juas
Joint Universities Accelerator School

RADIATION SAFETY

Archamps - JUAS 2016

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Safety Officer

ISIS Spallation Neutron Source

STFC-Rutherford Appleton Laboratory

Science & Technology Facilities Council
ISIS

Two accelerator facility examples

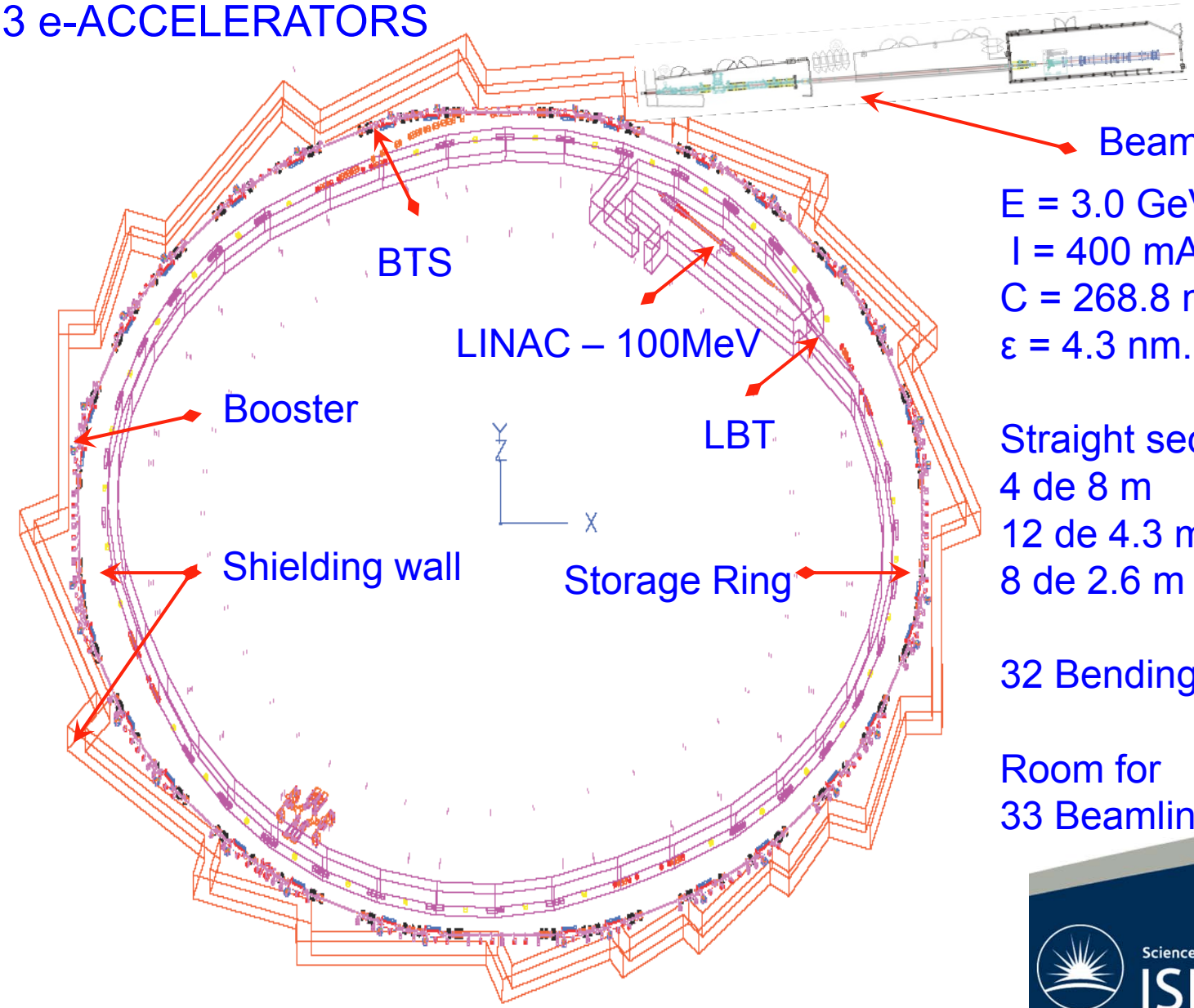
a. ALBA Synchrotron Light Source

b. ISIS Neutron Spallation Source

a. ALBA Synchrotron Light Source


A L B A

THE 3 e-ACCELERATORS



Beamline

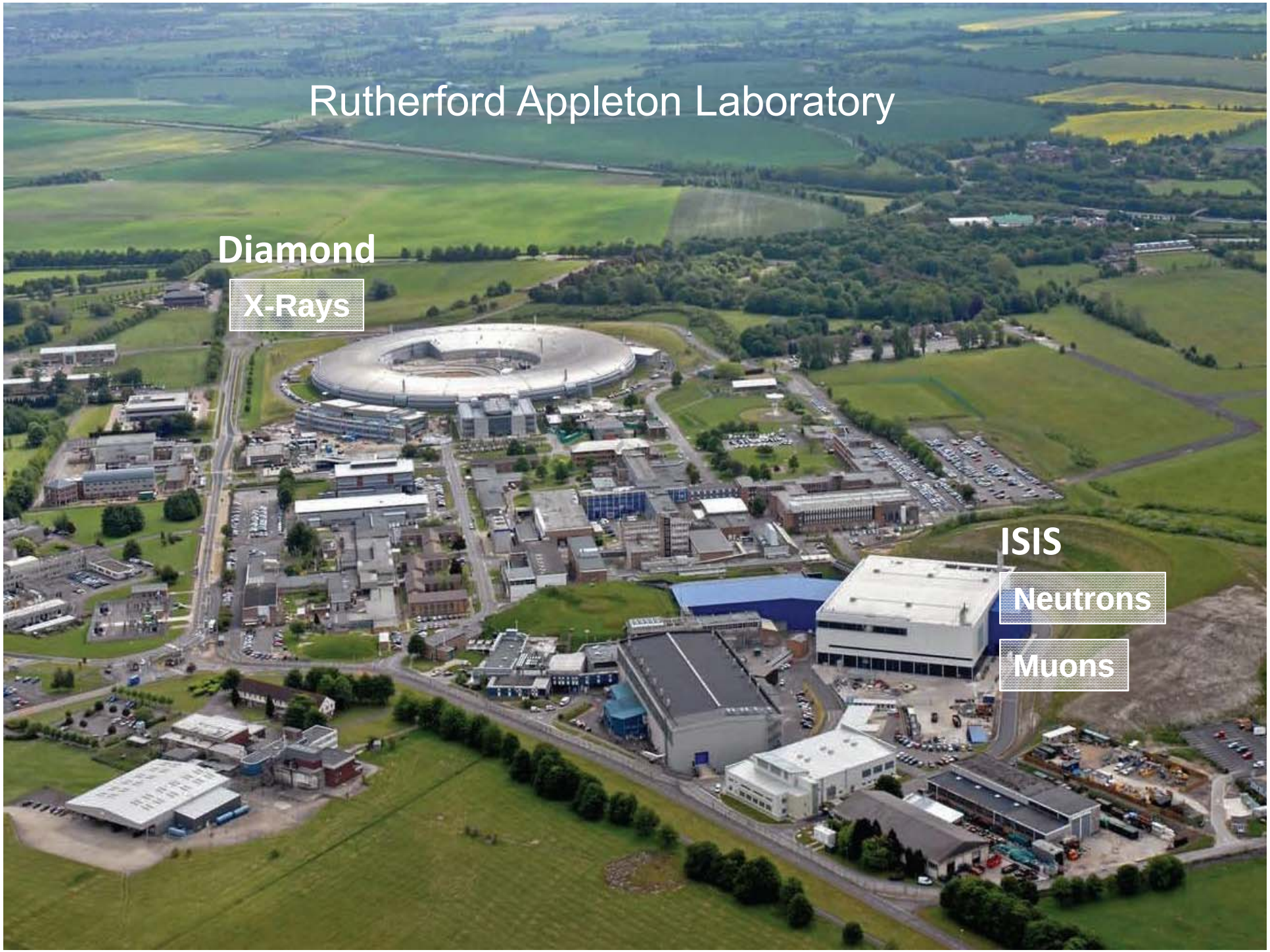
E = 3.0 GeV
I = 400 mA
C = 268.8 m
ε = 4.3 nm.rad

