THE CURE BY THE RINGS

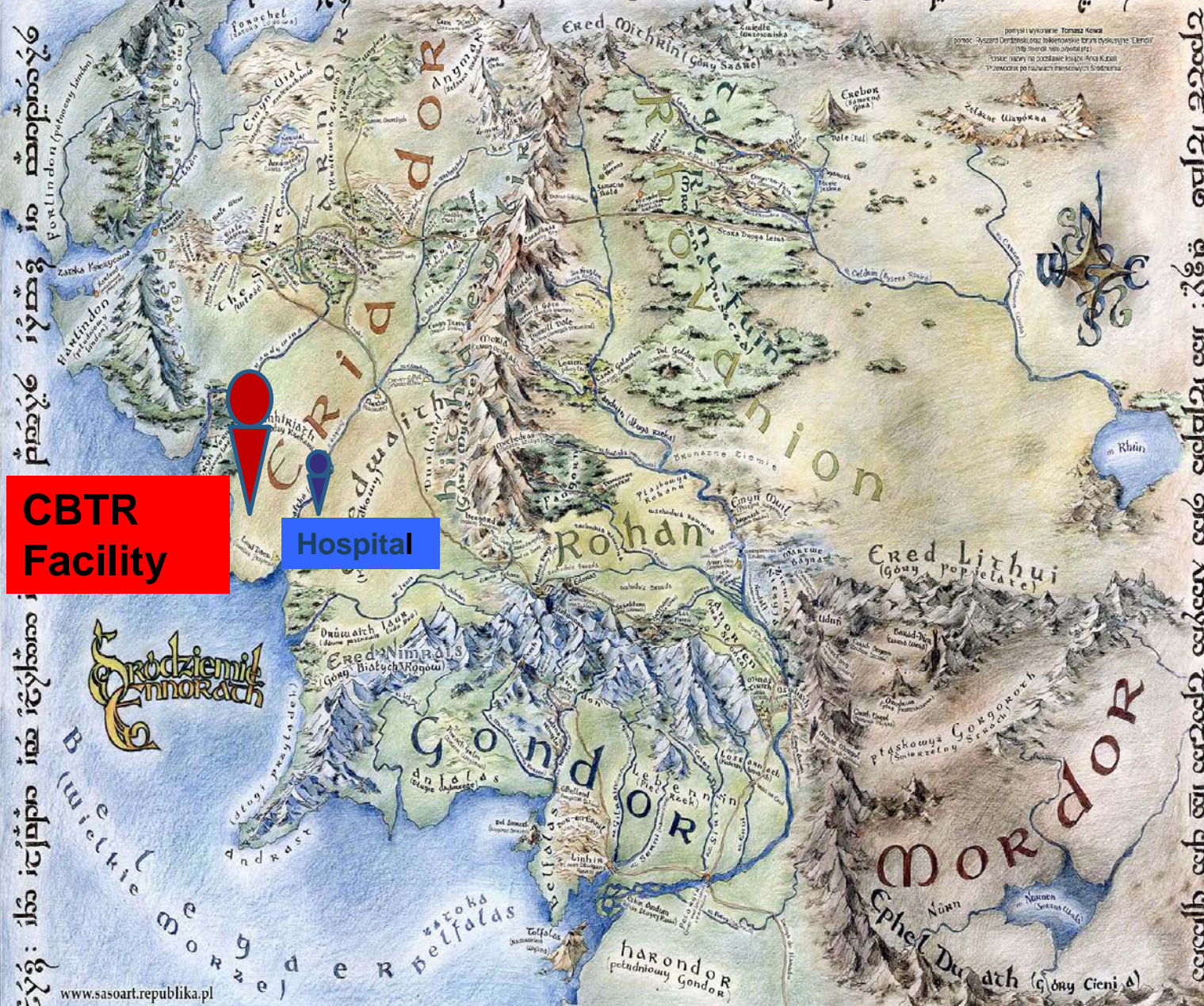## CANCER TREATMENT FOR ALL SPECIES

James dela Cruz
Veliko Dimov
Han Li
Mauro Pivi
Valeria Rizzoglio
Sebastian Rothe

CBTR Ion Therapy Center

CBTR
Facility

Hospital

Some of the Target Species

Hobbit (low energy)

Goblin
(definitely need eye
tumor treatment)

