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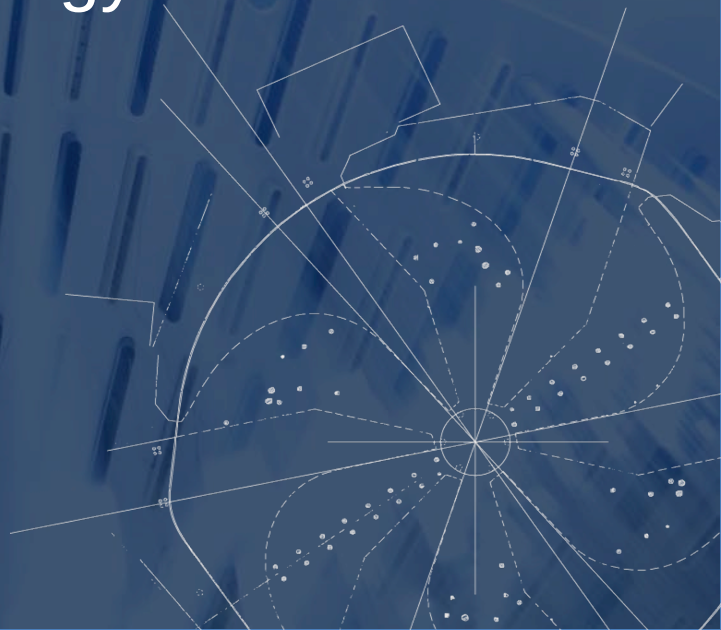
Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

Beam Development Strategy

Jens Dilling

SAP EEC July 2016

Date July 22 2016



Outline

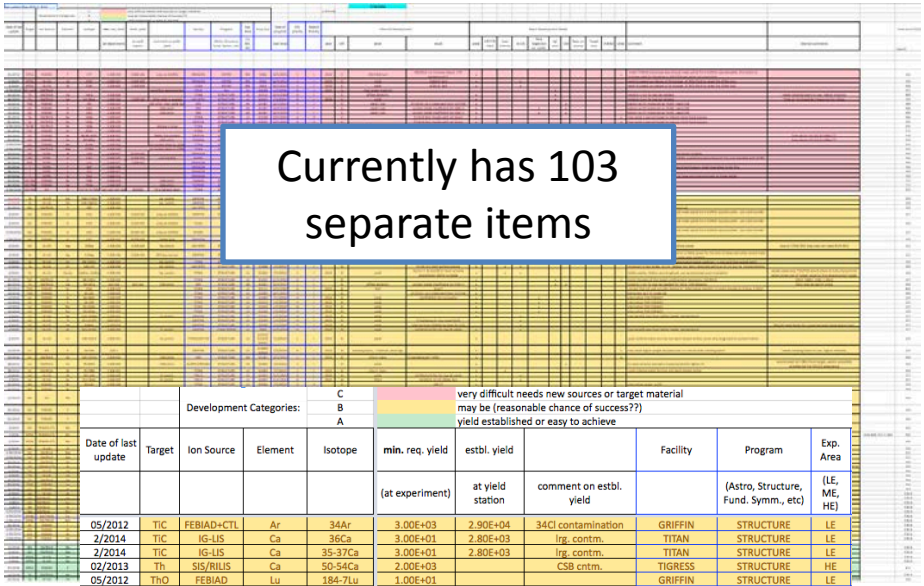
- Beam Development Strategy Committee
- Beam Development Database
- Process
- Statistics
- 2016-2017 Beam Development Plan (schedule 131)

Beam Development Strategy Committee

Member	Position
Friedhelm Ames	Group Leader, ISAC Facility Operations & Development
John Behr	Research Scientist, Deputy department Head – ISAC Nuclear Physics
Barry Davids	Research Scientist – Nuclear Astrophysics, ISAC Beam Scheduler
Jens Dilling (Chair)	Interim ALD – Physical Sciences, Nuclear Physics
Adam Garnsworthy	Research Scientist – Nuclear Structure,
Alexander Gottberg	ARIEL Target Physicist
Peter Kunz	RIB Target Physicist
Jens Lassen	Laser Ion Source Spectroscopist
Bob Laxdal	Interim ALD – Accelerator Division
Marco Marchetto	ISAC High Energy Facility Coordinator
Chris Ruiz (Scientific Secretary)	Research Scientist – Nuclear Astrophysics

