

NUSTAR Project Status Report

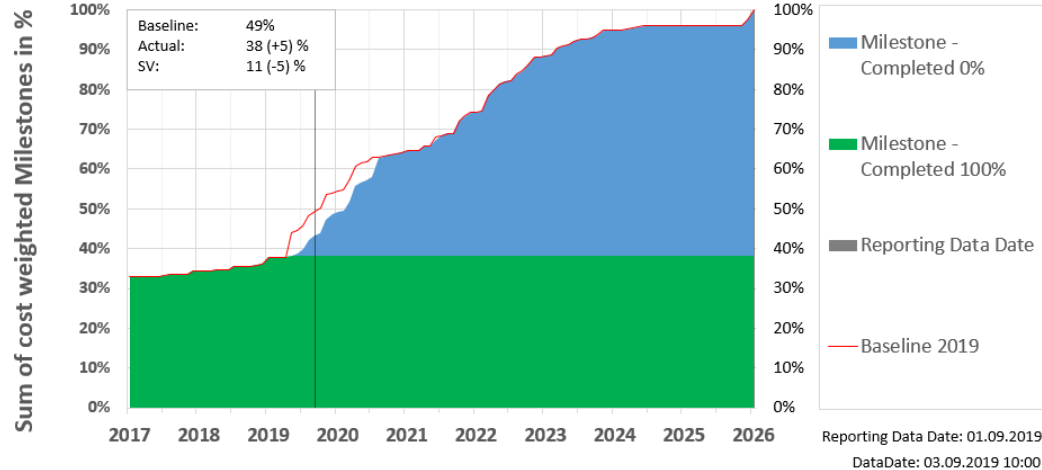


J. Gerl
NUSTAR Week
25. September 2019
Paris, France

NUSTAR Project Progress



Progress S-Curve NUSTAR



Schedule analysis

	Milestone % completed 100%		Milestone % not completed in past		Progress delay
	Actual = 38%		past open = 5%		6,1%
1.2.5.1.1.2	9,7%	1.2.5.1.2.5	2,3%	1.2.5.1.1.2	4,8%
1.2.5.1.1.1	4,1%	1.2.1.2.1	0,6%	1.2.3.3	0,5%
1.2.5.1.1.2.1	2,9%	1.2.2.15	0,5%	1.2.2.14.1	0,5%
1.2.5.1.2.5	2,7%	1.2.2.1	0,2%	1.2.2.16.2	0,3%
1.2.2.14.2	2,1%	1.2.5.1.4.1	0,7%	1.2.6.6.1	
1.2.5.1.2.3.1	1,7%	1.2.6.3	0,1%	1.2.6.6	
1.2.5.1.2.3.2	1,6%	1.2.5.1.4	0,1%	1.2.6.5	
1.2.2.16.2	1,3%	1.2.6.6.1	0,1%	1.2.6.5	
1.2.2.14.1	1,1%	1.2.1.2	0,1%	1.2.6.4.1	

None are time critical

S- curve comments & mitigation proposal milestone in the past

- 1.2.5.1.2.5 (2,3%) – Neutron ToF spectrometer (NeuLAND) **FAT in clarification**
- 1.2.1.2.1 (0,6%) – GSI-PMA Stopping cell, extraction, cooling...(1. share) **Will be shifted due to unexpectedly long ECE processing time**
- 1.2.2.15 (0,5%) – Fast timing FATIMA **Will be shifted due to unexpectedly long contract delays**

S- curve comments & mitigation proposal progress delay

- 1.2.5.1.1.2 (4,8%) – GLAD magnet **Awaiting final SAT measurements**
- 1.2.3.3 (0,5%) – RFQ and switchyard **Awaiting detailed technical specs for contract**
- 1.2.2.14.1 (0,5%) – HISPEC/DESPEC **Awaiting contracts to be signed**

Critical M3/M4 Milestones



M3 – TDR approved

PSP	Workpackage Name	ID	M3 Actual	M3 Baseline	red= delayed compared to baseline 2019 orange = to be completed in next 3 month
1.2.1.2.1	EXP Stopping cell, extraction, cooling, beam-distribution system, and electrostatic beamlines_C01	387-	15.05.2019	15.05.2019	Unexpected long waiting for TDR approval Need approval at next ECE meeting
1.2.2.3.1	EXP Mechanics (rails, support, etc) + installation_C01	388-	15.10.2019	15.10.2019	ECE meeting scheduled Nov 4-5, 2019 approval expected

M4 – In-Kind Contract Signed

PSP	Workpackage Name	ID	M4 Actual	M4 Baseline	red= delayed compared to baseline 2019 orange = to be completed in next 3 month
1.2.1.2.1	EXP Stopping cell, extraction, cooling, beam-distribution system, and electrostatic beamlines_C01	387-	03.02.2020	03.02.2020	Council assignment in Dec 2019 required (GSI provider, in-kind)
1.2.2.3.1	EXP Mechanics (rails, support, etc) + installation_C01	388-	15.04.2020	15.04.2020	Council assignment in Dec 2019 required (GSI provider, in-kind)

TDR Status



tdr#	title	submission status	date	approval status	date
2_01	LEB infrastructure	expected	Nov 19		
2_02	Cryogenic Stopping cell	submitted	Aug 18		
2_03	Beam tracking/identification	obsolete			
2_04	HISPEC/DESPEC infrastructure	submitted	Nov 18		
2_05	NUSTAR DAQ	submitted	Nov 16	approved	Jun 18
2_06	MINOS	obsolete			
2_07	Active target (India)	expected	Nov 22		
2_08	HYDE	expected	Nov 22		
2_09	LYCCA	submitted	Jun 08	approved	Sep 08
2_10	Plunger	submitted	Apr 14	approved	Jun 14
2_11	AIDA	submitted	Aug 08	approved	Mrz 13
2_12	DEGAS	submitted	Aug 14	approved	Jul 15
2_13	FATIMA	submitted	Mrz 15	approved	Jul 15
2_14	BELEN	submitted	Jan 14	approved	Aug 14
2_15	MONSTER	submitted	Feb 13	approved	Aug 14
2_16	NEDA	submitted	Sep 14	approved	Jan 16
2_17	DTAS	submitted	Apr 12	approved	Jan 13
2_18	Isomeric moments	expected	Nov 19		
2_19	MATS/LaSpec	submitted	Sep 09	approved	Mai 10
2_20	R3B multiplet	submitted	Dez 08	approved	Mai 11
2_21	GLAD	submitted	Jun 06	approved	Jul 08
2_22	R3B tracking	submitted	Nov 14	approved	Jul 15
2_23	Large Area ToF Wall	obsolete			
2_24	CALIFA barrel	submitted	Nov 11	approved	Jan 13
2_25	CALIFA fwd endcap	submitted	Nov 14	approved	Jul 15
2_26	Si tracker	expected	Mrz 20		
2_27	NeuLAND	submitted	Nov 11	approved	Jan 13
2_28	R3B vacuum	expected	Sep 19		
2_29	R3B infrastructure	expected	Nov 19		
2_30	R3B spectrometer	expected	Nov 21		
2_31	R3B spectrom tracking	obsolete			
2_32	ACTAF	submitted	Sep 15	approved	Jun 17
2_33	ILIMA Schottky	submitted	Dez 17	approved	Dez 18
2_34	ILIMA TOF detectors	submitted	Dez 17	approved	Okt 18
2_35	ILIMA Heavy ion detector	submitted	Nov 17	approved	Okt 18
2_36	AGATA	obsolete			
2_37	Slowed down beam setup	expected	Nov 21		
2_38	EXPERT	submitted	Sep 16	approved	Jul 17
2_39	Super-FRS Exp infrastructure	submitted	Mai 19		
2_40	Liquid hydrogen target	expected	Jul 21		
2_41	(Ice target and tensor force)	expected	Jul 21		
2_42	(future WASA)	expected	Jul 24		

