

CARE BENE
CERN Dec. 2008

RACCAM EMMA ANAC
overview, status

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RACCAM

1/ FFAG R&D, rapid beam acceleration/manipulation
 2/ Application to protontherapy

- . A preliminary design of a 180MeV proton ring, spiral scaling optics, has been realized
- . It has been shown that there are no show stoppers
- . Magnet and RF have been subject to thorough study
- . A magnet prototype has been built
- . Beam dynamics has been investigated in detail
- . Various principles of fast beam manipulation proper to the FFAG method have been investigated
- . A costing has been done

| | |
|--|--------------------------|
| Extraction energy, variable | 70 – 180 MeV |
| Injection energy | 5.5 – 17 MeV |
| Momentum ratio | 3.62 |
| Number of cells | 10 |
| Packing factor | 0.34 |
| Field index, k | 5 |
| Spiral angle | 53.7 deg. |
| Qh / Qv | 2.76 / 1.55~1.60 |
| Radius, extraction/injection/dR | 3.46 m / 2.78 m / 0.67 m |
| Drift length, extraction/injection orbit | 1.42 m / 1.15 m |
| Frev, 15->180 MeV | 3.03 -> 7.54 MHz |
| Frev, 5.5->70 MeV | 1.86 -> 5.07 MHz |

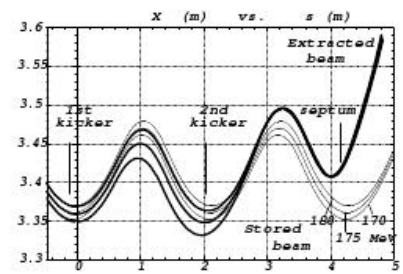
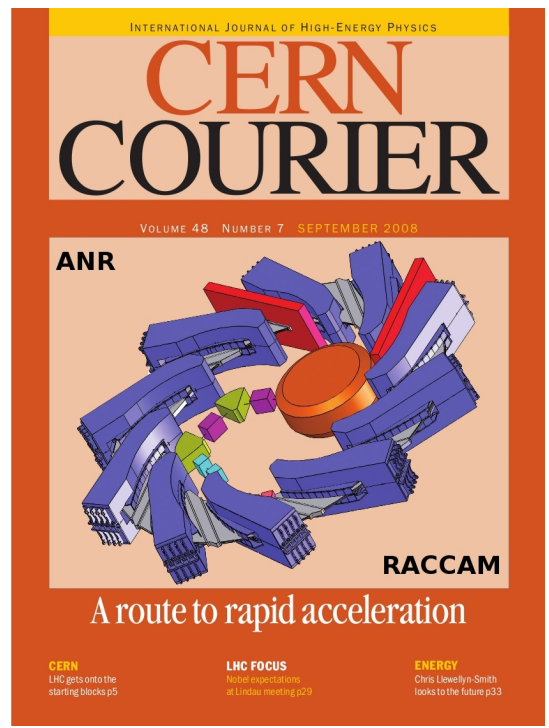


Fig. 21. Double-kicker extraction, applied to three closed orbits ranging in 170-180 MeV

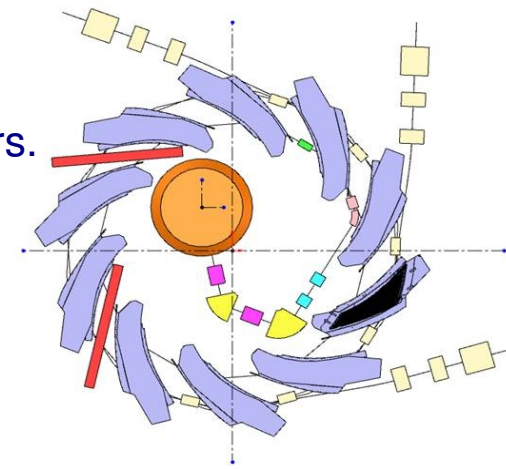
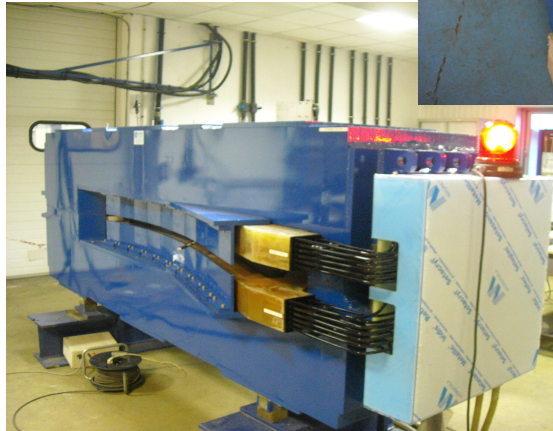
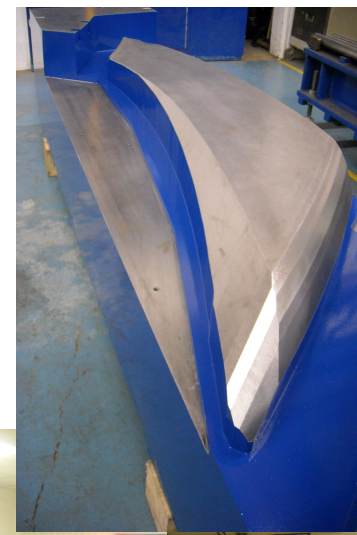
Goal of the magnet prototyping :

