FRIB

FRIB400

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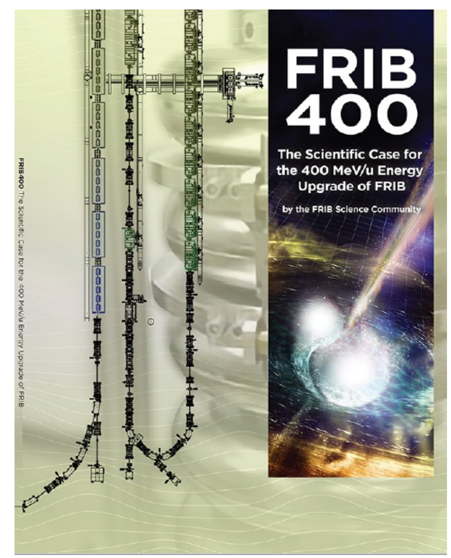
Outline

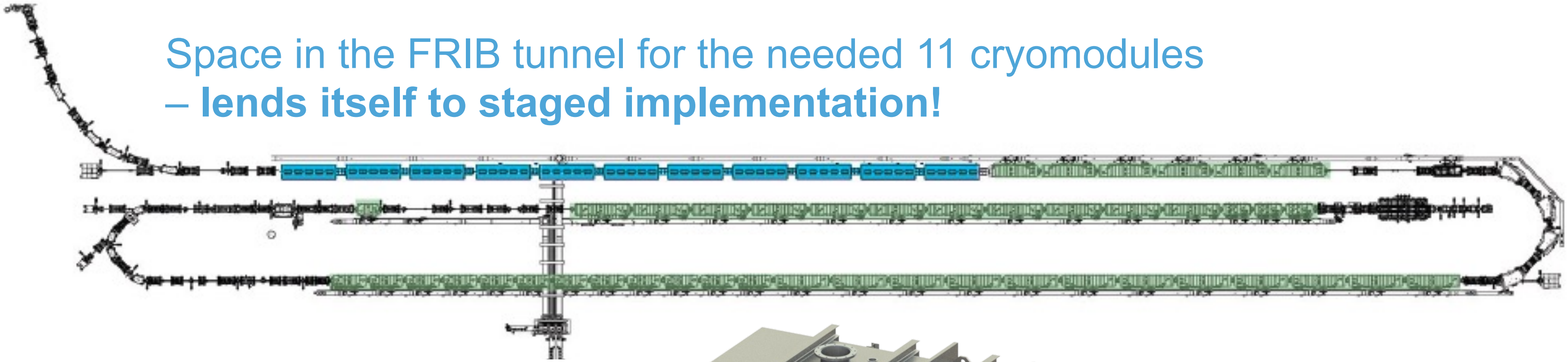
- The opportunity
- Layout and R&D status
- FRIB400 advantage – higher intensity, higher luminosity, higher purity
- Staged implementation with minimal disruption of the user program