22 approved by ECE

3 under evaluation by ECE

3 needed for Phase-1 and are still expected this year

9 more expected, but not time critical

Risk Register



Risk ID	Status	Risk description	Probability	Performance impact	Risk Score	Strategy	Preventive mitigation	Contingency plan	Residual Risk
173	Mitigation proposed	[NUSTAR infrastructure] Cause: The budget for infrastructure is not approved yet. It is supposed to come from common fund that requires a signed or at least agreed MoU. Event: No budget available to order infrastructure. Impact: Installation of experiment cannot start.	25%	severe	14	mitigate	GSI or FAIR should give cash advance to infrastructure measures 2 Million EUR.	Other money source have to be made available.	0
157	Mitigation proposed	[R3B multipliers] Cause: Multiplet R3B and cryogenic infrastructure assigned to ACC as part of the CBWG review. Funding needs to be ensured. Event: Budget not yet available. Impact: R3B experiments cannot be performed.	25%	major	13	escalate	Assign item to relevant area and find best market prices /technical solution (done). Decision about the funding is pending.		0
156	Mitigation proposed	[Laspec - Laser and DAQ Hut LEB cave] Cause: Laser and DAQ Hut LEB cave assigned to FAIR site and building as part of CBWG review. Funding needs to be ensured. Event: Budget not yet available. Impact: Incomplete infrastructure for Laspec and NSPEC, possible safety issue and denial of operative licence.	25%	major	13	escalate	Assign item to relevant area and find best market prices /technical solution (done). Decision about the funding is pending.		0
155	Mitigation proposed	[LEB/HEC beam dump] Cause: LEB beam dump and/or HEC beam dump assigned to ACC as part of the CBWG review. Funding needs to be ensured. Event: Budget not yet available. Impact: Possible beam safety issues and denial of operative licence @NUSTAR experiment caves.	25%	major	13	escalate	Assign item to relevant area and find best market prices /technical solution (done). Decision about the funding is pending.		0
240	Mitigation proposed	[LEB Buncher/Spectrometer] Cause: LEB Buncher/Spectrometer assigned to accelerator as part of the CBWG review. Full version is recommended by CBWG. Funding needs to be ensured. Event: Budget not yet available. Impact: Required specifications may not be reached; Realization might be delayed. Experiments cannot be performed at all .	25%	major	13	escalate	Further optimize the design to save costs (done) . Decision about the funding is pending.		0

Would like to include technical risks...

Score Card



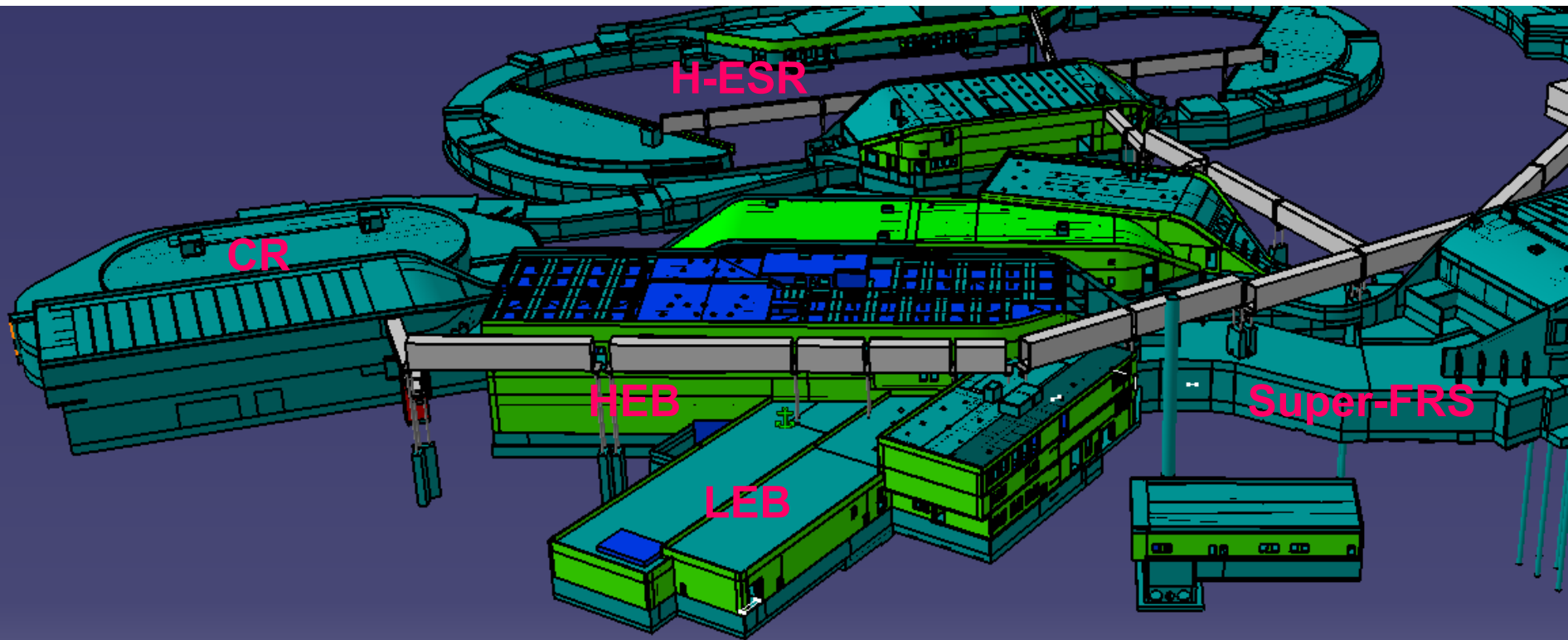
	NUSTAR sub-system	TDR	Cost [k€ 2005]	Funding	Construction	Date completion	Test/Commissioning
Day 1	LEB infrastr.	<div><div></div></div>	1,806	<div><div></div><div></div></div>		06/2023	
	HISPEC/DESPEC	<div><div></div><div></div></div>	10,817	<div><div></div><div></div></div>	<div><div></div><div></div></div>	03/2024	<div><div></div><div></div></div>
	MATS	<div><div></div><div></div></div>	1,173	<div><div></div><div></div></div>	<div><div></div><div></div></div>	08/2024	<div><div></div><div></div></div>
	LaSpec	<div><div></div><div></div></div>	253	<div><div></div><div></div></div>	<div><div></div><div></div></div>	05/2021	<div><div></div><div></div></div>
	R3B	<div><div></div><div></div></div>	17,788	<div><div></div><div></div></div>	<div><div></div><div></div></div>	03/2023	<div><div></div><div></div></div>
	ILIMA	<div><div></div><div></div></div>	1,099	<div><div></div><div></div></div>		12/2023	
		83% value weighted	32,936	94% secured	56% value weighted		

progressing steadily...

