Case Study Presentation

GROUP 1

Banana
Republic
Advanced
Ion
National

Center

We are glad to introduce the new cancer therapy facility, designed to treat various kind of disease with innovative ions species.

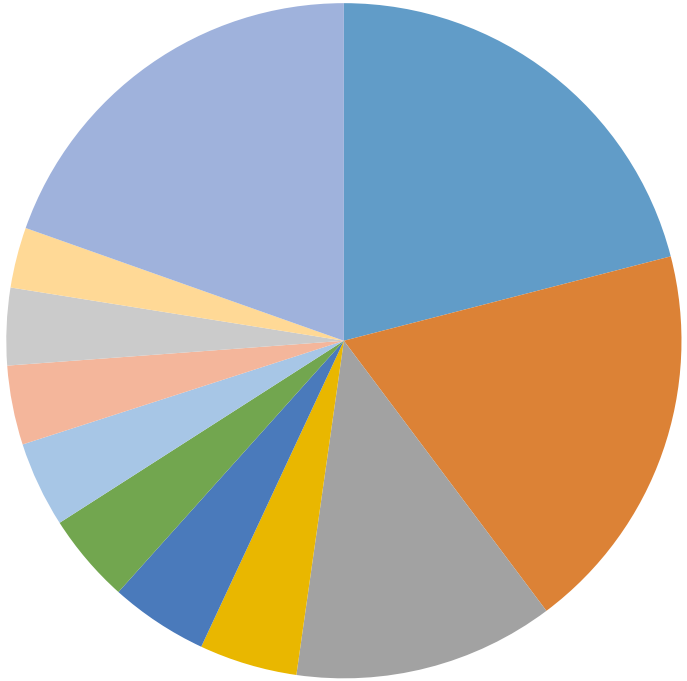
Welcome to Banana Republic

- Banana Republic: A democratic military republic
- Motto: 'The president works for the people, and not the people for the president'. ('Free of bureaucracy country', President General Casc).
- Main income: natural resources and tourism
- Population: 5M
- GPD: 20,000 US dollars
- Facility next to Largest national hospital at 10 minutes distance
- Collaboration with the only university (NUB) to train students
- Local experts in nuclear engineering (energy and defense), to be trained in other centers abroad

Proportion of Deaths in the Banana Republic

- Cancer (29.9%)
- Heart disease (19.7%%)
- Celebrovascular diseases (5.5%)
- Chronic lower respiratory diseases (4.6%)
- Accidents (4.4%)
- Diabetes (3.0%)
- Alzheimer's disease (2.6%)
- influenza and pneumonia (2.4%)
- suicide (1.5%)
- kidney disease (1.4%)
- others (25.0%)