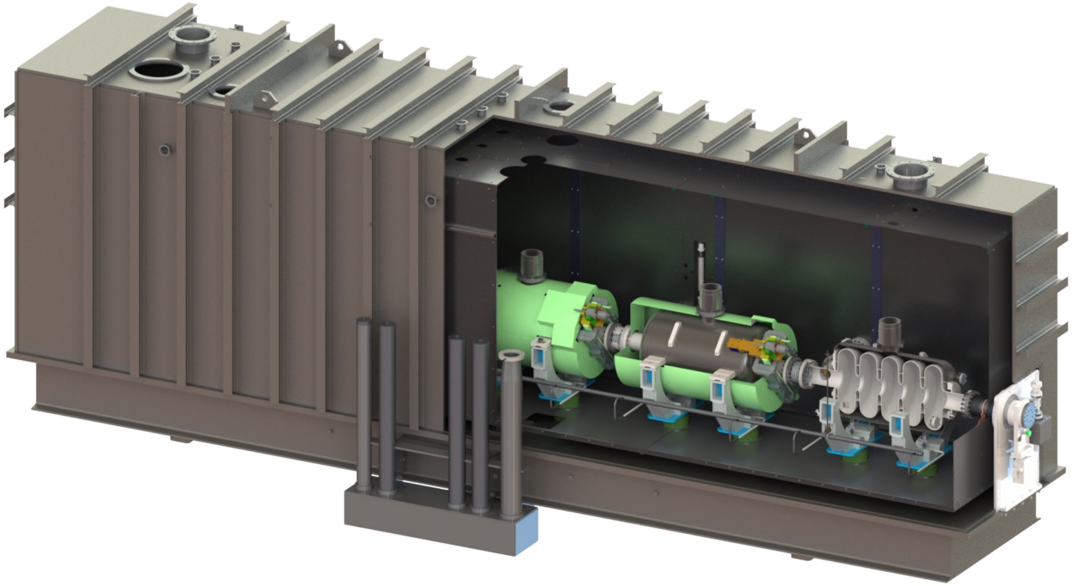
See the Whitepaper and presentations during the meeting for the science opportunities!



FRIB400 – The opportunity to upgrade to 400 MeV/u primary beam energy for U

Space in the FRIB tunnel for the needed 11 cryomodules – **lends itself to staged implementation!**





- FRIB design allows the opportunity to operate at higher primary beam energy
- 55 SC elliptical cavities (β_{OPT}=0.65, 644 MHz) in 11 cryomodules at 17.5 MV/m accelerating field will provide 400 MeV/u beam energy for U

Status of R&D for FRIB400

P. Ostroumov *et al.*

- Technology being demonstrated (see Peter's talk in Accelerator session)
  - High-Q is demonstrated with nitrogen doping and mid-T furnace baking
- Fully-dressed cavity is ready for testing
  - Titanium He vessel
  - Combined tuner includes a stepper motor and piezo element
- High power RF coupler is being developed
- Two niobium cavities were tested multiple times
- The dressed cavity is being prepared for cold testing