- . prove the feasibility of a spiral gap shaping FFAG magnet, in particular scaling property
- . assess the agreement between manufacturing and theoretical design

. Magnetic measurements are underway at SigmaPhi

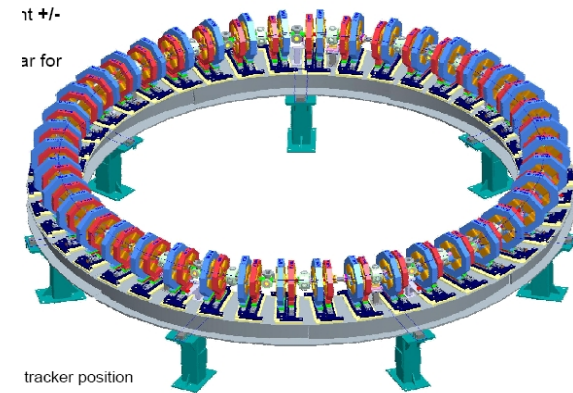
• Status :

- RACCAM ends next February
- All objectives will be completed
- New application for funds from National Research Agency, IBA+ETOILE+LPSC+SigmaPhi+AIMA/D, last October :
a PDR of a 250 MeV proton ring based on RACCAM design, in 2 years.
Objectives : evaluate the unique features of the FFAG method,
evaluate potential of
application in several domains as fast acceleration, medical



Task 11.3 - EMMA

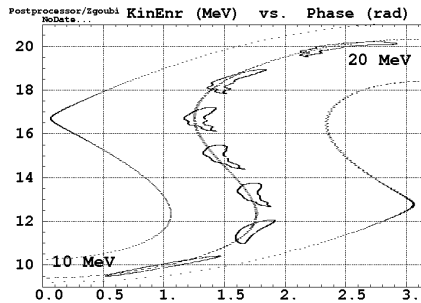
- **Non-scaling FFAGs under study in view of :**
 - **muon acceleration in a Neutrino Factory**
 - **proton & ion acceleration for cancer therapy**
 - **muon production for μ SR**
 - **spallation neutron production and ADSR**
- **So far, only scaling FFAGs built**
 - **At low-energy muon range of rigidities**
 - **KEK : POP & 150 MeV proton ring**
 - **KURRI : 3-stage ADS prototyping experiment**
 - **PRISM : muon bunch capture and longitudinal phase rotation**
- **In EuCARD:**
 - **Construction of “diagnostics” beamline**
 - **Commissioning & experimental measurements**



