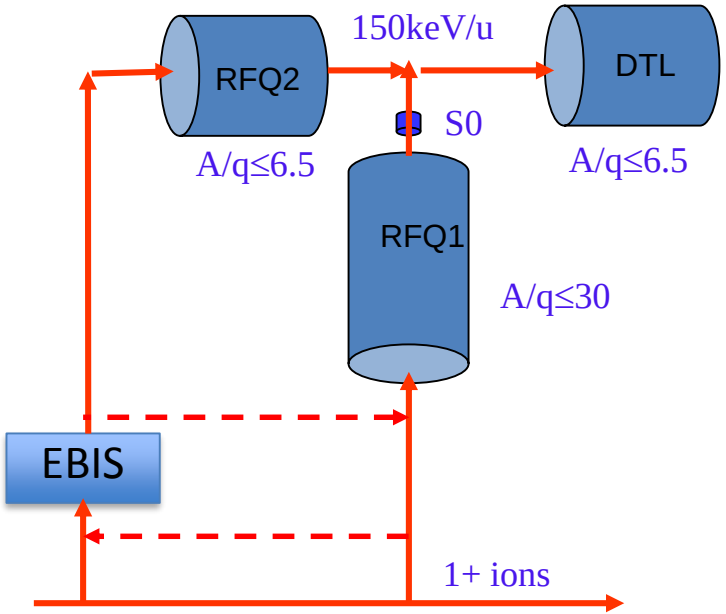
Variant 1: Add 2nd RFQ (150keV/u)

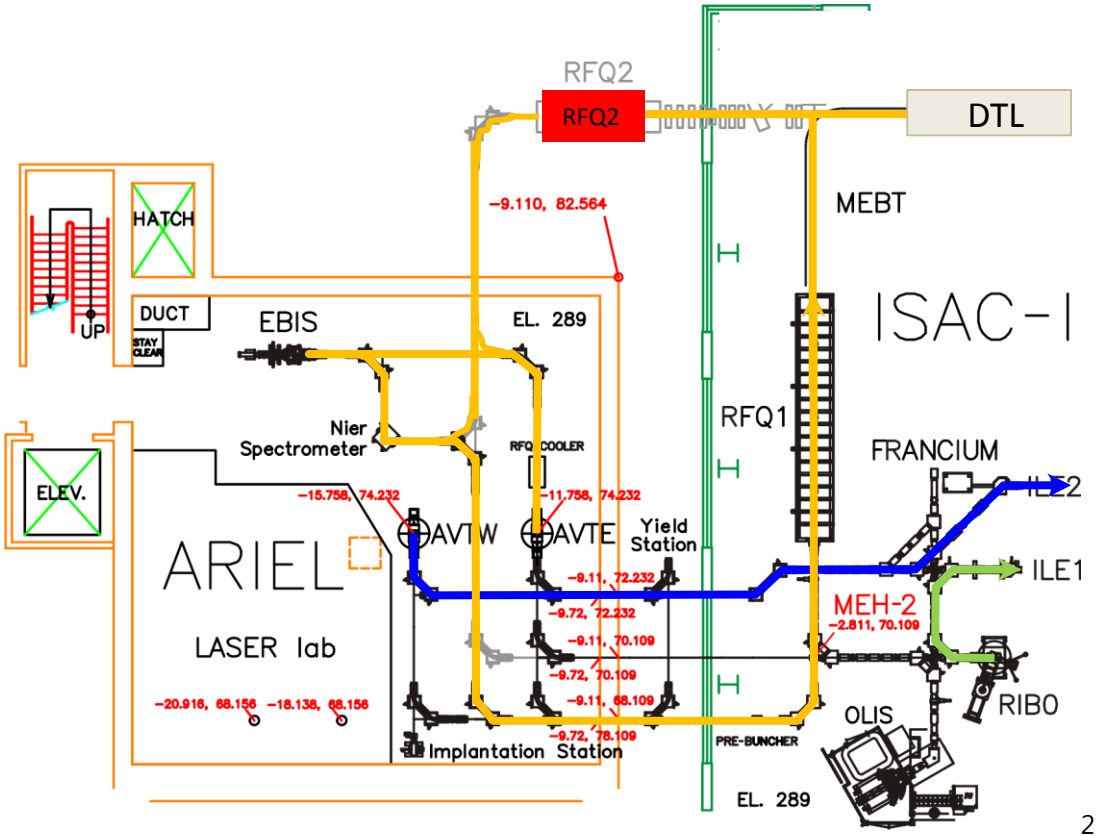
Pros for RFQ2	Cons for RFQ2
Adds redundancy to acceleration	Takes effort and RFQ1 is reliable
May design for capture >80%	But, longitudinal emittance will grow
Increase space charge threshold >10micA	Depends almost exclusively on EBIS for all masses
Helps train HQP	Needs new building

