



Canada's National Laboratory for  
Particle and Nuclear Physics

# ISAC Low-Energy Area

**Adam Garnsworthy**  
ARIEL Principal Scientist and TRIUMF Senior Scientist

November 8<sup>th</sup> 2019

ISAC Strategy Workshop  
Vancouver, BC, Canada



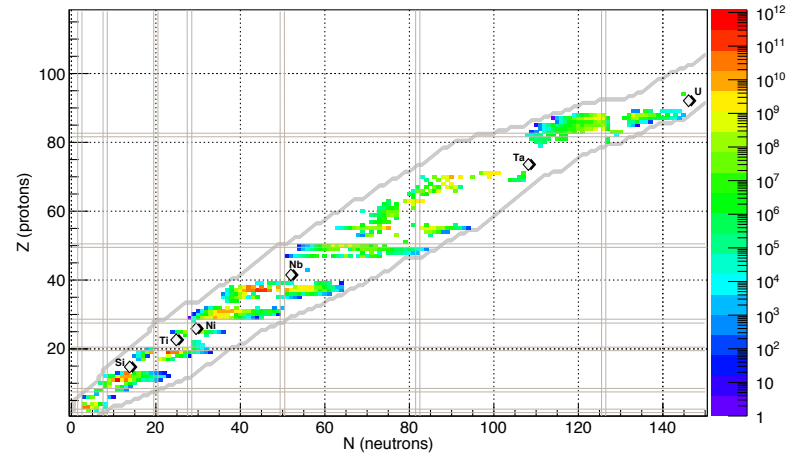
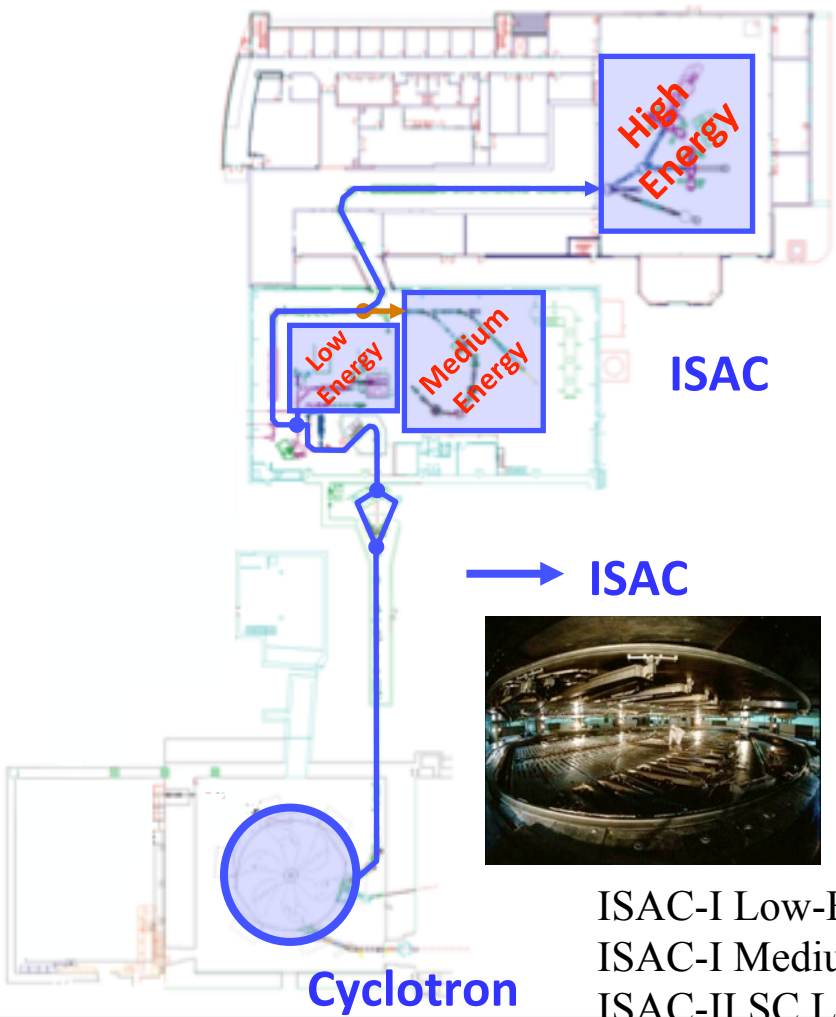
# TRIUMF-ISAC

## Isotope Separator and ACcelerator

*1 RIB delivery to experiments*

500MeV  $p^+$  at 100 $\mu$ A on ISOL target

SiC, NiO, Nb, ZrC, Ta,  $UC_x$  Targets  
Surface, FEBIAD, IG-LIS ion sources



ISAC-I Low-Energy <60keV

ISAC-I Medium E <1.5MeV/u

ISAC-II SC LINAC <10MeV/u

Ground state + decay, material science

Astrophysics

Nuclear reactions and structure

# TRIUMF-ARIEL

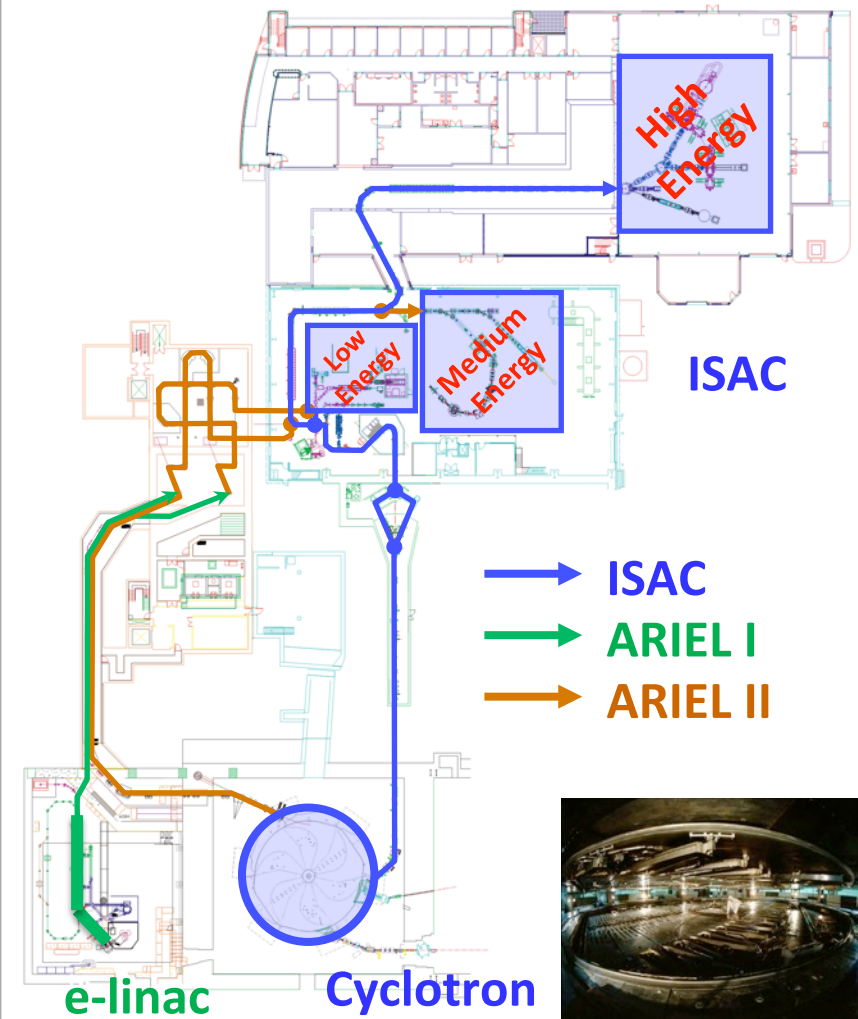
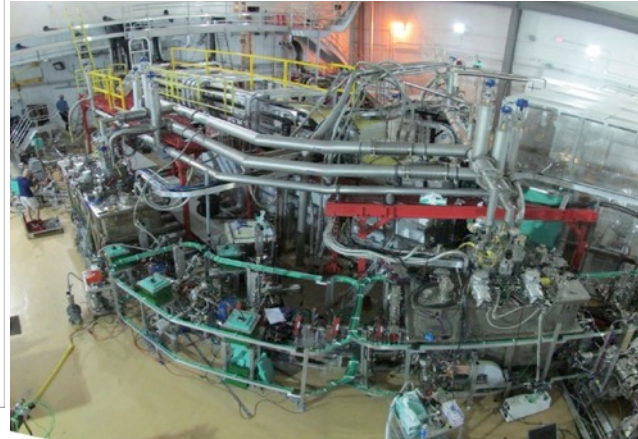
## Advanced Rare-Isotope Laboratory

