NUSTAR Status Report

J. Gerl

GSI Darmstadt, Germany

NUSTAR Week, Valencia

September 2014

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
SHE	Nuclear physics and chemistry of super-heavy elements

The Approach

Complementary measurements leading to consistent answers

The Collaboration

> 800 scientists

182 institutes

38 countries

The Investment

82 M€ Super FRS

73 M€ Experiments

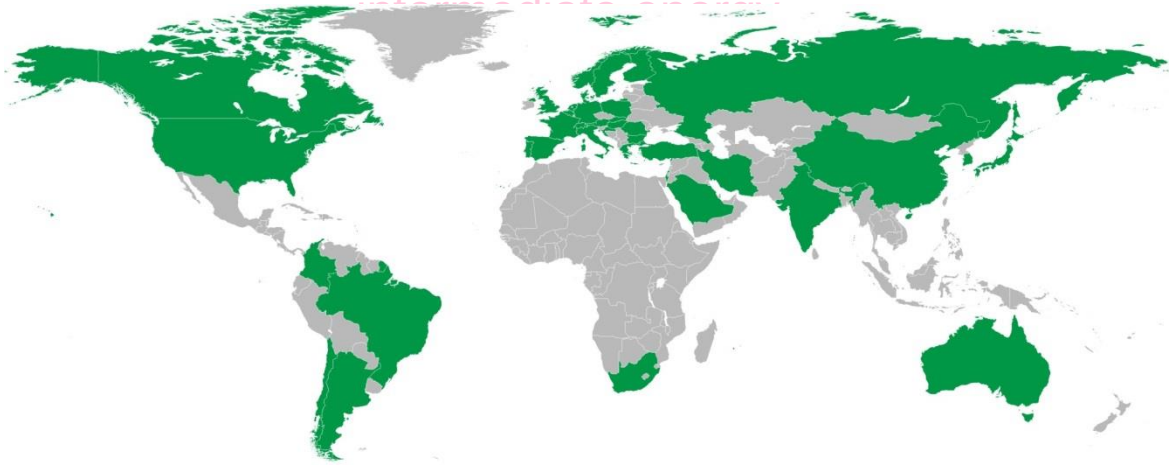
NUSTAR - The Project

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



at high beam energy

Super FRS RIB production, identification and spectroscopy

SHE Nuclear physics and chemistry of super-heavy elements

The Approach

Complementary measurements leading to consistent answers

The Collaboration

> 800 scientists

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The Investment

82 M€ Super FRS

73 M€ Experiments

For the future we will distinguish ACTIVE Collaborators / Groups

NUSTAR experiments update

Modularized Start Version (MSV)	
1.2.1	LEB Super-FRS
1.2.2	HISPEC/DESPEC
1.2.3	MATS
1.2.4	LaSpec
1.2.5	R^3B
1.2.6	ILIMA

PRESPEC-AGATA – experimental campaign at FRS ended successfully

Beyond MSV	
1.2.8	ELISe
1.2.9	EXL

NESR required – alternative/intermediate „operation“ within MSV under discussion

New experiments	
1.2.10	Super-FRS physics
1.2.11	SHE (Super Heavy Elements)

Physics case accepted by ECE

Physics case welcomed by CC

NUSTAR - TDR Status

- Approved TDRs:
  - MATS (all subsystems)
  - LaSPEC (all subsystems)
  - HISPEC/DESPEC (LYCCA, DTAS, AIDA, Plunger, MONSTER, BELEN)
  - R3B (NeuLAND, CALIFA-barrel, GLAD)

- Recently Submitted:
  - HISPEC/DESPEC ((DEGAS, AGATA)

TDR submission Profile				
2014	2015	2016	2017	2018
14	14	3	0	0

Further TDRs expected in 2014

- LEB Super-FRS
  - LEB ion catcher
- HISPEC/DESPEC
  - FATIMA
  - NEDA
- R^3B
  - Tracking detectors
  - Large Area ToF Wall
  - CALIFA forward
  - Target recoil detector
  - Active target
  - DAQ
- ILIMA:
  - ToF detectors

No really critical TDRs remain for later submission!

Most of the cost intensive TDRs are done or will be submitted in 2014!

ECE - TDR Guidelines

TDR Content:

1. Authors highlighting:
   a. The contact person and
   b. Indicating the Collaboration
2. Executive summary of a few pages
3. Scientific case highlighting the importance of thedevice
4. Technical design highlighting:
   a. Design choices
   b. Advantages with respect to other designs
   c. In the exceptional case where, at the time of the TDR evaluation, a choice remains open, this needs to be well motivated, the future choices have to be clearly detailed together with, the timescale, the procedure to take the decision and the impact on the funding.
   d. Include technical references that could expedite the proposal review.
5. Project organization, responsibilities, work packages and timelines with critical milestones
6. Cost estimate including expected funding

ECE - TDR Guidelines

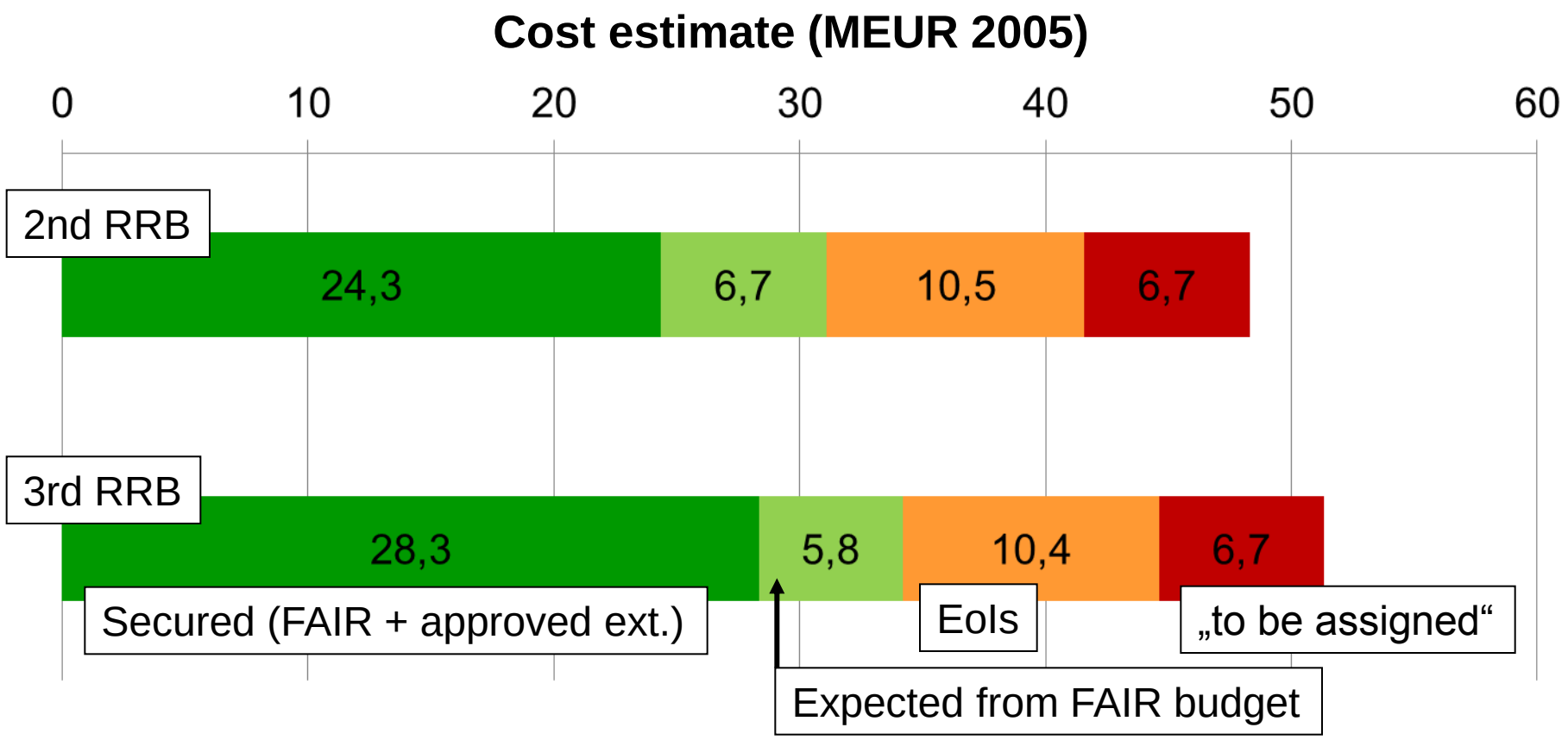
TDR Submission:

TDRs should be submitted electronically by the NUSTAR spokesperson (with the Technical Coordinator and the Resource Coordinator in CC) to the FAIR research Director.

