PowerMat

Collaborative efforts at GSI on irradiation and thermo-mechanical dynamic testing experiments

M. Tomut

PowerMat Participants

	Laboratories	
1	CERN	Geneva, Switzerland
2	**ELI-NP** (Extreme Light Infrastructure – Nuclear Physics)	Bucharest-Magurele, Romania
3	GSI	Darmstadt, Germany
4	**POLIMI**	Milan, Italy
5	POLITO	Turin, Italy
6	UM	Malta
X	**NIMP** (National Institute of Materials Physics)*	Bucharest, Romania
	Industries (in WP1 Innovation)	
X	Brevetti Bizz	Verona, Italy
X	RHP Technology	Seibersdorf, Austria

* Participating as associated (subcontractor)

PowerMat Collaborations

Irradiation, Beam impact

1 ***Facility: HiRadMat; SPS, CERN*** — **Geneva, Switzerland**

Experiments: MultiMat ; PI: Alessandro Berrtarelli — **2017**

Participants: CERN, Malta, GSI

FlexMat; PI: Marilena Tomut — **2018**

Participants: GSI, CERN, Malta

2 ***Facility: M-Branch; UNILAC, GSI*** — **Darmstadt, Germany**

Experiments:

- **Materials for high dose, high energy density application- on-line measurements and irradiation experiments”** — **2018 - 2019**

PI: Marilena Tomut

Participants: GSI, ESS &

- **Radiation damage scaling in accelerator materials for beam intercepting devices: from high flux light ions to high energy protons”**

PI: Alessandro Bertarelli — **2018 - 2019**

Participants: CERN, GSI, Polimi

PowerMat Collaborations

Laser induced shock waves and
laser driven particle beam irradiation

1 ***Facility: PHELIX laser and LIGHT beamline, GSI*** **Darmstadt, Germany**

Aproved Experiments:

Study of fast processes induced by laser-driven short pulse proton beam in carbon materials ;

PI: Marilena Tomut

Previous experiment - 2015:

Laser driven spallation in carbon materials ; PI: Marilena Tomut

Proposal 2019 ?:

Laser driven shock waves

2

Facility: E5 experimental area for materials in extreme conditions at ELI-NP

Bucharest, Romania

Planned Experiments – during commissioning phase – 2019?

Materials response to laser driven short proton beam pulses

PowerMat Collaborations

1 **Thermomechanical simulations of transient response to particle/laser beam impact**

Expertise: University of Malta- ANSYS
Polito – Autodyn, LS DYNA

Benefiting experiments:
- HiRadMat: MultiMat, FlexMat, …
- Low energy U beam impact- M-branch
- Laser induced shock waves: GSI
- Laser driven proton beam induced pressure wave: GSI, ELI-NP

2 **FLUKA simulations relevant to operation conditions and irradiation experiments**

Operation conditions:
- HL-LHC: collimators
- FAIR: production targets: Super-FRS, antiproton, beam catchers, Suoer-FRS, beam dumps

Irradiation experiments :
- M-branch at GSI: light and medium Z ions
- He implantation combined with light ion irradiation for modulating dpa

