



ESA & CNES Final Presentation Days 2017



UNIVERSITY OF JYVÄSKYLÄ

RADEF status report

**ESA/ESTEC Contract No. 18197/04/NL/CP:
"High Energy Heavy Ion Test Facility for
Component Radiation Studies"**

&

**CCN-1 to ESA/ESTEC Contract No.
4000111630/14/NL/PA:**

**"Utilisation of the High Energy Heavy Ion
Test Facility (RADEF) at the University of
Jyväskylä (JYFL) for Component Radiation
Studies 2016-2017"**

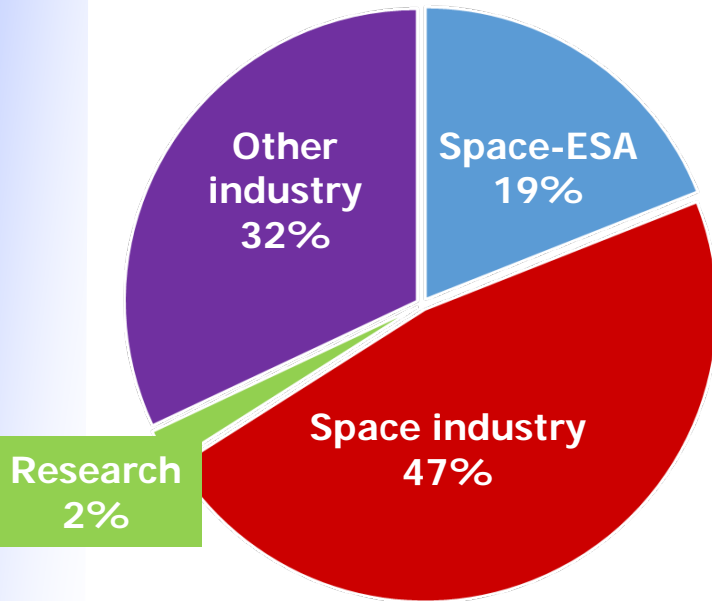
Heikki Kettunen, JYFL





Use of beam time

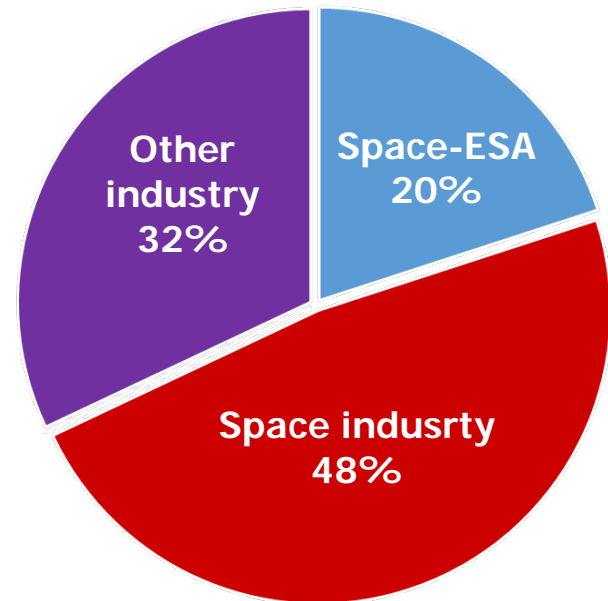
2015



Research
2%

- 1128 total beam hours
- 44 campaigns
- 18 industrial- and 3 academic users
- 69 visitors

2016



- 1142 total beam hours
- 41 campaigns
- 18 industrial- and 1 academic users
- 82 visitors





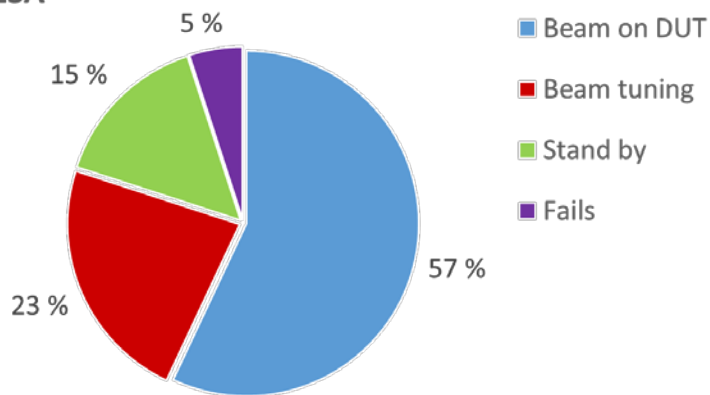
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Distributions of ESA and non-ESA beam times