Elf

Human

and the brain tumor of Sauron

THE PERIODIC TABLE
* OF MIDDLE-EARTH *

INCLUDES CHARACTERS FROM
THE LORD OF THE RINGS &
THE HOBBIT BY J.R.R TOLKIEN

by Emil Johansson
LOTRPROJECT.COM

Hobbits

F 1 — FRODO			
B 4 — BILBO	**Me** 5 — MERIADOC BRANDYBUCK		
Pi 13 — PEREGRIN TOOK	**Ft** 14 — FREDEGAR BOLGER		
Dn 21 — BELLADONNA TOOK	**Ot** 22 — OTHO SACKVILLE-BAGGINS	**Eg** 23 — ELANOR GARDNER	**Ro** 24 — ROSE COTTON
Bu 40 — BULLROARER TOOK	**Lo** 41 — LOBELIA SACKVILLE-BAGGINS	**Sg** 42 — SAMWISE GAMGEE	
Ol 65 — OLD TOOK	**Lt** 66 — LOTHO SACKVILLE-BAGGINS	**Hg** 67 — HAMFAST GAMGEE	
Go 91 — GOLLUM (SMÉAGOL)	**De** 92 — DÉAGOL	**Fm** 93 — FARMER MAGGOT	

Men

Bb 25 — BARLIMAN BUTTERBUR	**Ml** 26 — MASTER OF LAKETOWN	**H** 27 — HÁMA	**Em** 28 — ÉOMER	**Td** 29 — THÉODRED	**Im** 30 — IMRAHIL	**Fr** 31 — FARAMIR	**Hb** 32 — HALBARAD	**Ar** 33 — ARAGORN
Bf 50 — BILL FERNY	**Bd** 51 — BARD THE BOWMAN	**Gm** 52 — GAMLING	**Eo** 53 — ÉOWYN	**Te** 54 — THÉODEN	**Ag** 55 — ANGBOR THE FEARLESS	**Br** 56 — BOROMIR	**Be** 57 — BERGIL	**I** 58 — ISILDUR
Gh 76 — GHÂN-BURI-GHÂN	**Gir** 77 — GIRION	**Gb** 78 — GRIMBOLD	**Gr** 79 — GRÍMA	**Eb** 80 — ERKENBRAND	**Fg** 81 — FORLONG OF LOSSARNACH	**Dt** 82 — DENETHOR II	**Bn** 83 — BEREGOND	**Ee** 84 — ELENDIL
	Beo 102 — BEORN	**Ms** 103 — MOUTH OF SAURON	**Bw** 104 — BARROW-WIGHTS	**Kd** 105 — THE KING OF THE DEAD	**Nz** 106 — THE NAZGÛL	**Wk** 107 — THE WITCH-KING OF ANGMAR	**Gth** 108 — GOTHMOG	

Unknown (Gth)

Elves

Ci 6 — CÍRDAN	**Gl** 7 — GIL-GALAD	**Gd** 8 — GALADRIEL	**Tr** 9 — THRANDUIL
Ed 15 — ELROND	**Gf** 16 — GLORFINDEL	**Ce** 17 — CELEBORN	**L** 18 — LEGOLAS
Aw 34 — ARWEN	**Li** 35 — LINDIR	**Gi** 36 — GILDOR	**Gn** 37 — GALION
Eh 59 — ELROHIR	**El** 60 — ELLADAN	**Er** 61 — ERESTOR	**Ha** 62 — HALDIR

Half-Elves (Ed)

Treebeard

T 10 — TREEBEARD	**Q** 19 — QUICKBEAM
W 38 — OLD MAN WILLOW	

E 2 — ELBERETH GILTHONIEL	**Tb** 3 — TOM BOMBADIL	
Sa 11 — SARUMAN	**Au** 12 — GOLDBERRY	
Ga 20 — GANDALF		
Ra 39 — RADAGAST		

Orcs/Goblins/Uruks

Rc 63 — ROÄC	**Gw** 64 — GWAIHIR			
Bg 85 — BOLG	**Az** 86 — AZOG	**U** 87 — UGLÚK	**Gu** 88 — GOLFIMBUL	**Sm** 89 — SMAUG	**Db** 90 — DURIN'S BANE
Gor 109 — GORBAG	**Sr** 110 — SHAGRAT	**Gk** 111 — GRISHNÁKH	**Gg** 112 — GREAT GOBLIN	**Sh** 113 — SHELOB	**S** 114 — SAURON

Dwarves

Du 43 — DURIN I	**Th** 44 — THRÓR		**Oi** 45 — OÍN	**Dr** 46 — DORI	**Bi** 47 — BIFUR
Dur 68 — DURIN VI	**Tn** 69 — THRÁIN II	**Ba** 70 — BALIN	**Fi** 71 — FÍLI	**Goi** 72 — GLÓIN	**Nr** 73 — NORI	**Bo** 74 — BOFUR
Da 94 — DÁIN II IRONFOOT	**To** 95 — THORIN OAKENSHIELD	**Dw** 96 — DWALIN	**Ki** 97 — KÍLI	**G** 98 — GIMLI	**Or** 99 — ORI	**Bm** 100 — BOMBUR