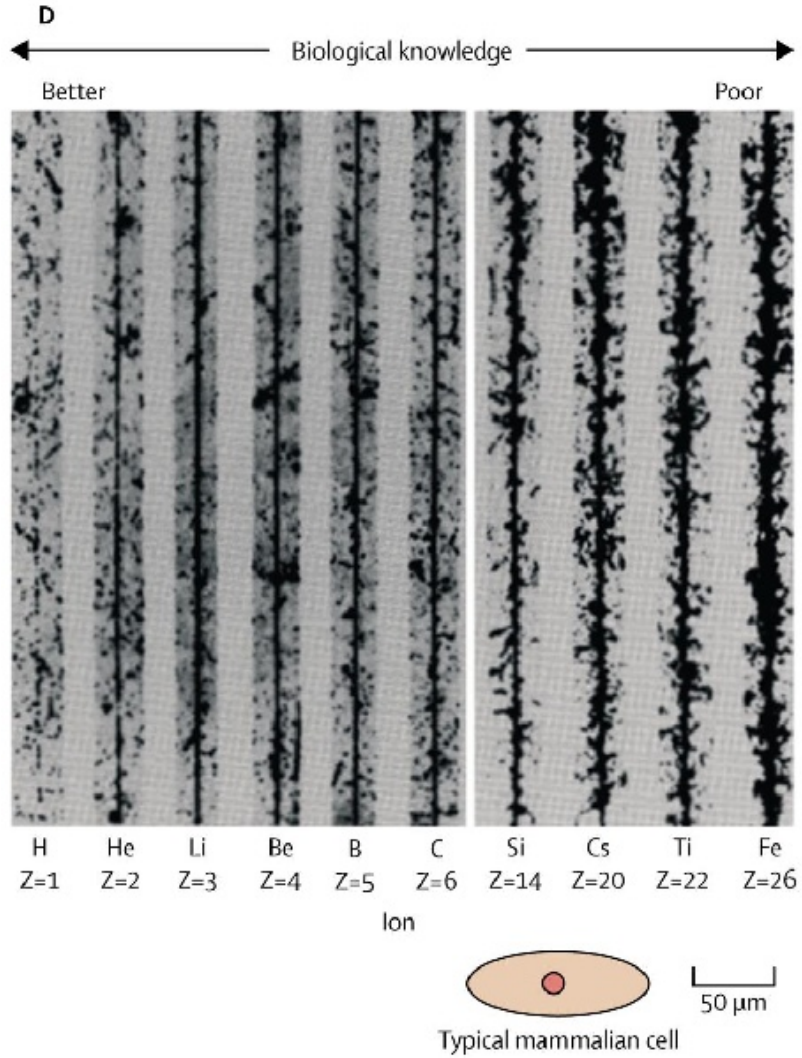
Distribution of 10- year tumour based prevalence for selected cancers



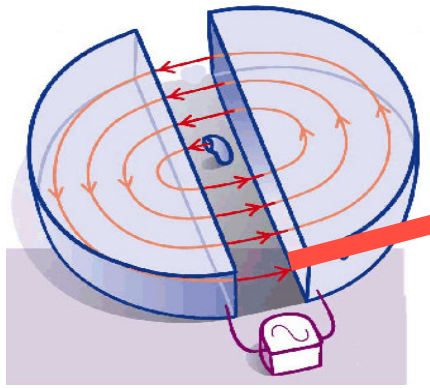
- Prostrate (21.0%)
- Breast (18.8%)
- Colorectal (12.5%)
- Lung (4.7%)
- Melanoma (4.7%)
- Non-Hodgkin lymphoma (4.3%)
- Bladder (4.1%)
- Body of Uterus (3.8%)
- Tyroid(3.7%)
- Kidney(2.9%)
- All other cancers(19.6%)

