

ISAC is 20 Years Old (or is it?)

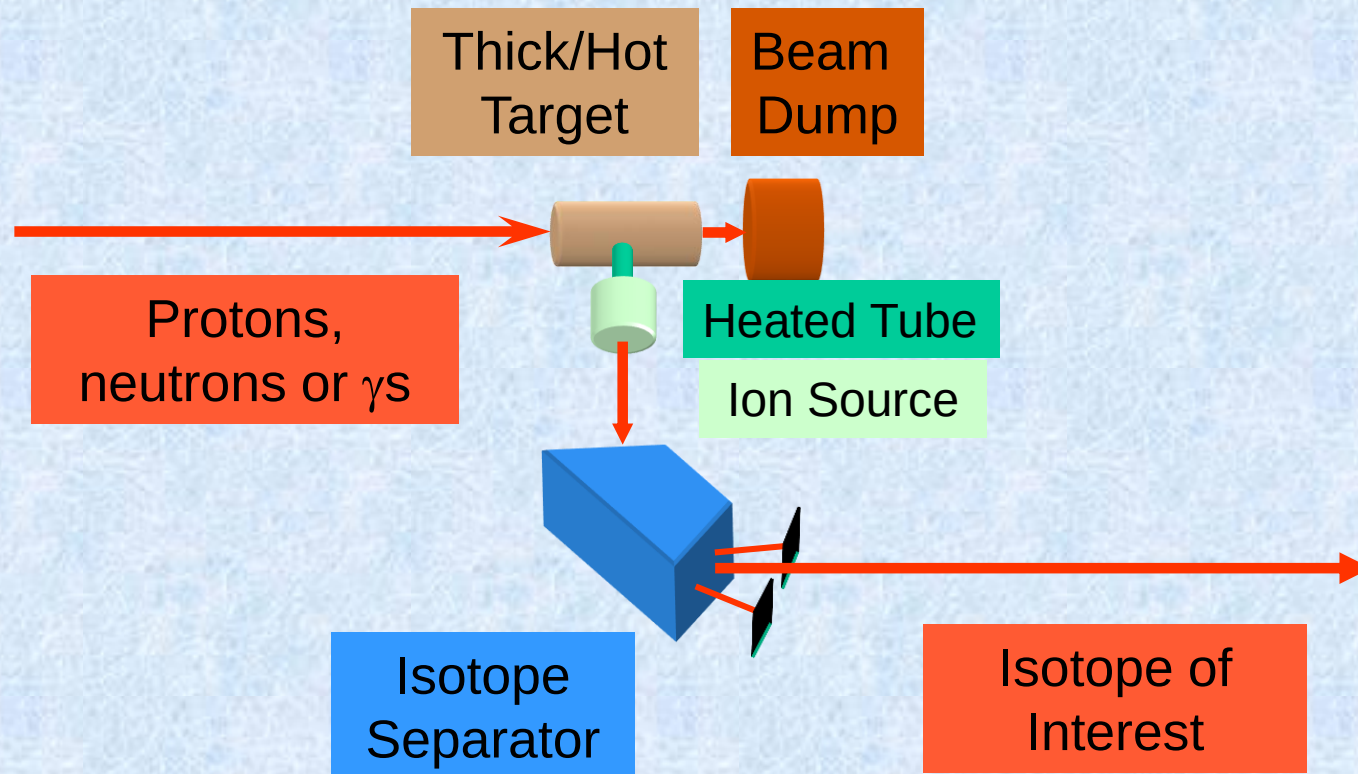
P. W. Schmor

2019 Annual TARA General Reunion
Sept 19, 2019

ISOL

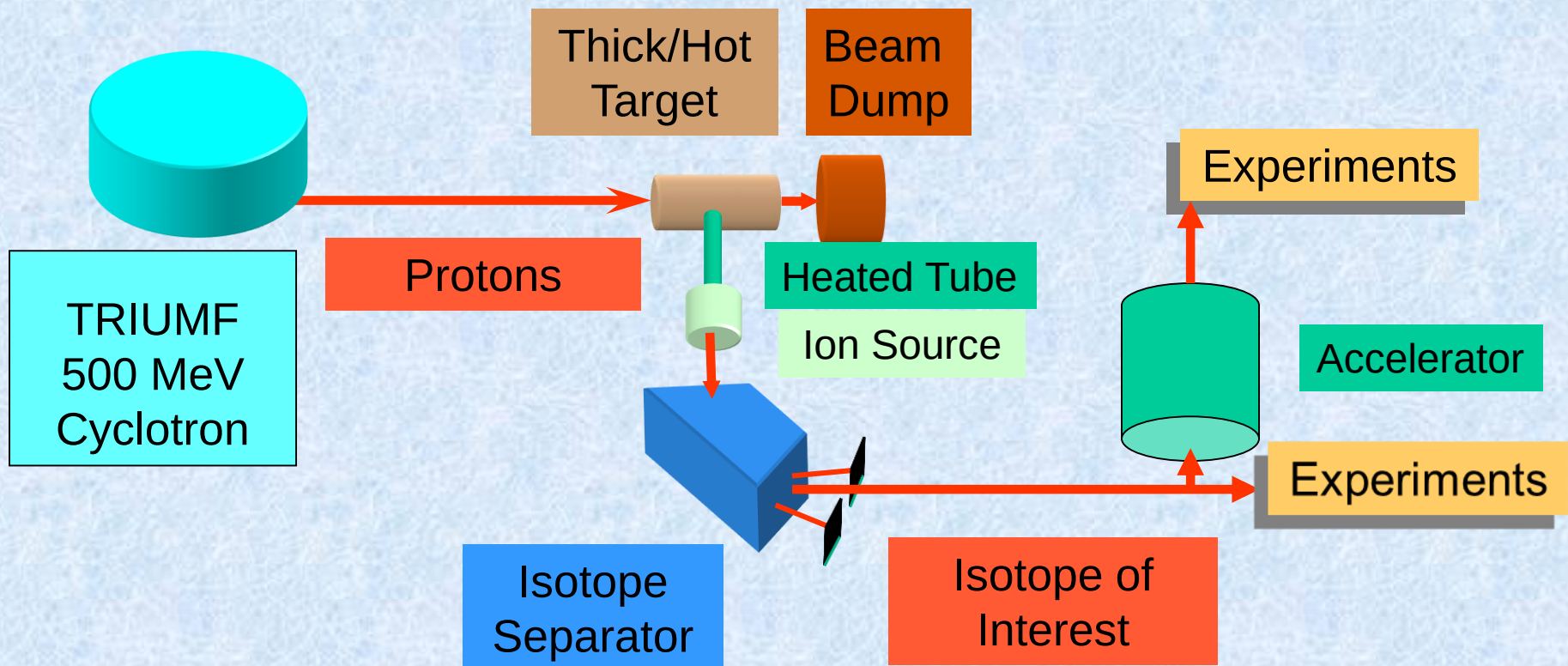
{Isotope Separation On Line}
{aka Ion Source On Line}

An Approach to Create & Study the Properties of
Short-Lived Isotopes



ISAC

{ISOL + ACcelerators}



The Proposal for a TRIUMF-ISOL Facility

June 1985

- Does not use word 'ISAC'
- Plan includes a Post Accelerator
- This proposal was basis for funding announcement in June 1995
- 34 years ago

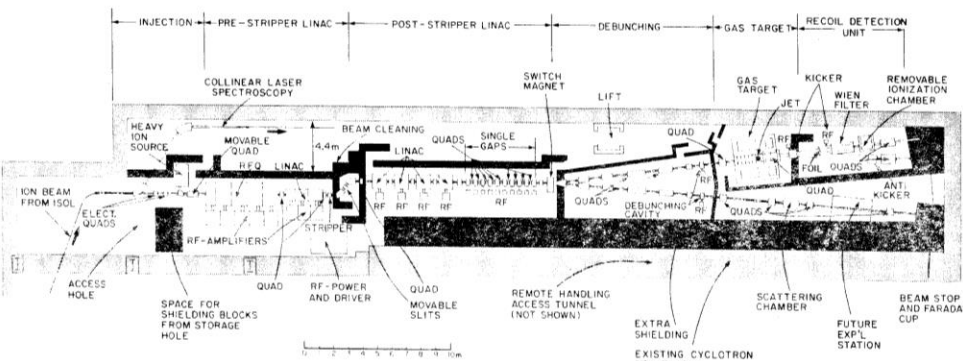


Fig. III.23. A schematic representation of a possible layout of an ISOL post-accelerator based upon suggestions of R. Klein [Kle 84].