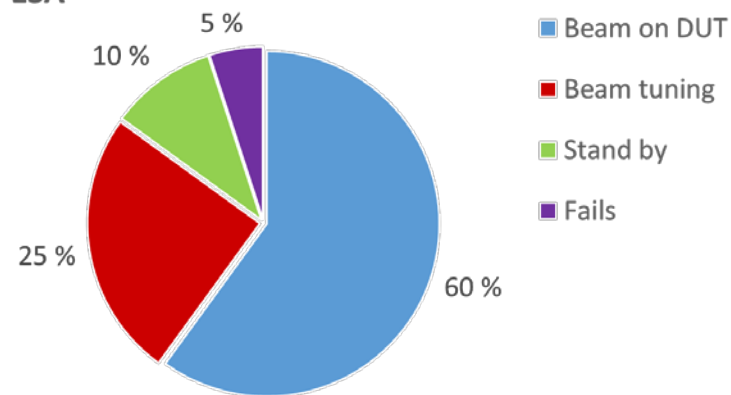
2015

ESA

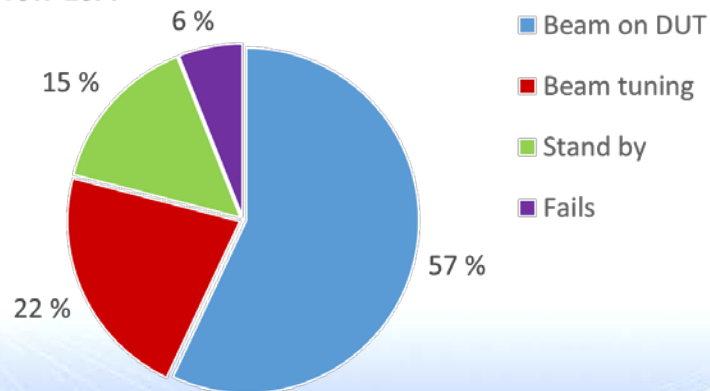


2016

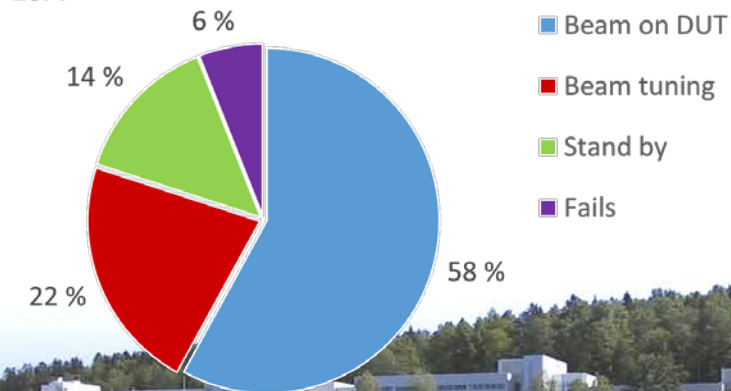
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Non-ESA



