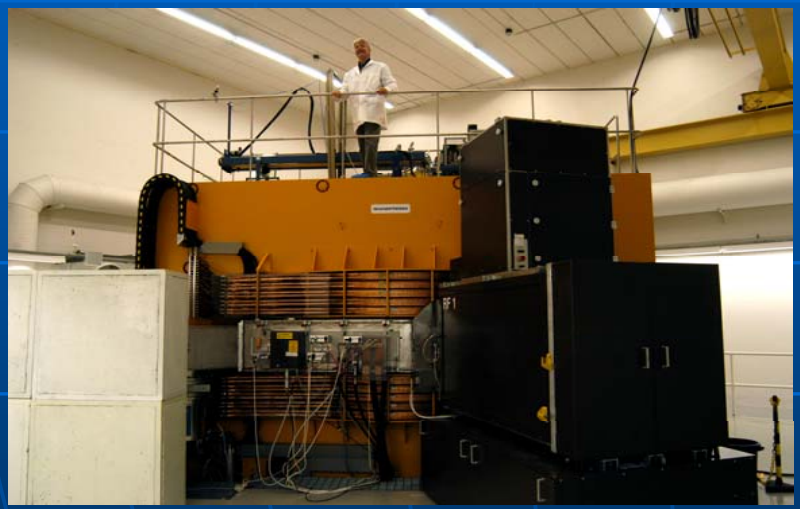
Accelerator Laboratory of the University of Jyväskylä

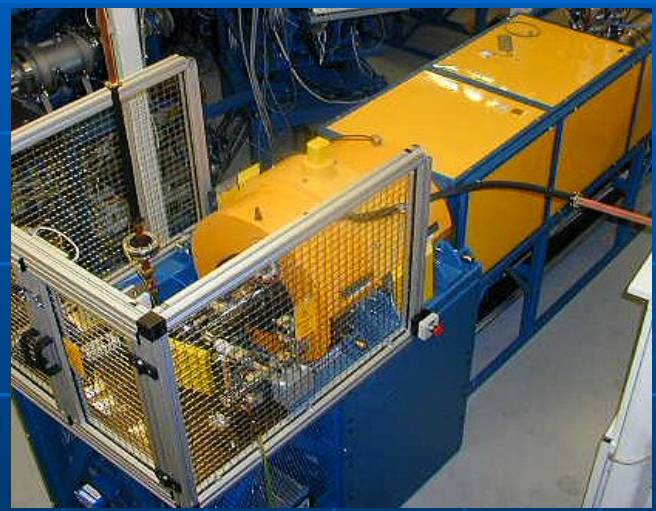
- Part of the Department of Physics (JYFL)
- Basic research in nuclear-, accelerator- and materials physics
- Applications in space- and medical physics & paper industry
- Center of Excellence status of the Academy of Finland
- EU's Major Research Facility i.e. "Large Scale Facility"

Machine description

K-130 cyclotron:

- Heavy-ions up to Xe ≤ 1.3 GeV, protons ≤ 60 MeV
- All gaseous and 19 metallic elements
- Dedicated beam cocktails for the irradiation tests



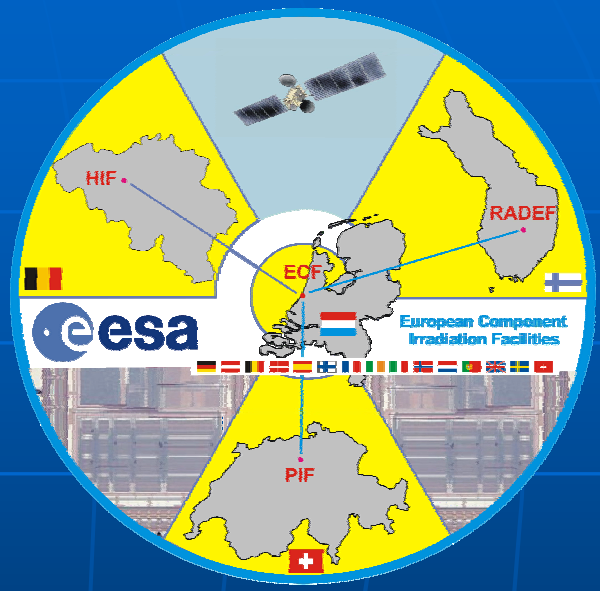


- Two ECR (6.4 and 14.5 GHz) ion sources for heavy-ions
- TWTA transmitter for double/triple frequency mode
- Multicusp ion-source for protons

The New ESA Sponsored Test Site

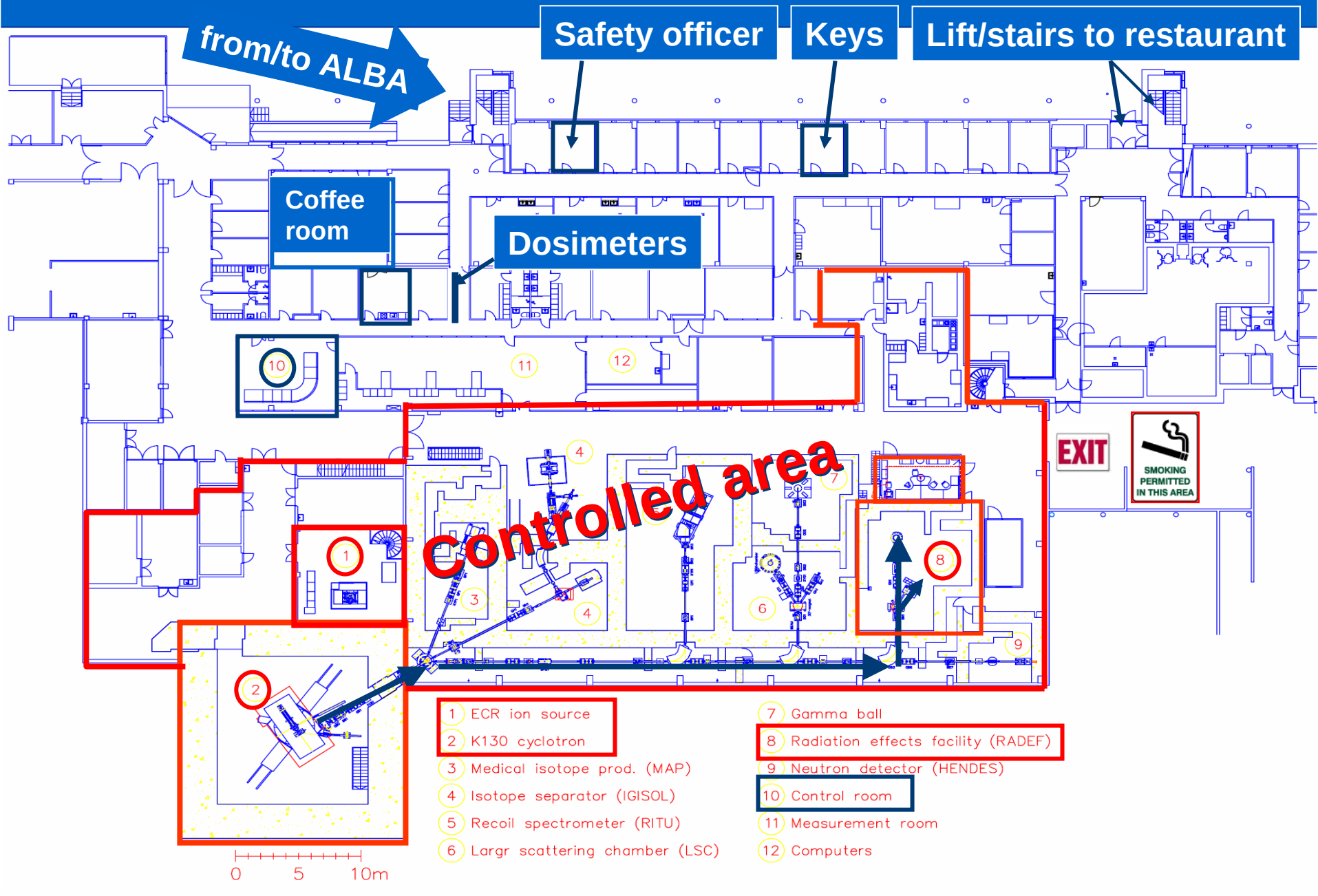
ESTEC/Contract No. 18197/04/NL/CP

”Utilisation of the High Energy Heavy Ion Test Facility for Component Radiation Studies”