Preparation for cold testing

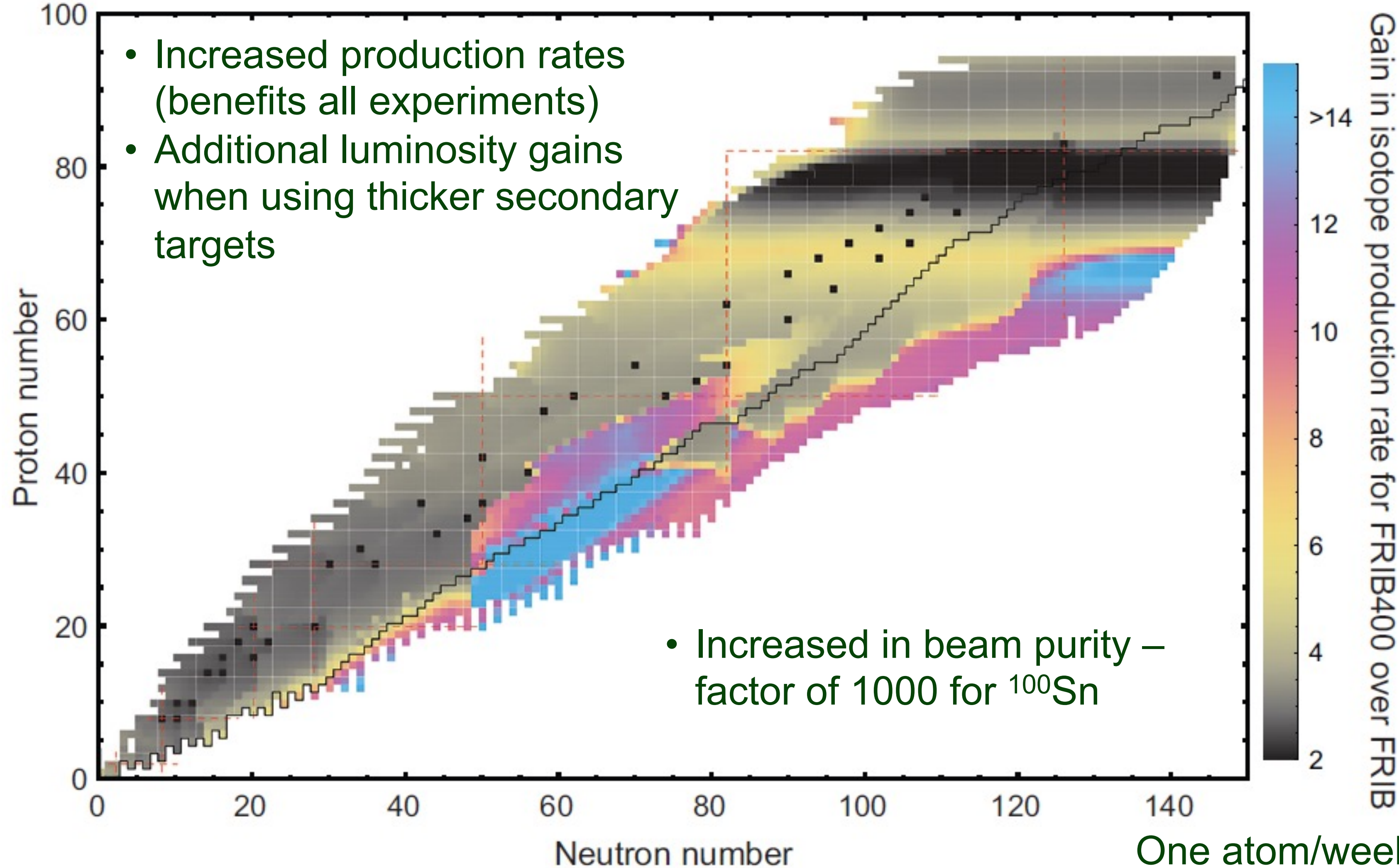
Cavity in He vessel

Bare niobium cavity

FRIB and FRIB400 beam energies

Element	Z	A	FRIB	FRIB400	Element	Z	A	FRIB	FRIB400
O	8	16	320	587	Sn	50	124	235	463
O	8	18	281	533	Xe	54	124	252	490
Ne	10	20	320	587	Xe	54	136	221	440
Ne	10	22	287	542	Sm	62	144	242	474
Ar	18	36	320	587	Dy	66	156	234	462
Ar	18	40	285	539	Er	68	162	228	452
Ca	20	40	320	587	Yb	70	168	227	450
Ca	20	48	264	506	Yb	70	176	215	430
Ni	28	58	292	551	Os	76	184	220	438
Ni	28	64	268	512	Pt	78	190	220	438
Se	34	82	255	492	Pt	78	198	206	413
Kr	36	78	284	537	Hg	80	196	216	430
Kr	36	86	257	496	Hg	80	204	206	413
Zr	40	92	248	492	Pb	82	204	209	418
Mo	42	92	276	525	Pb	82	208	205	410
Cd	48	106	268	513	Bi	83	209	207	414
Sn	50	112	265	509	U	92	238	200	400

FRIB400 advantage – higher yields, higher luminosity, higher purity

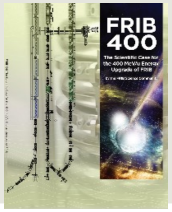


- Increased production rates (benefits all experiments)
- Additional luminosity gains when using thicker secondary targets

