

On the GATE simulation of FFF Medical Linac

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- MC Simulation
- Data & Validation
- Results for (FFF)

Goals

- **GATE Simulation of the 6 MV photon beam Elekta Precise accelerator.**
- **Study of the Free flattening filter mode.**

MC simulation



Cuts:

Electrons: 500 keV
Gammas 10 keV

Physics :

- Compton, - Photo-Electric, pairs creation
- Ionization – Bremsstrahlung, Annihilation, Multiplesattering

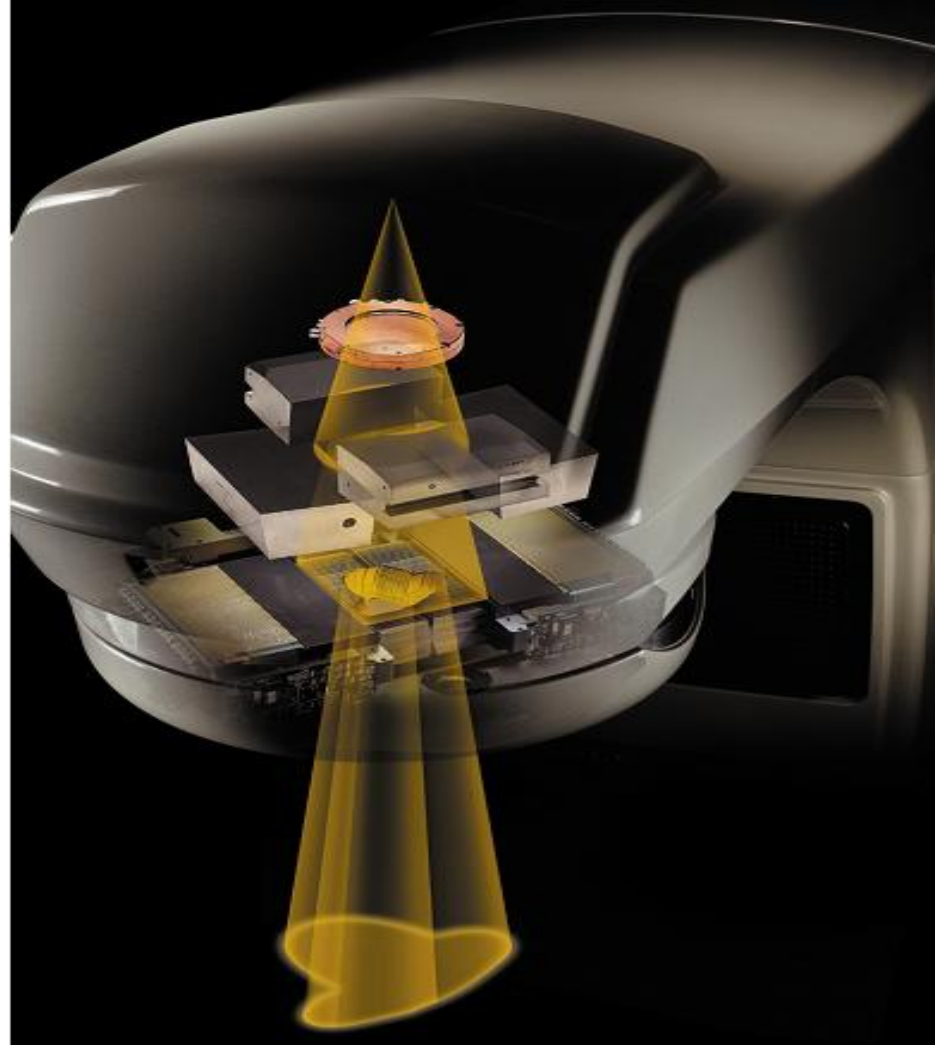
MC simulation

A. The electron source:

B. Geometry

- Target
- Primary collimator
- Flattening Filter
- ionization chamber
- Backscatter plate
- Mylar Mirror
- Secondary collimator

C- Output



Geometry A

Thanks to Prof. G. Dietmar
AKH, Vienna



A- Linac Head:

Patient Independent part:

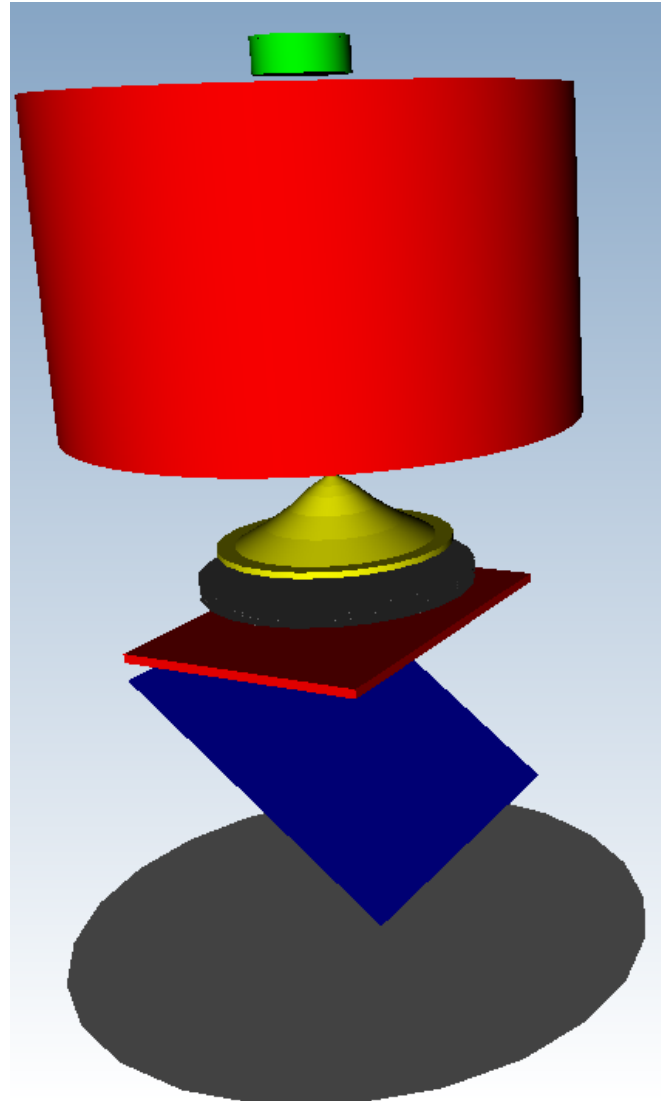
Phasespace is a cylinder:

70 mm radius, 1mm tick

Are stored the :

-cinematique properties of
the particles

-History and the production
mechanisms



Target

Primary collimator

Flattening Filter

Ionization chamber

Back-scatter plate

Mylar Mirror

Phase space

Geometry B



B- Linac Head:

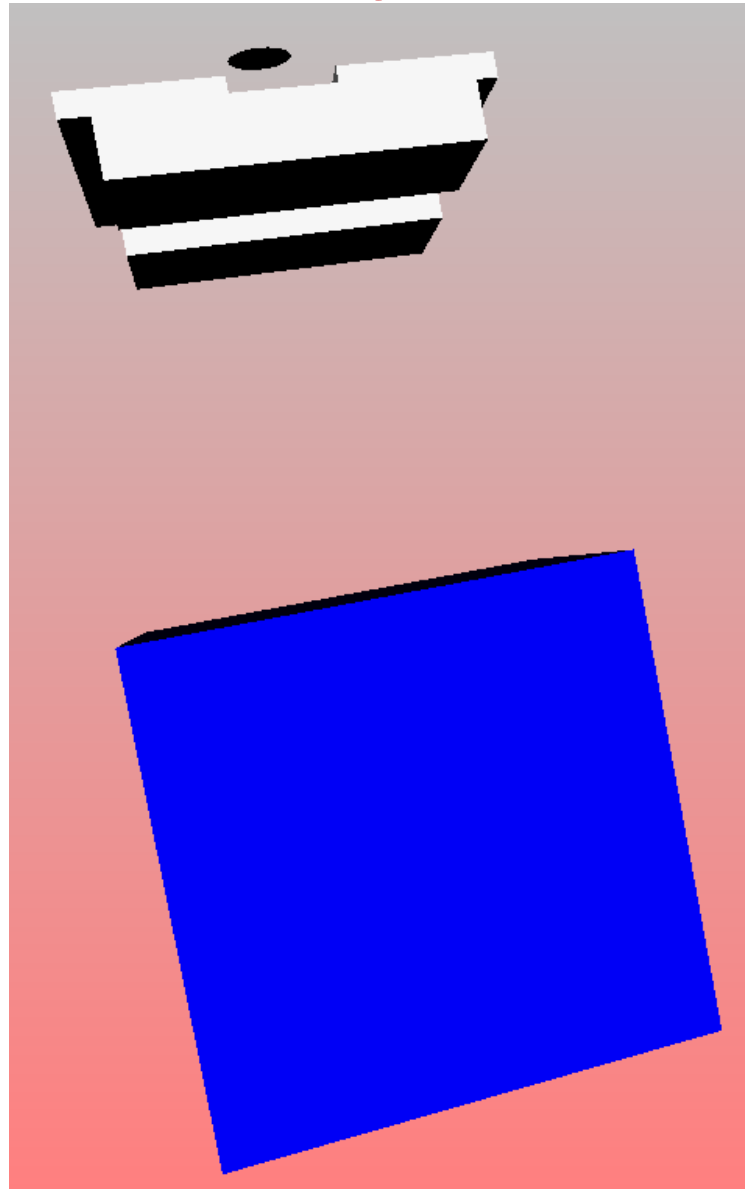
Patient dependent part:

Simple Water phantom:

a cubic tank:

Volume: 58.4 cm³

DSP 100m



Phase space

X,Y Jaws

Water Phantom

Electron Beam



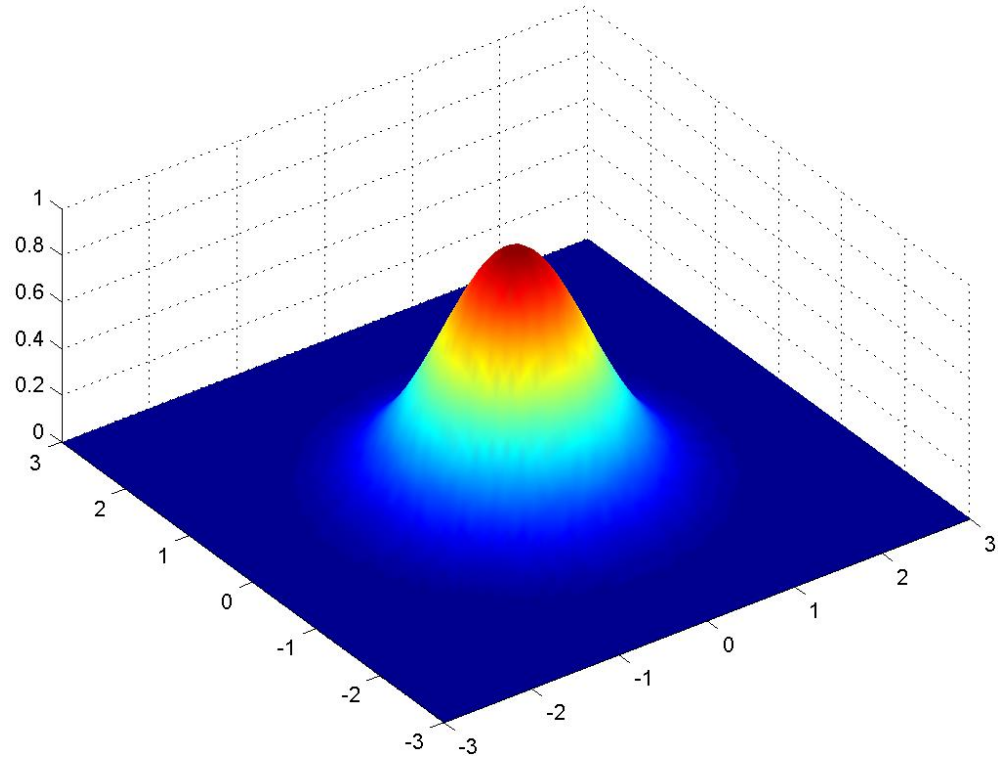
Circular shape

Gaussian energy distribution:

**$\langle E \rangle = 6.7 \text{ MeV}$
 $\sigma = 0.212 \text{ MeV}$**

Gaussian spatial distribution:

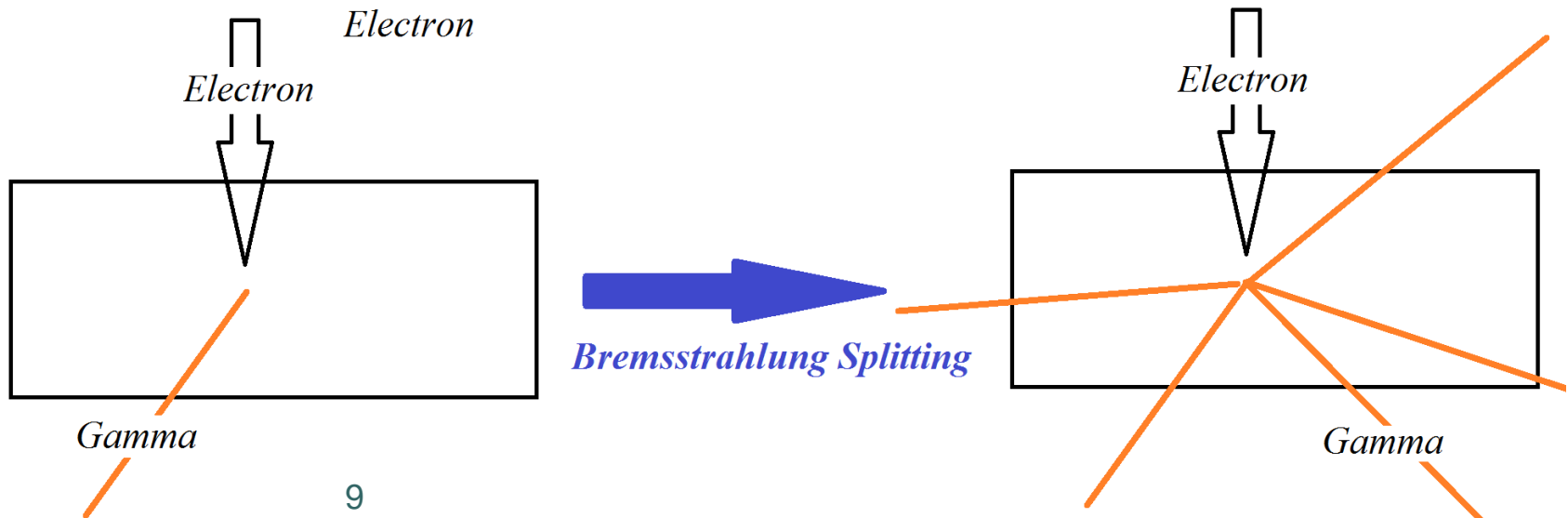
**Centered on the target beam
 $\sigma = 0.467 \text{ mm}$**