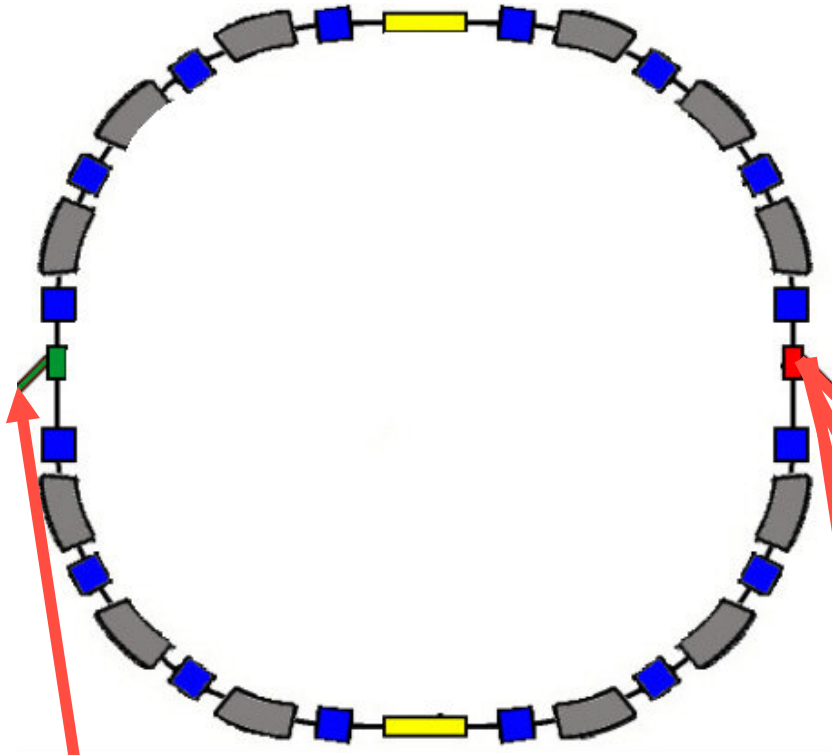
Choice of Particle types Li

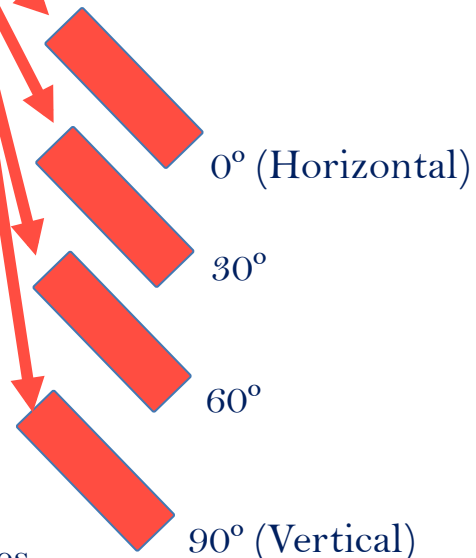
- Strong interest for radiobiology studies and therapy
- Good RBEs
- Good ballistic focusing
- Readily available
- Relatively low magnetic strength requirement for gantry operation
- Relatively low cost
- Compact source