Straight section:
4 de 8 m
12 de 4.3 m
8 de 2.6 m

32 Bending Magnets

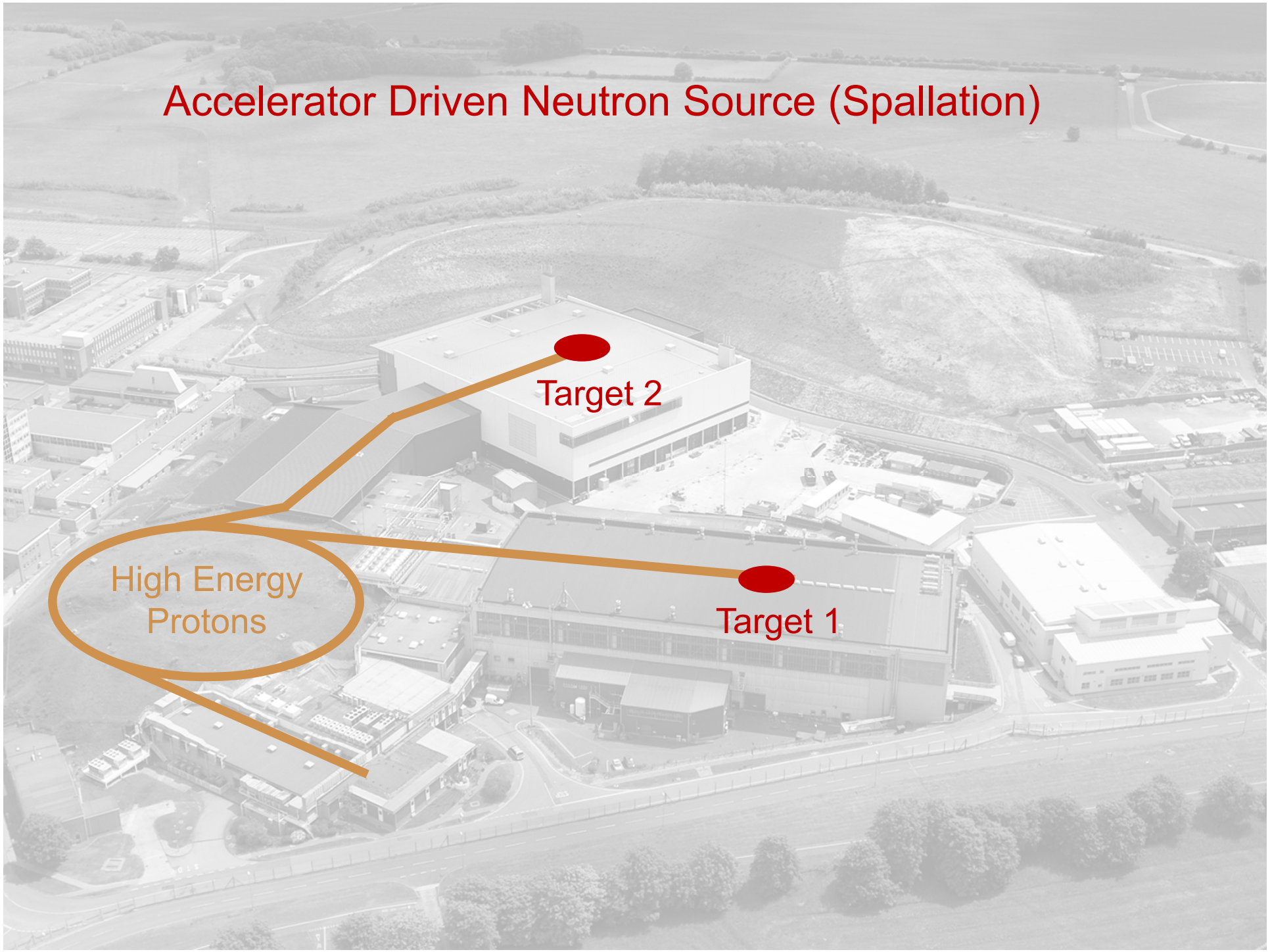
Room for
33 Beamlines

b. ISIS Neutron Spallation Source

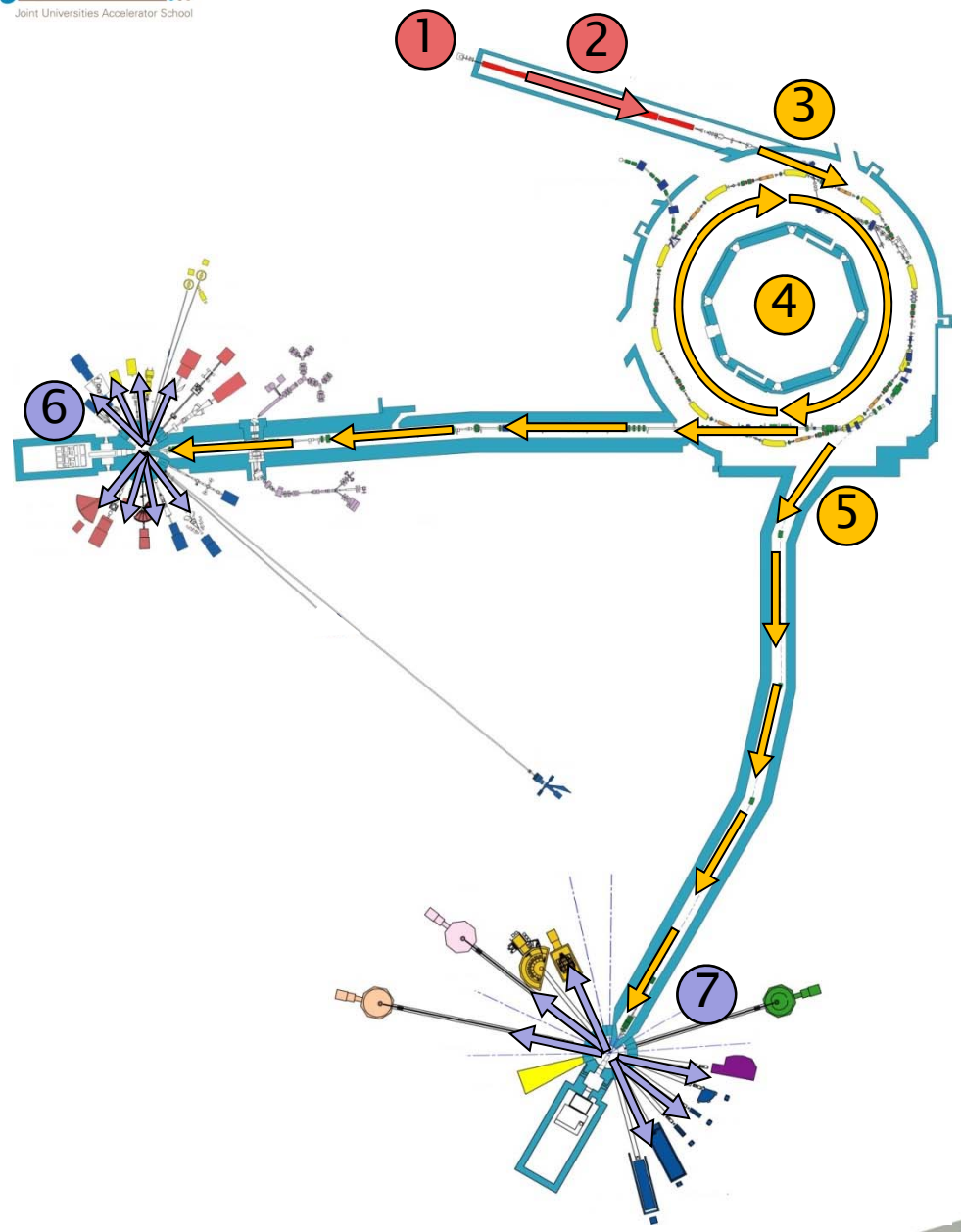

Rutherford Appleton Laboratory
Diamond
X-Rays
ISIS
Neutrons
Muons


Accelerator Driven Neutron Source (Spallation)

Accelerator Driven Neutron Source (Spallation)



How ISIS works



1 **Ion source:**
produces negative H^- ions.

2 **Linear accelerator:**
accelerates H^- ions to 37% speed of light.

3 **Alumina foil:**
strips away electrons leaving protons.

4 **Synchrotron:**
accelerates protons to 84% speed of light.

5 **Extracted proton beam**

6 + 7 **Tungsten targets:**
neutrons are produced through spallation

INTRODUCTION

Historical examples

International organizations

Part A.

Dose magnitudes

Part B.

Radiation sources

Part C.

Radiation shielding

Part D.

Radiation Safety Systems

Part E.