Super-FRS and NUSTAR Caves

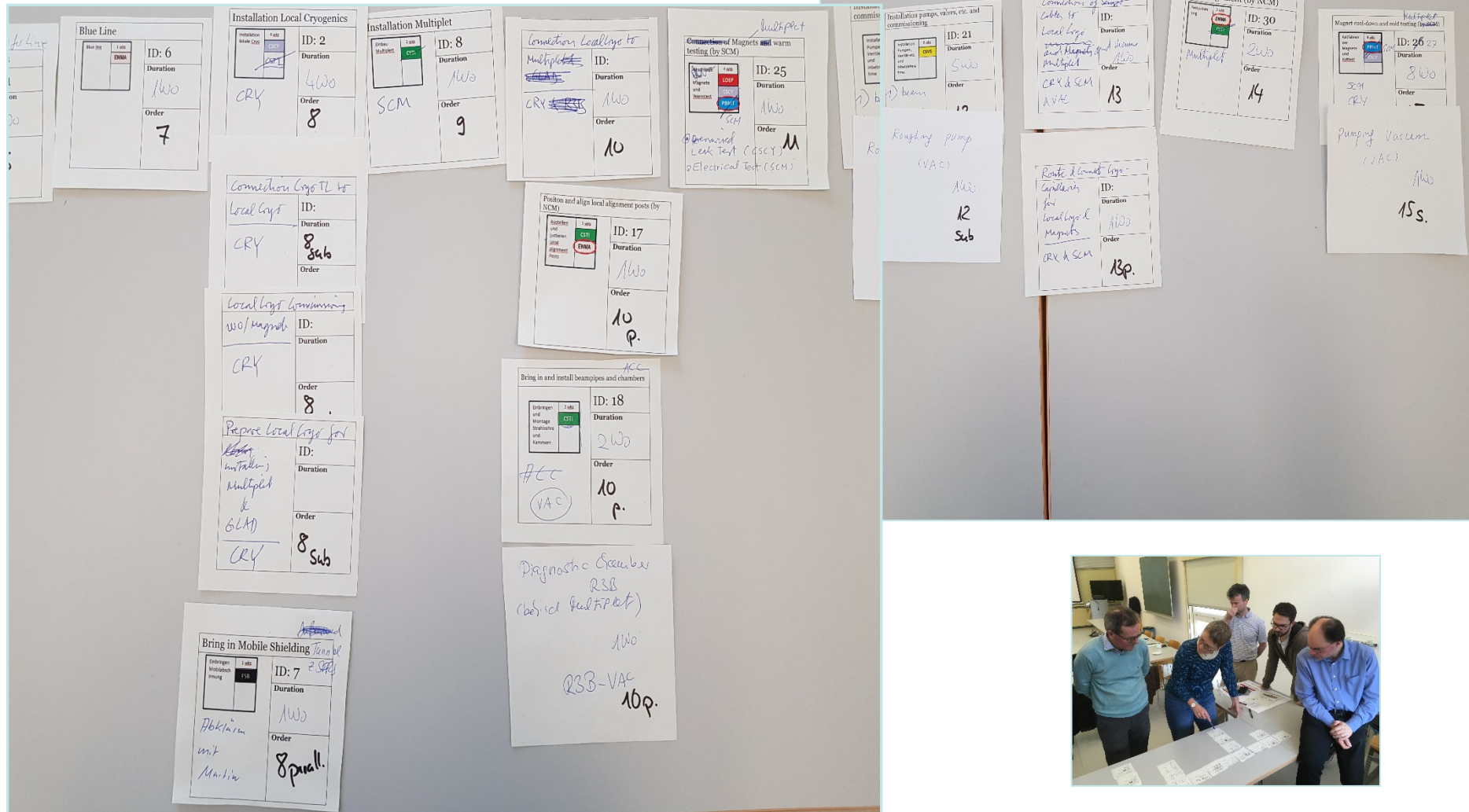


- All NUSTAR infrastructure and experiments are planned to start moving into the FAIR buildings in 2022-2024.
- Realization planning is $\approx 3/6$ months (caves/CR) behind schedule.



NUSTAR Installation Workshops 2019

How to install technical infrastructure and experimental equipment...



Blue Line

Blue Line	ID: 6
Duration	1W0
Order	7

Installation Local Cryogenics

Installation Local Cryogenics	ID: 2
Duration	4W0
Order	8

Installation Multiplet

Installation Multiplet	ID: 8
Duration	1W0
Order	9

Connections Leadings to Multiplet

Connections Leadings to Multiplet	ID: 10
Duration	1W0
Order	10

Connections of Magnets and warm testing (by SCM)

Connections of Magnets and warm testing (by SCM)	ID: 25
Duration	1W0
Order	M

Installation pumps, valves, etc. and commissioning

Installation pumps, valves, etc. and commissioning	ID: 21
Duration	SW0
Order	12

Connections of Magnet Cables to Local Cryo and Magnets and Multiplet

Connections of Magnet Cables to Local Cryo and Magnets and Multiplet	ID: 13
Duration	1W0
Order	13

Fine Alignment (by NCM)

Fine Alignment (by NCM)	ID: 30
Duration	2W0
Order	14

Magnet cool-down and mold testing (by NCM)

Magnet cool-down and mold testing (by NCM)	ID: 26
Duration	8W0
Order	15s.

Position and align local alignment posts (by NCM)

Position and align local alignment posts (by NCM)	ID: 17
Duration	1W0
Order	10 P.

Bring in and install beampipes and chambers

Bring in and install beampipes and chambers	ID: 18
Duration	2W0
Order	10 P.

Local Cryo Commissioning w/o magnets

Local Cryo Commissioning w/o magnets	ID: 8
Duration	SW0
Order	8

Prepare Local Cryo for Local Cryo Installation Multiplet & GLAD

Prepare Local Cryo for Local Cryo Installation Multiplet & GLAD	ID: 8
Duration	SW0
Order	8 Sub

Bring in Mobile Shielding Tunnel

Bring in Mobile Shielding Tunnel	ID: 7
Duration	1W0
Order	8 parallel.

Diagnostic Beamline RSB (asial Multiplet)

1W0

RSB-VAC 10p.

Roughing pump (VAC)

1W0

12 Sub

Route & Connect Cryo Cables for local cryo magnets

1W0

13p.

Pumping Vacuum (VAC)