EMMA Layout

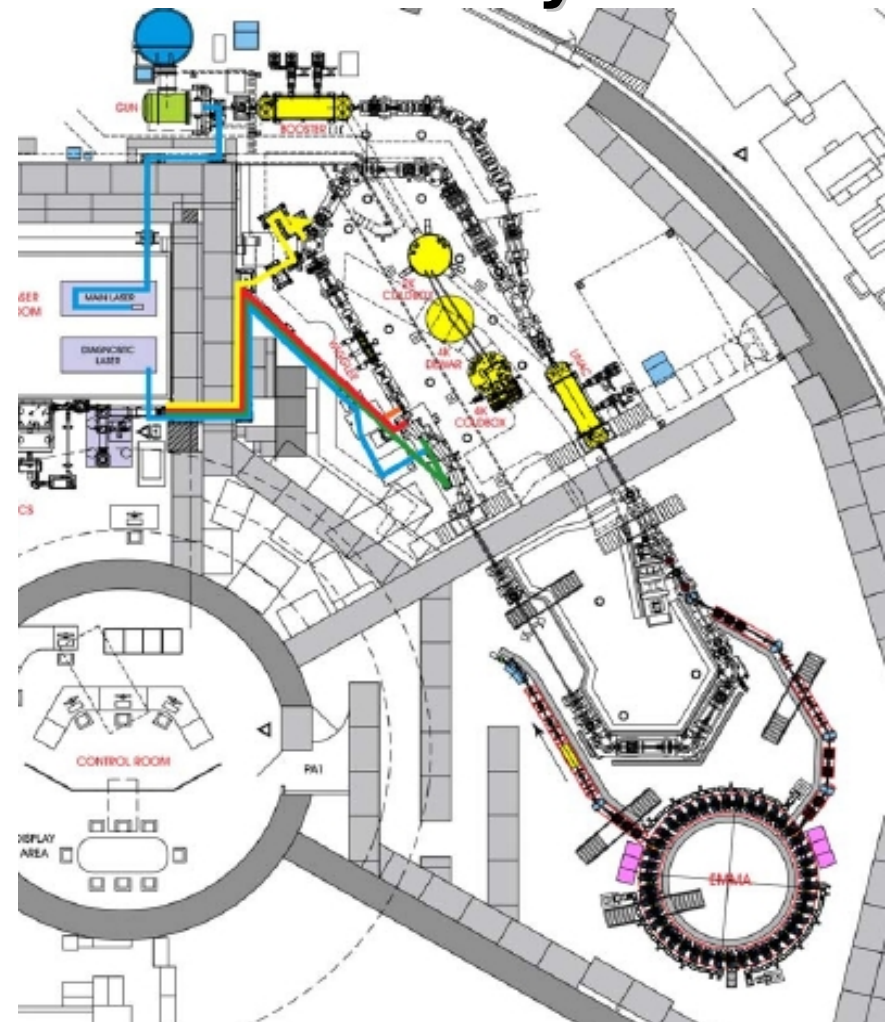
- **EMMA : proof of principle ns-FFAG**

- construction at Daresbury Laboratory, started 04/2007, 3.5 years project to the end of 09/10. 6.2M£
- electron acceleration from 10-20 MeV
- uses ALICE (4th GLS prototype) as injector
- diagnostics are very important for qualifying the ns-FFAG principles



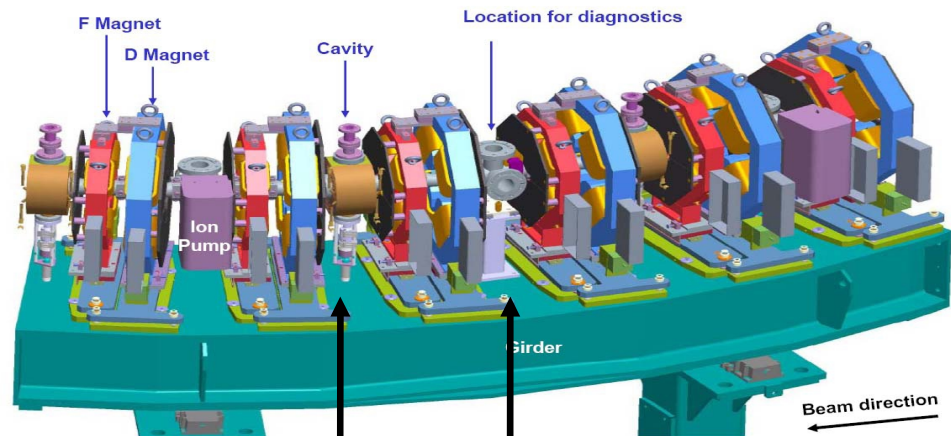
- **Goals of EMMA experiment :**

- prove rapid, “gutter” acceleration
- investigate resonance Xing
- assess acceptance
- operability, operating conditions



- **Parameters :**

- Circumference 16.57 m
- 42 F/D doublet cells
- 1.3 GHz, 20-120 kV/Cavity RF
- 3 pi.mm bunch emittance
- <32 pC bunch charge
- < 20 Hz repetition rate