PowerMat Collaborations

1 **Fracture mechanics and high strain rate tests**

Expertise / Host : Polito

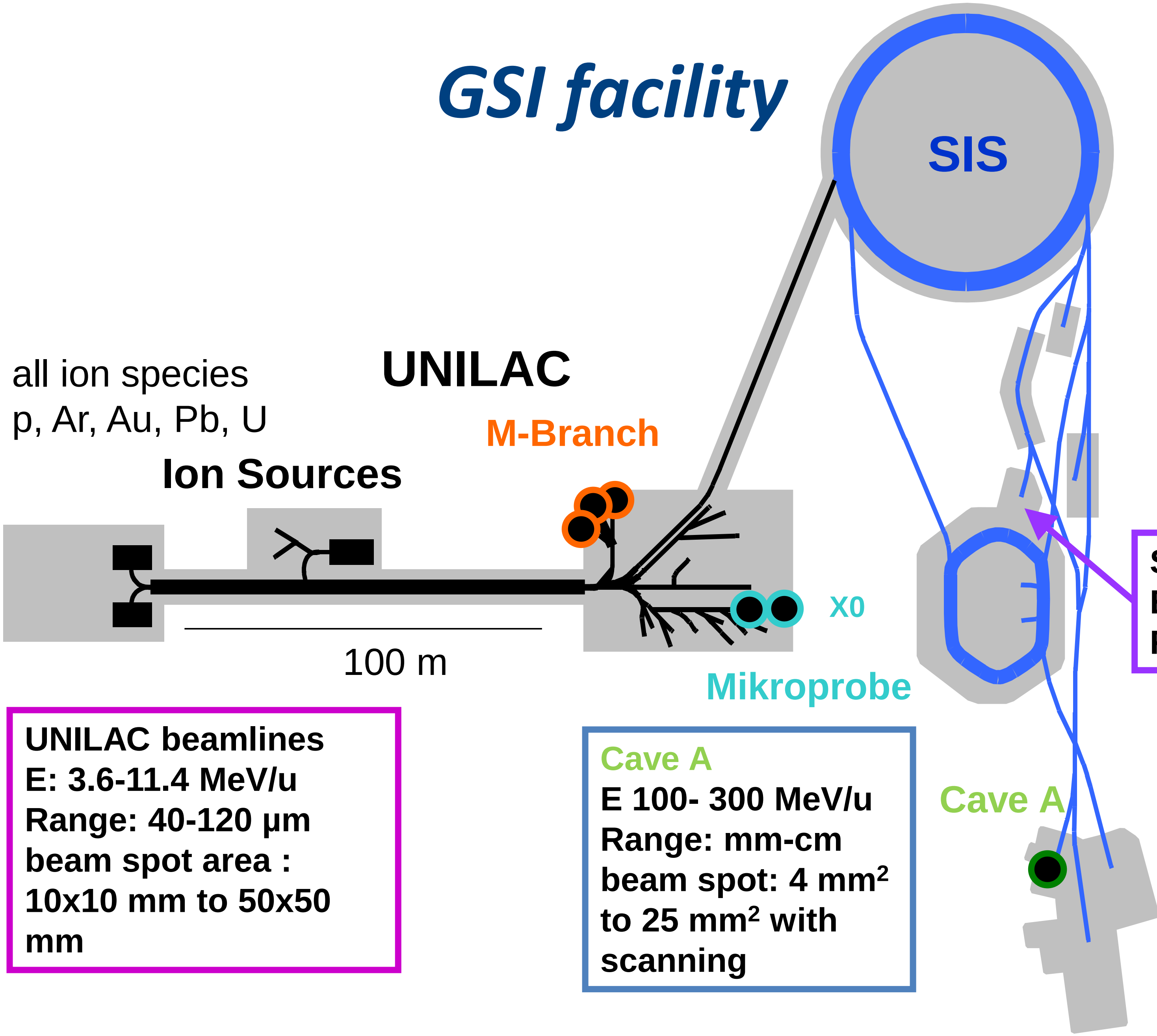
Benefiting experiments / materials:

CERN – collimator and beam absorber materials

GSI – high power target, beam dumps /catchers, luminescence screen materials

Expertise GSI: impact nanoindentation and fatigue

GSI facility



SIS 18 beam dump
E up to 1 GeV/u
Range: cm

UNILAC beamlines
E: 3.6-11.4 MeV/u
Range: 40-120 µm
beam spot area :
10x10 mm to 50x50 mm

Cave A
E 100- 300 MeV/u
Range: mm-cm
beam spot: 4 mm^2 to 25 mm^2 with scanning

UNILAC: beam parameters

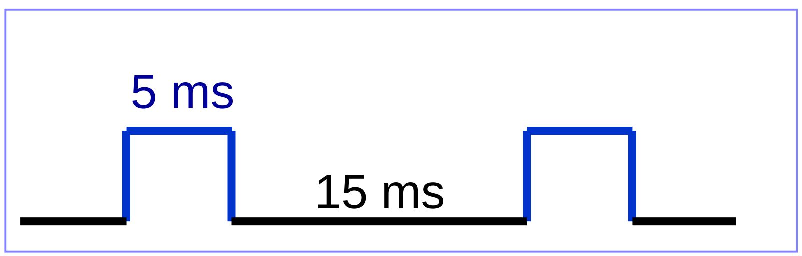
3.6 / 4.8 / 5.6 / 8.6 / 11.4 MeV/u typical energies