Trolls

Bt 49 — BERT	
Tm 75 — TOM	
Bl 101 — BILL	

KEY

birth date / death date — b.??? d.??? — **Np** 254 — YOUCANNOT PASSIUM
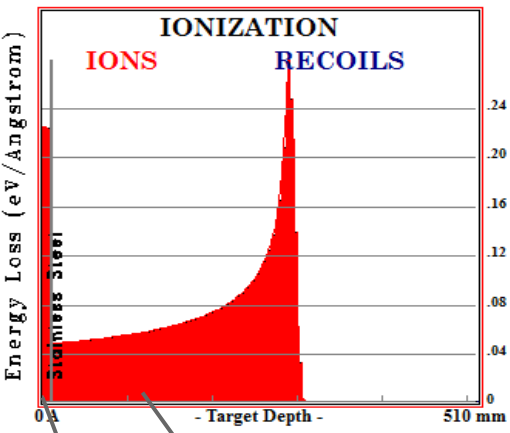number, symbol, character name

ABBREVIATIONS

M.o.t.A. — Music of the Ainur
Y.T. — Year of the Trees
F.A. — First Age
S.A. — Second Age
T.A. — Third Age
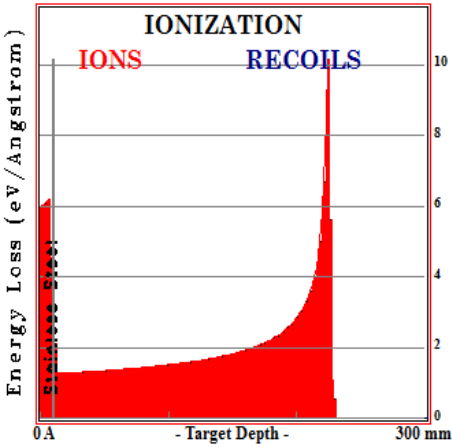Fo.A. — Fourth Age

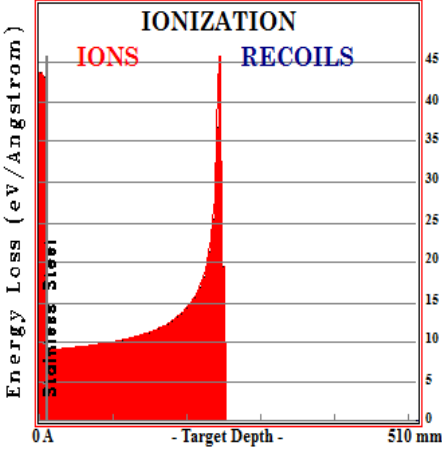⊙ Wearer of the One Ring

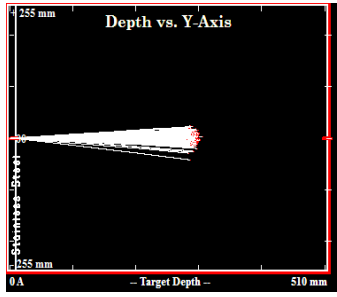# SRIM simulation for Armoured Sauron
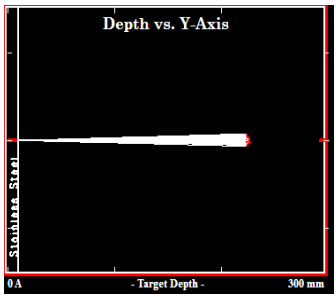
250 MeV H+

416 MeV C6+

875 Mev/U Argon

A-150 Tissue-Eqiv. Plastic (ICRU-099)

10 mm armor layer (stainless steel)

p+ scatters much more than c6+

Argon ions (**875 MeV/u**)

Accelerator layout

p   250MeV/u
C6+   416MeV/u
Ar18+ 875MeV/u

7MeV/u

| ECR |
| ECR |

| R&D |
| R&D |

RFQ 1   IH 1

RFQ 2   IH 2

heavy ion linac
(upgrade phase II)

