



The ISTC G-342 and TANDEM Projects: Status and Perspectives

David Tananashvili
E.Andronikashvili Institute of Physics



E.Andronikashvili Institute of Physics

Leading research institution in Georgia from 1950s.

Main reseach topics:

**Cosmic ray and elementary particles, Condensed matters,
Biophysics, Plasma physics.**

Research facilities: Nuclear reactor (4MW), Cosmic ray station



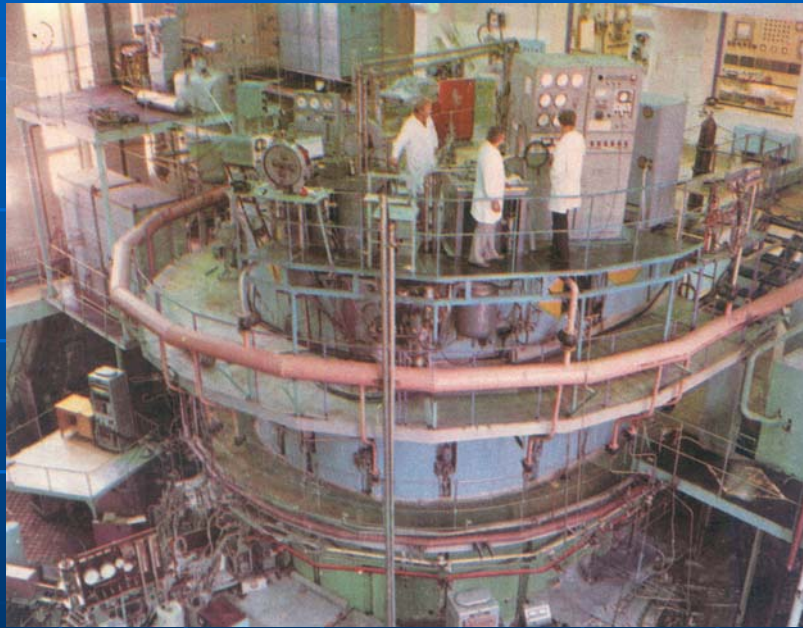
**Research nuclear reactor near
Mtskheta, aerial view**

Activities of our group:

- **Radiation material sciences
(1958-1988);**
- **Biophysics
(From 1989).**

E.Andronikashvili Institute of Physics

Research Nuclear Reactor (4MW)



**Experimental area of
Research nuclear reactor**

Due to political reasons:

**1988 – conservation of active
zone;**

**1998 – Removal of nuclear
fuel;**

1999 – Cooperation with ISTC



ISTC Project G-342

“Effect of Spirulina platensis Cultivation Procedure on the Intracellular Accumulation and Distribution of Iodine: Process Development for Generation of Iodine-Enriched Culture of Spirulina platensis” (2000-2003)

Project Managers: **Levan Topchishvili** , **David Tananashvili**
E.Andronikashvili Institute of Physics

Project Collaborator: Dr. Tanya Kuritz
Chemical Division, ORNL, USA

OAK RIDGE NATIONAL LABORATORY

Managed by UT Battelle for the Department of Energy





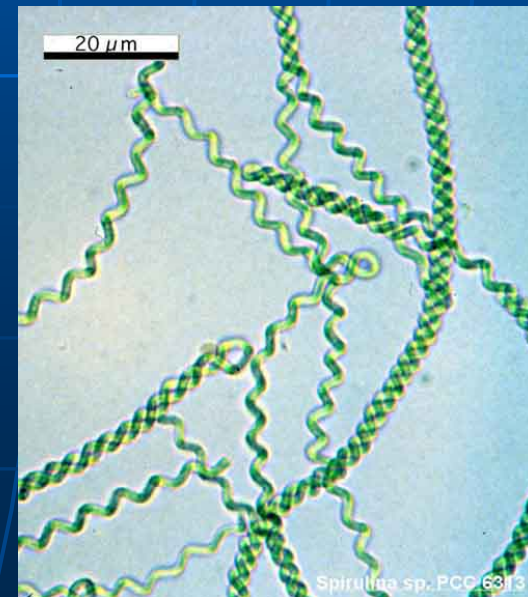
ISTC Project G-342

**What is
Spirulina platensis?**

Microalga

or

Bacterium?





ISTC Project G-342

Chemical composition of SPIRULINA:

- **proteins (55%-70%),**
protein content in soy beans - ~32%
- **carbohydrates (15%-25%),**
- **essential fatty acids (18%),**
- **vitamins,**
- **minerals and**
- **pigments like carotenes, chlorophyll *a* and phycocyanin.**



ISTC Project G-342

Spirulina is considered as an excellent food, lacking toxicity and having corrective properties against viral attacks, anemia, tumor growth and malnutrition.