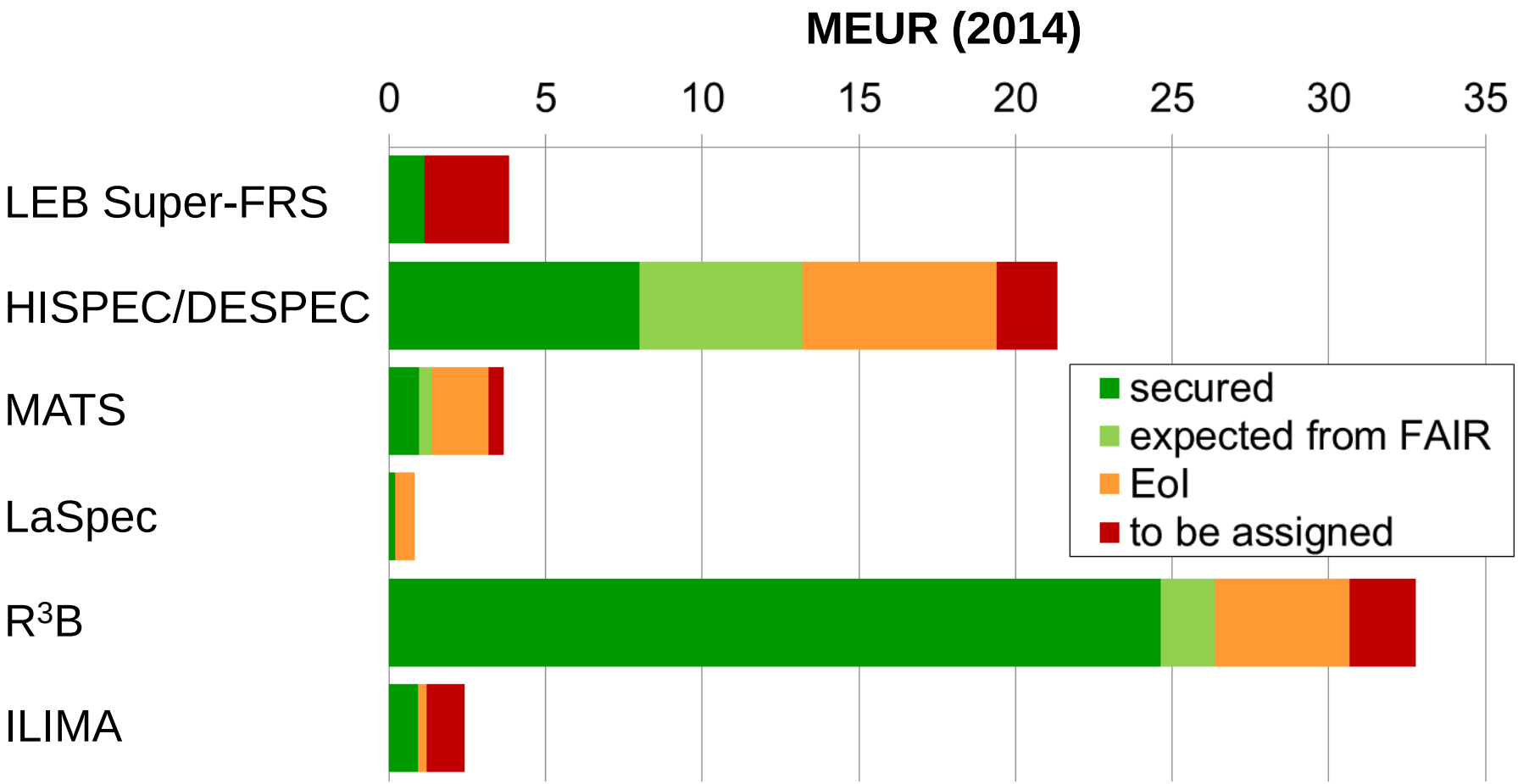
A cover letter should state:

- The contact person
- The status of the device, i.e. whether
  - o The TDR, or parts of it, had undergone a previous review
  - o There has already been funding allocated to it
  - o It has already been partially or fully built
- A list of potential experts, which could be consulted in the review (Those must not be members of the respective collaboration).

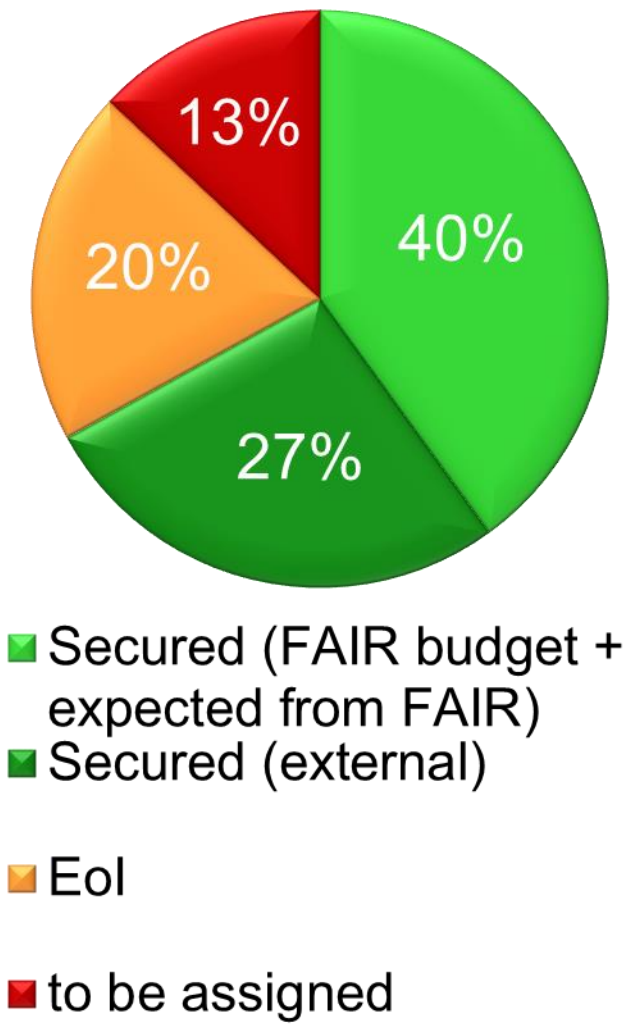
Overall funding status of NUSTAR project