*1 RIB → 3 simultaneous RIBs*

### ARIEL Project:

- new electron linac driver for photo-fission
- new proton beamline
- new target stations and front end

E-linac and electron beamline  
Sept. 2014



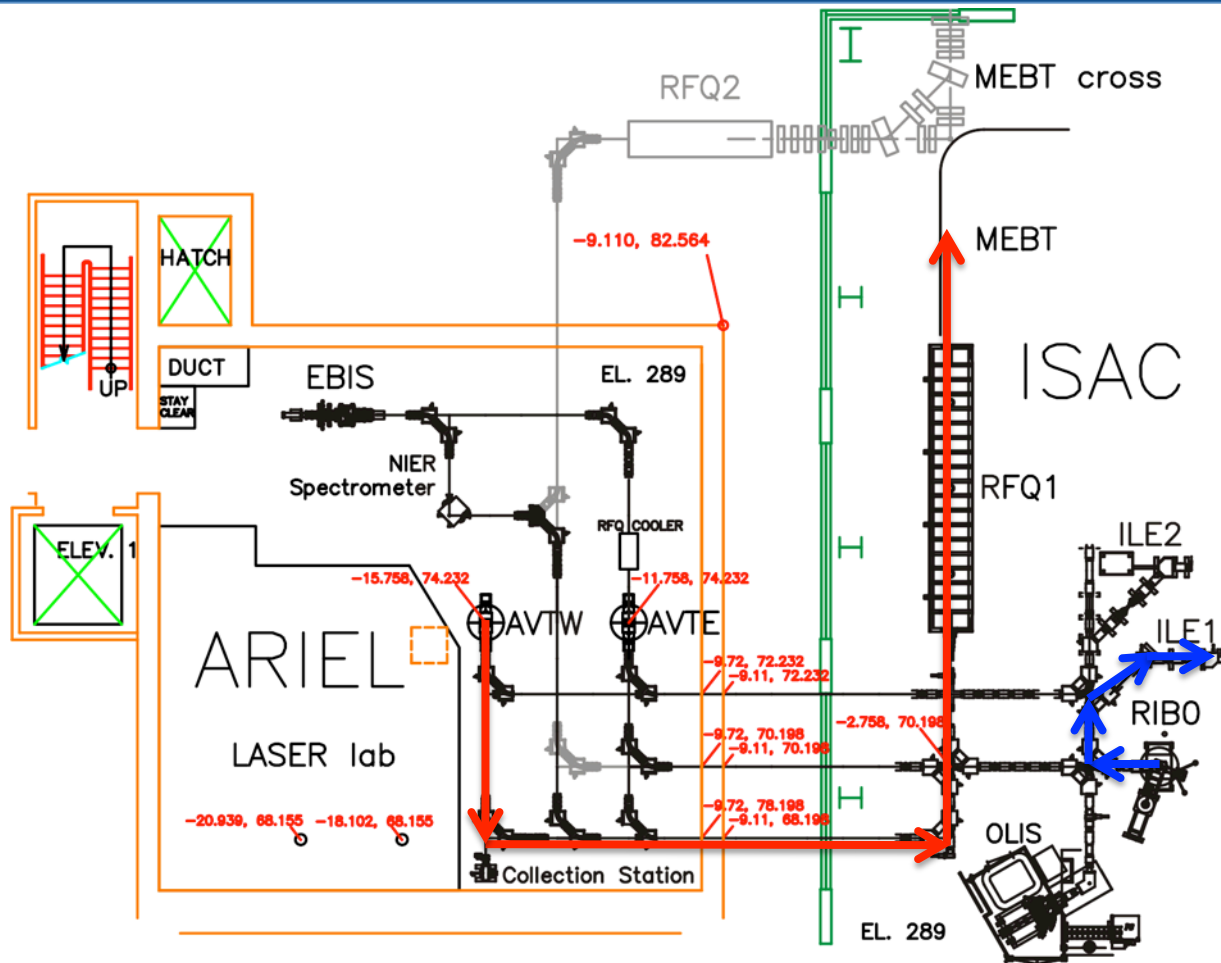
Desire to ramp up  $\beta$ -NMR from current  $\sim 6$  weeks of ISAC schedule  $\rightarrow$   $\sim 3$  months  
POLARIS project seeking funding from CFI to expand spectrometers.

Major change in ARIEL-II objectives for Phase 1 made by Change-Control Board (CCB) in August 2019.

**BeO targets will not be operated initially at AETE.**

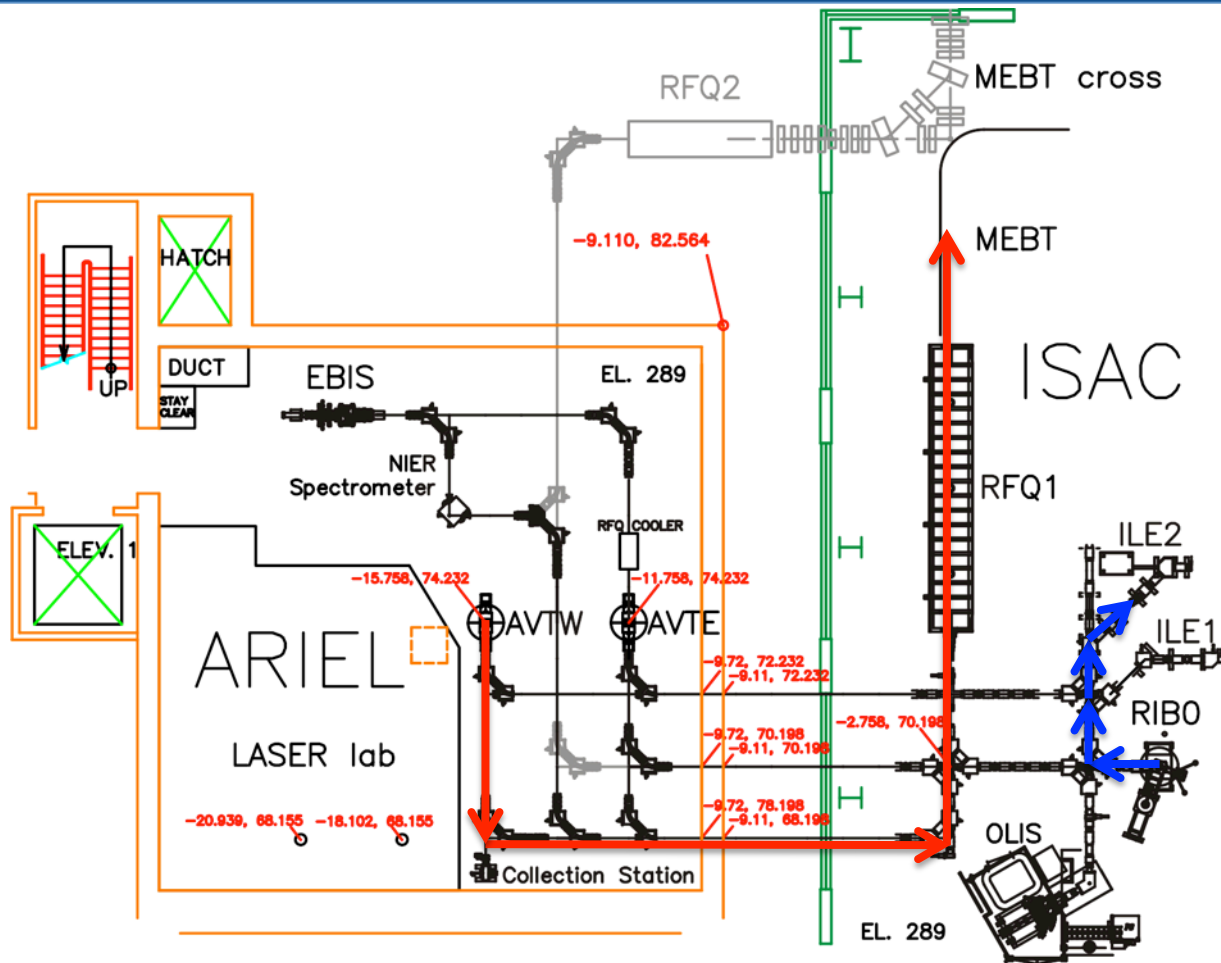
TRI-DN-19-13 - Phase 1 and BeO Targets (Document-173858)

AETE operation allows for increase  $^8\text{Li}$  beamtime delivered from ISAC target.



