



# RADEF status report

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

&

**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"**

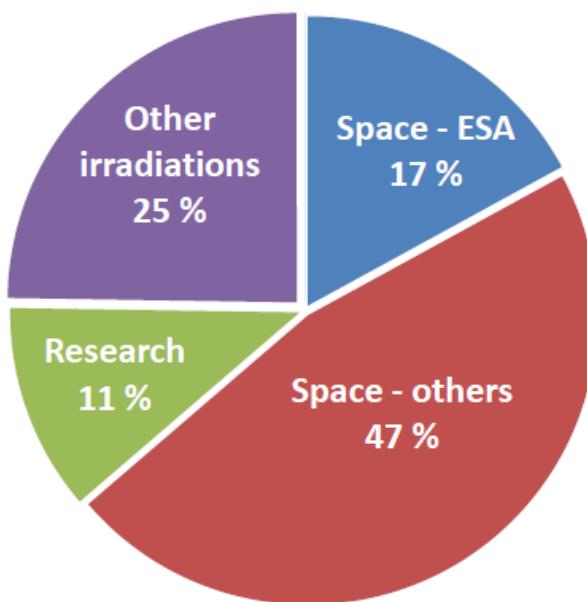
Ari Virtanen, JYFL



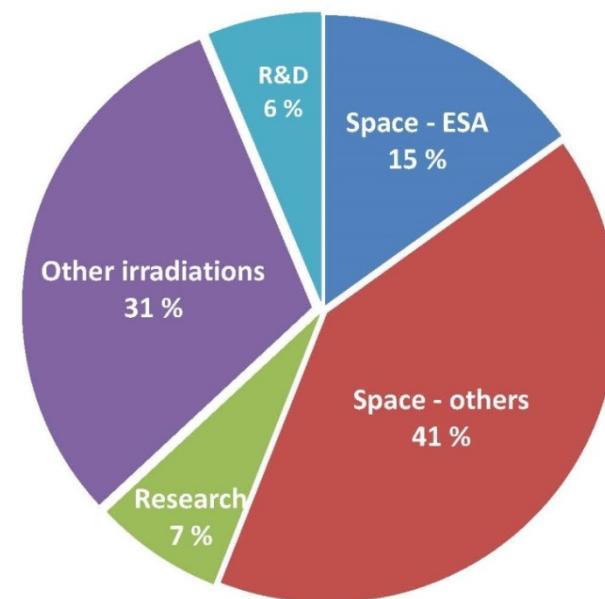


## Usage of beam time

2013



2014



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

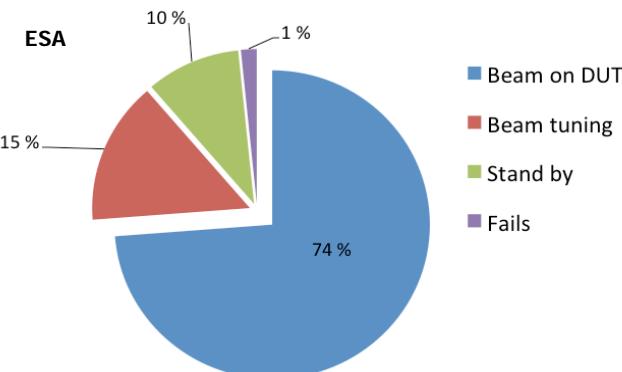
- 1315 total beam hours
- 41 campaigns
- 14 industrial- and 2 academic users
- 81 visitors



