The Project-X Research Program

- ***Neutrino experiments***

A high-power proton source with proton energies between 1 and 120 GeV would produce intense neutrino sources and beams illuminating near detectors on the Fermilab site and massive detectors at distant underground laboratories.

- ***Kaon, muon, nuclei & neutron precision experiments***

These could include world leading experiments searching for muon-to-electron conversion, nuclear and neutron electron dipole moments (edms), precision measurement of neutron properties and world-leading precision measurements of ultra-rare kaon decays.

- ***Platform for evolution to a Neutrino Factory and Muon Collider***

Neutrino Factory and Muon-Collider concepts depend critically on developing high intensity proton source technologies.

- ***Nuclear Energy Applications***

(1) Materials testing Facility. (2) Accelerator, spallation, target and transmutation technology demonstration which could investigate and develop accelerator technologies important to the design of future nuclear waste transmutation systems and future thorium fuel-cycle power systems.

Detailed discussion on Project X website

Example Research Program, definitive space of accelerator parameters on PXPS Indico site

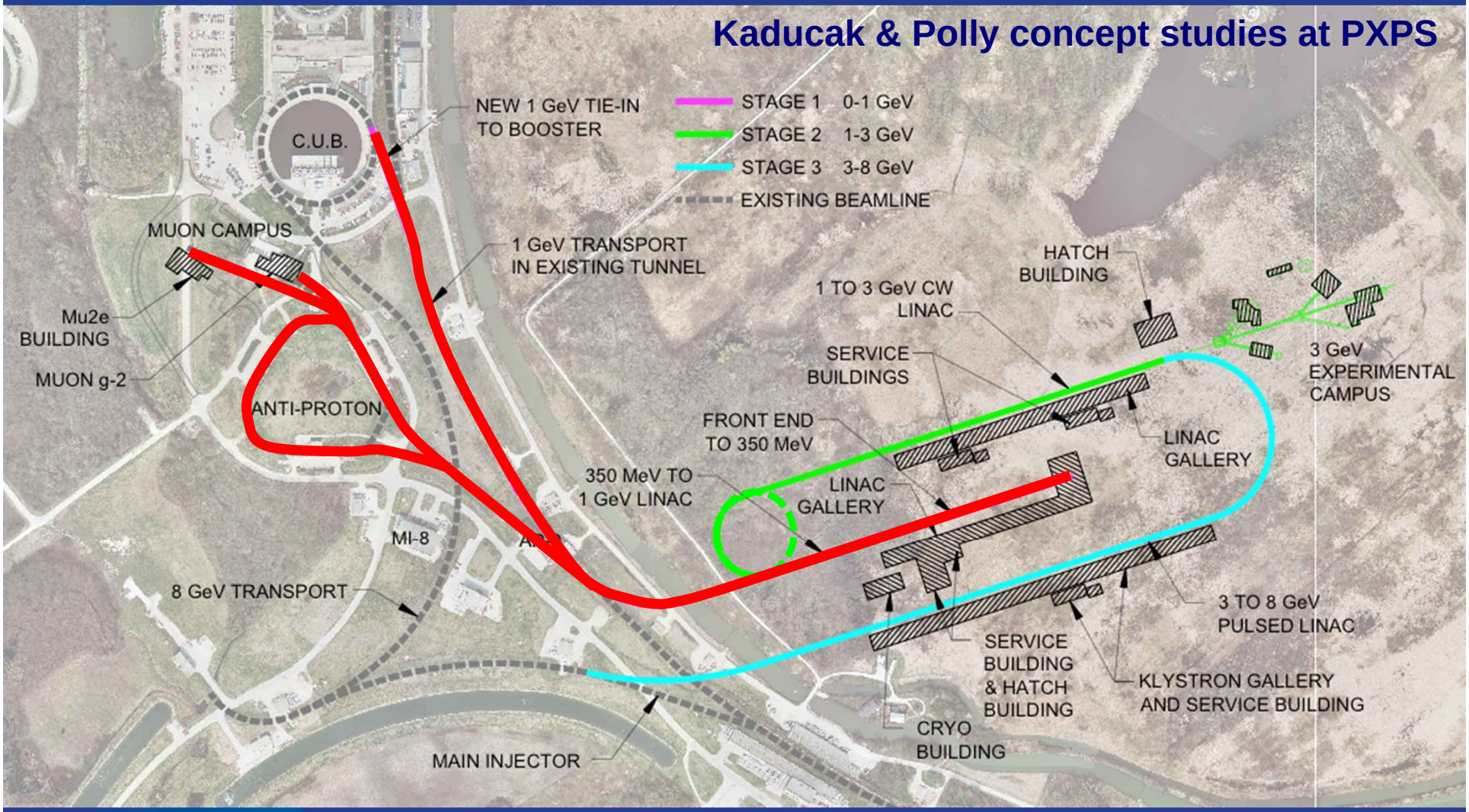
Project X Campaign

Program:	Onset of NOvA operations in 2013	Stage-1: 1 GeV CW Linac driving Booster & Muon, n/edm programs	Stage-2: Upgrade to 3 GeV CW Linac	Stage-3: Project X RDR	Stage-4: Beyond RDR: 8 GeV power upgrade to 4MW
MI neutrinos	470-700 kW**	515-1200 kW**	1200 kW	2450 kW	2450-4000 kW
8 GeV Neutrinos	15 kW +0-50kW**	0-42 kW* + 0-90 kW**	0-84 kW*	0-172 kW*	3000 kW
8 GeV Muon program e.g, (g-2), Mu2e-1	20 kW	0-20 kW*	0-20 kW*	0-172 kW*	1000 kW
1-3 GeV Muon program, e.g. Mu2e-2	-----	80 kW	1000 kW	1000 kW	1000 kW
Kaon Program	0-30 kW** (<30% df from MI)	0-75 kW** (<45% df from MI)	1100 kW	1870 kW	1870 kW
Nuclear edm ISOL program	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
Ultra-cold neutron program	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
Nuclear technology applications	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
# Programs:	4	8	8	8	8
Total max power:	735 kW	2222 kW	4284 kW	6492 kW	11870kW

* Operating point in range depends on MI energy for neutrinos.

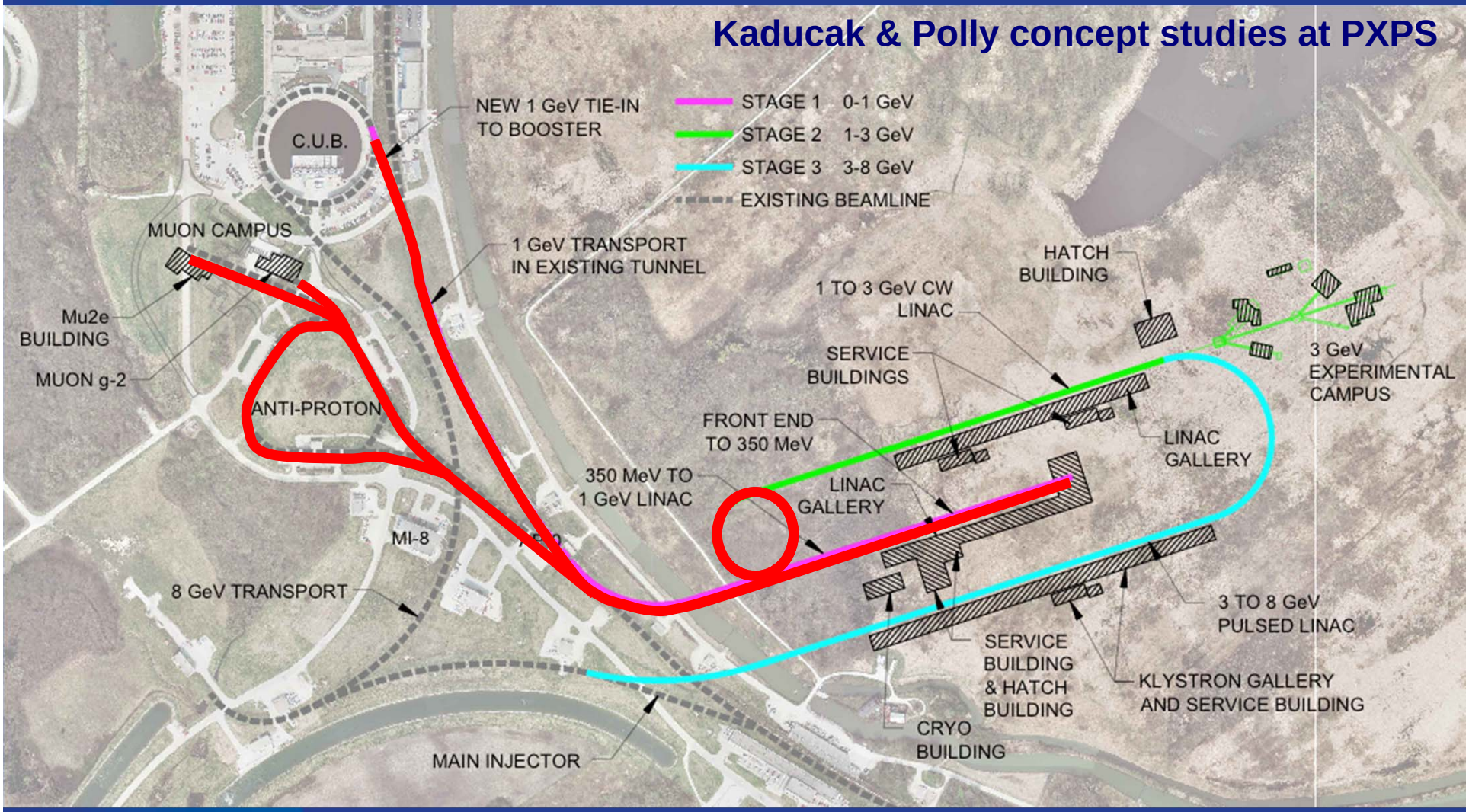
** Operating point in range depends on MI injector slow-spill duty factor (df) for kaon program.

