

Cryo-Collimator (Catcher) for FAIR SIS100 and LHC ? Task 3

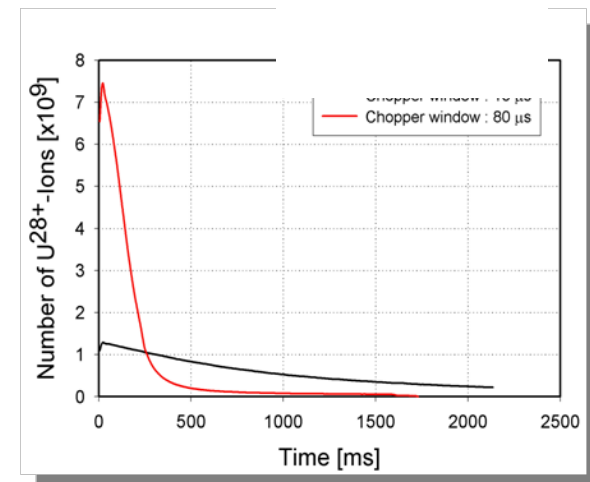
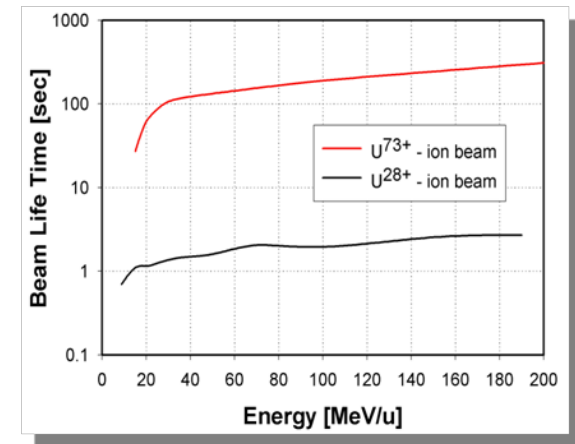
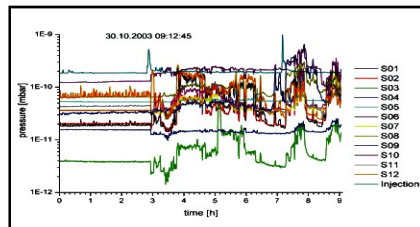
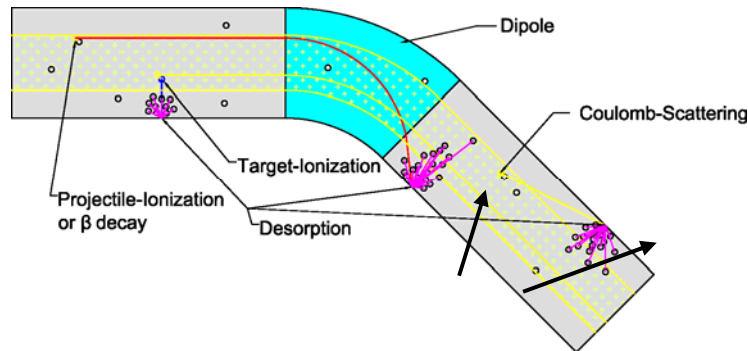
COLMAT Kick-off meeting