Status of NUSTAR experiment funding

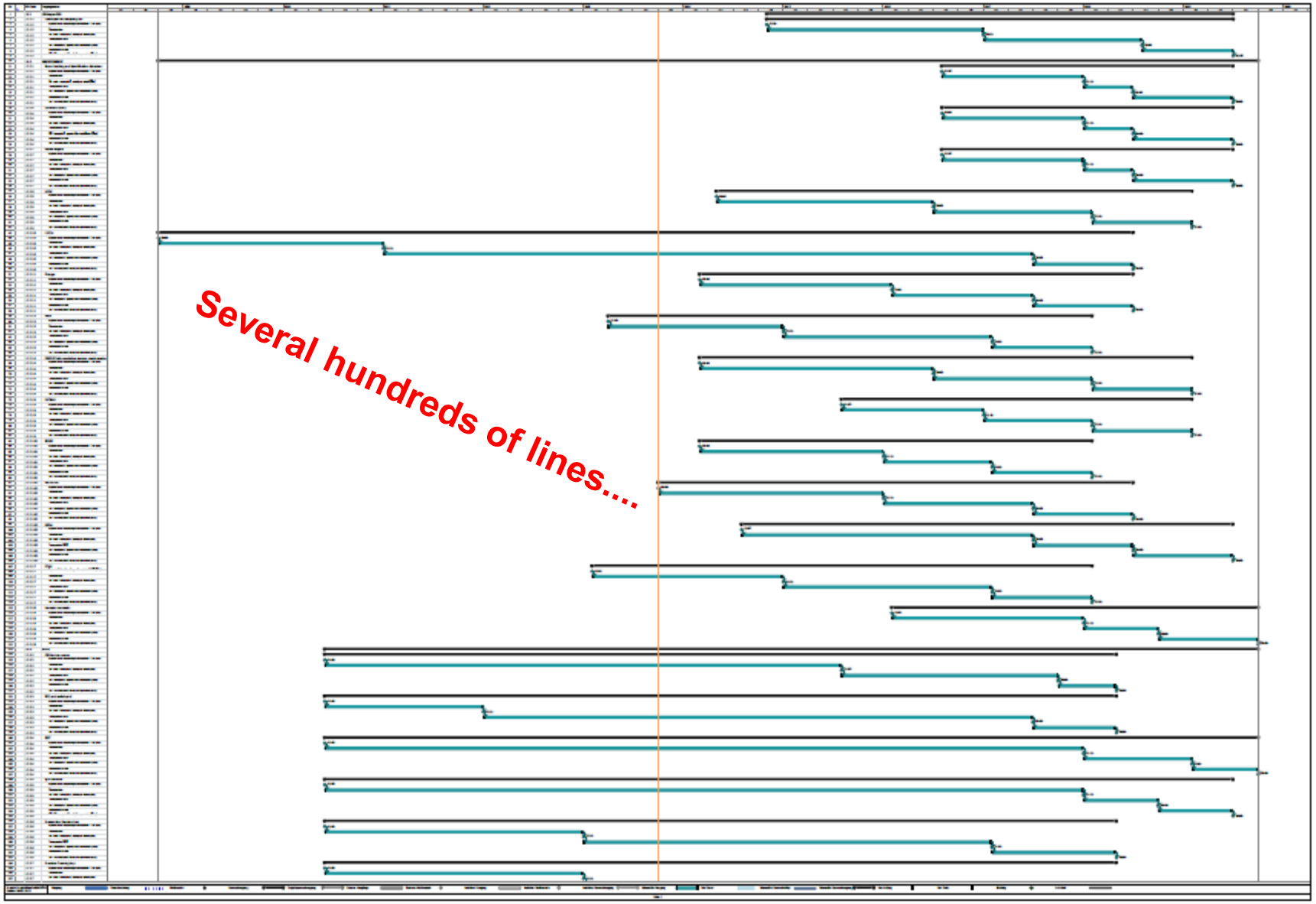


Secured funding, EoIs, and to be assigned



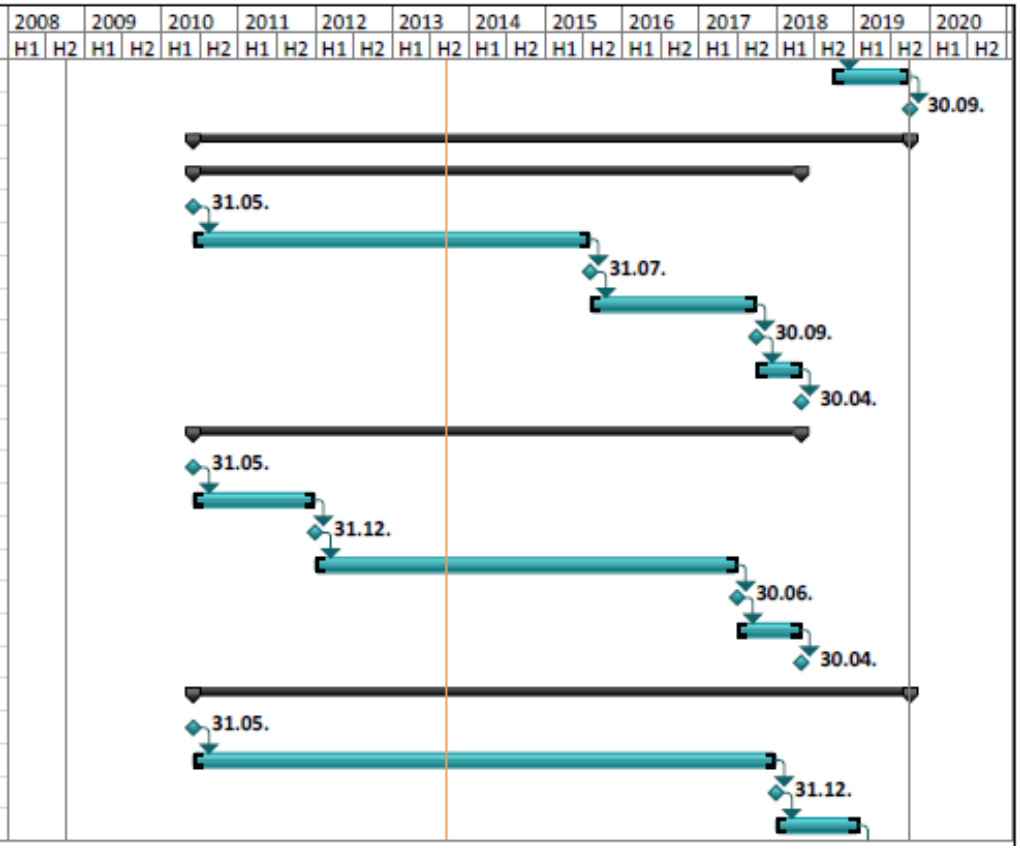
- FAIR shareholders and associates
  - Finland (only external)
  - France (only external)
  - Germany
  - India
  - Poland
  - Romania
  - Russia
  - Sweden
  - UK
- Additional funding from:
  - Belgium
  - Bulgaria
  - Hungary
  - Israel
  - Italy
  - Japan
  - Spain
  - .... contributors are highly welcome

NUSTAR – Project Plan



NUSTAR – Project Plan

Nr.	PSP-Code	Vorgangsname
121	1.2.2.18	Installation in Cave
122	1.2.2.18	SAT Bb accepted / ready for operation [M12]
123	**1.2.3**	**MATS**
124	1.2.3.2	Off-line ion source
125	1.2.3.2	Approval of workpackage description / TDR [M3]
126	1.2.3.2	Construction
127	1.2.3.2	Pre-series accepted / prototype tested [M8]
128	1.2.3.2	Transport to FAIR
129	1.2.3.2	SAT accepted / approval for installation [M10]
130	1.2.3.2	Installation in Cave
131	1.2.3.2	SAT Bb accepted / ready for operation [M12]
132	1.2.3.3	RFQ and switchyard
133	1.2.3.3	Approval of workpackage description / TDR [M3]
134	1.2.3.3	Construction
135	1.2.3.3	Pre-series accepted / prototype tested [M8]
136	1.2.3.3	Transport to FAIR
137	1.2.3.3	SAT accepted / approval for installation [M10]
138	1.2.3.3	Installation in Cave
139	1.2.3.3	SAT Bb accepted / ready for operation [M12]
140	1.2.3.4	EBIT
141	1.2.3.4	Approval of workpackage description / TDR [M3]
142	1.2.3.4	Construction
143	1.2.3.4	Pre-series accepted / prototype tested [M8]
144	1.2.3.4	Transport to FAIR



NUSTAR experiments are generally ahead of time and could become operational before the FAIR facility is ready!

