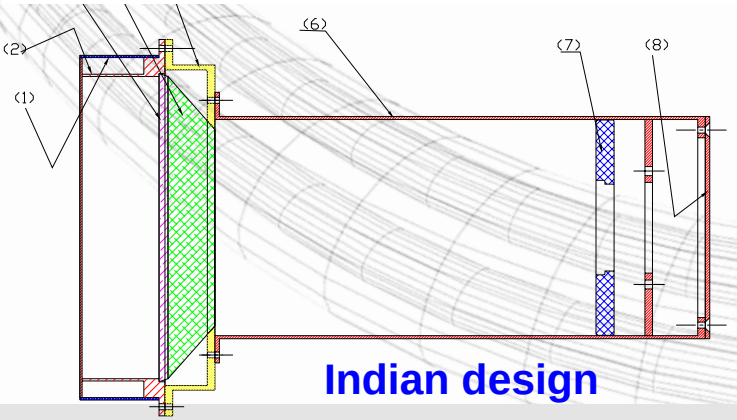






The MONSTER cells



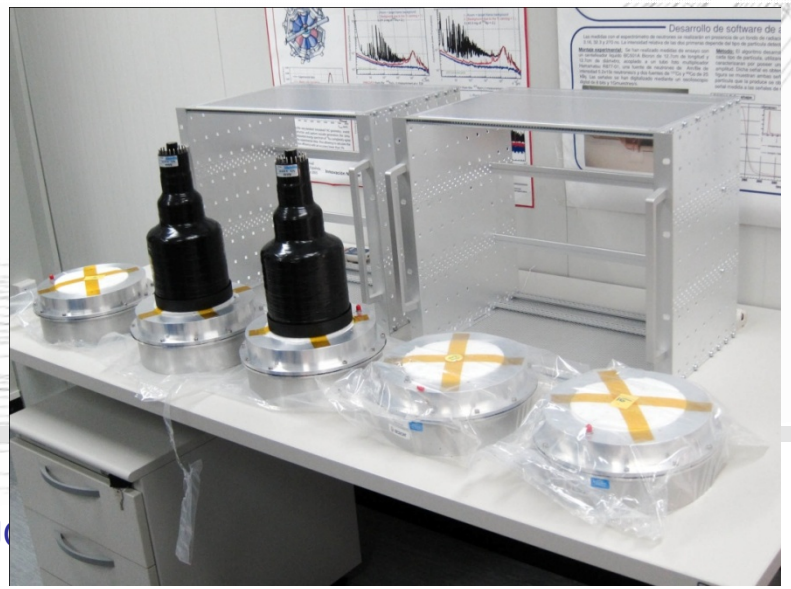


Indian design

The construction of the cells will be shared between Spain (CIEMAT, IFIC), India (VECC), Finland (Univ. of Jyvaskyla), Sweden (Univ. of Uppsala).

-CIEMAT + St. Gobain design, used for the 30 cell demonstrator.
-India will build a prototype cell according to the standard specifications.

Joint tests will be performed on the characterisation of the cells.



NUSTAR Organisation

NUSTAR Council

Reps. of all institutes

Board of FAIR Collaborations

Chair of Board of Reps.

Sub-Project Spokespersons

All 9 projects

Board of Representatives

5 reg. members, Project Manager, Super-FRS Chair

FAIR Scientific Department

Project Manager, Resource Coordinator

Collaboration Council

Sub-Project Management

Sub-Project Manager, Working group chairs

Common Working Groups

Project Manager, Working group chairs

Project Management

Project Manager, Resource Coordinator Tech. and Admin. Officer

J. Gerl
A. Herlert
N. Goel

Technical Board

Resumee

FAIR has started…

- Civil construction is starting now
- Planning is very advanced
- Impressive progress with accelerator components and detectors
- Optimizing current experiments by employing NUSTAR developments

