



# **RADEF status report**

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

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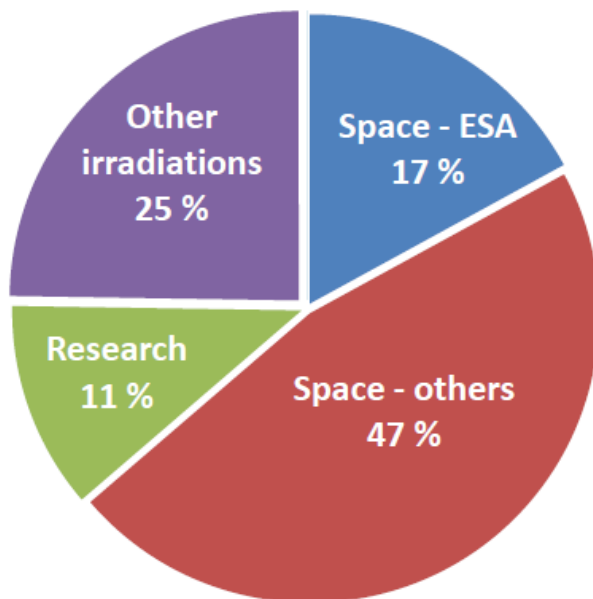
**ESA/ESTEC Contract No.  
4000111630/14/NL/PA:  
"Utilisation of the High Energy Heavy Ion  
Test Facility (RADEF) at the University of  
Jyväskylä (JYFL) for Component Radiation  
Studies 2014-2015"**

**Ari Virtanen, JYFL**



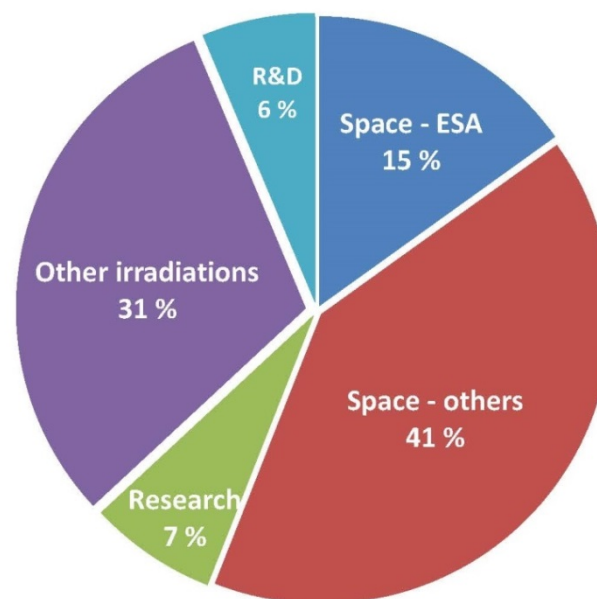
## Usage of beam time

**2013**



- 1455 total beam hours
- 45 campaigns
- 23 industrial- and 5 academic users
- 73 visitors

**2014**

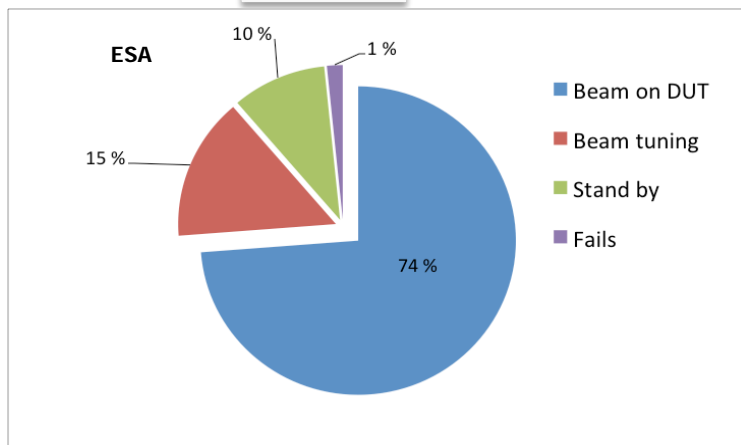


- 1315 total beam hours
- 41 campaigns
- 14 industrial- and 2 academic users
- 81 visitors