**ISAC – LEBT**  
GPS, GRIFFIN

**ARIEL – MEBT/SEBT**  
DRAGON, TUDA-I  
EMMA, IRIS,  
TIGRESS, TUDA-II

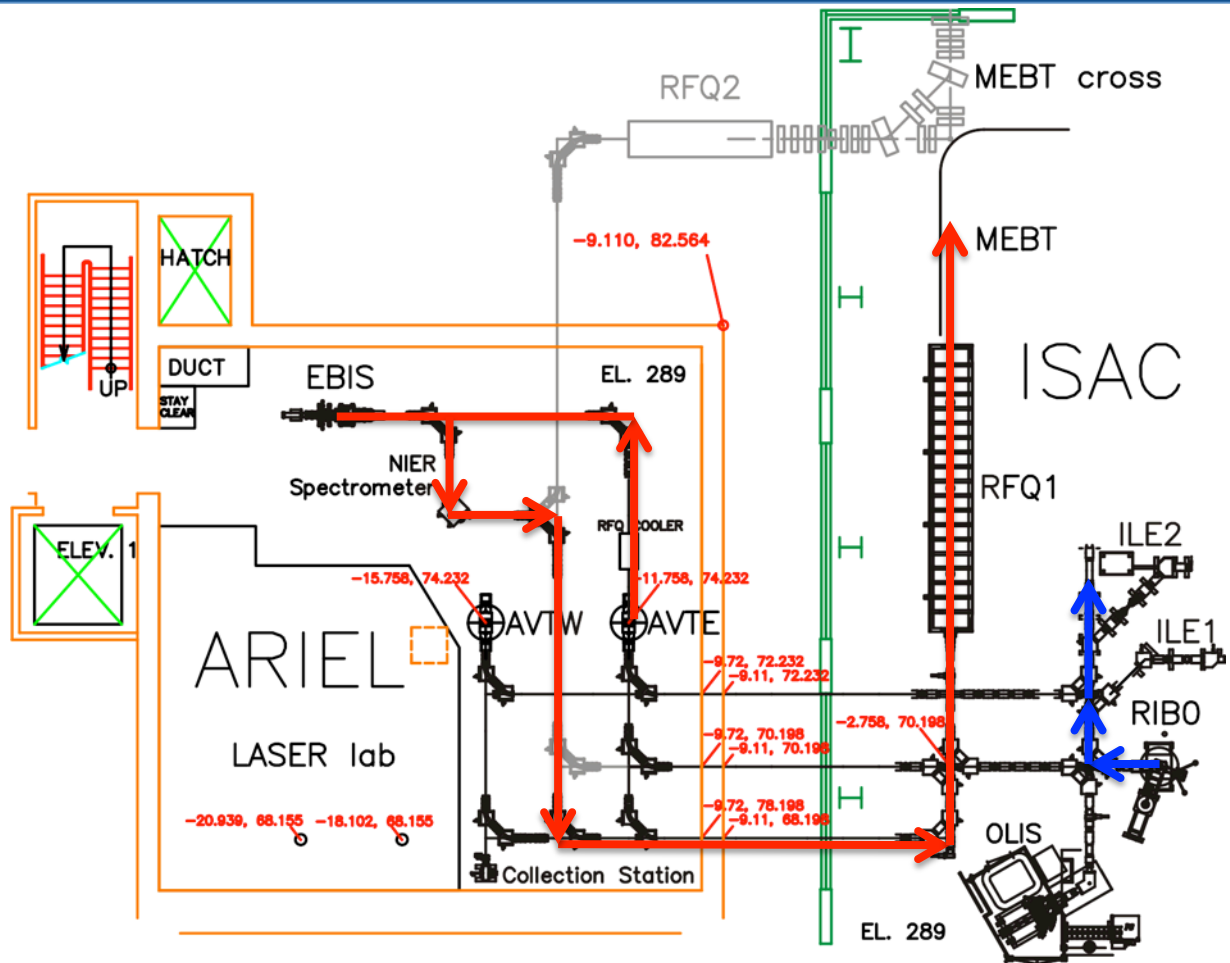


## ISAC – LEBT

TITAN, Laser Spec.,  
beta-NMR, OSAKA, MTV

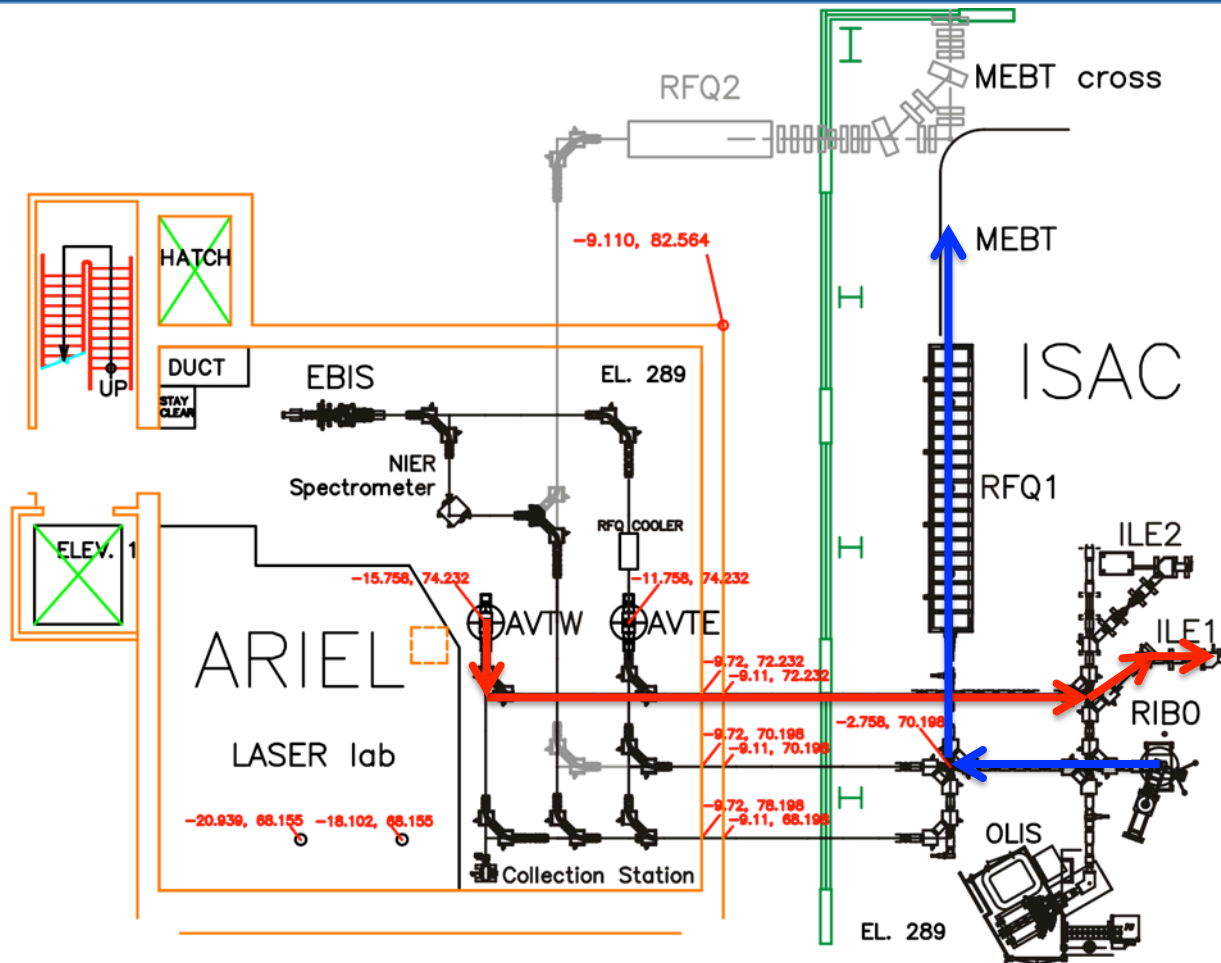
## ARIEL – MEBT/SEBT

DRAGON, TUDA-I  
EMMA, IRIS,  
TIGRESS, TUDA-II



**ISAC – LEBT**  
Francium

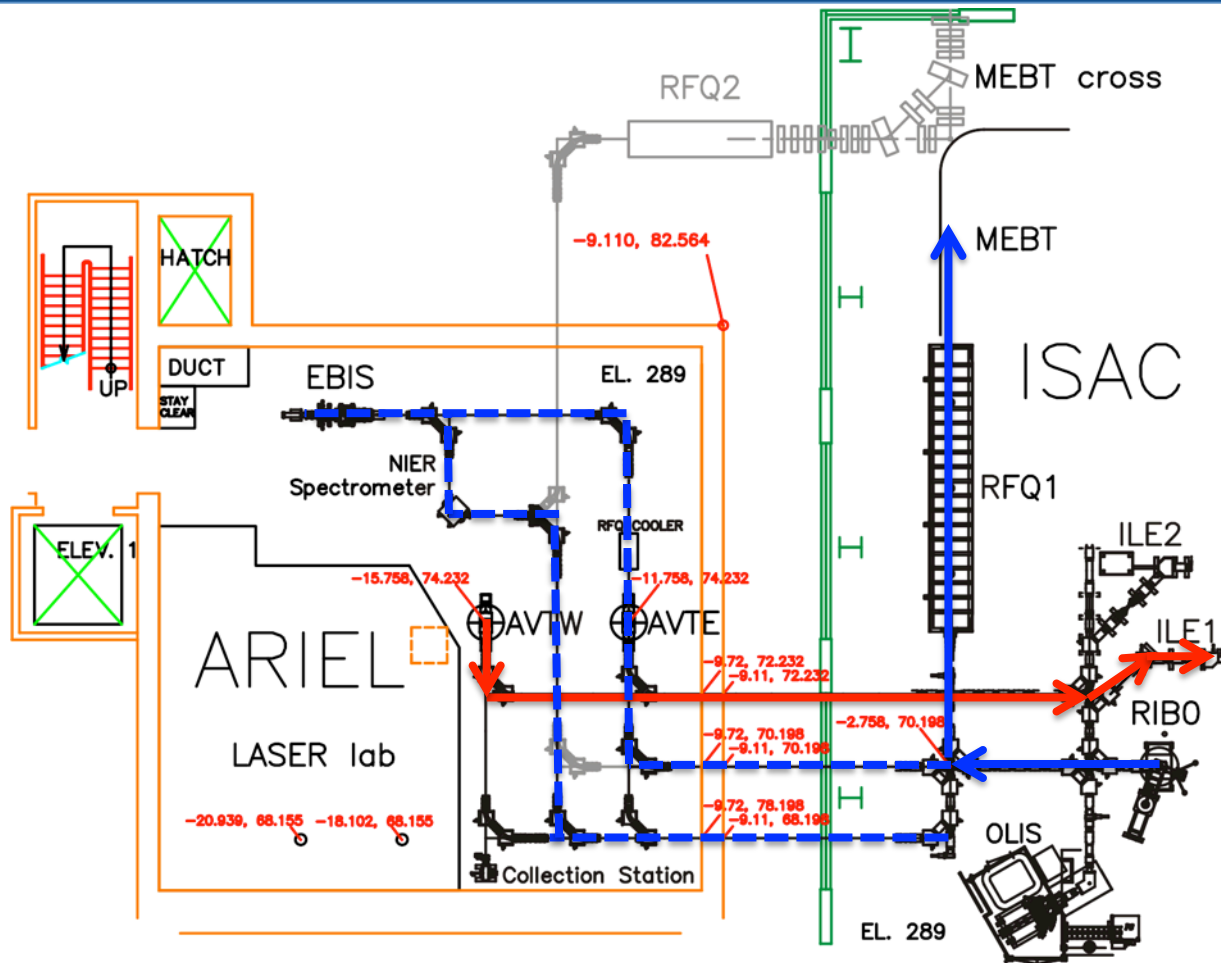
**ARIEL – MEBT/SEBT**  
DRAGON, TUDA-I  
EMMA, IRIS,  
TIGRESS, TUDA-II