Beam Development Database

- Beam Development Database kept on “Master Spreadsheet” – updated by Scientific Secretary
- Each “line item” represents an individual development action e.g. “Measure a specific yield with a given target/source combination”
  - A single experiment can have many line items, but each line item is associated with a single experiment
- Database records:
  - Experiment number
  - EEC priority (can be a full proposal or an LOI)
  - ISAC Facility and research area (Structure, Astro, Fund. Symm.)
  - Development type, proposed dates (and results when available)
  - *Minimum* required intensity, requested intensity.
- Developments categorized into 3 degrees of “difficulty”
  - Category A “yield established or easy to achieve”
  - Category B “More uncertain, but reasonable chance of success”
  - Category C “Very difficult – Needs new target material, ion source, or technique”



		Development Categories:		C		very difficult needs new sources or target material				
				B		may be (reasonable chance of success??)				
				A		yield established or easy to achieve				
Date of last update	Target	Ion Source	Element	Isotope	min. req. yield (at experiment)	estbl. yield at yield station	comment on estbl. yield	Facility	Program (Astro, Structure, Fund. Symm., etc)	Exp. Area (LE, ME, HE)
05/2012	TiC	FEBIAD+CTL	Ar	34Ar	3.00E+03	2.90E+04	34Cl contamination	GRIFFIN	STRUCTURE	LE
2/2014	TiC	IG-LIS	Ca	36Ca	3.00E+01	2.80E+03	Irg. contm.	TITAN	STRUCTURE	LE
2/2014	TiC	IG-LIS	Ca	35-37Ca	3.00E+01	2.80E+03	Irg. contm.	TITAN	STRUCTURE	LE
02/2013	Th	SIS/RILIS	Ca	50-54Ca	2.00E+03		CSB cntm.	TIGRESS	STRUCTURE	HE
05/2012	ThO	FEBIAD	Lu	184-7Lu	1.00E+01			GRIFFIN	STRUCTURE	LE
12/2012	UC	FEBIAD	O	21-24O	1.00E+01			TITAN	STRUCTURE	LE
2/2014	UC	IG-LIS	At	221-4At	1.00E+03	3.00E+03	Fr contm.	TITAN	STRUCTURE	LE
1/2015	UC	SIS/RILIS	In	134/135In	10			TITAN	STRUCTURE	LE
1/2015	UC	SIS/RILIS	Cu	75-81	10-100			TITAN	STRUCTURE	LE
1/2015	Nb	SIS/RILIS	Sr	74Sr	50		Rb contm.	GRIFFIN	STRUCTURE	HE
5/30/2016	Nb	SIS/RILIS	Mn	61-70Mn	6e2 to 0.2	70	(61Mn yield)	GRIFFIN	STRUCTURE	LE
5/30/2016	HPNb	SIS/TRILIS	Cu	56Cu	50			TITAN	ASTRO	LE
5/30/2016	HPNb	SIS/TRILIS	Mn	48Mn	50			TITAN	ASTRO	LE
05/2012	UC	FEBIAD	I	128I	1.00E+06			TITAN	STRUCTURE	LE
5/30/2016	ZrC	FEBIAD	As	66As	1.00E+02			TITAN	STRUCTURE	LE
5/30/2016	ZrC	FEBIAD	Br	70Br	1.00E+02		(Al-Br from FEBIAD)	TITAN	STRUCTURE	LE
5/30/2016	ZrC	FEBIAD	Se	70Se	1.00E+02		seen from ZrC+FEBIAD	TITAN	STRUCTURE	LE
12/2014	Nb	SIS/RILIS	Rb	83Rb	5.00E+07	5.00E+10	CSB cntm.	EMMA	ASTRO	HE
2/2014	SiC	SIS/RILIS	Mg	20Mg	5.00E+01	5.00E+03	Na contm.	IRIS	STRUCTURE	HE
7/2016	HPSiC	IG-LIS	Be	7Be	5.00E+07	7.00E+07	(yield for 5/2014)	DRAGON	ASTRO	ME
7/2016	HPSiC	IG-LIS	Be	7Be	1.00E+07	7.00E+07	(yield for 5/2014)	DRAGON	ASTRO	ME
07/2016	HPSiC	FEBIAD	F	18F	5.00E+06	5.00E+07	average of #16,#17,#32	TUDA	ASTRO	HE
12/2014	Ta	SIS/RILIS	Be	12Be	1.50E+03	9.40E+03	unsual tgt. oper.	IRIS	STRUCTURE	HE
05/2012	Ta	IG-LIS	Tb	146Tb	1000	3000000	Irg. contm.	GRIFFIN	STRUCTURE	LE
2/2014	UC	FEBIAD	Kr	96-99Kr	3000/500/5			GRIFFIN	STRUCTURE	LE
10/2012	UO/UC	SIS	K	49-53K	1.00E+02			TITAN	STRUCTURE	LE