NUSTAR – Project Plan

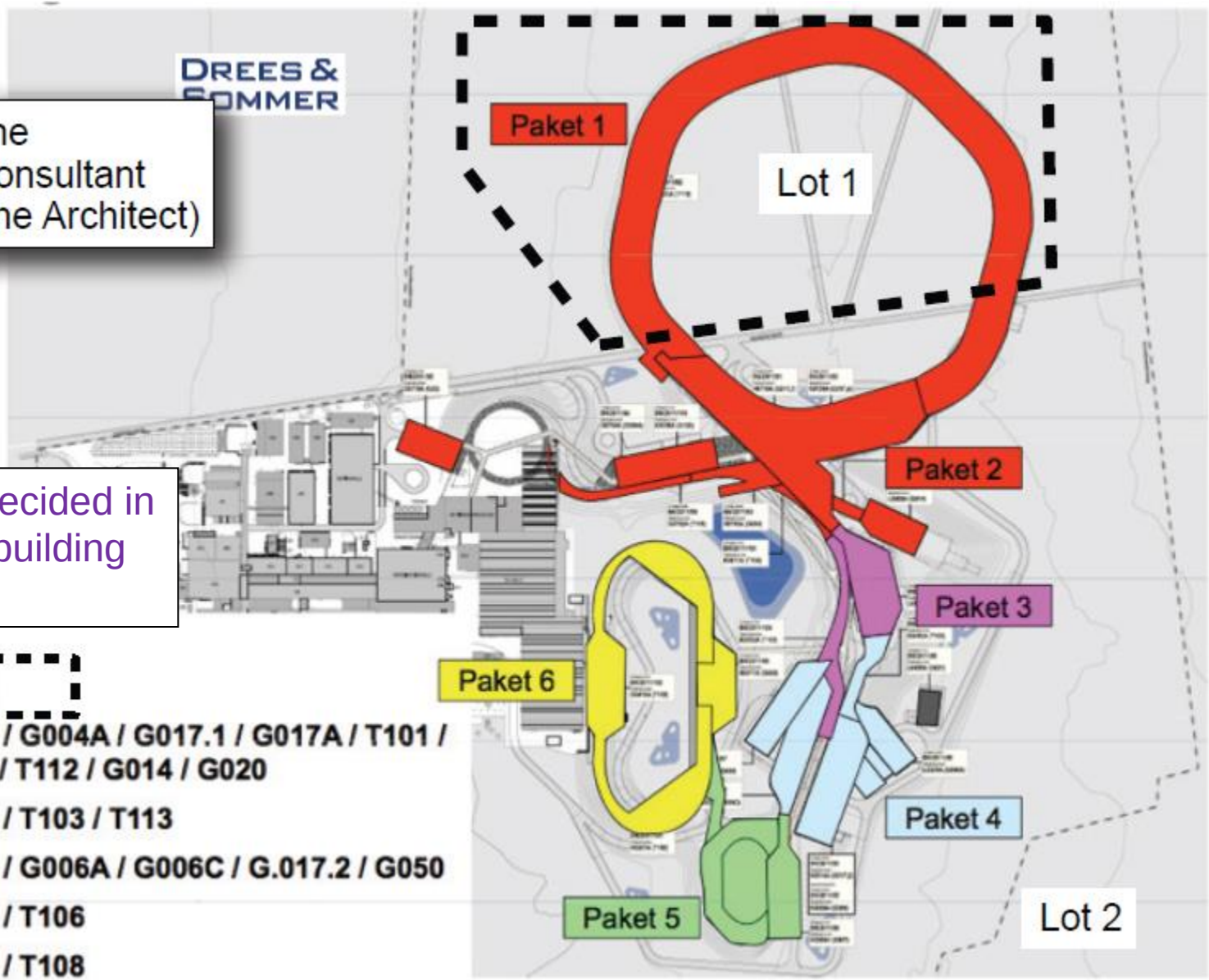
To be done:

- Detailed project plans (work packages) in preparation
  - Adding information on funding (technical details under discussion)
  - Milestones to be added to “Major Milestone Plan” of each experiment
- Link to accelerator and civil-construction plans
  - “NUSTAR Major Milestone Plan”
- Aggregate data from experiment plans

FAIR – Construction

As suggested by the Project Steering Consultant (not approved by the Architect)

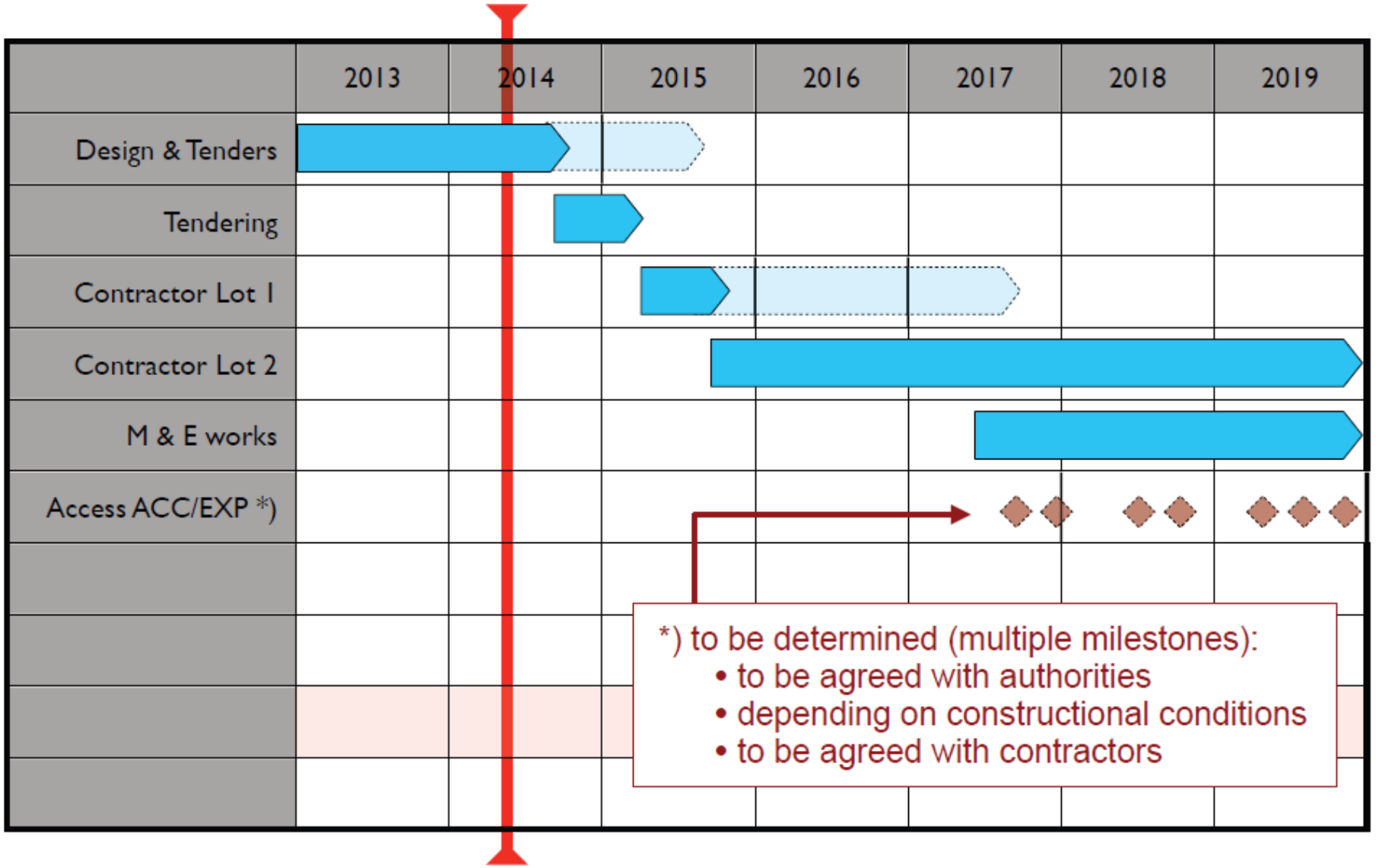
Sequence to be decided in consultation with building company