splitter   CERN-PSB type   combiner
            synchrotron
            4 rings
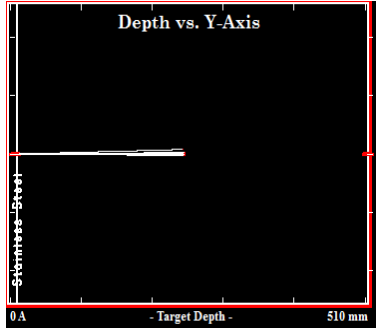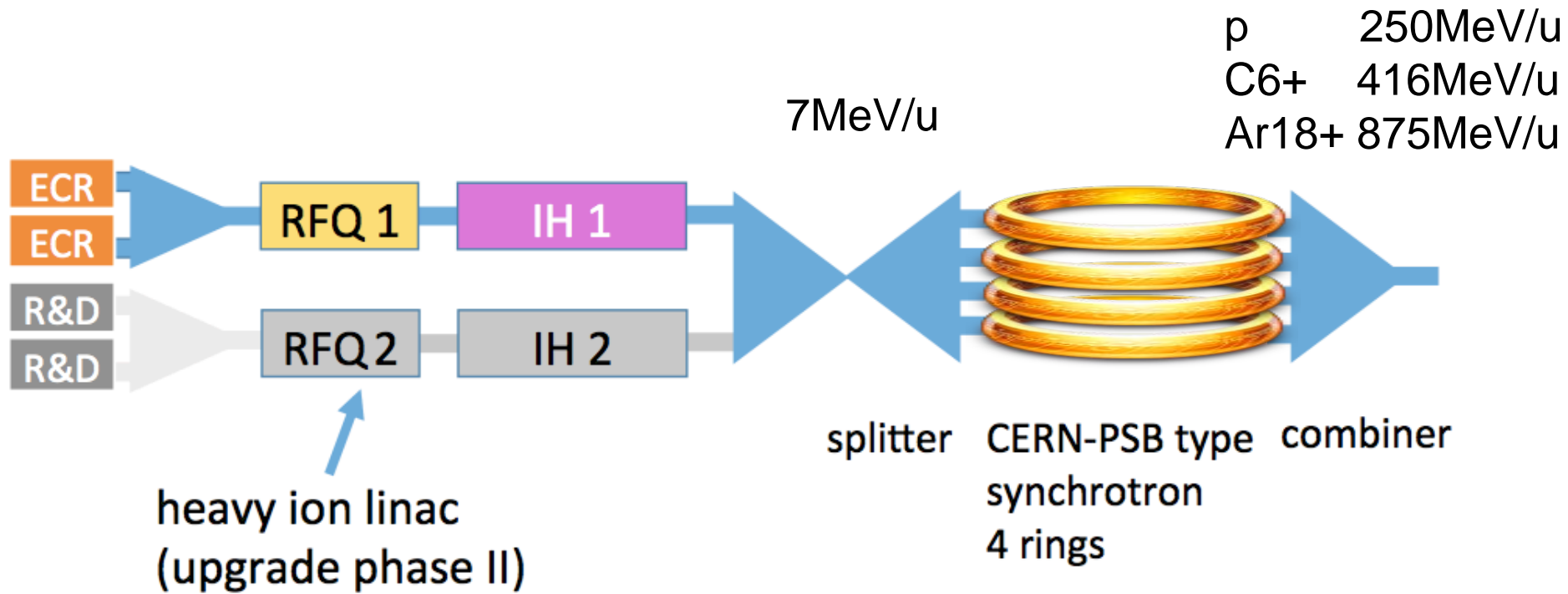
Acceleration and extraction sequence