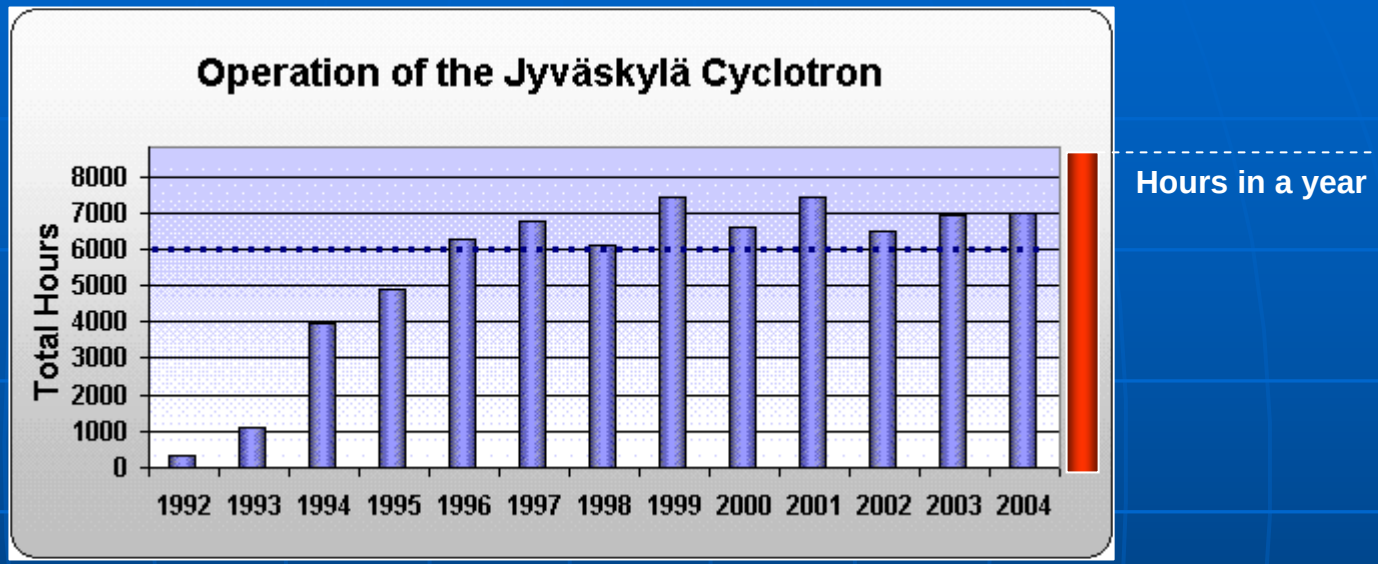


- The development phase started in summer 2004
- Acceptance test took place in April, 2005
- Inauguration is tomorrow May 27, 2005