CERN

Peter Spiller

17.6.2009

Ionization Beam Loss and Dynamic Vacuum



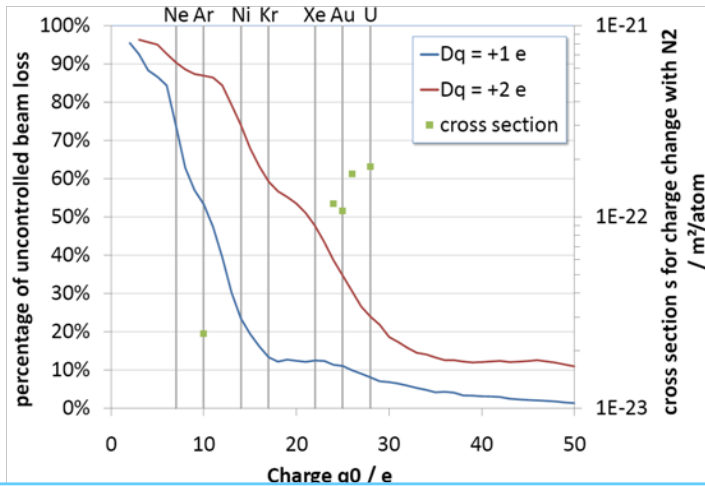
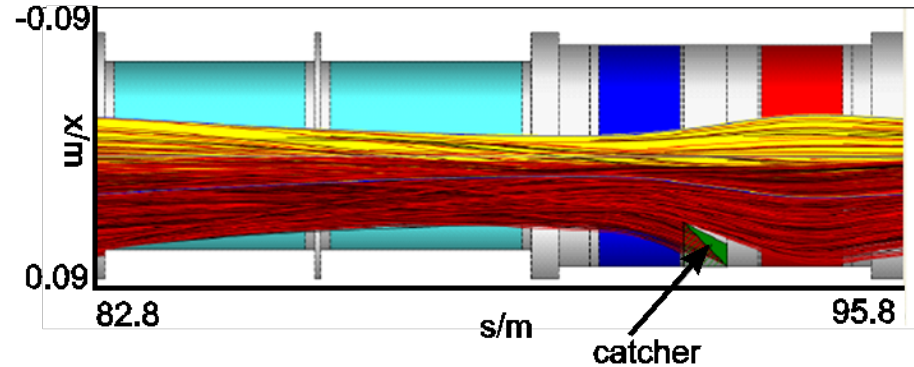
Main Issue for the SIS100 System Design:

- Life time of U²⁸⁺ is significantly lower than of U⁷³⁺
- Life time of U²⁸⁺ depends strongly on the residual gas pressure
- Ion induced gas desorption ($\eta \approx 10\,000$)** increases the local pressure
- Beam loss increases with intensity (**dynamic vacuum**)

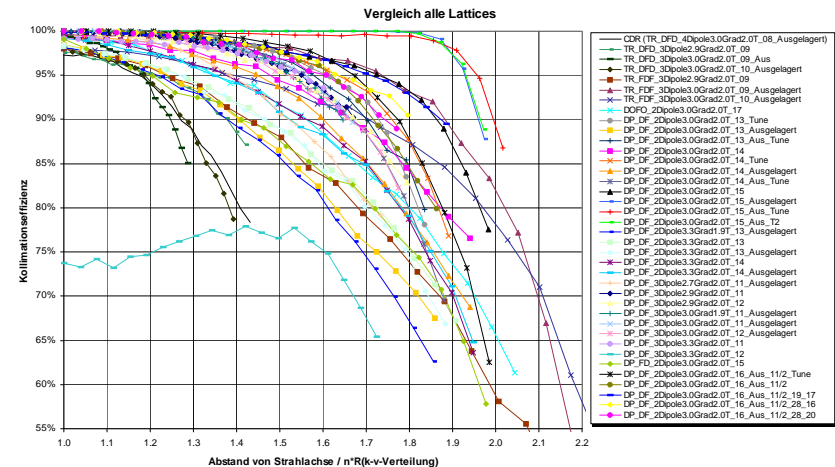
Intermediate Charge State Heavy Ion Operation

- Optimized lattice for peaked distribution of ionization beam loss
- Catcher system for ionization loss control with low desorption yield material
- Strong distributed pumping system
(sufficient area and sufficiently cold (actively cooled) vacuum chambers)
- Long term pumping after built up of stacks of monolayers (cryogenic surfaces)
- Infinitely refreshable (e.g. in a shut downs)
- Low systematic beam loss to prevent initial pressure bumps
- Low initial static pressure with a small amount of heavy components
(warm sections determine the average, initial pressure)
- Fast ramping and short cycle times (for a fast decrease of cross sections)