magnet hysteresis cycle

B-field

IV

III

II

I

IV

III

II

I
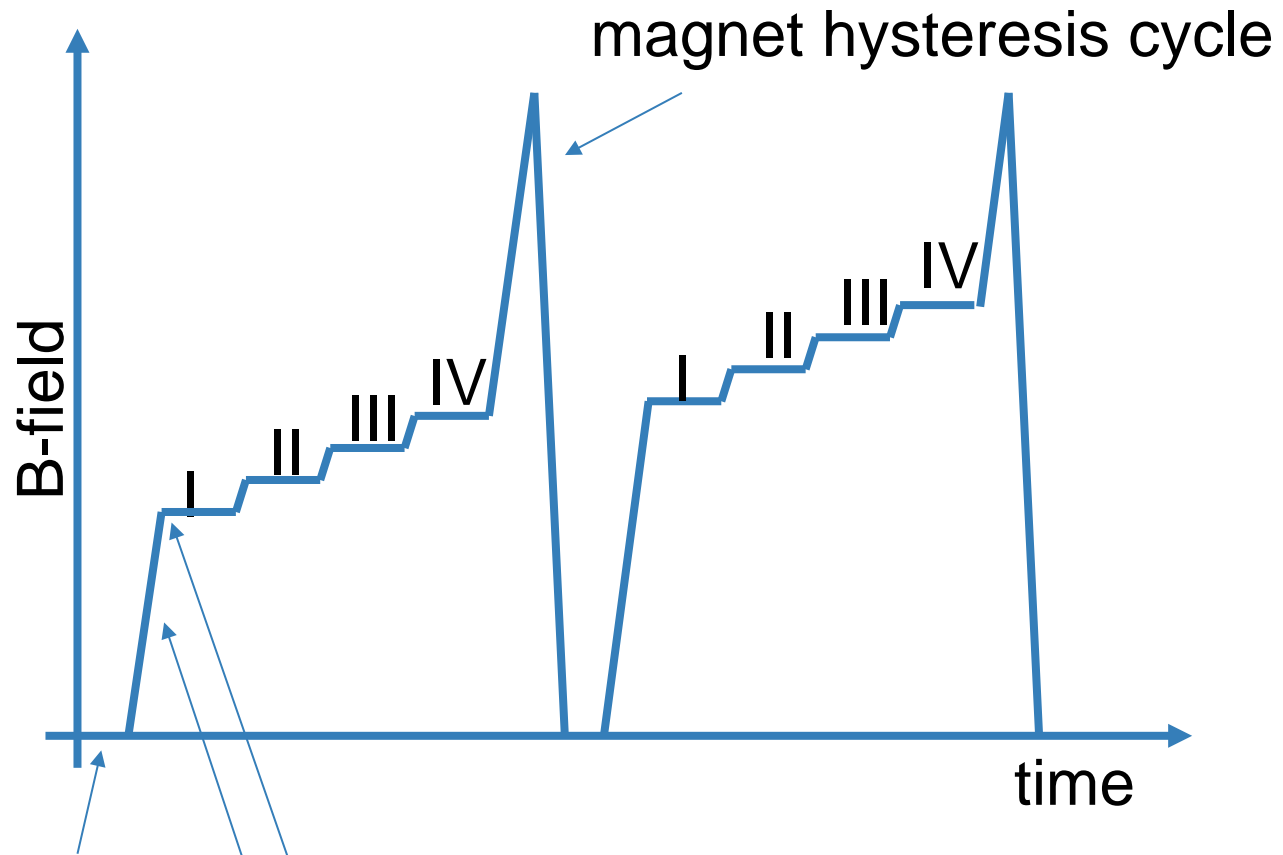
time

injection in rings I-IV

slow extraction of ring I
ramp up to first energy

-> HUGE Reduction in beam delivery time

Properties of the Rings

- Most elements when fully stripped have charge/mass ratio Z/A ≈ 2.
- Z/A ratio determines B
- .
- Elements with same Z/A or Bρ ratio can be accelerated in the <u>same ring</u>.
  Even if they have very different masses!

- For 1.5 T field = 8 m ρ
- 32 dipoles @ 1.57 m length
- With straight sections: 120 m circumference
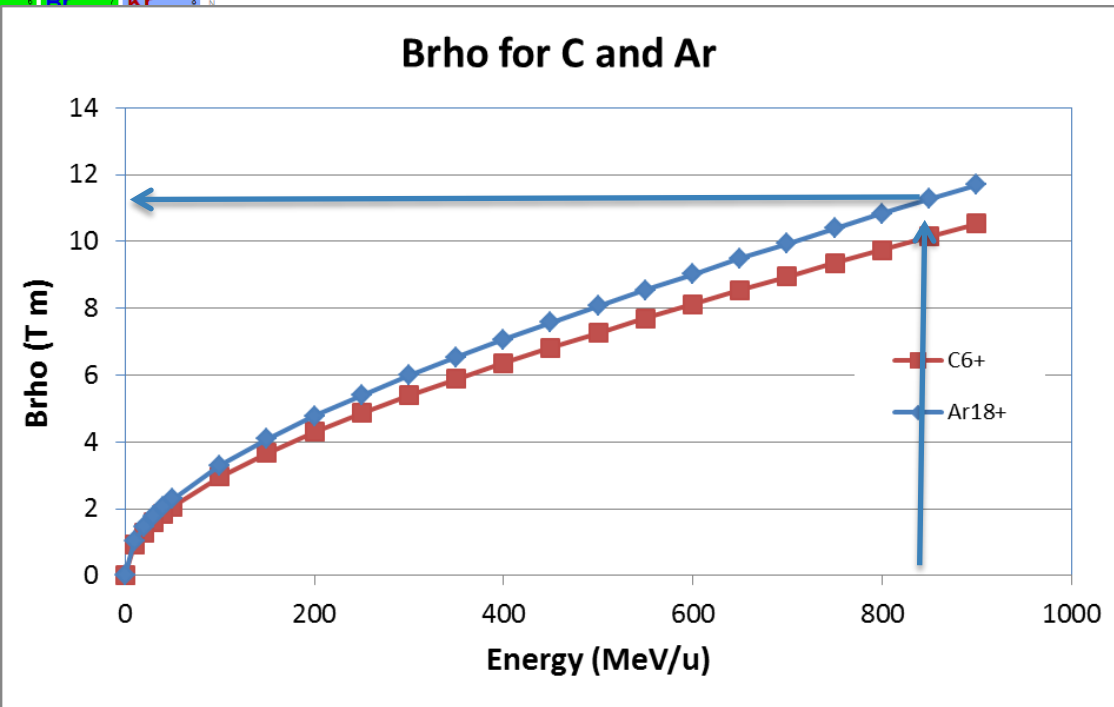
Magnets and RF cavities inventory