Radiation monitors

1. Historical examples
2. International organizations

…from the painters of dials with fluorescence paints containing radium…

…and the poor patients and doctors…

….Hiroshima and Nagasaki…

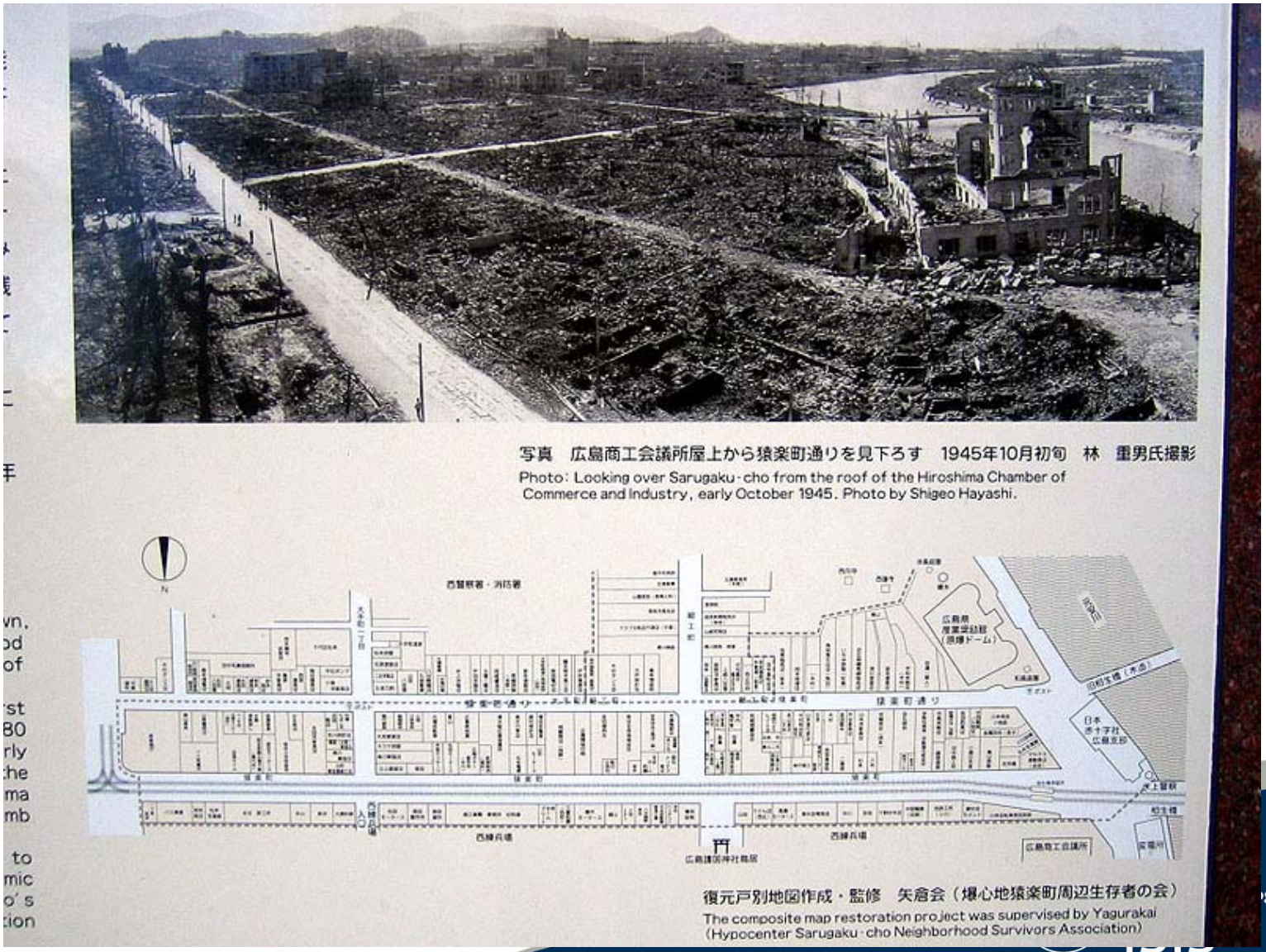


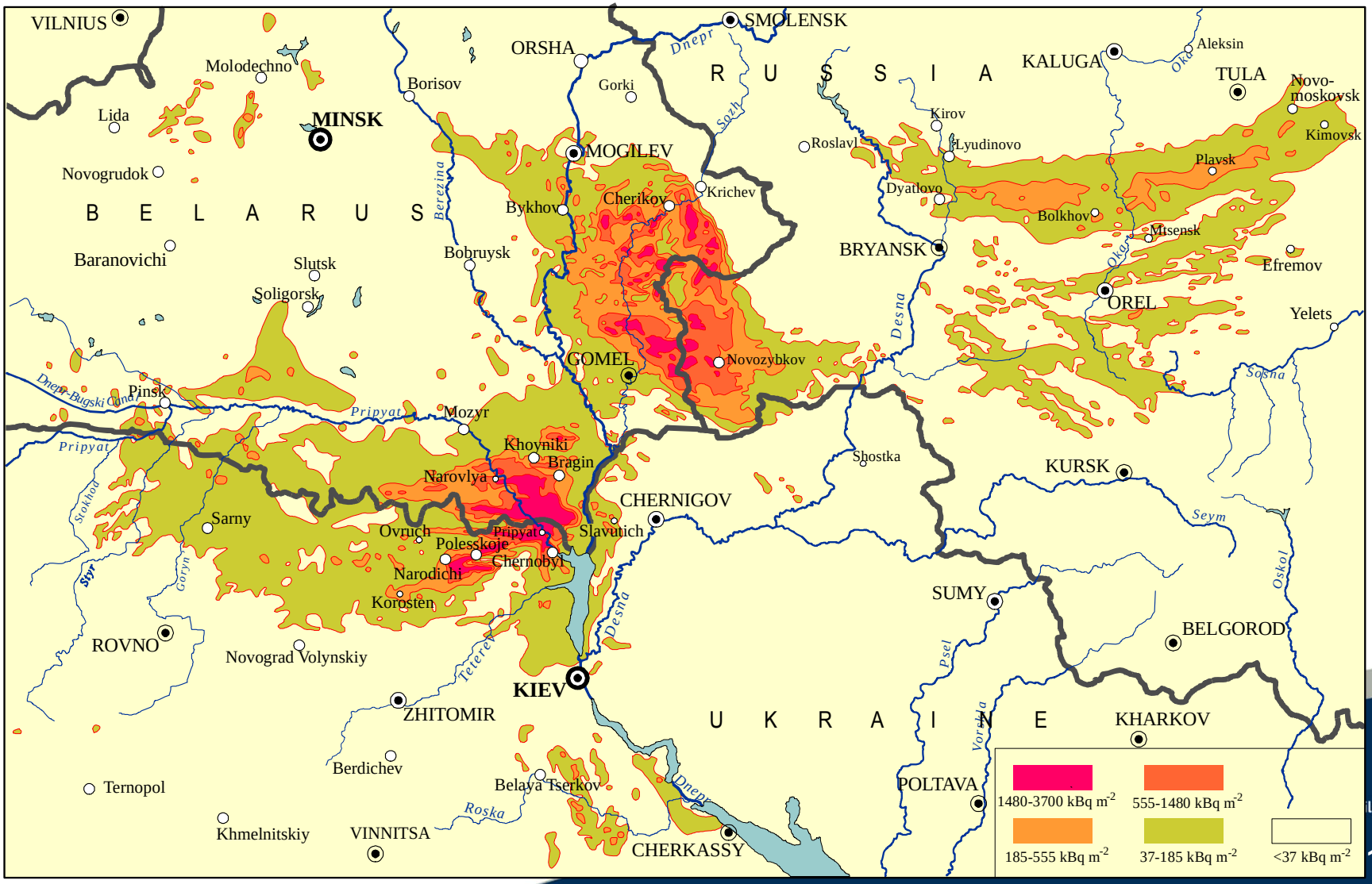
写真　広島商工会議所屋上から猿楽町通りを見下ろす　1945年10月初旬　林　重男氏撮影