	RFQ1	RFQ2
Injection Energy (keV/u)	2.04	2.04
Extraction energy (keV/u)	153	153
capture (3 harmonic) %	80	80-100
min A	2	2
max A	30	6.5
long emit (keV/u-ns)	0.5	???
max Veff (MV)	4.53	1.06



Adding 2nd RFQ (150keV/u)

- Lacks a strong motivation without 2nd accelerator path
- RFQ1 can be injected with 1+ or EBIS beam up to A<30 so will ~match efficiency of RFQ2 for A>30 and match/better RFQ2 for 7<A<30
- RFQ2 could be designed to increase capture above 80% but this would increase longitudinal emittance – capture in DTL may be impacted plus beam quality at user
- could be designed to increase space charge threshold above 10micA (present RFQ1 limit)

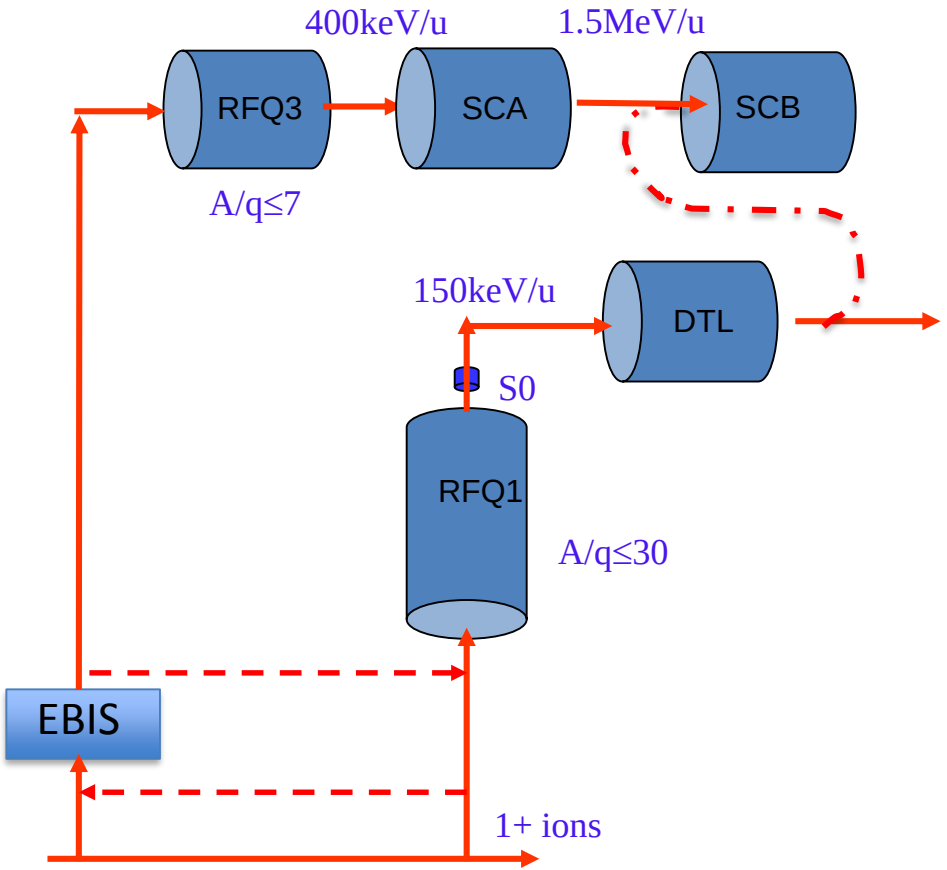


Variant 2: Add 2nd RFQ (400keV/u)

RFQ3 would inject directly into SCA low beta cryomodule at 400keV/u for 2nd accelerator path