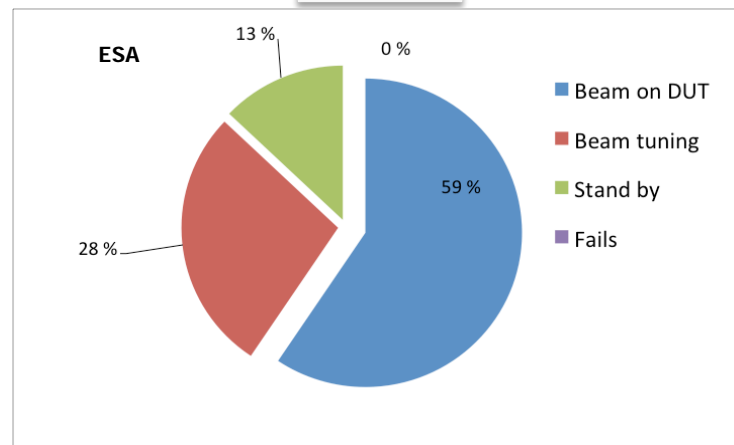


## Beam distributions of ESA- and non-ESA beam times

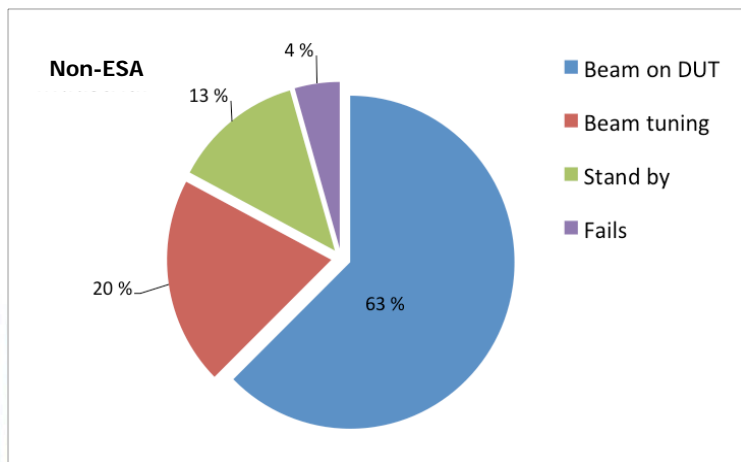
**2013**



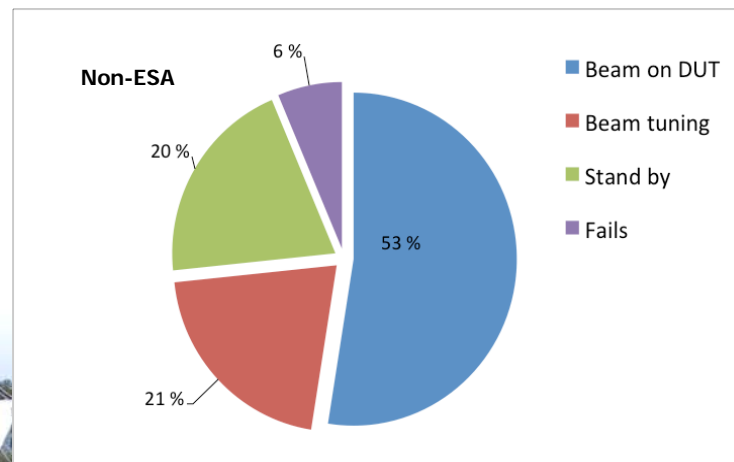
**2014**



**Non-ESA**



**Non-ESA**





# CNES/ESA Radiation Effects Final Presentation Days 2015

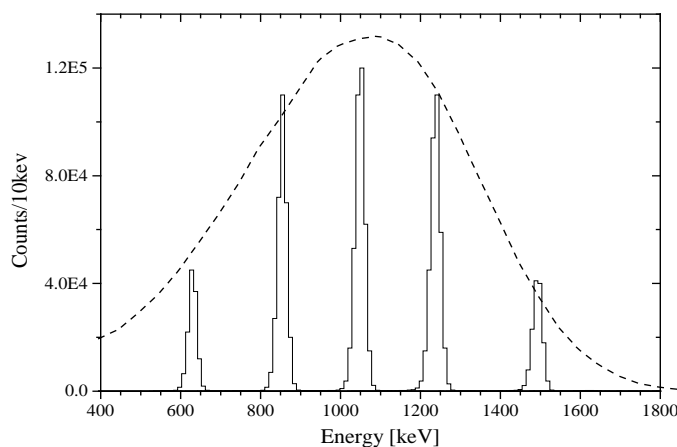


UNIVERSITY OF JYVÄSKYLÄ

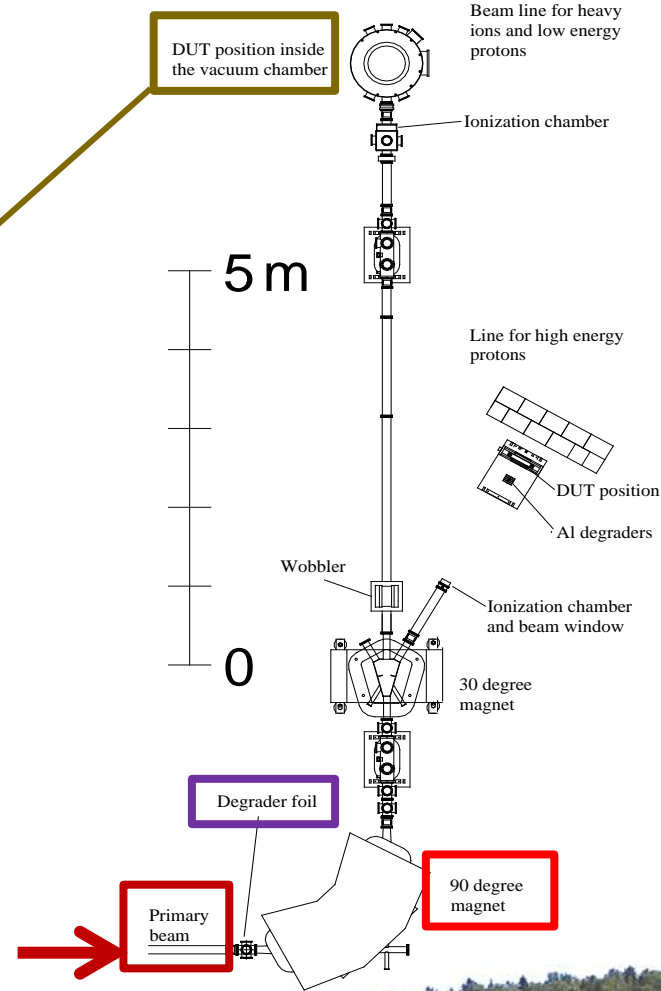
## Beam development

### Low energy protons at RADEF – Application to 28-nm SRAMs

Reported in Data Workshop Records of NSREC 2014



Energy distributions of proton beams obtained by using **8 MeV primary beam**, **411  $\mu\text{m}$  thick aluminum degrader** and **five different magnetic fields in 90 degree dipole magnet**. All the measurements are 60 second long. The dashed line shows the simulated energy distribution without magnetic separation.





# CNES/ESA Radiation Effects Final Presentation Days 2015



## Publications for 2013 - 2014

*A. Javanainen, V. Ferlet-Cavrois, J. Jaatinen, H. Kettunen, M. Muschitiello, F. Pintacuda, M. Rossi, J. R. Schwank, M. R. Shaneyfelt, A. Virtanen*

Semi-Empirical Model for SEGR Prediction

IEEE Trans. Nucl. Sci. Vol. 60 (2013) 2660

*W. Gieszczyk, P. Bilski, P. Olko, R. Herrmann, H. Kettunen, A. Virtanen, N. Bassler*

Evaluation of the Relative Thermoluminescence Efficiency of LiF:Mg,Ti and LiF:Mg,Cu,P TL Detectors to Low-energy Heavy Ions Radiation Measurements, Vol. 51-52 (2013) pp. 7-12