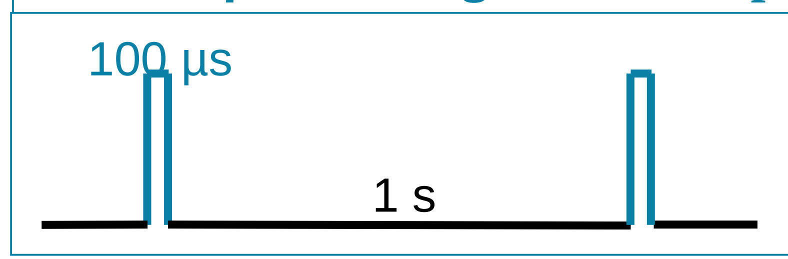
50 Hz Mode (Penning, ECR)

50 Hz
5 ms length of macropulse

high-current mode (MEVVA source)
(for SIS experiments)

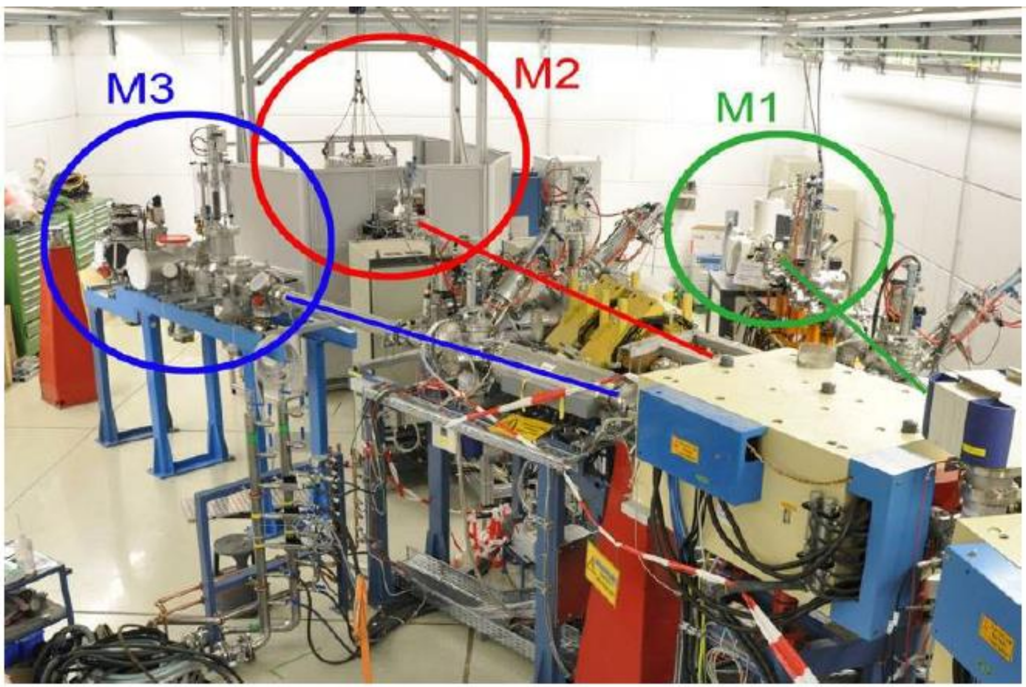
1-2 Hz
100-200 µs length of macropulse

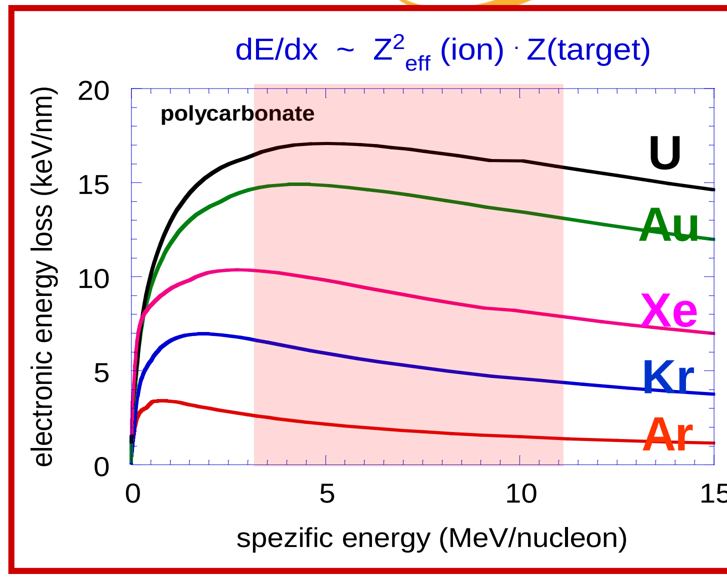




M-branch irradiation facility at GSI
In situ experiments

- energies close to Bragg peak:
  - to maximize energy deposition and damage
  - to avoid activation
- online and in situ monitoring: video camera, fast IR camera, SEM, XRD, IR spectroscopy





