EXTENTION OF FREE-STANDING TARGET TECHNOLOGIES ON IFE REQUIREMENTS: DD TARGET PRODUCTION AND PREACCELERATION

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**Snowmass 2002 Fusion Energy Sciences Summer Study
8-19 July 2002, Snowmass Village, Colorado,**

Support: RAS, ISTC project #512 & #1557, IAEA project #11536

OUTLINE

❑ IFE TARGET FABRICATION

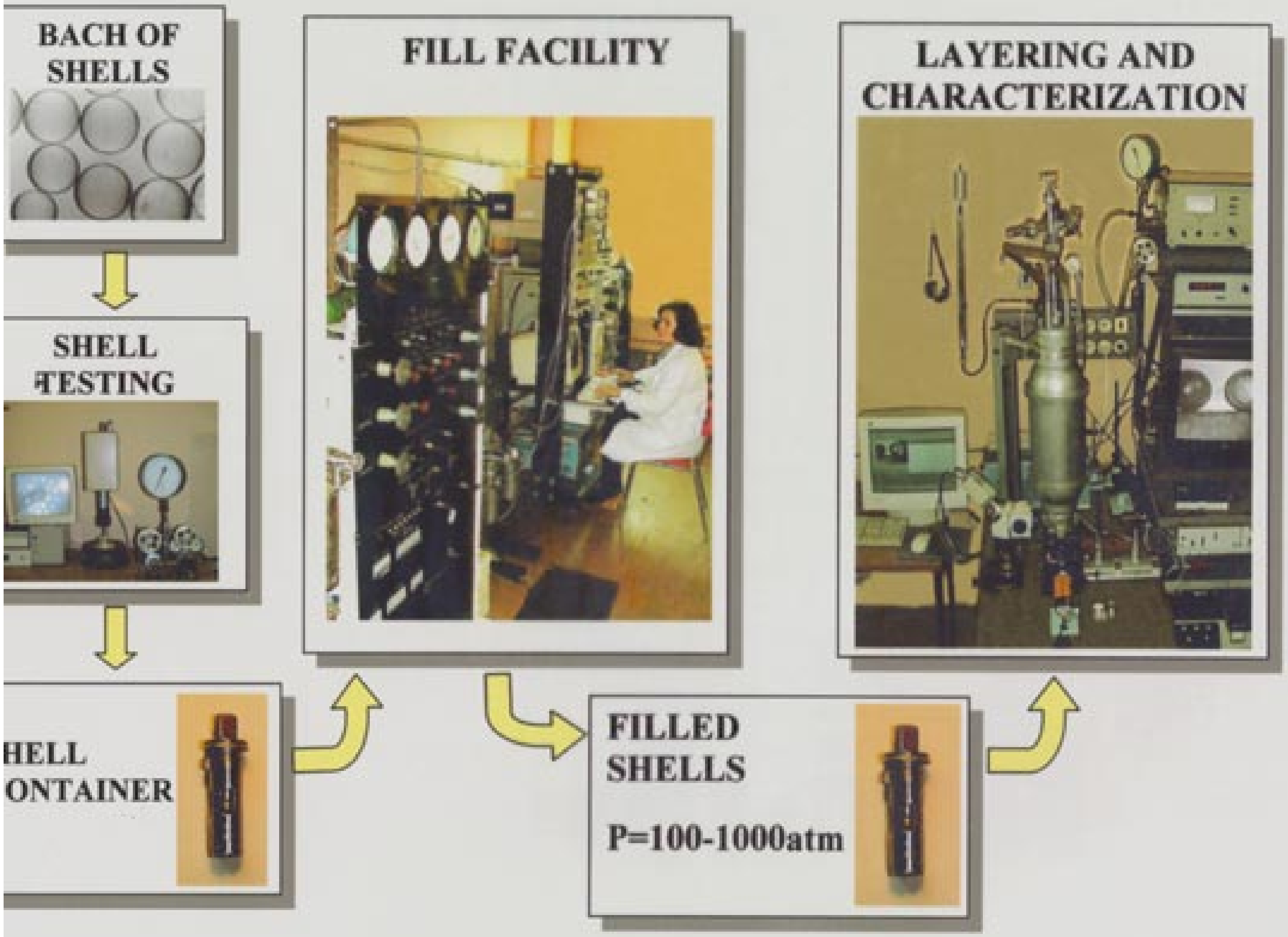
1. Theoretical modeling of the FST technologies for IFE target fabrication
2. Physical layout of the FST-layering experiment

❑ IFE TARGET DELIVERY INTO A BURN AREA

1. Target survival and protection issues
2. A concept of IFE target factory

.OPED FOR 1 mm TARGETS

NG A BACH OF FREE-STANDING SHELLS AT EACH PRODUCTION STEP
S DIFFUSION FILLING OF 25 SHELLS UP TO 1000ATM
EL LAYERING INSIDE MOVING TARGET LESS THEN 12 SEC.