ESA

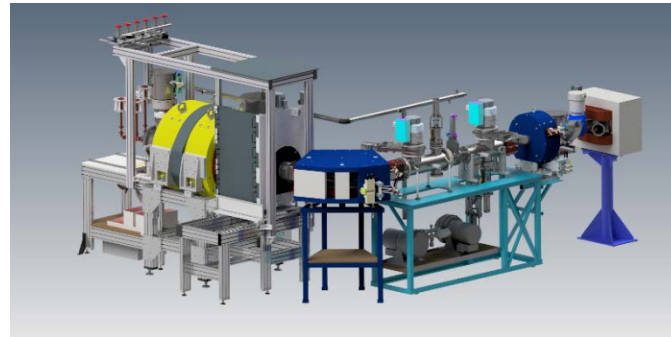




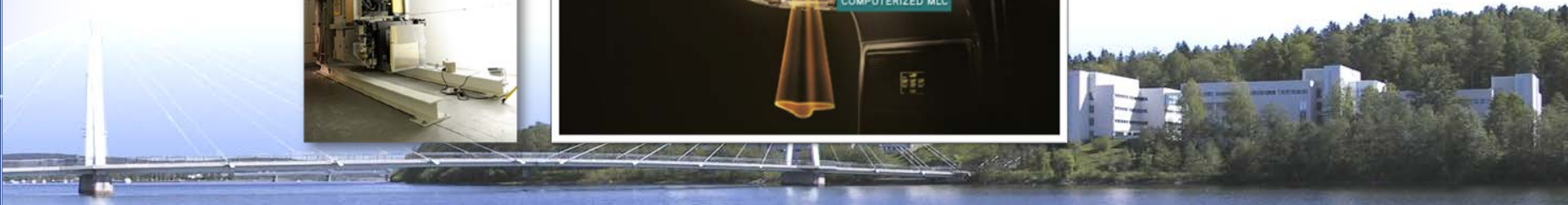
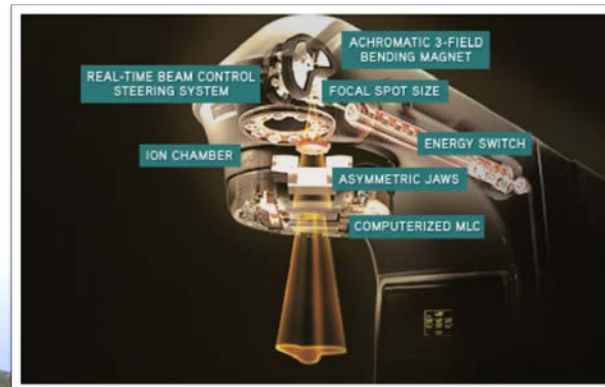
Ongoing and Recent Developments

ESA GSTP ESTEC/Contract No. 4000112736/14/NL/PA *“Development of a High Energy Beam Combination of Ions and Electrons for Radiation Test of Electronic Components”*. Start date 01/02/2015 – 01/02/2017.

-New 18 GHz Ion Source HIISI and 16.2 MeV/n beam cocktail



-High energy electron accelerator, LINAC





New 18 GHz Ion Source HIISI and 16.2 MeV/u beam cocktail

Present: The 9.3 MeV/u cocktail used at JYFL. Species marked with † have $m/q \approx 3.3$ and all others $m/q \approx 3.7$

Ion	$\Delta m/q$ (%)	Energy (MeV)	LET at surface (MeV·cm ² /mg)	LET at Bragg peak (MeV·cm ² /mg)	Range (μm)
¹⁵ N ⁴⁺	0	139	1.87	5.92 (@191 μm)	202
²⁰ Ne ^{6+†}	0	186	3.59	9.41 (@138 μm)	146
³⁰ Si ^{8+†}	-0.09	278	6.53	13.7 (@114 μm)	130
⁴⁰ Ar ^{12+†}	-0.06	372	10.1	18.9 (@100 μm)	118
⁵⁶ Fe ¹⁵⁺	-0.56	523	18.6	29.7 (@75 μm)	97
⁸² Kr ²²⁺	-0.71	768	31.2	41.7 (@68 μm)	94
¹³¹ Xe ³⁵⁺	-0.26	1217	57.4	67.9 (@57 μm)	89

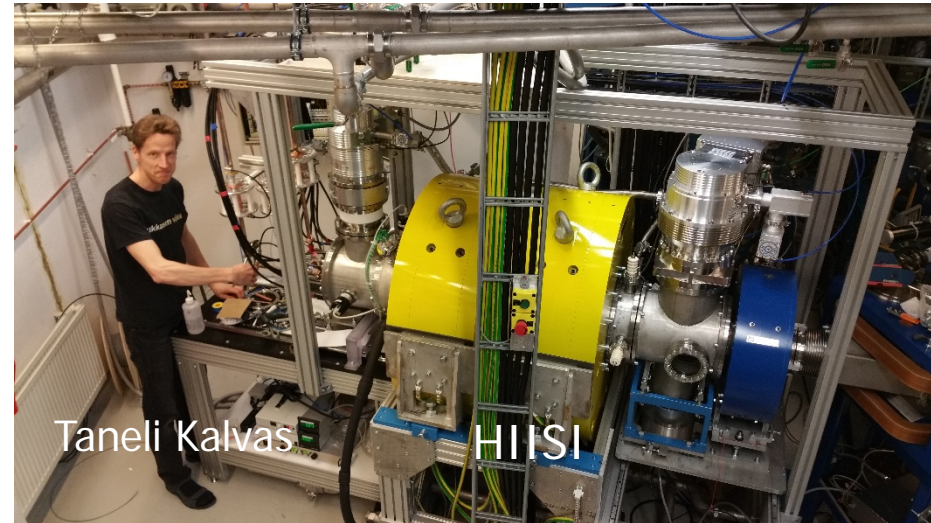
Spring 2017: The 12.5 MeV/u, $m/q = 3.2$ cocktail proposed to be used at JYFL with 24 segment magnets