SRIM code

ion species ..C…Xe...U

flux:
up to10^{10} ions/cm^2 s

Beamtime application at GSI 2018-2019

G-PAC

31 Proposals granted

UNILAC: 98 days

SIS18: 100 days

ESR/Cryring: 63 days

S CRYRING standalone

Proposal ID	Accelerator	Spokesperson	Affiliation	Local Contact Person	Proposal Title	Shifts requested main	Shifts requested parasitic	Beam time preferred in	Ranking	Shifts recommended main	Shifts recommended parasitic
ESR / CRYRING											
E138	CRYRING	Weber, Günter	Helmholtz-Institut Jena Fröbelstieg 3	Lestinsky, Michael	The Ground-State Lamb Shift in the Heaviest Hydrogen-like Ion (U^{91+}): High-Resolution X-ray Spectroscopy at the CRYRING electron cooler	54	–	2018/19	A	39	0
E137	ESR	Braeuning-Demian, Angela	GSI, Planckstrasse 1 64291 Darmstadt	Braeuning-Demian	Energy determination of the 1s2 2s1/2 – 1s2 2p3/2 radiative transition in Li-like uranium ions via resonant coherent excitation in crystal	18	–	2018	A	18	0
E129	CRYRING	Rothhardt, Jan	Institute of Applied	Lestinsky, Michael	Photoionization of C+ ions at CRYRING	30	–	2018/19	S	CRYRING standalone: 30	
E130	ESR	Quint, Wolfgang	GSI	Litvinov, Yury	Cooling and precision spectroscopy of $^{209}Bi^{82+}$ ion ensembles with the ARTEMIS and SPECTRAP experiments at the HITRAP facility	30	–	2018/19	A	10	0
E128	ESR	Nörtershäuser, Wilfried	Technische Universität Darmstadt	Litvinov, Yury	Dielectronic Recombination-assisted laser spectroscopy: A new tool to investigate the hyperfine-puzzle in $Bi^{80+,82+}$	30	–	2018/19	A	10	0
E131	CRYRING	Schippers, Stefan	Justus-Liebig-Univer	Lestinsky, Michael	Precision collision spectroscopy of Be-like ions at the CRYRING@ESR electron cooler	27	–	2018/19	A	27	0
E132	ESR	Hagmann, Siegbert	GSI	Litvinov, Yury	Electron Emission following 1s Adiabatic Ionization and Quasi-resonant 1s-1s Charge Transfer in Symmetric Heavy-Ion Atom Collisions	48	–	2018	A	48	0
E121	ESR	Litvinov, Yuri	GSI Darmstadt	Litvinov, Yuri	Measurement of the bound-state beta decay of bare ^{205}Tl ions	21	–	2018	A	21	0
E127	ESR	Reifarth, Rene	Uni Frankfurt	Litvinov, Yury	Measurements of proton-induced reaction rates on radioactive isotopes for the astrophysical p process	45	–	2018/19	A	15	0
SIS18 HADES / CBM											
S471	SIS18	Herrmann, Norbert	Physikalisches Institut Raum 1.107	Sturm, Christian	mCBM @ SIS18 – A CBM full system test-setup for high-rate nucleus-nucleus collisions at GSI / FAIR	6	81	2018/19	A	6	81
S477	SIS18	Stroth, Joachim	in-house room in KB	Pietraszko, Jerzy	Properties of hadron resonances and baryon rich matter	177	–	2018	A	88	0
NUSTAR: R3B											
S444	SIS18	Gernhäuser, Roman	TU-München Physik-Department ZTL	Simon, Haik	R3B – 2018 COMMISSIONING (CALIFA, L3T, GLAD, NeuLAND & Tracking)	25	5	2018	A	16	19
S465	SIS18	Aumann, Thomas	TU Darmstadt Inst. für Kernphysik Schlossgartenstr. 9	Simon, Haik	Dipole response of the drip-line nuclei ^{6}He and $^{22,24}O$	39	–	2018/19	A	12	0
S442	SIS18	Sorlin, Olivier	GANIL, 15 Bd Henri	Simon, Haik	Study of multi-neutron configurations in atomic nuclei towards the drip line	22	–	2019	A	22	0
S467	SIS18	Paschalis, Stefanos	University of York, U	Simon, Haik	Single-particle structure of neutron-rich Ca isotopes: shell evolution along Z=20	14	–	2019	A	14	0