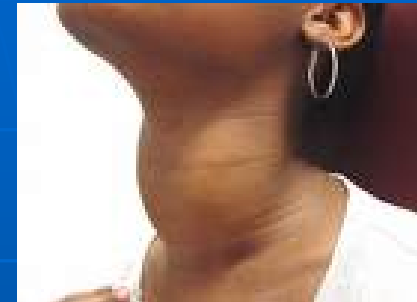


ISTC Project G-342

Why to enrich it by Iodine?

According to the data of Georgian Ministry of Public Health about **45% of population has goiter (pathology of thyroid gland)**.

The reasons of this disease can be different – **deficiency of iodine and other microelements**, disturbances in immune system, malnutrition and etc.



In the Hellbrunn Gardens, Salzburg, Austria





ISTC Project G-342

The goal of this project was
the establishment of iodized *Spirulina platensis*
optimal cultivation procedure (iodine
compound, light, temperature, agitation
regimes, culture medium) and storage
conditions, and their impact on the
intracellular accumulation and distribution of
Iodine.



ISTC Project G-342

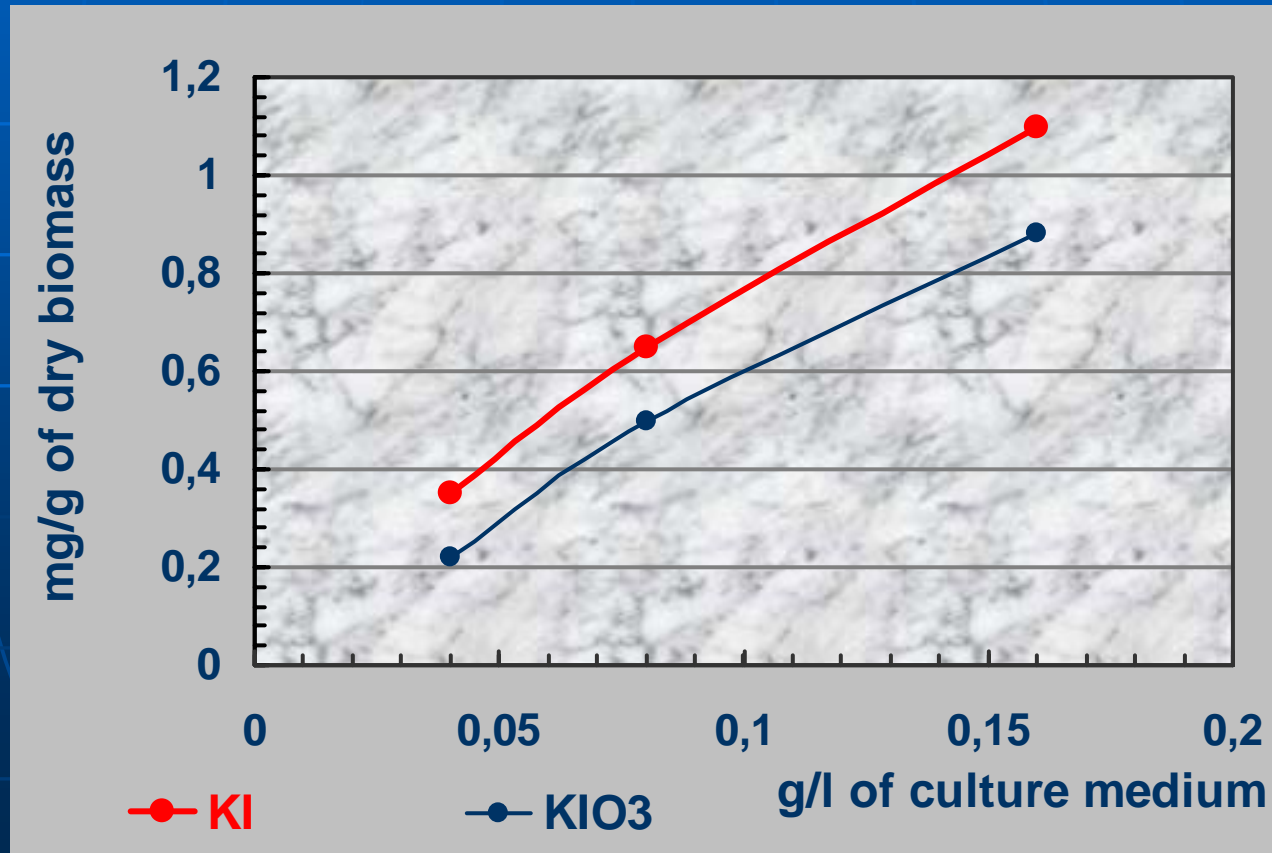
The objectives of this project were:

- (1) development of a large-scale method for *Spirulina platensis* cultivation;**
- (2) Optimization of the conditions of iodine incorporation into the cells;**
- (3) development of method for extraction of iodine-enriched fractions that will be used for the treatment of metabolic diseases due to iodine deficiency.**