*C. Vockenhuber, J. Jensen, J. Julin, H. Kettunen, M. Laitinen, M. Rossi, T. Sajavaara, O. Osmani, A. Schinner, P. Sigmund, H. J. Whitlow*

Energy-loss straggling of 2-10 MeV/u Kr ions in gases

Eur. Phys. J. D 67 (2013)

*A. Javanainen, V. Ferlet-Cavrois, A. Bosser, J. Jaatinen, H. Kettunen, M. Muschitiello, F. Pintacuda, M. Rossi, J. R. Schwank, M. R. Shaneyfelt, A. Virtanen*

SEGR in SiO<sub>2</sub>-Si<sub>3</sub>N<sub>4</sub> Stacks

IEEE Trans. Nucl. Sci., vol. 61, no. 4 (2014) pp. 1902-1908

*G. Tsiligiannis, L. Dillillo, V. Gupta, A. Bosio, P. Girard, A. Virazel, H. Puchner, A. Bosser, A. Javanainen, A. Virtanen, C. Frost, F. Wrobel, L. Dusseau, and F. Saigné*

Dynamic Test Methods for COTS SRAMs

IEEE Trans. Nucl. Sci., vol. 61, no. 6 (2014) pp. 3095-3102

*A. Echler, P. Egelhof, P. Grabitz, H. Kettunen, S. Kraft-Bermuth, M. Laitinen, K. Mülle, M. Rossi, W. H. Trzaska, A. Virtanen*

Application of Calorimetric Low Temperature Detectors (CLTD's) for Precise Stopping Power Measurements of Heavy Ions in Matter

J Low Temp Phys (2014) pp.1573 - 7357

*K. Peräjärvi, T. Eronen, D. Gorelov, J. Hakala, A. Jokinen, H. Kettunen, V. Kolhinen, M. Laitinen, I. D. Moore, H. Penttilä, J. Rissanen, A. Saastamoinen, H. Toivonen, J. Turunen, J. Äystö*

Production of pure <sup>133m</sup>Xe for CTBTO

Hyperfine Interactions, Vol. 223, no. 1-3, (2014), pp. 239 - 243

*H. Kettunen, V. Ferlet-Cavrois, P. Roche, M. Rossi, A. Bosser, G. Gasiot, F.-X. Guerre, J. Jaatinen, A. Javanainen, F. Lochon, A. Virtanen*

Low energy protons at RADEF - Application to 28-nm SRAMs

2014 IEEE radiation Effects Data Workshop; held in conjunction with The IEEE Nuclear and Space Radiation Effects Conference 14-18 July, 2014, Paris, France



## Other space related contributions

**SkyFlash 262890 FP7 Project** – *“Development of Rad-Hard non volatile Flash memories for space applications”* funded by the European Union's 7th Framework Programme Collaborative Project, 09/01/2011 — 02/28/2014.



**R2RAM 640073 H2020 Project** - *“Radiation Hard Resistive Random-Access Memory”* funded by the European Union under Horizon2020 framework, 01/01/2015 — on-going

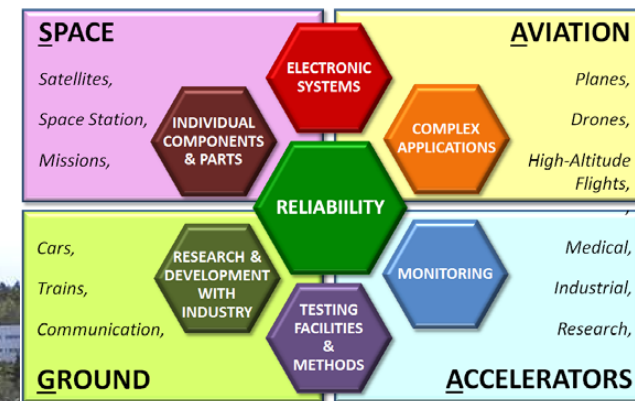


Group members acted as reviewers, session chairs and award committee members in NSREC and RADECS