Process

- Database kept up to date by Scientific Secretary (C. Ruiz) by referencing:
  - Outcomes of latest EEC meeting
  - ISAC Yield Database
  - Experimental developments (Garnsworthy, Dilling)
  - Discussions with BDSC subcommittee (Ames, Gottberg, Kunz, Lassen)

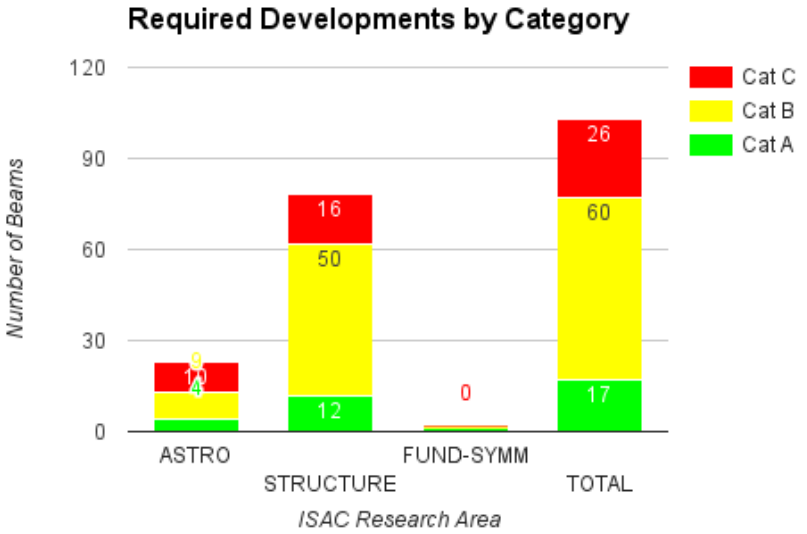
- After Beam Requests Deadline, consult with ISAC Scheduler (B. Davids) regarding likely target/ion-source sequence
  - Going forward: dedicated development target in schedule

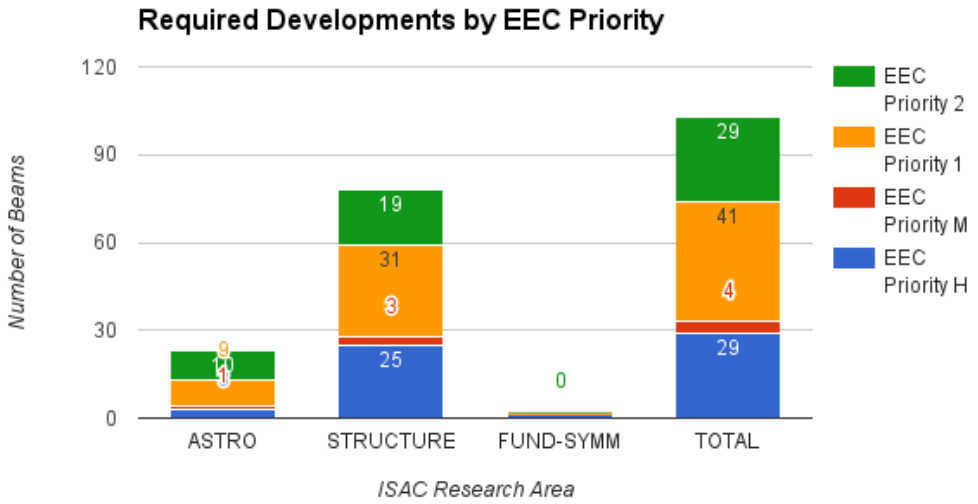
- Subcommittee meets to identify High priority development items associated with those targets/sources
  - Preparation of “shopping list”

- Medium-to-long term developments also proposed according to Beam Development Group, based on feasibility, guided by database and EEC priorities → Some level of “High Risk / High reward”

- Full committee meets to critique/prioritize list
  - Some items rejected due to resource constraints
  - Synergy between developments encouraged (e.g. many Medium priority experiments may benefit from addressing one or two High priority experiment developments)