Kaducak & Polly concept studies at PXPS



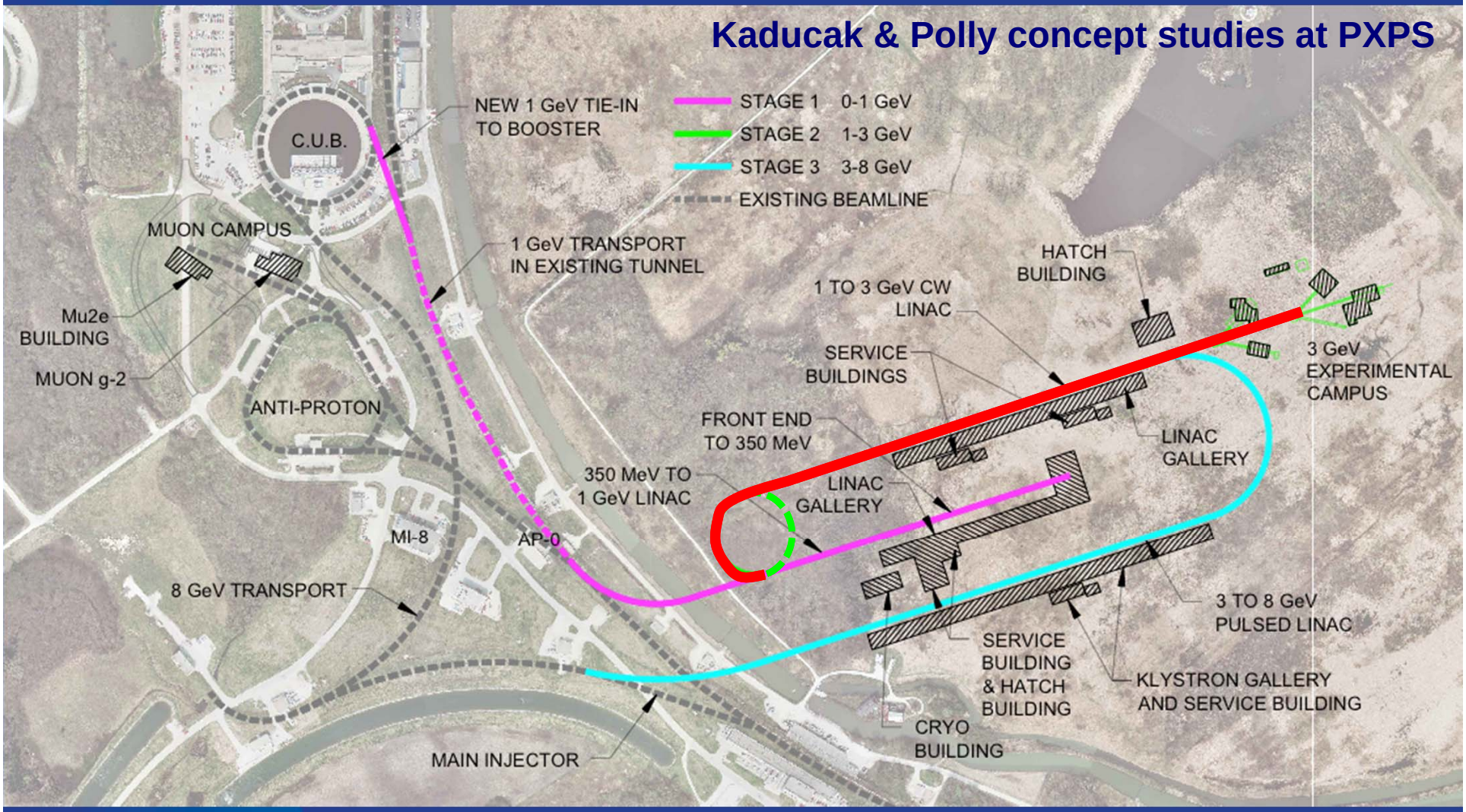
Stage 1: CW Linac (1 GeV, 1 mA) feeds Booster allowing 60-70% more beam at 8 and 120 GeV. 900 kW of CW beam remains at 1 GeV, and can be used in combination with existing AP0, former anti-proton rings, and new Muon Campus

Kaducak & Polly concept studies at PXPS



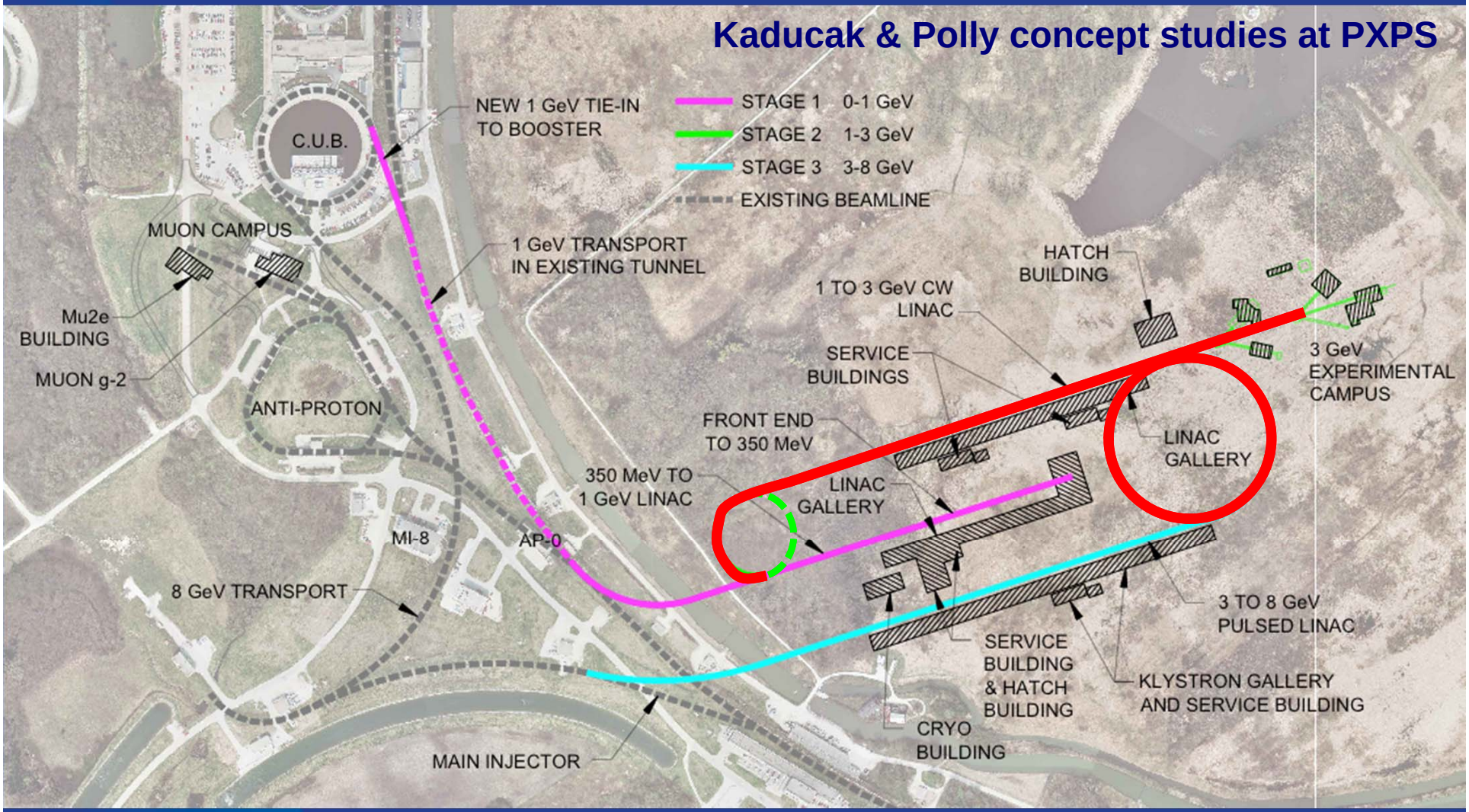
Stage 1a: A compressor ring allows non-CW experiments to be mounted in the existing 1 GeV experimental areas.