Collaboration with MU2 and Vanderbilt continued:

- Alex Bosser does his PhD at RADEF and Arto Javanainen left for Vanderbilt for a year

RADEF is one of the six beneficiaries among 21 collaborators in EU's Marie-Curie Innovative Training Network proposal RADSAGA, coordinated by CERN



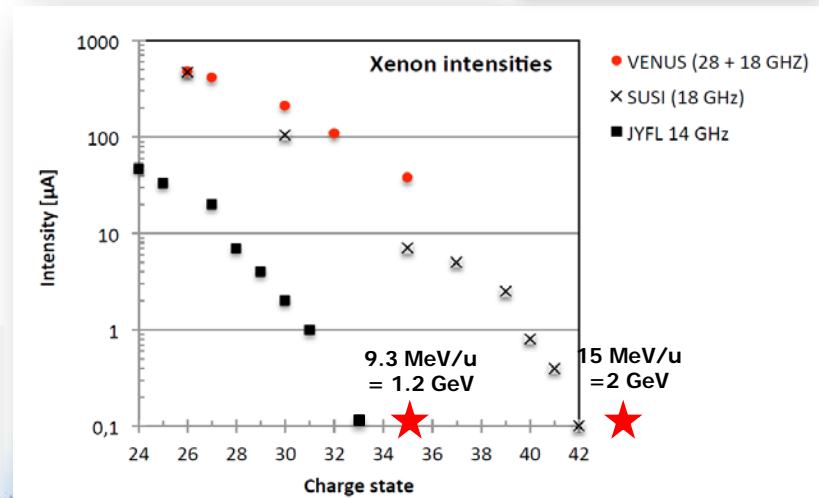
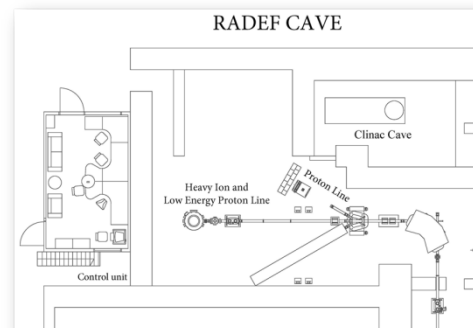
## Forthcoming developments

**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.

**1. Electron Beam.** Commissioning of Clinac electron accelerator, recently installed in the RADEF facility so, that it can be used in RHA tests of satellite electronics on MEO orbits and e.g. JUICE mission.

**2. New ion Beam Combination.** Complete the construction of the new HIISI (Heavy Ion Ion Source Injector) 18 GHz ECR ion source so, that K-130 accelerator is able to produce more energetic ion beam combination, aiming 15 MeV/u in energy. The new cocktail would include also heavier ion than Xe, e.g. Au.

**3. User Interface.** Upgrade the RADEF web pages and adapt them better to illustrate the updated user interface and the ECIF LET calculator, which will be extended to include the new ion combination. A user interface for the Clinac electron accelerator will also be developed.



## Group photo taken in May, 2013





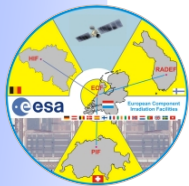
## CNES/ESA Radiation Effects Final Presentation Days 2015



[RADEF promotional video](#)

<https://m3.jyu.fi/jyumv/Members/arjavana-40jyu.fi/409504>

Jukka Mikko Heikki Ari Taheli Arto Alex



# CNES/ESA Radiation Effects Final Presentation Days 2015

# THANKS

...AND DON'T FORGET  
OUR DELICIOUS  
HOMEPIZZA

HOME = KOTI  
in Finnish

# KOTIPIZZA

## PIZZA/PIZZOR

	NORMAL NORMAL	FAMILY GROS	MEDIUM PAIN
1 TOPPING/FÜLLING	6,90	14,80	8,20

MINEPIZZA/HÄFLECHSEPIZZA #3			
Pizza with tomato sauce, mushrooms, olives			
MARGHERITA #10			
Tomato sauce, mozzarella cheese, mozzarella			