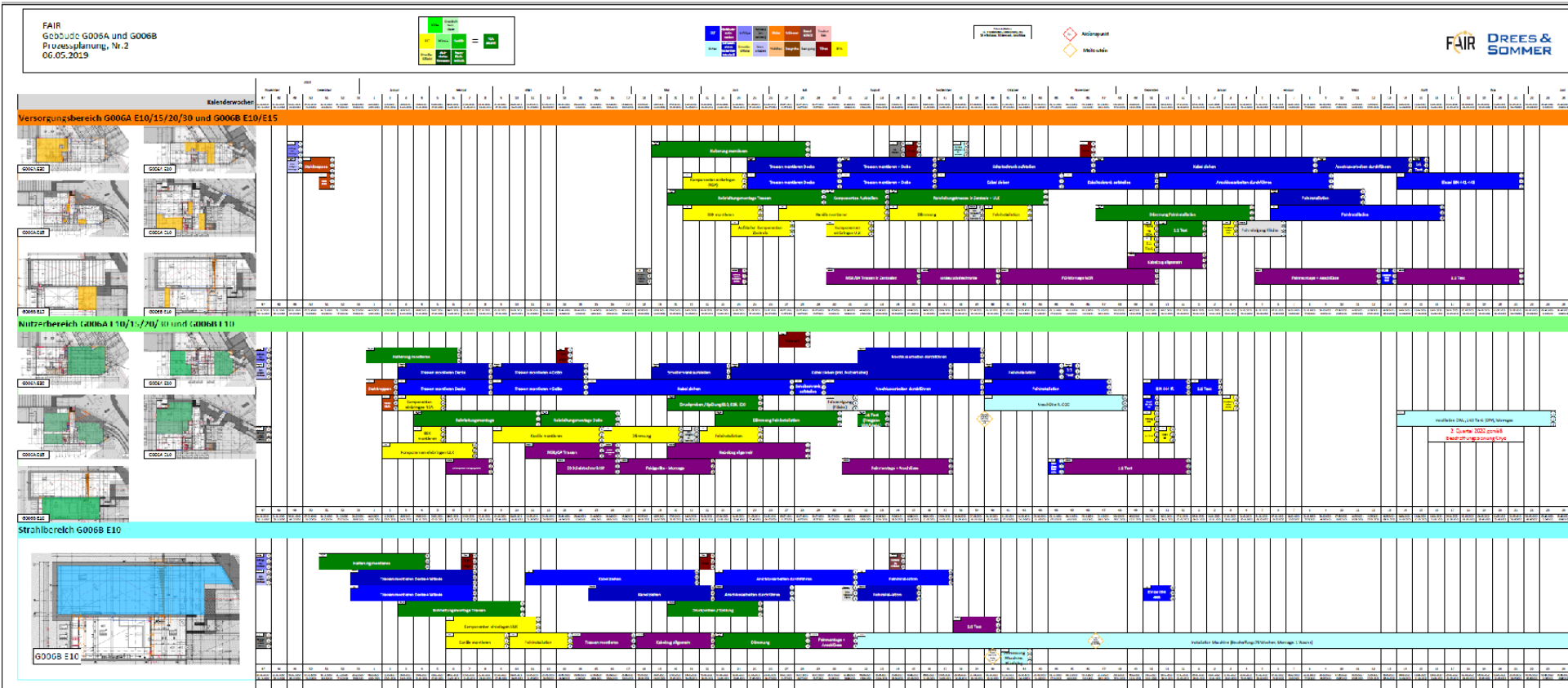
1W0

15s.





result of yet another workshop with building planners...

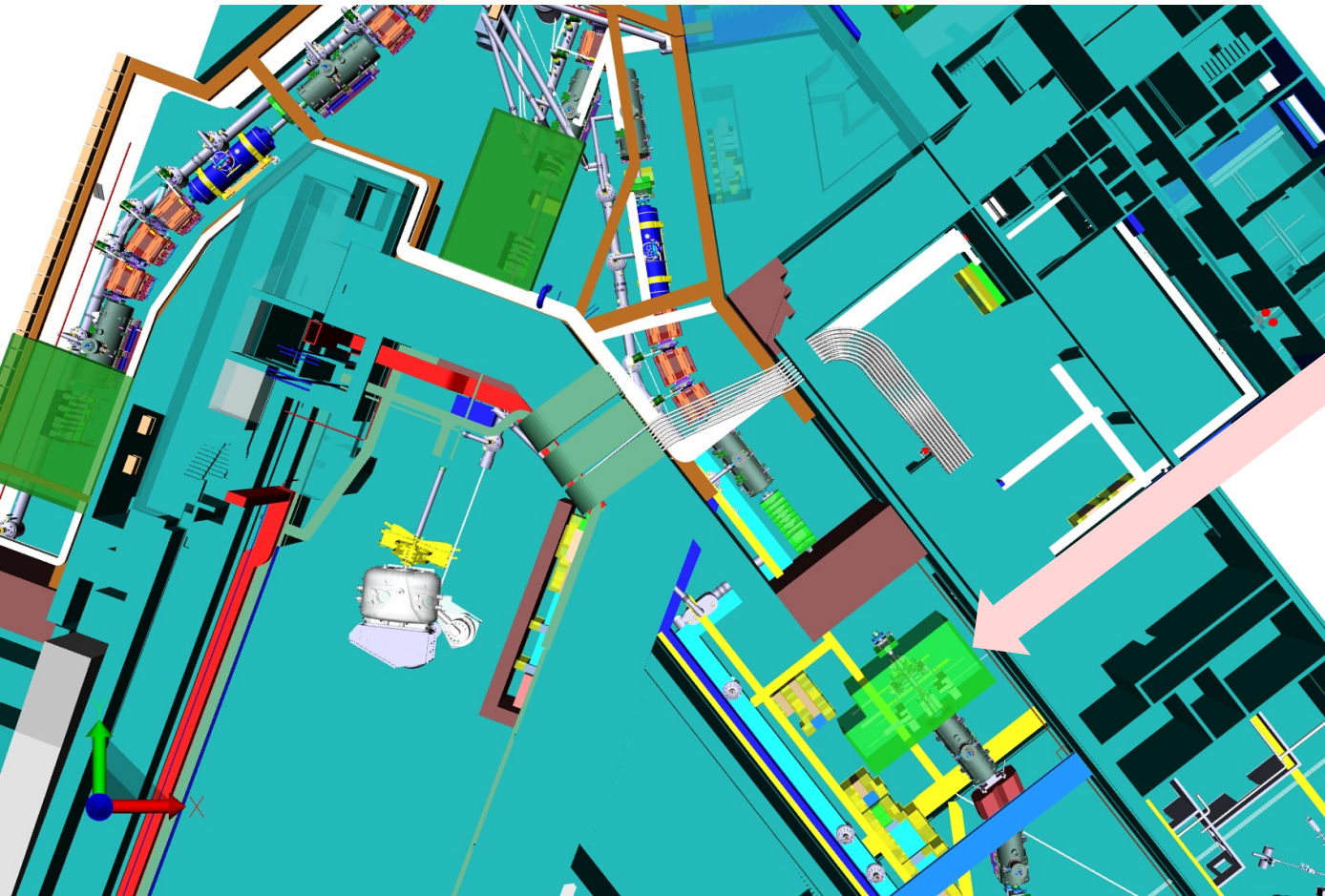


... will be refined and parallelized in the coming two years

Digital Mock Up



A detailed 3D model of the whole facility helps to avoid collisions



Experiments are asked to provide set-up models to be included in the facility model

Recent Infrastructure Activities



- Cable data base (almost) completed
- Detector gas supplies (including LN2) defined
- Cooling power needs updated
- Electronic racks organized
- Concrete shielding blocks organized
- Access defined for all doors
- UPS and clean power in discussion
-