… NUSTAR is in good shape

… last chance to get more involved

NUSTAR Annual Meeting: Feb. 27. – March 2, 2012 at GSI Darmstadt

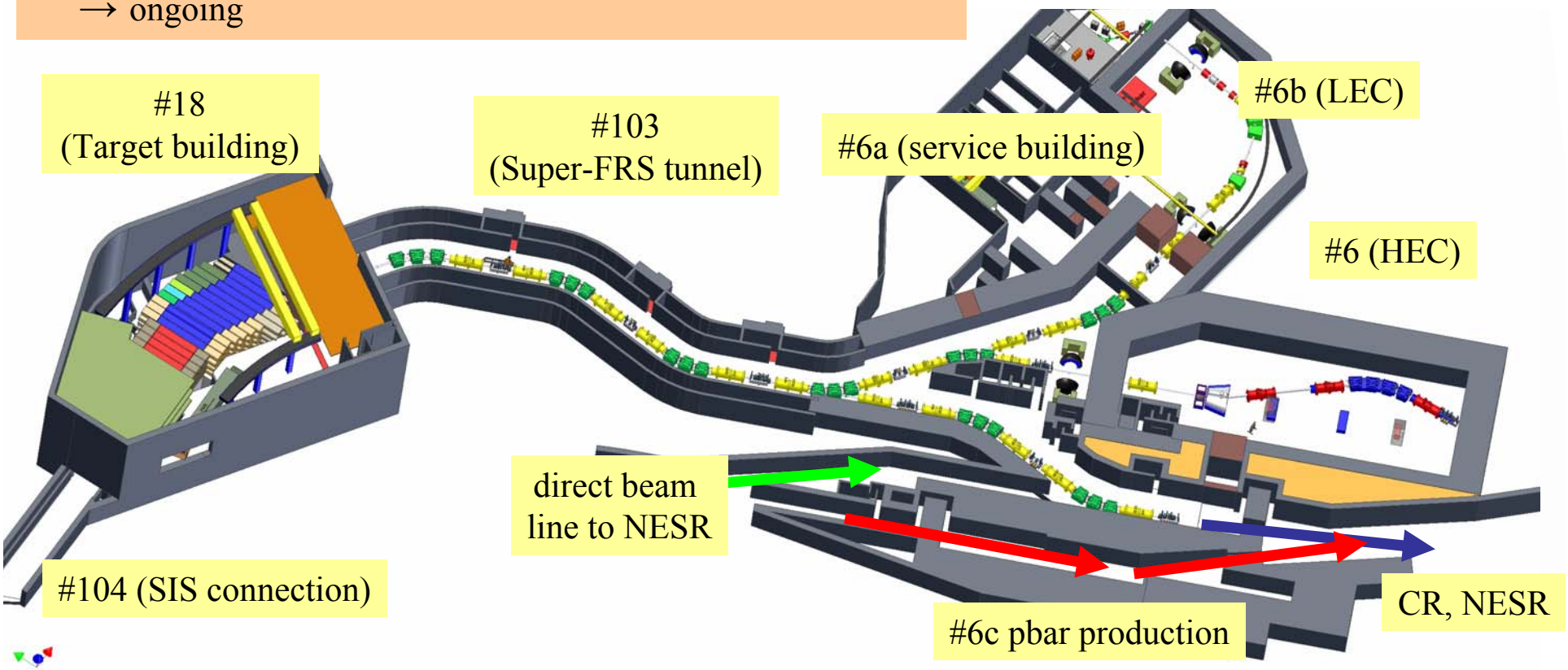
NUSTAR Week: Oct. 8 – 12, 2012 at VECC Kolkata

Super-FRS Buildings
(as originally presented for ZBau)