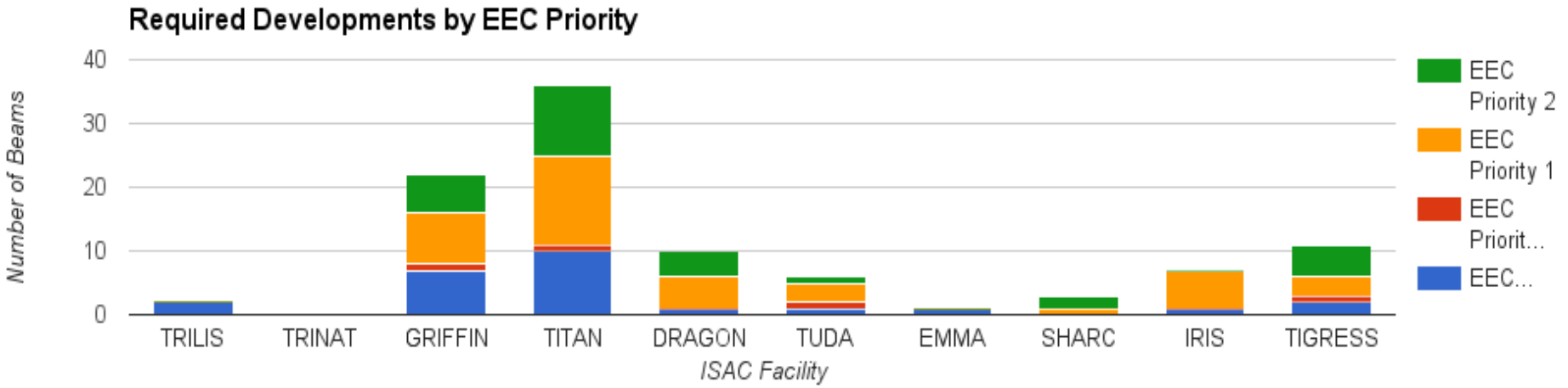
Statistics





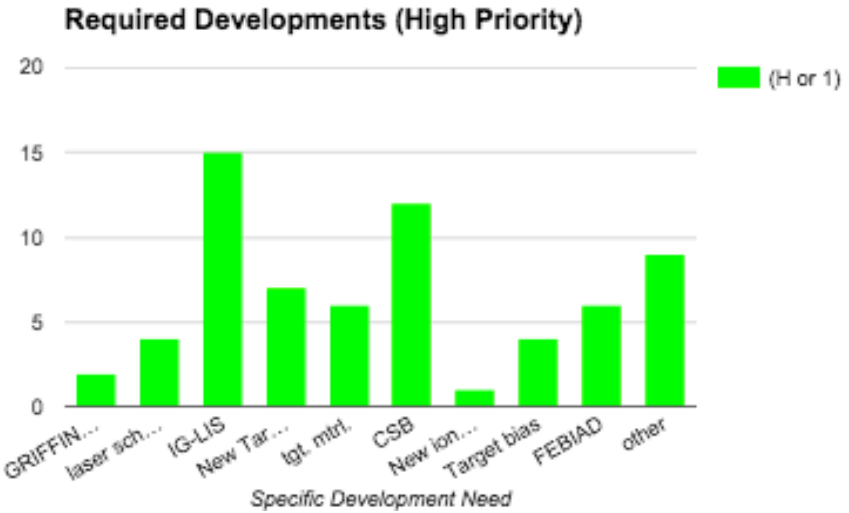
- Majority of Astrophysics developments category A or B, but substantial fraction category C
- Vast majority of Nuclear Structure developments category B
- Nuclear Structure represents 76%, Astrophysics 22%