**ISAC – LEBT**  
 DRAGON, TUDA-I  
 EMMA, IRIS,  
 TIGRESS, TUDA-II

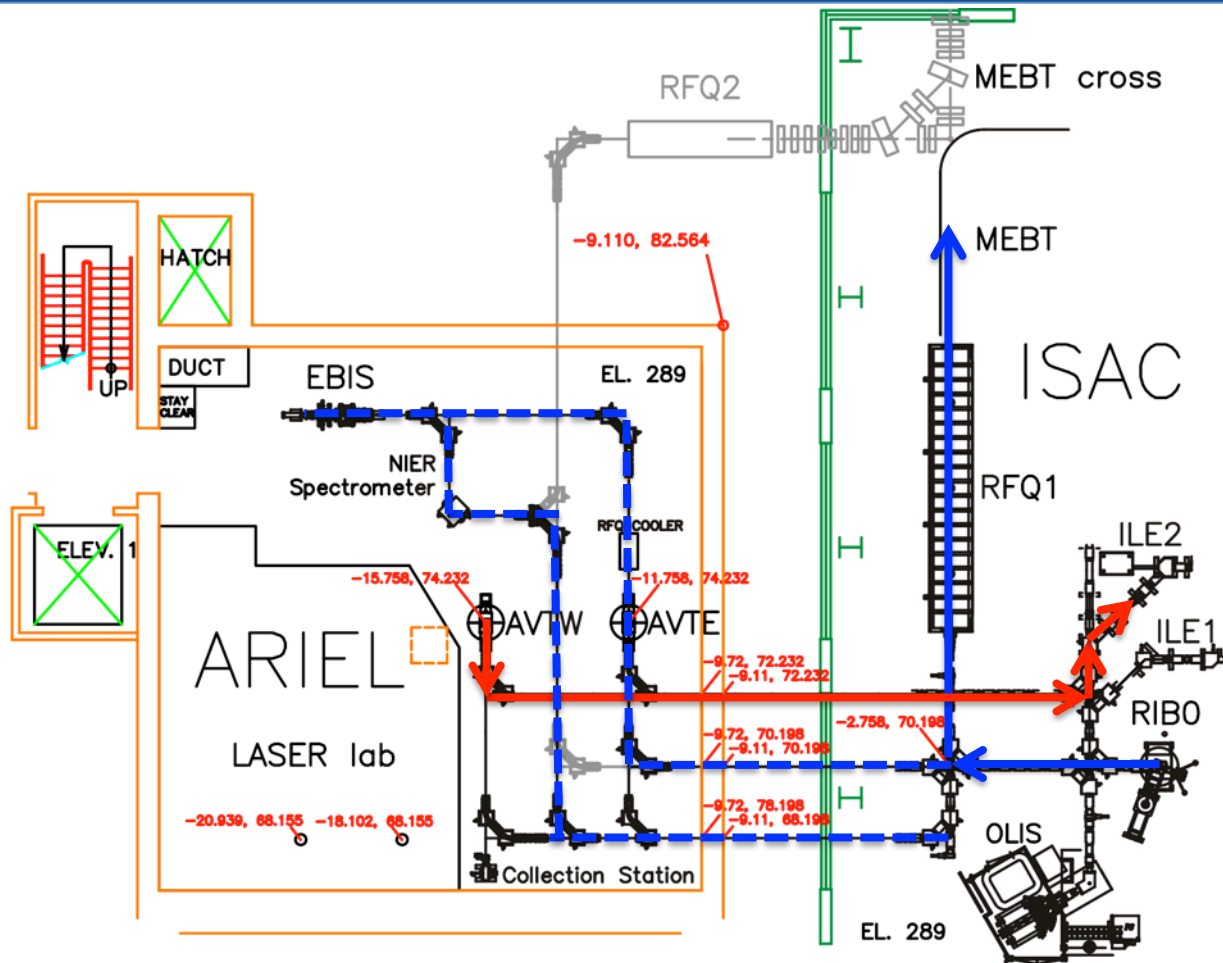
**ARIEL – LEBT**  
 GPS, GRIFFIN





**ISAC – LEBT**  
 DRAGON, TUDA-I  
 EMMA, IRIS,  
 TIGRESS, TUDA-II

**ARIEL – LEBT**  
 GPS, GRIFFIN

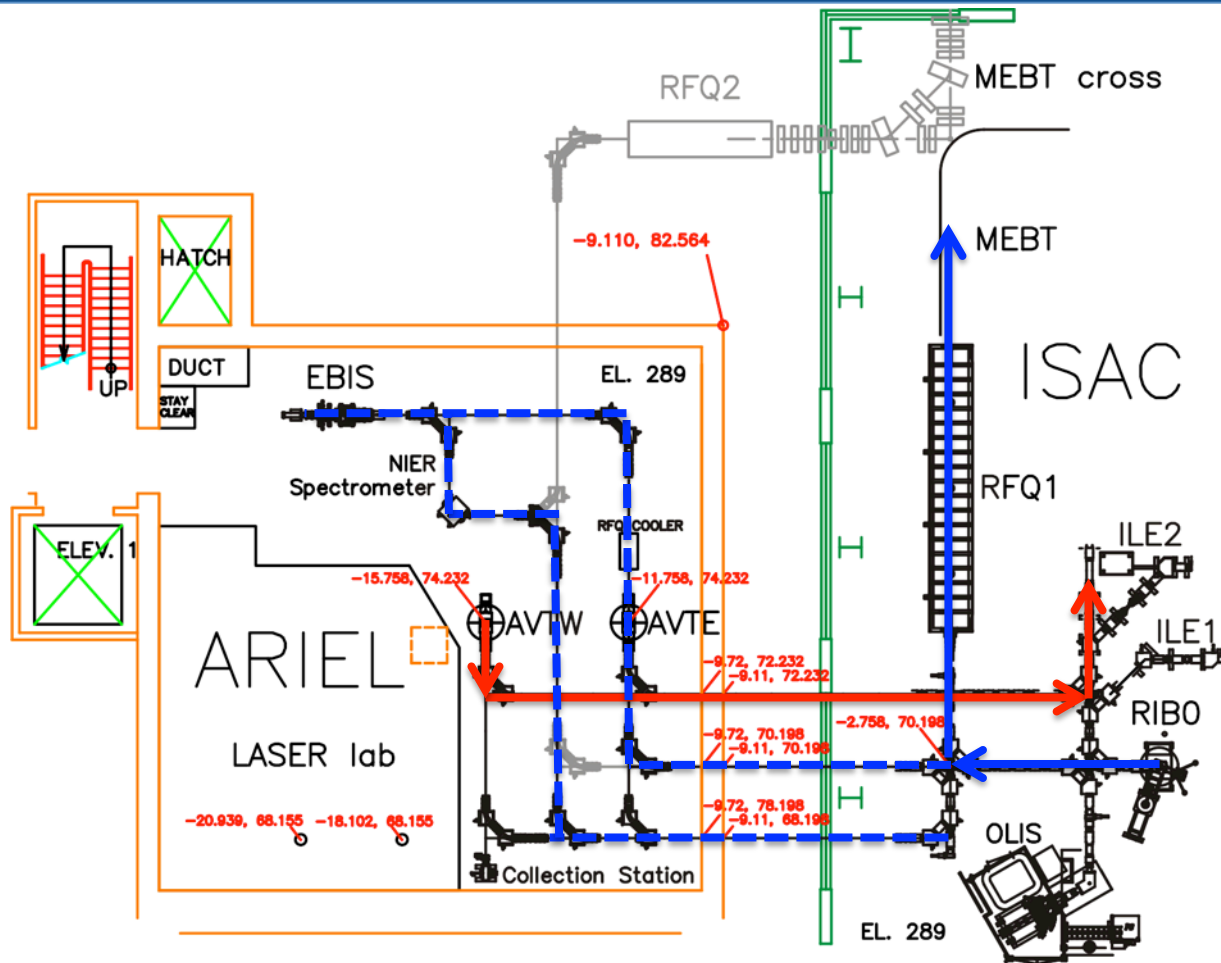


## ISAC – LEBT

DRAGON, TUDA-I  
EMMA, IRIS,  
TIGRESS, TUDA-II

## ARIEL – LEBT

TITAN, Laser Spec.,  
beta-NMR, OSAKA, MTV



**ISAC – LEBT**  
 DRAGON, TUDA-I  
 EMMA, IRIS,  
 TIGRESS, TUDA-II