Laboratory floor plan

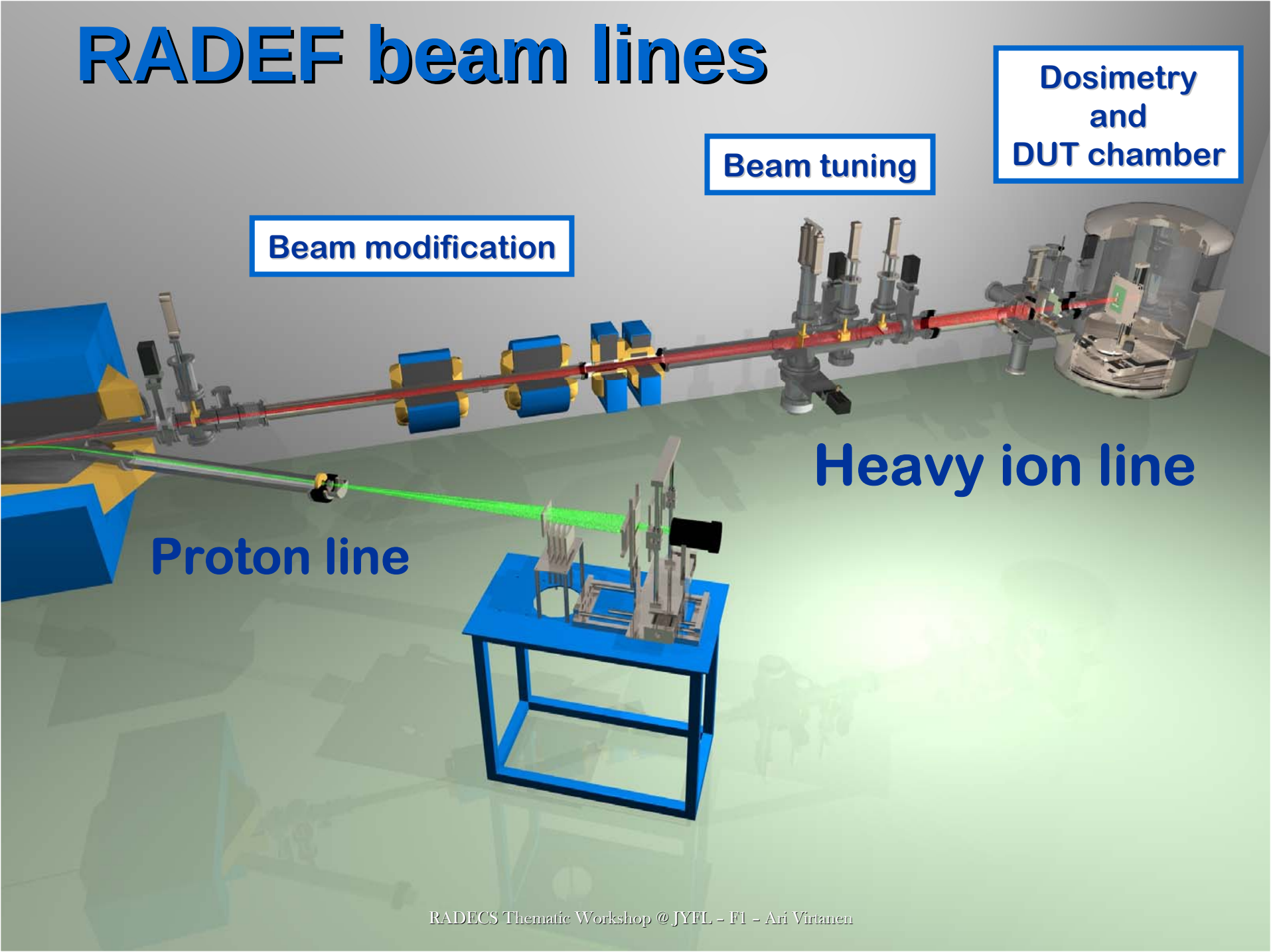


Usage and management

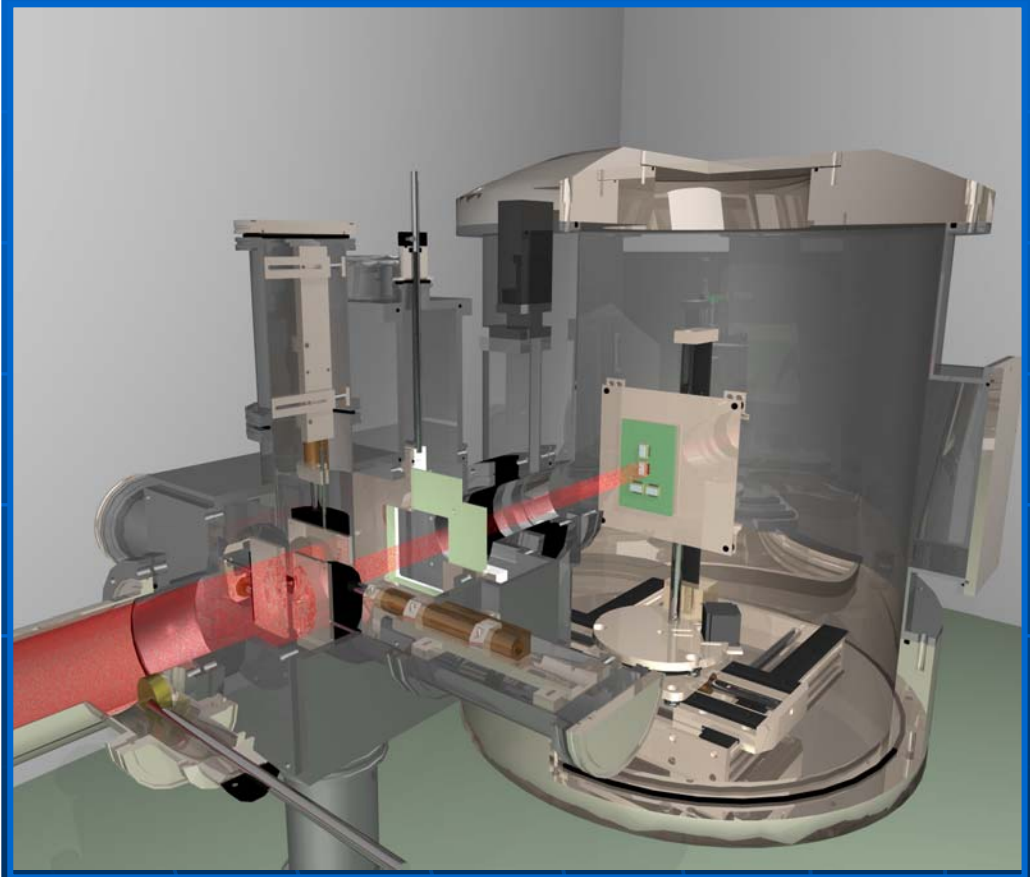


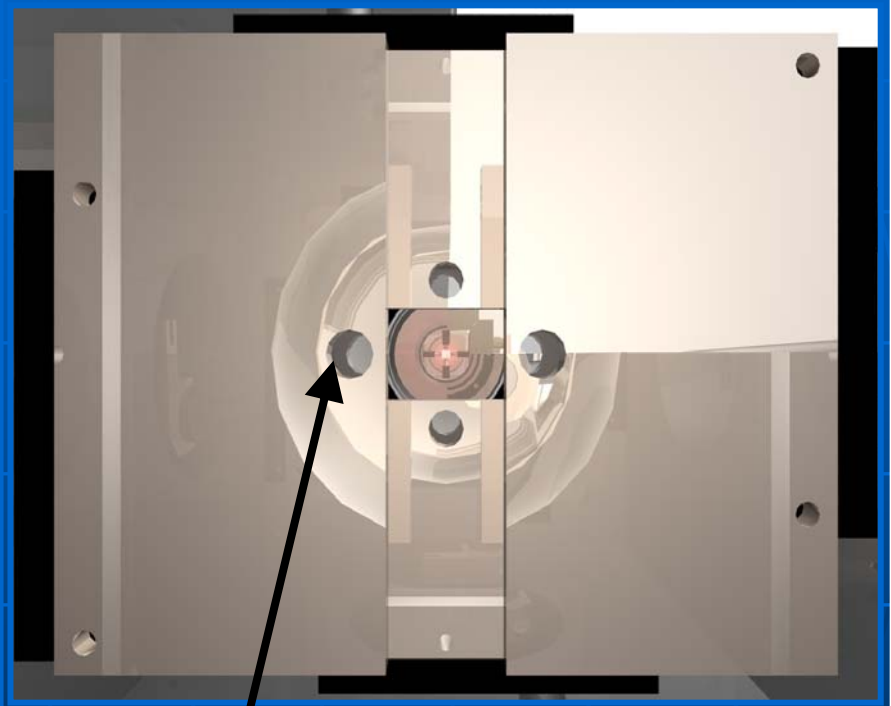
- Beam times for basic research
  - Two annual calls of proposals to PAC
- Dedicated beam times for
  - MAP MedTech Ltd. - radioisotope production (~ 10%) - weekly
  - ESA and European space industry (~ 10%) – upon request