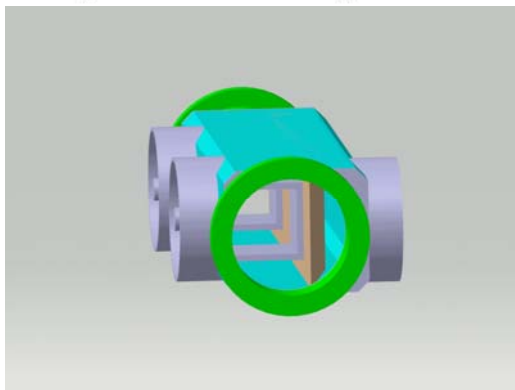
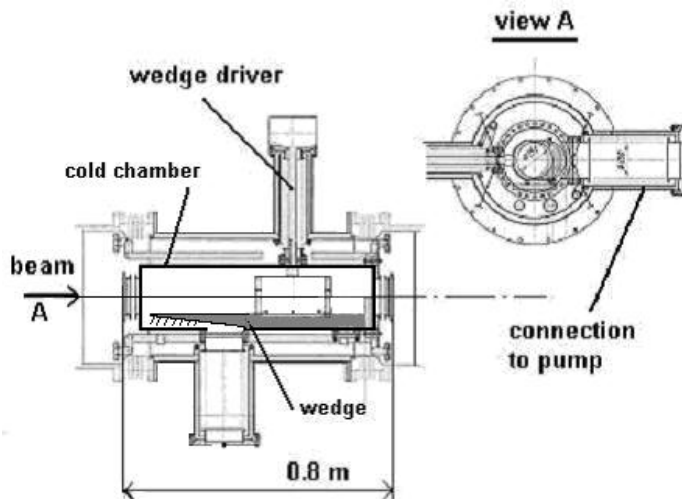
New lattice design for intermediate charge state heavy ion operation with ionization beam loss: Charge separator lattice



Fraction of ions missing the catchers increases for lighter ion and multiple ionization



Catching efficiency has been compared for different lattice types as a function of the distance of the catcher from the beam edge (for $U^{28+} > U^{29+}$)



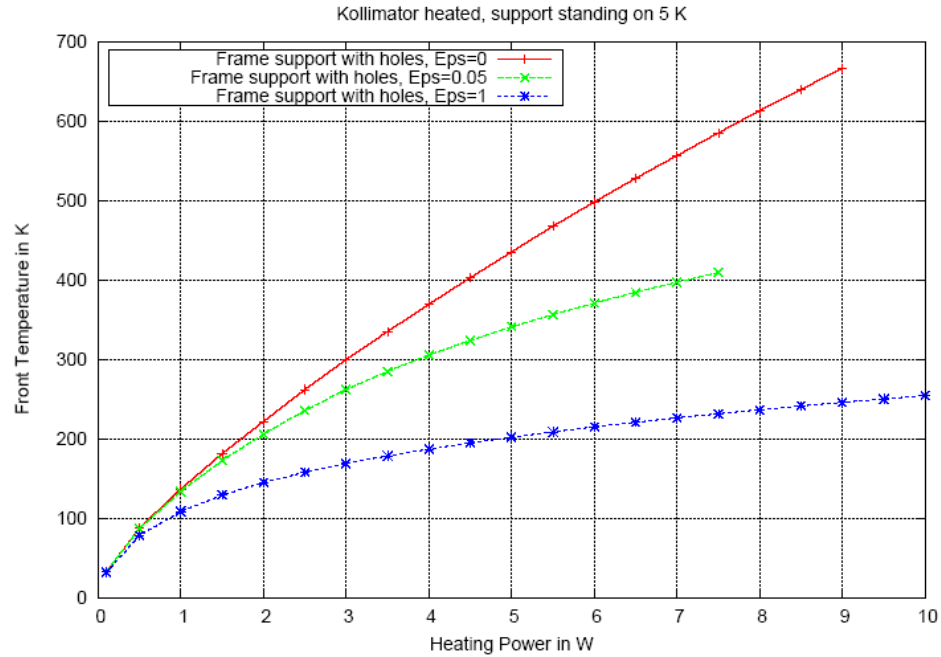
Design Concepts

Desorption Catcher		
Absorber wedge		
Length	m	0.6
Density	kg/m ³	8
Material		Copper
Low desorption coating		100 nm Ni, 100 . 200 nm Au
Temperature	K	50 .. 100 K
Weight	kg	2.3
Alignment tolerance	mm	0.5
Heat release from the beam	W	< 10
Chamber		
Aperture	mm ²	135 x 65
Chamber shape		rectangular
Operation temperature	K	4.5
Cooling power	W	100
General		
Length of module	m	0.7
No. of modules per superperiod		8
Total no. of collimators		66