TRIUMF



THE TRIUMF-ISOL FACILITY

A PROPOSAL FOR AN INTENSE
RADIOACTIVE BEAMS FACILITY

MESON FACILITY OF:

UNIVERSITY OF ALBERTA
SIMON FRASER UNIVERSITY
UNIVERSITY OF VICTORIA
UNIVERSITY OF BRITISH COLUMBIA

OPERATED UNDER A CONTRIBUTION FROM THE
NATIONAL RESEARCH COUNCIL OF CANADA

JUNE 1985

Proposal for TRIUMF ISOL Facility

June 1985

- Proposal presented to TRIUMF BOM
- Plan has post acceleration (ISAC lite)
 - ◆ ≤ 5 kW on Target
- Presented to NSERC for Funding
 - ◆ NSERC recommends a test ISOL as 1st step

TRIUMF

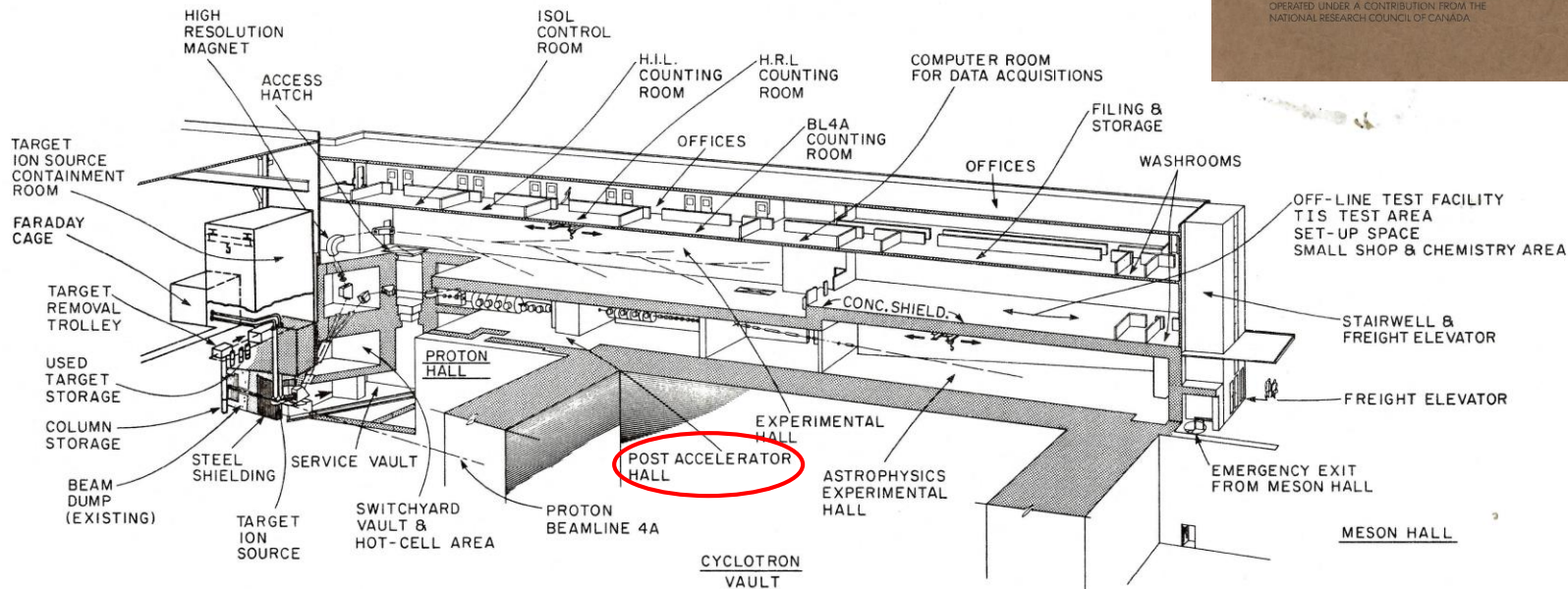


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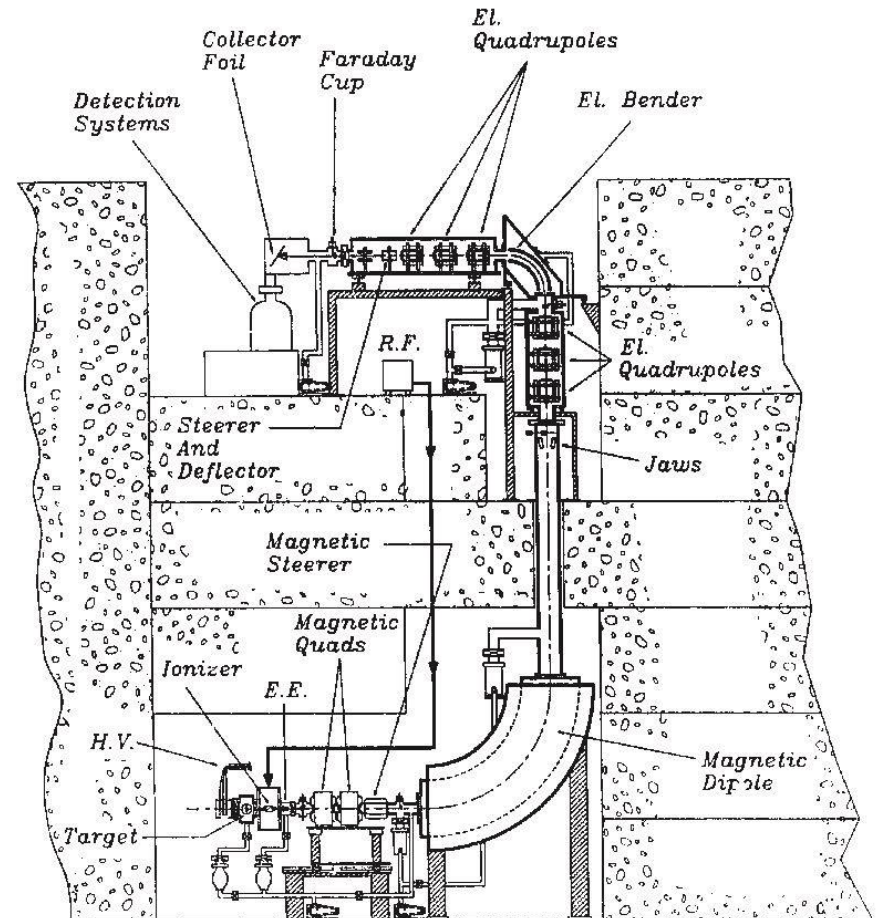
JUNE 1985



TISOL (Test ISOL)

(Power on target ≤ 0.5 kW)

- 1985 – Design of TISOL begins
- 1987 – TISOL installed at TRIUMF
 - ◆ Operates until 1999
- 1st Nuclear Astrophysics Exp at TISOL yields accurate estimates of ^{16}O production in massive stars & improves estimates for the production of heavier masses from supernova explosions



TISOL → ISAC

- 1987 – 1993 – Planning for ISAC put on Hold
 - ◆ TRIUMF develops KAON facility plan
- 1987 – 1999 – TISOL Experiments
- Oct 1993 – 5 Year funding request to Federal Government
 - ◆ \$67.5M included for ISAC in this request
- Feb 1994 – Collapse of KAON Proposal
- March 31, 1995 – Future funding of TRIUMF uncertain
 - ◆ TRIUMF operates on month by month funding approvals

Funding of ISAC

[from notes of Alan Astbury]

- A. Astbury took over as director of TRIUMF 1st April 1994.
- “We (*TRIUMF*) produced a very slim document about what TRIUMF would do for its future. It contained mostly CERN, medical things (MDS NORDION), μ SR, etc, but there was one new effort; TISOL.”
- “I (*Astbury*) spoke to this proposal in Ottawa in July 1994. Harry Swain had rounded up an audience containing eight deputy ministers”

Funding of ISAC I

[from notes of Alan Astbury]