RADEF beam lines



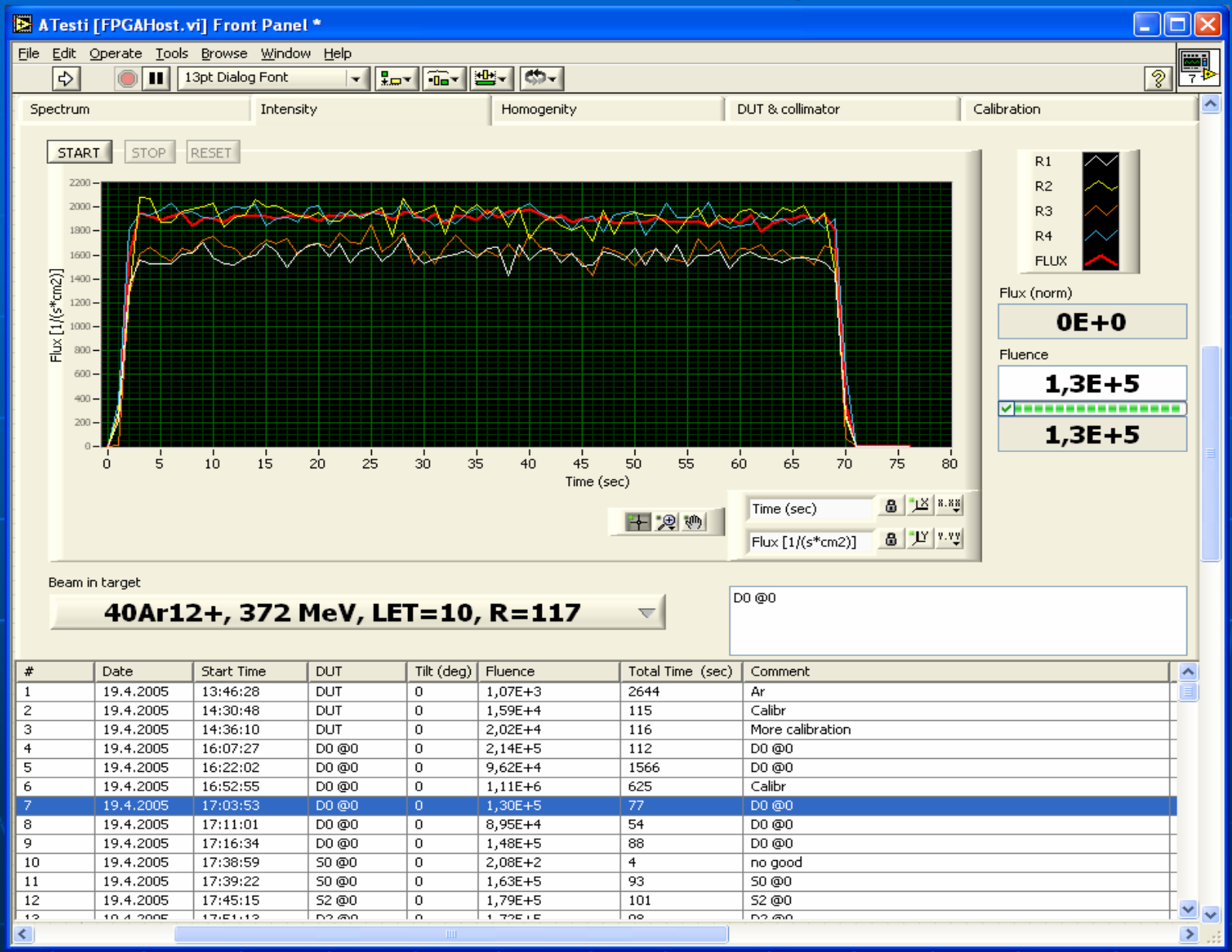
Dosimetry





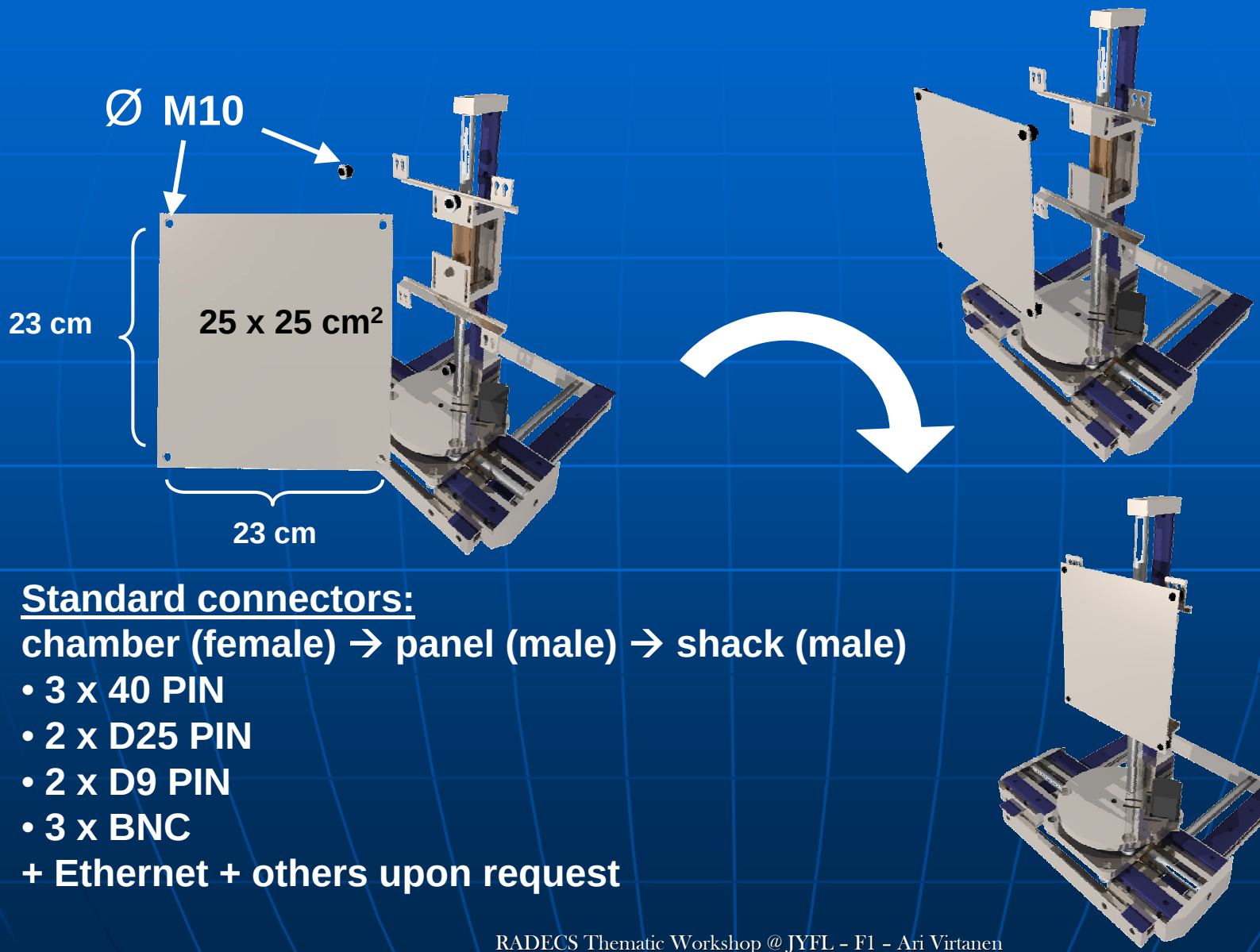
Area 0.5 cm²

Beam monitoring



#	Date	Start Time	DUT	Tilt (deg)	Fluence	Total Time (sec)	Comment
1	19.4.2005	13:46:28	DUT	0	1,07E+3	2644	Ar
2	19.4.2005	14:30:48	DUT	0	1,59E+4	115	Calibr
3	19.4.2005	14:36:10	DUT	0	2,02E+4	116	More calibration
4	19.4.2005	16:07:27	D0 @0	0	2,14E+5	112	D0 @0
5	19.4.2005	16:22:02	D0 @0	0	9,62E+4	1566	D0 @0
6	19.4.2005	16:52:55	D0 @0	0	1,11E+6	625	Calibr
7	19.4.2005	17:03:53	D0 @0	0	1,30E+5	77	D0 @0
8	19.4.2005	17:11:01	D0 @0	0	8,95E+4	54	D0 @0
9	19.4.2005	17:16:34	D0 @0	0	1,48E+5	88	D0 @0
10	19.4.2005	17:38:59	S0 @0	0	2,08E+2	4	no good
11	19.4.2005	17:39:22	S0 @0	0	1,63E+5	93	S0 @0
12	19.4.2005	17:45:15	S2 @0	0	1,79E+5	101	S2 @0

DUT plate installation



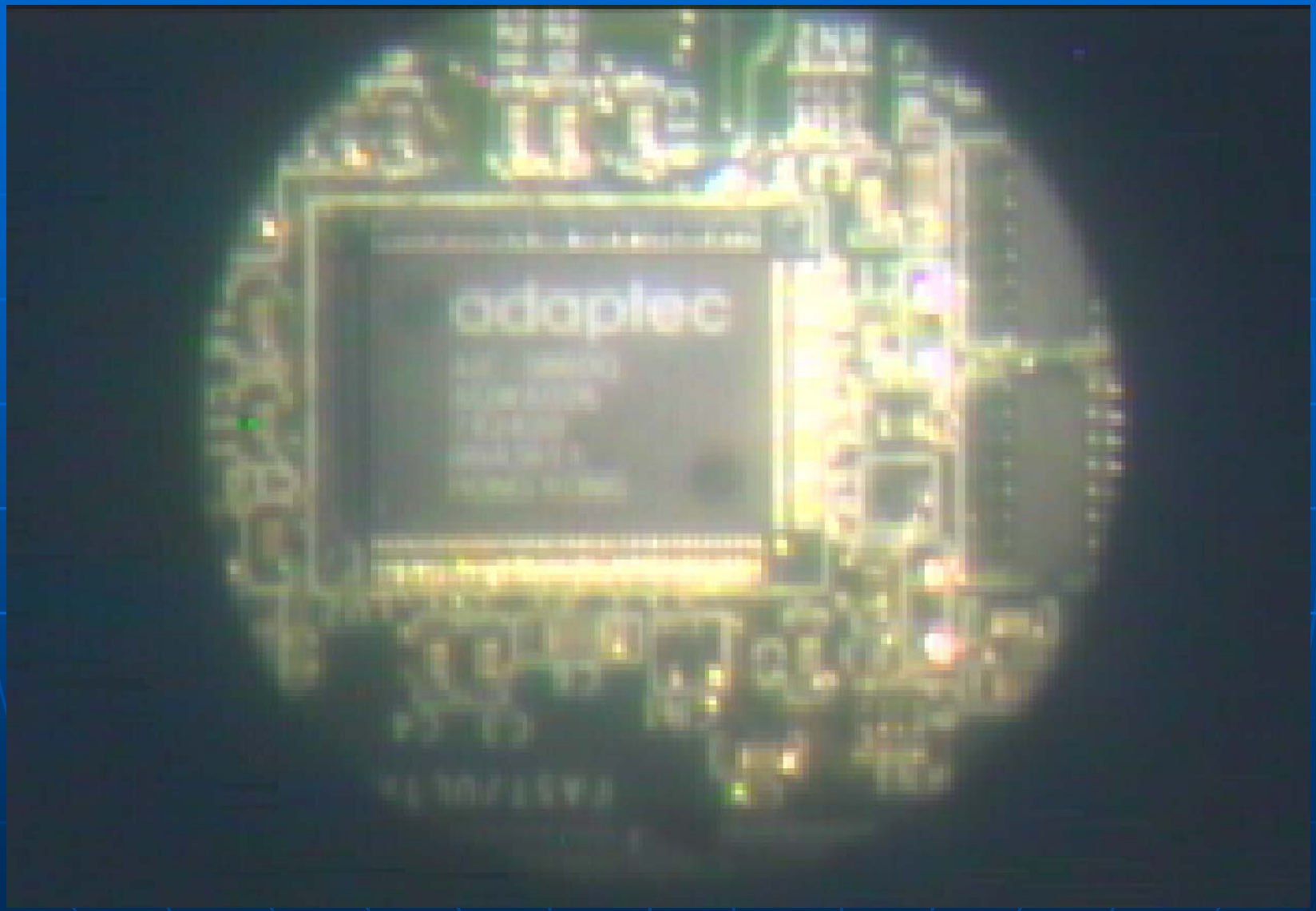
Standard connectors:

chamber (female) → panel (male) → shack (male)

- **3 x 40 PIN**
- **2 x D25 PIN**
- **2 x D9 PIN**
- **3 x BNC**

+ Ethernet + others upon request

Monitoring the DUT



Radiation Safety Procedures

JYFL
Accelerator Laboratory

READ ME PLEASE

VISITORS

Visitors coming for short term work at The Accelerator Laboratory are kindly asked to follow these safety practices.