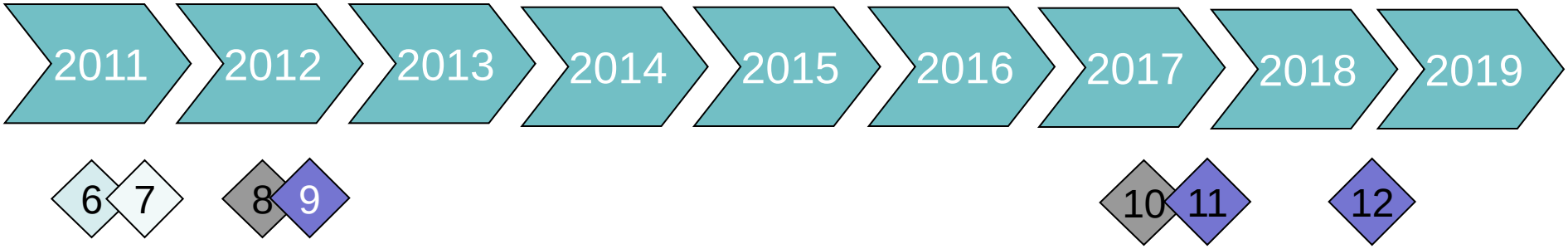
exemplary

Paket 1	T110
Paket 2	G004 / G004A / G017.1 / G017A / T101 / T104 / T112 / G014 / G020
Paket 3	G018 / T103 / T113
Paket 4	G006 / G006A / G006C / G.017.2 / G050
Paket 5	G007 / T106
Paket 6	G009 / T108

FAIR – Construction Planning



Timeline MSV



6 Submission of construction applications

7 Start Site preparation

8 First civil construction contracts

9 Building of accelerator & detector components

10 Partially finishing civil construction work

11 Start installing & commissioning accelerator and detector components

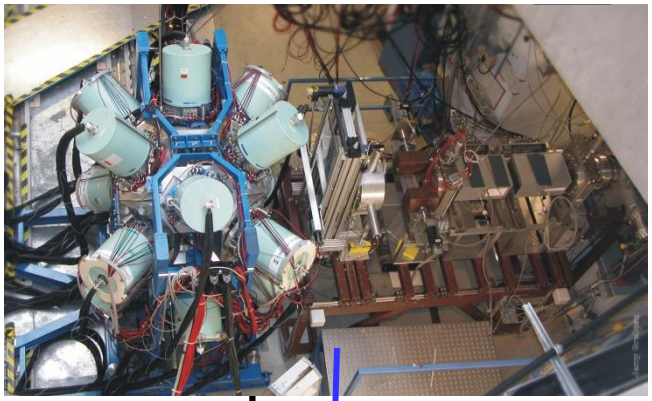
12 Start commissioning with beam

To be updated as soon as building construction contracts are clear!

[Günther Rosner]

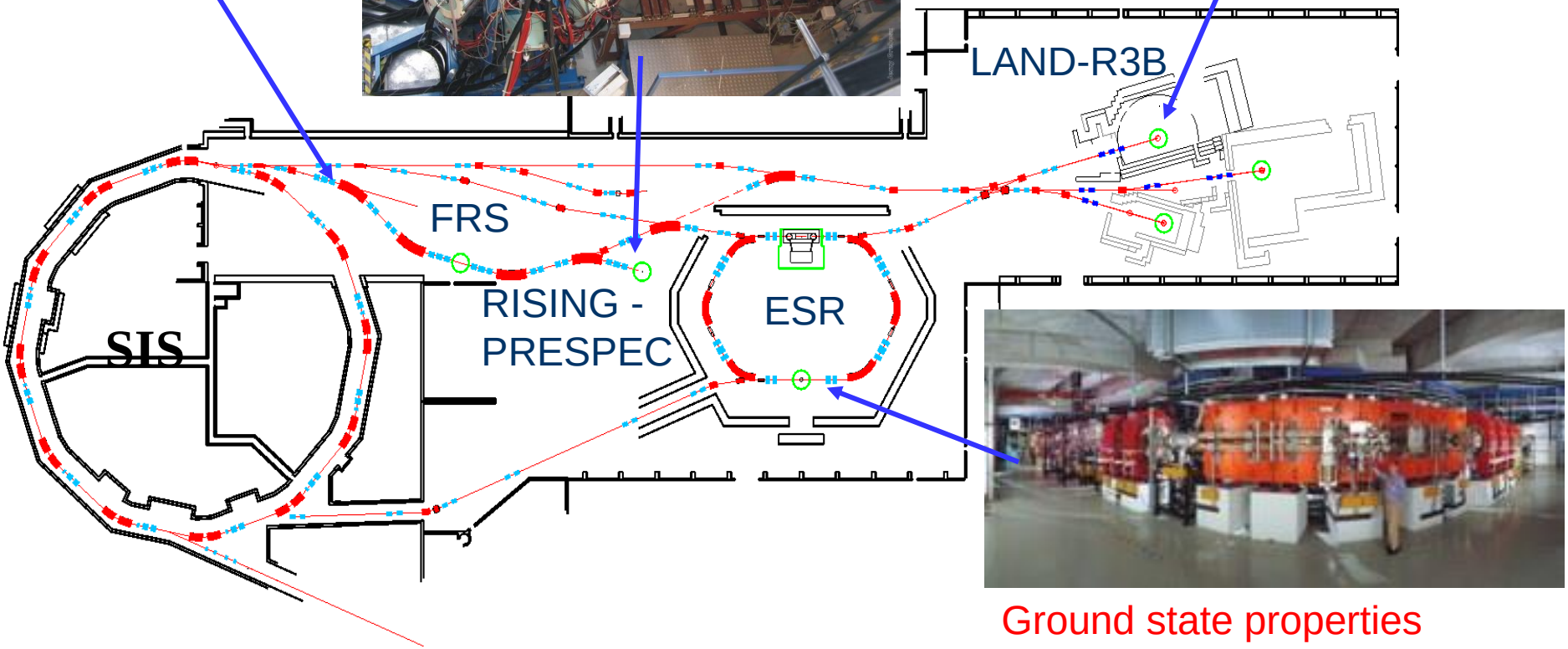
...exploit existing research opportunities at GSI

Decay studies,
In-beam spectroscopy



Reaction studies

production and
separation of
exotic nuclei



Ground state properties
inverse reactions

Beam time at GSI

Current planning:

2015 Break for SIS-18 upgrade and shielding enforcement and UNILAC renovation

2016 Break for SIS-18 upgrade and shielding enforcement renovation, UNILAC operation under discussion

2017: Q1: SIS-18 commissioning, Q2: SIS-18 operation starts, mainly FAIR preparation and experiment commissioning

2018: at least 3 months, mainly FAIR preparation and experiment commissioning

2019: Super-FRS and NUSTAR Experiment commissioning Day-one experiments

Day-1 Experiments

FAIR asks to define Day-1 experiments

- Needed for building/accelerator planning
- Needed by funding agencies to priorize investments

Assume readiness of building/accelerator

Think of phasing experiments

Consider international competiton…

Staging possibilities of NUSTAR experiments

Gradual completion of detection systems

First beam
- Cutting-edge programme with partial systems

- Completion of detector systems

Full operation
- Maximum scientific reach through increased efficiency and resolution

Gradual completion of scientific capabilities

First beam
- Focus on systems for prioritized science

- Construction of complementary systems

Full operation
- Increased scientific scope by further capabilities

Dynamic process: Linked to FAIR progress, NUSTAR funding opportunities, science demands....