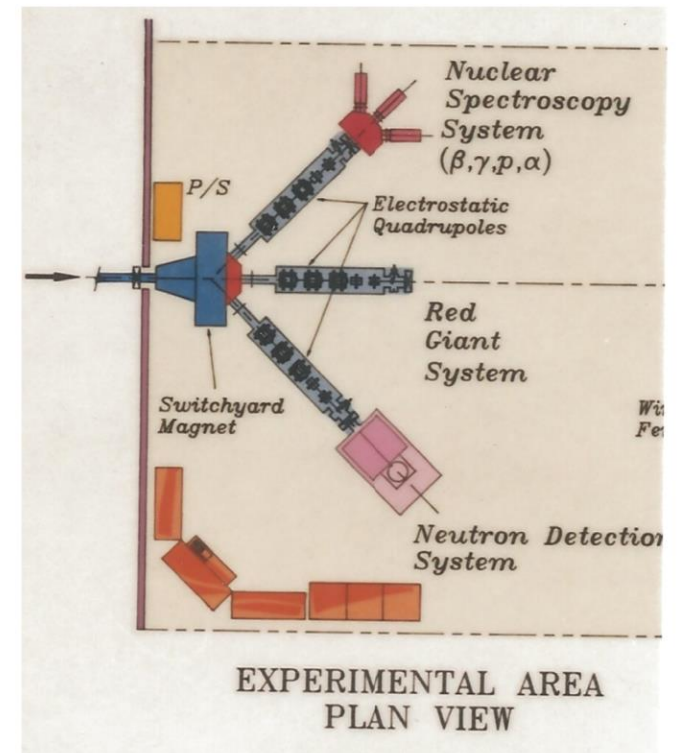
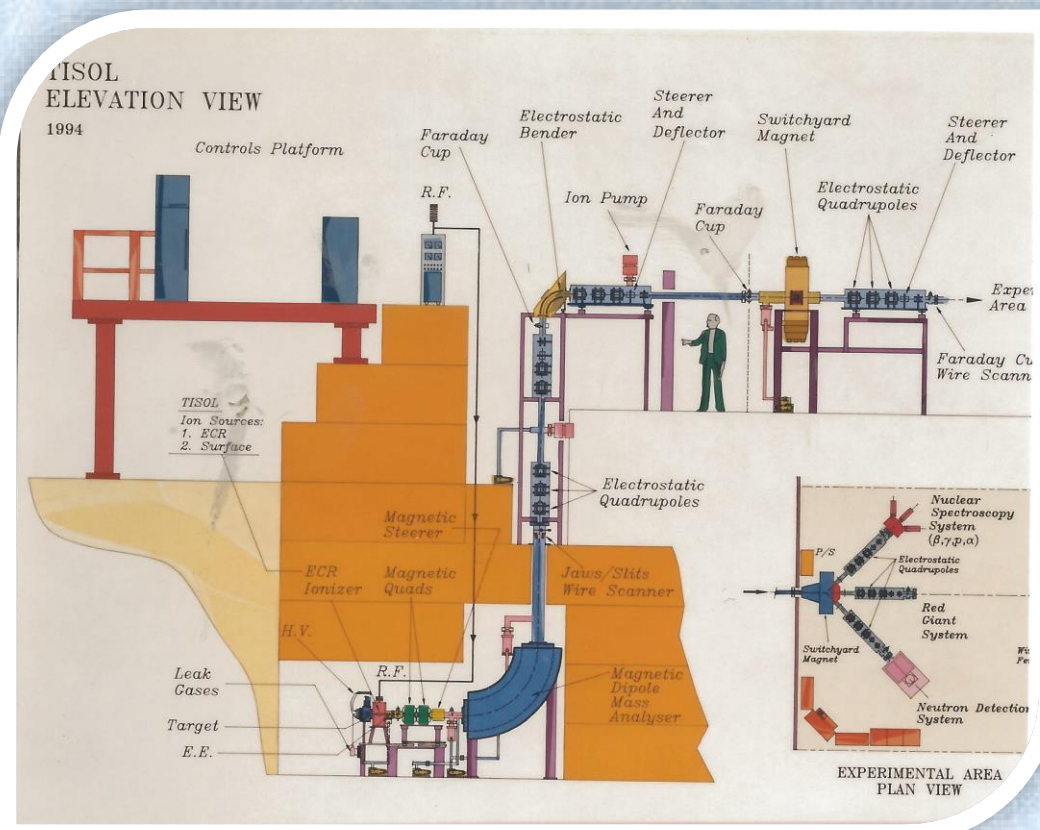
- “He (*Swain*) solicited help from Dick Taylor to come up with a list of international particle and nuclear physicists to whom the TRIUMF proposal would be sent for comment. Dick’s task would be to summarize their comments in a report which Harry could use with John Manley”
- “There was a fairly uniform response from the nuclear physicists,
 - ◆ Basically they said, don’t mess about with TISOL, go straight to ISAC “

TISOL → ISAC I

- “Early in June, I (*Astbury, 1995*) received a phone call from Harry. He could only come up with \$167M for the five years, we (*TRIUMF*) were aiming for \$200M, so was I (*Astbury*) prepared to try to make a go of it. It was evening; TRIUMF time, but he (Swain) needed a reply by 9:00 am Ottawa time next day. “
- “The LHC contribution must be included at some level, otherwise all bets were off! It was a long personal night; it was clear that some 40 people would have to be let go, in order to create some capital over the five years, “
- “I would say that ISAC came about for two main reasons. We paid attention to good external advice, and the political hiatus provided time to do some planning. If the money had come quickly, we may well have set off down the wrong road”.

ISAC Begins

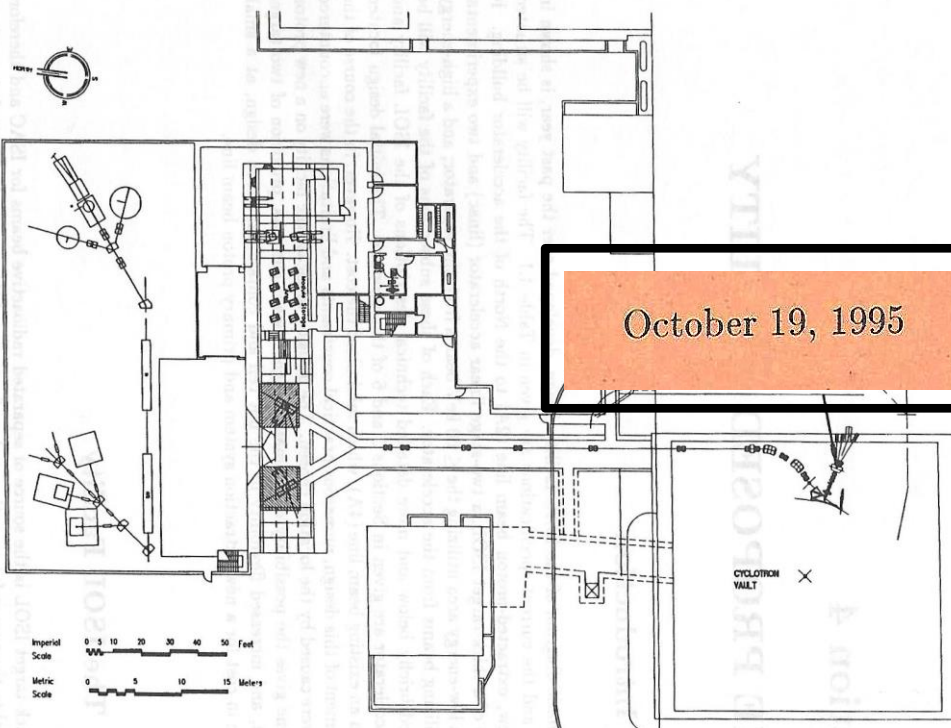
- June 1995 - Funding Announcement
 - Funds redistributed from other TRIUMF approved Civil Projects
- TISOL continues to run until 1999



ISAC Funding was announced on June 1995

ISAC Proposal submitted Oct. 1995

(24 Years ago)



October 19, 1995

TRIUMF



ISAC

A PROPOSAL FOR AN INTENSE
RADIOACTIVE BEAMS FACILITY

October 19, 1995

CANADA'S NATIONAL MESON FACILITY
OPERATED AS A JOINT VENTURE BY:

UNIVERSITY OF ALBERTA
SIMON FRASER UNIVERSITY
UNIVERSITY OF VICTORIA
UNIVERSITY OF BRITISH COLUMBIA

UNDER A CONTRIBUTION FROM THE
NATIONAL RESEARCH COUNCIL OF CANADA

ASSOCIATE MEMBERS:

UNIVERSITY OF MANTORA
UNIVERSITÉ DE MONTREAL
UNIVERSITY OF TORONTO
UNIVERSITY OF REGINA

TRI-95-1

Figure 4.1: The proposed ISAC facility.