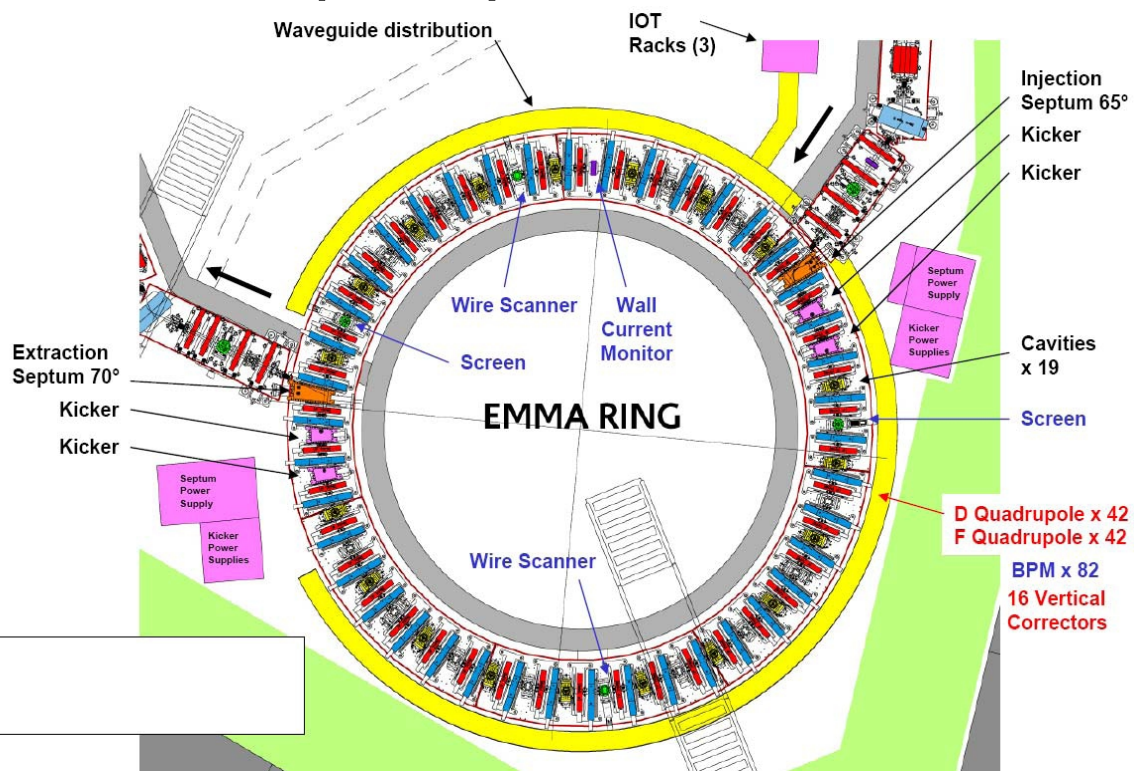


Girder

EMM
A
cell

Waveguide distribution

IOT Racks (3)



• Status :

- Rack room in progress
- Injection line in construction
- Beam line design finalized

Ring magnets :

- All 84 magnets assembled at TESLA
- Magnetic measurements in progress

Girders :

- Under manufacturing

RF :

- Cavity successfully tested at DL
- Delivery started, completed end 01/09
- IOT power source tested
- Delivery end 03/09, incl. distribution

Injection line magnets :