RADIATION SAFETY

All visitors working inside the controlled area **must have personnel dose control**. Dosimeters can be provided also by the home institute. Recognition as **Category A** radiation worker requires a document from the home institute stating this status. This document is valid for one year unless otherwise specified in the document. A document of personnel radiation exposure history is required at the latest if the recording threshold is exceeded in the dose control provided by JYFL (unless "no earlier radiation work" is signed on RS-1).
The data for radiation work and dose control is entered in the computer database with the aid of form **RS-1**. At the proper occasion check the validity of your data.

Do this:

- Fill the form **RS-1** (first visit or changes) and visit the safety officer. **We need the dates of your visit and to assure your dose control and to check your working conditions for every visit.**
- Fill the form **Visitors** and leave it to the safety officer, department office or your host.

GENERAL SAFETY

The laboratory keys are provided by the safety officer. The following practice must be applied in order to maintain the desired safety level.

- **Keys must always be given back before you leave**. The validity of the entrance key will be cancel if this rule is violated. Never leave your keys reachable for outsiders.
- **Lost keys must be notified immediately**. The fee of 50 FIM per each lost key will be charged before new keys are delivered.
- Do not deliver the lock codes (controlled area) to unauthorised persons.

Radiation Safety Officer: **Teuvo Poikolainen,** room: **FL103**, phone: **2404.**
I'll try to be in my office 10-11 and 13-14; normally reachable by dialling 2404.

FORMS AND INFO

- Forms and info on radiation safety available in the room S127 (below).
- The safeguards for the radiation practice are included in the **Radiation Protection Manual**.

JYFL
Accelerator Laboratory

RADIATION SAFETY RS-1

Radiation work at JYFL Accelerator Laboratory

A
Name: | Birthday: . . (-)
Home institute and address: | Nationality: | Title:

B
Current status at home institute: ☐ Staff member ☐ Student
☐ Category A radiation worker, ☐ Category B (temporary) radiation worker
Attached documents: ☐ Monitoring document (EC countries), ☐ Health control, ☐ Personnel dose
I hereby assure that I have not done radiation work earlier (involving personnel dose control).
Signature

C
Radiation work at JYFL (use following numbers for working categories):
(1) Experiments with accelerator beams **(2)** Radionuclides (unsealed sources)
(3) Sealed sources **(4)** Accelerator technology

Time periods at JYFL DD.MM.YY - DD.MM.YY	*	Work category (numbers above)	Time periods at JYFL DD.MM.YY - DD.MM.YY	*	Work category (numbers above)

* Dosimeter provided by the home institute

D
Mailing addresses for the registered doses at JYFL:
Other than home institute: | ☐ Send my personnel dose record also to:

E
Remarks:

INFO
Information on personnel dose record is normally mailed once per year.
Read the local instructions: "Radiation exposure monitoring and health surveillance during temporary visits at JYFL or abroad".
Mark dates: DD.MM.YY (DD = day, MM = month, YY = year)
If there are changes in parts A, B or D, fill in a new form (earlier forms available from safety officer).
Form shall be returned to radiation safety officer without delay.

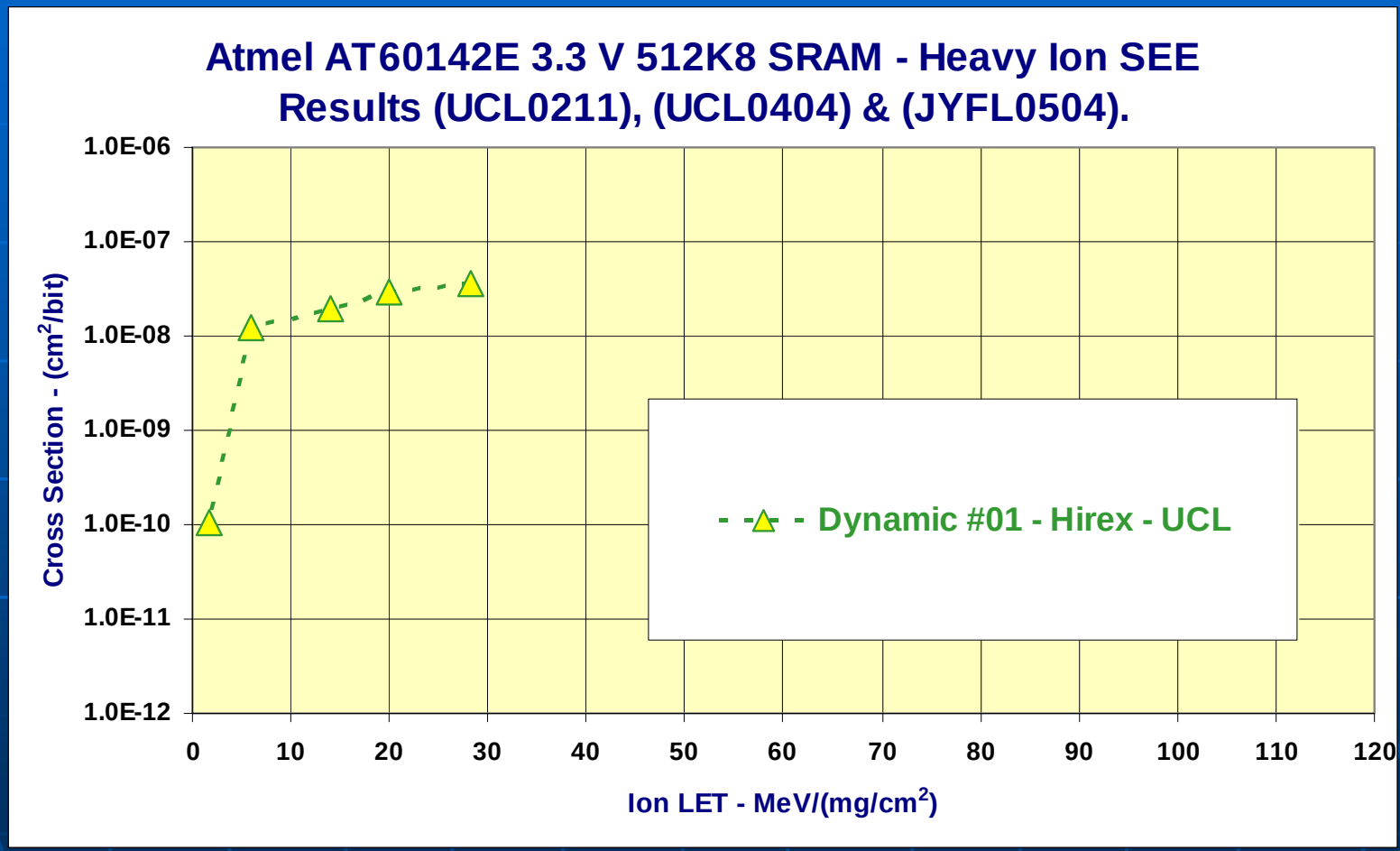
Standard High Penetration Cocktail (9.3 MeV/A)

#	$^{A}Ion^{q+}$	E [MeV]	R_{SRIM} [µm]	R_{BNL} [µm]	St.power [SRIM]	LET [BNL]	Δm/q [‰]
1	$^{15}N^{4+}$	139	202.1	218.0	1.8	1.7	0.0
2	$^{20}Ne^{6+}$	186	145.8	149.0	3.6	3.5	0.0
3	$^{30}Si^{8+}$	278	130.1	132.0	6.4	6.0	- 0.9
4	$^{40}Ar^{12+}$	372	117.9	117.0	10.2	10.0	- 0.6
5	$^{56}Fe^{15+}$	523	97.4	99.0	18.5	18.0	- 5.6
6	$^{82}Kr^{22+}$	768	94.0	96.0	32.1	30.0	- 7.1
7	$^{131}Xe^{35+}$	1217	89.1	97.0	60.0	53.0	- 2.6