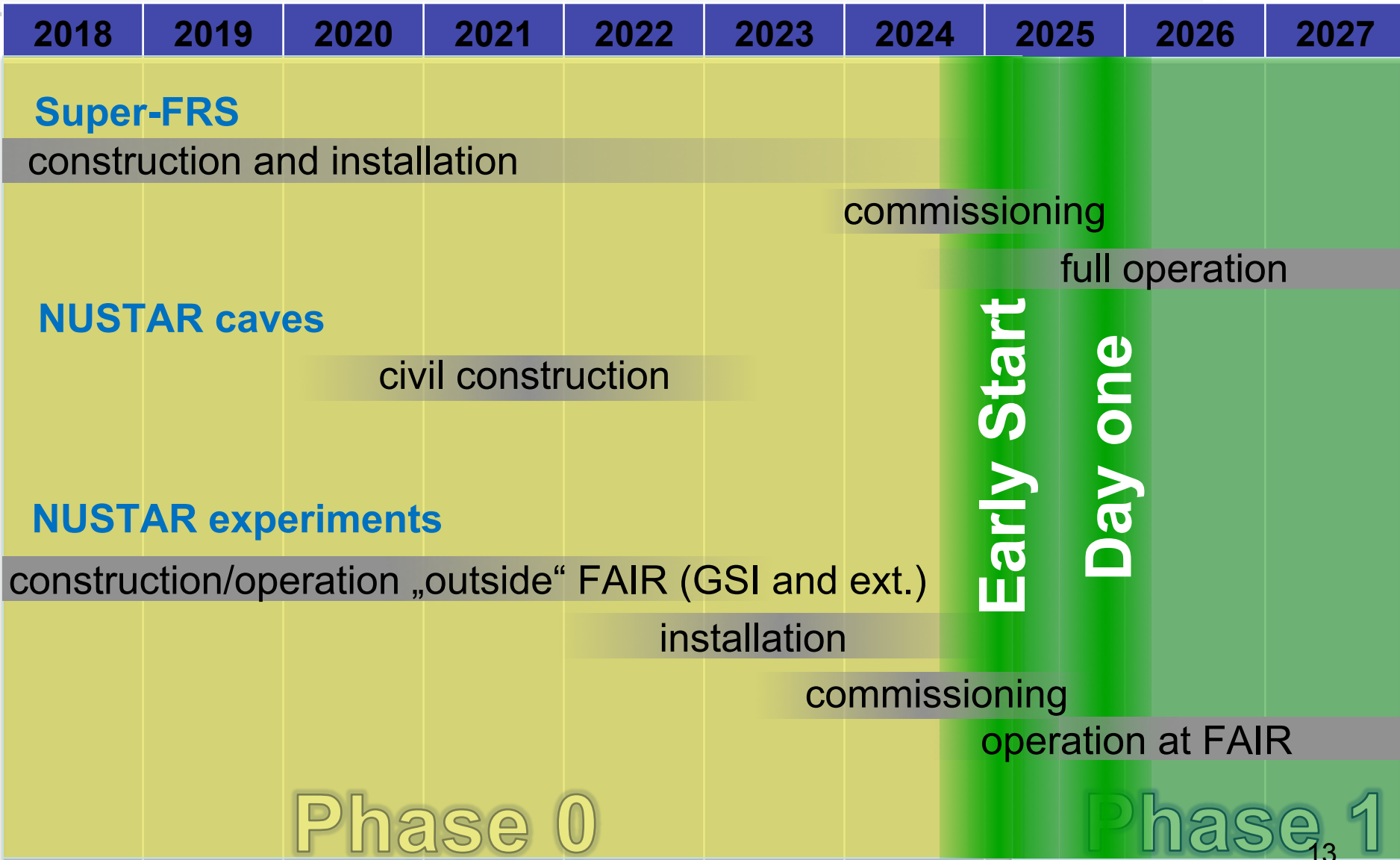


Critical to Success



- Acquiring funding for NUSTAR infrastructure through MoU
- Fulfilling all formal safety requirements to be able to operate the planned set-ups
- Getting sufficient beam time at GSI for i) testing FAIR/NUSTAR equipment, ii) re-gaining operating experience and iii) training scientists and technicians

NUSTAR Overall Schedule



Granted beam time at FAIR/GSI Phase-0

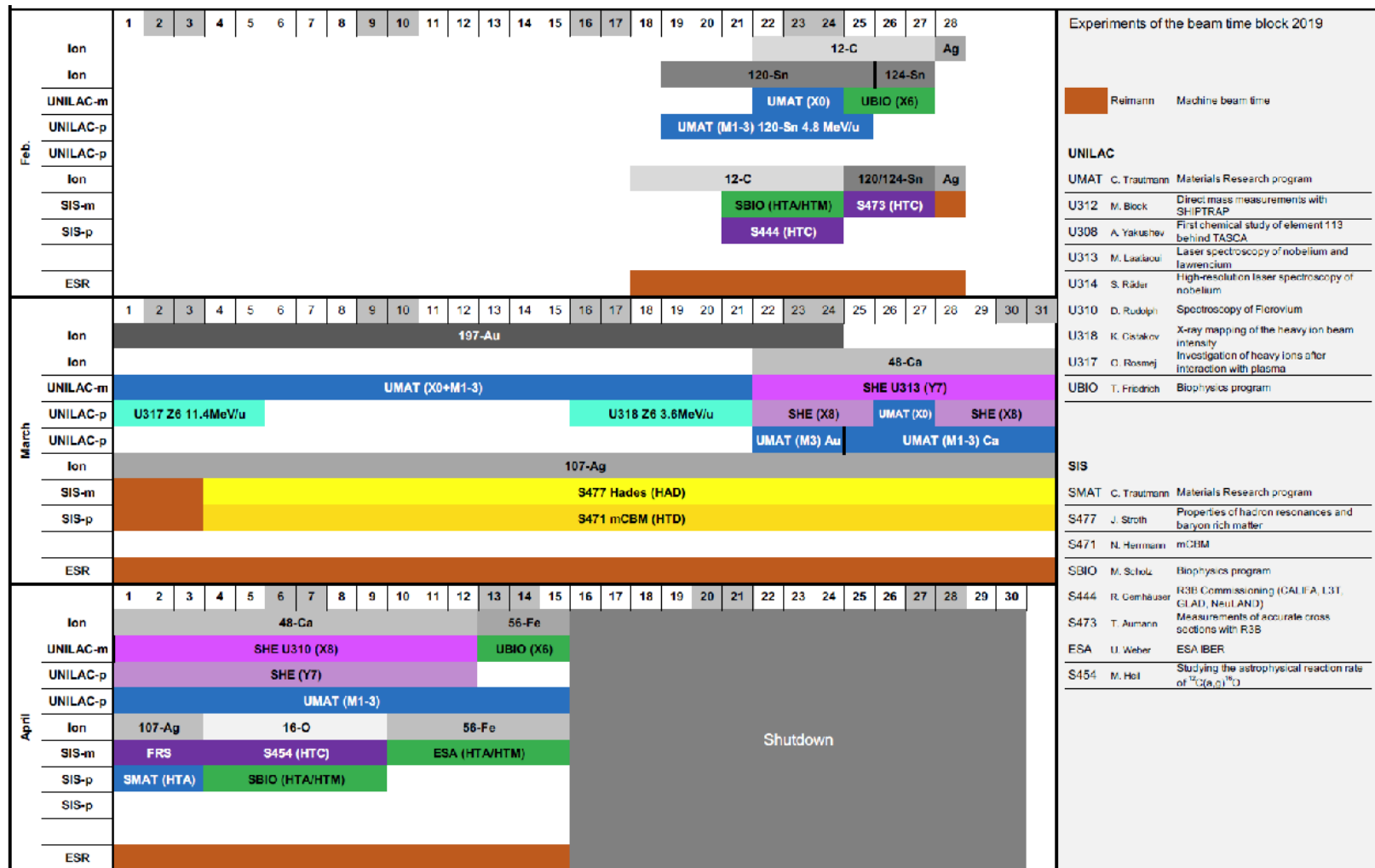


FRS and detector commissioning/development w. parasitic beam

E121	Measurement of the bound-state beta decay of bare ^{205}Tl ions
E127	Measurements of proton-induced reaction rates on radioactive isotopes for the astrophysical p process
S465	Dipole response of the drip-line nuclei ^6He and $^{22,24}\text{O}$
S442	Study of multi-neutron configurations in atomic nuclei towards the drip line
S467	Single-particle structure of neutron-rich Ca isotopes: shell evolution along $Z=20$
S455	Fission investigated with relativistic-radioactive beams and the advanced SOFIA@R3B setup
S447	Studies of the d+p signal and lifetime of the $^3_{\Lambda}\text{H}$ and $^4_{\Lambda}\text{H}$ hypernuclei by new spectroscopy techniques with FRS
S474	Detector tests with the prototype of the CSC for the Super-FRS and direct mass measurements of neutron-deficient nuclides below ^{100}Sn
S468	Search for new neutron-rich isotopes and exploratory studies in the element range from terbium to rhenium
S452	The Oblate-Prolate Shape Transition around $A\sim 190$
S460	Investigation of 220-A-230 Po-Fr nuclei lying in the south-east frontier of the $A\sim 225$ island of octupole deformation
S450	Study of $N=126$ nuclei: isomeric and beta decays in ^{202}Os and ^{203}Ir