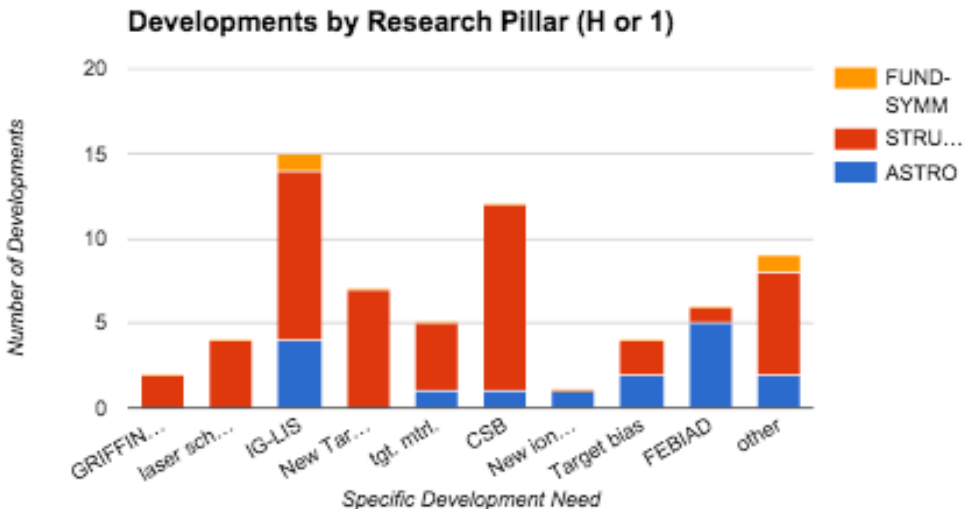
Statistics



- Majority of DRAGON development needs category C
- Most facilities are dominated by category B (with exception of IRIS, EMMA)
- Most facilities dominated by EEC priority (H or 1)

Statistics



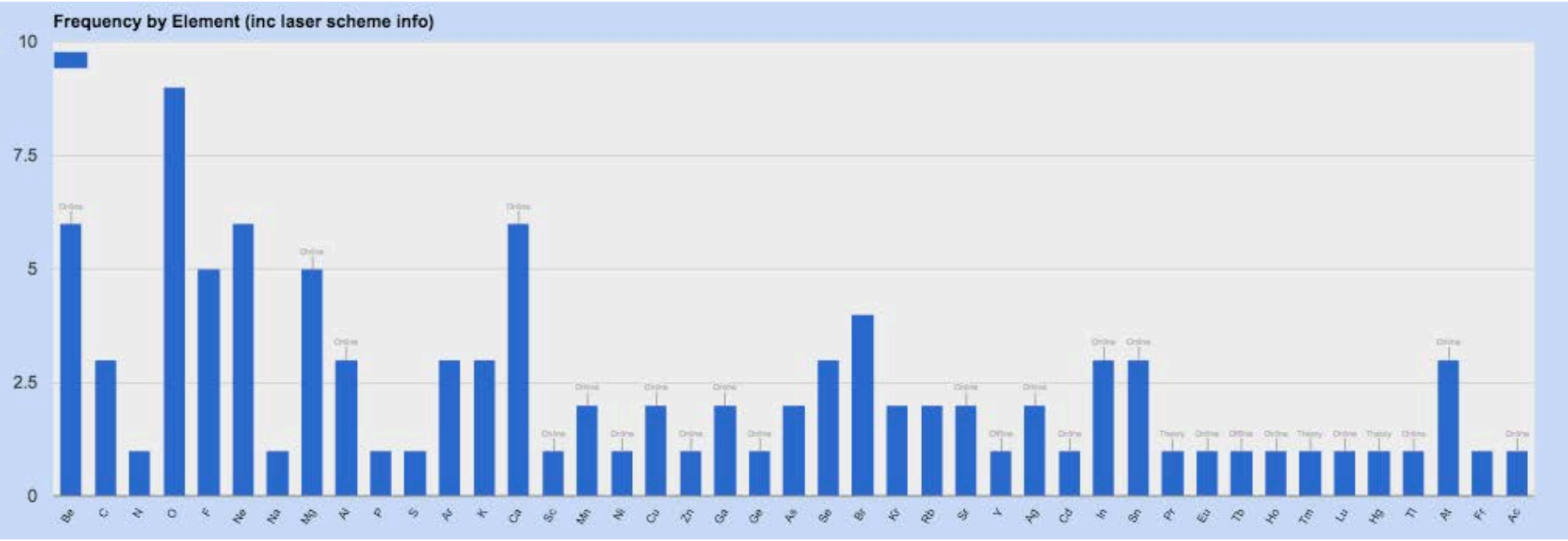


Categories:

GRIFFIN Yield Measurement
Laser scheme
IG-LIS
New Target/ion source combo
New target material
Charge State Booster
New ion source
Target bias (ISAC module)
FEBIAD
other

- Note: Most developments require careful yield measurements – not mutually exclusive with other categories (yield measurements excluded from these charts)
- Large needs for IG-LIS, CSB (background), FEBIAD, new target/source combo
- Combined need for Astrophysics & Structure for FEBIAD development plus large ISAC target module bias (for extraction of Mass 26>30 atoms and molecules

Statistics



Development requirement frequency of elements

- Laser information shows whether a scheme exists in theory, has been developed offline, or has been tested online.