NUSTAR - Phases

Phase	Instrumentation	Facility requirements	Programme
0	basic set-ups sub-arrays standard EDAQ	FRS, other labs	commissioning, preparatory exp. dedicated campaigns
1	full functionality of main set-up NUSTAR EDAQ	Super-FRS, LEB-Cave, Storage Ring	„Day-1“ cutting-edge campaigns
2	all (MSV) components ready	+ SIS100	Full (MSV) science programme
3	novel, improved instr.	Full FAIR facility	Increased scientific scope

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Phases in case of HISPEC/DESPEC

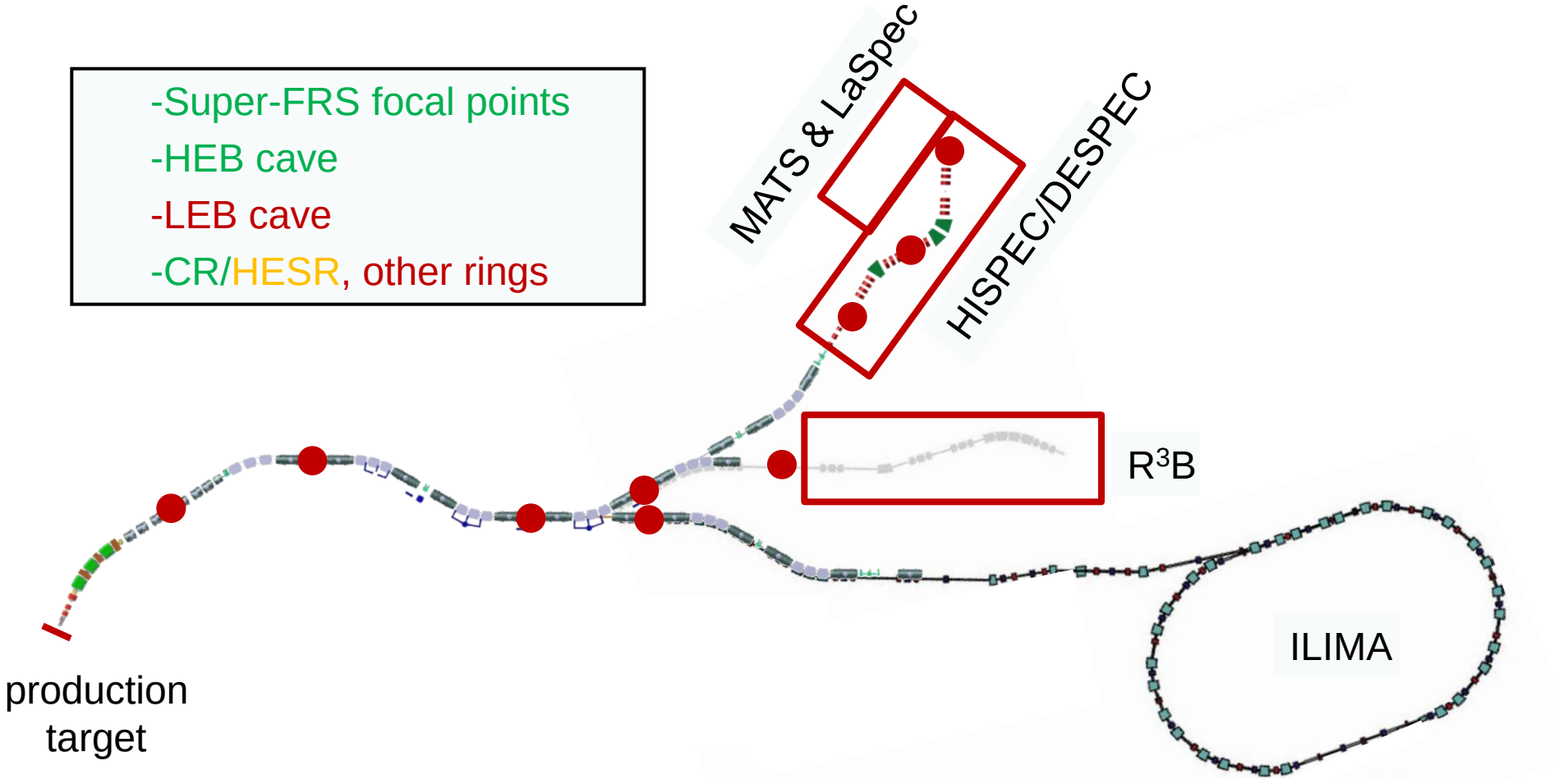
Description	Beam tracking and identification detectors	HISPEC/DESPEC Beamline	Mechanics + installation	Common EDAQ	Safety	Cabling and related (HISPEC/AGATA)	Active target (MINOS)	Active target (India)	AGATA	HYDE	LYCCA	Plunger	AIDA	DEGAS	FATIMA	BELEN	MONSTER	NEDA	DTAS	Isomeric Moments
TDR																				
PSP code	1.2.2.1	1.2.2.2	1.2.2.3	1.2.2.4	1.2.2.5	1.2.2.6	1.2.2.7.1	1.2.2.7.2	1.2.2.8	1.2.2.9	1.2.2.10	1.2.2.11	1.2.2.13	1.2.2.14	1.2.2.15	1.2.2.16.1	1.2.2.16.2	1.2.2.16.3	1.2.2.17	1.2.2.18
phase 0	X	X	X	X	X	X	X		X		X			X	X	X			X	
phase 1	X	X	X	X	X	X			X		X		X	X	X	X	X		X	
phase 2							X					X		X			X			
phase 3								X		X				X				X		X

Readiness of NUSTAR experiments

Modularized Start Version (MSV)		Phase 0	Phase 1
1.2.1	LEB Super-FRS		
1.2.2	HISPEC/DESPEC	√	√
1.2.3	MATS	√	√
1.2.4	LaSpec	√	√
1.2.5	R^3B	√	
1.2.6	ILIMA	√	
Beyond MSV			
1.2.8	ELISe		
1.2.9	EXL	√	
New experiments			
1.2.10	Super-FRS physics	√	√
1.2.11	SHE	√	√

NUSTAR Experimental Areas

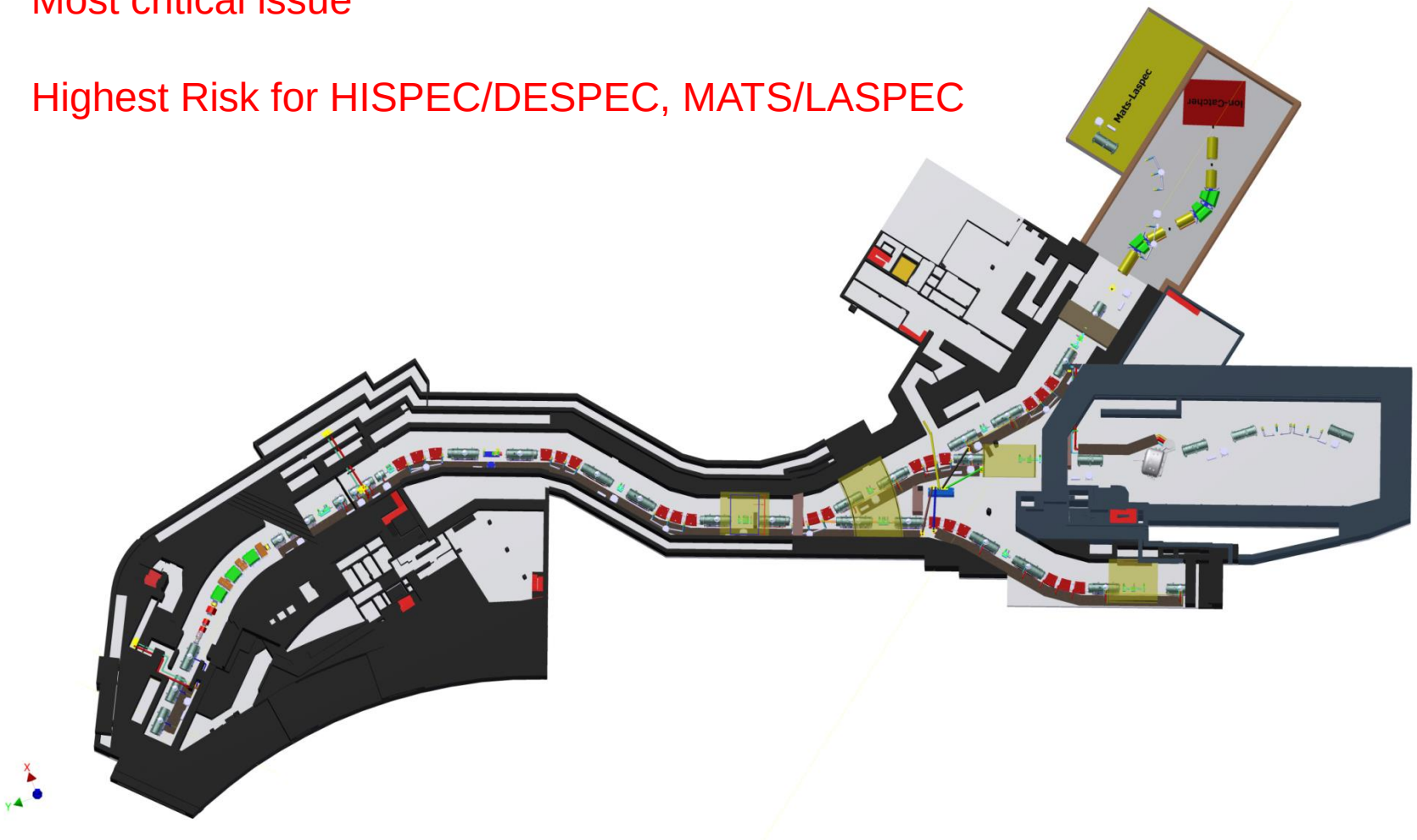
- -Super-FRS focal points
- -HEB cave
- -LEB cave
- -CR/HESR, other rings