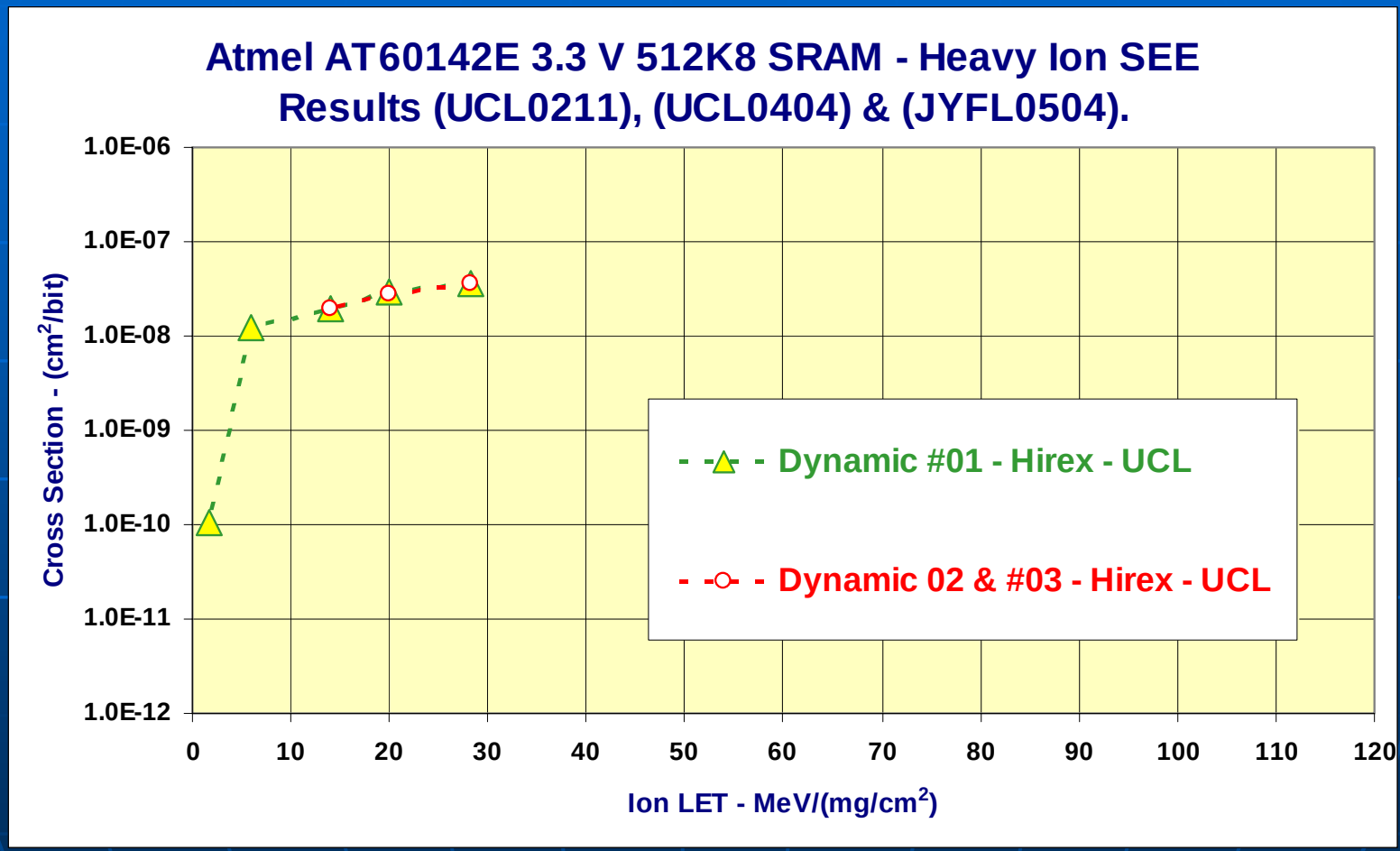
+ Other cocktails with E/A ~ 3.6 MeV/A or 6.1 MeV/A