**ARIEL – LEBT**  
 Francium

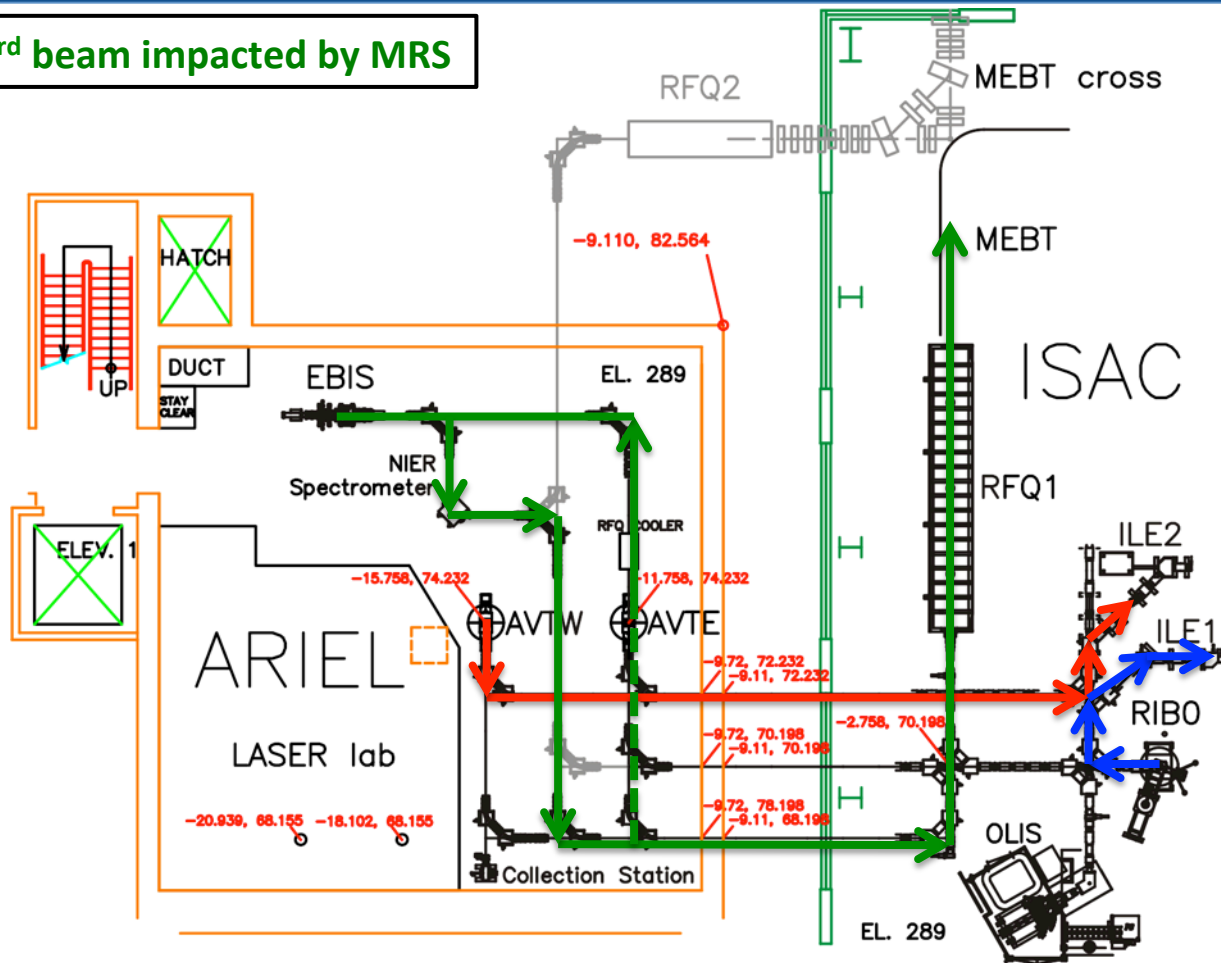
The lack of a second RFQ+DTL path limits beam delivery to only one accelerated beam to ME and HE areas at a time.

With this in mind, there are many options to deliver 2 beams simultaneously. Either [accelerated + LE], or [two LE].

Effectively doubles yearly beamtime to each of these two areas.

The primary constraint in LE area is that [TITAN, Laser Spec., beta-NMR, OSAKA, MTV] share a common beam path.