Ion	$\Delta m/q$ (%)	Energy (MeV)	LET at surface (MeV·cm ² /mg)	LET at Bragg peak (MeV·cm ² /mg)	Range (μm)
¹⁶ O ⁵⁺	-0.88	203	1.86	7.16 (@283)	287
²⁹ Si ⁹⁺	-0.24	363	5.29	14.0 (@186)	196
⁵⁸ Fe ¹⁸⁺	-0.27	727	15.8	29.3 (@125)	148
⁶⁵ Cu ²⁰⁺	0.58	801	19.1	34.0 (@115)	138
⁸⁴ Kr ²⁶⁺	0	1047	28.3	40.9 (@108)	134
¹²⁹ Xe ⁴⁰⁺	-0.15	1614	54.2	69.2 (@81)	119

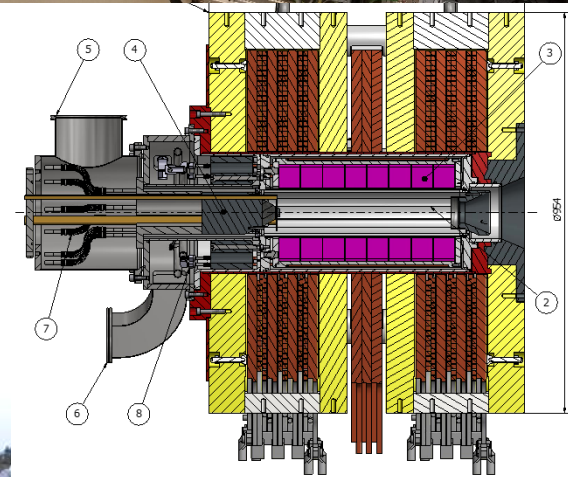
Autumn 2017: The 16.2 MeV/u, $m/q = 2.8$ cocktail proposed to be used at JYFL with 36 segment magnets

Ion	$\Delta m/q$ (%)	Energy (MeV)	LET at surface (MeV·cm ² /mg)	LET at Bragg peak (MeV·cm ² /mg)	Range (μm)
¹⁷ O ⁶⁺	-0.75	275	1.55	7.17 (@452)	456
²⁰ Ne ⁷⁺	0.06	319	2.40	8.95 (@336)	344
⁴⁰ Ar ¹⁴⁺	0	638	7.31	18.6 (@240)	253
⁵⁷ Fe ²⁰⁺	-0.27	913	13.7	29.3 (@181)	204
⁸³ Kr ²⁹⁺	0.16	1335	24.7	40.9 (@156)	181
¹²⁶ Xe ⁴⁴⁺	0.25	1999	49.1	69.3 (@113)	151

In addition, 10 MeV/u ¹⁷⁹Au⁵⁴⁺, LET 94 MeV·cm²/mg at Bragg peak (@50μm), Full Range 98 μm (SRIM2013)