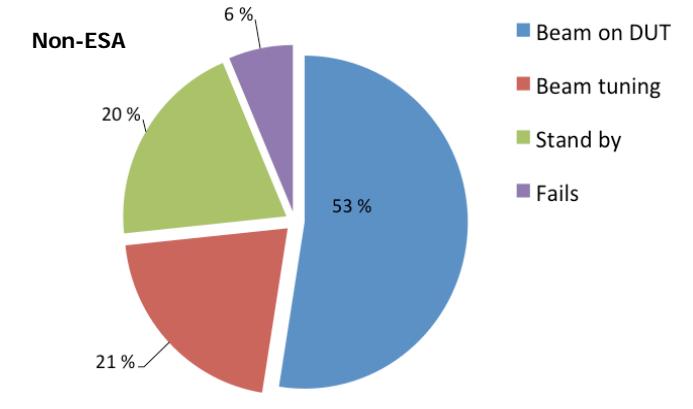
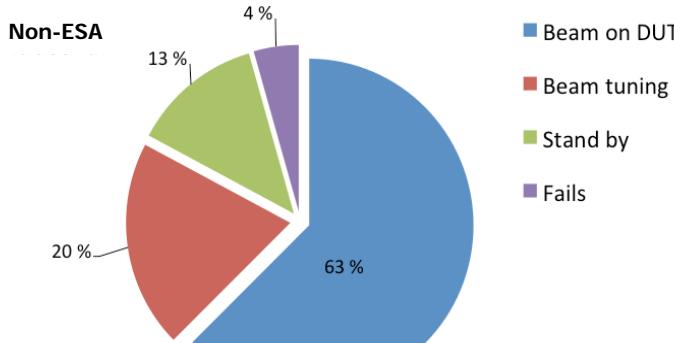
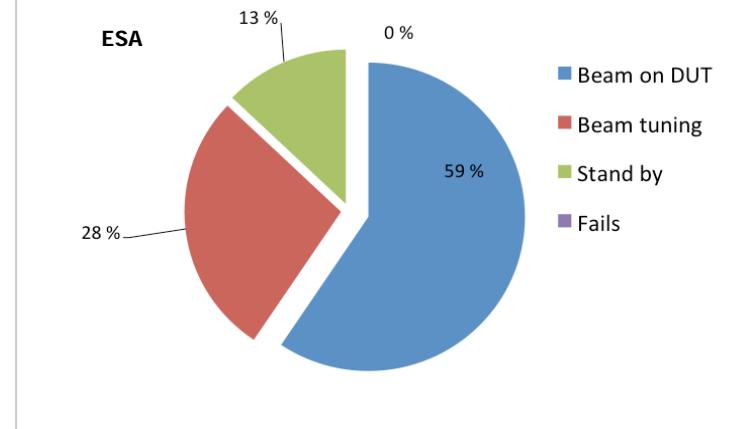


