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Technical specification of the Flip Chip bonder for the NOA (Nuova Officina Assergi) clean-room

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Acronym	**Description**
INFN	Istituto Nazionale di Fisica Nucleare
NOA	Nuova Officina Assergi
SIPM	Silicon Photo Multiplier
WIMPS	Weakly Interacting Massive Particles
LNGS	Laboratori Nazionali del Gran Sasso

Tab. 1 Acronym list and description

1 FLIP CHIP BONDER SCOPE

1.1 INFN is the Italian organization devoted to the study of the fundamental constituents of matter, and carries out experimental and theoretical research in the fields of subnuclear, nuclear, and astro-particle physics. Fundamental research in

these areas requires the use of cutting-edge technologies and instrumentation, that INFN develops both in its own laboratories and in collaboration with International Laboratories and several industries. Moreover, the INFN promotes the application of the skills, methods, and experimental techniques developed in its own R&Ds in other fields, as medicine, artistic preservation, and environmental protection. These activities are carried out in close collaboration with the Italian Universities.

1.2 NOA (Nuova Officina Assergi) is a new facility of technological excellence that INFN plans to build at LNGS (Laboratori Nazionali del Gran Sasso). The NOA project is funded by Regione Abruzzo in the framework of the “Restart program” (legge 125.15 and CIPE 49.16).
One of the most important goals of NOA is the construction and the instrumentation of a large clean-room, devoted to the packaging of silicon based detectors, as SiPMs. The Darkside-20k experiment, that foresees a 20 ton Liquid Argon TPC to search for Dark Matter particles (WIMPS) and requires more than 20 m^2 of SiPMs to be packaged, will be the first user of the NOA clean-room.

1.3 Turning the SiPM wafers, produced by a silicon foundry, into the DarkSide photo-detectors requires a long and challenging path, deserving cutting edge equipment and personnel with appropriate training. The Flip Chip bonder, object of this tender, represents a major step of a long chain: SiPMs, obtained by wafers diced at NOA, must be carefully bonded on the tile PCB. Each tile hosts 24 SiPMs with dimensions 7.9 x 11.7 mm^2. The selected tile PCB substrate has to be made with a low radioactivity material. The large area to be bonded, exceeding 20 m^2, in a relatively short time, asks for a robust, reliable and easy-to-use equipment. The large number of SiPMs to be packaged, ~250000, requires a high speed bonder. The DarkSide SiPM will be equipped with Through Silicon Vias (TSVs); the corresponding pads will have area of about 200 x 200 μm^2. Each SiPM will have few bonding pads both for the cathode and the anode.

2 GENERAL CONDITIONS

2.1 This document describes the characteristics and the requirements of the Die/Flip Chip bonder to be installed in NOA.

2.2 The Contractor will certify the compliance of the manufacturing, assembly and production test procedures to the relevant International standards, as Iso 9001.

2.3 When the terms “will”, “Should”, “has/have to” or “must” are used in this document, it means the Flip Chip bonder must strictly conform with the specified technical requirements and/or operating parameter and/or functionality described in the text.

2.4 For the whole duration of the contract the English language, for written and/or oral communications will be allowed.

2.5 The term “Manufacturer” in this document indicate any company that is going to present an offer.

2.6 The term “Contractor” in this document indicate the selected company.

3 TECHNICAL OFFER

The technical offer must be written in English and must include a Technical Report describing:

- the Flip Chip bonder features;
- the instruction of use;
- the procedure adopted to guarantee the proper performance of the equipment;
- the guaranteed performance and measurement precision;
- any maintenance procedure expected by the user;
- the Flip Chip bonder construction and customization time schedule.

Sub-contracts are not allowed, nor in the Flip Chip bonder sub-parts, beyond the maximum allowed by the Italian law (30 %). The Manufacturer must sign a declaration stating all the parts of the equipment have been made or assembled by the company that assumes the full responsibility for the proper manufacturing and working of the whole equipment.

