# Grid Stripper Foils in Isochronous Cyclotron for the Production of Medical Isotopes

BEAM

Dr. Sergey Korenev

The European Cyclotron Progress Meeting ECPM XXXIX, Belgium, September 23-26, 2015

Answers for life.

#### Outline

- 1. Introduction
- 2. Eclipse cyclotron form Siemens.
- 3. Novel concept of dual beam based on grid stripper foils.
- 4. Experiments with grid foils.
- 5. Grid foil for single beam
- 6. Conclusion



#### Introduction

The medical isotopes as a biomarkers found a large application for Positron Emission Tomography (PET).

The isochronous cyclotrons used for the production of medical isotopes.

Siemens manufactures the commercial isochronous cyclotron Eclipse long time from 1995.

These cyclotrons often use converting of negative hydrogen ions to protons by stripper foils. The stripper foils typically fabricated based on carbon foils.

**Goal & motivation** 

## The performance improving of Eclipse cyclotrons is main goal.

## Motivation is search of new approaches for improving of isochronous cyclotron.

Subject of presentation

### The main results of testing and evaluation for grid stripper foils from 5 Eclipse cyclotrons for :

- 1. Production of dual beam.
- 2. Lifetime.
- 3. Performance of accelerator.

Siemens Cyclotron and Chemistry Solutions Manufacturing PET cyclotrons since 1995

• Siemens Eclipse cyclotrons use to produce the medical isotope <sup>18</sup>F (primary), <sup>11</sup>C, <sup>15</sup>O

The main parameters of Eclipse cyclotrons are:

- 1. Kinetic energy of protons is 11 MeV
- 2. Beam current is  $120\mu A$  (dual  $60\mu A$ )



#### SIEMENS

#### Siemens Eclipse Cyclotron



Unrestricted © Siemens AG 2014 All rights reserved.

http://www.siemens.com/mi

Standard process for production of medical isotopes on Eclipse cyclotron

Irradiation of enriched water (<sup>18</sup>O) target by proton beam for nuclear reactions with protons for production of medical isotope <sup>18</sup>F.



Unrestricted © Siemens AG 2014 All rights reserved.

SIEMENS

#### Main concept of dual beam with grid foil

The main idea based on the propagation of beam across grid foil with the separation of beam to proton beam on stripper and negative hydrogen ions across holes



### Additional opportunities from using of grid foils as a strippers for production of multi-beams

#### SIEMENS





#### **Stripper foil**



#### **Fabrication of grid carbon foils**

The fabrication of grid carbon foil based on the two main steps:

1. Production of regular sheet of carbon foil, for example from ACF METALS.

2. Laser drilling of holes in Laserage Technology Corporation: http://www.laserage.com



#### Carousels with grid foils



#### Experiments with dual beam

- 1. Forming of dual beam.
- 2. Study of life time.



#### Forming of dual beam

### The goal of these experiments is test on concept of dual beam with grid foil.

#### The results for 3 cyclotrons are given in table

No	Proton beam current	lon source	lon source	Difference in ion
	on DV 224, 225, 227,	(Arc) current	(Arc) current	source
	μΑ	with Foil-Foil	with Grid-Foil,	(Arc) current, mA
		(current mode),	mA	
		mA		
1	40x2beam=80	190-210	80-110	100-110
2	60x2beams=120	280-350	170-200	120-150

Study of life time of grid foils

The goal of this study is understanding of real life time for grid foils.

The life time determines by mechanical damages and loses of beam.

The main current mechanism of destroy of stripper foil is thermal from dissipation of beam power.

Experiments on the 4 Eclipse cyclotron showed, that after 10-15 hours we have wrap of foils.

#### Beam current 45 mA

Experiments with current 45 mA were shown thermal effect from beam, which leads to warp of regular carbon foil.

The grid foils have no this effect, and allows to have longer life time



Regular carbon foils after 10 hours for average beam current about 45 μa



Carbon grid foils after 20 hours for average beam current about 45 μa





Carbon grid foils after 100 hours for average beam current about 45 μa

Regular carbon foils after 20 hours for average beam current about 45 μa

#### Beam current 60 $\mu$ A



20 hours for average beam current about 60 µa





Unrestricted © Siemens AG 2014 All rights reserved.

SIEMENS

#### Conclusion

The concept of grid foil as a foil stripper is interesting from fundamental and applied aspects.

The grid foil allowed to produce the dual beams.

The lifetime of grid foils increased to few times.

#### Thank you!



**Dr. Sergey Korenev** Sr. Physicist, SIEMENS Healthcare MI / USA / CCS R&D

810 Innovation Drive Knoxville, TN USA 37932-2751

Phone: +1 (865) 218-2652 E-mail: sergey.korenev@siemens.com

Answers for life.

Unrestricted  $\textcircled{\mbox{\scriptsize o}}$  Siemens AG 2014 All rights reserved. Page 23