ISTC Project G-342

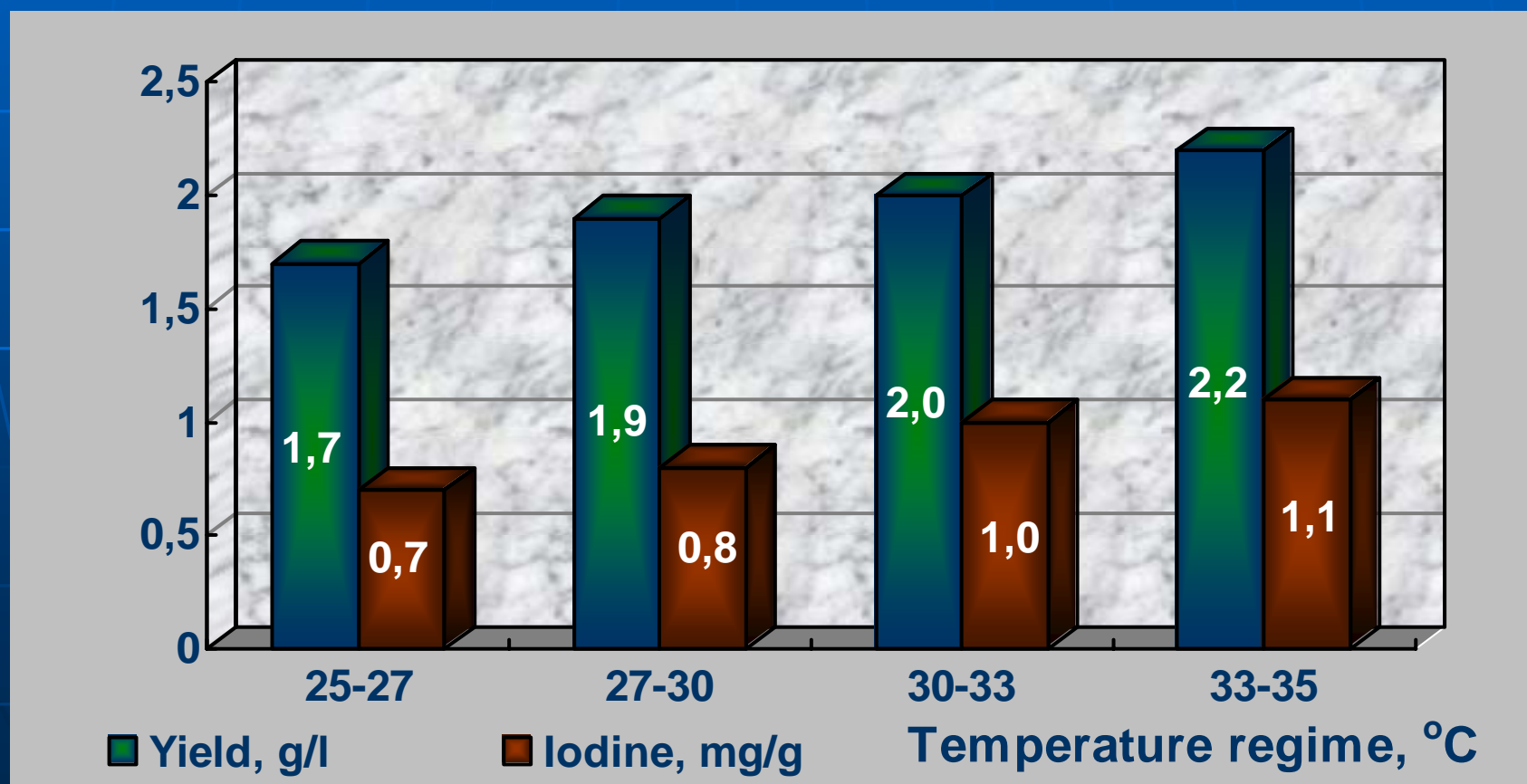
analysis of the effect of chemical nature of iodine compound on the concentration and distribution of iodine accumulated by cells