Photo: Looking over Sarugaku-cho from the roof of the Hiroshima Chamber of Commerce and Industry, early October 1945. Photo by Shigeo Hayashi.

復元戸別地図作成・監修　矢倉会（爆心地猿楽町周辺生存者の会）

The composite map restoration project was supervised by Yagurakai (Hypocenter Sarugaku-cho Neighborhood Survivors Association)

1. Historical examples
…the effects of the Chernobyl accident…



UNSCEAR: United Nations Scientific Committee on the Effects of Atomic Radiation

- Sources and effects of ionizing radiation. Volume II: Effects (2000)
- Hereditary effects of radiation (2001)

http://www.unscear.org/

IAEA: International Atomic Energy Agency

http://www.iaea.org/

ICRP: International Commission on Radiological Protection.

- Publication 103: “The 2007 Recommendations of the International Commission on Radiological Protection”

http://www.icrp.org/

ELSEVIER

ICRP Publication 103

Annals of the ICRP

The 2007 Recommendations of the International Commission on Radiological Protection

ICRP Publication 103

Approved by the Commission in March 2007

Keywords: Justification; Optimisation; Dose limits; Constraints; Reference Levels

(n) The Commission now recognises three types of exposure situations which replace the previous categorisation into practices and interventions. These three exposure situations are intended to cover the entire range of exposure situations. The three situations are:

- *Planned exposure* situations, which are situations involving the planned introduction and operation of sources. (This type of exposure situation includes situations that were previously categorised as practices.)
- *Emergency exposure* situations, which are unexpected situations such as those that may occur during the operation of a planned situation, or from a malicious act, requiring urgent attention.
- *Existing exposure* situations, which are exposure situations that already exist when a decision on control has to be taken, such as those caused by natural background radiation.