## Beam distributions of ESA- and non-ESA beam times

2013



2014

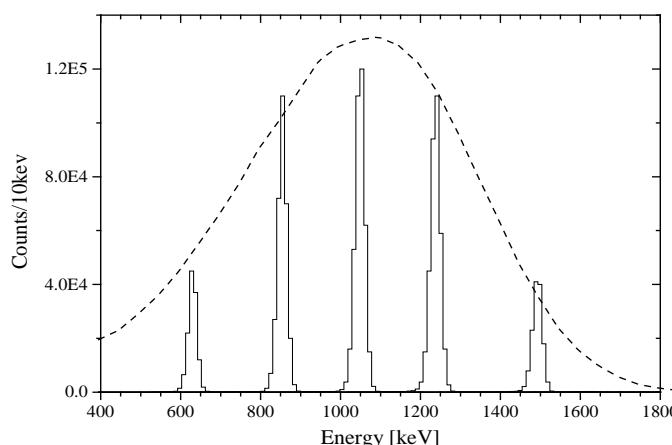




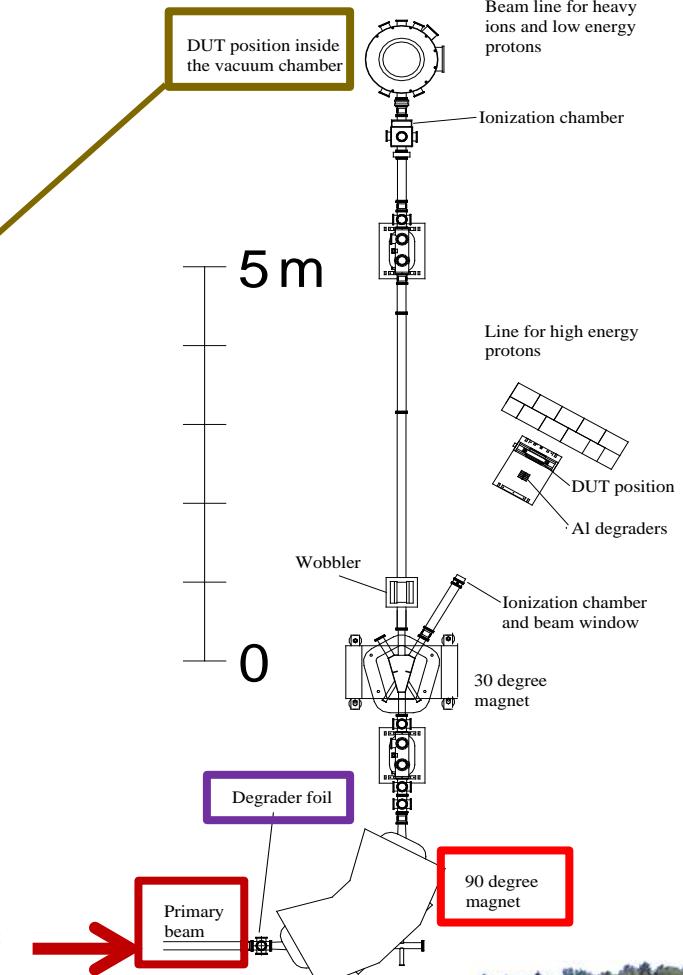
## Beam development

### 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 µm 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.





## 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  $\text{SiO}_2-\text{Si}_3\text{N}_4$  Stacks  
IEEE Trans. Nucl. Sci., vol. 61, no. 4 (2014) pp. 1902 –1908

*G. Tsiliogiannis, 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

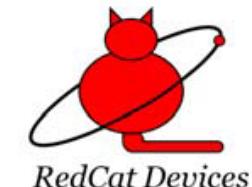
*K. Peräjärvi, T. Eronen, D. Gorelov, J. Hakala, A. Jokinen, H. Kettunen, V. Kolhinen, M. Laitinen, I. D. Moore, H. Penttilä, J. Rissanen, A. Saastamoinen, H. Toivonen, J. Turunen, J. Åystö*  
Production of pure  $^{133m}\text{Xe}$  for CTBTO  
Hyperfine Interactions, Vol. 223, no. 1-3, (2014), pp. 239 – 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

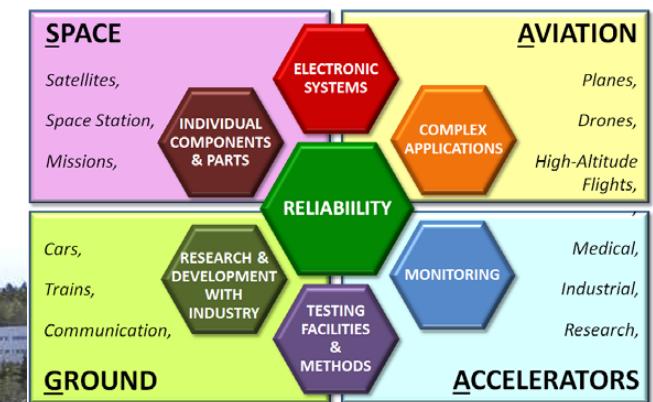


Group members acted as reviewers, session chairs and award committee members in NSREC and RADECS

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 RADSGA, coordinated by CERN