Low Energy Branch Building

Most critical issue

Highest Risk for HISPEC/DESPEC, MATS/LASPEC



Steps towards the LEB building

Perform 2nd. architect study (end of 2013) done

Inform/convince relevant funding agencies (early 2014) done

Find agreement with SPARC/FLAIR (2014) done

Form a consortium of funding agencies (2014)

Establish a funding roadmap (2014-2015)

Get agreement by FAIR Council and management (2015)

Plan building in detail (2016)

Apply for building permission (2016)

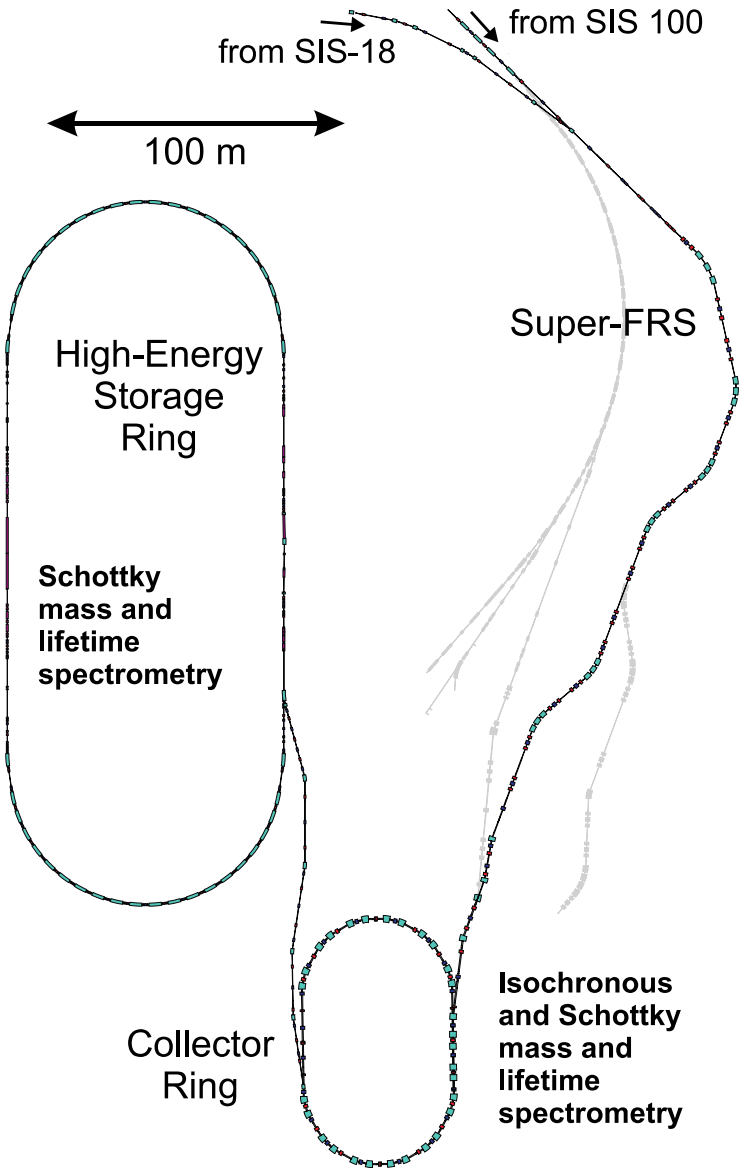
Build the LEB cave (2016-2017)

Install infrastructure and experiments (2018-2019)

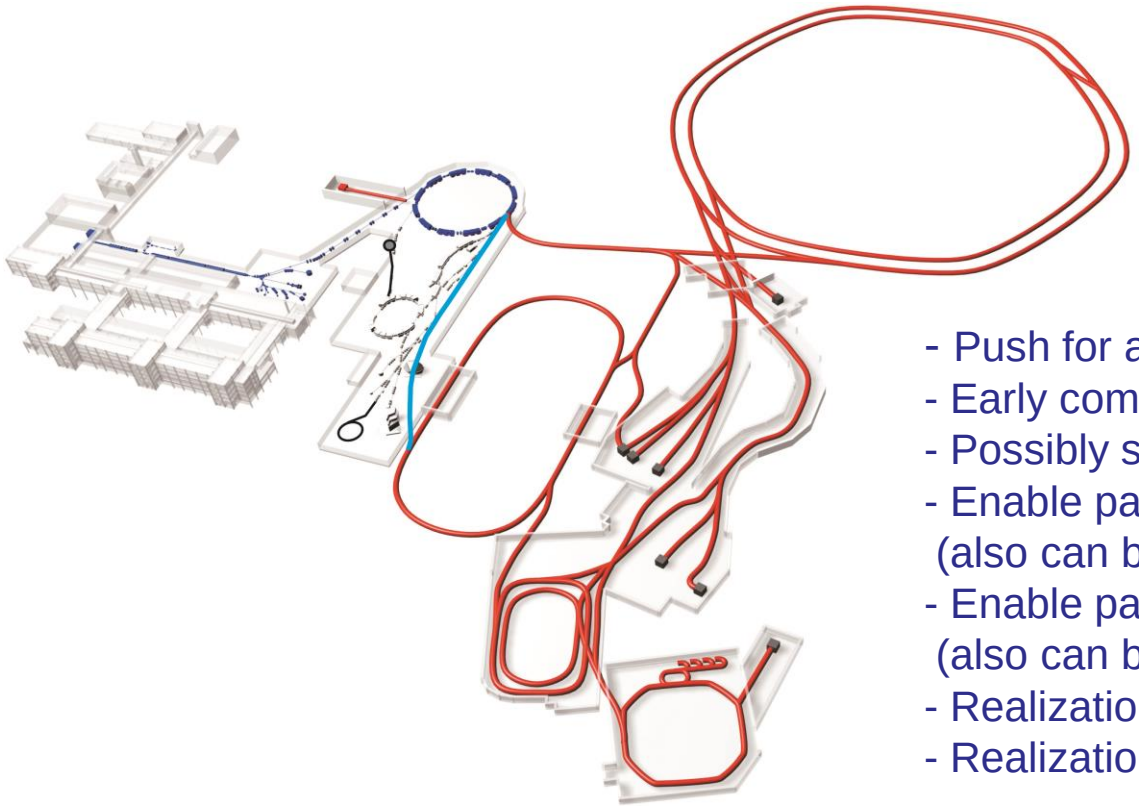
Perform Day One experiment in 2019!!!