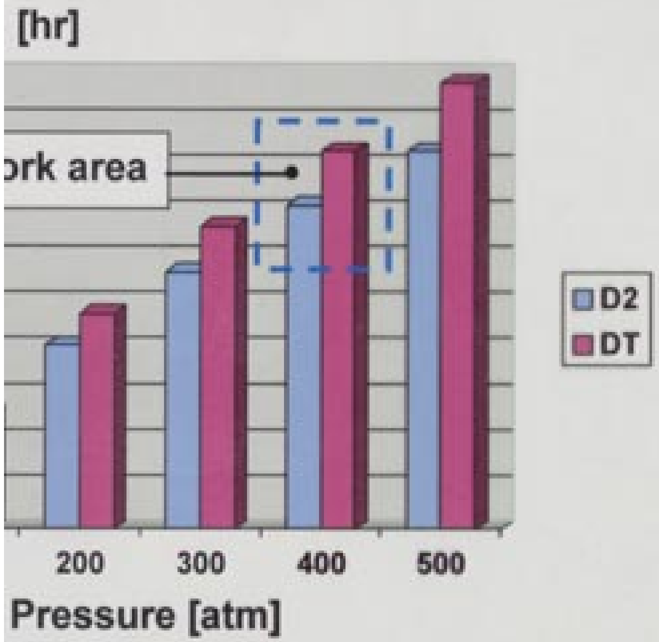


RSSE ⇒ IAEA pr. #11536

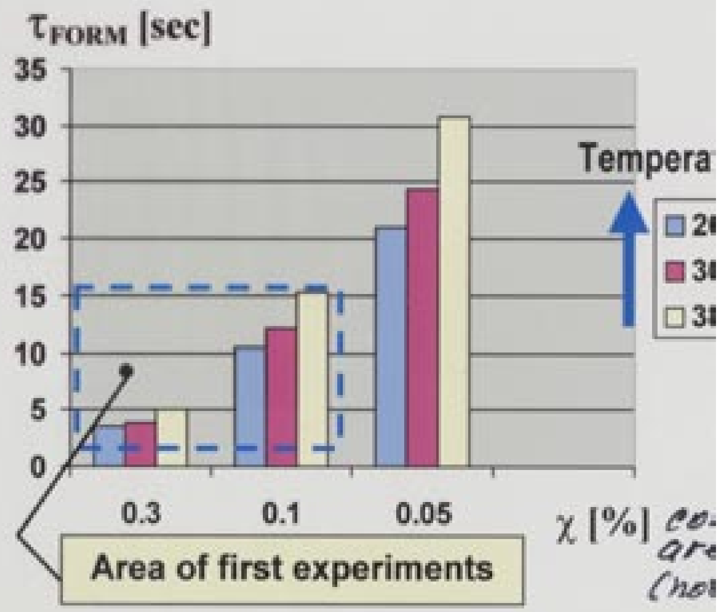
Reported: IFSA-
Sept. 2001, Kyoto,

RY EXTENSION ON IFE TARGET DESIGN MADE DURING 2000-2001 HAS SHO
SYSTEM IS SUITABLE FOR FIRST EXPERIMENTS WITH REACTOR TARGETS

made in the frame of the IAEA project #11536



ll time by diffusion for a 4- mm CH shell with a 45- μm thick wall.



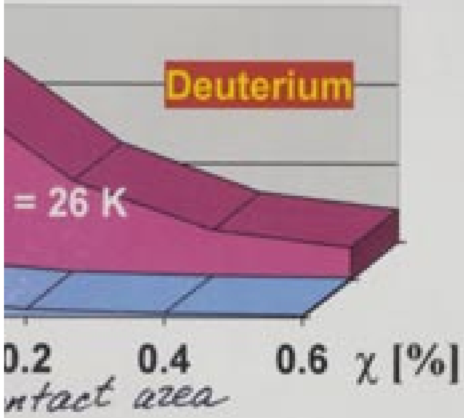
The CHGT-1 layering time *vs.* the experimental conditions.