Bremsstrahlung Splitting

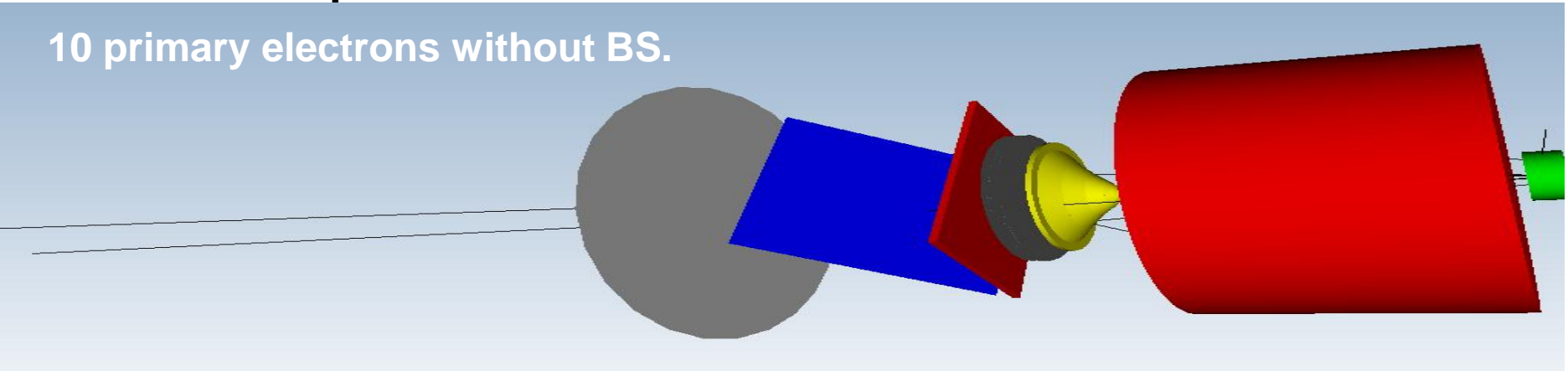
Technique: MC Efficiency x 8

If $E_{e^-} > 5,7$ MeV 100 photons are generated (scale 1/100)

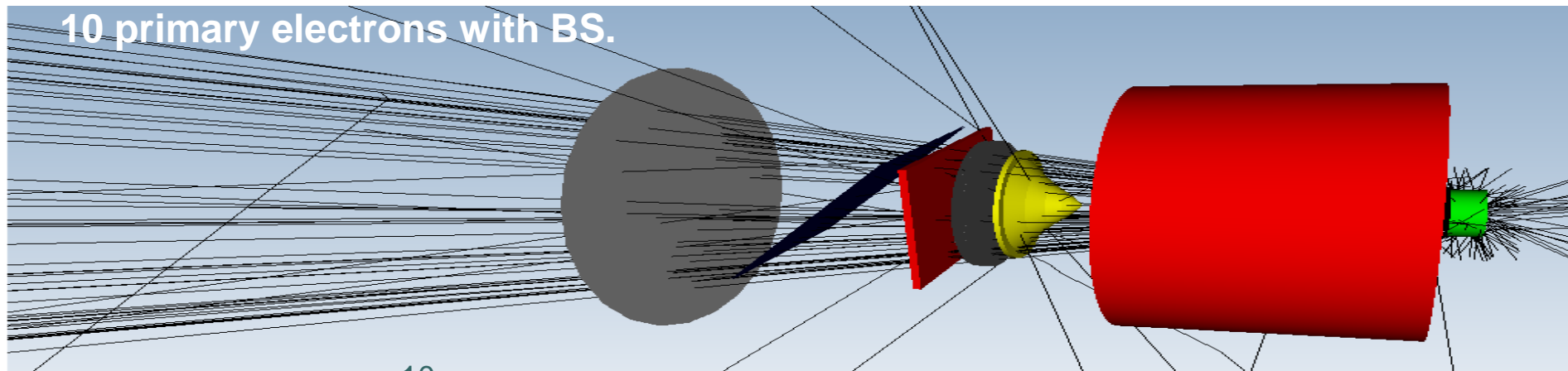


Bremsstrahlung Splitting

10 primary electrons without BS.



10 primary electrons with BS.



MC. Data

GATE: v6.2

GRID: (phasespace: with and without the flattening filter)

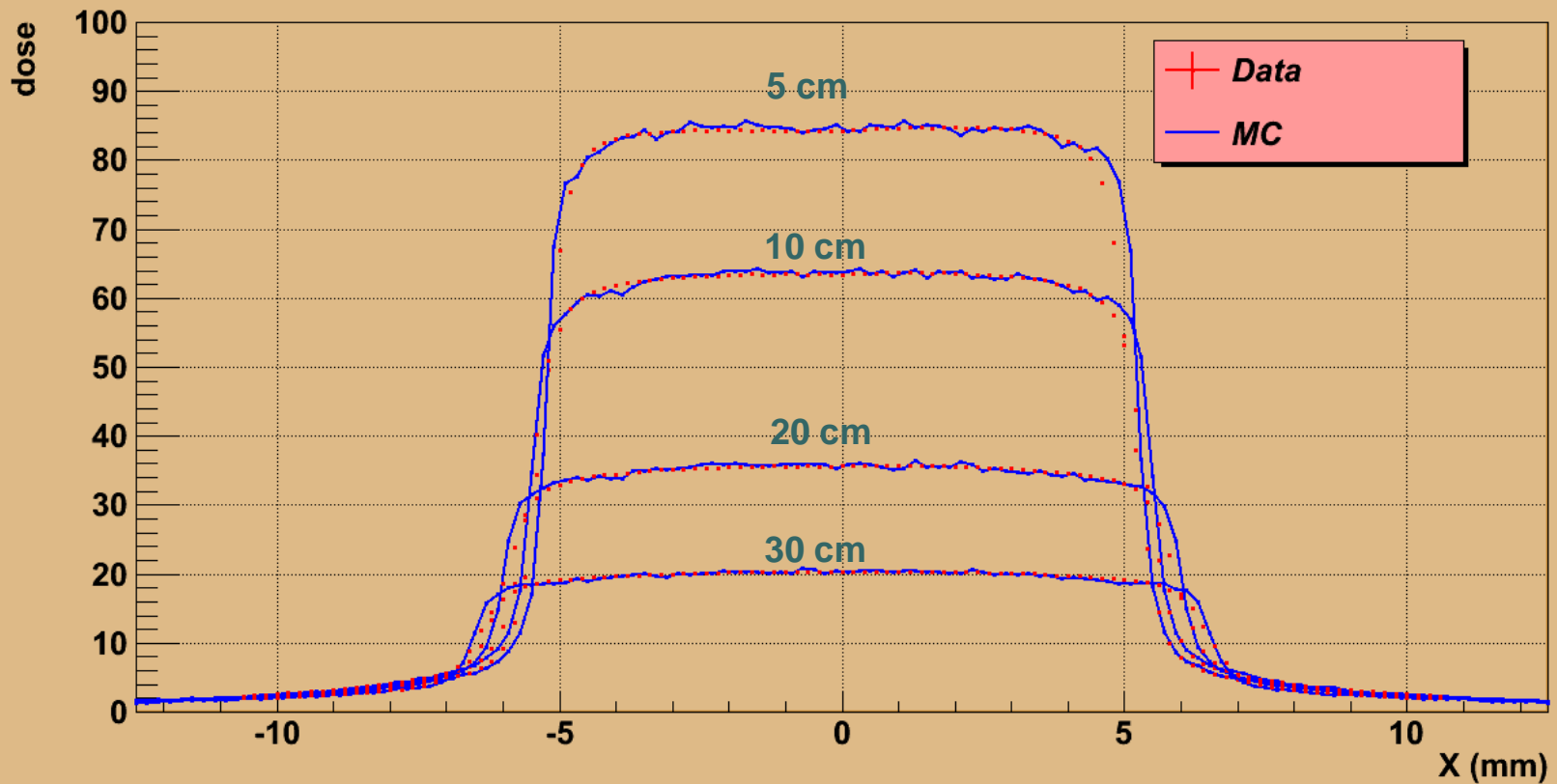
-Samples with : 3000 runs

- 10⁶ Primary electrons per run

```
-rw-r--r-- 1 tayalati atlas 155M May 11 21:57 output-PS_100_980_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 22:15 output-PS_100_981_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 22:01 output-PS_100_982_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 21:55 output-PS_100_983_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 21:59 output-PS_100_984_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 22:08 output-PS_100_985_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 22:12 output-PS_100_986_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 22:06 output-PS_100_987_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 22:04 output-PS_100_988_5.7.root
-rw-r--r-- 1 tayalati atlas 155M May 11 22:01 output-PS_100_989_5.7.root
-rw-r--r-- 1 tayalati atlas 154M May 11 18:47 output-PS_100_98_5.7.root
```