ILIMA strategy within MSV

To perform ILIMA experiments in the HESR, part of the detector equipment planned for the NESR will be needed to be built for the HESR. Novel, highly-sensitive non-destructive particle detectors are being already developed within the Stored Beams division of FAIR@GSI. The first prototype is being successfully used in the ESR for atomic-, nuclear- and astrophysics experiments



Ring Task Force: Suggestion 0 (SIS18→HESR)

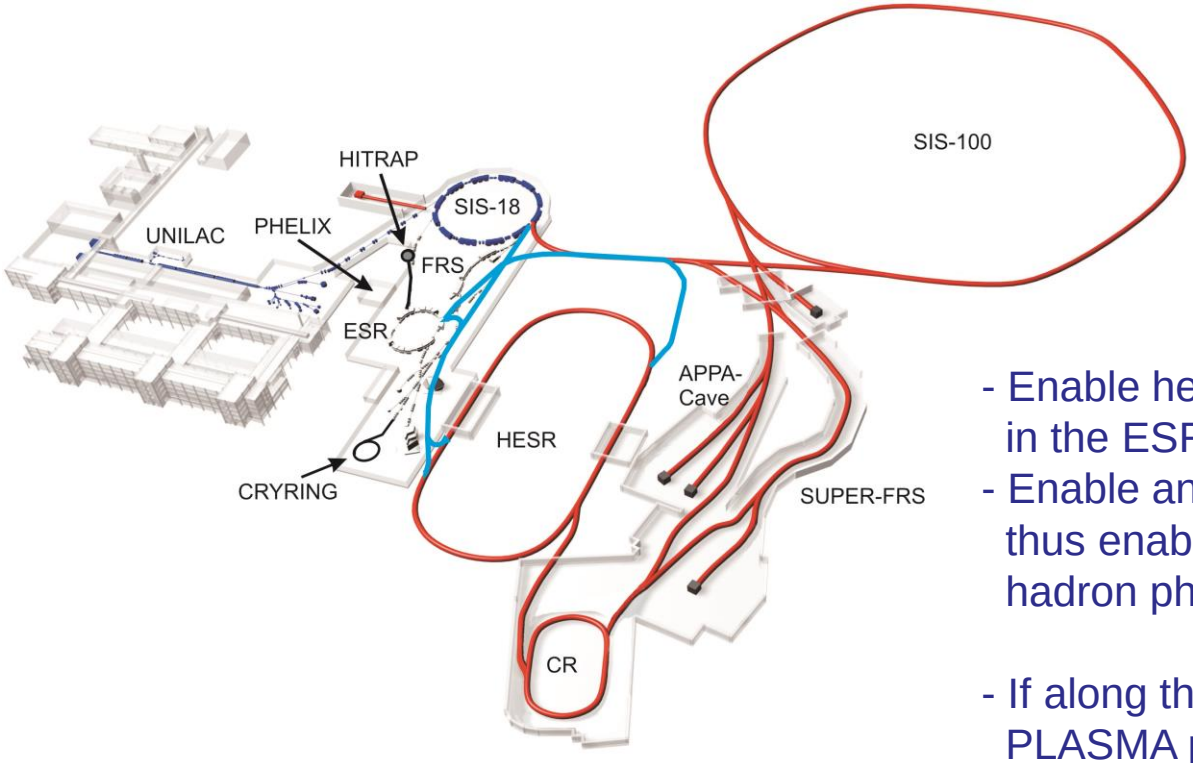


- Push for an early construction of HESR building
- Early commissioning of HESR with protons
- Possibly some PANDA physics with protons
- Enable parallel operation of HESR and SIS100 (also can be run during construction of SIS300)
- Enable parallel operation of HESR and CR (also can be run during construction of RESR)
- Realization of SPARC program at the HESR
- Realization of a part of ILIMA with ESR-HESR

- “Forgotten” beam-line ?

Possible design(s) of the beam line is(are) being studied
The results are to be reported in Autumn

Ring Task Force: Suggestion 1 (CR→(HESR)→ESR)

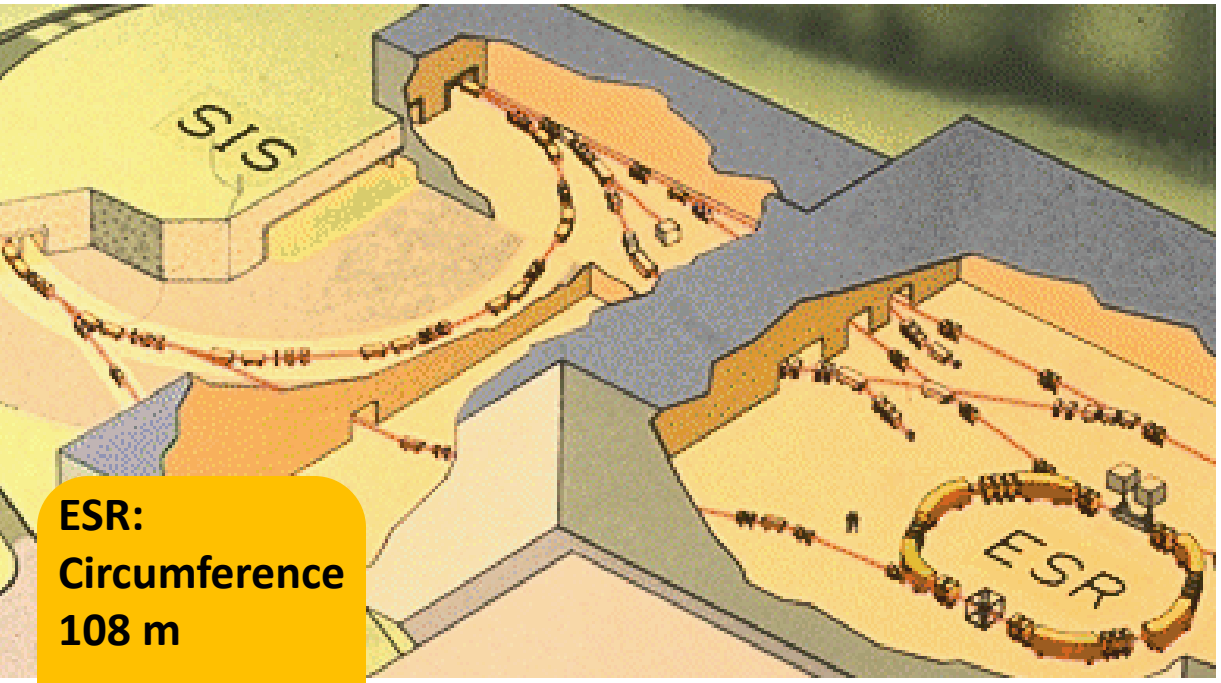


- Enable heavy ions from the Super-FRS in the ESR for EXL/ELISE (ILIMA?)
- Enable antiprotons in the ESR/CRYRING, thus enabling FLAIR program as well as hadron physics with slow antiprotons

- If along the HESR building, a synergy with PLASMA physics to construct the tunnel

Possible design(s) of the beam line will be studied in detail.
Several options exist.

Cryring at the ESR

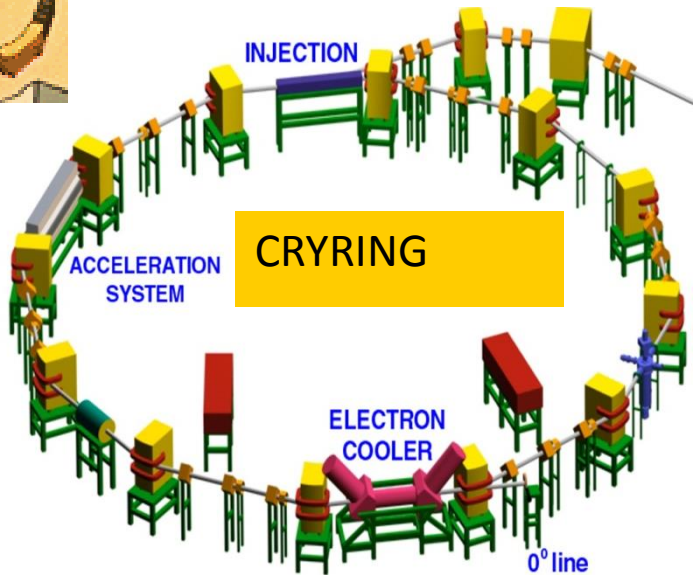


ESR:
Circumference
108 m

Bρ: 10 Tm

Cryring
Circumference
54 m

Bρ: 1.44 Tm



Cryring+ESR: beam energies 0.1-1.0 MeV/u - reaction rates measurements in the Gamow window of the **rp-process**

Conclusions

NUSTAR continues to be in a leading position

Most sub-collaborations are ready for Phase 0 experiments at the FRS and other facilities
→ Take advantage of any opportunities

Preparation for Phase 1 at the Super-FRS are progressing well and Day-1 experiments can be defined
→ Take care of competitors

LEB cave and new Ring physics options are on the horizon