ISTC Project G-342

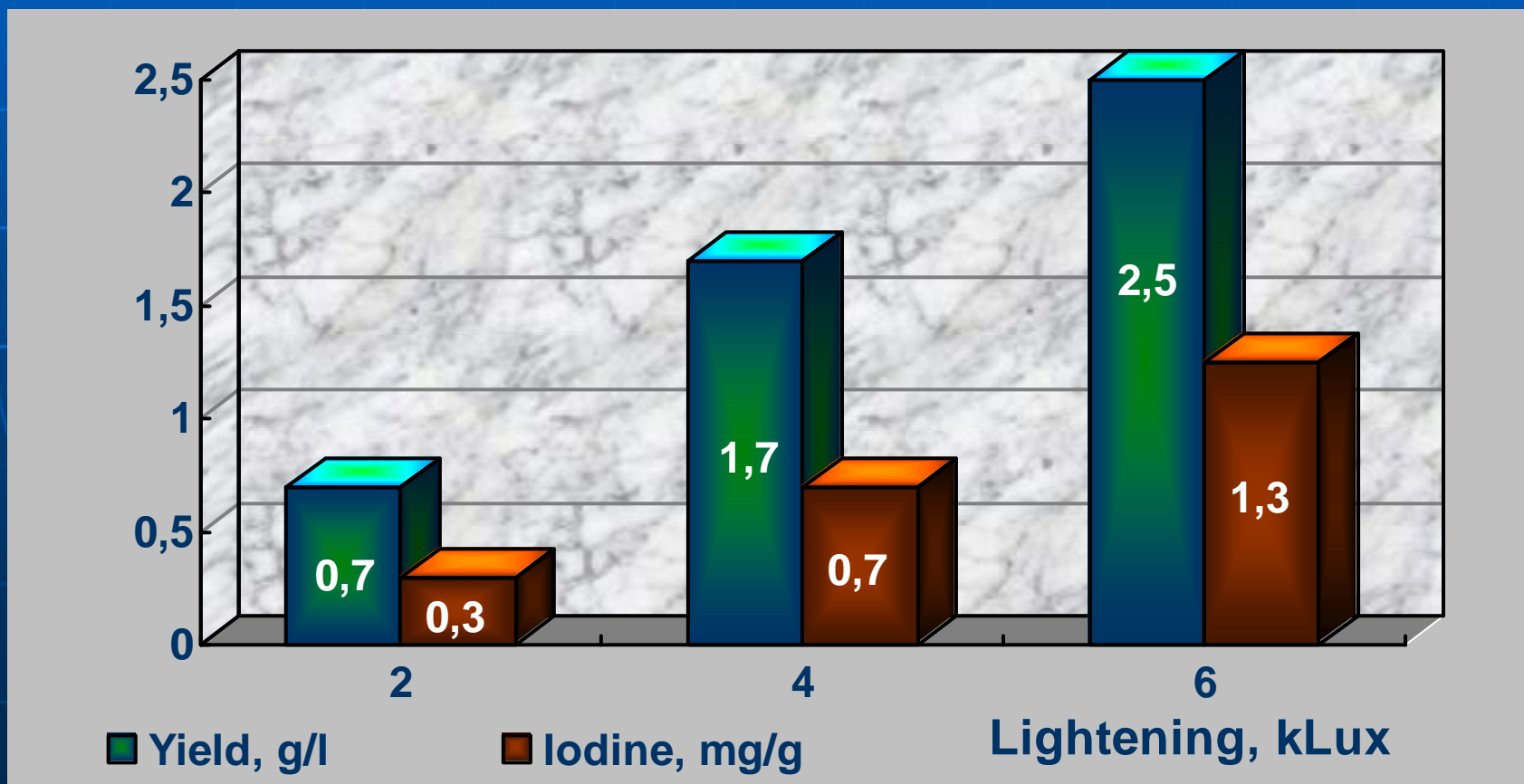
The effect of cultivation temperature on the concentration and distribution of iodine in cells