MC vs Real Data

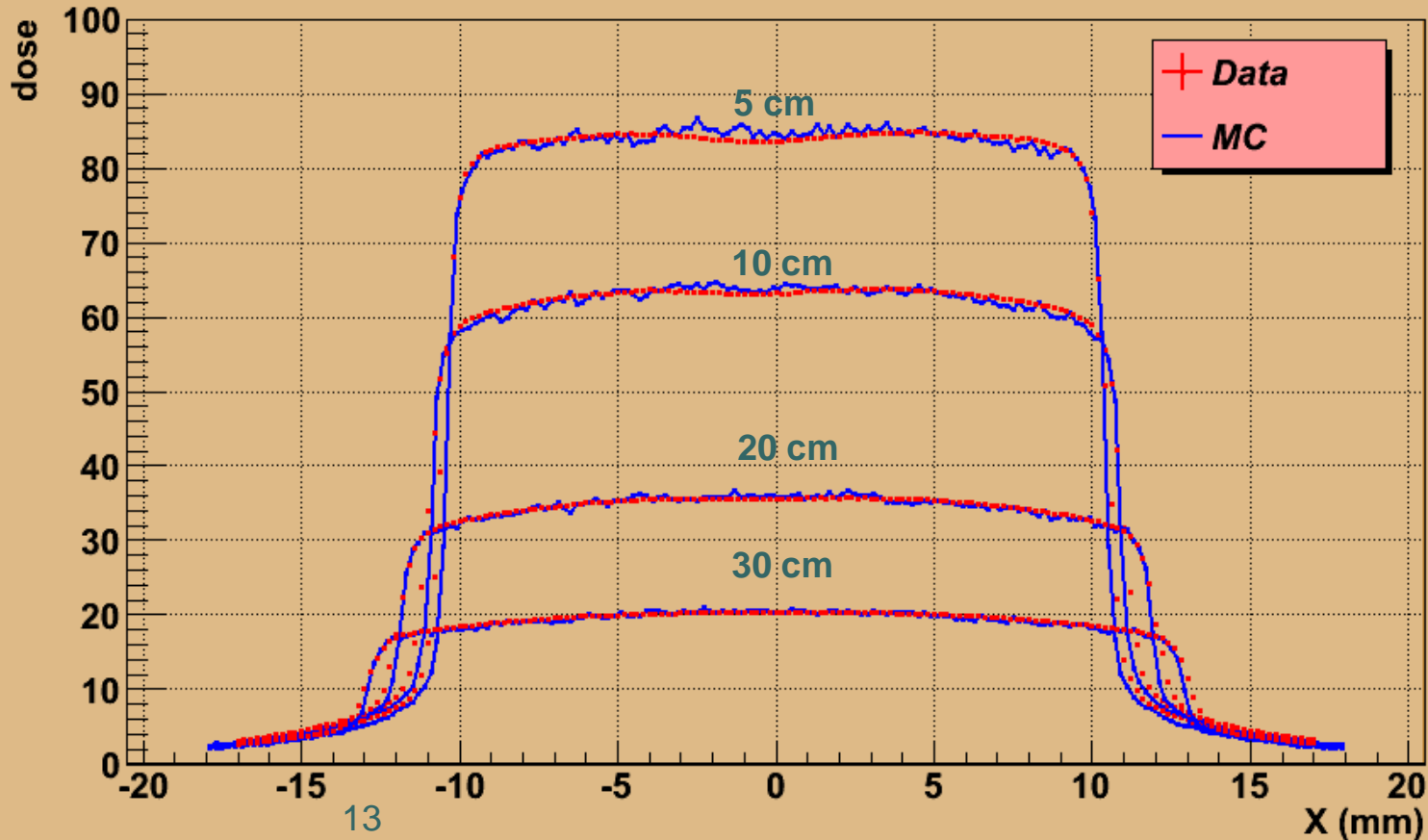
Dose profile Normal Mode (with the flattening filter) $10 \times 10 \text{ cm}^2$ field



