

Minutes of the INTAS meeting 18.3.2004 at GSI

Participants: A. Sidorin (Dubna), W. Müller (TU Darmstadt), V. Ziemann (Uppsala), A. Dolinskii (Kiev and GSI), A. Lehrach (Jülich), O. Boine-F., B. Franzke, R. Hasse, M. Steck (GSI)

Formalities

The contract with INTAS has been signed by INTAS and GSI. Before sending the contract back to INTAS (and thereby officially starting our project) O.Boine-F. needs to receive the completed IGFs from the Dubna and Kiev teams ! After the official start of our project 50 % of money granted by INTAS will be transferred to the teams and to the individual grant holders. After acceptance of the first periodical report another 40 % can be transferred. The last 10 % will be due after acceptance of the final report. For the transfer of funds each team needs to provide their bank account information (NIS teams please see INTAS web page).

Task 1: Physics models for cooling forces, IBS and target

Right now there exist at least two codes (Betacool and PTARGET) within our INTAS teams that are used for beam dynamics studies and determination of equilibrium beam parameters in the presence of electron cooling, intra-beam scattering (IBS) and internal target effects. Betacool uses different models for the cooling force (Budker formula, Parkhomchuk formula, Derbenev-Skrinsky formula). PTARGET uses a simplified formula for magnetized cooling. Both codes rely on rms IBS rates. The treatment of target effects in both codes is still under development or needs benchmarking. A joint computer library of physics models will greatly simplify the further development in the field as well as the improvement of existing codes.

Concerning the electron cooling forces a first starting point and example case will be the implementation of the Derbenev-Skrinsky formula (provided by the Dubna team) within our library. The comparison with more detailed approaches (e.g. by the Erlangen group or plasma simulation codes, like VOPAL) should be pursued (OBF will contact Prof. Töpfer).

Although RHIC measurements showed that rms IBS rates are in fairly good agreement with the observed emittance growth, there is still need for development towards 'detailed' IBS models for electron cooled beams. P. Zenkevich will coordinate the efforts towards a detailed IBS model for the joint library. The TEMF team (W. Müller, T. Lau) is presently working on numerical schemes for coulomb collisions in particle-in-cell codes. These schemes should be presented and discussed during the first workshop.

R. Hasse pointed out that the scaling of the theoretically obtained equilibrium momentum spread vs. particle number N does not agree with the ESR measurements. This point should be addressed at the first workshop.

Concerning the accurate modeling of the scattering in dense targets (pellets) a dedicated one-day workshop will be organized during the HESR consortium meeting in Uppsala in June. A. Lehrach will look into the presently available models for beam-target interaction.

A 'matrix' was suggested by V. Ziemann in order to clarify the hierarchy of the physics models and their interfaces (first draft by O. Boine-F., to be discussed !):

	'detailed' model, basis for calculation of rates, 'deliverable'	Rates for arbitrary ion distribution f , 'deliverable'	RMS rates, 'deliverable'	coordination
e-cooling	Velocity dependent 'nonlinear' Force $\vec{F}(B, \vec{v}, \dots)$	$\tau_j^{-1}(B, f, \dots)$	$\tau_j^{-1}(B, \varepsilon_i, \dots)$	A. Sidorin
IBS	Velocity dependent Fokker-Planck coefficients, averaged over one turn $\langle \beta(\vec{v}) \rangle, \langle D(\vec{v}) \rangle$	IBS rates averaged over one turn as a function of $f(v_i)$ $\langle \tau_j^{-1}(f) \rangle_{turn}$	IBS rates averaged over one turn as a function of the emittances $\langle \tau_j^{-1}(\varepsilon_i) \rangle_{turn}$	P. Zenkevich
target	Are Fokker-Planck coefficients sufficient? Do we need Boltzmann-type or Monte-Carlo modeling (large angle scattering !)?	Beam heating rate per turn $\tau_j^{-1}(f)$ due to collisions with target atoms. Beam loss rate due to large angle scattering $\tau_{loss}^{-1}(f)$	Same, but as a function of the rms beam emittances $\tau_j^{-1}(\varepsilon_i), \tau_{loss}^{-1}(\varepsilon_j)$	A. Lehrach

The velocity dependent Fokker-Planck coefficients will be needed for the detailed modeling using existing particle tracking codes (UAL, MAD, ...). A. Sidorin raised the question if the transformation through the cooler sections can be done efficiently within existing tracking codes (space charge of the electron beam). This question should be discussed in detail during the first workshop !

It was pointed out by B. Franzke, that also the beam-beam effect is of concern for the design of the proposed NESR. O. Boine-F. will contact N. Malitsky at BNL, who presently works on including the beam-beam effect within UAL for RHIC modeling.

The rates will be needed for reduced studies of emittance evolution or equilibrium emittances using 'quick tools' (rate equation solvers).

Task 2: Joint library

Some first ideas on technical standards for the joint library:

- Before the first meeting O.Boine-F. will distribute an example library containing various IBS rate models.
- Lattice description in MAD/MADX format
- Preferably C/C++ code, or at least module interfaces in C.
- Each module should be well documented (sources and interface).
- The preferred operating system (for compilers, library generation) is Linux.
- We do not intend to provide a GUI for the library.
- O. Boine-F. will demonstrate during the first meeting how the compiled library can be accessed from an easy to use interpreted language (here Python).

- It was suggested to ask the Kiev team, if they would volunteer to be our code/library keeper.

Task 3: Beam-impedance interaction

Not discussed. O. Boine-F. will present result during the first workshop.

Task 4: Trapped particle studies

The Dubna and ITEP team will work on the modeling of three-stream-type coupling between the cooler electrons, trapped residuals gas ions and the circulating beam. Related experiments will be conducted in COSY this June. The calculation of threshold currents is based on a model developed already by P. Zenkevich.

Task 5: Experiments

The goal is to concentrate on a small number of 'key' experiments which can test critical modeling issues (and/or are relevant for high energy cooling). A first discussion took place during this meeting. During the first project meeting this discussion should be continued leading to a consensus on the 'key' experiments to focus on. Attached you will find parameter list for the machines CELSIUS, COSY and ESR provided by V. Ziemann, A. Lehrach and M. Steck.

Outline of the discussion:

An experiment on electron cooling equilibrium above transition energy is planned in the ESR (M. Steck).

The experimental data that is already available on longitudinal cooling forces, IBS rates and scaling of equilibrium beam parameters with particle number and energy should be reviewed carefully. During the first workshop a collection of this data should be presented in a review talk (V. Ziemann).

Models for the beam-target interaction should be compared with measurements in CELISUS using the WASA pellet target.

Detailed measurements of transverse cooling forces seems to be most important. The possible measurement of transverse cooling forces using a kicked 'pencil' beam should be worked out in detail for the first workshop (O. Boine-F., M. Steck, V. Ziemann). Other attempts to measure transverse cooling forces/rates (e.g. M. Chanel in LEAR) should be reviewed.

Beam echoes are a very sensitive probe for weak diffusion effects (due to e.g. IBS) in rings. The possibility of longitudinal or transverse echo measurements in the different rings should be discussed during the first workshop (O. Boine-F., R. Hasse). Recently transverse echoes were measured successfully in RHIC.

See the attached machine/beam parameters for CELSIUS, COSY and ESR.

First project meeting

The Kiev team (represented by A. Dolinskii in our meeting) was asked kindly to organize our first 'official' INTAS project meeting in the second half of May. Preferably Thursday to Saturday because of the cheaper flights.