ISTC Project G-342

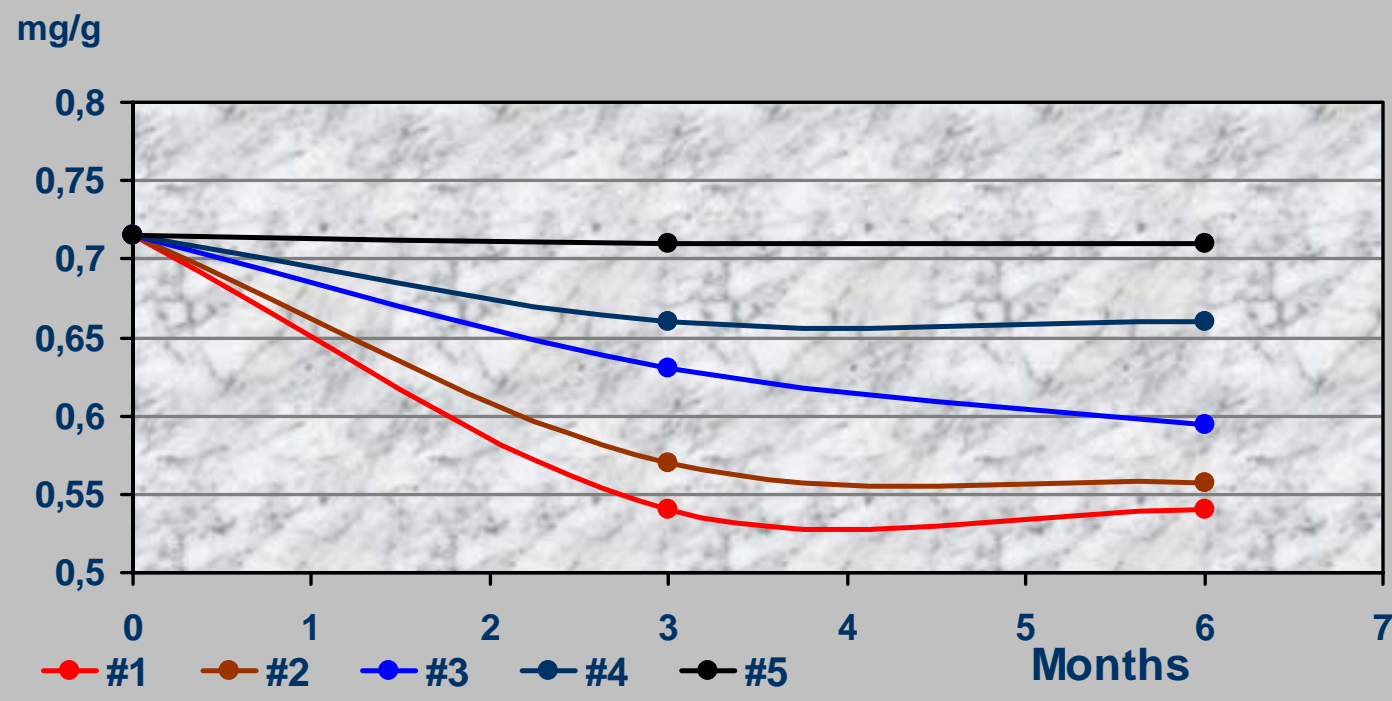
The effect of light regime on the concentration and distribution of iodine in cells





ISTC Project G-342

The effect of storage conditions on the concentration of iodine in cells



- #1 – at lightening by 100 W incandescent lamp in open vessels;
- #2 – at lightening by 100 W incandescent lamp in closed vessels,
- #3 – at daylight in open vessels;
- #4 – at daylight in closed vessels,
- #5 – dark and cool place.

After ISTC Project G-342 fulfillment

I. Beritashvili Institute of Physiology

**the in vivo investigation of iodine-enriched
Spirulina on acute toxicity, chronic toxicity and
specific activity**

**Department of Endocrinology, Tbilisi State
Medical University**

The clinical investigations of this supplement.

After ISTC Project G-342 fulfillment

The results showed that iodine-enriched Spirulina is effective for prevention and treatment of diffuse, diffuse-nodular and nodular goiter. But some mechanisms are still unknown, e.g.

- **bioavailability,**
- **nutrient distribution in human organism, etc.**

The isotope labeling is the best technique for investigation of these problems.

Isotope Labeling

Radioisotope labelling has been an important tool in the biological sciences.

Labelling chemicals of interest with specific rare radioisotopes (^3H , ^{14}C and ^{41}Ca).

They can usually be incorporated into biomolecules **without modifying their natural properties** and with low natural abundances.

Accelerator Mass Spectrometry - AMS

Over the last ten years, AMS has evolved as a biomedical tool, offering the required sensitivity, selectivity, and precision to register these isotopes, other methodologies have been unable to achieve this goal in practice.

The high sensitivity of AMS allows addressing important issues in nutrition, pharmacology and comparative medicine.

“The Investigation of Nutrient Tracing and Metabolic Disorders by Accelerator Mass Spectrometry”

At Lawrence Livermore National Laboratory it has been possible to trace a physiological dose of beta-carotene in humans for 200 days (**S.R.Dueker et al. Long-Term Kinetic Study of b-carotene, Using Accelerator Mass Spectrometry in an Adult Volunteer. *Journal of Lipid Research*, 2000, v.41, pp.1790–1800).**

In fact, initial studies using ^{14}C -labelled agents suggest that activities as low as **a few nCi/person** can be used to assess metabolism, and activities as low as **100 nCi/person** can be used to address macromolecular binding in the study of candidate drugs or toxicants. This level of radioactivity is less than that from a single day's exposure to background ionizing radiation, or a chest x-ray.

“The Investigation of Nutrient Tracing and Metabolic Disorders by Accelerator Mass Spectrometry”

Tritium (the period of half-decay ~ 12.3 years)

(M.L. Roberts et al. Nuclear Instruments & Methods In Physics Research Section B - Beam Interactions With Materials and Atoms, 1994, v.92, No.1-4, pp.459-462) and

Radiocarbon (the period of half-decay ~ 5730 years)

(K. Stenstrom et al. Nuclear Instruments & Methods in Physics Research Section B - Beam Interactions with Materials and Atoms, 1997, v.123, No.1-4, pp.245-248) are obvious labels in organic nutrition.