TRIUMF SITE
in 1996
Prior to Construction of ISAC





ISAC 1 Construction

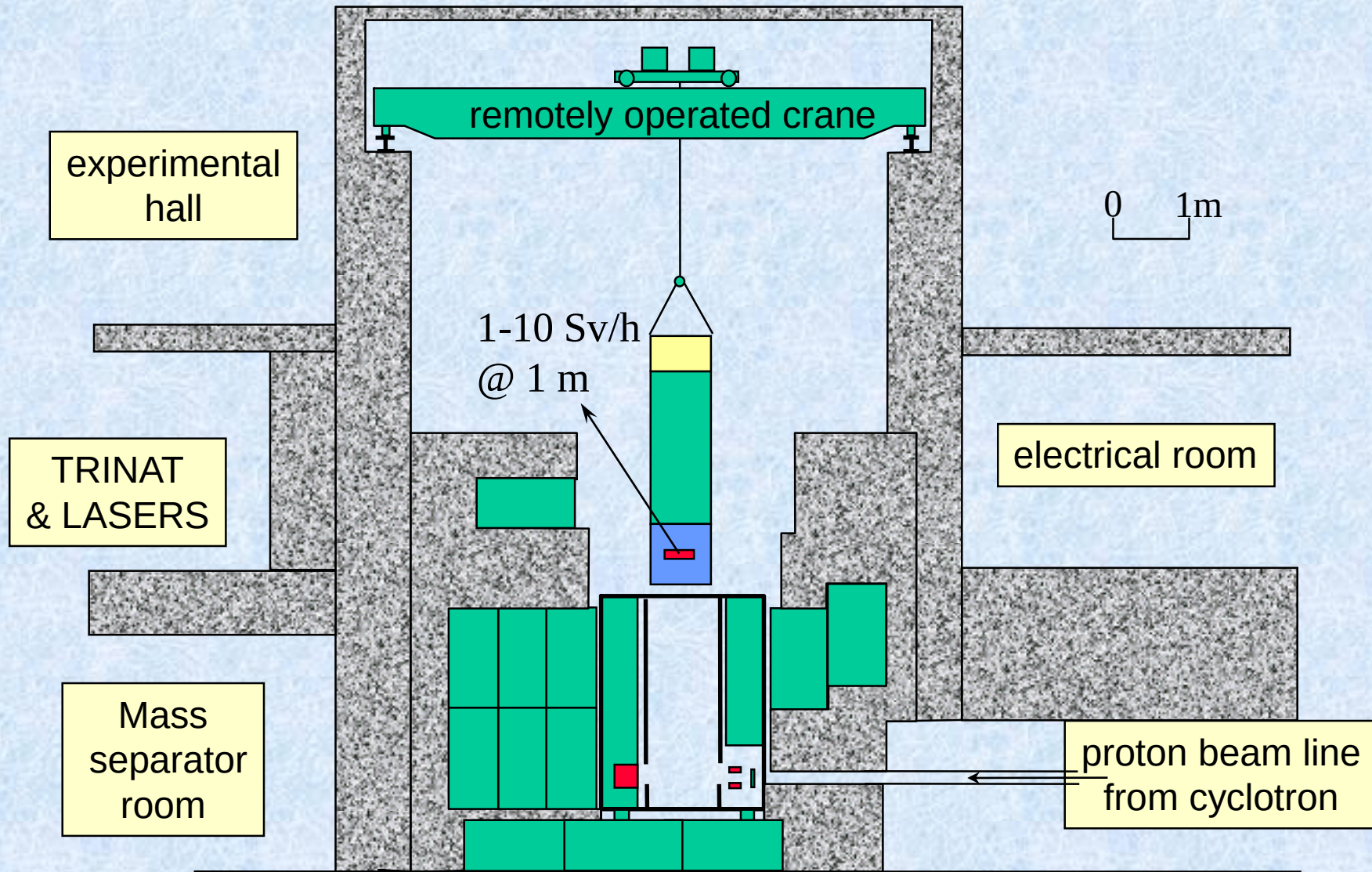
July 1999



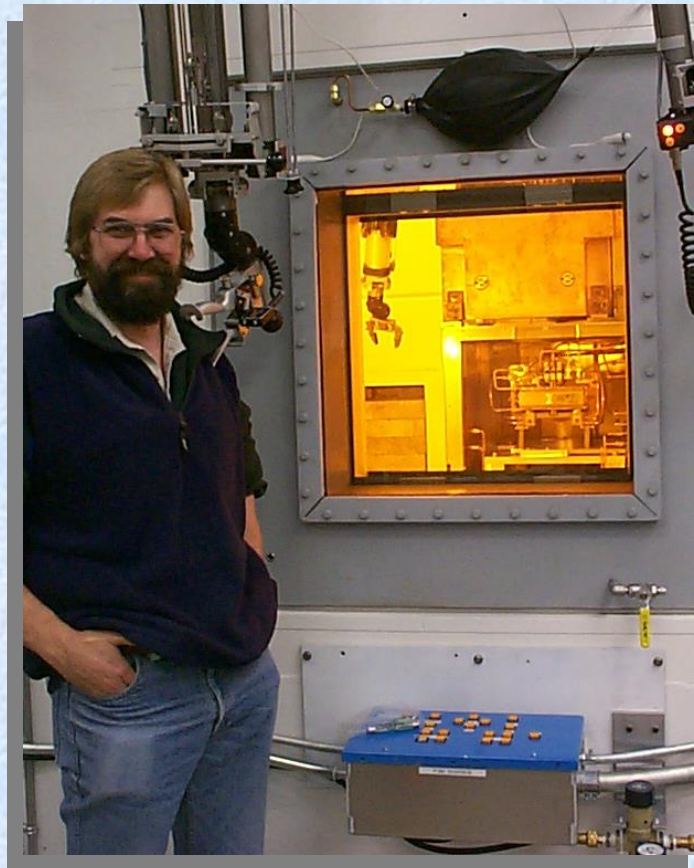
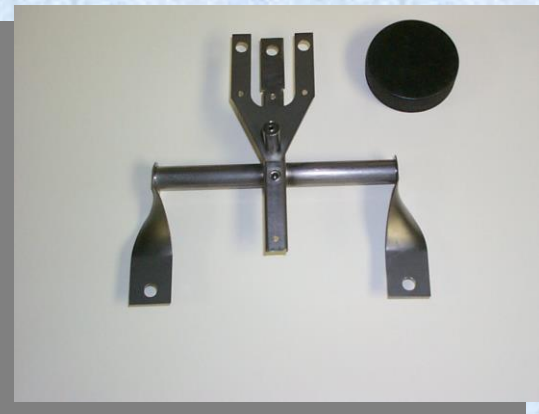
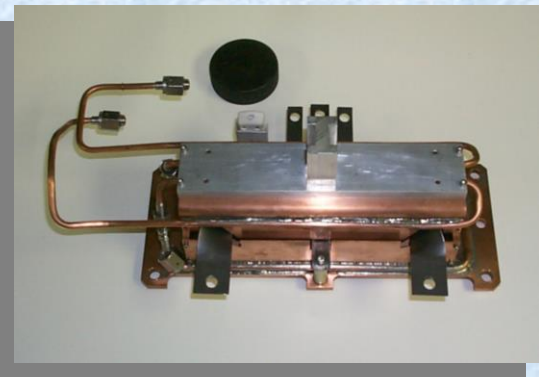
ISAC I SPECIFICATIONS

- DRIVER
 - ◆ $1 - 100 \mu\text{A}$ @ 500 MeV for ISAC
- ISAC (ISOL + ACCELERATORS)
 - ◆ ISOL Target Area
 - * **Shielded for $100 \mu\text{A}$ of 500 MeV Protons on Uranium**
 - * **Up to 50 kW on Target**
 - » **Achieved with Mo in Dec 1999 (20 years ago)**
 - ◆ ISAC I
 - ◆ Low Energy
 - ◆ **$E \leq 60 \text{ keV}$**
 - ◆ **$A_{\text{max}} \approx 240$**
 - ◆ Accelerated Beams
 - ◆ **Variable Energy**
 - ◆ **$0.15 \text{ to } 1.5 \text{ MeV/u}$**
 - ◆ **1st full energy beam in Dec 2000 (19 years ago)**
 - ◆ **Charge/mass = $q/A \geq 1/30$**

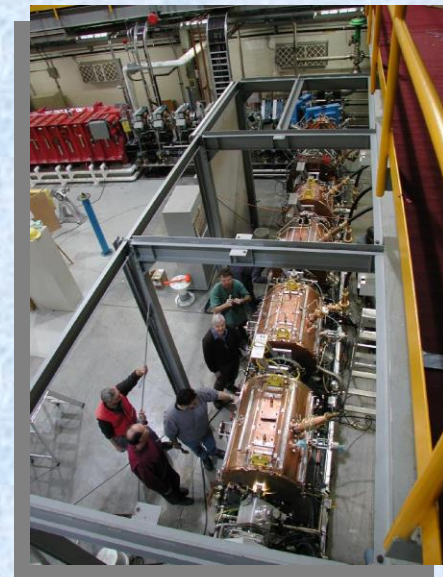
ISAC TARGET SERVICING



REMOTE HANDLING for ISAC TARGETS, ION SOURCES & MODULE COMPONENTS



ACCELERATOR TECHNOLOGY for ISAC I



Copper Plating Facility Cloverdale



● ISAC (ISOL + ACCELERATORS) Achieved Milestones

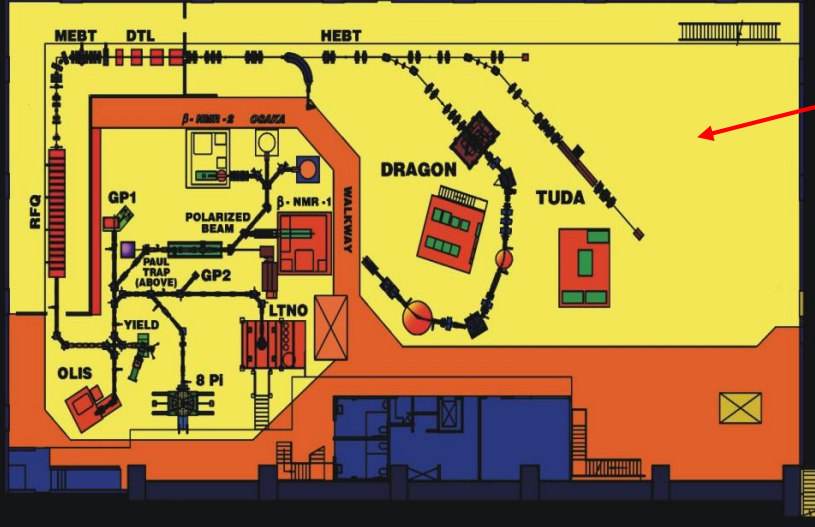
◆ ISAC-I

- Low Energy (First RIB Experiment in November 1998)
 - * **$E \leq 60 \text{ keV}$ & $A_{\text{max}} \approx 240$**
 - * **Nov 30, 1998 – First Radioactive Beam to TRINAT**
- High Energy (First Beam in December 2000)
 - * **Variable Energy from 0.15 to 1.5 MeV/u for $q/A \geq 1/30$**
 - * **Dec 21, 2000 - First Full Energy Stable Beam**
 - * **March 23, 2001 - First Beam through TUDA**
 - * **April 24, 2001 - First Beam through DRAGON Gas Target**
 - * **July 25, 2001 - Accelerated RIB (^8Li to TOJA)**
 - * **Oct 05, 2001- ^{21}Na to TUDA**
 - * **Oct 17, 2001 - ^{21}Na to DRAGON**