Kaducak & Polly concept studies at PXPS



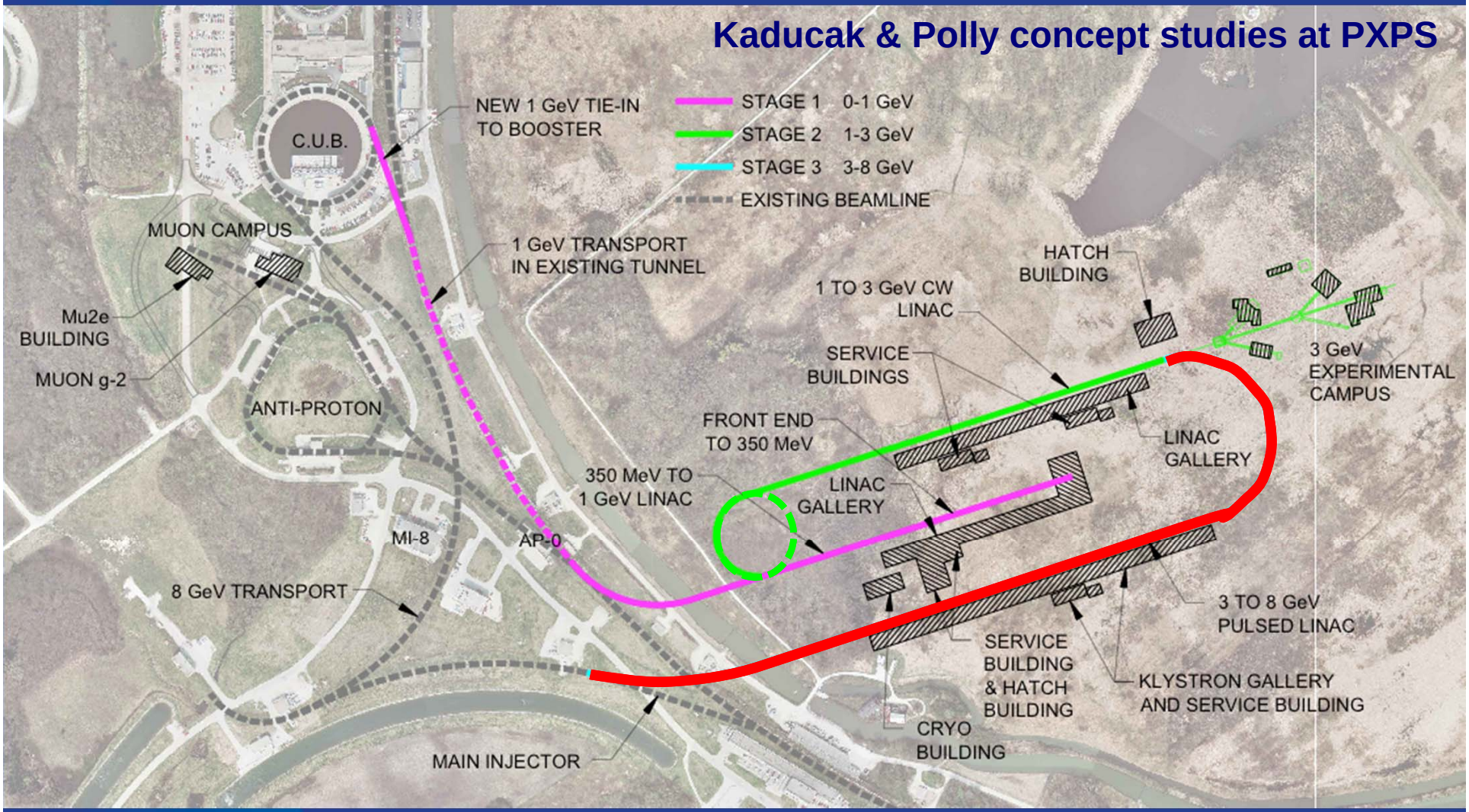
Stage 2: CW linac for 1 to 3 GeV constructed to feed new 3 MW experimental campus. Reuses first 180˚ of 1 GeV bunching ring for transport.

Kaducak & Polly concept studies at PXPS



Stage 2a: A compressor ring allows non-CW experiments to be mounted in the 3 GeV experimental areas.

Kaducak & Polly concept studies at PXPS



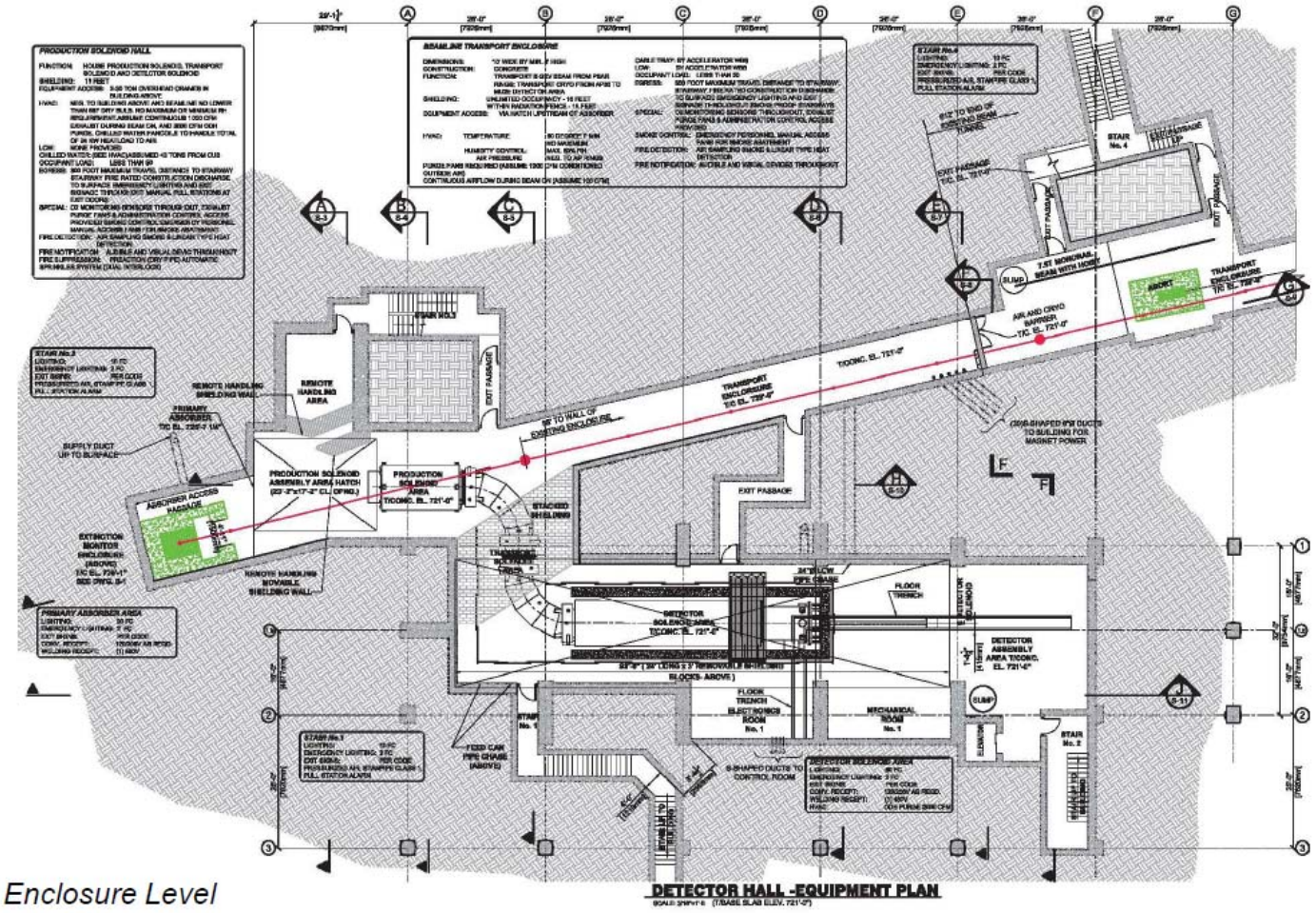
Stage 3: Pulsed linac constructed to feed Recycler. Reuses firs
3 GeV bunching ring fo

Siting Issus and Priorities

- ***Mu2e evolution:*** *Berm shielding, Production Solenoid shielding swap-out from bronze to tungsten. Not clear where power limit is at current site.*
- ***LBNE evolution:*** *1200kW operations.*
- ***1MW Nuclear station:*** *Focus on target station for spallation target. Is AP0 a candidate for a 100kW demonstration station? Can this evolve to 1000kW?*
- ***Beam Splitter Infrastructure:*** *e.g, location and size of Mu2**e/**nuclear splitter.*
- ***Proton edm infrastructure:*** *Transport of 250 MeV (T_p) protons to muon campus.*
- ***Kaon and muon campus:*** *Have models with BNL designs.*