+ Protons up to 60 MeV

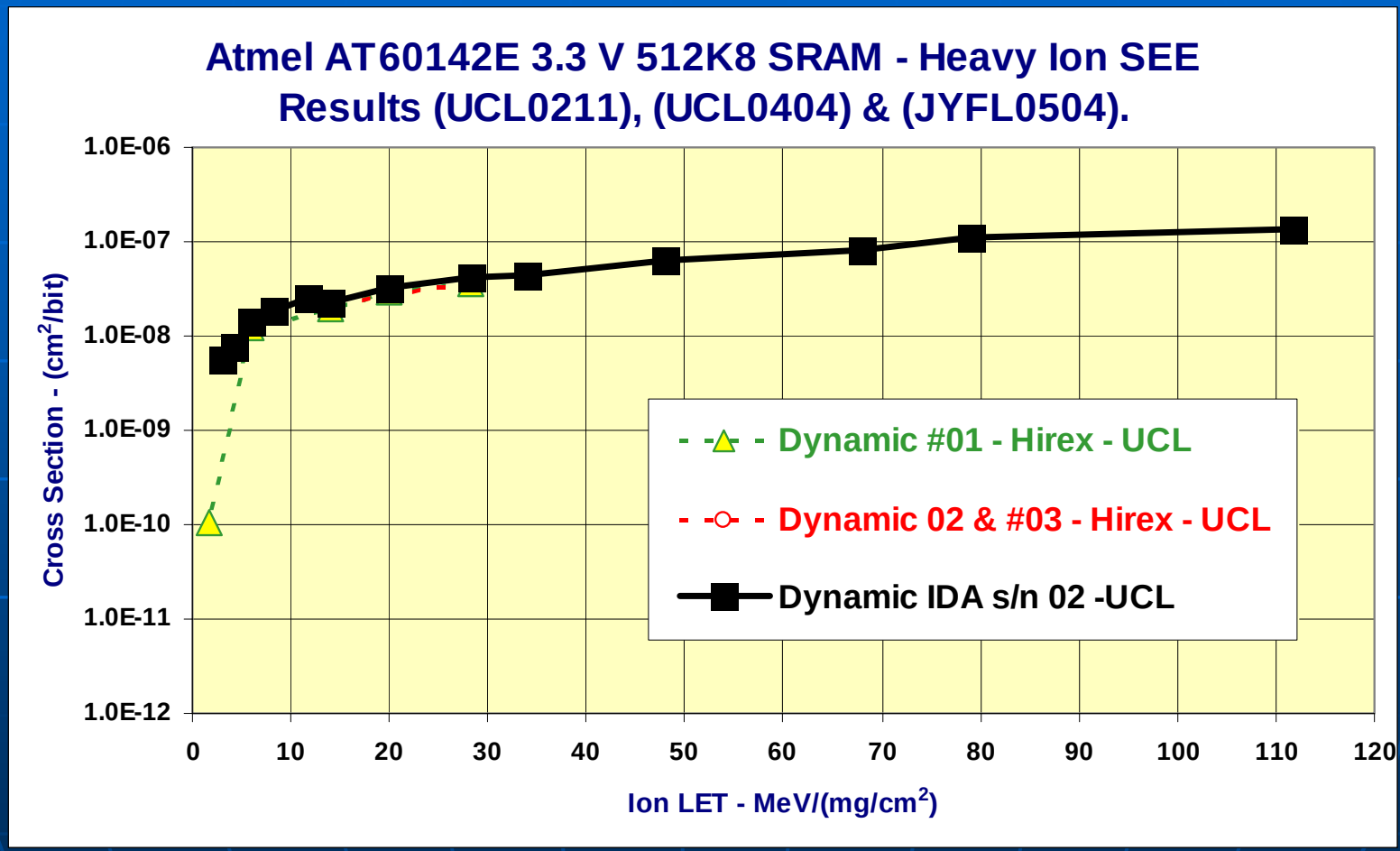
Heavy Ion Test Results – Atmel AT60142E



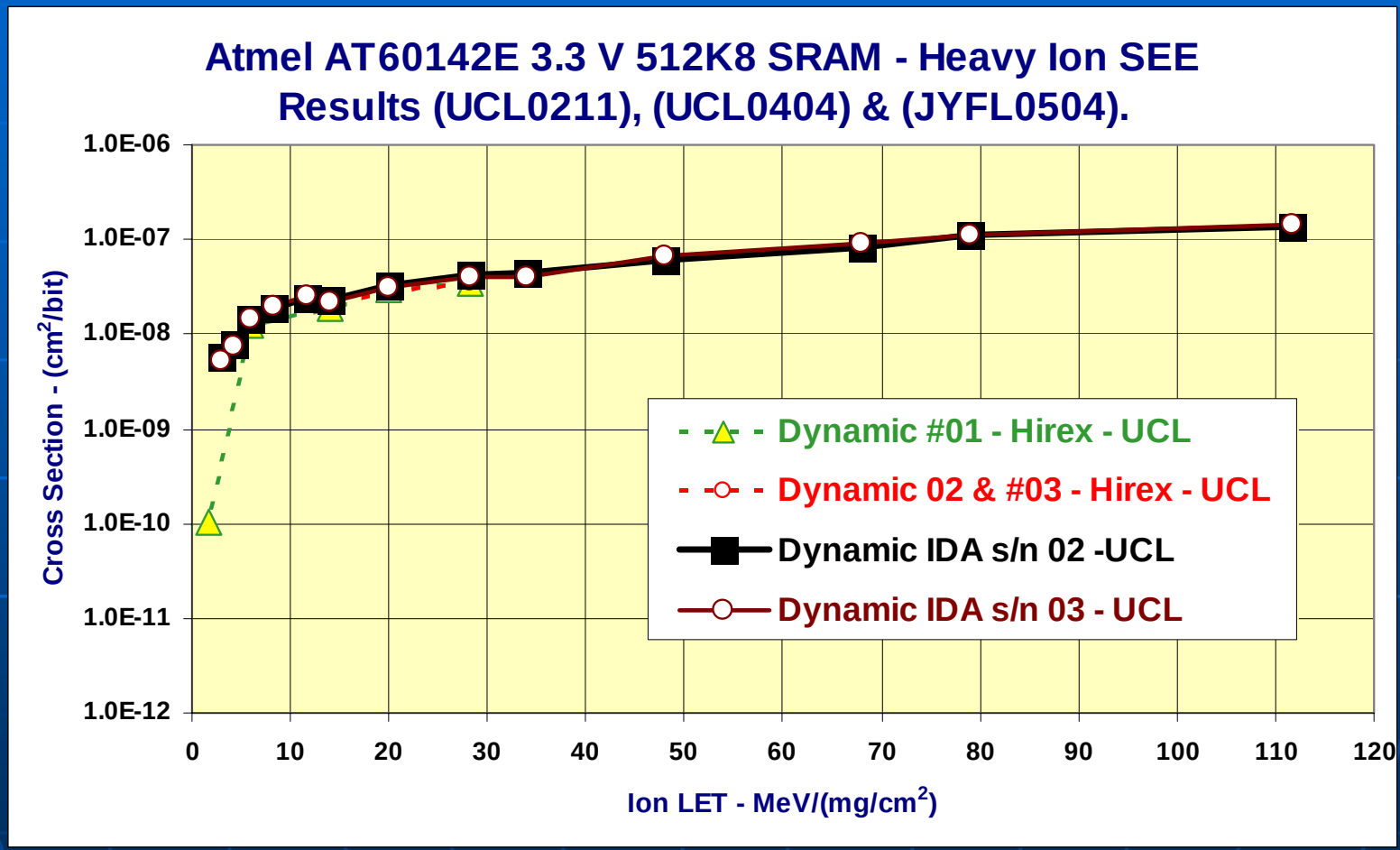
Heavy Ion Test Results – Atmel AT60142E



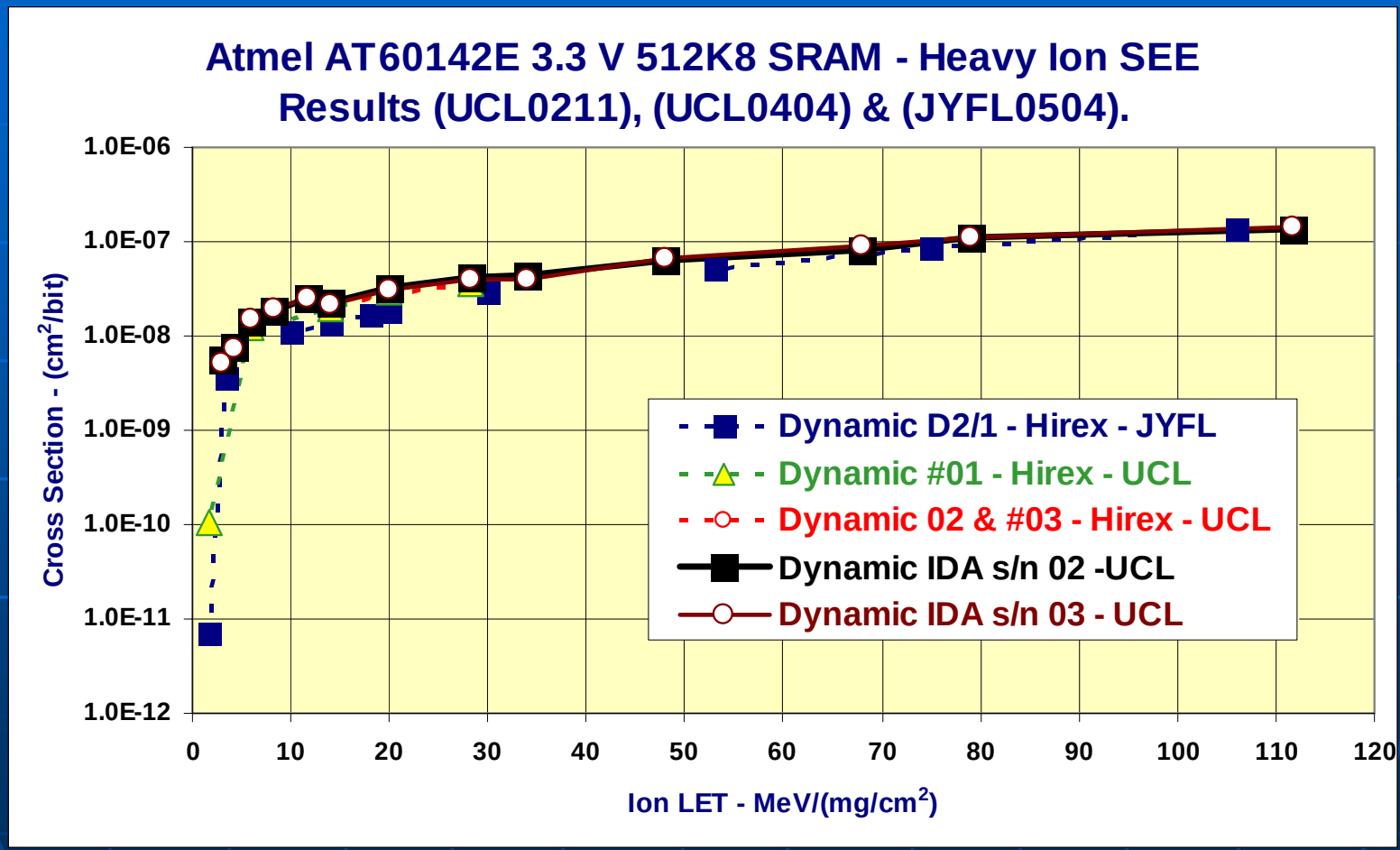
Heavy Ion Test Results – Atmel AT60142E



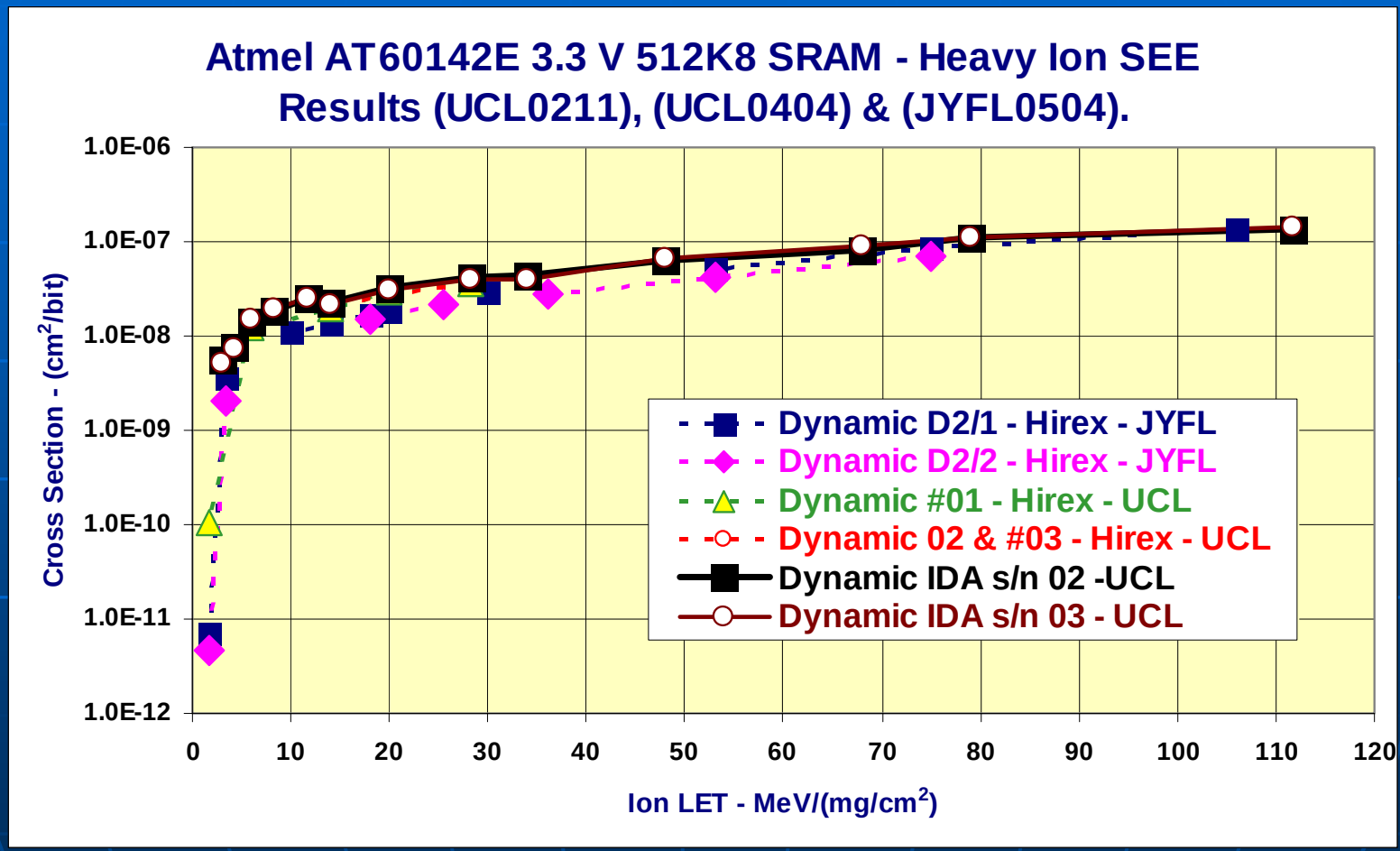
Heavy Ion Test Results – Atmel AT60142E



Heavy Ion Test Results – Atmel AT60142E

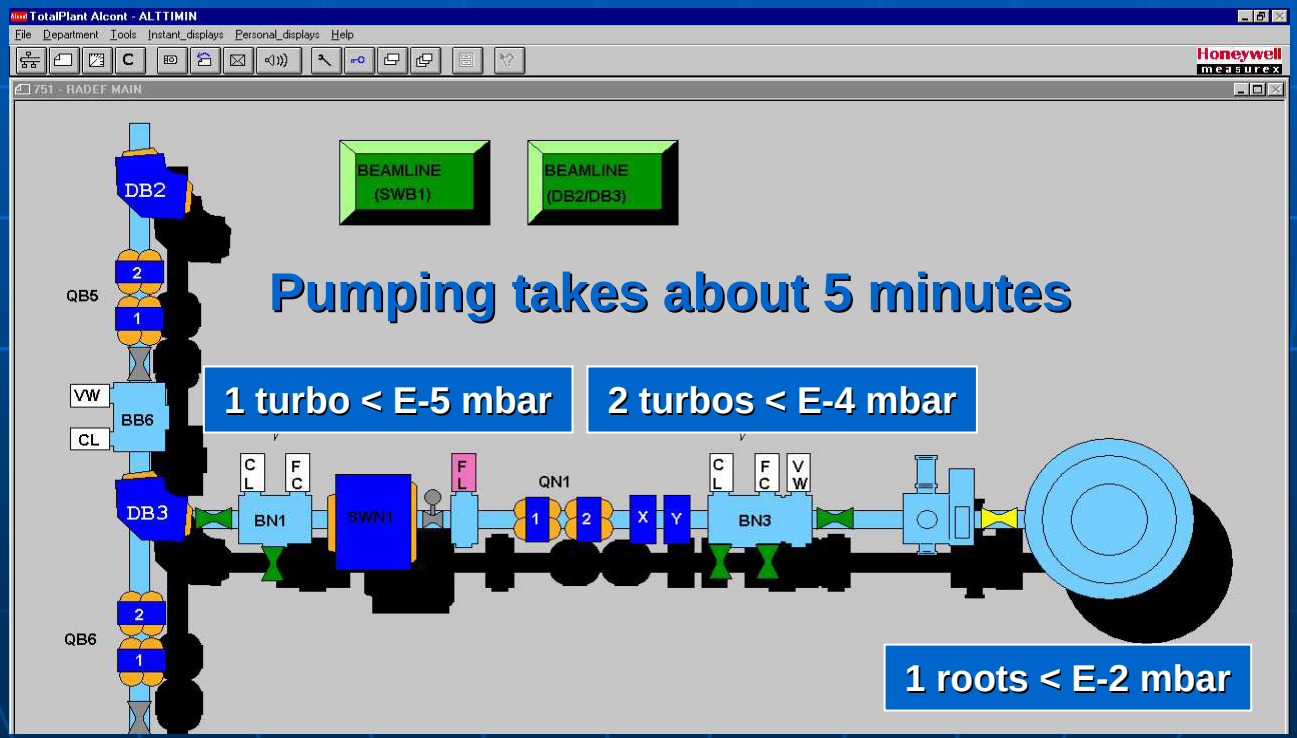


Heavy Ion Test Results – Atmel AT60142E



Beam Characteristics and Operation

- Spot size ~ 4 x 4 cm^2 with a homogeneity of ± 10 %
- Flux adjustable up to ~ 10^6
- 4 hours reserved for tuning
- Ion change + calibration:
  - inside the same cocktail ~ 1 hour
  - between cocktails ~ 2 hours
  - from heavy ions to protons ~ 4 hours



Scheduling and charging

- Beam time scheduled quarterly
- ESA beam time requests to RHS, others to AV
- 4 hours set-up time will be used by JYFL
- Cancellations caused by:
  - customer - no charging if done two weeks before
    - after that 50 % charging
  - us – no charging
- ESA has fixed cost – others 525 €/h)

Future developments