Taneli Kalvas HIISI





High energy electron acclerator, LINAC

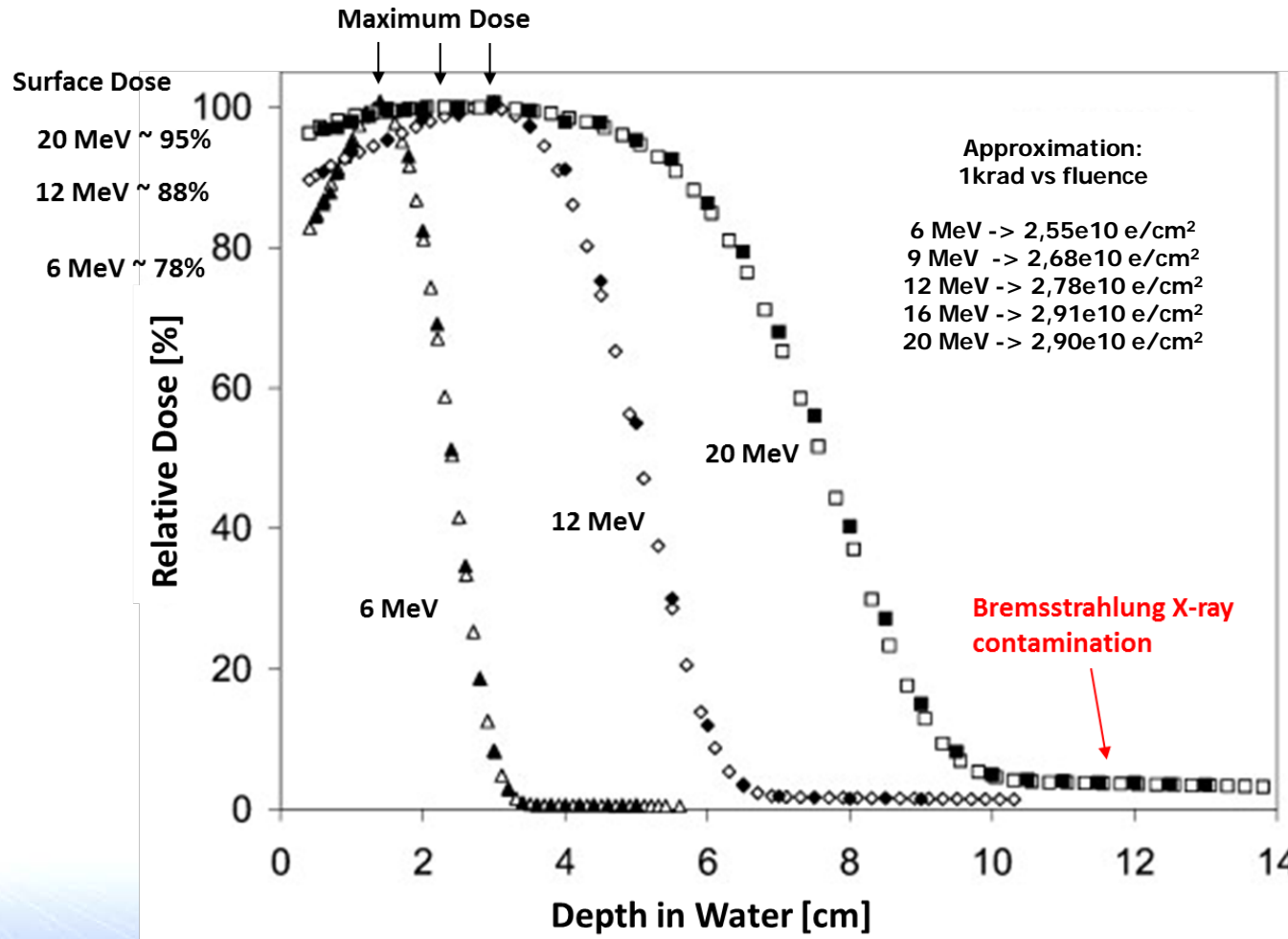


- Model: VARIAN cLINAC 2100 cd
- Electron and photon beams
- Electron energies: 6, 9, 12, 16 and 20 MeV
- Dose rates at maximum in water: 100, 200, 300, 400, 500, 600 and 1000 rad/min
- Photons: 6 and 15 MV Bremsstrahlung radiation
- Dose rates at maximum in water: 100, 200, 300, 400, 500 and 600 rad/min
- Maximum beam size in isocentric point 30x30 cm²
- Heavily pulsed beam: 1/1000
- 4 users until now



