The AGATA project aims at the construction of an array of germanium detectors where a photo peak efficiency larger than 40% and a peak-to-total ratio larger than 50% are obtained through the use in real time of pulse shape analysis (PSA) and γ-ray tracking algorithms. In the initial phase of the project, a subset of the array, composed of five triple clusters and known as the AGATA Demonstrator, will operate at the Laboratori Nazionali di Legnaro. The initial goal of the campaign at LNL is to prove that indeed PSA and γ-ray tracking can be successfully performed in real time.

The validation of the γ-ray tracking at LNL will occur on the most demanding conditions achievable in a low-energy stable-beam facility, i.e. with reactions with velocities of the γ-emitting products up to β≈10% and relatively high intensity beams. Once this is achieved, the AGATA Demonstrator will be used in coupled operation with the PRISMA magnetic spectrometer to perform spectroscopic studies of mode-ratily neutron-rich nuclei populated by grazing reactions as multi-nucleon transfer or deep inelastic collisions with the stable beams delivered by the Tandem-ALPI and the PIAVE-ALPI accelerator complex. Nevertheless, the coupling of the AGATA Demonstrator with complementary detectors, other than PRISMA, opens experimental possibilities beyond the afore mentioned reactions, with direct, Coulomb excitation as well as fusion-evaporation reactions.

The compact arrangement of five triple clusters of AGATA is the optimal geometry of the array for the experimental activity of the Demonstrator foreseen at LNL. The detectors will be placed in front of the PRISMA spectrometer input aperture, therefore distributing the active volume in the best positions regarding Doppler broadening, considering that the nuclei of interest will be detected by PRISMA. The photopeak efficiency of the AGATA Demonstrator placed at the nominal 23.5 cm target-to-detector distance is roughly 3%. Given the low solid angle coverage, the Demonstrator can be also used at shorter target-to-detector distances, with an increase in photopeak efficiency (the value is approximately 7% when the detectors are moved by 10 cm closer to the target position) and without significant losses in the resolution and peak-to-total performance.

PRISMA is a large acceptance magnetic spectrometer designed to work with grazing reactions with the heavy ion beam provided by the LNL accelerator complex. The basic characteristics of PRISMA are described in ref. [1]. For the following discussion it is relevant to mention that PRISMA uses ion-tracking position-sensitive detectors to achieve the mass resolution. The tracking detectors provide the basic information to obtain the trajectory and velocity of the reaction products. According to the Monte Carlo simulations [3], up to velocities of approximately v/c=10%, the intrinsic AGATA detector resolution is almost fully recovered if the recoil velocity module is measured with a relative precision better than 1%, and if the recoil velocity direction is measured with a precision better than 1°. These values are actually well within the possibilities of PRISMA.

FIG. 1. Photo of the AGATA support structure coupled to the PRISMA magnetic spectrometer.
As mentioned before, the AGATA Demonstrator at LNL is strongly constrained by the experimental campaign coupled to PRISMA. The different elements of the mechanics and infrastructures are such that the coupling and experimentation with both setups are possible. In the following, the different elements of the infrastructure will be described in more detail.

The setup is intended to measure coincidences between the γ-rays detected by the AGATA Demonstrator and the reaction products detected by PRISMA. The AGATA Demonstrator is installed on a mobile platform, shown in figure 1, that will rotate together with PRISMA in such a way that reaction products, detected in the spectrometer focal plane in coincidence with the γ-rays, will have a forward trajectory with respect to the array in order to benefit from the lowest Doppler broadening. The detectors are hosted into a shell made out of 15 elementary AGATA flanges. The shell is positioned on a trolley which can slide on the same platform, rigidly linked to PRISMA. It is thus possible to easily modify the target-detector distance and to access the scattering chamber and to the instrumentation placed closed to the target. The whole support structure has minimal impact on the rotation of PRISMA. Taking into account the rest of the mechanical structure (beam line, scattering chamber), the angular range 58° to 130° is possible (with the Demonstrator placed at the closest distance from the target), while for the largest distance from the target the possible range is 38° to 130°. If one of the detectors is removed, PRISMA can be positioned at smaller angles, respectively 37° and 21°.

The liquid nitrogen (LN2) infrastructures of the AGATA Demonstrator setup at PRISMA are build by the incoming vacuum isolated LN2 line, the distribution manifold, the collector manifold and the nitrogen liquid and gas exhaustion line. The incoming line, already used during the CLARA project, copes with the rototranslation of the array through specially designed Johnston joints. The distribution manifold is vacuum isolated and allows the connection of up to 15 Ge-detectors. A new collector manifold, rigidly connected to the support structure of the array, was designed. In order to comply with the safety regulations, the excess fluids (gaseous and liquid nitrogen) produced during the filling cycle should be evacuated outside the Tandem building. Therefore, an evaporator was placed in the basement to speed up the gasification of the excess liquid. The distribution manifold is connected to the evaporator via a flexible vacuum hose running through a dedicated flexible cable tray (cable chain) similar to the two previously used by PRISMA.

The sliding seal scattering chamber previously used with CLARA was replaced with a new lower absorption chamber. The final part of the beam line as well was replaced by a specially designed telescopic beam line.

The digitizers and the Detector Support System (autofill and power supplies) will be hosted in racks mounted on the same platform used previously for the frontend electronics and power supplies of CLARA, which is rigidly linked to the structure of PRISMA, as shown in figure 2. The optical fibres connecting the digitizers to the pre-processing electronics run into the same cable chain hosting the liquid nitrogen exhaust pipe and are then taken through the basement up to the pre-processing racks sitting in the AGATA-PRISMA control room. The racks for the pre-processing electronics are water cooled and fully protected for thermal and acoustic noise insulation. The pre-processing racks are connected to the digitizers, placed in the experimental hall, via 75 m long optical fibres, and to the PSA computer farm, placed instead in the main computer room of the Tandem building, via 15 m long fibres. The main computing farm for AGATA is instead placed in another building, at the location of the TIER-2 centre for the CMS and ALICE experiments. Again, the computing farms are connected via optical fibres.