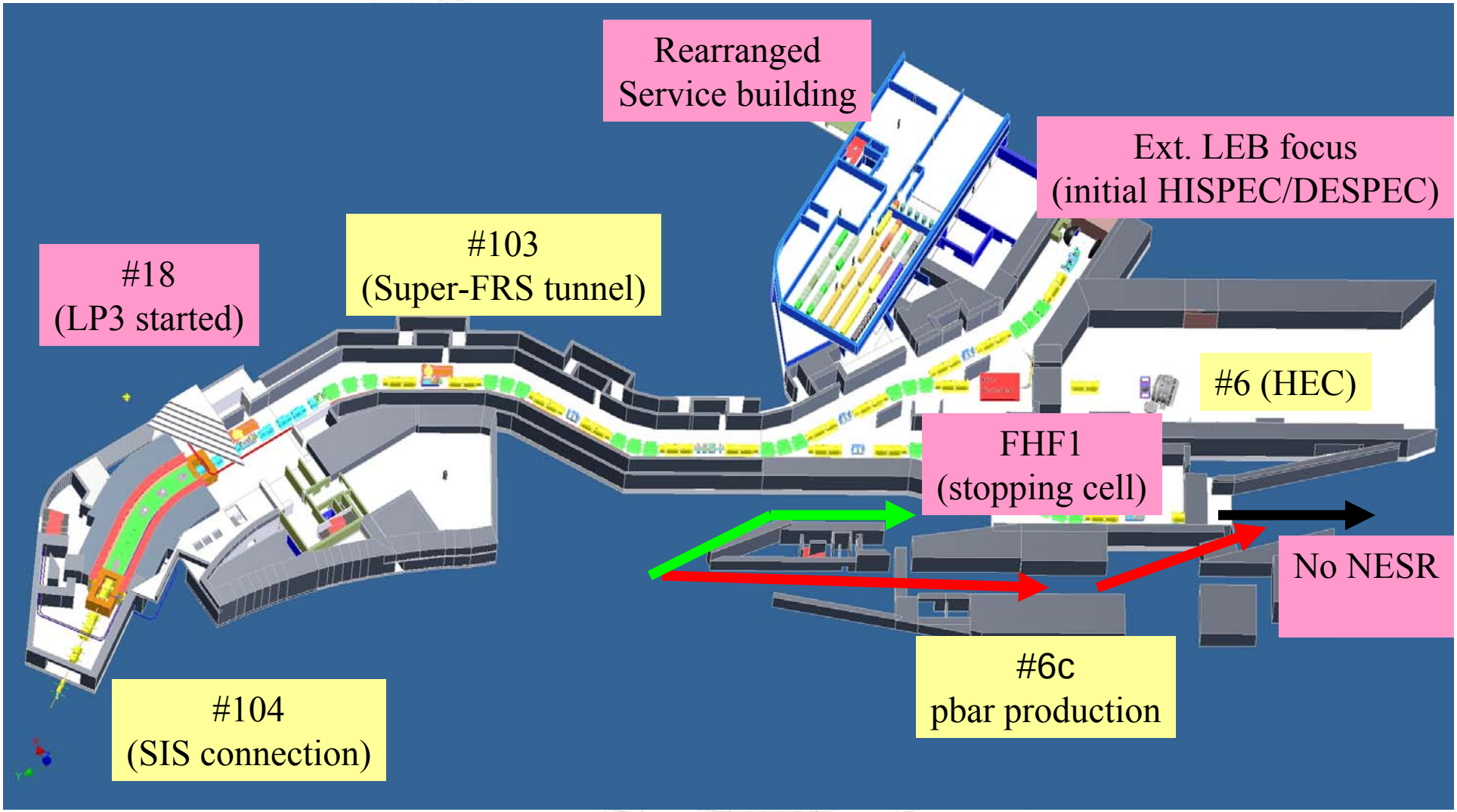
- LP1 (basic technical considerations) √
- LP2 (preliminary design, cost estimate) √
  → Modularized Start Version (MSV)
- LP3 (blueprint planning, detailed costs),
  → ongoing

Roadmap CC

Module	Construction time (months)	Ready for installation
0	72	2016 / 17
1	28	2016 / 17
2	60	2016
3	60	2017



Super-FRS Buildings (modularized start version)



How to proceed?

LEB

1. Parallel planning to get costs and not to loose time
   Agreed by FAIR, requires 68 k€ from collaborators
2. Organize extra funds to ask for building permit and start construction
   Extra funds (estim. 1.5 M€) from external sources and/or from experiments to be raised within 1.5 years

Ring Sub-Projects

1. Prepare a realization plan
   Continue R&D for TDRs, be ready if new funds come in
2. Pursue an attractive experiment programme at the ESR
   To keep the collaboration together
3. Realize essential parts of the instrumentation
   To be employed in other NUSTAR sub-projects