S455	SIS18	Taieb, Julien	CEA DAM IdF Bruyeres le Chatel 92297 Arpajon	Simon, Haik	Fission investigated with relativistic-radioactive beams and the advanced SOFIA@R3B setup	30	15	2018	A	21	15
NUSTAR: S-FRS											
S447	SIS18	Saito, Takehiko	GSI, Planckstrasse 1	Scheidenberger, Christoph	Studies of the $d + \pi^-$ signal and lifetime of the $^{3}_{\Lambda}H$ and $^{4}_{\Lambda}H$ hypernuclei by new spectroscopy techniques with FRS	36	– (18)	2019	A	27	18
S474	SIS18	Plass, Wolfgang	GSI Helmholtz Cent	Scheidenberger, Christoph	Detector tests with the prototype of the CSC for the Super-FRS and direct mass measurements of neutron-deficient nuclides below 100-Sn	21	–	2018/19	A	21	0
S468	SIS18	Pietri, Stephane	GSI	Scheidenberger, Christoph	Search for new neutron-rich isotopes and exploratory studies in the element range from terbium to rhenium	27	–	2018	A	14	8
S469	SIS18	Purushothaman, Sivaji	GSI Helmholtzzentrum für	Scheidenberger, Christoph	Accurate slowing-down measurements of heavy ions in gases and solids in the kinetic energy range of (30 to 300) MeV/u with the high-resolution magnetic spectrometer FRS	9	18	2018	A	0	12
NUSTAR: DESPEC											
S452	SIS18	Witt, Waldemar		Gerl, Jürgen	The Oblate-Prolate Shape Transition around A~190	48	–	2018/19	A	24	0
S460	SIS18	Morales López, Ana Isabel	Instituto de Física Corpuscular (CSIC-Universitat de	Gorska-Ott, Magdalena	Investigation of 220-A-230 Po-Fr nuclei lying in the south-east frontier of the A~225 island of octupole deformation	16	–	2018/19	A	16	0
S450	SIS18	Podolyak, Zsolt	Department of Physics University of	Gorska-Ott, Magdalena	Study of N=126 nuclei: isomeric and beta decays in ^{202}Os and ^{203}Ir	18	6	2019	A	18	6
S470	SIS18	Pietri, Stephane	GSI	Gerl, Jürgen	Test of an HISPEC TEGIC detector for Low Energy Branch experiments	0	6	2018	A	0	6
S451	SIS18	Katrik, Peter	GSI Planckstrasse 1 64291 Darmstadt	Scheidenberger, Christoph	Depth profiling of activity induced by lost heavy ions	0	10	2018/19	A	0	10
UNILAC / SHE											
U308	UNILAC	Yakushev, Alexander	GSI Helmholtzzentrum für	Yakushev, Alexander	First chemical study of element 113 behind TASCA	84	72	**2018**: 72 paras. beam;	A	84	72
U310	UNILAC	Rudolph, Dirk	Department of Physics Lund University	Yakushev, Alexander	Spectroscopy of Flerovium Decay Chains & Discovery of ^{290}Fl	75	24	2018/19	A	42	24
U312	UNILAC	Block, Michael	GSI	Block, Michael	Direct mass measurements and investigations of isomeric states in Lr and Rf isotopes around the deformed neutron shell closure at N = 152 with SHIPTRAP	42	30	2018/19	A	42	30
U313	UNILAC	Laatiaoui, Mustapha	KU Leuven, IKS, Celestijnenlaan 200d,	Block, Michael	Laser spectroscopy of nobelium and lawrencium	84	–	2018/19	A	84	0
U314	UNILAC	Raeder, Sebastian	GSI Helmholtzzentrum für	Block, Michael	High-resolution laser spectroscopy of nobelium isotopes and isomers	42	21	2019	A	42	21
U316	UNILAC	Kraft-Bermuth, Saskia	I.Physics Institute Justus-Liebig-Universitaet	Gerl, Jürgen	Test of calorimetric low-temperature detectors (CLTDs) for detection of HI at low and inter-mediate ion energies for application in NUSTAR	–	27	2018/19	A	0	27