MC vs Real data

Dose profile Normal Mode

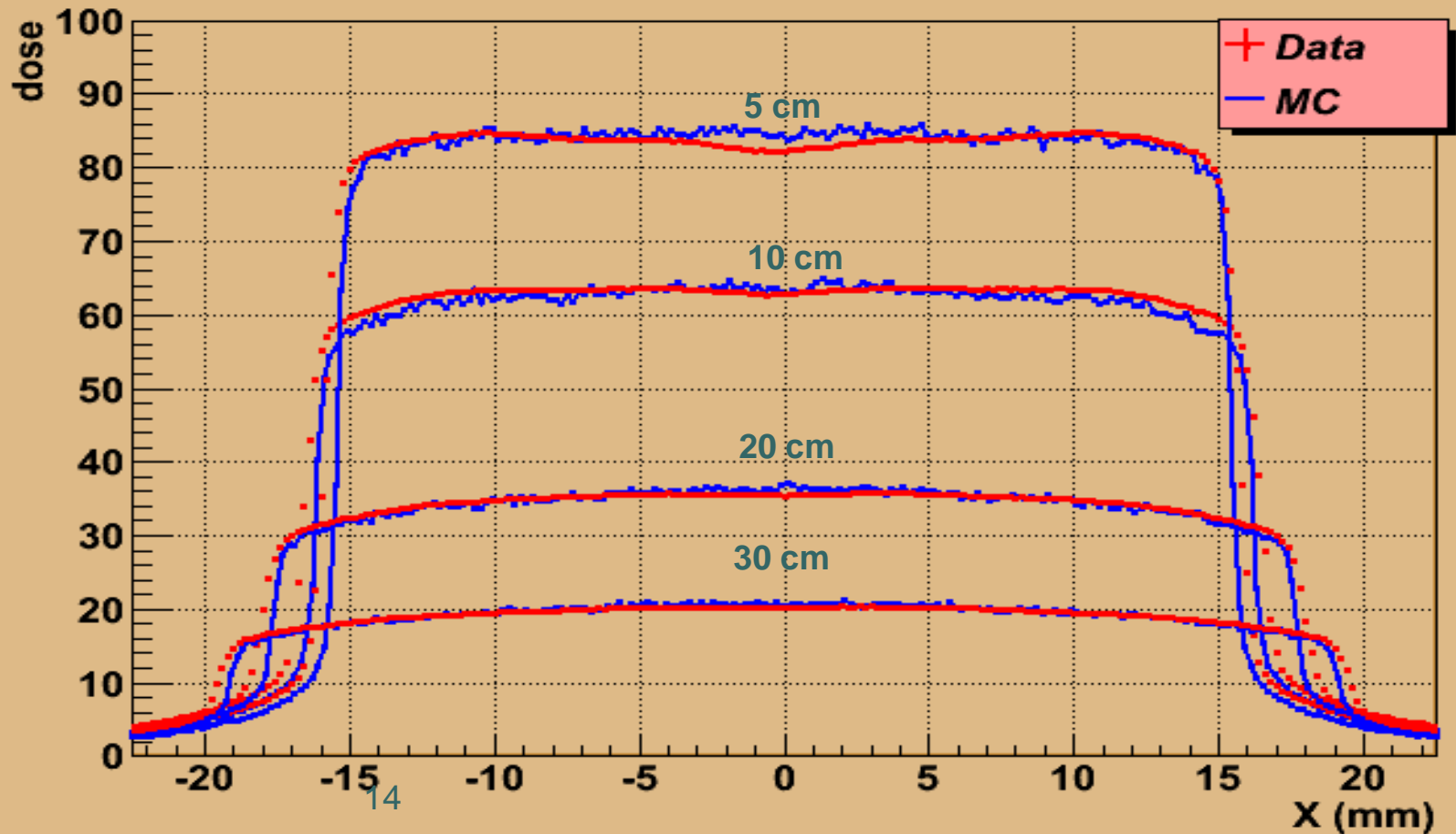
20x20cm² field



MC vs Real data

Dose profile | Normal Mode

30x30cm² field



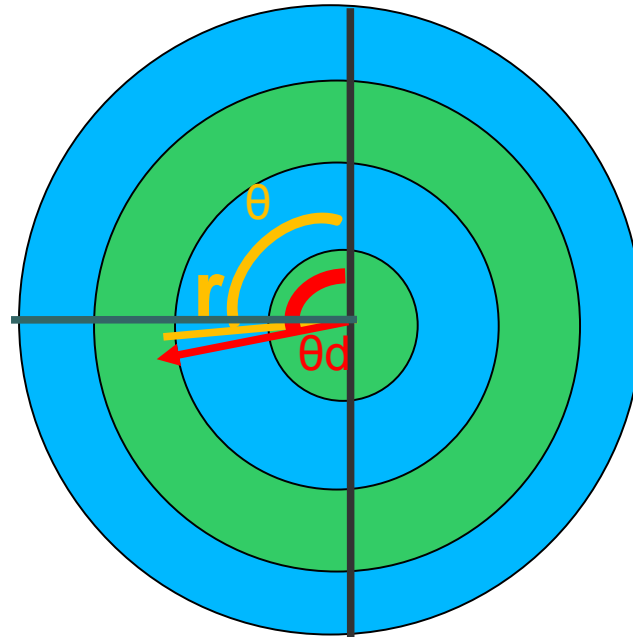
MC vs Real data

Depth dose | Normal Mode

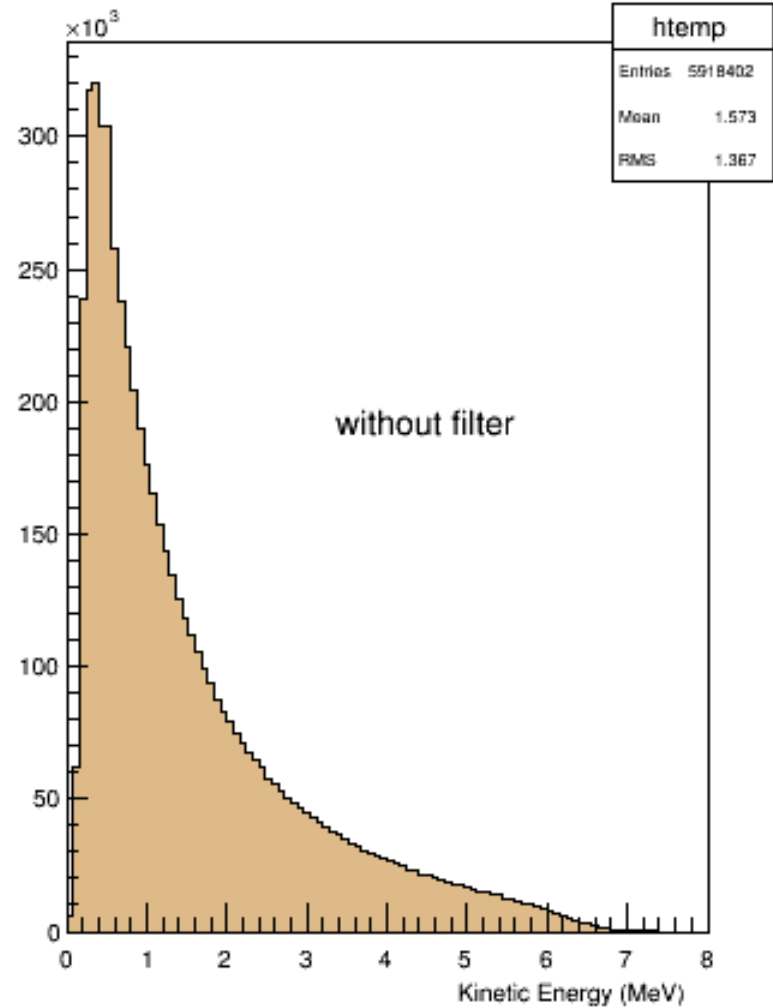
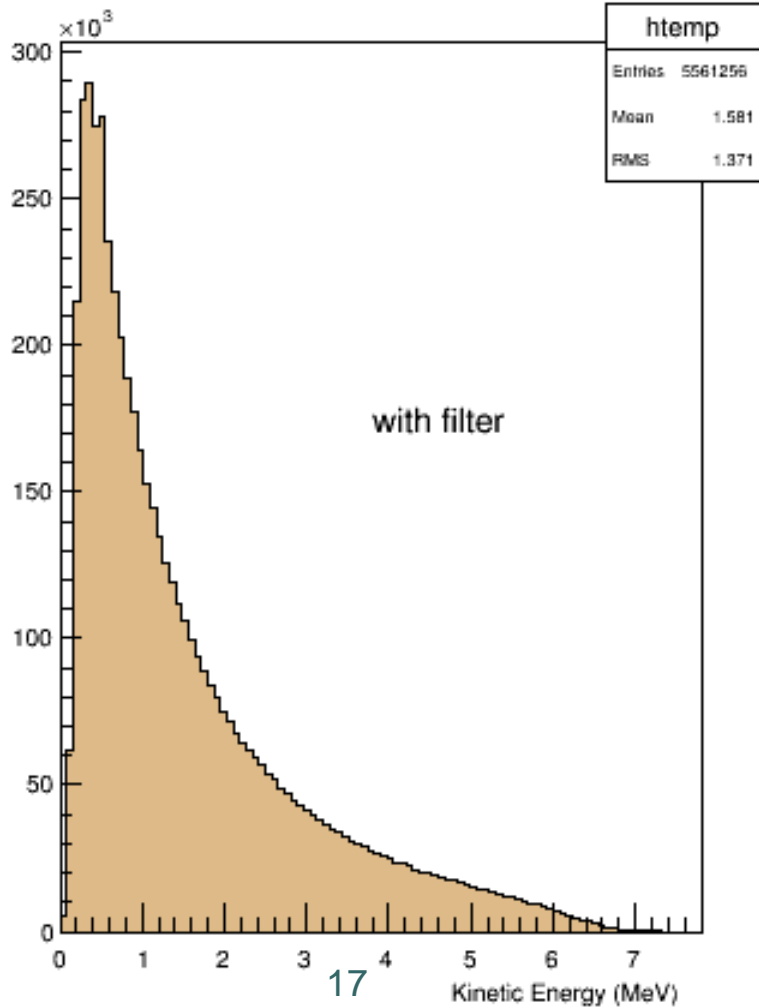
10x10cm² field