Evolution of muon campus

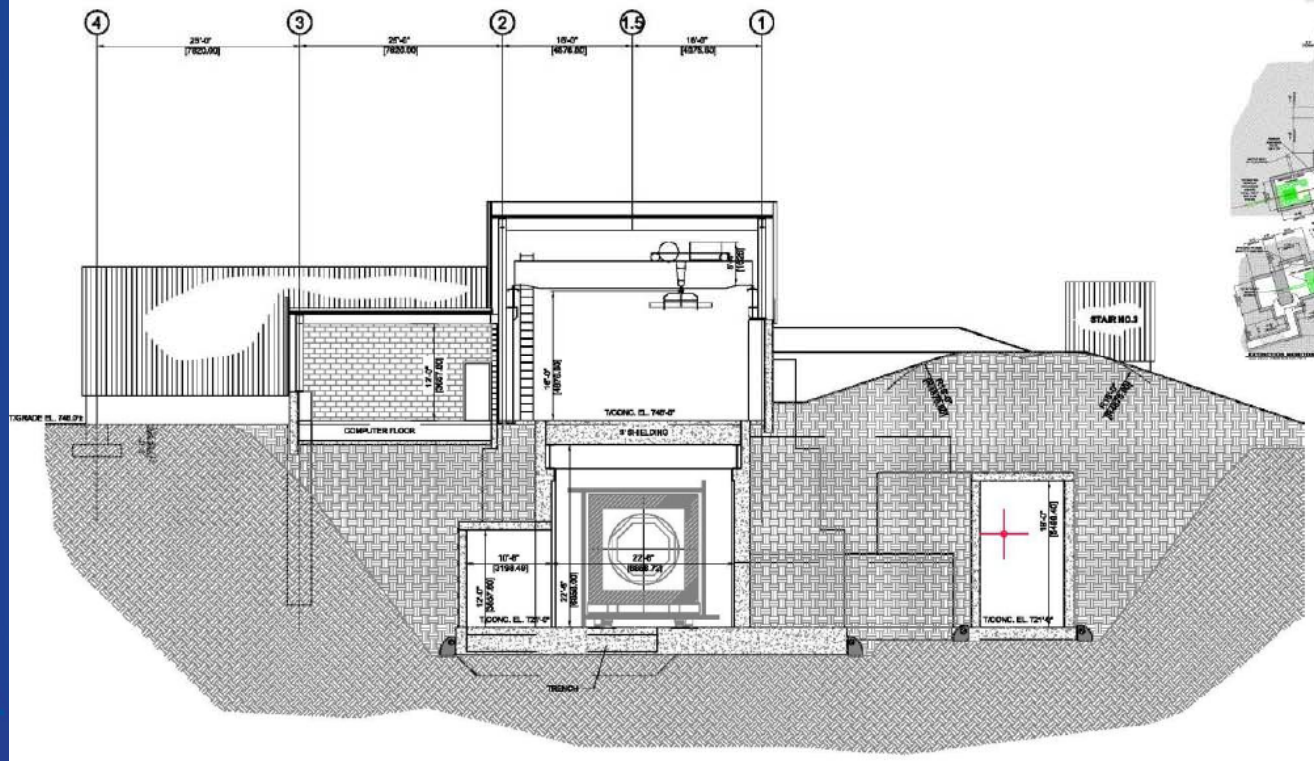
Design Status

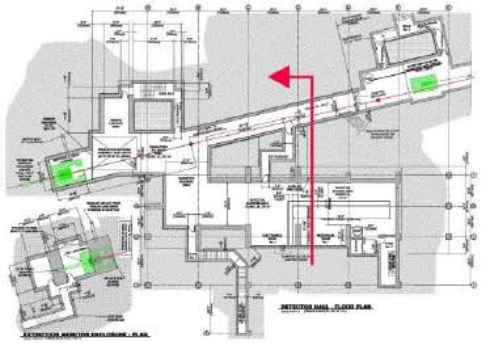


Plan at Enclosure Level

Courtesy Steve Dixon, June 2012

Design Status



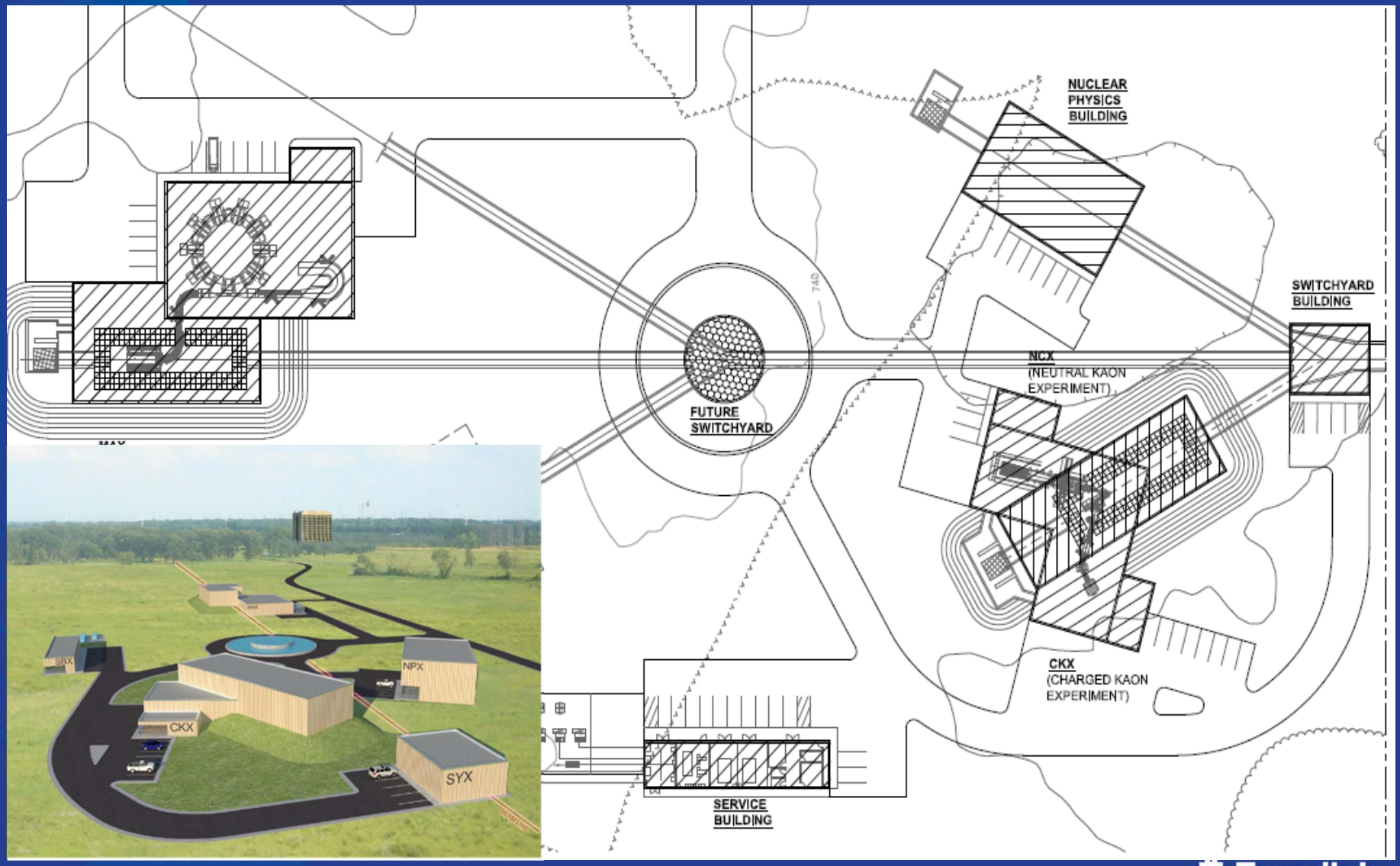


Section Looking West

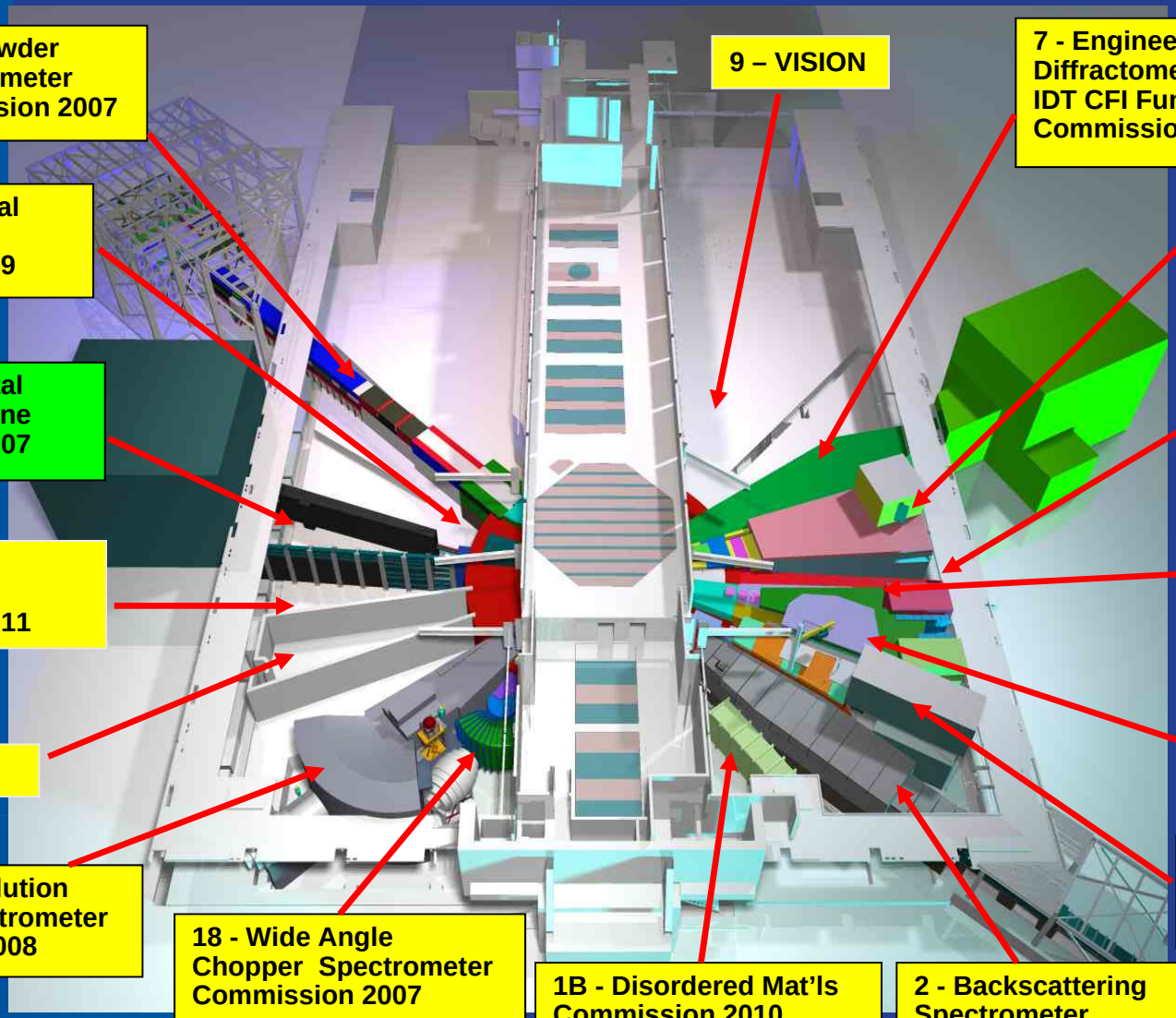
SECTION D 8-1

Courtesy Steve Dixon, June 2012

Project-X High-Intensity Campus



Beamline 13 Has Been Allocated for Nuclear Physics at SNS



11A - Powder Diffractometer Commission 2007

12 - Single Crystal Diffractometer Commission 2009

13 - Fundamental Physics Beamline Commission 2007

14B - Hybrid Spectrometer Commission 2011

15 – Spin Echo