Device name	Devices in operation	Remarks	Number of spares
Main dipole (1 family)	32 × 4	for 4 rings	1 + coils
Main quadrupole (3 families)	24 × 4	4 rings	1 + coils
Main ring sextupoles (2 families)	4 × 4	4 rings	1 + coils
Main ring horizontal correctors	12 × 4	4 rings	2
Main ring vertical correctors	12 × 4	4 rings	2
Tune kicker Air-cooled	2 × 4	4 rings	1
Injection bumpers	2 × 4	4 rings	1
Beam Dump bumpers	2 × 4	4 rings	1
Air-cored correction quadrupoles	1 × 4	4 rings	0
Thin' magnetic extraction septum	1 x 4	4 rings	Coils
Thick' magnetic septum	1 x 4	4 rings	Coils
Electrostatic extraction septum	1 x 4	4 rings	selected components
Magnetic injection septum	1 x 4	4 rings	Coils
Electrostatic injection septum	1 x 4	4 rings	selected components
RF cavity (312.5 kHz)	1 x 4	4 rings	1 + selected components
RF knock-out cavities	1 x 4	4 rings	1 + selected components
Chopper bumpers	4	common extraction line	1 + coils
Extraction line dipoles	25	12 irradiation rooms	1 + coils
Extraction line quadrupoles	52	12 rooms	2 + coils
Extraction line horizontal correctors	20	12 rooms	1
Extraction line vertical corrector	20	12 rooms	1
Raster Scanning Magnets	24	12 rooms	2
Injection line dipoles	6	common injection line	Coils
Injection Line quadrupoles	25	common injection line	1 + coils
Injection line horizontal corrector	10	common injection line	1
Injection line vertical corrector	10	common injection line	1
Riesenrad dipole	2	Gantry room	0
Proton gantry dipoles	6	Gantry rooms	0

Injector Parameters

Operational frequency of the RFQ and IH 220 MHz.

|	Proton	Carbon	Argon
Relativistic Beta after the linac	0.122	0.122	0.122
Revolution period in synchrotron(us)	3.2	3.2	3.2
max number of turns for multiturn injection	20	20	20
pulse length from linac (for each ring) (us)	64	64	64
time needed to change the injection magnets(us)	2	2	2
total length of the pulse from the source (us)	262	262	262
circumference of synchrotron 120m			

Injection scheme into the 4 rings

From ion source

t.b.a

After linac
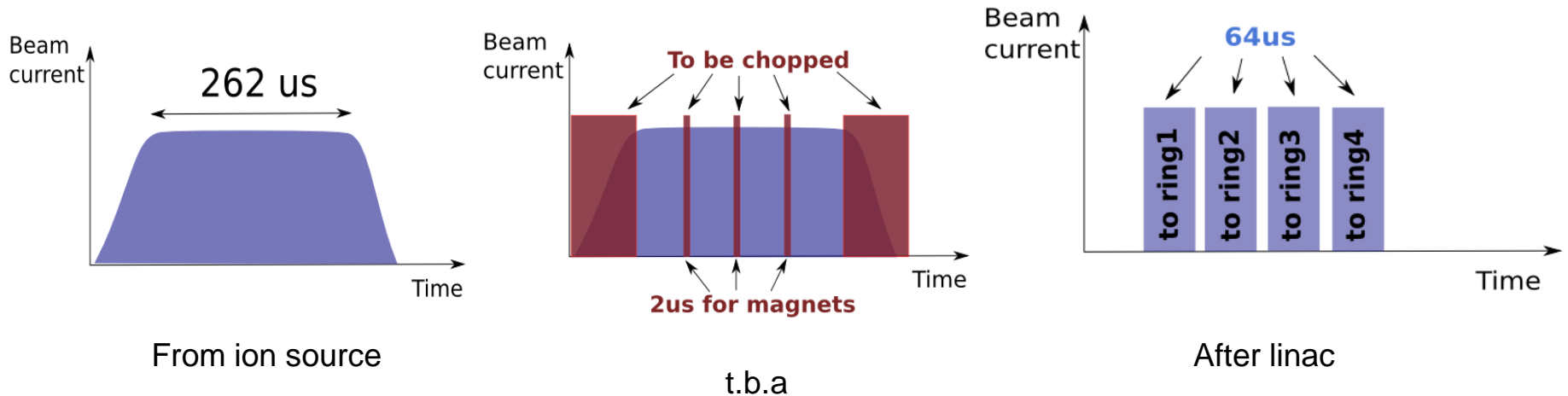
Treatment sequence

➢ two patients in two different rooms

➢ the technicians start preparing the patient (alignment and position verification)