◆ ISOL Target Area

- * **Shielded for 100 μA of 500 MeV Protons on Uranium**
- * **Dec 17, 1999 – 100 μA on Mo Target**
- * **May 25, 2001 - 40 μA on Nb Target**
- * **July 23, 2001 - 40 μA on Ta Target**
- * **October 18, 2001 – 15 μA on SiC Target**
- * **May 2002 – 30 μA on SiC Target**

ISAC EXPERIMENTAL HALL



Layout of ISAC I Experimental Facilities (1999)

ISAC at TRIUMF

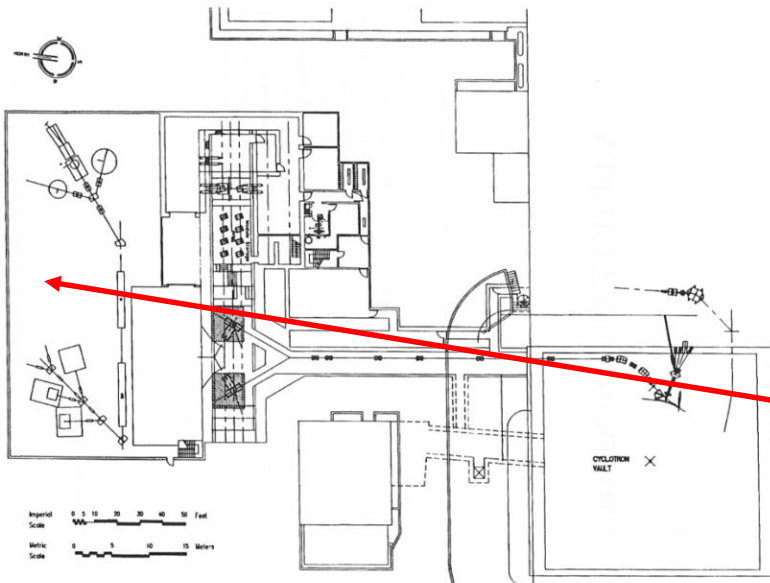
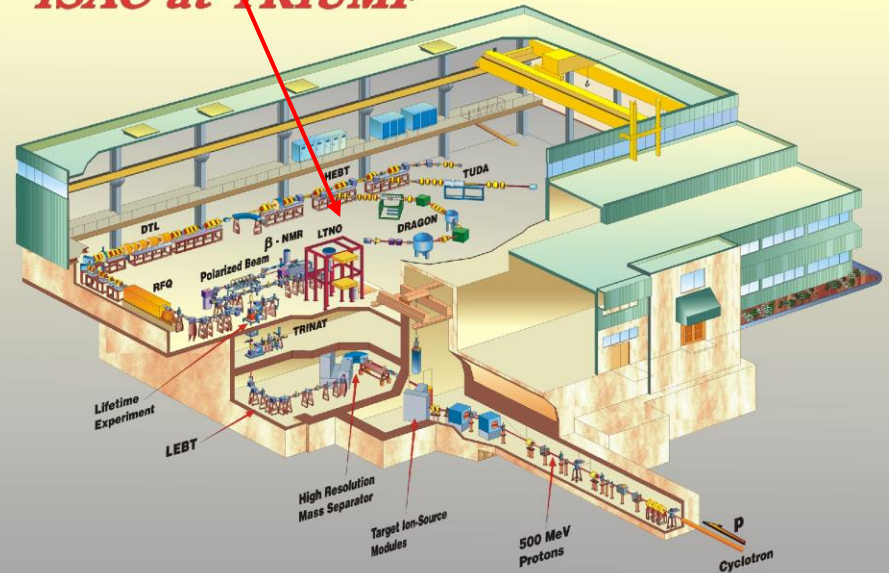


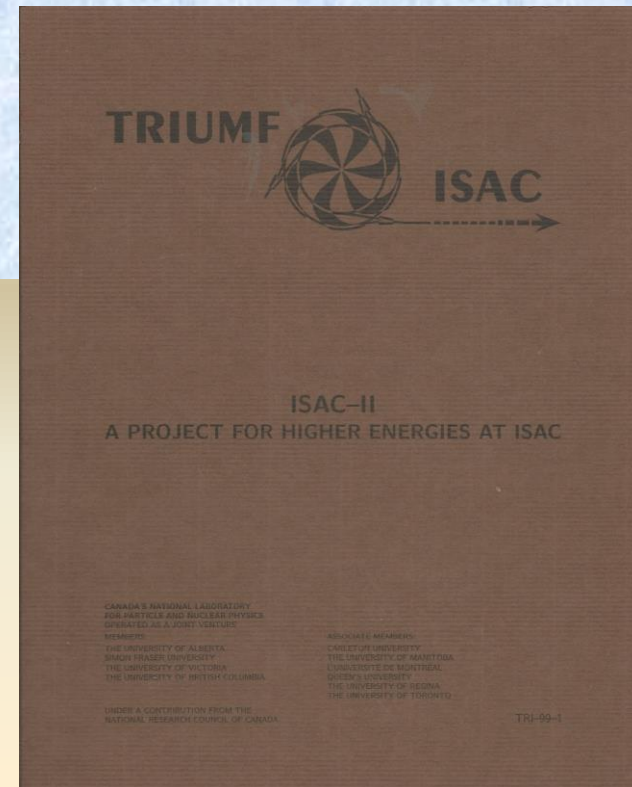
Figure 4.1: The proposed ISAC facility.

Proposed Layout of ISAC Experimental Facilities (1995)

ISAC I  ISAC II

ISAC II Timeline

- Spring 1998
 - ◆ Workshops at Dunsmuir & McMaster
 - Defined basic ISAC II parameters
- May 1998 – Plan presented to TRIUMF LRPC
- August 1999
 - ◆ ISAC-II proposal submitted
- April 2000 - Funding Announcement
 - ◆ Canadian Gov. approves a reduced 5 year plan
- April 2001
 - ◆ Provincial Gov't provides \$8.7M for Civil Construction
 - ◆ TRIUMF Royalties provide an additional \$1M



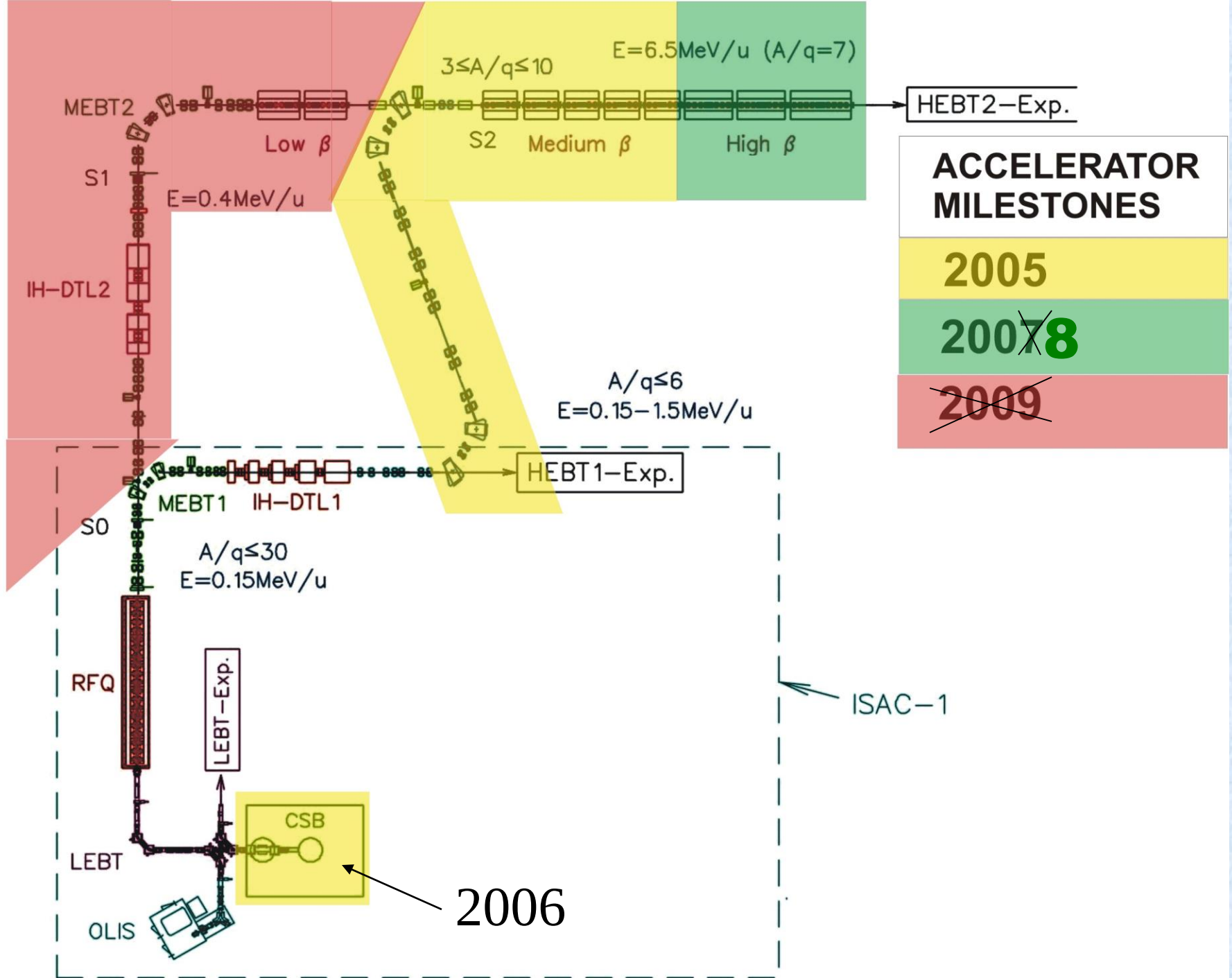
ISAC II Parameters & Project Revised with Reduced Funding (2000 – 2005)