17 - High Resolution Chopper Spectrometer Commission 2008

18 - Wide Angle Chopper Spectrometer Commission 2007

1B - Disordered Mat'ls Commission 2010

2 - Backscattering Spectrometer Commission 2006

3 - High Pressure Diffractometer Commission 2008

4A - Magnetism Reflectometer Commission 2006

4B - Liquids Reflectometer Commission 2006

5 - Cold Neutron Chopper Spectrometer Commission 2007

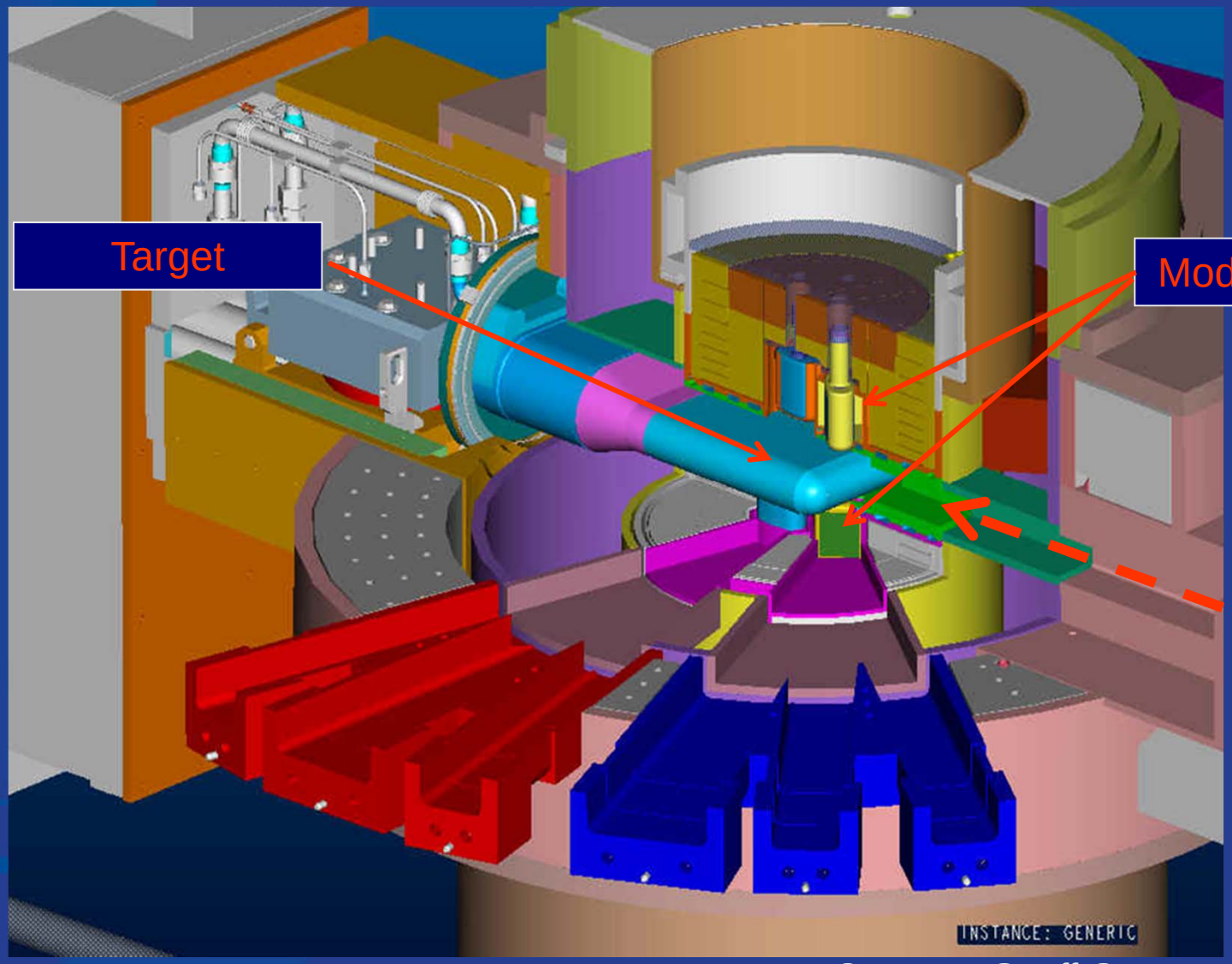
6 - SANS Commission 2007

7 - Engineering Diffractometer IDT CFI Funded Commission 2008

9 – VISION

Courtesy
Geoff Greene

ORNL SNS Spallation target



Courtesy Geoff Greene

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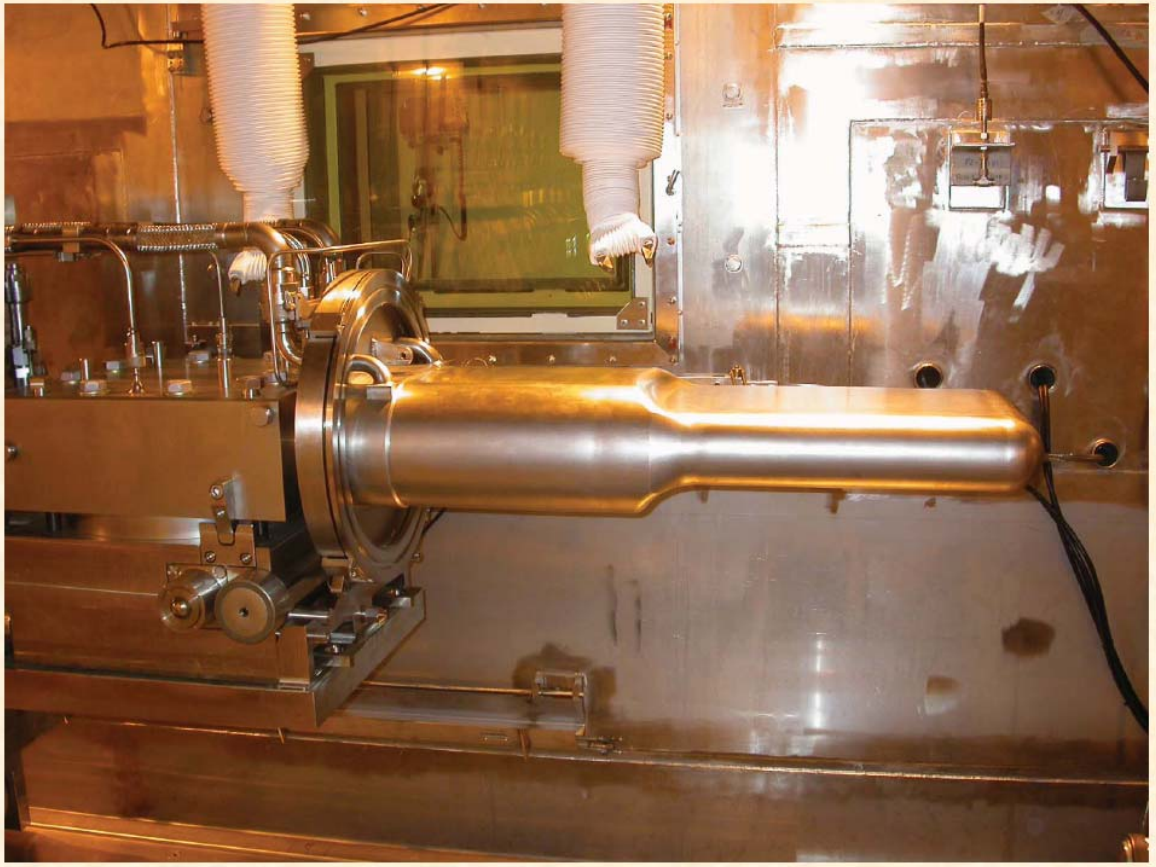