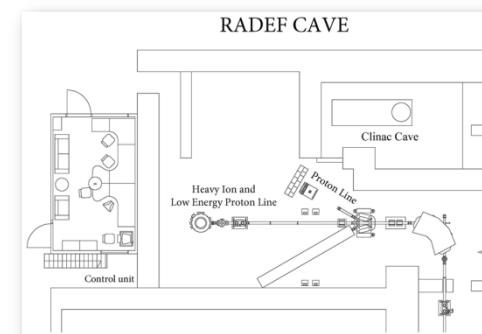


## Forthcoming developments

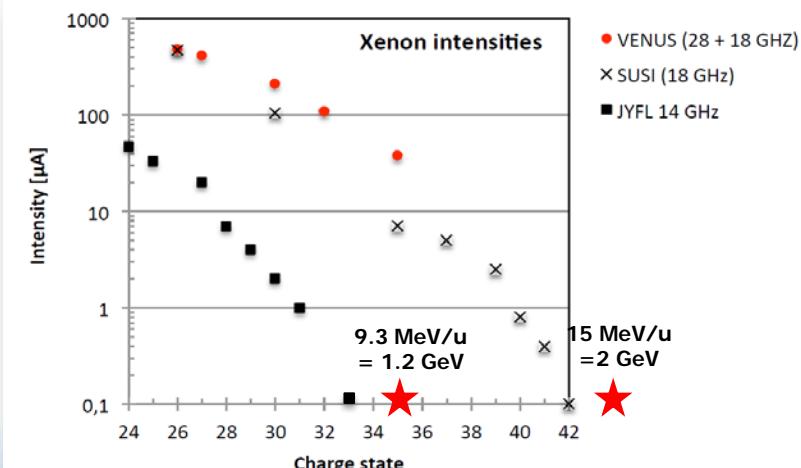
**ESA GSTP ESTEC/Contract No.**

**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.



# CNES/ESA Radiation Effects Final Presentation Days 2015



Group photo taken in May, 2013





## CNES/ESA Radiation Effects Final Presentation Days 2015

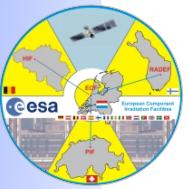


UNIVERSITY OF JYVÄSKYLÄ

### 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



UNIVERSITY OF JYVÄSKYLÄ

# THANKS

...AND DON'T FORGET  
OUR DELICIOUS  
HOMEPIZZA

HOME = KOTI  
in Finnish

**KOTIPIZZAMENU**

**PIZZA/PIZZOR**

	NORMAL	FAMILY	MEDIUM	PAN
	ADMIRAL	GROSSE	PEANNE	
1 TOPPING/FÜLLUNG	6,90	14,80	8,20	
MÜNCEPIZZA/HACKFLEISCHPIZZA #3				
Pizza mit Knoblauch, Hackfleisch und Knoblauchsauce				
MARGHERITA #10				
Tomato sauce, mozzarella cheese/Tomatensauce, mehr Käse				
2 TOPPINGS/FÜLLUNGEN 7,90 16,80 9,20				
OPERA #1				
Tuna, ham, Thunfisch, Schinken				
Ban, mozzarella/Schinken, Champignons				
TROPICANA #3				
Ban, pinapple/Schinken, Ananas				
PEPPERONI #11				
Tuna, pepperoni/sausage/Tunfisch, Pepperoniwurst				
ALL POLLO #14				
Grilled chicken, prezzemolo/Grilltäikinalehti, Arvensi				
3 TOPPINGS/FÜLLUNGEN 8,90 18,80 10,20				
FRUIT DREAM #5				
Tuna, prawns, mussels/Thunfisch, Krabben, Muscheln				
SPECIAL OPERA #6				
Ban, ham, Thunfisch, Schinken, Salami				
CAZUZA #7				
Selena, peppers, olives/Cilantro, Paprika, Oliven				
VEG TAFELMÄR #9				
Mushrooms, peppers, olives/Champignons, Paprika, Oliven				
AMERICANA #15				
Ban, cheese, ham, Bacon/Bananen, käse, räucherlachs				
POLLO AMERICANO #17				
Grilled chicken, pinapple, Avocado, Edelpfirsich				
BACONPIZZA #19				
Roast bacon, egg, red onion/Speck gebraten, Ei, rote Zwiebel				
4 TOPPINGS/FÜLLUNGEN 9,90 20,80 11,20				
QUATTRO STAGIONI #2				
Tuna, ham, mushrooms, prawns/Thunfisch, Schinken, Champignons, Krabben				
POLLO AMERICANA #18				
Grilled chicken, chicken, pinapple, jalapeños/Muscadine, Grilltäikinalehti, Karri, Jalapeño				
MEXICANA #13				
Mexican salsa, pepperoni, jalapeños, pinapple, jalapeños/Peperoni, Jalapeño, Grilltäikinalehti, Karri, Jalapeño				
PENNETTA #19				
Frisch gebackenes, your own choice/Viel Füllungen nach Wunsch				
ZÖDAS #20				
Greek-style cheese, red onion, peppers, olives (low fat cheese)/Käse nach griechischer Art, rote Zwiebel, Paprika, Oliven (geringe Fettz.				
BACON IRISH #22				
Bacone sauce, roast bacon, pinapple, red onion/Backfischsauce, Speck gebraten, rote Zwiebel, Paprika				
MOZZARELAPIZZA #23				
Mozzarella cheese, pinapple, sun-dried tomato, basilico (low fat) /Mozzarellakäse, Ananas, Sonnenblumenöl, Basilikum (geringe Fettz.				
GREEK-GREEKESCHES PIZZAT				
5 TOPPINGS/FÜLLUNGEN 10,90 22,80 12,20				
KEBAB #16				
Kebab sauce, felber meat, Greek paprika, red onion, peppers/Kebabsauce, gegrilltes Fleisch, rot Zwiebel, Paprika, Rotes-Schilf				
<b>SPECIAL PIZZAS</b>	<b>NORMAL</b>	<b>FAMILY</b>	<b>MEDIUM</b>	<b>PAN</b>
EINDECKERPIZZA #25	3,40	17,80	9,70	
Chicken, ham, cheese, bacon, "rein mindestens 10 Jahre", Knoblauch, Brot, rotes Thunfischfilet, Gegrillter Thunfischfilet, Salat, Saucenmix				
PIZZA MEXICANA #26	10,90	22,80	12,20	