➢ Once the patient is ready then the technician requests the mastership

➢ If the beam is used by the other patient, the technician sees a countdown on the computer screen
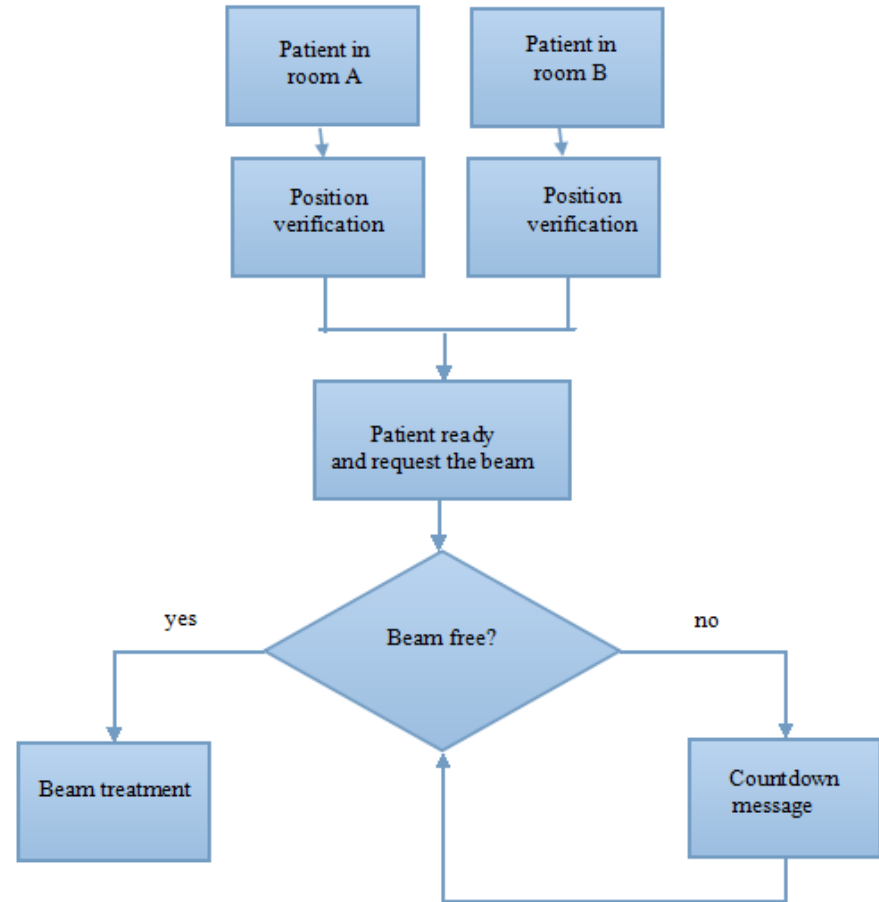
"The beam doesn't wait for the patient, the patient waits for the beam" (TM).