Target Module

UT-BATTELLE

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY
Performance Measures

SNS SPALLATION NEUTRON SOURCE

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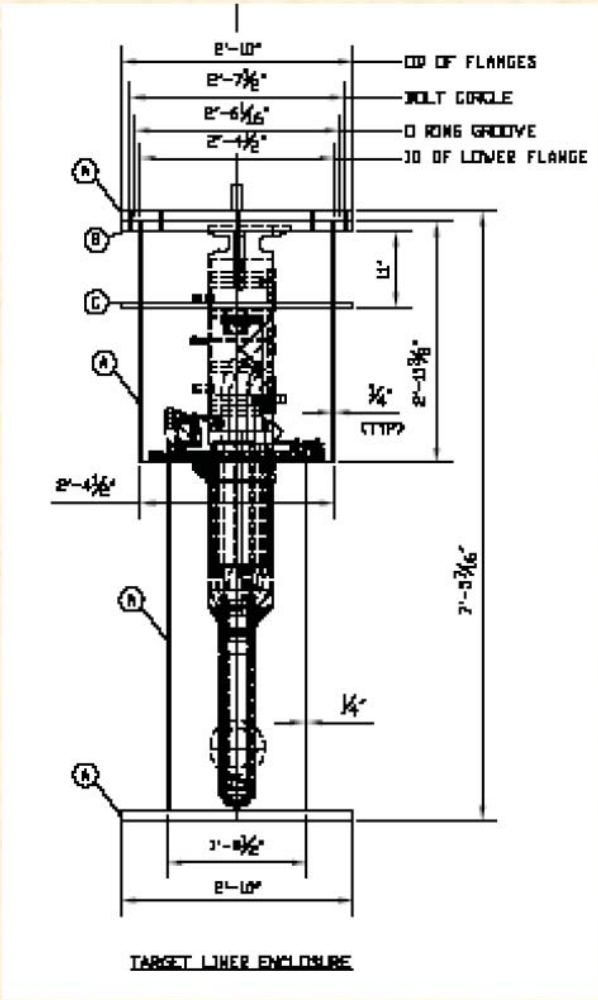
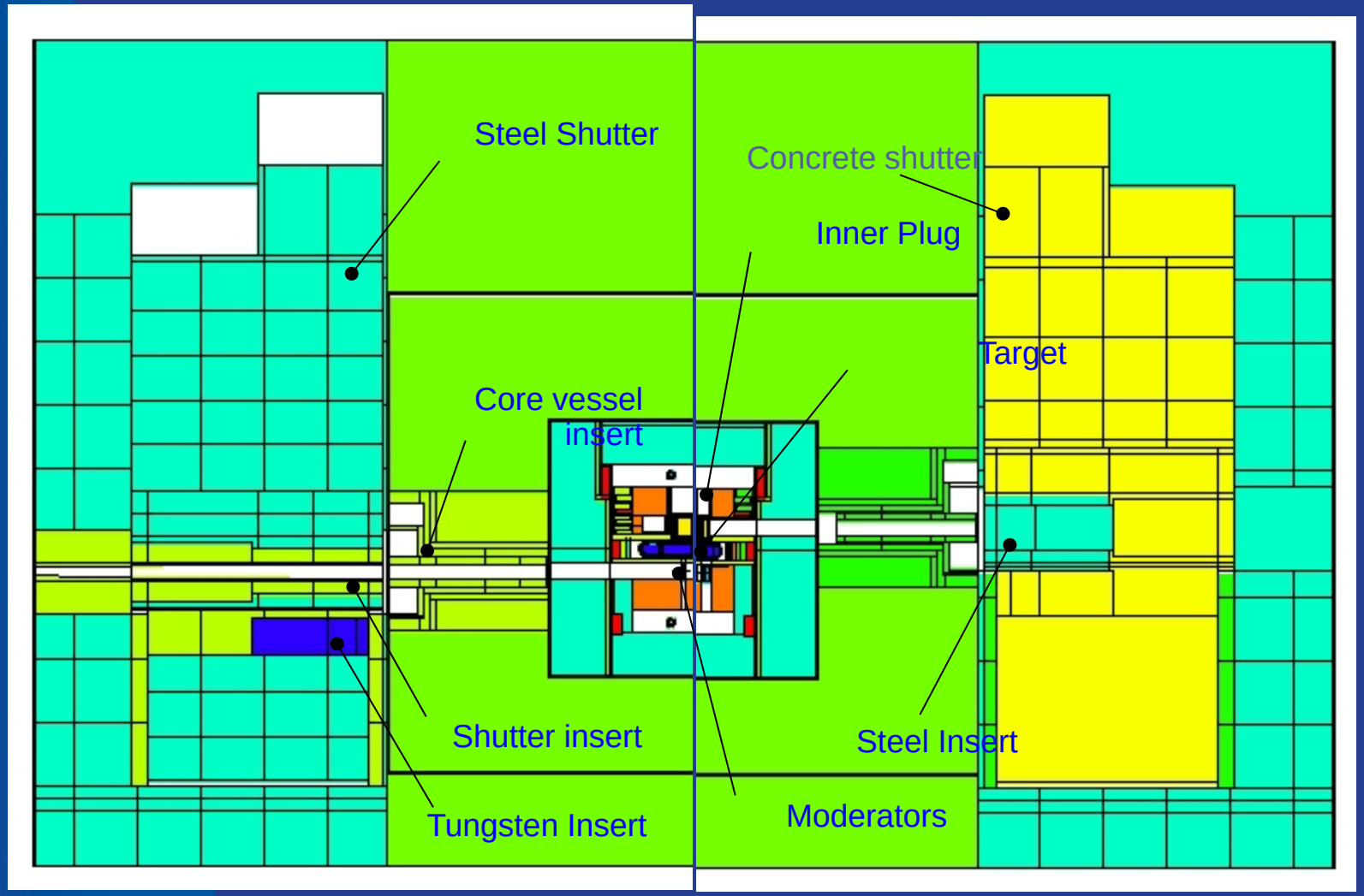
Courtesy Steve Trotter