2 TOPPINGS/FÜLLINGEN	7,90	16,80	9,20
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OPERA #1			
Tomato sauce, mushrooms, olives, cheddar			
CAPRICCIOSA #4			
Tomato sauce, mushrooms, olives, cheddar			
TROPICANA #3			
Tomato sauce, mushrooms, olives, cheddar			
PEPPERONI #22			
Tomato sauce, mushrooms, olives, cheddar			
ALLA POLLO #14			
Grilled chicken, pepperoni, mozzarella cheese, mozzarella			

3 TOPPINGS/FÜLLINGEN	8,90	18,80	10,20
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FRUIT & MEAT #5			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
SPECIAL OPERA #6			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
CACCIATORI #7			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
VEGETARIANA #9			
Mushrooms, pepperoni, olives, cheddar, mozzarella			
AMERICANA #13			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
POLLO AMERICANA #17			
Grilled chicken, pepperoni, mozzarella cheese, mozzarella			
BACONPIZZA #19			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			

4 TOPPINGS/FÜLLINGEN	9,90	20,80	11,20
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QUINTO STAGIONE #7			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
POLLO RICCIARDO #11			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
MEXICANA #15			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
PENNELITA #18			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
ZOBAS #20			
Grilled chicken, pepperoni, mozzarella cheese, mozzarella			
BAKON #22			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
MEXICANA #24			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
MEXICANA #26			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
MEXICANA #28			
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MEXICANA #30			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
MEXICANA #32			
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MEXICANA #36			
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MEXICANA #38			
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MEXICANA #40			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
MEXICANA #42			
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MEXICANA #44			
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MEXICANA #46			
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MEXICANA #48			
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MEXICANA #70			
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MEXICANA #84			
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MEXICANA #86			
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MEXICANA #88			
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MEXICANA #94			
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MEXICANA #96			
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MEXICANA #98			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
MEXICANA #100			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			

5 TOPPINGS/FÜLLINGEN	10,90	22,80	12,20
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SEMI MEAT			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
BAKON #22			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
MEXICANA #24			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			
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MEXICANA #100			
Tomato sauce, mushrooms, olives, cheddar, mozzarella			

## SPECIAL PIZZA/

	NORMAL NORMAL	FAMILY GROS	MEDIUM PAIN
SPECIAL PIZZAS			

BURGERPIZZA #25			
Cheddar cheese, beef'n' mozzarella, red, long slice mushrooms, olives, Cheddar sauce, Beef'n' mozzarella SAL, Long Island Burgersauce			
PANCAKE #21			
Pancake mix, salad mix, cherry tomatoes, Parmesan cheese/ Pannkuchen mix, Salatmischung, Kirschtomaten, Parmesan			
DELLUSONI #24			
A dough that is high in fibre, sautéed chicken, cheddar sauce, red onion, Sautéierte Hühnerfleisch, Cheddar Sauce, rote Zwiebeln			

NORMAL MONSTER/MONSTER			
5 toppings / 5 varieties (chicken, meat, fish, veggie, cheese) + dip + bread sticks/ 5 Zutaten / 5 Sorten (Hühnerfleisch, Fleisch, Gemüse, Käse) + Dip + Brotsticks			
BIG MONSTER/GRAND MONSTER			
Big pizza + 5 toppings + dip + bread sticks/ Große Pizza + 5 Zutaten + Dip + Brotsticks			

LIGHT PIZZA			
With half the cheese/ Mit halber Menge an Käse			
FINISH MEAT PIZZA #26			
With half the cheese/ Mit halber Menge an Käse			

COFFEE/AFFEE			
ESPRESSO			
DOUBLE ESPRESSO/DOPEL-ESPRESSO			
CAPPUCINO			
CAFE LATTE			
TEA/TEE			
NOI CHOCOLATE/PACAO			
DOUGHNUT/DOHUT			

DRINKS/GETRÄNKE			
DRINK AS MUCH AS YOU LIKE			
100% PURE VITAMIN C DRINK			
Coca-Cola, Coca-Cola Light, Fanta, Sprite, Pepsi, Ben & Jerry's			
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