PhaseSpace

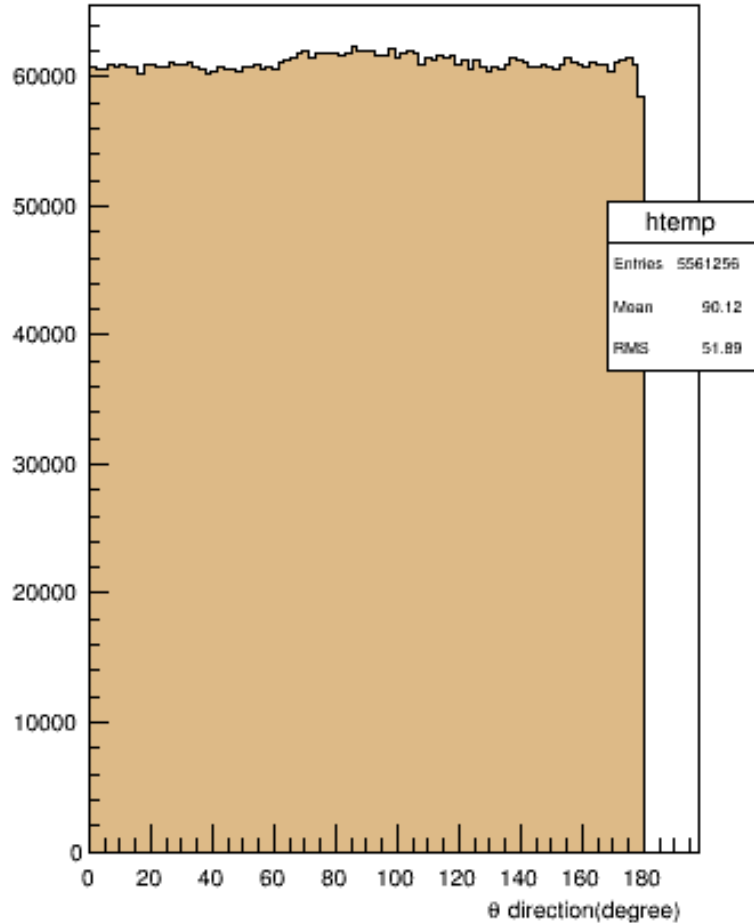


Energy Spectrum

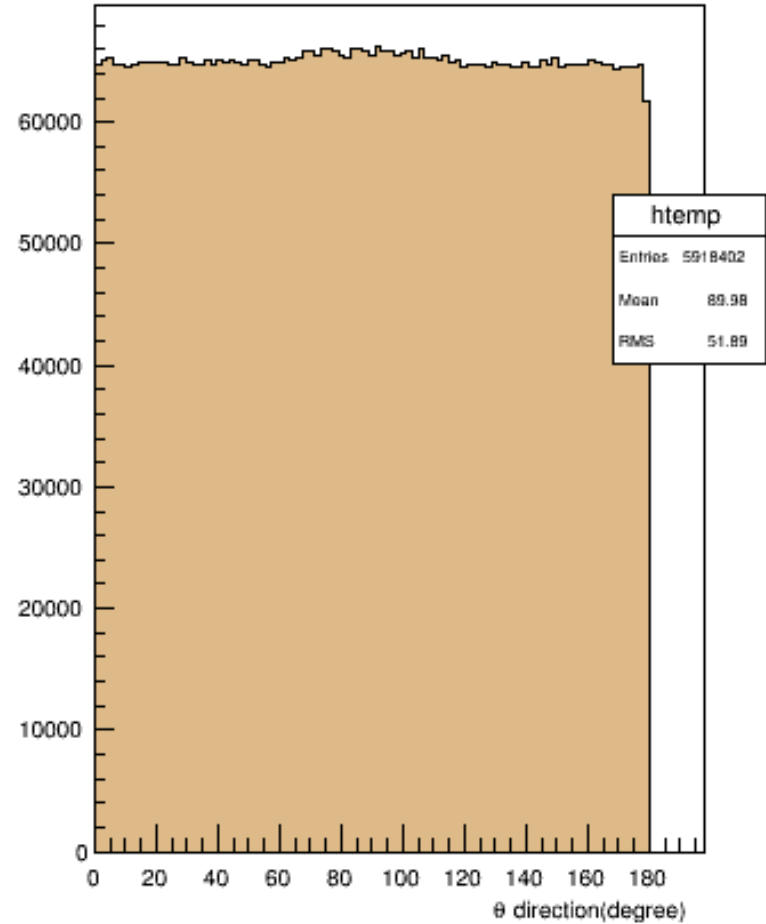


Zenith

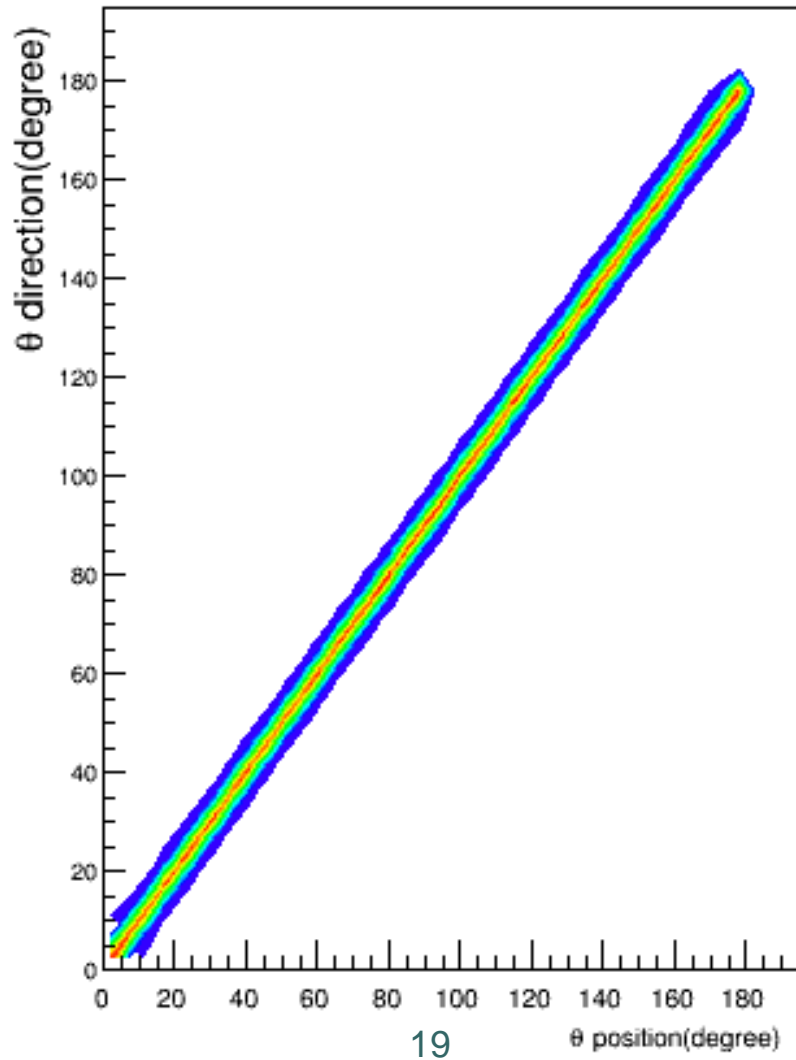
with filter



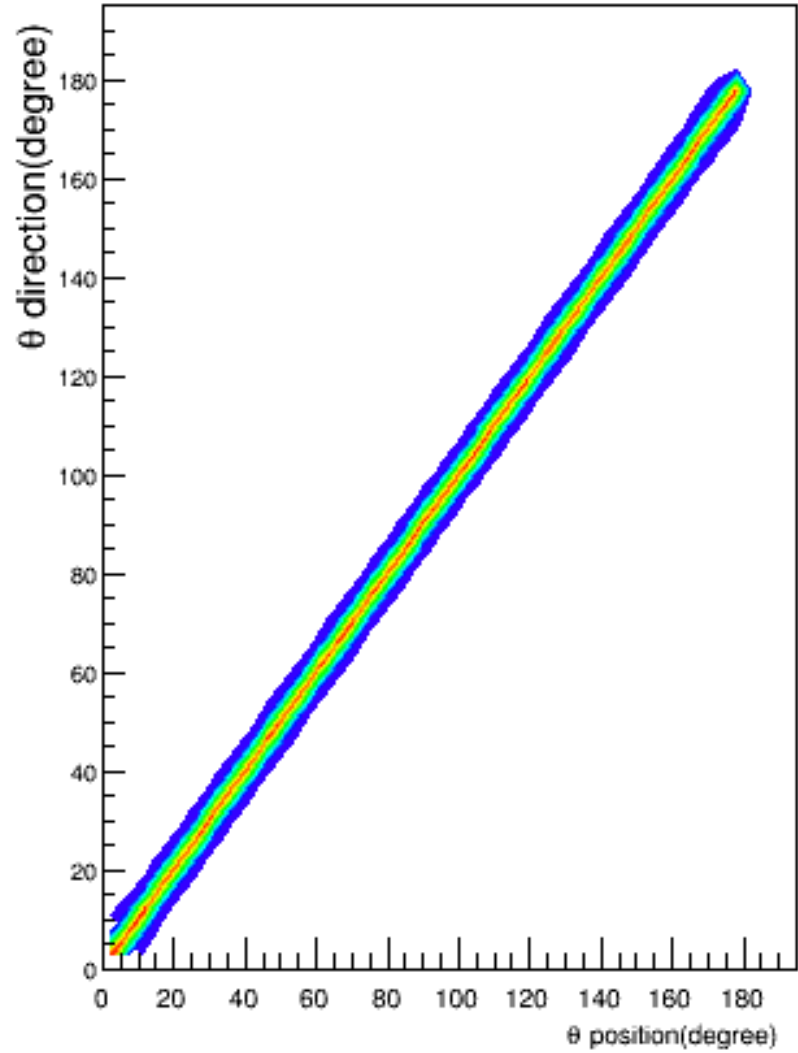
without filter