Mat-PAC

43 Proposals granted

UNILAC: 50 days

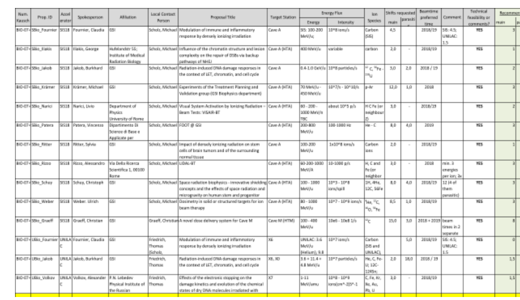
SIS18: 8 days

Bio-PAC

14 Proposals granted

UNILAC: 2 days

SIS18: 11 days



Plasma-PAC

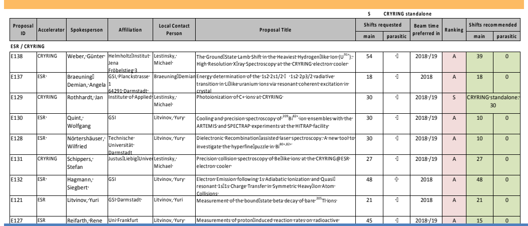
5 Proposals granted

UNILAC: 30 days parasitic

SIS18: 12 days parasitic

Beamtime application at GSI 2018-2019