Target Module Packaging



Courtesy Steve Trotter

Target Monolith Model

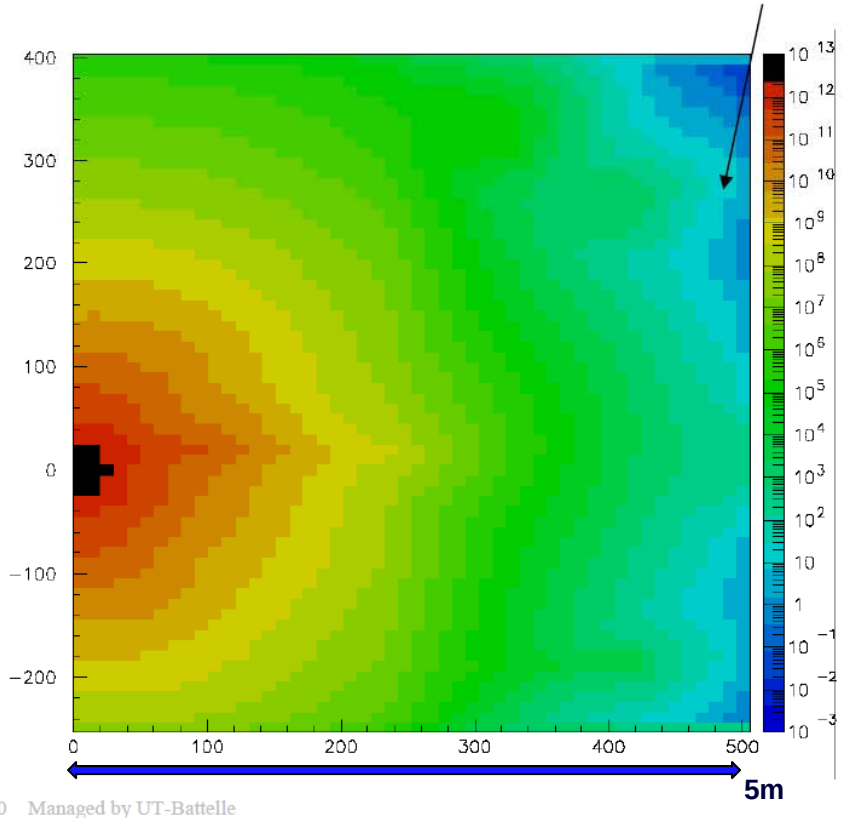


Courtesy Tony Gabriel

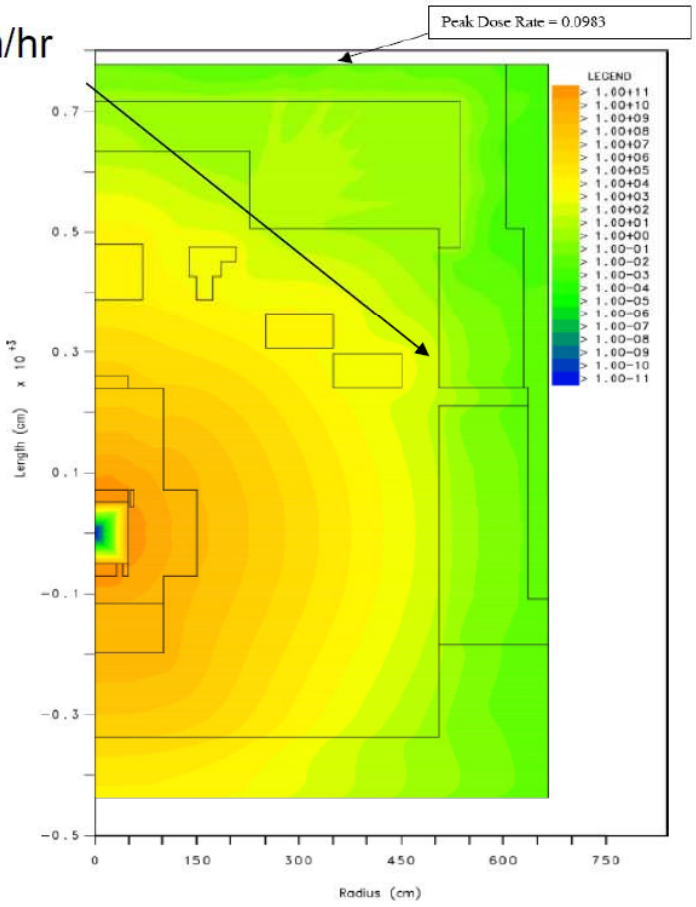
SNS Target Monolith Shielding: MCNPX versus DORT Dose Rate (mrem/hr)

3D MCNPX, 35º-75º

10 mrem/hr



2D DORT, ±25º



10 Managed by UT-Battelle

Courtesy Tony Gabriel

Target Disposition Operations

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Performance Measures

SNS SPALLATION NEUTRON SOURCE

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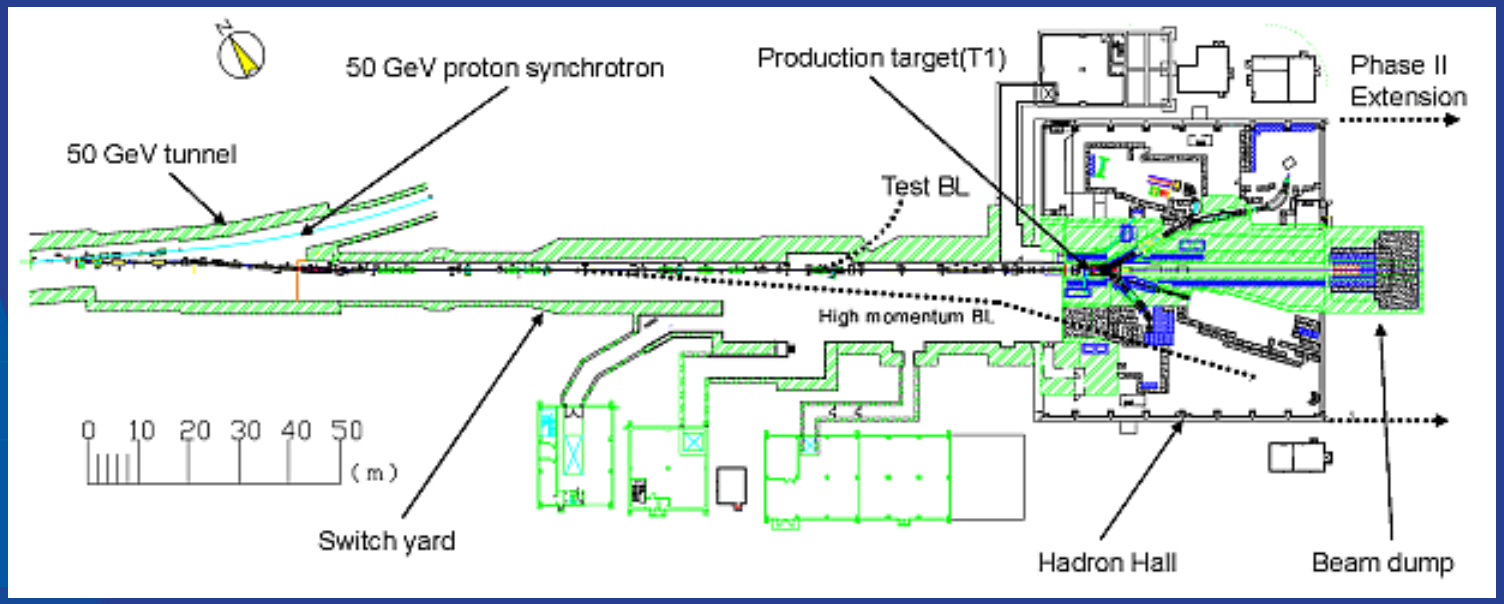
JPARC kaon & muon hall designed to 1-MW:

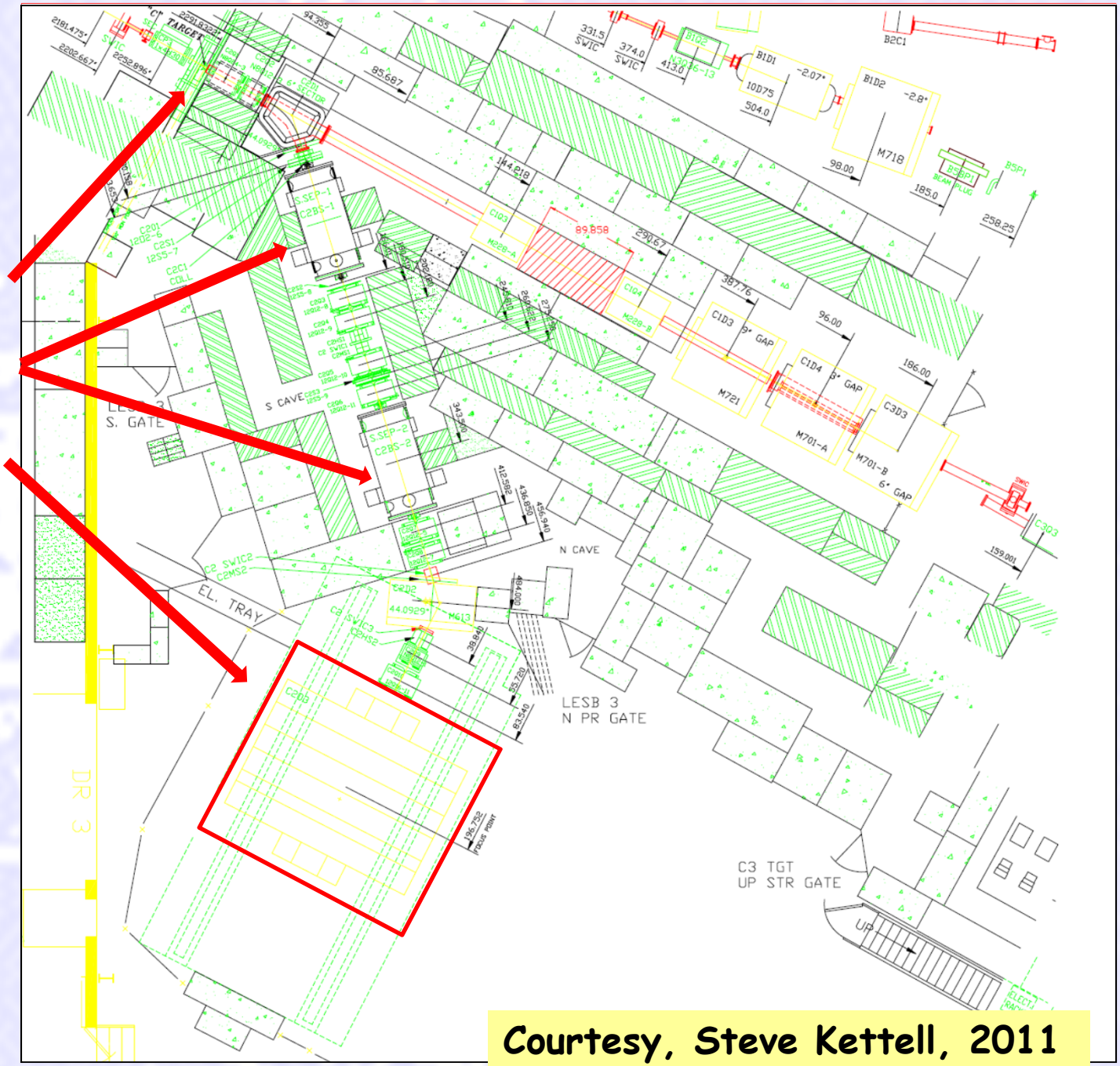


Siting of the Charged kaon PX prototype (E949) experiment at the BNL AGS operated at 50 kW