4 CONTRACTUAL RESPONSIBILITIES

4.1 Relying on a detailed and robust electrical and mechanic design, the manufacturer will assemble, test and deliver the Flip Chip bonder to LNGS (AQ), Italy. The INFN reserves to right to move the above assembling, testing and delivering in an area around within 50 km from the one indicated above.

4.2 The contractor will be responsible for carrying out a series of tests at the factory to verify the performance of the Flip Chip bonder before the delivering to the LNGS.

4.3 The Contractor will deliver the Flip Chip bonder only after written notification to INFN.

4.4 In case of non-conformity of the Flip Chip bonder to the technical specification reported in this document, the Contractor will be charged for the costs of the modifications and/or repair, including the eventual cost of the Flip Chip bonder shipping-back to the factory and new shipment to the LNGS. In addition, the Contractor is responsible for the cost related to the substitution of defective components.

4.5 After signing of the contract, INFN will be allowed to have free access to the manufacturing site to check the advancement of the Flip Chip bonder construction.

4.6 After the installation of the Flip Chip bonder, INFN will perform an on-Site Acceptance Test to verify the matching of the performances of the Flip Chip bonder with those required in the specifications reported in this document.

4.7 The Contractor has the full un-sharable responsibility for the procurement of materials, construction, test and delivery of the Flip Chip bonder.

5 CONTRACT MANAGEMENT

5.1 The Contractor has to appoint a technical manager (Contract Engineer) in charge of the contract, who will coordinate all the technical and organizational communications between the parties for the whole contract duration and in the following period of warranty service.

5.2 The Contract Engineer has to send a written progress report, on a monthly basis, highlighting the status of the Flip Chip bonder construction and customization, specifying any deviation from the scheduled planned baseline.

5.3 The Flip Chip bonder has to be delivered to LNGS (Italy) or in another place, within 50 km from LNGS, at the address the INFN will communicate to the Contractor. The Flip Chip bonder packaging should guarantee the Flip Chip bonder integrity and has to be made in a reusable way, so that the Flip Chip bonder can be promptly shipped back to the company if any malfunctioning unrecoverable is discovered.

5.4 The Flip Chip bonder must be delivered within 7 months from the placement of the order. INFN has the right to cancel the order after a delay larger than 1 month (i.e. after 8 months from the placement of the order).

6 FLIP CHIP BONDER REQUIREMENTS

6.1 The Flip Chip bonder should have a minimum capacity rating of 20 dies/min for 5 µm (3 standard deviation) applications and 40 dies/min for 10 µm (3 standard deviation) applications (positioning time). Multi-head systems are preferred. The offer should specify the number of dies bonded per minute in thermo-compression/eutectic bonding (positioning time excluded).

6.2 The Flip Chip bonder substrate working area should be larger than 270 x 270 mm^2.

6.3 The Flip Chip bonder should have a bond force in a range equal or larger than 10 g ÷ 2000 g and an active bond-force control.
6.4 The Flip Chip bonder should have a thermo-compression/eutectic bonding with a temperature up to 300° C, with a pre-heating of the substrate and a hot pick-up tool with a rump up/down <10 s at 300° C. The temperature resolution should be ≤1° C.

6.5 The Flip Chip bonder availability should have a relative up-time larger than 95 %.

6.6 The Flip Chip bonder should be equipped with CCD cameras to monitor the full bonding process.

6.7 The Flip Chip bonder should have the capability of wafer mapping and auto-loading for wafers up to 10” with automatic die ejector.

6.8 The Flip Chip unit should support both the die attach and the flip chip process.

6.9 The Flip Chip bonder should include a Wafer & Waffle/Gel-PAK Adapter.

6.10 The Flip Chip bonder, including the required services, should fit into a space not exceeding 1500 x 2000 x 2000 mm^3.

6.11 Internal and external cables should be halogen free and classified as fire retardant. The ends of the wires and cables must be clearly marked and identified according to the circuit diagrams and tables.

6.12 The Flip Chip bonder should be equipped with an epoxy dispenser.

6.13 The offer should include the setup for customer specific application.

6.14 The Flip Chip bonder should handle flip chip dies with size (s) in the range 1 mm < s < 20 mm or wider, and thickness (t) in the range 50 µm < t < 5 mm or wider.