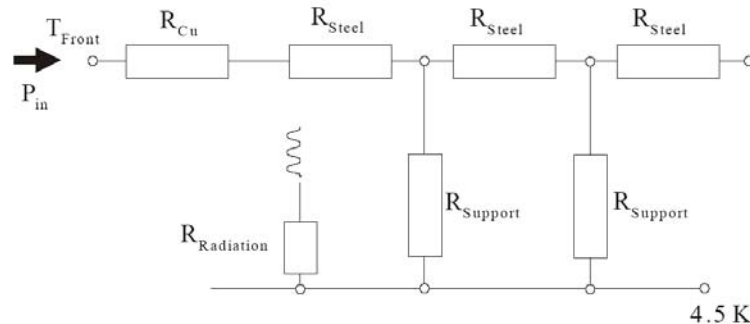
- Set-up of a prototype cryo-catcher with similar technical design as finally used for SIS100
- Installation of the prototype cryo-catcher at a HE Cave at GSI and test with SIS18 heavy ions beams

- Measurement of the pressure rise on the beam axis
- Measurement of the amount of gas desorption and effective desorption yield
- Measurement of the mass spectrum of the desorbed atoms
- Measurement of the catcher temperature at different beam loads
- Determination of the required cooling power at different beam loads
- Beam position and number of ions

Simulation of Operation Conditions



ANSYS



Component/task	Costs [k€]
External Design	40
Cryostat, heat shield, cold-warm-transition	100
Local cryogenics	100
UHV diagnostics (Mass spectr. Total pressure gauge etc.)	GSI
Temperature measurement	GSI
Electronics	GSI
Valves	GSI
Beam Instrumentation beam screen	GSI
Turbo pumps, valves	GSI
Collimator	20
Sum	200 - 250

Personal: (cost equivalent)

1 Physicist

1 Engineer

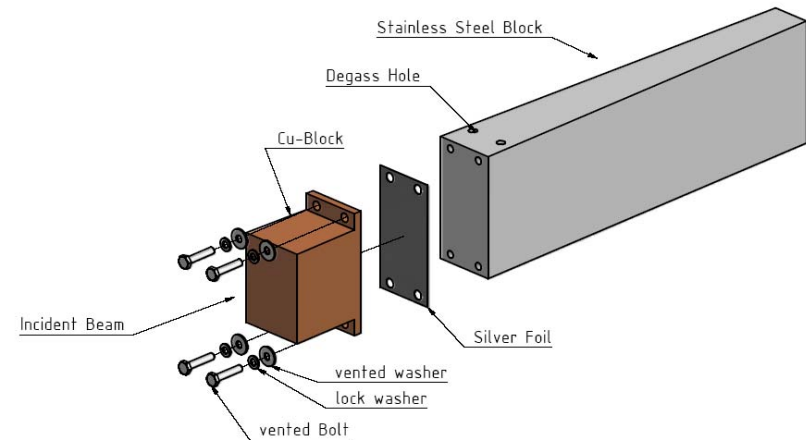
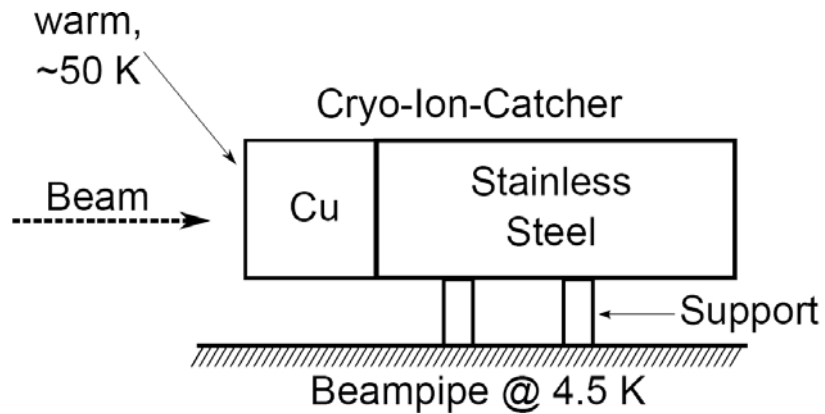
for 3 years