with filter

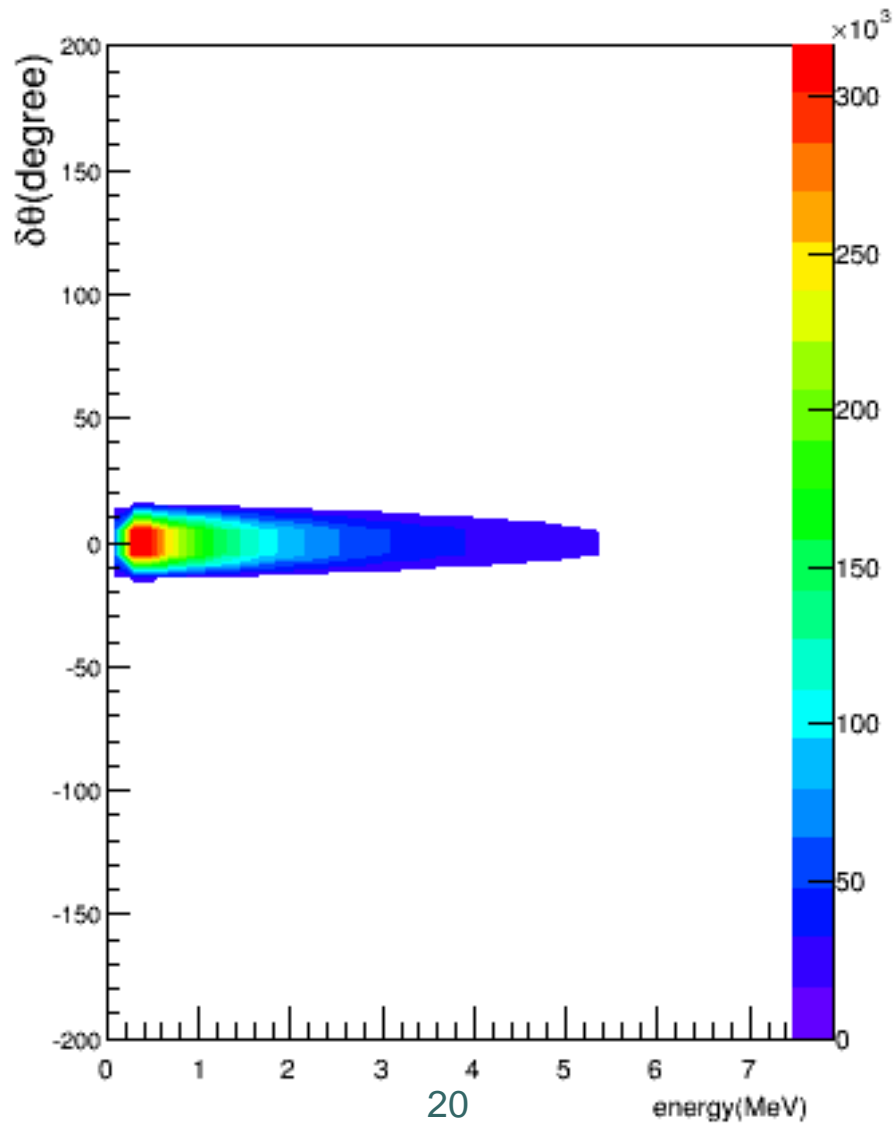


without filter



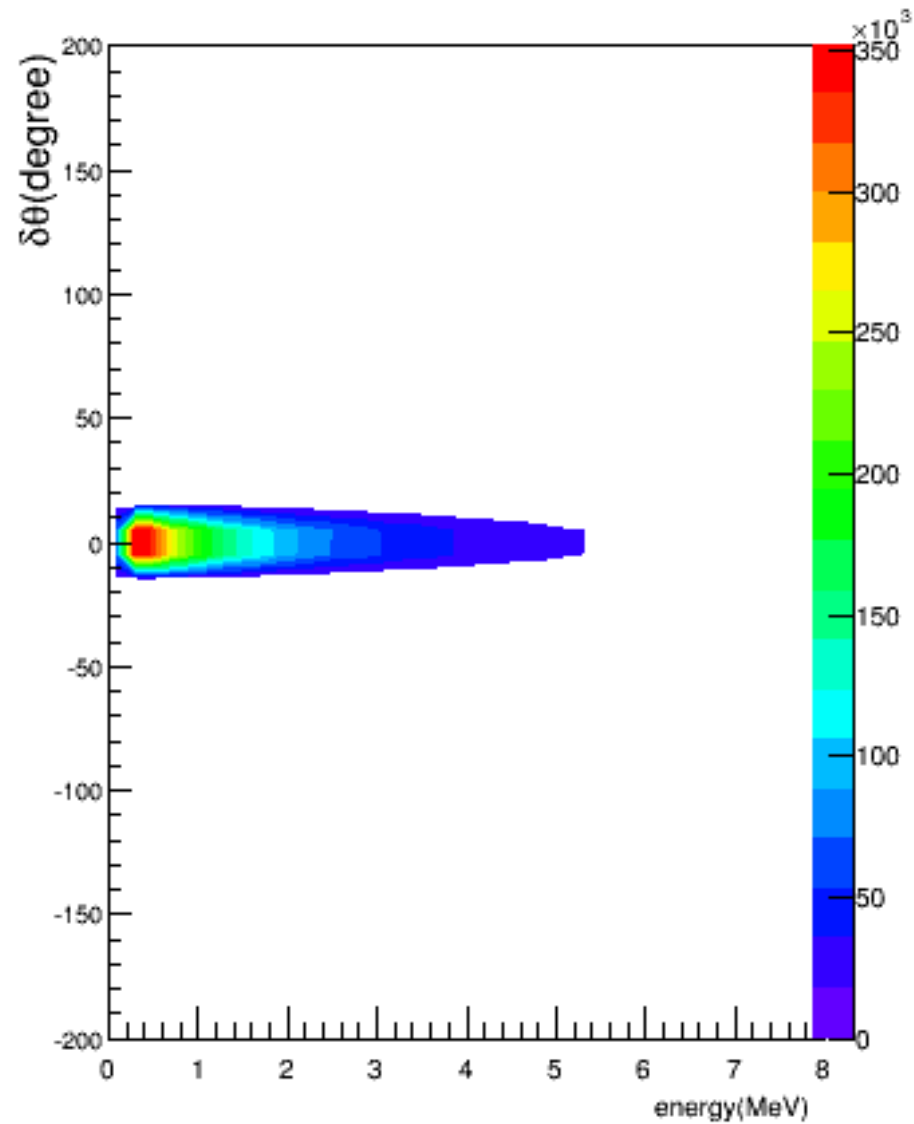


with filter



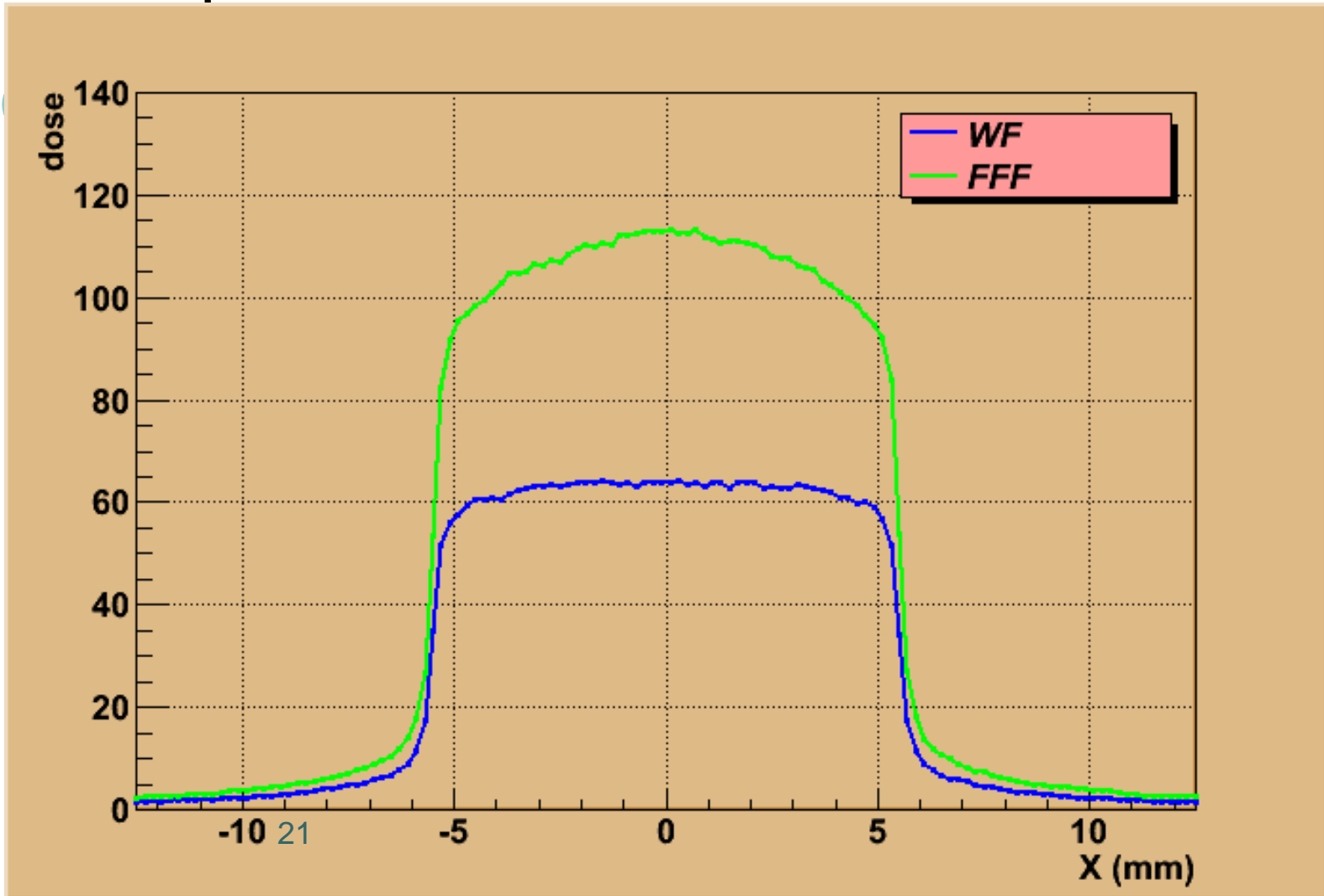
20

without filter



MC FF vs FFF

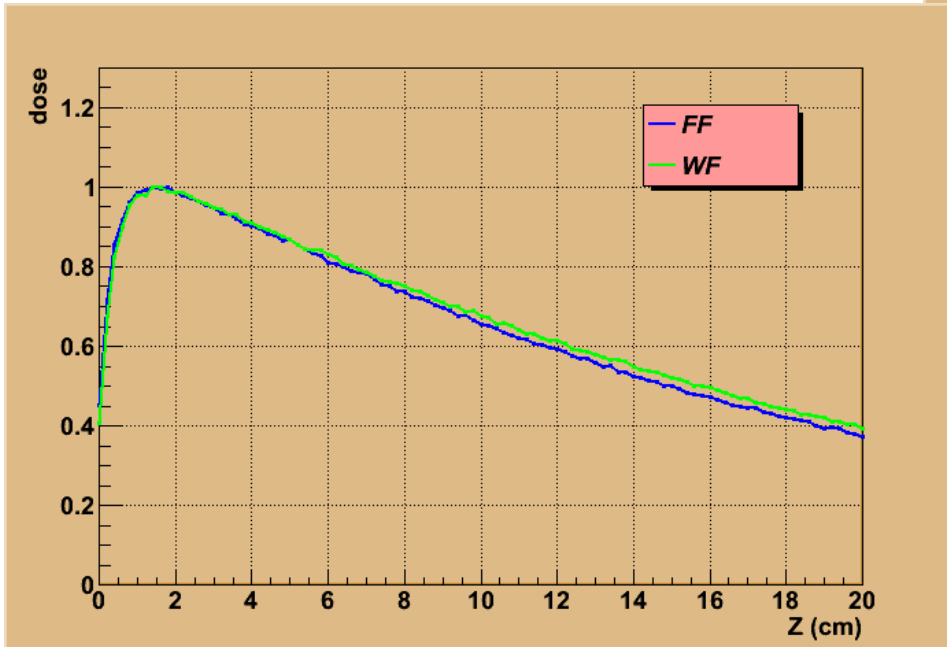