2016-2017 Plan (schedule 131 – short term goals)

Dates	Target	Ion Source	Module/Station	Priority	Beam	What	Exp	Facility	Area	Summary
Sep 6-26	Ta	TRILIS	TM2 W	No specific Development requirements. Yields only.						
3 weeks	SiC	IG-LIS	TM4 E	H	7Be	IG-LIS yield + Li contam	S1025	DRAGON	ASTRO	Laser ionized elements with specific background contamination needs.
				H	7Be	IG-LIS yield + Li contam	S1452	DRAGON	ASTRO	
				~~H~~	~~25Al~~	~~IG-LIS yield~~	~~5923~~	~~TUDA~~	~~ASTRO~~	
				H	20Mg	IG-LIS yield + Na contam	S1329	LAS-SPEC	STRUCTURE	
				~~M~~	~~22-25Al~~	~~IG-LIS yield + Na contam~~	~~S1191~~	~~TITAN~~	~~STRUCTURE~~	
3 weeks	SiC	FEBIAD	TM2 W	H	18F	FEBIAD Optimization	S1287	TUDA	ASTRO	Careful optimization of FEBIAD for light elements. Need extended development time to do this. Not in one single block, as is labour intensive.
				H	18Ne	FEBIAD Optimization	S870	TUDA	ASTRO	
				H	14O	FEBIAD Optimization	S1140	GRIFFIN	STRUCTURE	
				H	14O	FEBIAD Optimization	S924	TUDA	ASTRO	
				M	18F	FEBIAD Optimization	S1123	TUDA	ASTRO	
				M	18Ne	FEBIAD Optimization	S1110	TUDA	ASTRO	
				M	18Ne	FEBIAD Optimization	S874	TIGRESS	STRUCTURE	
3 weeks	Ta	TRILIS	TM4 E	H	12Be	Rotating Beam Yield	S1506	IRIS	STRUCTURE	Short-lived Be yields for LE structure experiments
				H	14Be	Rotating Beam Yield	S1621	TITAN	STRUCTURE	
				H	14Be	Rotating Beam Yield	S1054	GRIFFIN	STRUCTURE	
				H	14Be	Rotating Beam Yield	S1158	TITAN	STRUCTURE	
				M	108-112Sn	Yield + CSB bckgnd	S1009	TIGRESS	STRUCTURE	Sn yields if have time.
2 weeks	UC	TRILIS	TM2 W	~~H~~	~~75-81Cu~~	~~Yield~~	~~S1471~~	~~TITAN~~	~~STRUCTURE~~	High demand from experiments for this target. Thus postpone development for these species.
				~~H~~	~~134-135In~~	~~Yield~~	~~S1502~~	~~TITAN~~	~~STRUCTURE~~	
				~~H~~	~~70-78Ni~~	~~Yield~~	~~S1383~~	~~TITAN~~	~~STRUCTURE~~	
				~~H~~	~~78-80Zn~~	~~Yield + CSB contam~~	~~S1369~~	~~SUPER-ORRUBA~~	~~STRUCTURE~~	
				~~H~~	~~130-137Sn~~	~~Yield + CSB contam~~	~~S1187~~	~~IRIS~~	~~STRUCTURE~~	
				~~H~~	~~37Mg~~	~~Yield + CSB contam~~	~~S1621~~	~~TITAN~~	~~STRUCTURE~~	

- Some items were cut for reasons of logistics or resources (manpower)
- Balance of Astrophysics & Structure developments, facilities
- Guided by priority H, but some M
- Mainly category B, but some Category A and C (difficult but rewarding)
- Test of proton beam rotation

2016-2017 Plan (medium-long term goals)

- 2017: RF Booster to be developed and installed before ISAC RFQ (LEBT) to provide 8 kV boost to beams
  - Ensuring ISAC target module can run at lower HV
  - For molecular and atomic beams of mass ~26-30 (many of interest)
  - Benefits Astrophysics and Structure (TIGRESS) – accelerated beam
- 2017: Target Module refurbishing for HV stability → ongoing project to be finished in 2018
- 2017: New target material: HPSiC using carbon nanofibres
  - Fast release, high T operation
  - Benefits short-lived light mass beams
  - Future possibility of other carbides using same?

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