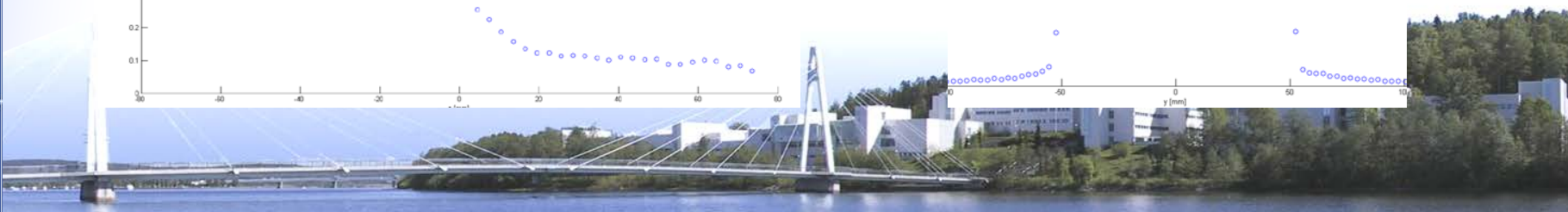
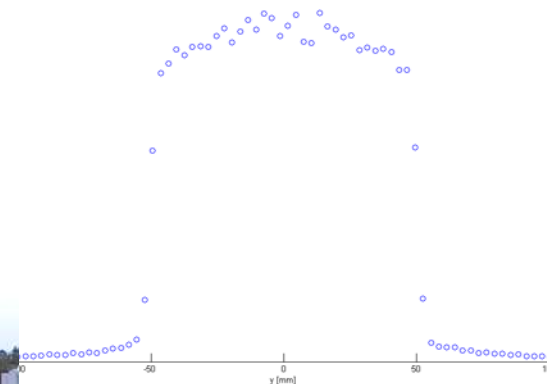
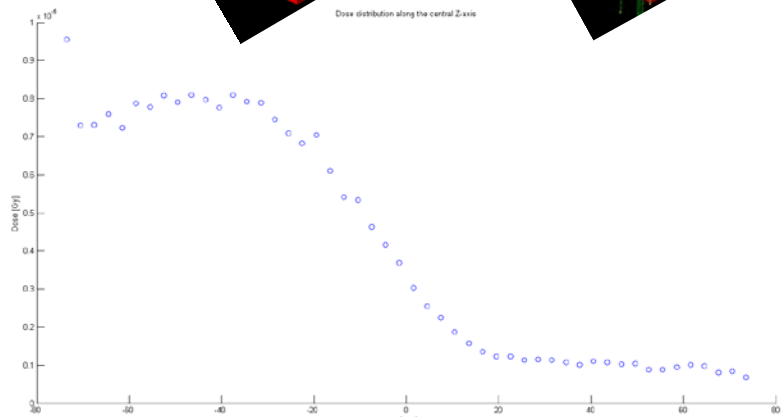
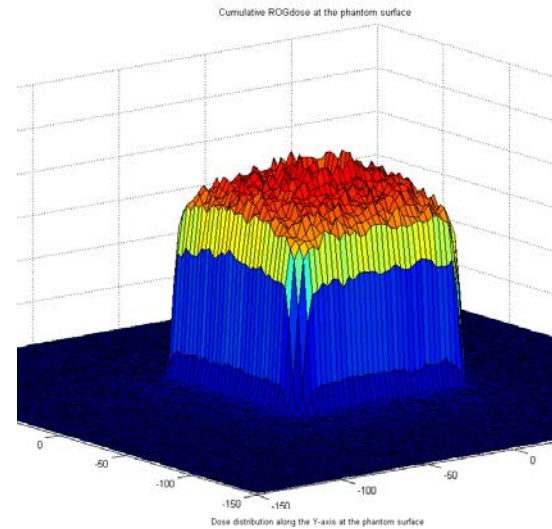
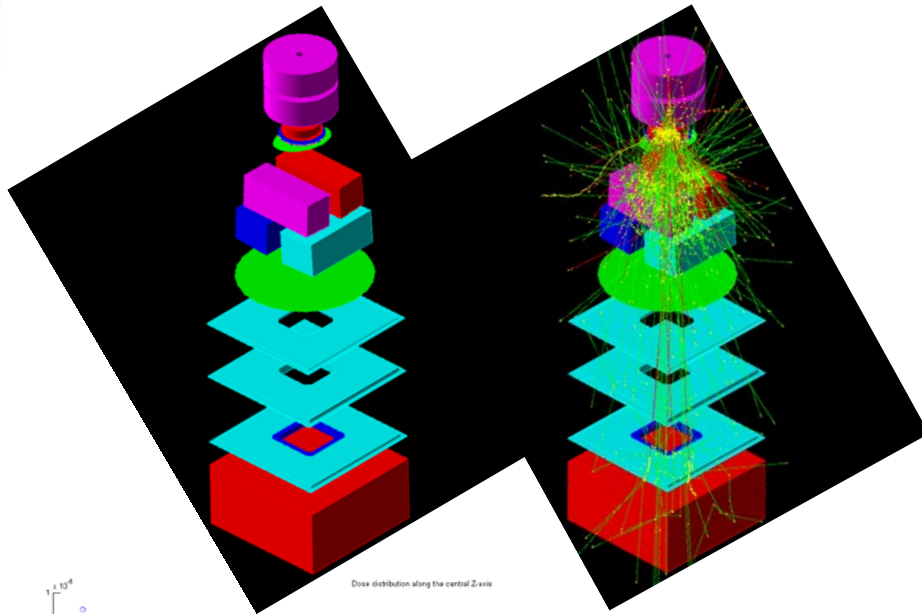