The studies show the potential of the AMS technique for the study of the long-term biokinetics of ^{14}C -labelled pharmaceuticals. The AMS technique allows the administered activity to be reduced by several orders of magnitude without compromising the study.

TANDEM

Tbilisi

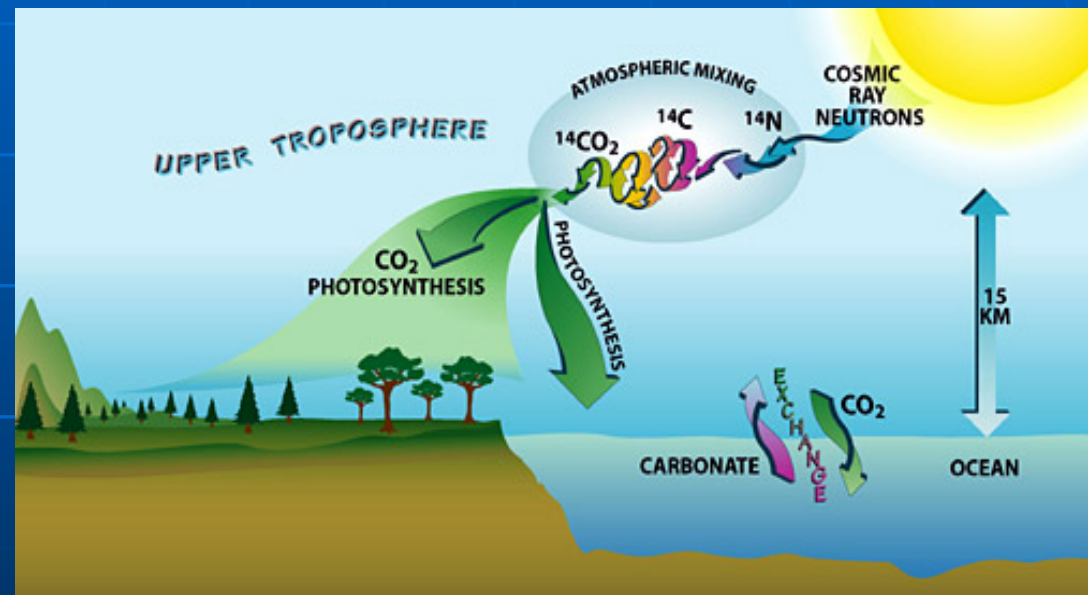
Accelerator based

Nuclear,

Dating and

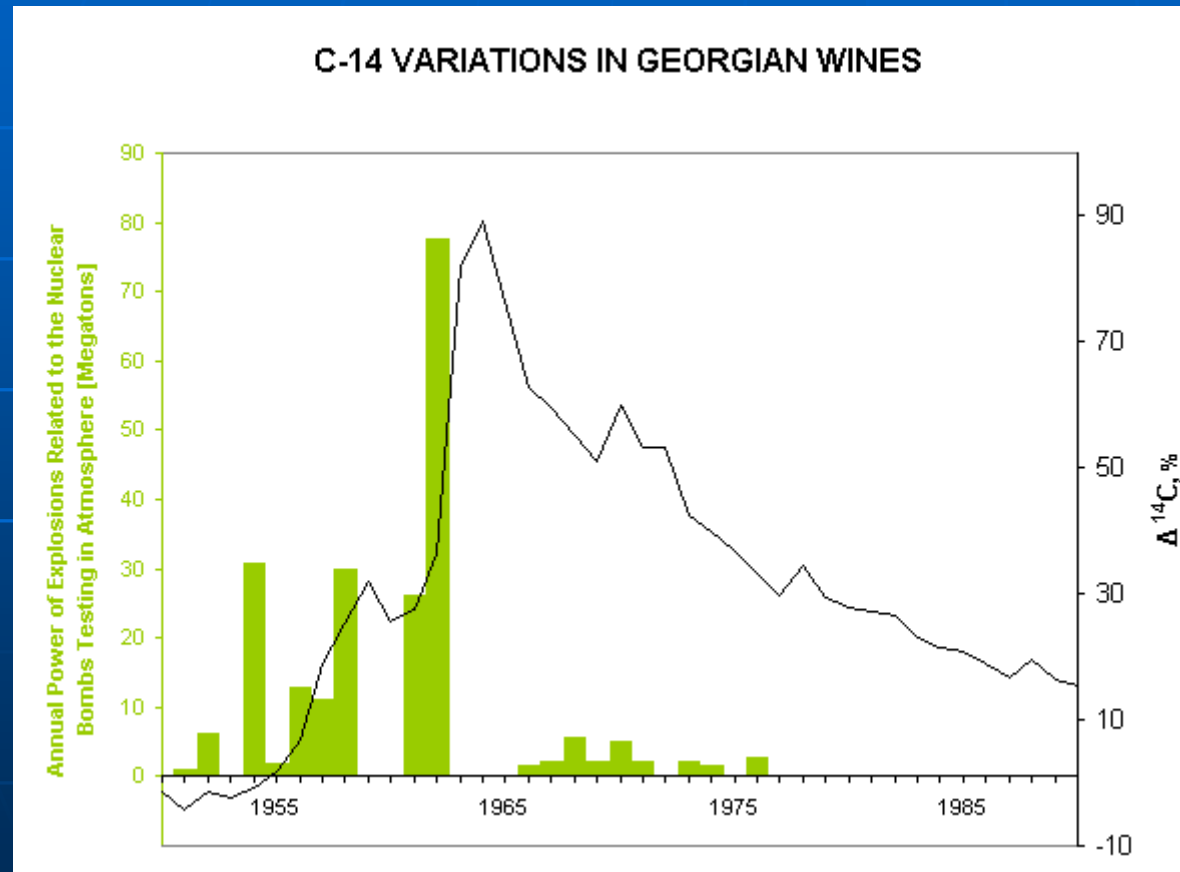
Environmental

Monitoring Regional center



I. Javakhishvili Tbilisi State University

Radiocarbon and Low-Level Counting Section



**A.A.Burchuladze,
S.V.Pagava,
P.Povinec,
G.I.Togonidze,
S.Usachev**

**Radiocarbon
variations with
the 11-year solar
cycle during the
last century**

**Nature, 1980,
v.287, pp.320-