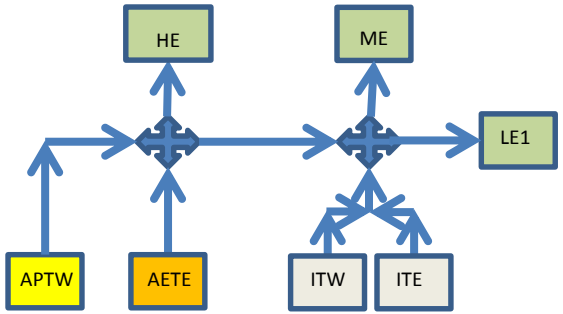
Pros for RFQ3	Cons for RFQ3
RFQ3 coupled with SCA adds 2nd accelerator path	Some loss in flexibility from initial scheme – EBIS only for 2nd path
Fits in vault, needs only modest enclosure and frees up new LE area	

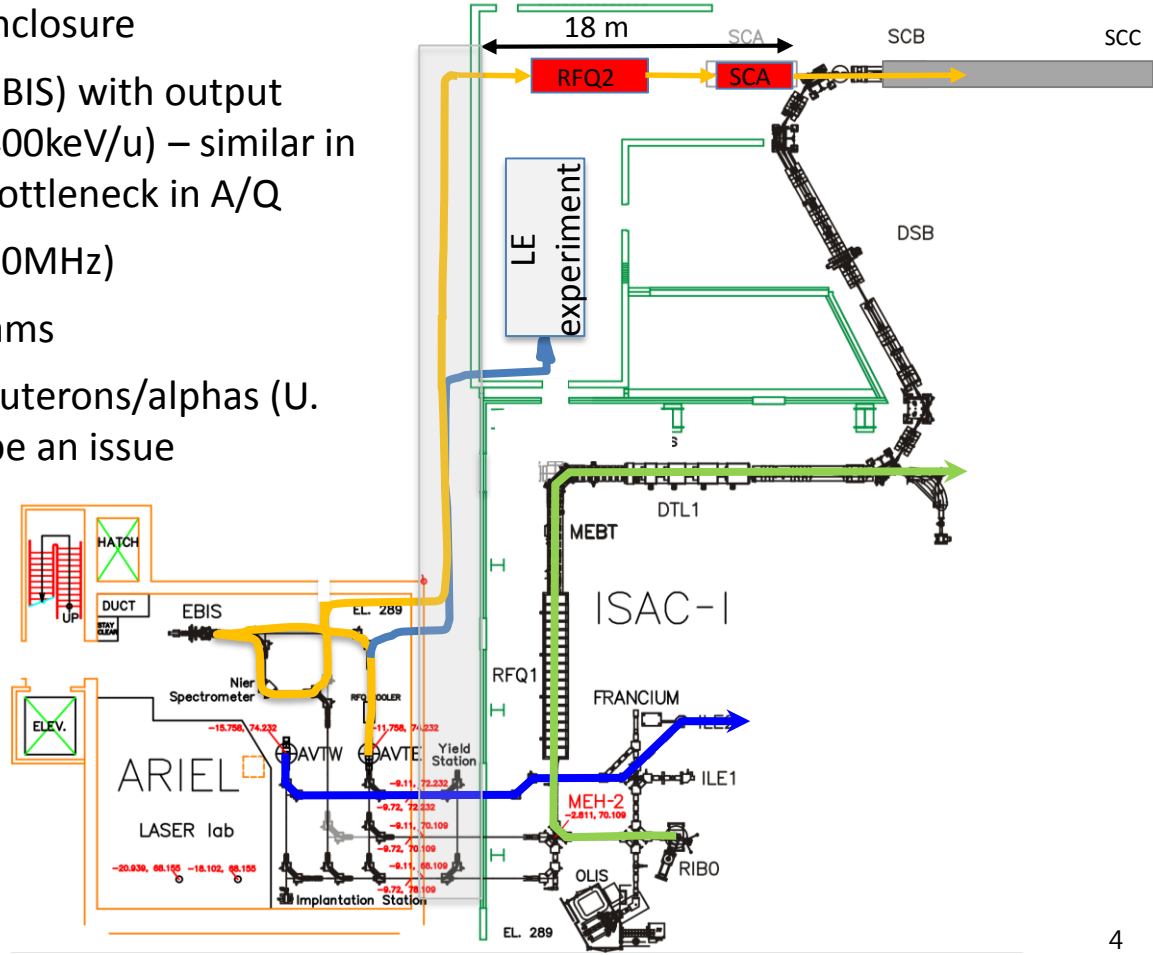
	RFQ3	SCA
Injection Energy (keV/u)	2.04	400
Extraction energy (keV/u)	400	1500
capture (3 harmonic) %	80	100
min A	2	2
max A	7	7
long emit (keV/u-ns)	~0.5	~0.5
max V_{eff} (MV)	2.8	7
Length (m)	5	3.2