- Construction in progress

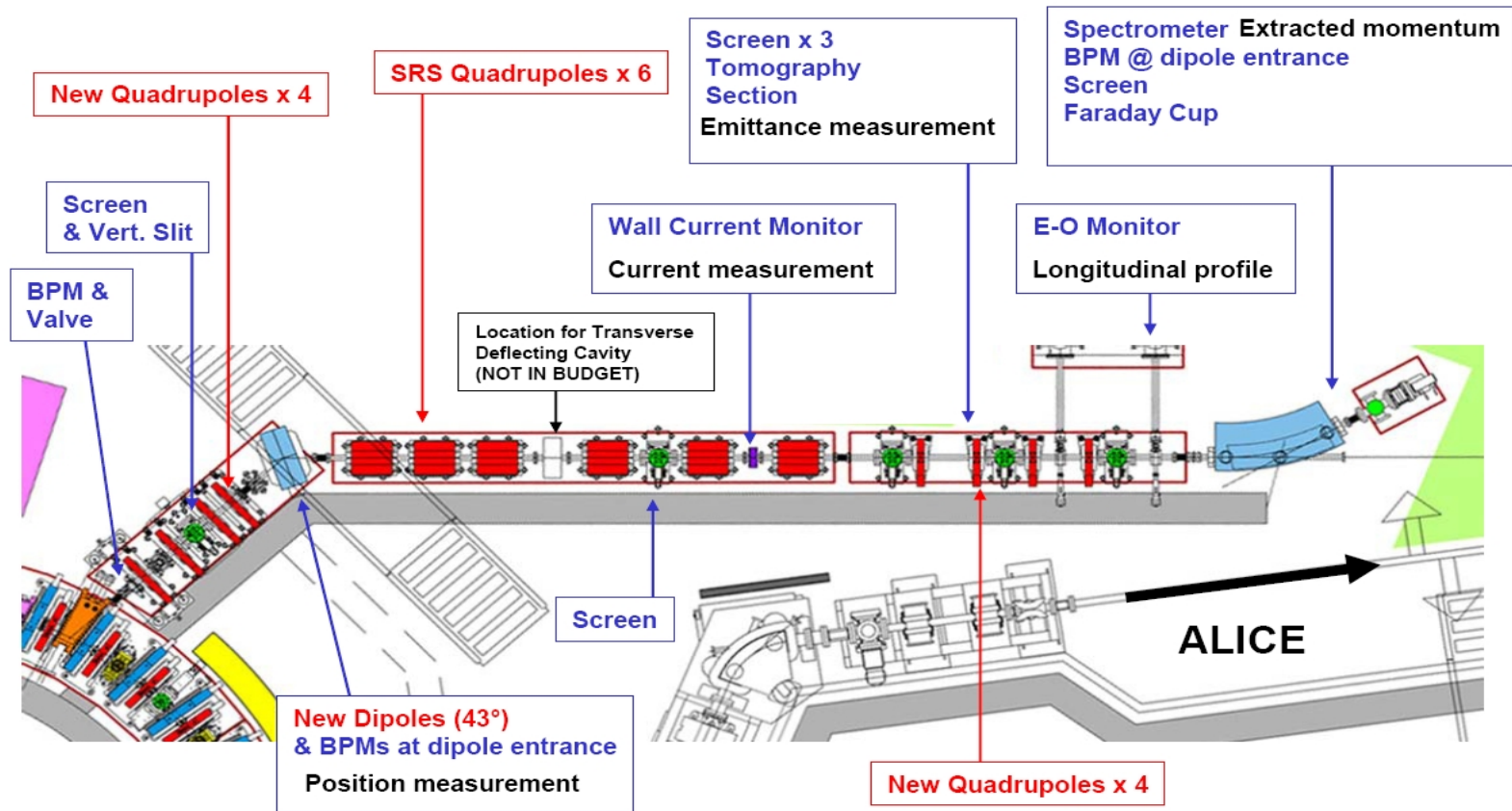
Pulsed kicker/septum magnets :

- Construction in-house, in progress

Diagnostics :