- ENERGY

- ◆ $E_{\text{MAX}} = 5.8 \text{ MeV/amu}$ for stripping to $A/q = 6$ (2005)
- ◆ $E_{\text{MAX}} = 6.5 \text{ MeV/amu}$ for stripping to $A/q = 7$ (2005 +)
- ◆ $E_{\text{MAX}} = 15 \text{ MeV/amu}$ for stripping to $A/q = 3$ (2005+)

- MASS

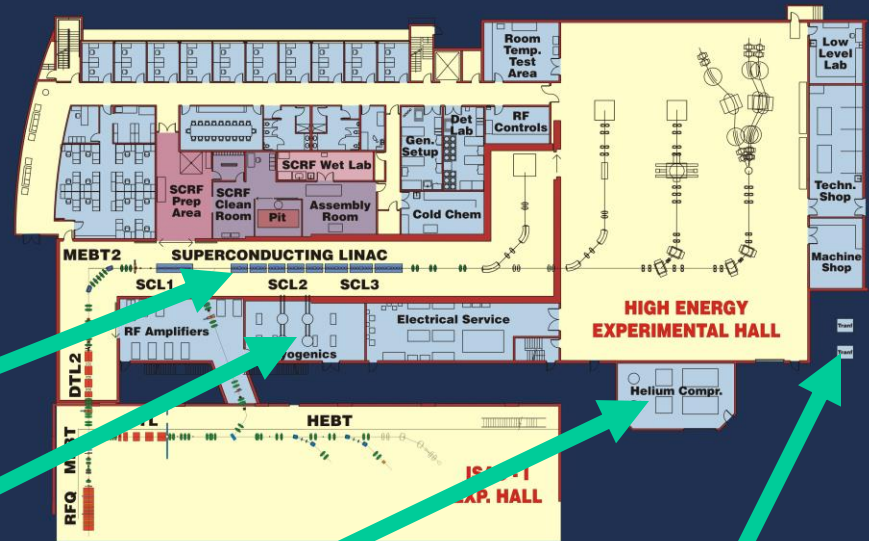
- ◆ $A_{\text{MAX}} = 60$ (2005)
- ◆ $A_{\text{MAX}} = 150$ (2005+)



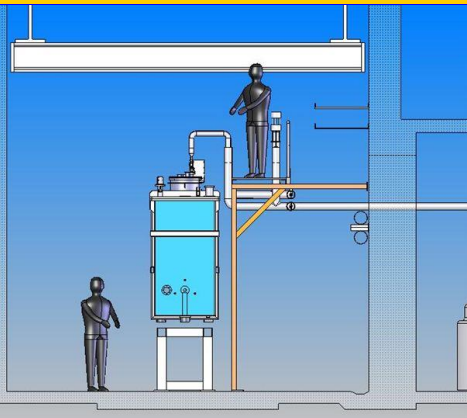
ISAC-II Building



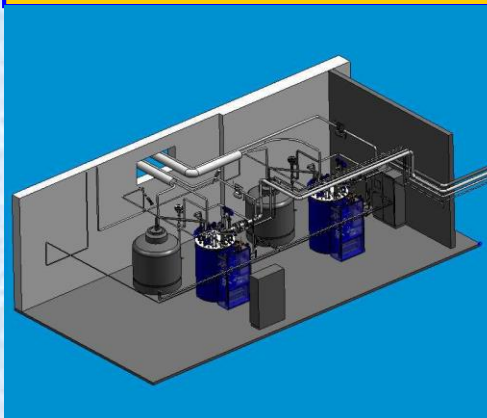
The ISAC - II Accelerator Floor



Linac Distribution



Refrigerator Room



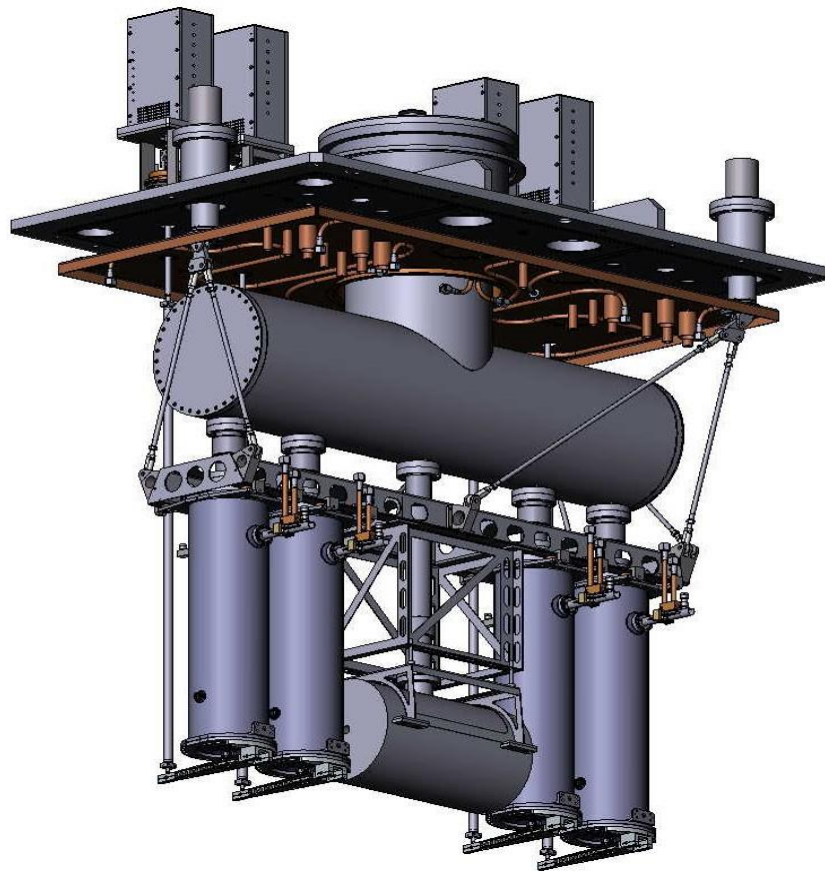
Compressor Room



Buffer

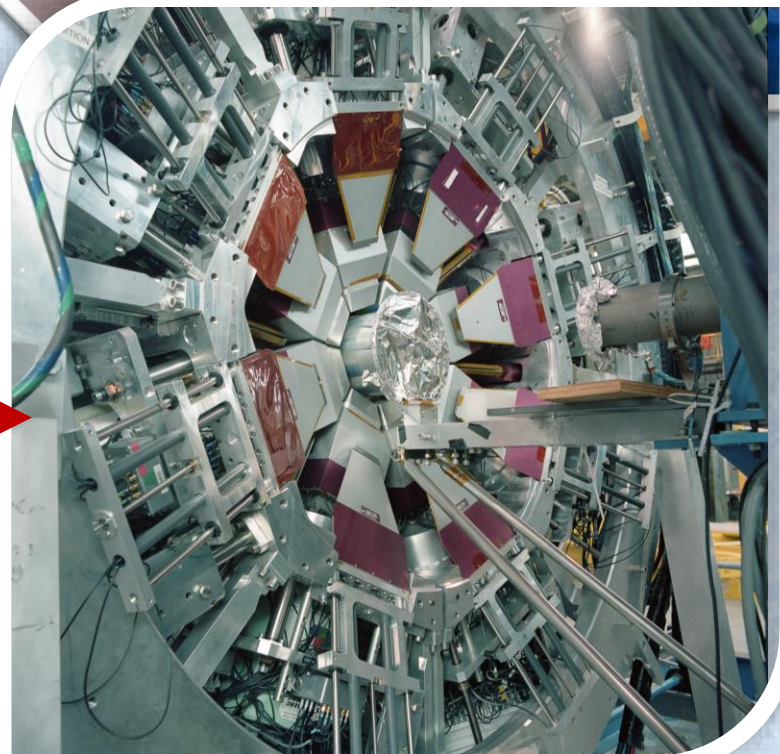
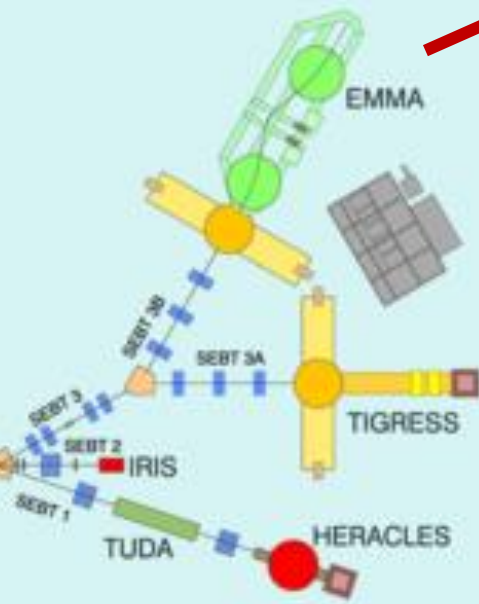