Building Layout
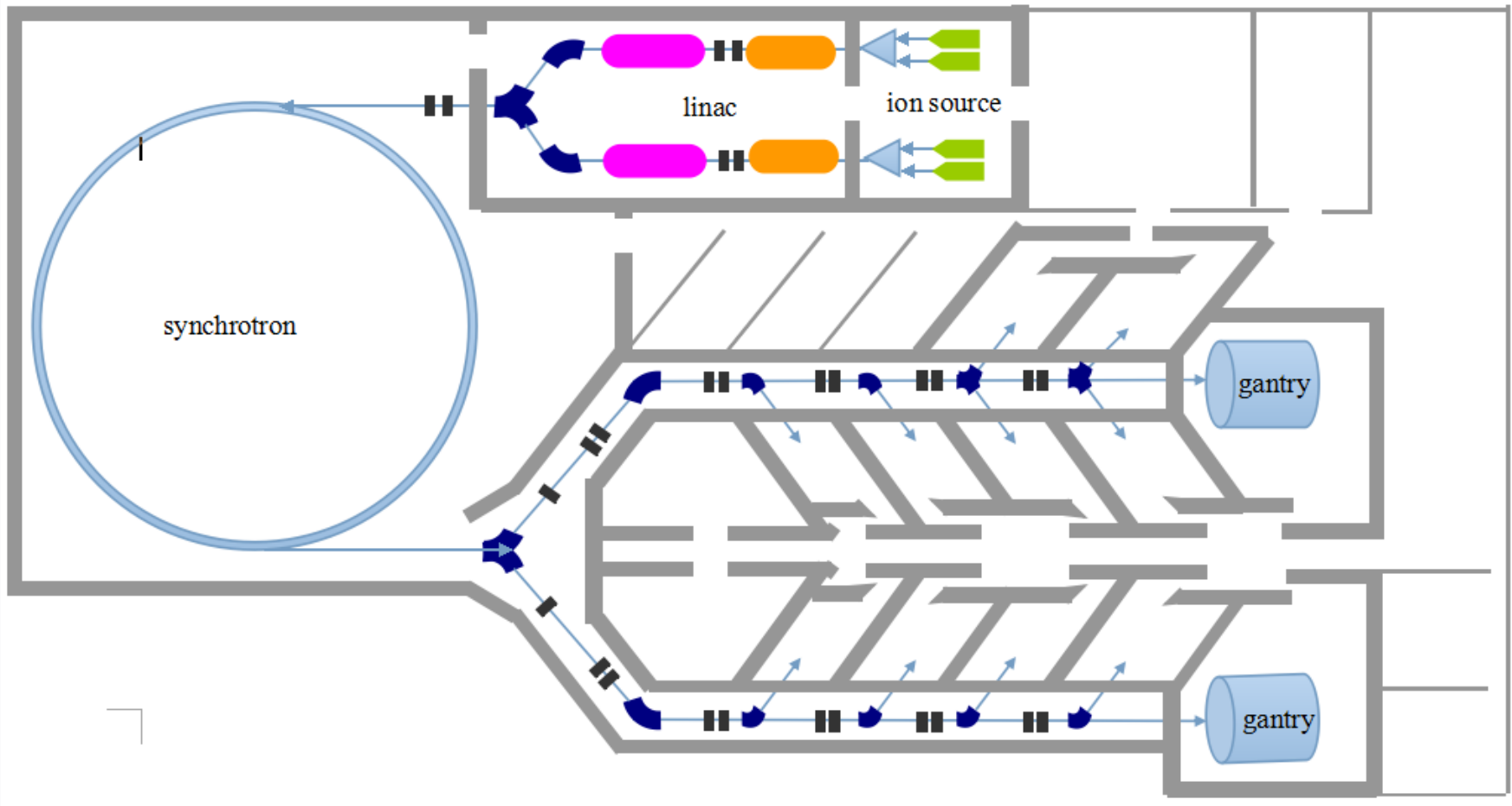
Timeline

Technical design   2.5 years

Building Construction   2 years

Manufacturing (accelerator)   3 years

Accelerator Installation
and Commissioning   2 years

Upgrade Phase 1   (Ar Linac)
Upgrade Phase 2 (Ar gantry)

Costs & Revenue

Construction		CBTR (million euros)
Building		~100
Accelerators		~200
Labour		~30
Total		~330

Annual Operating Cost Estimate ~ 30 million

Patients:
Fields: 2-3
Fractions: 35

Daily organization (Mo/Fr):

8 am – 6 pm: treatment patient
6 pm – 4 am: research
4 am – 8 am: daily Quality Assurance

During the weekend: research (from externals 2000 euros/beam hour)

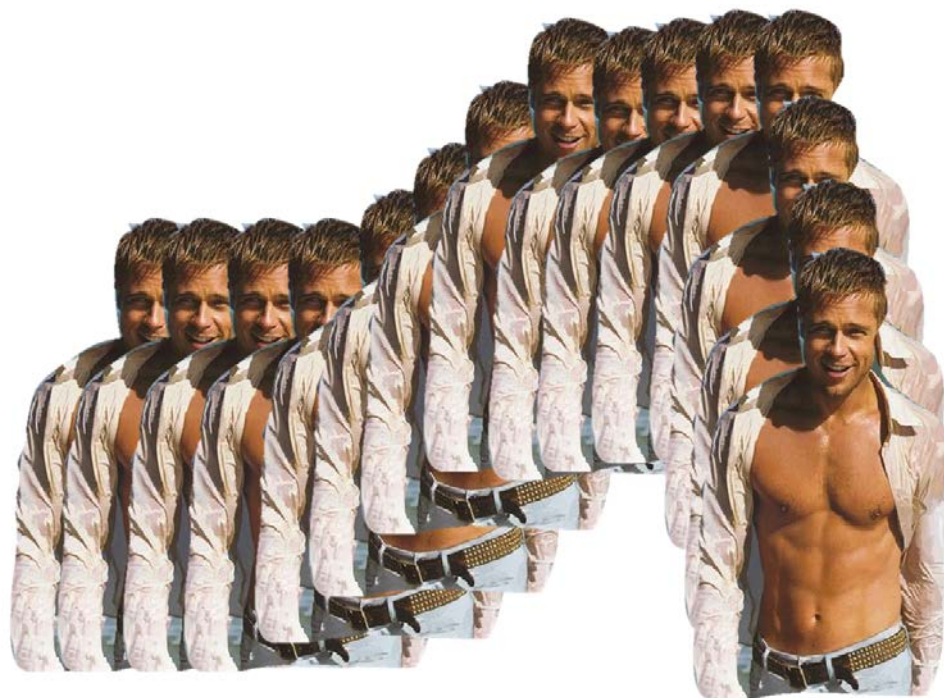2500 patients per year (~90M Euros per year)

We found a potential investor.

Summary

- reduction of magnetic hysteresis cycling by a factor of 4 compared to using one ring

- reduction of irradiation preparation time by an increase in the number of rooms

- possible upgrade by decoupling the four rings increasing the number of irradiations by 4

Reminder: The Spread out Brad Pitt

Thank you !