DESPEC Super-FRS R3B EXLILIMA

Beam Times in 2019



Tests and Experiments performed in 2019



FRS: test of new control system and detectors with low intensity primary beams

DESPEC: test of AIDA+FATIMA set-up with low intensity primary beams

R3B: Commissioning of GLAD and initial experiments with primary beams

	Prop. ID	Spokesperson	Local Contact Person	Proposal Title	
2019/20	S444 A	Gernhäuser, Roman	Simon, Haik	R3B - 2018 COMMISSIONING (CALIFA, L3T, GLAD, NeuLAND & Tracking) p,2p not reasonable without commissioned L³T	¹²C
	S465 A	Aumann, Thomas	Simon, Haik	Dipole response of the drip-line nuclei ⁶ He and ^{22,24} O	
2019/20	S473 A- (accepted change)	Aumann, Thomas	Simon, Haik	Constraining energy-density functionals and the density-dependence of the symmetry energy by measurements of accurate cross sections with large acceptance at R3B NeuLAND characterisation / secondary beams	^{120/4}Sn
2019	S464, Lol	Russotto, Paolo	Simon, Haik	Determination of Symmetry Energy at Supra-Normal Densities: a feasibility study	
	S454 A- (potential fall back)	Heil, Michael	Simon, Haik	Studying the astrophysical reaction rate of ¹² C(alpha,gamma) ¹⁶ O via Coulomb dissociation of ¹⁶ O into ⁴ He and ¹² C High rate tracking	¹⁶O
	S478	Khanzadeev, Alexey	Egelhof, Peter	Study of the nuclear spatial structure of neutron-rich B isotopes by proton elastic scattering in inverse kinematics	

Engineering runs in 2019

Preliminary



Nov. 11

Nov. 11

		UL	UR	Day Shifts (06:00 - 22:00)					Night - shifts (22:00 - 06:00) or all shifts @ Weekend	
				UNILAC	SIS18	HEST	ESR	FRS	CRYRING	Beam Studies
November	11 Mo	10/Ar ³⁺	10/Ar ³⁺	U01, UNILAC-AP-038.01			F01			
	12 Di			U01, UNILAC-AP-038.01						
	13 Mi			U02, UNILAC-AP-022.01/2	S01	H01				
	14 Do			U02, UNILAC-AP-022.01/2	S02	H01				
	15 Fr			U02, UNILAC-AP-022.01/2	S03	H02	L02			
	16 Sa									SIS-AP-048.01, SIS-AP-049.01 (2 shifts)
	17 So									SIS-RF-043.01, SIS-AP-051.01, SIS-AP-055.01
	18 Mo			UNILAC-BI-032.01	S04	H03		F00	C00	
	19 Di			UNILAC-BI-017.01			ESR-BI-020.01			ESR-BI-020.01
	20 Mi			UNILAC-BI-017.01	S05	HEST-BI-014.01	ESR-BI-046.01			ESR-BI-046.01
21 Do		SIS18-UI-011.01		LSR-LP-026.01			LSR-LP-026.01			
22 Fr		SIS18-BI-011.01		ESR-EP-028.01	F01		ESR-EP-028.01			
23 Sa							HEST BI 013.01 (3 shifts)			
24 So							ILSI-BI-013.01 (2 shifts)			
25 Mo	19/Ar ³⁺	19/Ar ³⁺		S06	H04	L03	F02			
26 Di				HEST-EP-019.01				HEST-EP-019.01		
27 Mi				H05						
28 Do				ILSI-LP-040.1		F03				
29 Fr				HEST-BI-010.01				HEST-BI-010.01		
30 Sa								UNILAC OP 021.01, HEST AP 031.01, HEST AP 033.01		
1 So								SIS18-AP-016.01 + SIS-AP-030.01 (3 shifts)		
Dezember	2 Mo	28/Ar ³⁺	28/Ar ³⁺			H07	E04	F04		FRS-EP-077.01
	3 Di				FRS-EP-077.01				FRS-UI-047.01	
	4 Mi					FRS-UI-047.01			FRS-UI-047.01	
	5 Do						FRS-BI-047.01	C01	FRS-BI-047.01	
	6 Fr									
	7 Sa								SIS18-UI-012.01 (3 shifts)	
	8 So								SIS-BI-045.01, SIS-RF-042.01 (2 shifts)	
	9 Mo			U03				F05	C02	
	10 Di								C03	
	11 Mi							FRS-UI-024.01	C04	FRS-UI-024.01
12 Do					FRS-EP-025.01	C05	FRS-EP-025.01			
13 Fr						C06				
14 Sa							SIS-AP-060.01, SIS-AP-055.01,			
15 So							SIS-AP-058.01, SIS-AP-050.01 (2 shifts)			
16 Mo						C07	Operator exam			
17 Di						C08	Operator exam			
18 Mi						C09				
19 Do						C10				

Dec. 19

Planned for commissioning and tests of
FRS, ESR, control system, experimental set-ups, detectors

Planned NUSTAR Experiments in 2020

Preliminary

FEB	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
UNILAC																	50-Ti					48-Ca							
										S444 // p + 12-C																			
SIS								COM // 1SBIO // 12-C									S442 // 40-Ar								S467 // 86-Kr				
ESR																													

MAR	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
UNILAC									197-Au							48-Ca															197
SIS	SXXX // 124-Xe						S474 // 124-Xe						FRS 124Xe->111Sn (E127)						ESA // 56-Fe												
ESR	E132 // 124-Xe												E127 // 124-Xe						E121 // 206-Pb												

APR	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30										
UNILAC				48-Ca																	48-Ca																			
SIS						S452 // 208-Pb																				S468 // 208-Pb										S470 // 238-U				
ESR																														E137 // 238-U										

MAY	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So	Mo	Di	Mi	Do	Fr	Sa	So							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
UNILAC											197-Au																				
																									HAD // 1-p						
SIS	S455 // 238-U				S460 // 238-U						SMAT // 238-U								S455 // 238-U				S440 // 1-p								
ESR					E138 // 238-U										E131 // 238-U																

UNILAC
 UMAT C. Trautmann
 U312 M. Block
 U308 A. Yakushev
 U313 M. Laatiaoui
 U314 S. Räder
 U310 D. Rudolph
 U311 G. Gregori
 U318 K. Cistakov
 U317 O. Rosmej
 UBIO T. Friedrich