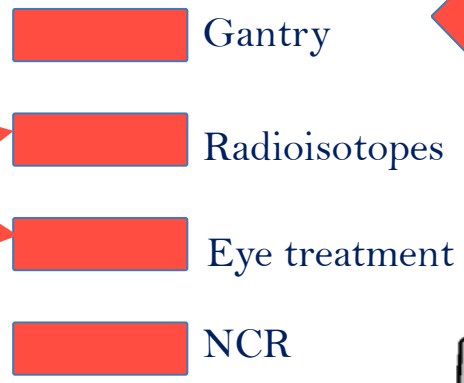


Accelerator complex





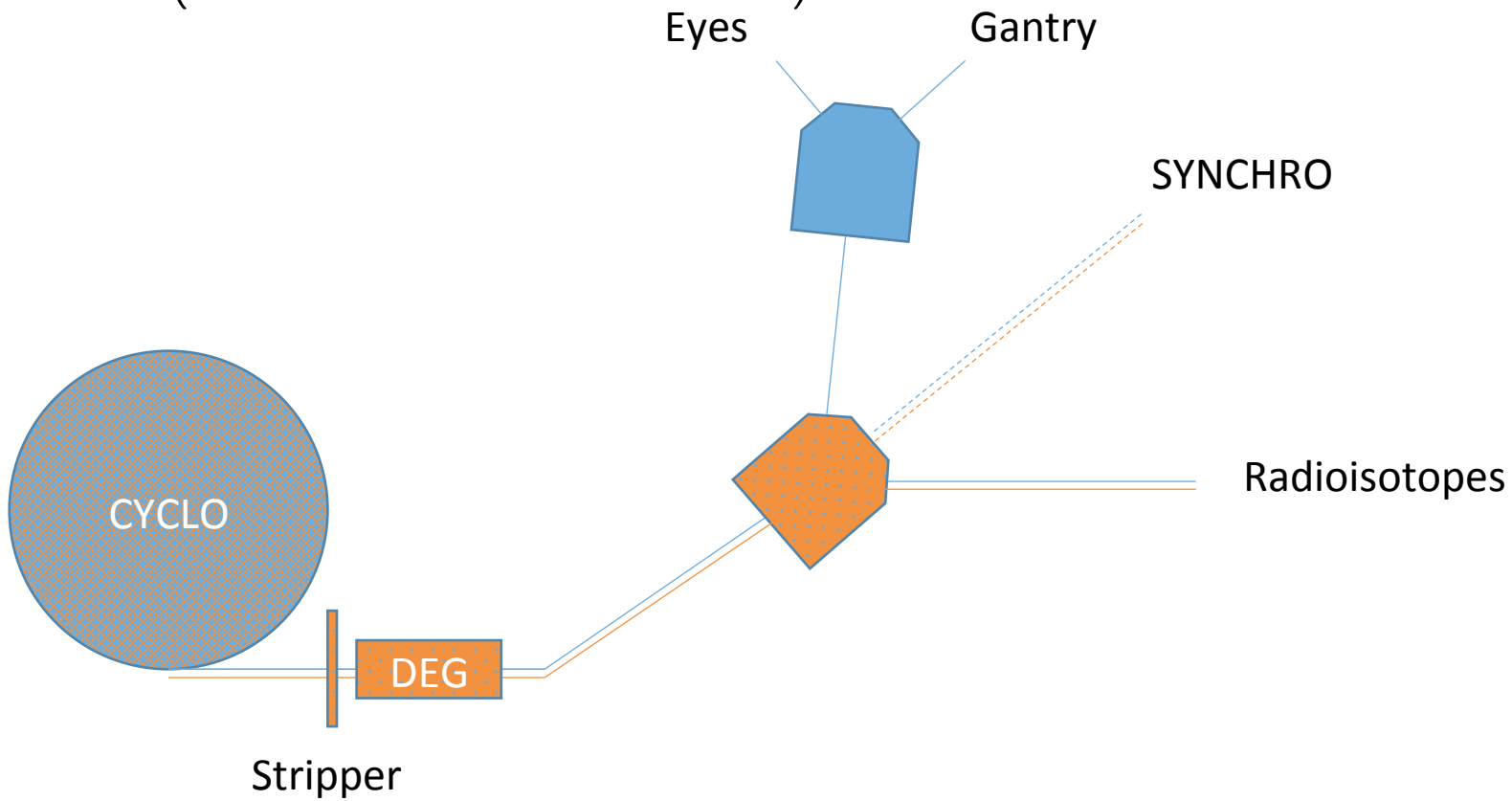




Cyclotron

- Sources: H_2^+, $^4He^{2+}$, $^6Li^{3+}$ (q/m = ½)
- SC Isochronous-Cyclotron (2.9Tm = 100MeV/u)

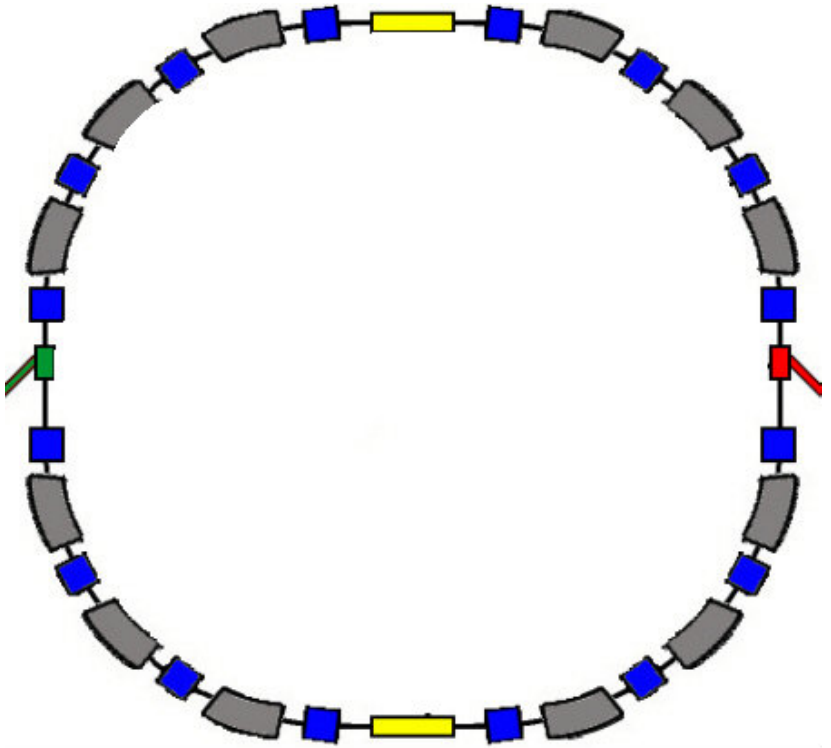
part. type	Depth [cm]
p	7.7
He	7.1
Li	6
C	2.5
O	2