Dose rate at maximum in water for electrons





Geant4 simulations (MSc. Student Valteri Lahti)



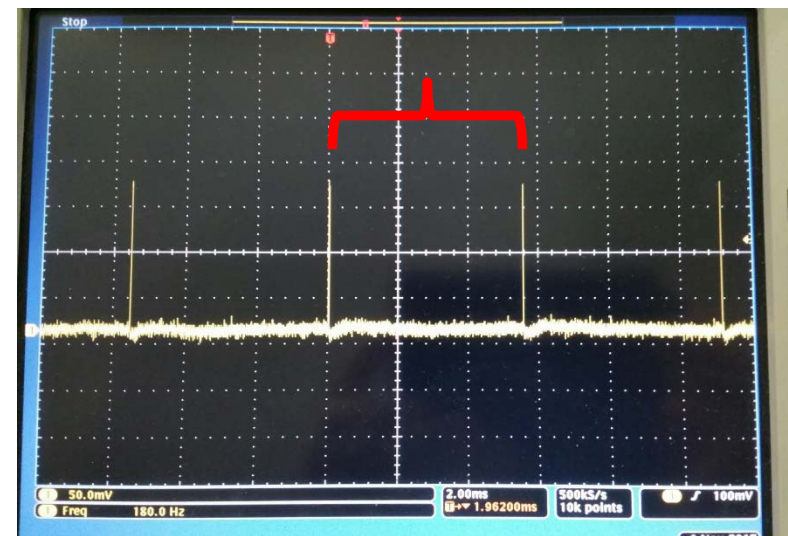
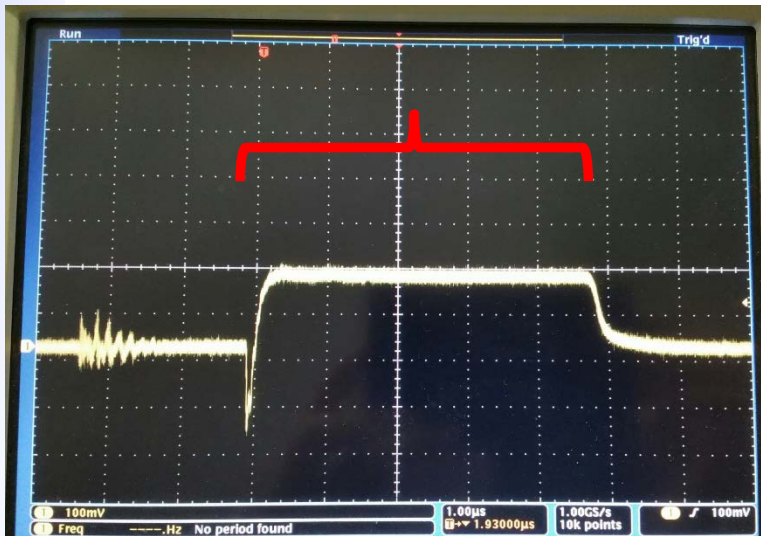


Beam Pulsing

For max dose rate 1000 rad/min:
Pulse width/Time between pulses = 1/1000

Pulse width ~ 5 μ s

Time between pulses ~ 5,7 ms





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Thank you for your attention