3<sup>rd</sup> beam impacted by MRS

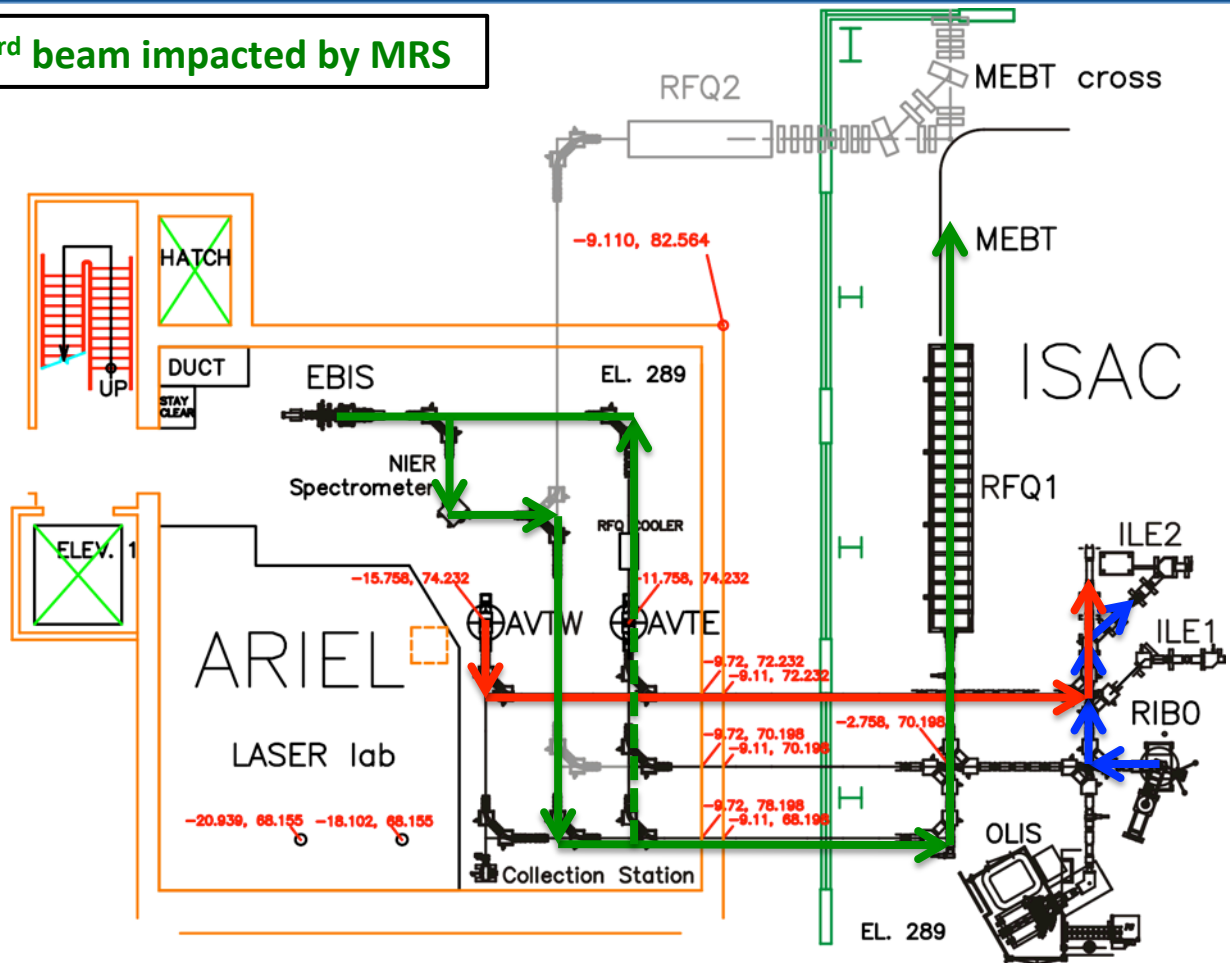


**ISAC – LEBT**  
GPS, GRIFFIN

**ARIEL – LEBT**  
TITAN, Laser Spec.,  
beta-NMR, OSAKA, MTV

**ARIEL – MEBT/SEBT**  
DRAGON, TUDA-I  
EMMA, IRIS,  
TIGRESS, TUDA-II

3<sup>rd</sup> beam impacted by MRS

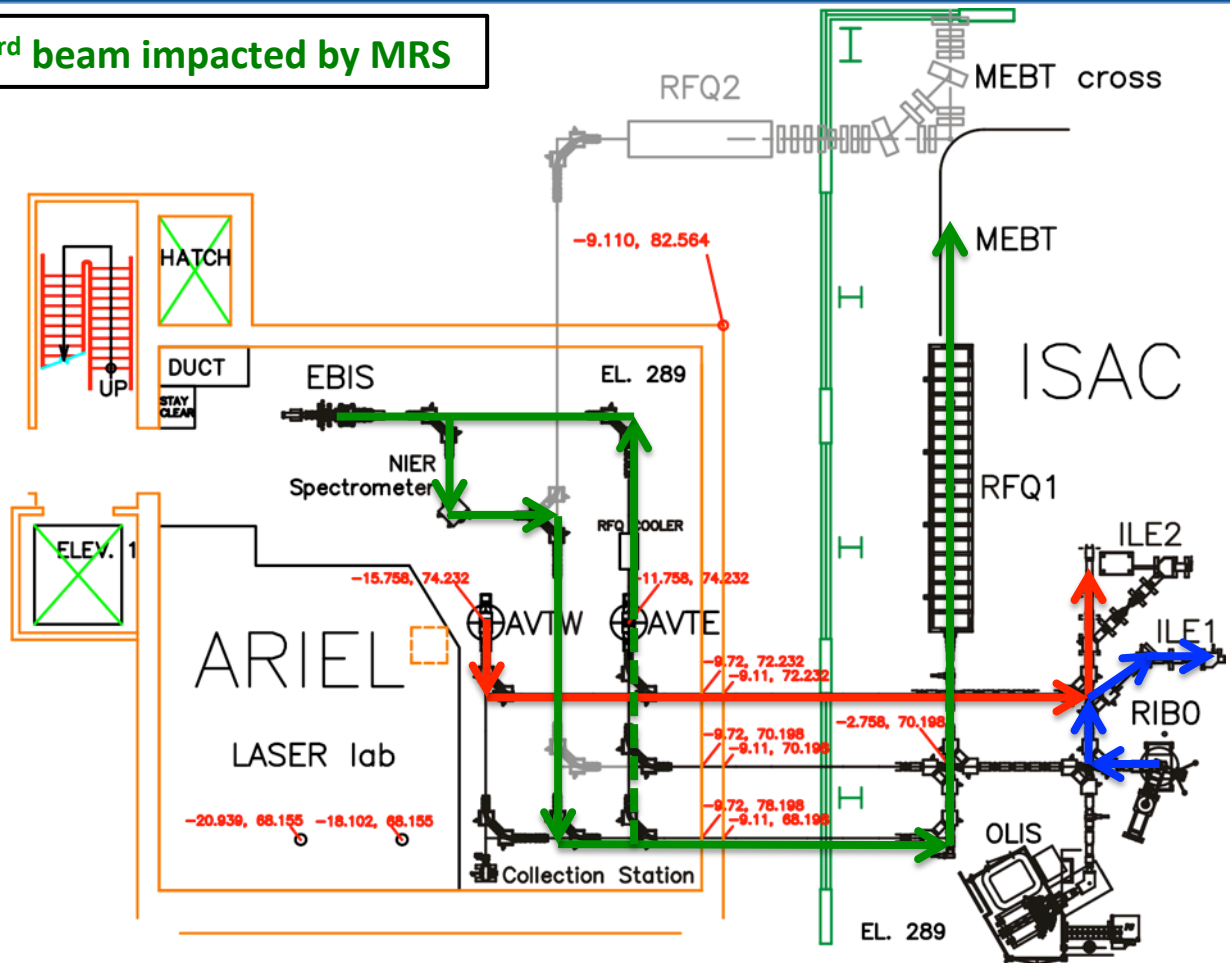


**ISAC – LEBT**  
 TITAN, Laser Spec.,  
 beta-NMR, OSAKA, MTV

**ARIEL – MEBT/SEBT**  
 Francium

**ARIEL – MEBT/SEBT**  
 DRAGON, TUDA-I  
 EMMA, IRIS,  
 TIGRESS, TUDA-II

3<sup>rd</sup> beam impacted by MRS

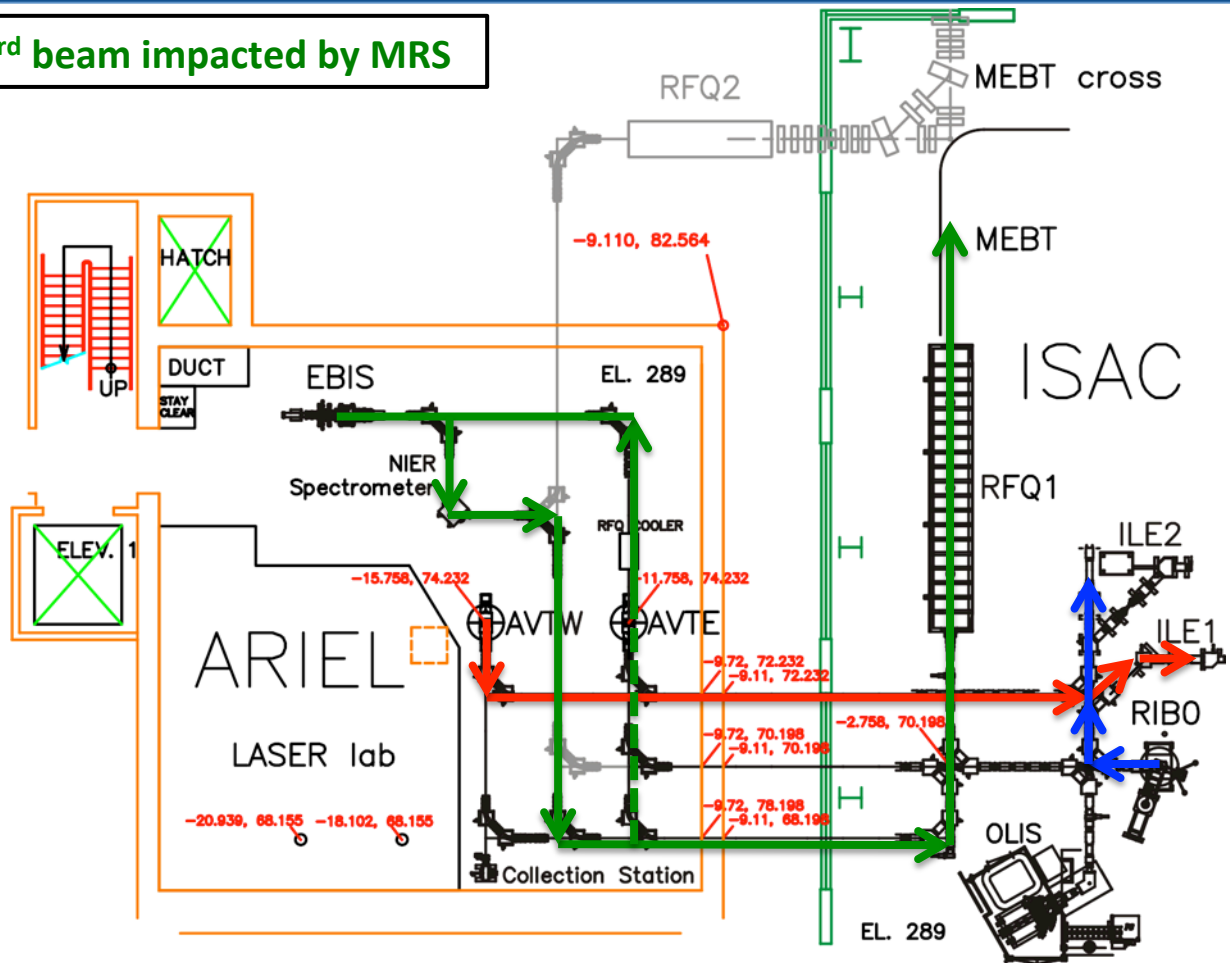


**ISAC – LEBT**  
GPS, GRIFFIN

**ARIEL – LEBT**  
Francium

**ARIEL – MEBT/SEBT**  
DRAGON, TUDA-I  
EMMA, IRIS,  
TIGRESS, TUDA-II

3<sup>rd</sup> beam impacted by MRS



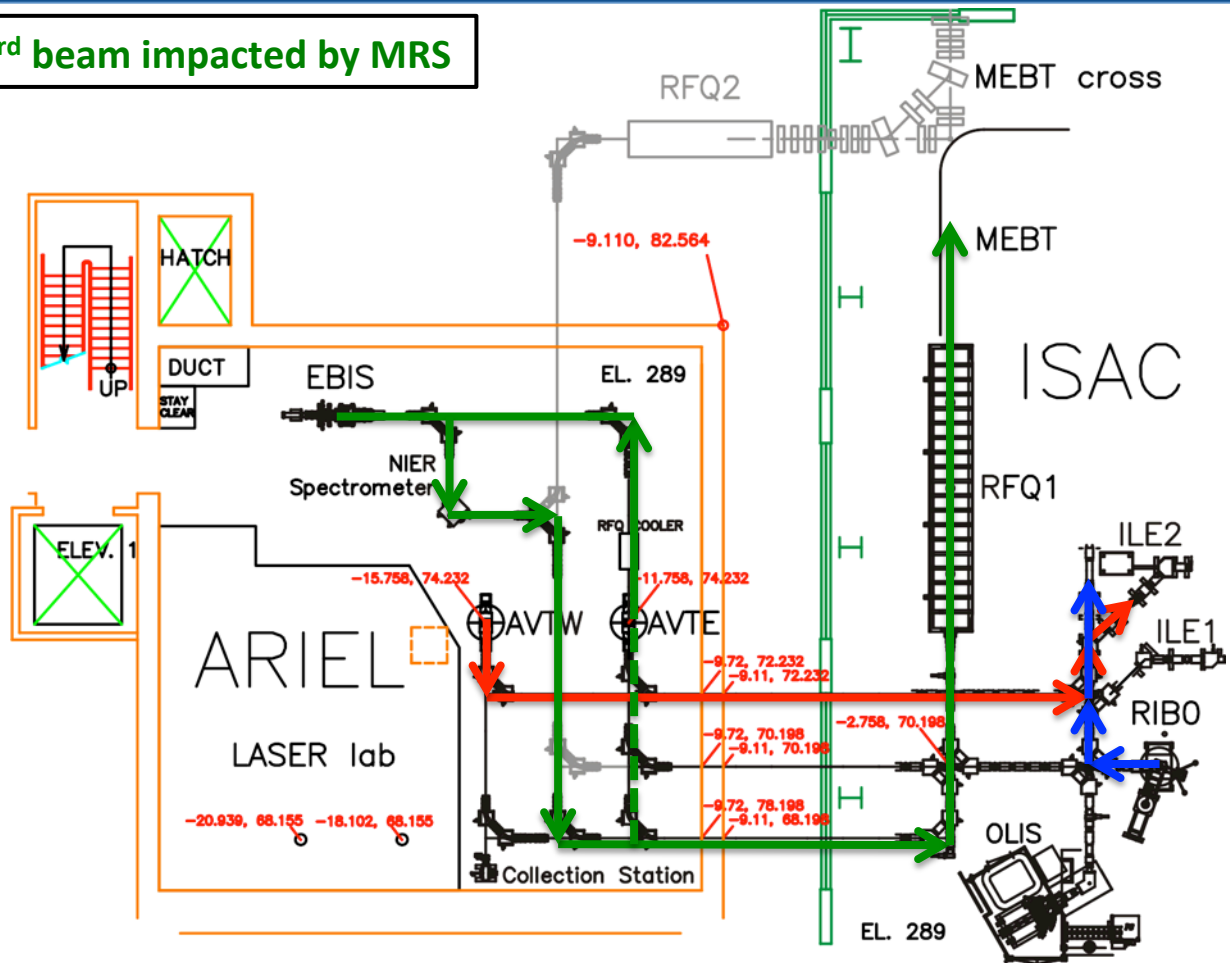
**ISAC – LEBT**  
Francium

**ARIEL – LEBT**  
GPS, GRIFFIN

**ARIEL – MEBT/SEBT**  
DRAGON, TUDA-I  
EMMA, IRIS,  
TIGRESS, TUDA-II



3<sup>rd</sup> beam impacted by MRS