Medium Beta Cryomodule



ISAC II Experiments

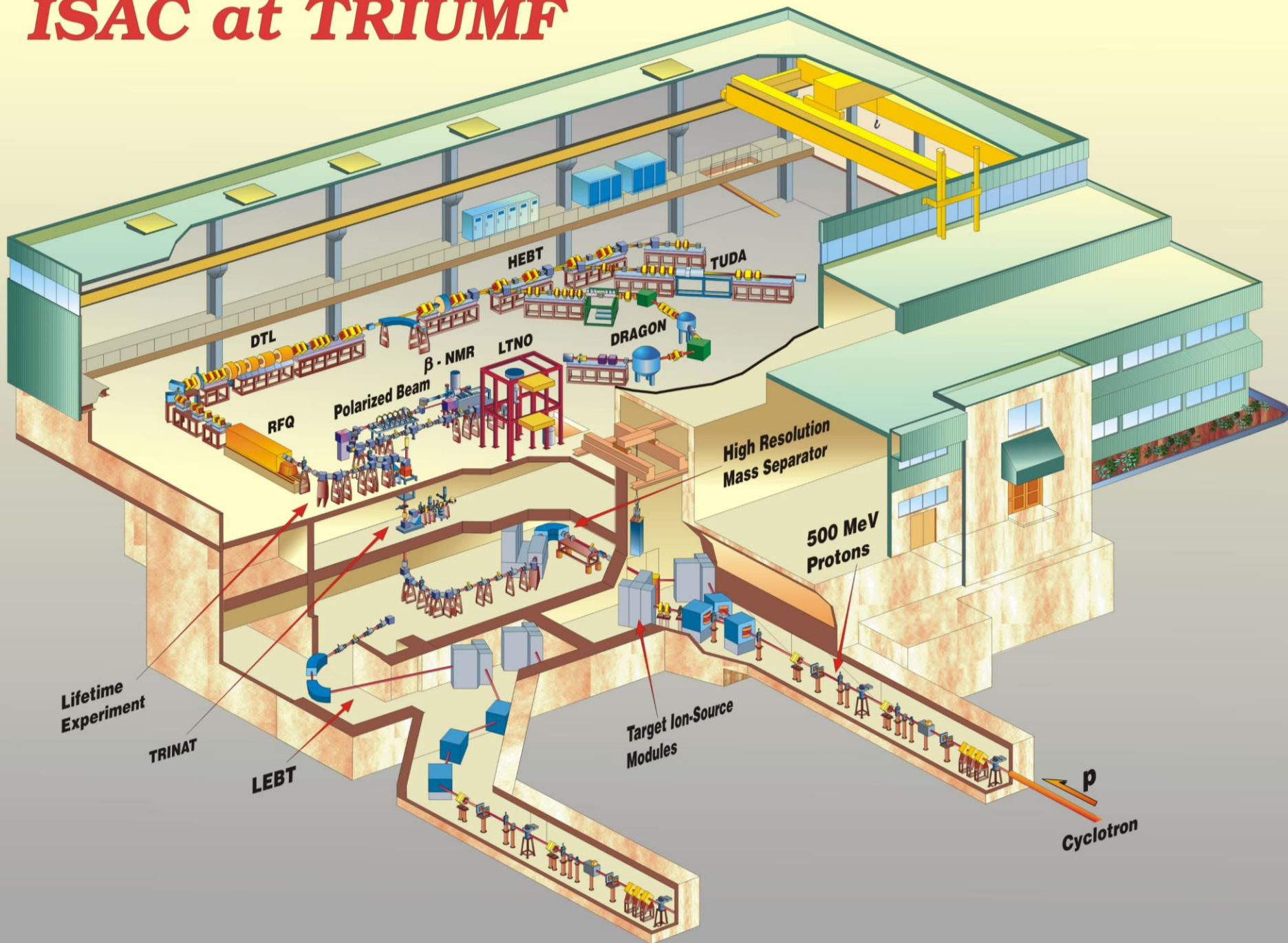
ISAC-II Experimental Hall



ISAC NEEDS MULTIPLE SIMULTANEOUS RIBs

- MAY 2002 – PRESENTATION TO ACOT NOTED
 - ◆ USER DEMAND (ALREADY) EXCEEDS ISAC CAPABILITY
 - NEED FOR MORE EXOTIC BEAM TIME
 - * INCREASED HOURS PER YEAR
 - * MULTIPLE DRIVER BEAMS
 - * MULTIPLE TARGET STATIONS
 - * MULTIPLE MASS SEPARATORS
 - * DUAL ACCELERATOR SYSTEMS
- UNLIKE THE TRIUMF CYCLOTRON, ISAC CANNOT SIMULTANEOUSLY GIVE BEAMS TO MULTIPLE EXPERIMENTS

ISAC at TRIUMF



ISAC PRIORITIES as SUBMITTED in 2005-10 PLAN

- OPERATE ISAC I & II
- DEVELOP NEW TARGETS, BEAMS & ION SOURCES
- COMPLETE ISAC II
 - ◆ ACHIEVE DESIGN SPECIFICATIONS
 - ◆ PROVIDE HEBT TO FUNDED TARGET STATIONS
- CONSTRUCT 2nd DRIVER BEAM & TARGET STATIONS
 - ◆ PROVIDE MULTIPLE SIMULTANEOUS EXOTIC BEAMS
 - ◆ INSTALL TARGET DEVELOPMENT STATION

ADVANCED RARE ISOTOPE LABORATORY

(2010 – 2023)

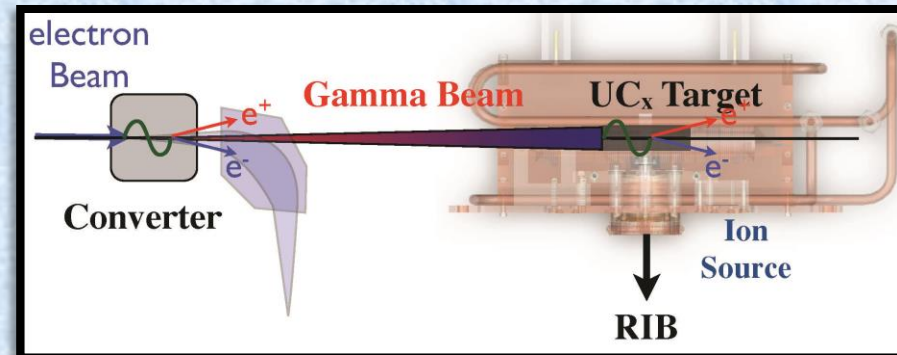
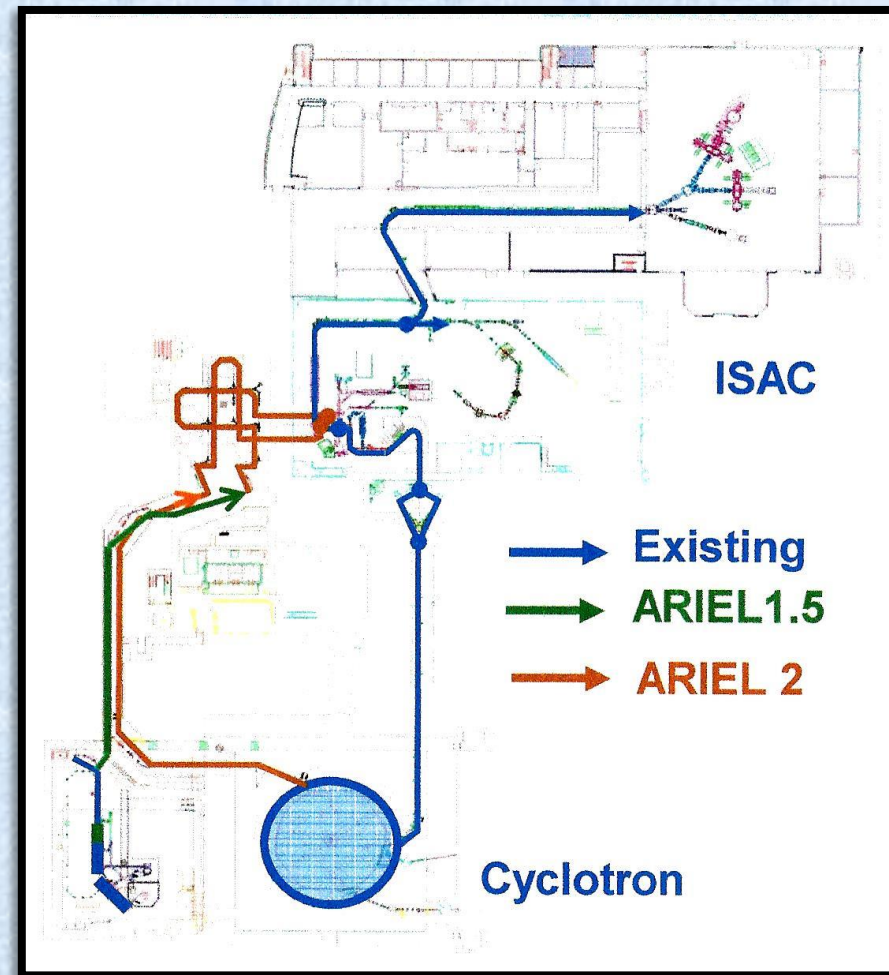