322.**

TANDEM

Tbilisi **A**ccelerator based **N**uclear, **D**ating
and **E**nvironmental **M**onitoring Regional
center

Participating Institutions:

Friedrich-Alexander Erlangen-Nuremberg University,

I. Javakhishvili Tbilisi State University,

E.Andronikashvili Institute of Physics,

Tbilisi State Medical University

Georgian Institute of Archeology ...

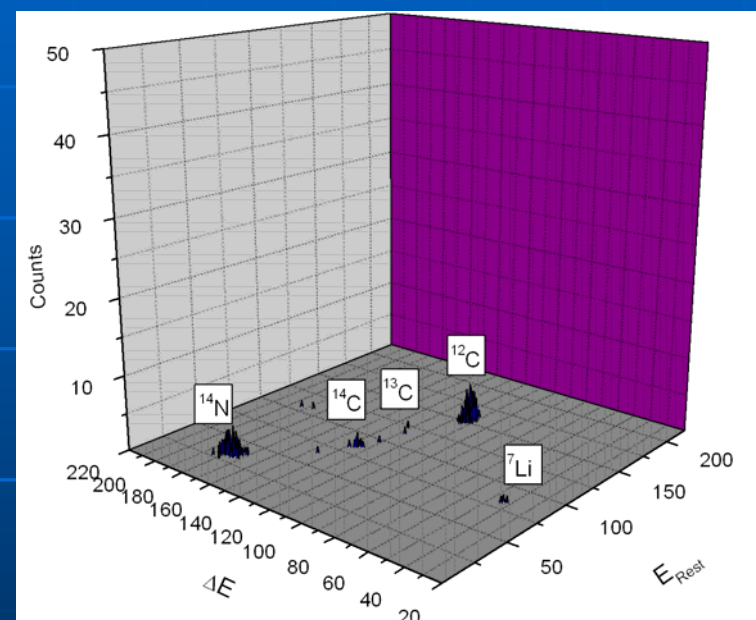
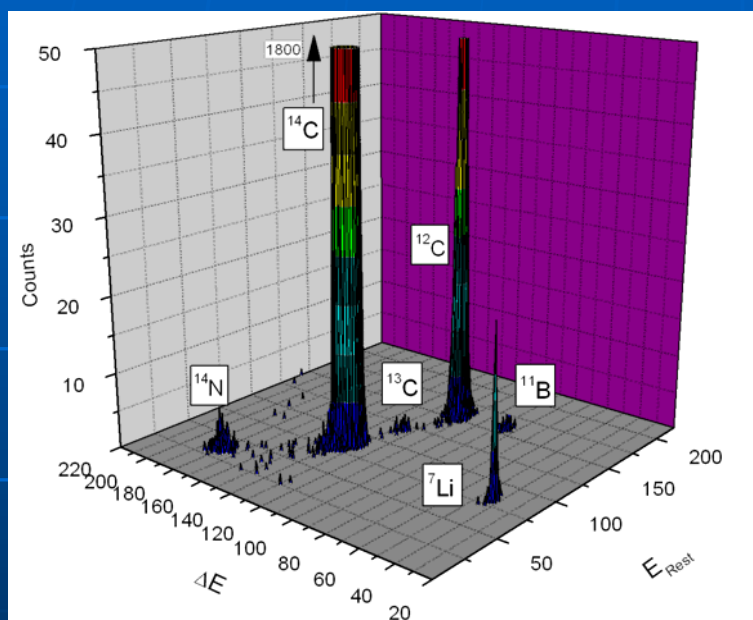
Our Collaboration with Erlangen-Nuremberg University



The Erlangen AMS facility



Our Collaboration with Erlangen-Nuremberg University



ΔE -E spectra for a modern calibration sample (left) and an unprocessed graphite sample (right), measured in 30 minutes.