- Increased in beam purity – factor of 1000 for ^{100}Sn

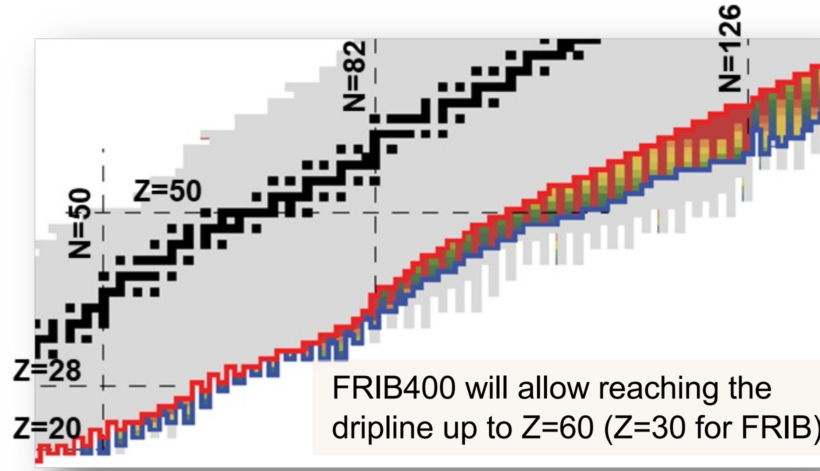
One atom/week limit

O. Tarasov



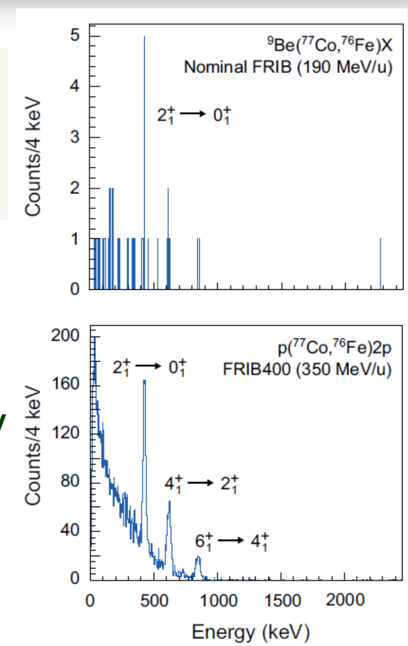
FRIB400 advantage
Examples of what it enables

- Major Science Themes:
  - Dense nuclear matter can be created and studied up to twice saturation density, critical for multi-messenger astrophysics
  - Double the reach of FRIB along the neutron dripline from Z=30 to Z=60 into a region relevant for neutron-star crusts and to allow study of extreme, neutron-rich nuclei such as ^{70}Ca
  - The emergence of neutron-star mergers as a likely site of the r-process highlights the need to study the most neutron-rich isotopes. FRIB400 will significantly extend the study of these isotopes.
  - Nuclear reactions can be performed in an energy regime of optimum nuclear transparency, improving their interpretation by reaction theory.
- FRIB400 will allow a kinematically-complete study of nuclear fission
- FRIB400 will expand the scientific impact of harvested isotopes by increasing the available yield of many isotopes by factor 10
- FRIB400 design is technically ready and can be implemented without interruption of the science program
- FRIB400 whitepaper: https://frib.msu.edu/_files/pdfs/frib400_final.pdf



FRIB400 will allow reaching the dripline up to Z=60 (Z=30 for FRIB)

FRIB400 will allow γ-ray spectroscopy with GRETA@HRS in regions out of reach at FRIB



Staged implementation possible without interrupting user operations

- Modest cost – see Thomas' plenary talk for details
- Technically ready: R&D ongoing, technology being demonstrated, prototype cavities tested, and team is in place
- Staged implementation possible during scheduled shutdowns
  - First shutdown would have to be a longer one to implement the cryo infrastructure (we will have those during the power ramp up)
  - Cryomodules can be put in one-by-one as they become ready during regular shorter maintenance shutdowns
- Every gain in energy is a gain in intensity – a benefit at every step

See the Whitepaper and presentations during the meeting for the science opportunities!