ARIEL Building
Completed 2013

- ARIEL will allow up to **three simultaneous RIB beams** for ISAC
- Additional Target Stations & Mass Separators
- ISAC utilizes one driver beam at 500 MeV and 50 kW to create RIBs for ISAC (#1 driver)
- Add e-Linac to create RIBs via photofission (#2 driver)
- Add a second beam from the cyclotron (#3 driver)

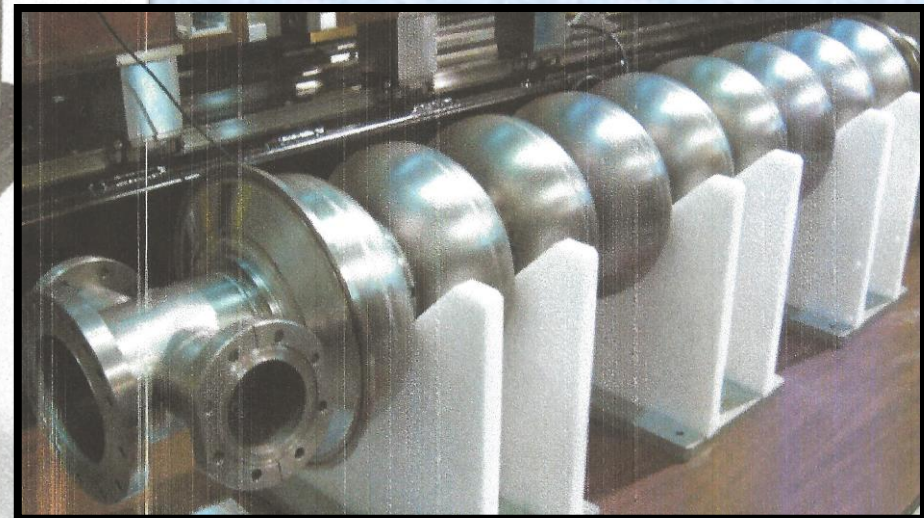
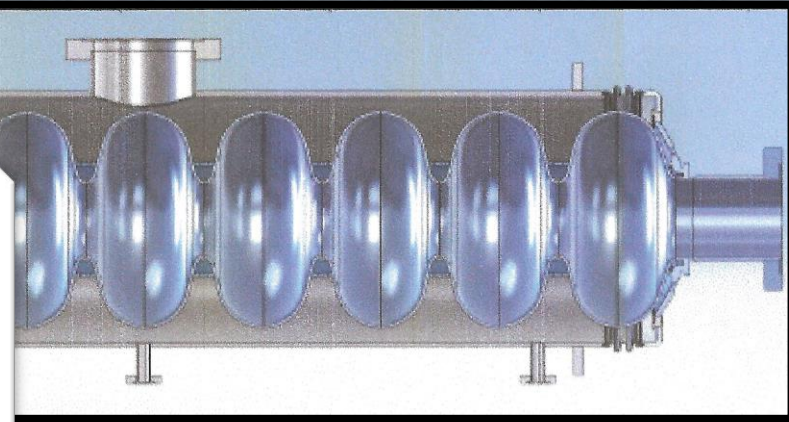
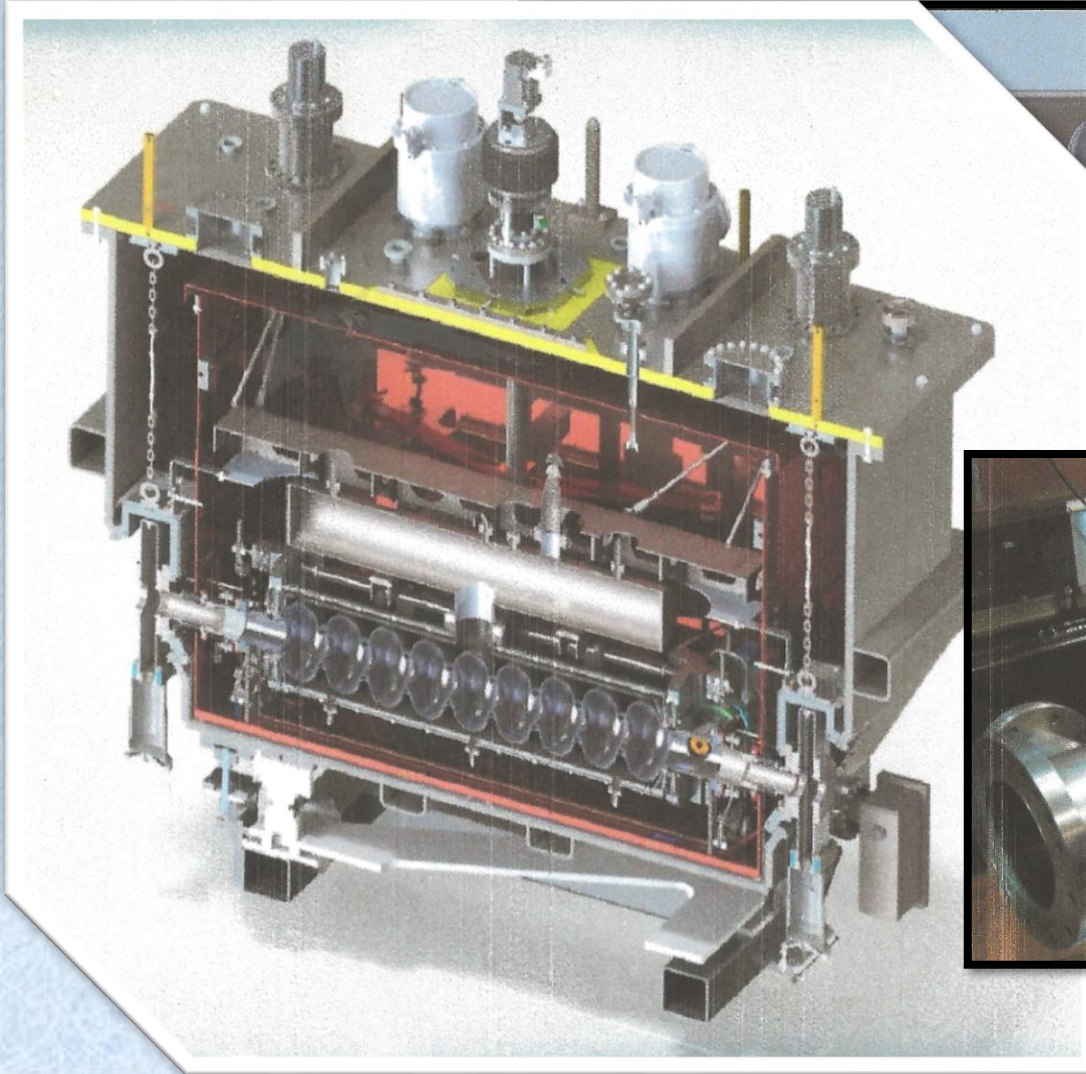
ARIEL TIME LINE

- ARIEL I
 - ◆ 2014 – e-Linac at 20 MeV
- ARIEL 1.5
 - ◆ 2017 – e-Linac at 30 MeV
 - ◆ 2018 – Complete e Beamline
- ARIEL 2
 - ◆ 2018-20 – Install target Station & RIB Beam Lines
 - ◆ 2020-24 – Install BL4N P & Proton Beam Line, RIB Beam Lines & Target Stations



ARIEL ACCELERATOR TECHNOLOGY

Injector Cryomodule



Anniversary Dates

Many Important Opportunities for Celebration

- | | |
|--|------------|
| ● ISAC Conception – June 1985 | ● 34 Years |
| ● Funding Announcement – June 1995 | ● 24 Years |
| ● UBC building permit – Sept 1996 | ● 23 Years |
| ● 1 st RIB to an Experiment- Nov 1998 | ● 21 Years |
| ● 100 μ A on Target – Dec 1999 | ● 20 Years |
| ● Declared Commissioned – Apr 2000 | ● 19 Years |
| ● 1 st Full Energy Beam – Dec 2000 | ● 19 Years |
| ● 1 st Accelerated RIB (^{21}Na) – Jul 25 2001 | ● 18 Years |

ISAC VIPs



- Gerardo Dutto
 - ◆ His leadership on the 100 μA Task Force provided TRIUMF the ability to safely accelerate 400 μA & to provide multiple intense simultaneous proton beams to experiments



- Alan Astbury
 - ◆ For his decision and courage to construct the world's most powerful RIB facility at TRIUMF



- John D'Auria
 - ◆ For his persistent championship of the Chemistry & Physics of Radioactive Beams at TRIUMF