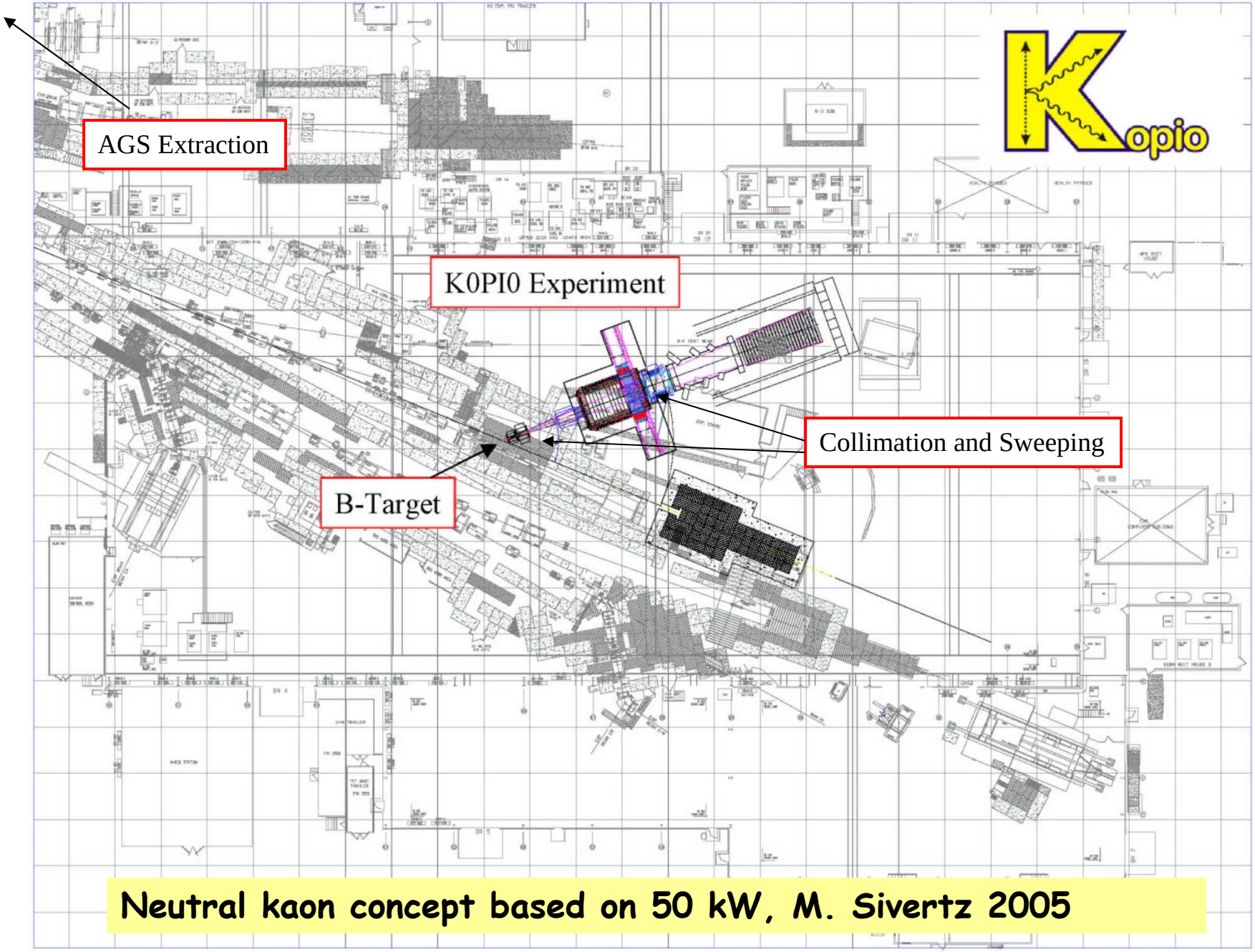
Target

ExB separators

Detector

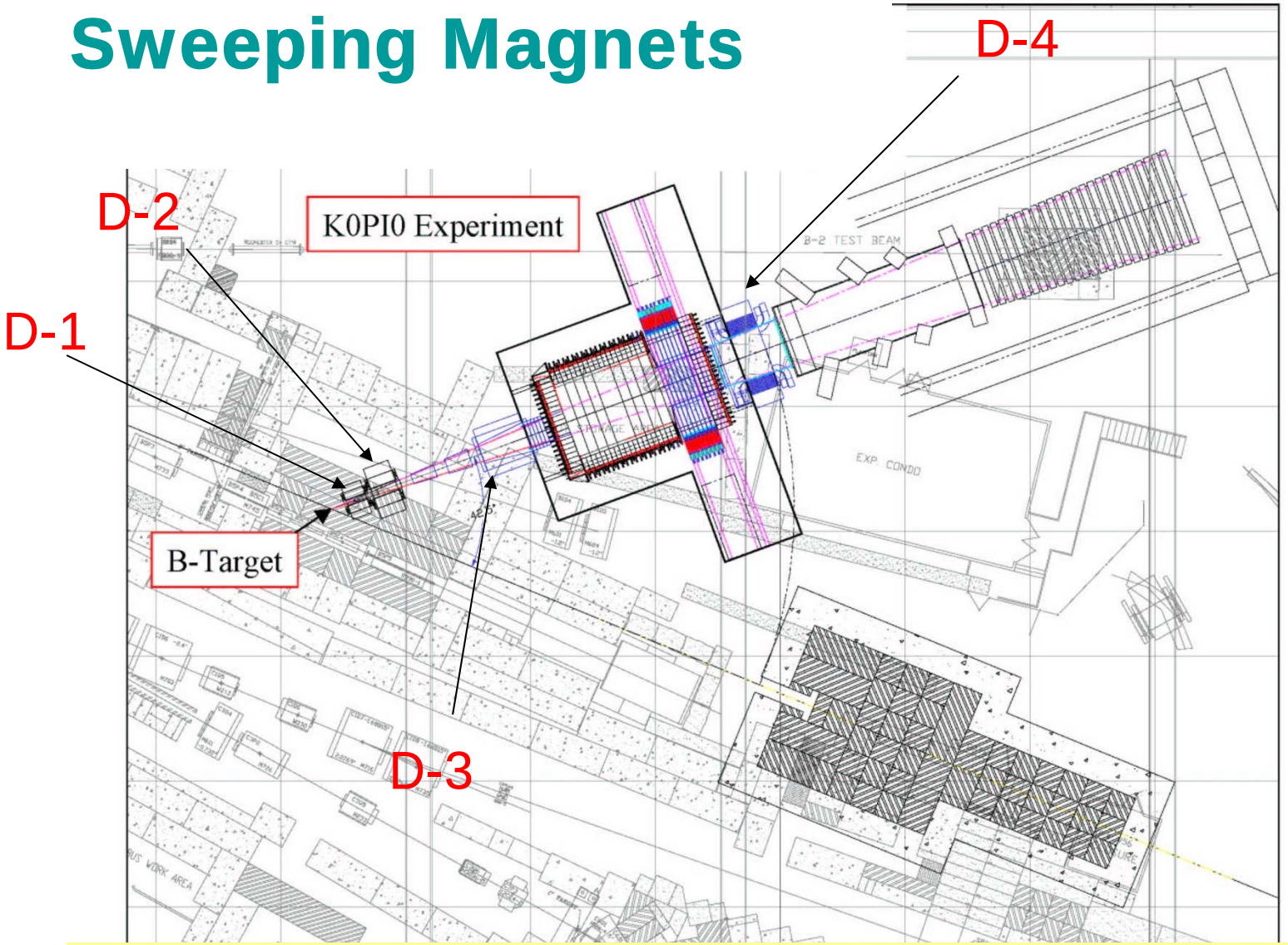


Courtesy, Steve Kettell, 2011



Neutral kaon concept based on 50 kW, M. Sivertz 2005

Sweeping Magnets



Neutral kaon concept based on 50 kW, M. Sivertz 2005