Adding 2nd RFQ to 400keV/u and SCA

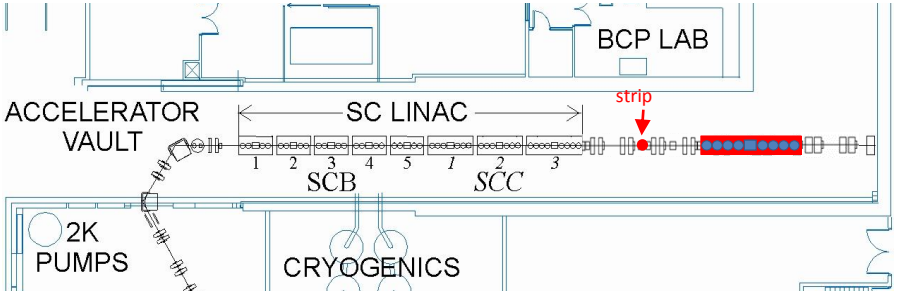
- LE beamline to new LE area – modest enclosure
- New RFQ tailored for A/Q from 2 to 7 (EBIS) with output energy compatible with SCA injection (400keV/u) – similar in size to FRIB RFQ – overcomes any DTL bottleneck in A/Q
- New "SCA" CM (7 cavities @ 4.1% and 70MHz)
- 2 independent post-accelerated RIB beams
- Could increase space charge limit for deuterons/alphas (U. Koester talk) but vault shielding would be an issue



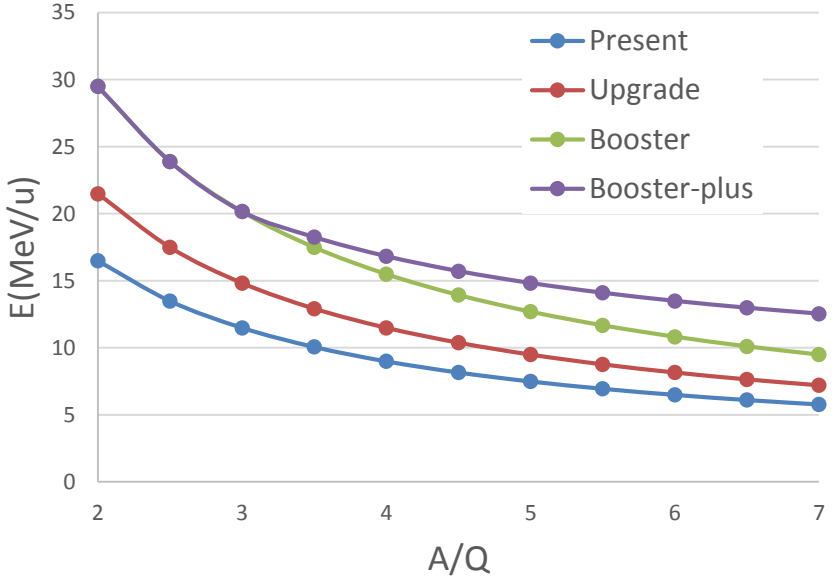


ISAC-II After-burner

- Upgrade SCB/SCC cavities by degassing and cables (Z. Yao talk)
- Add a high performing cryomodule with 8 cavities at beta=0.14 and f=106MHz
- Gain is 2MV/cavity or 16MV for the cryomodule
- Add a stripping foil between present ISAC-II and new CM to get to 2<A/q<3.5 depending on A – all masses >10MeV/u