Our Collaboration with Erlangen-Nuremberg University

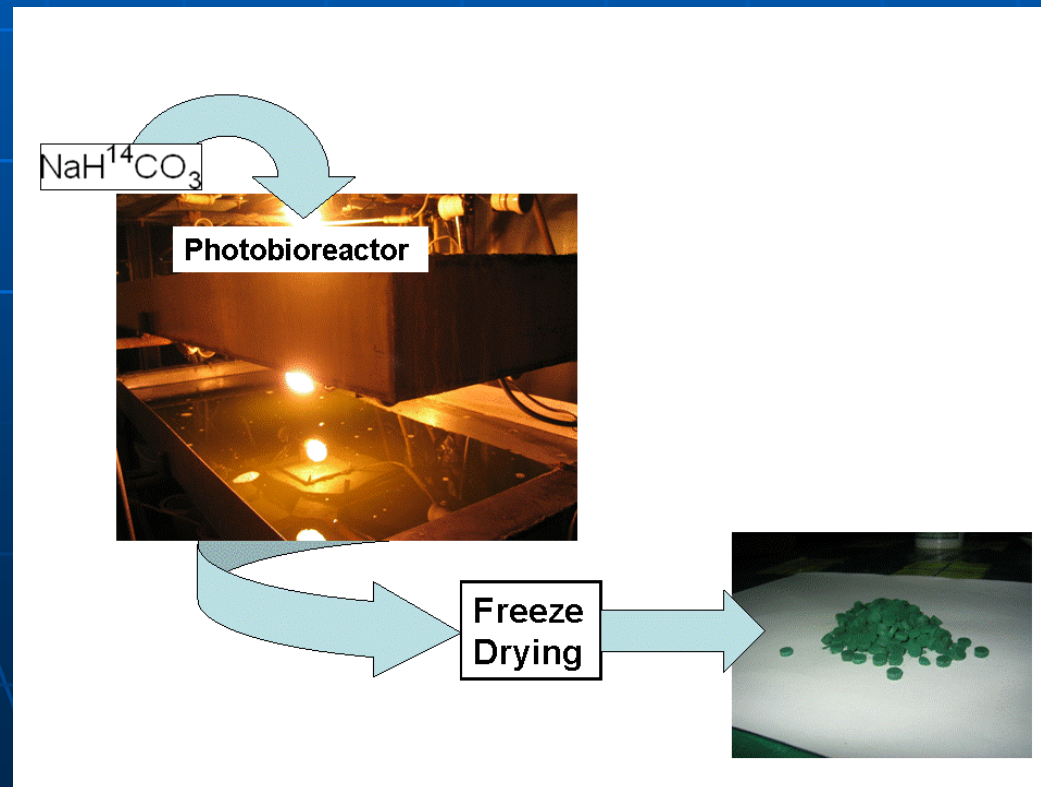
The results of preliminary measurements

Targetname	TARGETNUMMER	PMC	PMC Error	BEMERKUNG
Tiflis 07/05-1	Erl-8464	10,88	0,23	Spirulina pl. (biosample)
Tiflis 07/05-2	Erl-8465	21,38	0,27	Spirulina-iodine (biosample)
Tiflis 07/05-3	Erl-8466	107,71	0,51	Blood (before H Injection)
Tiflis 07/05-4	Erl-8467	107,05	0,52	Blood (after H injection)
Tiflis 07/05-5	Erl-8468	101,05	0,61	Heparin (H)

Current biomedical activities in the framework of TANDEM project

“The Investigation of Nutrient Tracing and Metabolic Disorders by
Accelerator Mass Spectrometry”

1. Labeling of *Spirulina platensis* by ^{14}C and proof of labeling by AMS measurements;



“The Investigation of Nutrient Tracing and Metabolic Disorders by Accelerator Mass Spectrometry”

2. Assessment of the distribution of nutrients from iodine-enriched *Spirulina platensis* labeled by ^{14}C :

- * AMS measurements of blood samples;**
- * AMS measurements of specific tissue (thyroid) samples;**

“The Investigation of Nutrient Tracing and Metabolic Disorders by Accelerator Mass Spectrometry”

- 3. The role of ^{14}C tracing in the assessment of human lipoprotein lipase activity;**
- 4. Early revelation of insulin resistance to avoid metabolic syndrome and diabetes mellitus type 2.**



**Be healthy and thank you very
much for your attention ...**