Synchrotron

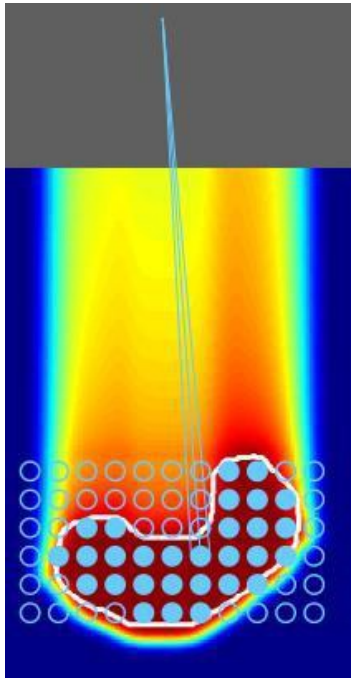
- Standard elements and well known techniques
- Warm magnets: B_max ≈ 1.5 T
- Max. energy determines size circumference: E_max (Li) ≈ 250 MeV/u (for 30 cm)
  → Synchrotron diameter ≈ 15 m
- Slow extraction: transverse RF-Knockout

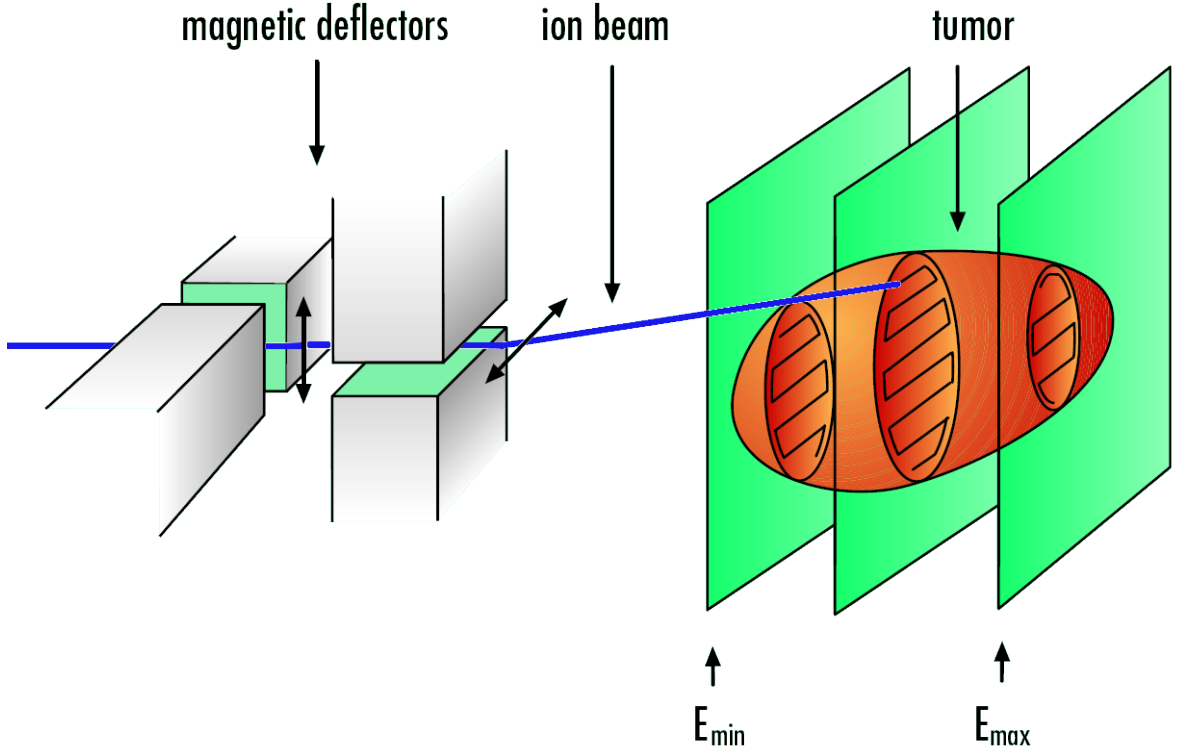
part. type	Depth [cm]
p	37.5
He	34.5
Li	30
C	13
O	10