**ISAC – LEBT**  
Francium

**ARIEL – LEBT**  
TITAN, Laser Spec.,  
beta-NMR, OSAKA, MTV

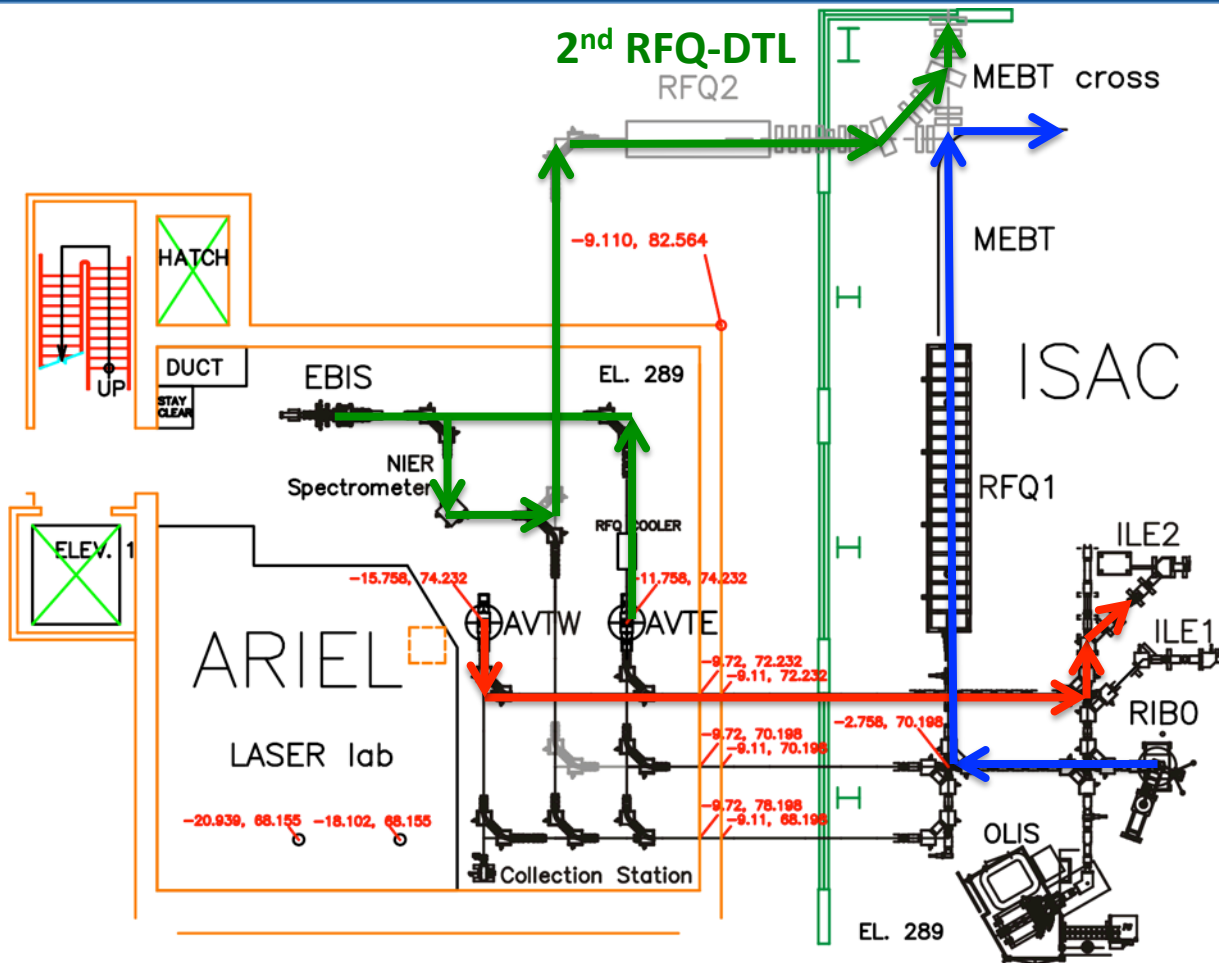
**ARIEL – MEBT/SEBT**  
DRAGON, TUDA-I  
EMMA, IRIS,  
TIGRESS, TUDA-II

The lack of a second RFQ+DTL path limits beam delivery to only one accelerated beam to ME and HE areas.

Many options to deliver 2 beams simultaneously. Either accelerated + LE, or two LE.

Only one ARIEL beam can be delivered into LE area at a time.

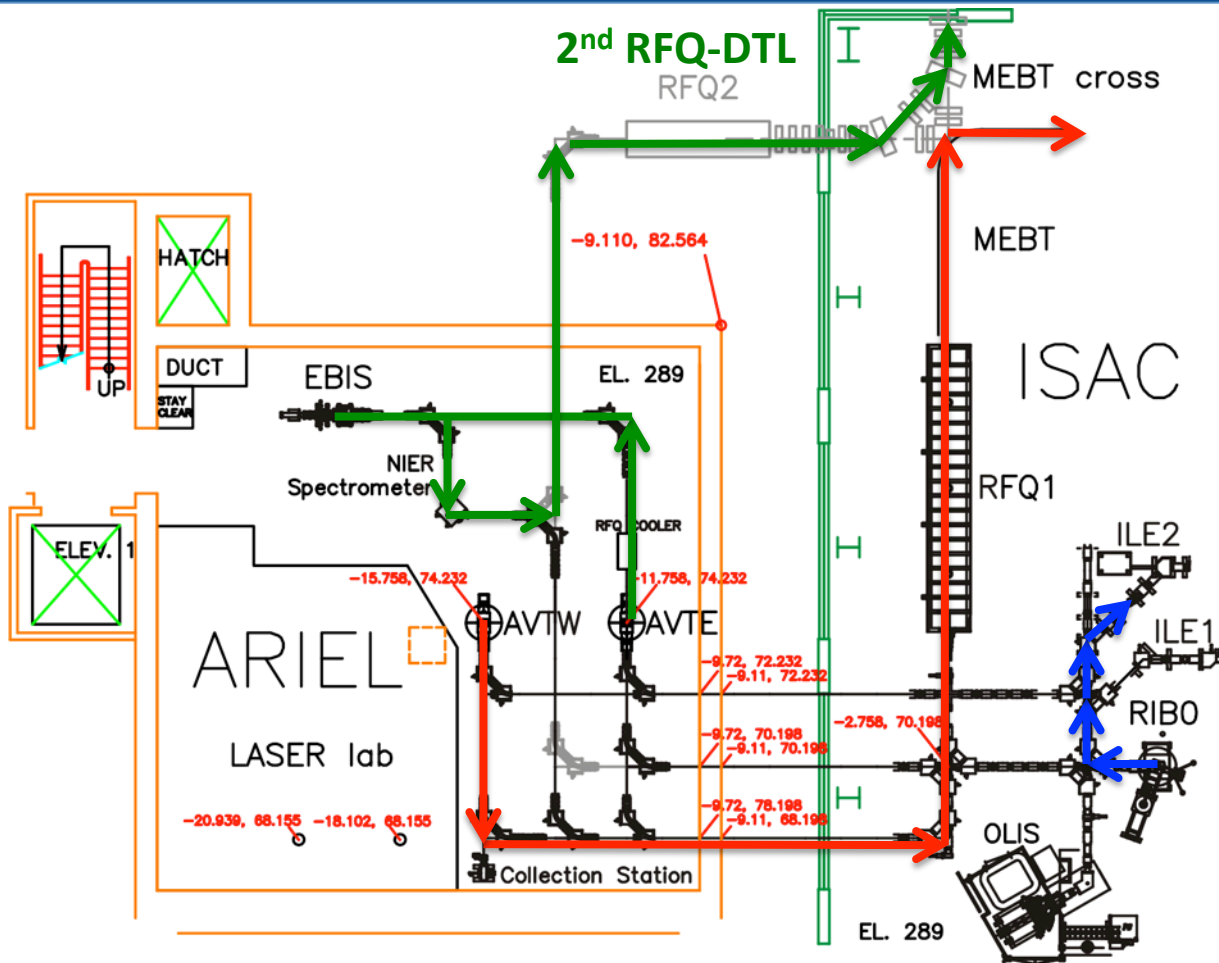
The lack of an MRS limits the options dramatically for 3 simultaneous beams. (Only  $^8\text{Li}$  from APTW can tolerate a pre-separator-only selection.)



**ISAC – MEBT**  
 DRAGON, TUDA-I

**ARIEL – LEBT**  
 TITAN, Laser Spec.,  
 beta-NMR, OSAKA, MTV

**ARIEL – SEBT**  
 EMMA, IRIS,  
 TIGRESS, TUDA-II



## ISAC – LEBT

TITAN, Laser Spec.,  
beta-NMR, OSAKA, MTV

## ARIEL – MEBT/SEBT

DRAGON, TUDA-I

## ARIEL – SEBT

EMMA, IRIS,  
TIGRESS, TUDA-II

- Two simultaneous accelerated beams only possible with 2<sup>nd</sup> accelerator chain (RFQ+DTL).
- Three simultaneous beams impacted by lack of ARIEL Medium Resolution Separator (MRS).

3000→6000 RIB hrs seems straightforward after switch on of an additional target station.

Routine 9000 RIB hrs to experiments is less obvious at this time due to constraints of beamline layouts and realistic experimental considerations.

Huge opportunity for increase in beam development activities which will benefit all experiments.



Canada's national laboratory for  
particle and nuclear physics

Laboratoire national canadien  
pour la recherche en physique  
nucléaire et en physique des  
particules

TRIUMF: Alberta | British Columbia | Calgary |  
Carleton | Guelph | McGill | Manitoba | McMaster |  
Montréal | Northern British Columbia | Queen's |  
Regina | Saint Mary's | Simon Fraser | Toronto |  
Victoria | Western | Winnipeg | York

Thank you!  
Merci!

Follow us at TRIUMFLab