SIS
 SMAT C. Trautmann
 S468 S. Pietri
 S452 W. Witt
 S477 J. Stroth
 S471 N. Herrmann
 S474 W. Plass
 SBIO M. Scholz
 S444 R. Gernhäuser
 S443 I. Mukha
 S459 V. Chudoba
 S473 T. Aumann
 S469 S. Purushothaman
 S460 A. Maroales López
 ESA U. Weber
 S454 M. Heil

ESR
 E121 Y. Litvinov

NUSTAR UNILAC

NUSTAR SIS/FRS

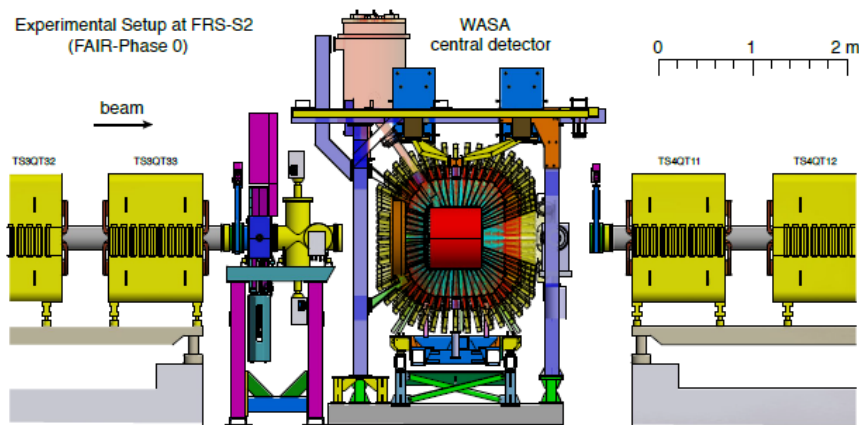
ESR

NUSTAR Experiments beyond 2020



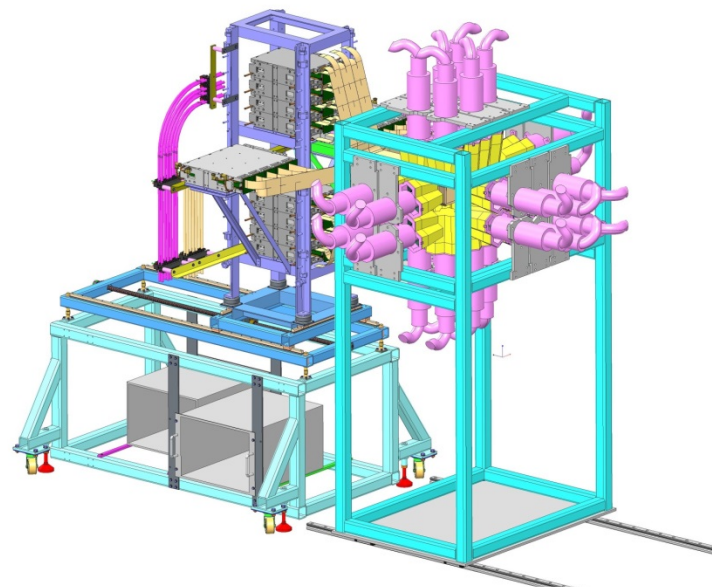
S447: Studies of the d+p signal and lifetime of the $^3_{\Lambda}\text{H}$ and $^4_{\Lambda}\text{H}$ hypernuclei by new spectroscopy techniques with FRS

Requires a special set-up of WASA at S2 of the FRS



S450: Study of $N=126$ nuclei: isomeric and beta decays in ^{202}Os and ^{203}Ir

Requires a new detector configuration with AIDA in its wide variant and 4π DEGAS

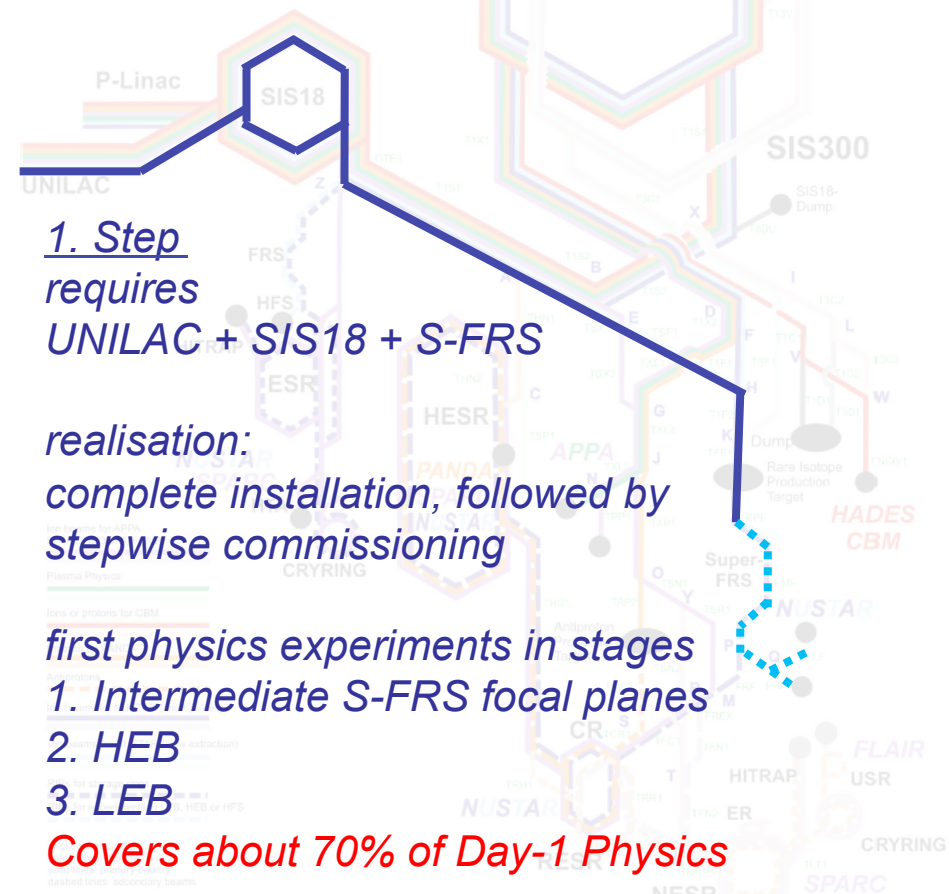
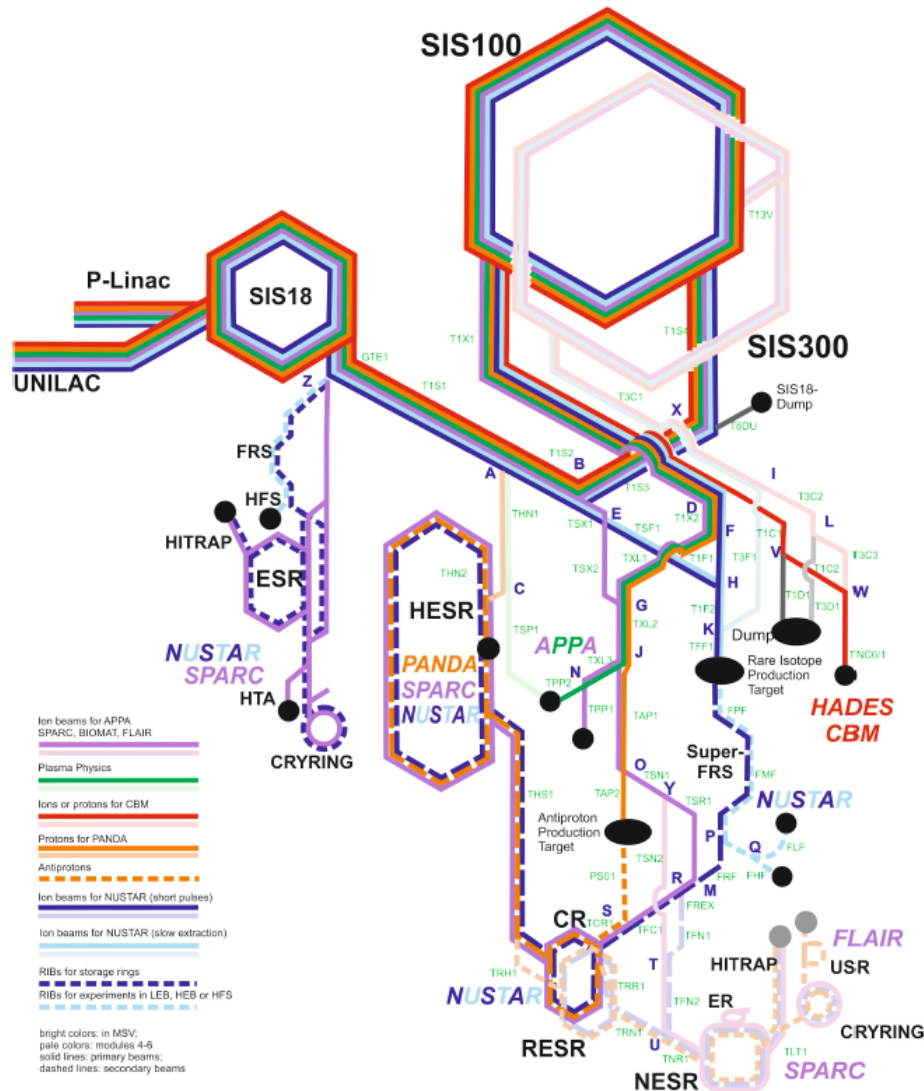