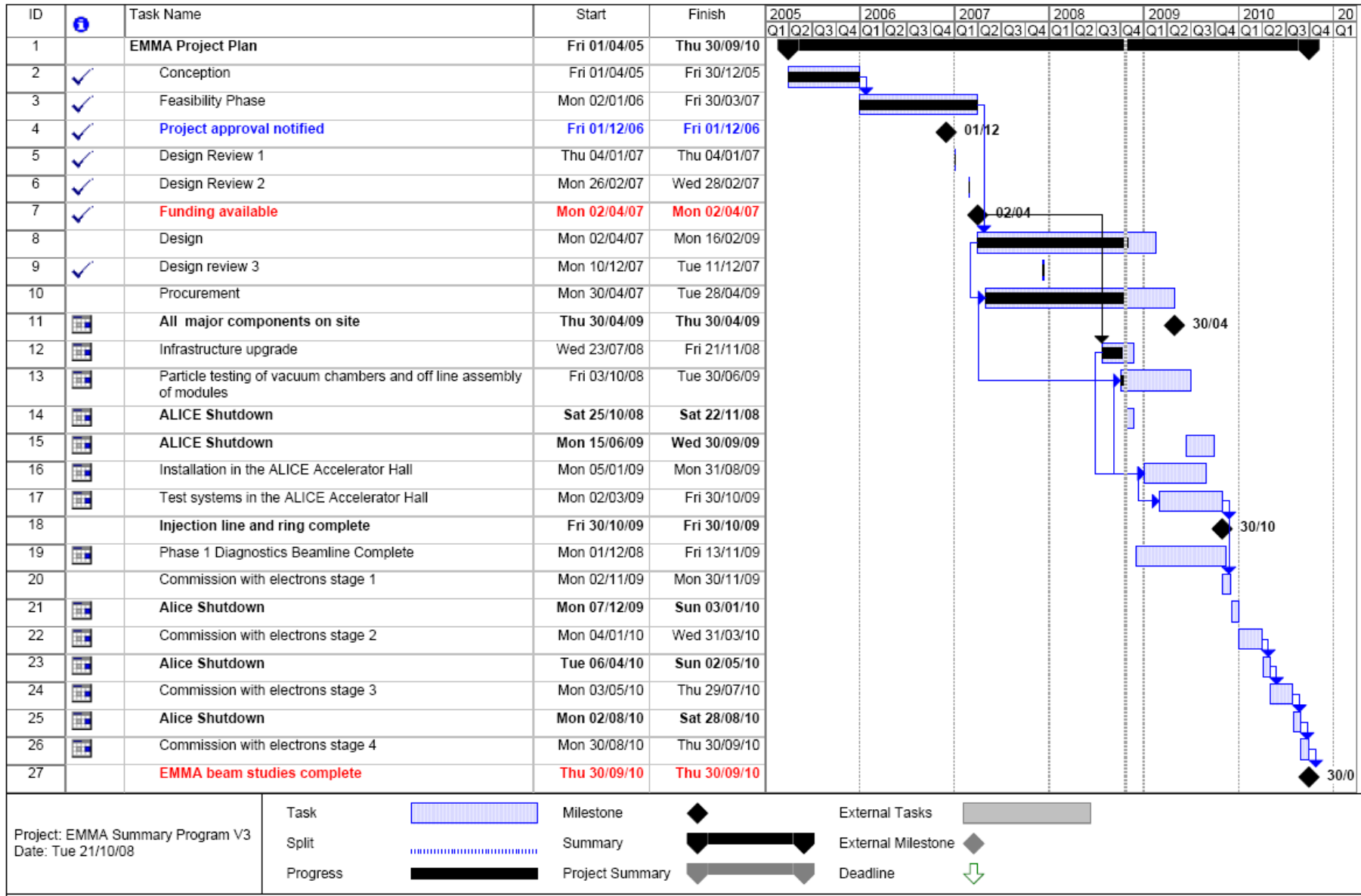
- BPMs : delivery November
- BPM electronics : under development
- Wall current monitors : under design
- Screen systems : under design
- Control system
- etc.

Diagnostics Line



- **Phase 1 :**
 - **First section of the beam line with BPMs, screens, Faraday cup**
- **Phase 2, the scheme above, based on FP7 fundings / ANAC :**
 - **Will comprise tomography section**

Schedule



Within ANAC

| | Beneficiary short name (all costs in €) | Person- Months | Personnel direct costs | Personnel indirect costs | Sub- contracting cost | Consumable and prototype direct costs | Travel direct costs | Material and travel indirect costs | Total direct costs | Total indirect costs | Total costs (direct +indirect) | EC requested funding' |
|----|--|-------------------|---------------------------|-----------------------------|-----------------------------|--|---------------------------|--|-----------------------|-------------------------|--------------------------------------|-----------------------------|
| 14 | | | | | | | | | | | | |
| 15 | CNRS | 5 | 26,000 | 15,600 | 0 | | 15,000 | 9,000 | 41,000 | 24,600 | 65,600 | 19,680 |
| 16 | STFC | 45 | 315,000 | 330,750 | 0 | 384,000 | 13,000 | 0 | 712,000 | 330,750 | 1,042,750 | 312,825 |
| 17 | ... | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 18 | ... | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 19 | ... | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 20 | ... | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 21 | ... | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 22 | ... | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 23 | Totals: | 50 | 341,000 | 346,350 | 0 | 384,000 | 28,000 | 9,000 | 753,000 | 355,350 | 1,108,350 | 332,505 |
| 24 | FIXED TARGETS | | | | | | | | | | 1,266,667 | 332,500 |
| 25 | CHECKING THE CONDITION | | | | | | | | | | OK | NOT OK |

Sub-task 3.1. External diagnostics design, construction and testing. The requirements for the diagnostics will come from tracking studies performed by CNRS-Grenoble and STFC at the Daresbury Laboratory. The design, construction and testing of the devices will be undertaken by staff in STFC. The installation in the beam-lines will also be done by STFC staff.

Sub-task 3.2. Commissioning and experimental running. Commissioning of EMMA using diagnostics will be undertaken by staff from STFC and CNRS. The experimental measurements with these devices required to determine the applicability of non-scaling optics for the applications being studied will also be made by staff at STFC and CNRS.