Total cost: 600 k€

Equipment partially provided by GSI

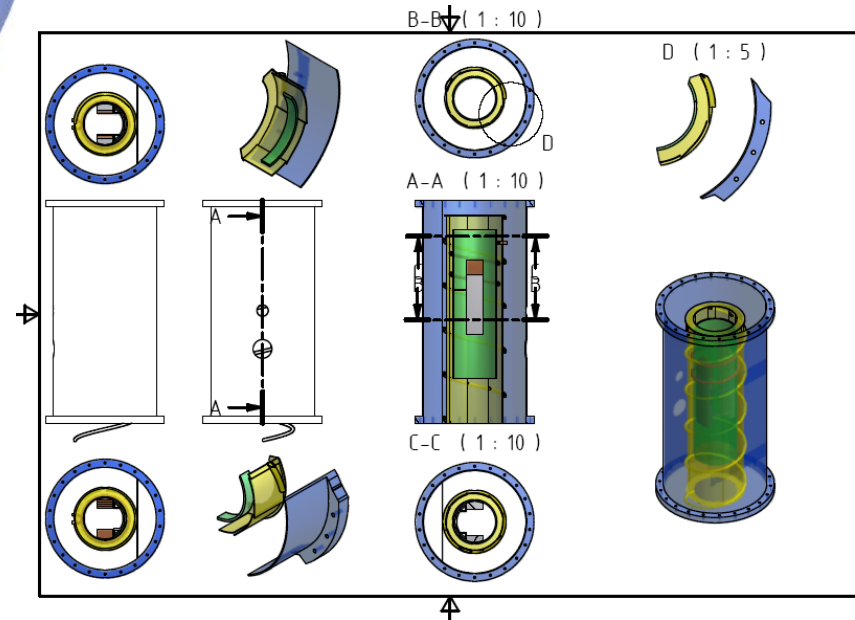
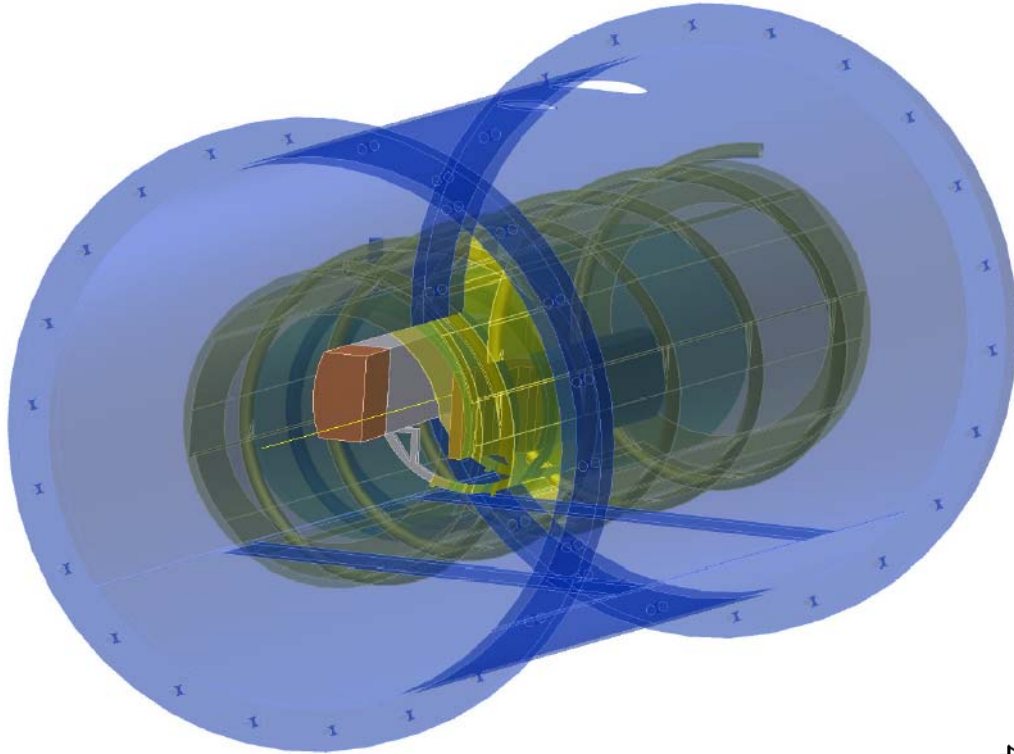
- Cryostat incl. heat shield and support with two cold-warm transitions for the connection to the HE beam transport system and a beam dump
- Beam screen monitor and slow beam transformer
- Catcher chamber with active cooling, temperature sensors, pressure gauges and mass spectrometer
- Evtl. horizontal movable
- Catcher, thermally insulated wedge and block with low desorption gold coating and temperature sensor
- Pumping system for beam pipe and insulation vacuum