G-PAC
31 Proposals granted
UNILAC: 98 days
SIS18: 100 days
ESR/Cryring: 63 days



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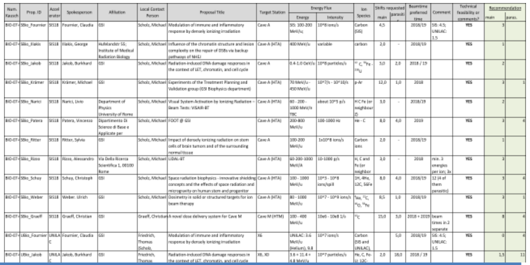
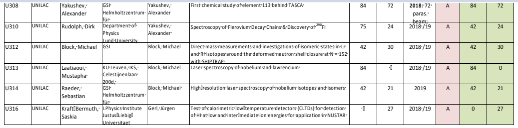
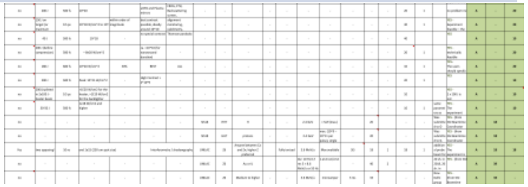
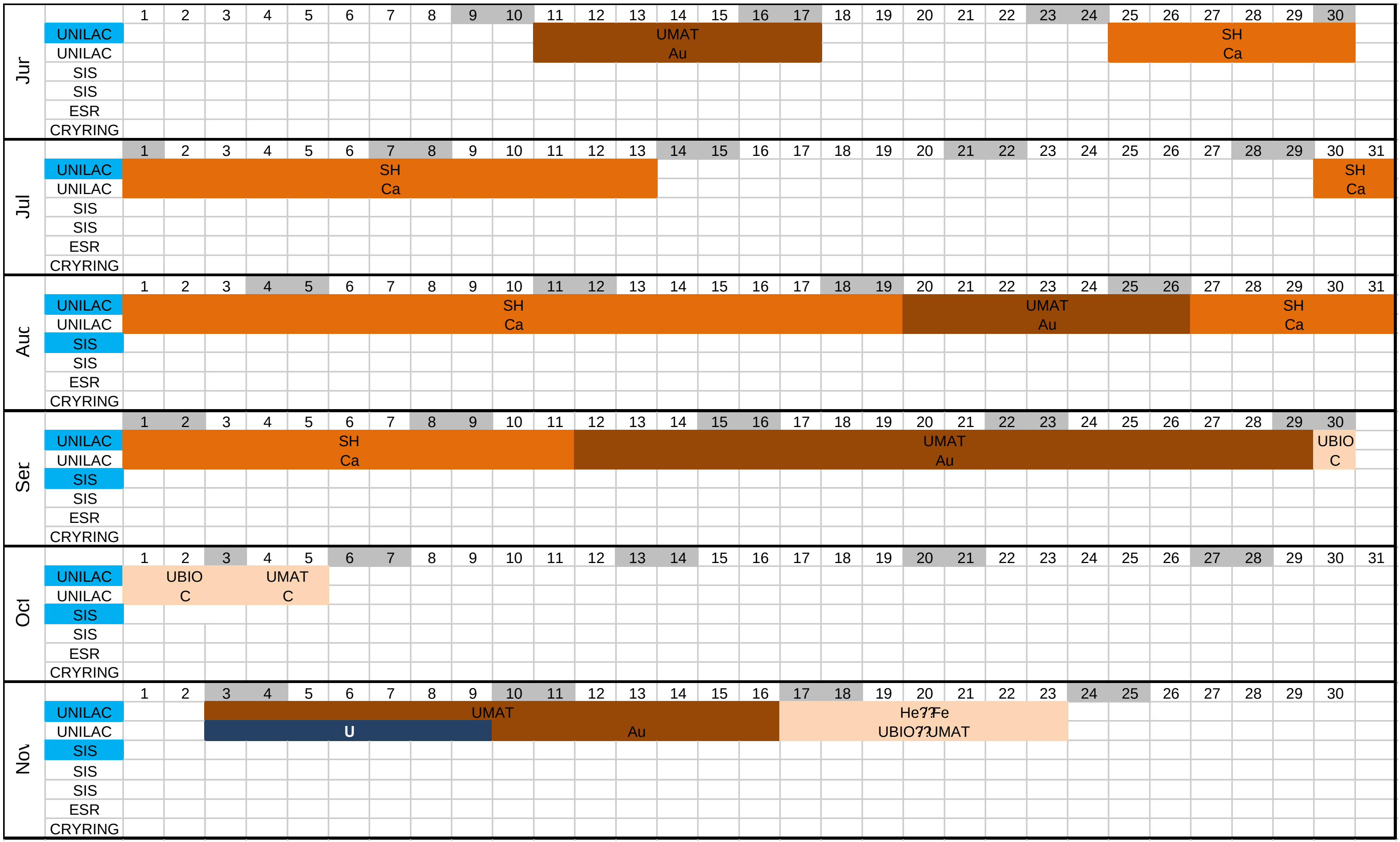