Pasta, Tomaten-Sauce mix, cherry tomatoes, Parmesan cheese/Pasta mit Tomaten-Sauce Mix, Kirschtomaten, Parmesan-Käse				
DELICIOSOPIZZA #24	11,40	24,30	13,20	
A Design that is light in taste, sweetened with cherries, red onions/ Süßes Design mit Kirschen, roten Zwiebeln und einem Beigabe aus grünem Rettichsalat, Pfeffersalat und Römersalat				
<b>KOTZONE</b>	<b>NIGHT-FIRE PIZZA DOME/</b>	<b>BALLASTOF FÜR FRISCHE PIZZABÖDEN</b>		
<b>GRILLED CHICKEN/GÄRTHÄNCHEN</b>			7,80	
Grilled chicken, cheese, bacon, "rein mindestens 10 Jahre", Gegrillter Thunfischfilet, Salat, Saucenmix				
<b>KEBAB</b>			9,80	
Kebab meat, Greek paprika, salat, felber sauce, sauce of your choice/Thunfischfilet, Griechische Paprika, Salat, Saucenmix				
<b>ZOMBIES</b>			9,80	
Greek-style cheese, paprika, red onion, salat, sauce of your choice /Käse nach griechischer Art, Paprika, rote Zwiebel, Salat, Saucenmix				
<b>PEPPERONI-PIZZA/BLAU CHEESE/</b>			9,80	
Pepperoni, Aubergine, red onion, salat, sauce of your choice/Pepperoni, Aubergine, rote Zwiebel, Salat, Saucenmix				
<b>MEXIKANA</b>			10,80	
Mexican salsa, griléd chicken, blue cheese, paprika, sauce of your choice/Mexikanische Salsa, Grilltäikinalehti, Blaue Käse, rote Zwiebel, Salat, Saucenmix				
<b>BARBECUE</b>			10,80	
Barbecue sauce, grilléd chicken, blue cheese, paprika, sauce of your choice/Barbecuesauce, Grilltäikinalehti, Blaue Käse, rote Zwiebel, Salat, Saucenmix				
<b>BERLUSCONI</b>			11,80	
Shaved chicken, cherries, red onions, sauce of your choice/Garlicktäikinalehti, Rote Zwiebeln, Pfeffersalat und Römersalat, Salat nach Wahl				
<b>COFFEES/KAFFEES</b>				
<b>COFFEE/KAFFEE</b>			1,50	
Coffee			2,40	
<b>DOUBLE ESPRESSO/DOPPEL-ESPRESSO</b>			2,50	
Cappuccino			2,50	
<b>CAP LATTE</b>			2,50	
Tea/tee			1,20	
<b>COFFEE LATTE/KAFFEE LATTE</b>			1,70	
Mocha/Motif/Cappuccino			2,20	
<b>DOUGHNUT/DOUGHNUT</b>			2,20	
<b>DRINKS/GETRÄNKE</b>				
<b>DRINK AS MUCH AS YOU LIKE/</b>				
SOUL EYE'S 5 EVERTINGEN KÖLN			2,70	
Coca-Cola, Coca-Cola Light, Fanta, Spritz 7UP, Limonade, Seidenlimonade			2,70	
<b>COCA-COLA COKE COLA LIGHT/</b>				
Coca-Cola, Coca-Cola Light, Coca-Cola ZERO, Fanta, Fanta Light, Sprite, Berkäppi, Maumi				
<b>0,5 L BOTTLE SPRING WATER</b>			1,80	
0,5L Wasser, Mineralwasser			3,80	
<b>2,5 L BOTTLED LEMONADE</b>				
Coca-Cola Coca-Cola Light, Coca-Cola ZERO, Fanta, Fanta Light, Spritz, Berkäppi				
<b>0,33 L BATTERY</b>			3,20	
2 D MILKA/MLCH			1,00	
<b>LUNCH</b>				
WEEKDAYS FROM 11AM TO 2PM/WERKTAGE 11-14 UHR				
During your lunchbreak, customers who buy several items at once receive a normal discount/günstige Rabatte. If you buy several items at once, the discount you can obtain from us ranges with additional discounts, if you buy more than one item.				
Zur Mittagszeit erhalten Sie keinen Rabatt, wenn Sie mehrere Artikel kaufen. Bei mehr als einem Artikel kann der Rabatt von uns um weitere Rabatte erhöht werden.				
The best way to get rid of excess heat is to drink water. We recommend that you drink at least 1.5 liters of water daily. Water is the best drink for the body. It is also good for the skin. It helps to remove toxins from the body. It is also good for the skin. It helps to remove toxins from the body.				
<b>KOTI PIZZA</b>				
Pizza, love & Understanding				
				