A more penetrating cocktail (10.9 MeV/A) will be developed:

#	$^{A}Ion^{q+}$	E [MeV]	R_{SRIM} [µm]	R_{BNL} [µm]	St.power [SRIM]	LET [BNL]	$\Delta m/q$ [‰]
1	$^{14}N^{4+}$	151	241.8	247.8	1.6	1.6	0.0
2	$^{28}Si^{8+}$	302	151.5	150.4	5.8	5.9	- 1.0
3	$^{56}Fe^{16+}$	604	117.1	119.3	17.1	17.1	- 1.4
4	$^{84}Kr^{24+}$	906	113.1	117.2	30.2	28.4	- 1.3
5	$^{129}Xe^{37+}$	1402	102.4	113.3	57.5	50.5	- 4.8

- Third frequency to the ECR will be installed
- Design/construction of a new chamber will be started
- Position sensitive detector for protons will be constructed

Support and contacts

Before the test:

- beam time reservations, planning…
- technical information, help – e.g. mounting fixture…
- hotel reservations, traveling information

During the test:

- Operation of the ion sources, accelerator and RADEF
  - calibrations, flux-, fluence-, homogeneity monitoring…
- Electronic and mechanical workshops
  - cabling, connectors, feed troughs…
- Radiation safety
  - dosimeters, keys…
- Internet, e-mail connections…

All inquiries to ari.virtanen@phys.jyu.fi and more info from www.phys.jyu.fi/research/applications/index.html