Next call for proposals in Spring 2020...

Phase-1 start-up scenarios and implications for day-1



NUSTAR start-up scenario for an advanced start of FAIR Phase-1



1. Step
requires
UNILAC + SIS18 + S-FRS

realisation:
complete installation, followed by
stepwise commissioning

first physics experiments in stages
1. Intermediate S-FRS focal planes
2. HEB
3. LEB

Covers about 70% of Day-1 Physics

Phase-1 start-up scenarios and implications for day-1



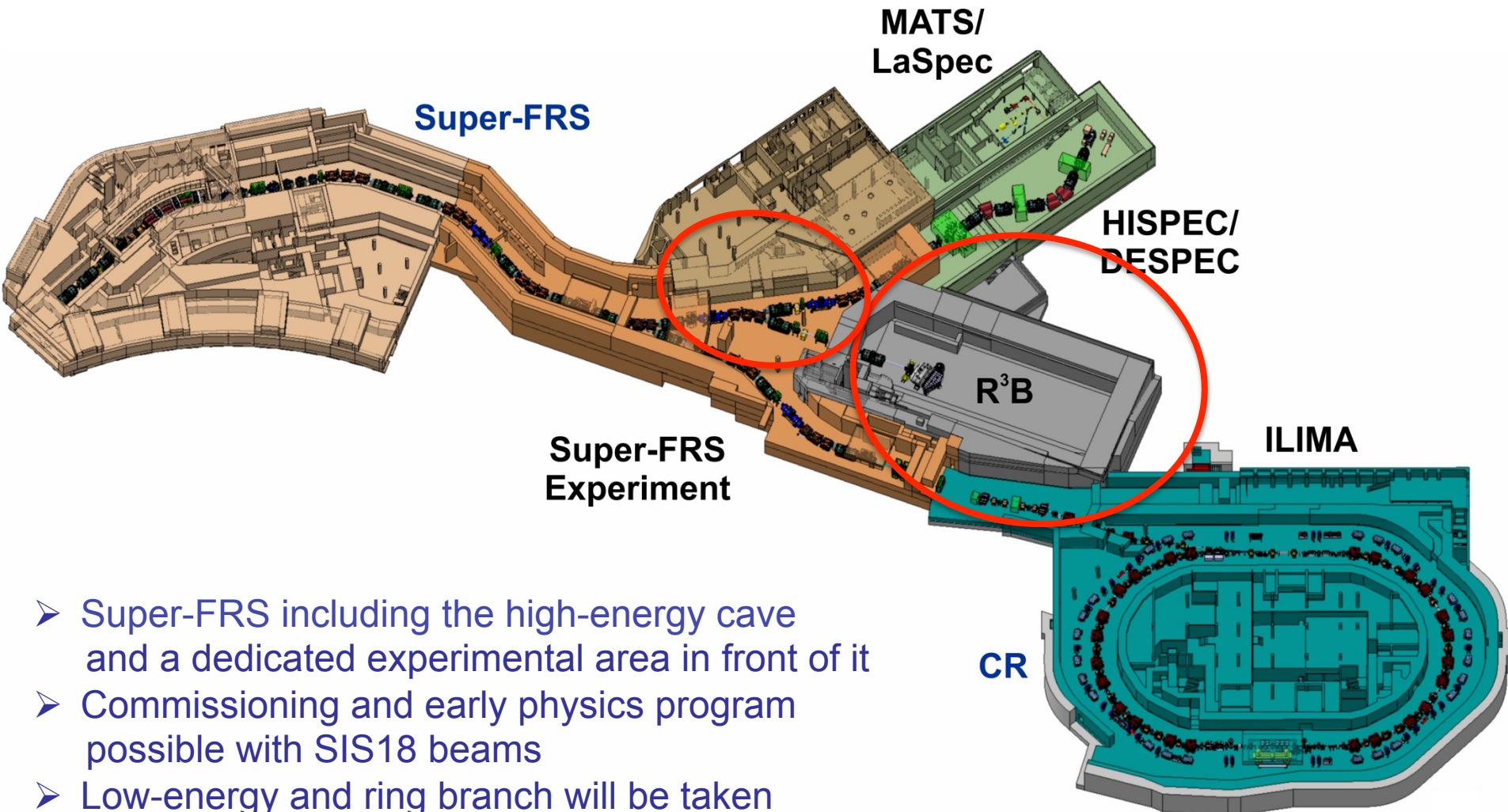
Advantages

- Early start of Phase-1 physics experiments
- Reduced risk by not requiring SIS100 operation
- Reduced risk by better resource balancing
- Reduced risk by staged approach not requiring full NUSTAR facility at once

Disadvantages

- Not serving all experiments from the beginning
- Longer total start-up time

NUSTAR Early Implementation



- Super-FRS including the high-energy cave and a dedicated experimental area in front of it
- Commissioning and early physics program possible with SIS18 beams
- Low-energy and ring branch will be taken consecutively into operation

Key Objectives for 2019/20



- Finalization of remaining (2-3) TDRs for Phase-1
- Establishing Common Funds in order to assure funding for infrastructure items (missing 10% of NUSTAR Day-1 invest)
- Perform full programme of Phase-0 experiments at GSI in order to
 - i) commission set-ups needed for Day-1, ii) gain operational expertise and know-how in such experiments, iii) train students and young researchers in preparation of Day-1, iv) re-gain the reputation of GSI/FAIR as top facility for forefront science
- Continue steadily the construction of all remaining components and sub-systems
- Further refine installation planning
- Elaborate on safety aspects of caves, set-ups and components