Dose Delivery System

- Active Rasterscanning (state of the art)
- Highest dose conformity
- Avoid passive elements where possible





Treatment Organization

- Beam operations open 24/7 > 300 days/ year
- Estimate 1500 patients/year, ~ 120 patients/day
- Center open for medical treatment
  - 6:00 am – 10:00 pm include QA (4 hrs/day)
  - 5 working days/ week
- NCR 7 days/week
  - Working days after medical treatment
  - Weekend 24 hrs

Cost estimation

< 2 x  (150 M€ each)

- Overall cost 250 M€
- Income 37.5 M€/year (1500 patients x 25 k€)
- Running cost 10 M€/year
  - 1 M€ for electricity
  - 7.5 M€ for personnel
  - 1.5 M€ for others
- Turn a round time is 10 years (extreme case, in reality 20 years)

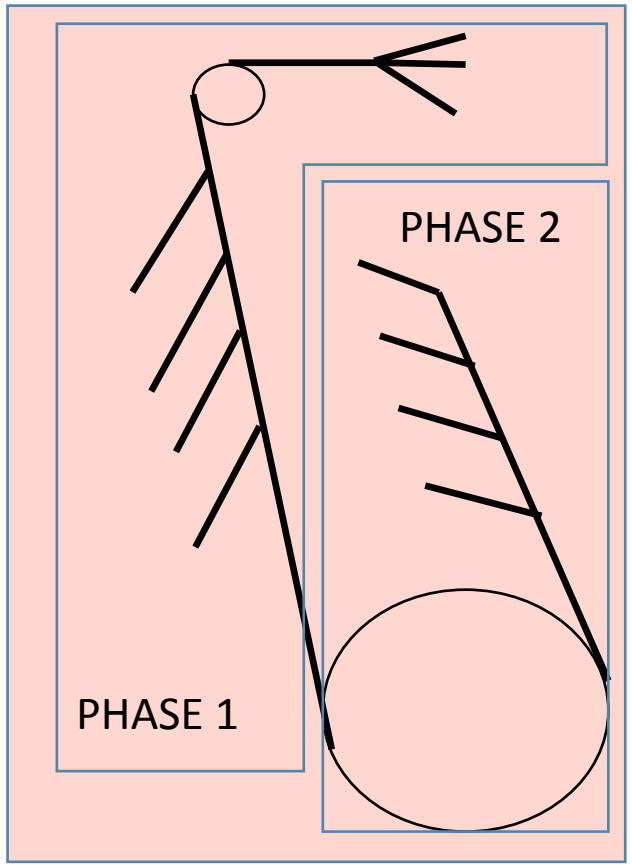
Project timeline

June 2016

CDR: Dec 2016

June 2017

Architecture, civil engineering



TDR

June 2020

Construction building, components: magnets, vacuum, power converters…

Dec. 2021

Com. Source 1

June 2021

Com. Source 2

First patient with cyclotron

June 2022

Com. Source 2

Synchrotron components, installation

June 2024

Synchrotron commissioning

First patient with synchrotron

Running 2022-2050

Thank you