UNILAC beams in days		
12C	5	5
48Ca	35	14
50Ti	28	21
197Au	25	25
	2018	**2019**





Beam%time%schedule%UNILAC



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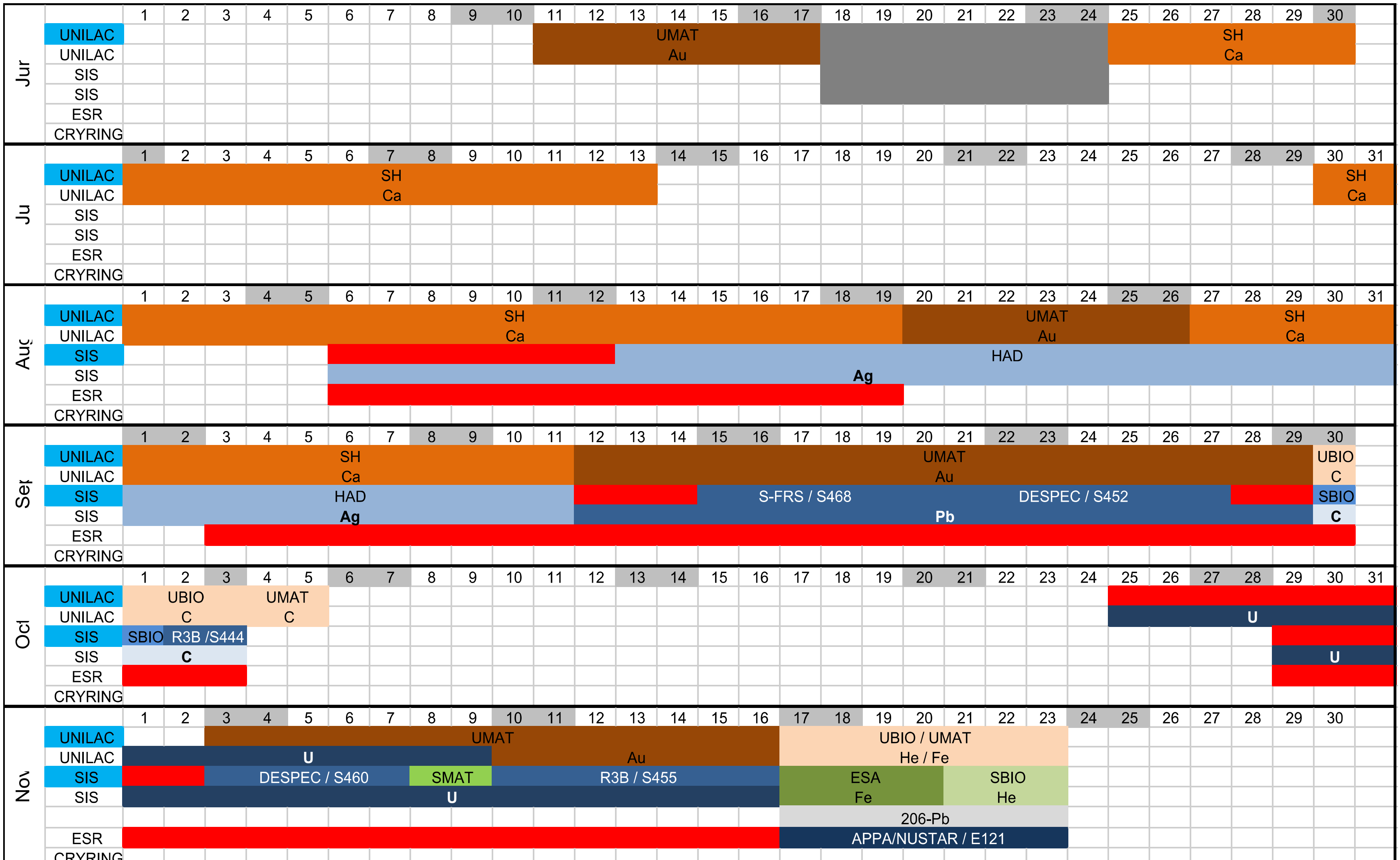

Planned experimental cave at SIS 18 - GSI

- **unique combination of intense relativistic heavy-ion beams and high-energy laser pulses - start 2020?**

Laser:
- up to 200J in 1-10ns pulses
- pulse shaping capability (but then probably less energy)
- 2-omega (527nm)
- possibility for phase plate and 3-omega (150J)

Heavy ion beam:
- Ions with Z from 1 (protons) up to 92 (uranium)
- Energy: several 100 MeV/u (--> range of several mm in solid density target !!)
- Pulses with up to 4e10 ions per pulse
- Pulse duration from 100ns up to few us
- Focusing down to approx. 1mm spot size
  ---> energy deposition approx. 10kJ/g (depends a bit on the material)
    ---> heating to approx. 1eV temperature (so well above the boiling temperature, entering WDM regime)

Proton microscope (instead of heavy ion beam):
- demonstrated 30um spatial resolution (expect 10um)
- temporal resolution (=exposure time) down to 10ns
- density resolution on %-level
- multi-frame capability (e.g. 4 frames within 1 us)

Thank you and
looking forward to further
collaboration