10x10cm² field



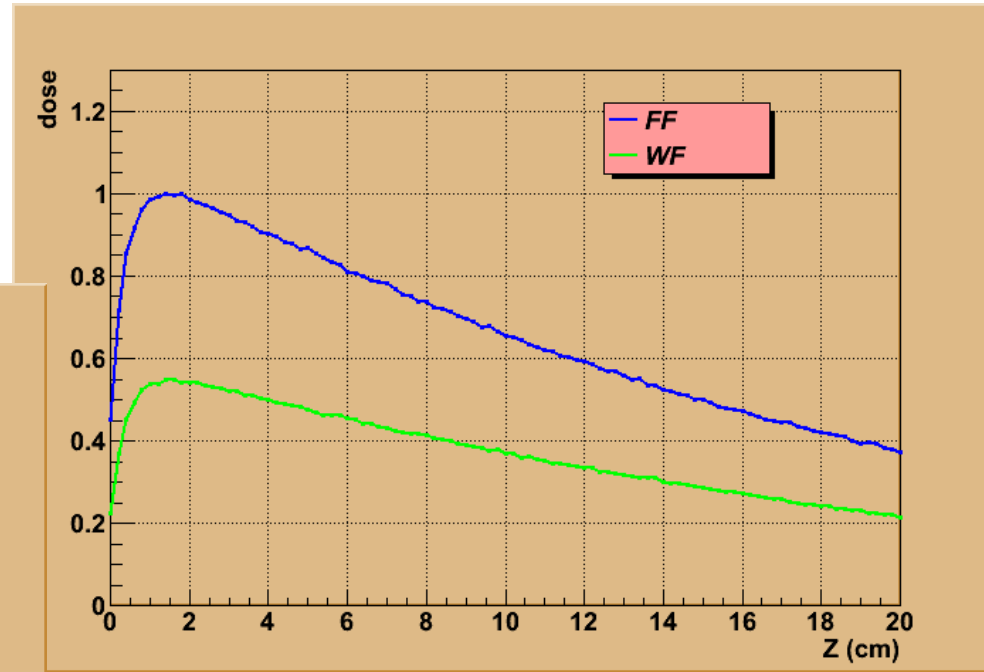
MC FF vs FFF

Depth dose

Normalized to the FFF mode



10x10cm² field



Not normalized

Conclusion

GATE MC simulation of the Linac Validated

FFF Under study