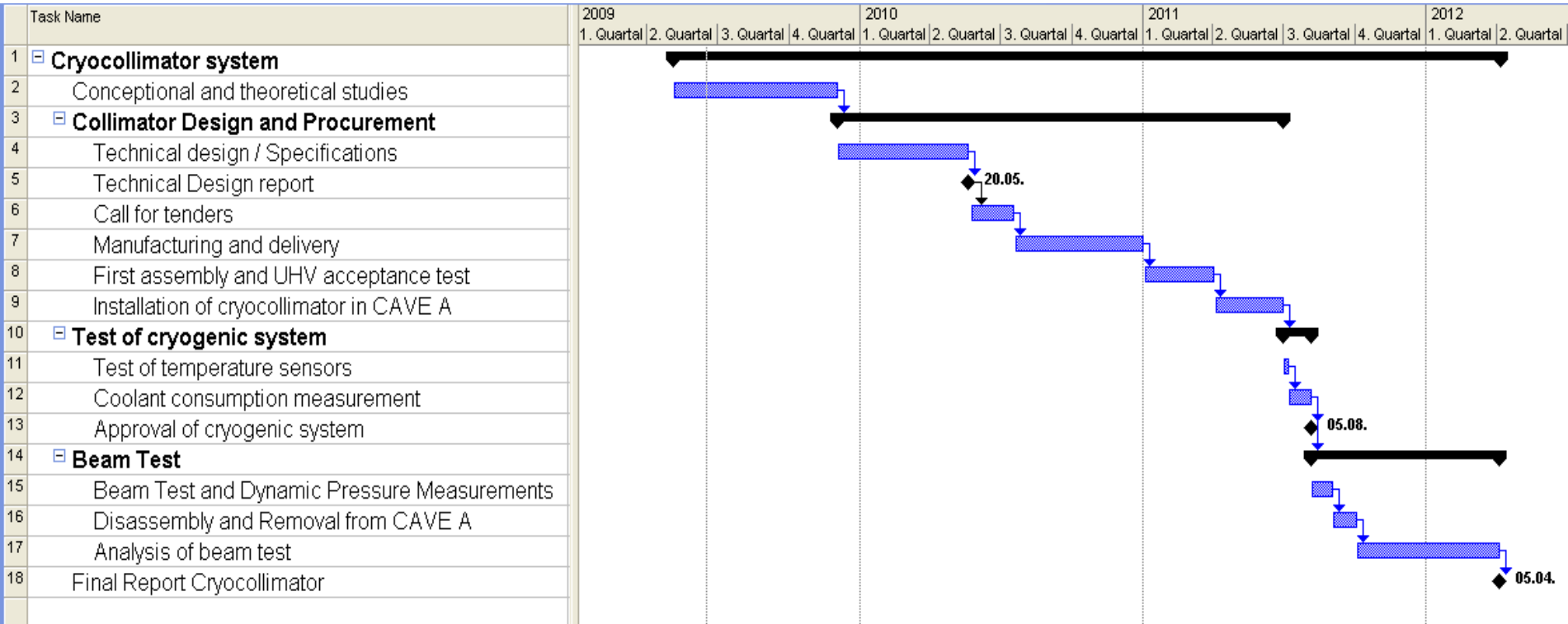
Design Considerations



Catcher head using low desorption material and coating
(Copper block with Gold coating and Nickel diffusion barrier)

Design Considerations





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CERN – contact ?

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