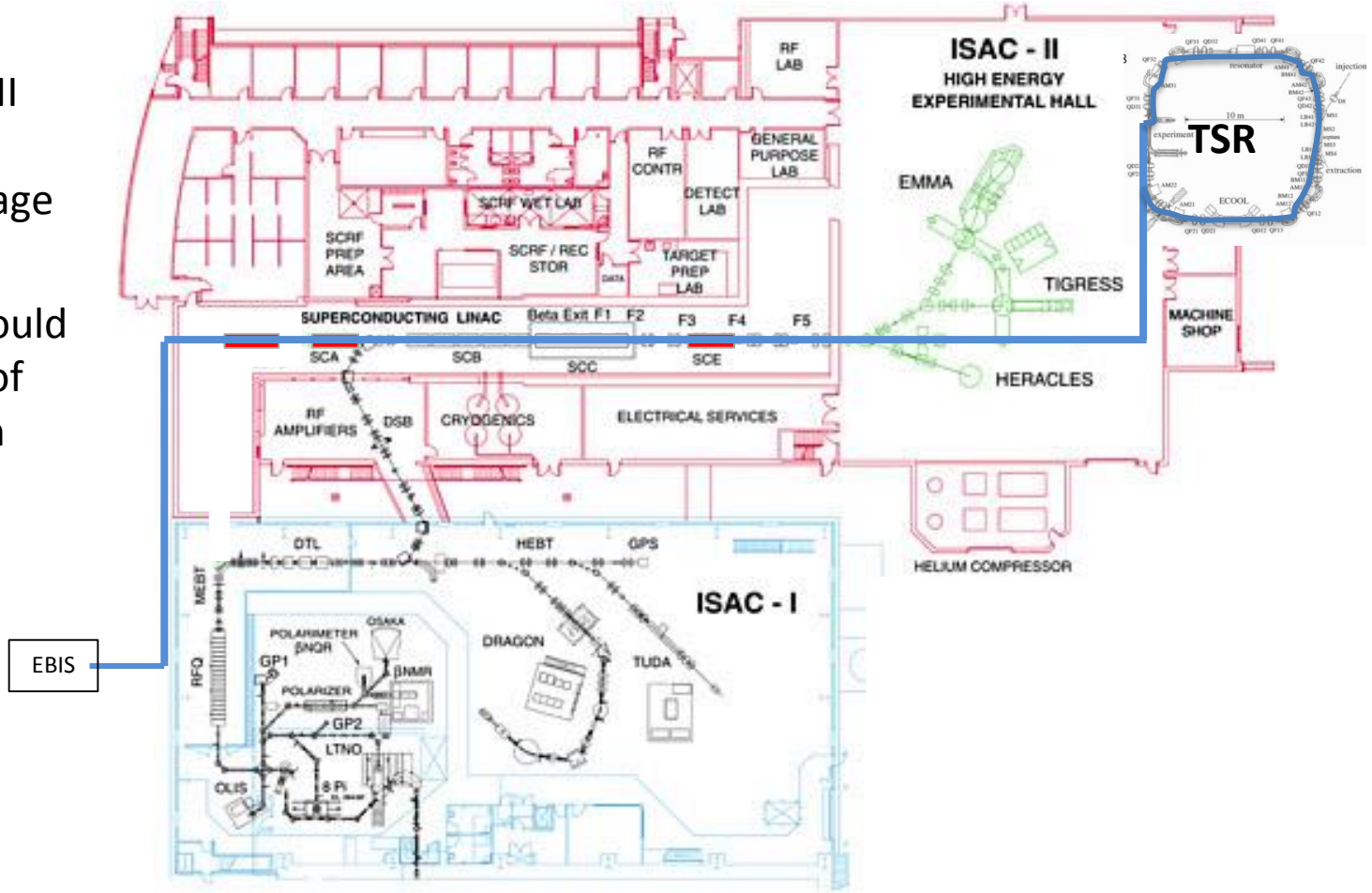


	SCD
Transmission	100
min A	2
max A	7
long emit (keV/u-ns)	~0.5
max Veff (MV)	16
Length (m)	4.2



Adding storage ring to ISAC-II

- The new 2nd line would feed ISAC-II experiments and could feed a storage ring like TSR
- Beam delivery would be independent of Dragon operation



Ring schemes in ISAC-II

Here are additional ring schemes from Oliver's 2017 Science Week presentation

1. Storage ring (TSR, CRYRING, ESR) with ISAC-II as injector
2. Storage ring – synchrotron combo to 450MeV/u, ISAC-II as injector with afterburner
3. Rapid cycling synchrotron for therapy and fragmentation – with after burner