7 FLIP CHIP BONDER INSTALLATION

The contract must include the Flip Chip bonder installation at LNGS (or in an area within 50 km from LNGS) by a Certified Engineer. The installation must include:

- Flip Chip bonder assembly and verification;
- Flip Chip bonder connection to existing services;
- At least two weeks of training to the INFN Personnel (total of 10 working days, 8 hours/day).

The Contractor will be charged for the cost of the Flip Chip bonder shipping and any custom duties (if applicable).
The cost of the travel, lodging, meals of the Contractor personnel in charge for the Flip Chip bonder installation will be covered by the Contractor. INFN cannot be charged of any expense for the Flip Chip bonder installation.

8 FLIP CHIP BONDER OPERATION AT LNGS

The Flip Chip bonder will operate in a clean room, at a temperature ranging between 20° C ÷ 24° C. It should be able to operate up to 24 hours/day, 7 days/week. The connectors to the power and to the controls should prevent accidental contacts of live parts with a protection degree IP20 (finger protected) or better.
LNGS will provide a connection to the 230 V, 50 Hz and/or to 3-phase 400 V, 50 Hz.

9 WARRANTY AND ASSISTANCE

9.1 The warranty period for the Flip Chip bonder must be 60 months. The warranty period starts from the data of formal acceptance of the Flip Chip bonder by the INFN. Any modification or operational change performed by INFN without a written approval by the Contractor, throughout the duration of the warranty period, would imply the termination of the warranty. The cost of the 60 months assistance, including eventual travel, lodging and meals of the Contractor personnel required, should be included in the present offer.

9.2 The Contract must include 5 years assistance at LNGS (or in a site within 50 km from LNGS), within 48 hours from the call, as explained in Tab. 2. The call will be made by e-mail, using an e-mail address the Contractor has to indicate in the offer. The call can be open any time from Monday 8 am to Friday 5 pm. The 48 hours do not include the time between Friday 5 pm to Monday 8 pm. As an example, for a Flip Chip bonder failure showing-up on Friday at 4 pm, the Contractor must provide assistance by Wednesday 8 am of the following week. The cost of the assistance, including the travel, lodging and meals of the Contractor personnel at LNGS or in a site within 50 km from LNGS, should be included in the present offer: INFN cannot be charged in future with any cost, independent of the number of assistance call required in the 5 years.

Day of the week	**Assistance call time**	**Assistance on site**
Monday	8 am ÷ 2 pm	Wednesday, same time
Monday	2 pm ÷ 5 pm	Thursday, 8 am
Tuesday	8 am ÷ 2 pm	Thursday, same time
Tuesday	2 pm ÷ 5 pm	Friday, 8 am
Wednesday	8 am ÷ 2 pm	Friday, same time
Wednesday	2 pm ÷ 5 pm	Monday, 8.30 am
Thursday	8 am ÷ 5 pm	Monday, 8.30 am
Friday	8 am ÷ 5 pm	Tuesday, 8.30 am

Tab. 2 Flip Chip bonder assistance

In case the company believes a Flip Chip bonder fault can be recovered by the INFN personnel, following the company instructions, this implies that:

- in case the problem is not solved, the opening time of the call remains the one inferable from the e-mail sent by INFN;
- the company gets the full responsibility of any damage caused by the execution of the actions suggested by the company to the INFN personnel;
- the recovery instruction should be written by e-mail too, to show the actions taken were suggested by the Contractor.

10 PERSONNEL TRAINING

The contract must include a training at the company site for up to two persons for a period of up a month. The travel, lodging and meals will be charged to INFN. The Contractor can use part of the training period to experience the personnel using other customer machines, including visits at customer sites. In this case the travel expenses will be charged to the Customer. INFN personnel under training cannot be employed in machine building or in any other activity related to product sell.

11 FURTHER SETTINGS

The INFN should have the possibility to request further custom setups in addition to the one mentioned at point 6.13, at the same price.

The responsible for the procedure

(Paolo De Remigis)