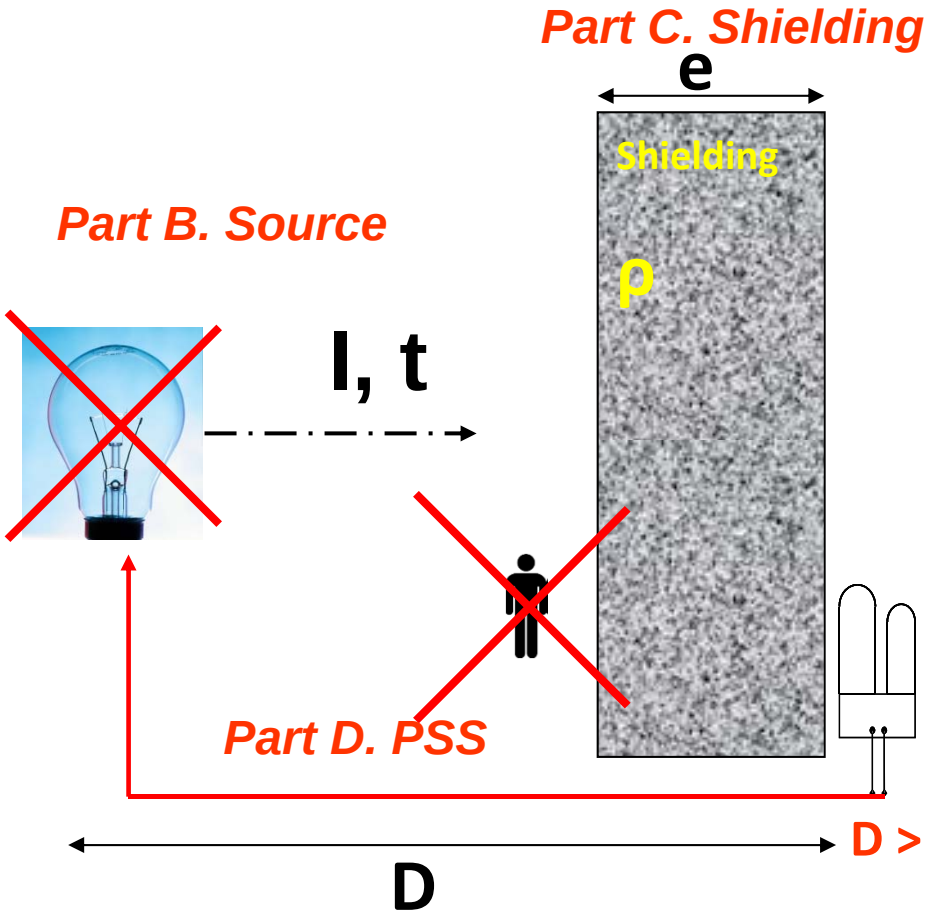
(o) The three key principles of radiological protection are retained in the revised Recommendations. The principles of *justification* and *optimisation* apply in all three exposure situations whereas the principle of *application of dose limits* applies only for doses expected to be incurred with certainty as a result of planned exposure situations. These principles are defined as follows:

- *The Principle of Justification*: Any decision that alters the radiation exposure situation should do more good than harm.
- *The Principle of Optimisation of Protection*: The likelihood of incurring exposure, the number of people exposed, and the magnitude of their individual doses should all be kept as low as reasonably achievable, taking into account economic and societal factors.
- *The Principle of Application of Dose Limits*: The total dose to any individual from regulated sources in planned exposure situations other than medical exposure of patients should not exceed the appropriate limits specified by the Commission.

ALARA principle

The Commission continues to distinguish amongst three categories of exposure: occupational exposures, public exposures, and medical exposures of patients (and comforters, carers, and volunteers in research). If a female worker has declared that she is pregnant, additional controls have to be considered in order to attain a level of protection for the embryo/fetus broadly similar to that provided for members of the public.

ALARA principle:
As Low As Reasonably Achievable



I	Source Intensity	
D	**Distance**	
e	Thickness	**Shielding**
ρ	Density / Composition	
N	Number of exposed workers	
t	**Time**	

From Wikipedia *(http://en.wikipedia.org/wiki/Ionizing_radiation):*
"Ionizing (or ionising in British English) radiation is radiation that carries **enough energy to liberate electrons from atoms or molecules**, thereby ionizing them. Ionizing radiation is composed of energetic subatomic particles, ions or atoms **moving at relativistic speeds**, **and electromagnetic waves on the high-energy** end of the electromagnetic spectrum."

HAZARD:

1. Exposure or vulnerability to injury, loss, evil, etc
2. A thing likely to cause injury, etc

RISK:

1. The possibility of incurring misfortune or loss;

Ionisation Radiation Hazard symbol