H shell ∅ 4 mm, ΔR = 45 μm, W = 200 μm DT (D2); P_{FILL} 423 atm (D_2) 427 atm (D

operties used in estimations: E = 3.83×10^9 Pa, $K_{D2} = 6\ 10^{-15}$ [mol/m^{3}Pa]

I.V. Aleksandrova et.al. Appl.Phys

)2: NEW RESULTS ON THE FST TECHNOLOGIES FOR IFE TARGETS LAYERING

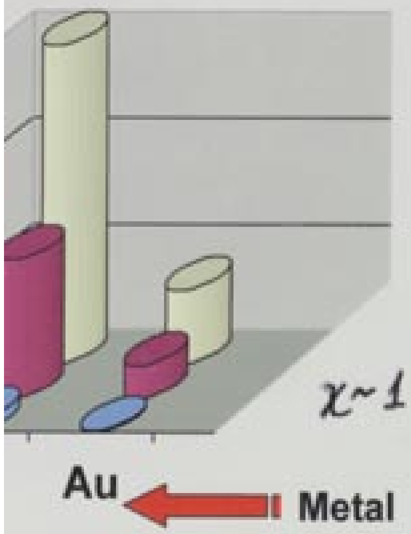


No reflecting layer, channel geometry variations

- **CHGT1** (∅4mm, ΔR 45 μm, 200 μm D_2)
- **CHGT2** (∅6mm, ΔR 300-500 μm, 200-300 μm D_2

The key issue is determination of an optima produce a target with a carefully layered fuel i plan to use the R&B cell for detailed analysis.

eliminary Results



With reflecting layer: Pd or Au of ~200 A^0

- **ICF target** (CH ∅1mm, ΔR 15 μm, 100 μm D_2)
- **CHGT1** (CH ∅4mm, ΔR 45 μm, 200 μm D_2)
- **CHGT2** (CH ∅6mm, ΔR 300-500 μm, 200-300 μm

The first calculations of metal layer cooling time for P Au have shown that effective value of χ becomes clos For that case the layering time of the CHGT2 is <10 se

FST-LAYERING. ADDITIONAL ACTIVITY

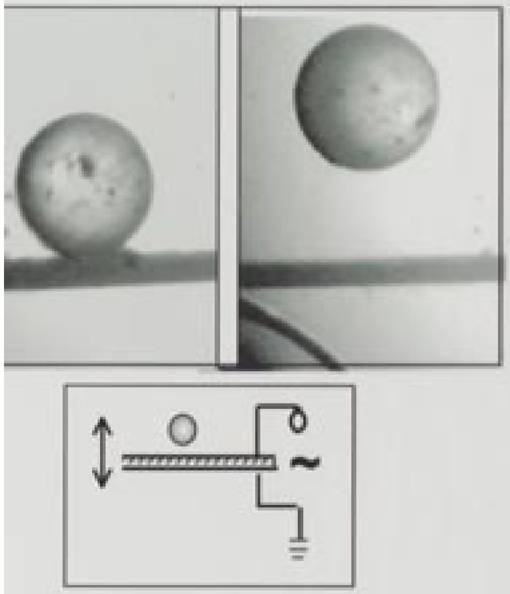
TART TO INVESTIGATE THE FUEL FREEZING IN A SHELL PLACED IN T
TO ELUCIDATE THE PHYSICAL FUNDAMENTALS UNDERLYING THE EFF
E FST-PROCESSES

ISSUES TO BE STUDIED

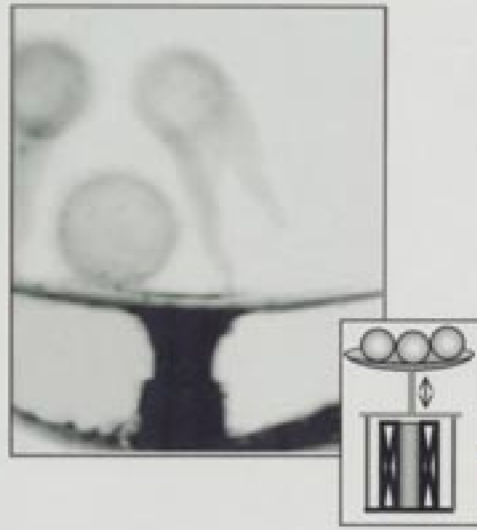
- Elastic shell deformation in the case of thin and thick wall
- Thermal contact area expansion over the shell surface
- Surface properties and the stress state
- Drop-wise condensation in the presence of a special doping
- Cooling rates influence on the layering results, etc.

[redacted] EQUIPMENT FOR TARGET TESTING [redacted]

A UNIT FOR TARGET MOTION DRIVER: ROTATING & BOUNCING (R&B) CEL



inverse piezo-effect



action of alternative magnetic field

VIBRATING MEMBRANE
2 modifications

Current WORK T: 4.2 ÷ 20 K; $\partial T/\partial t \approx 0.1 \div 50$

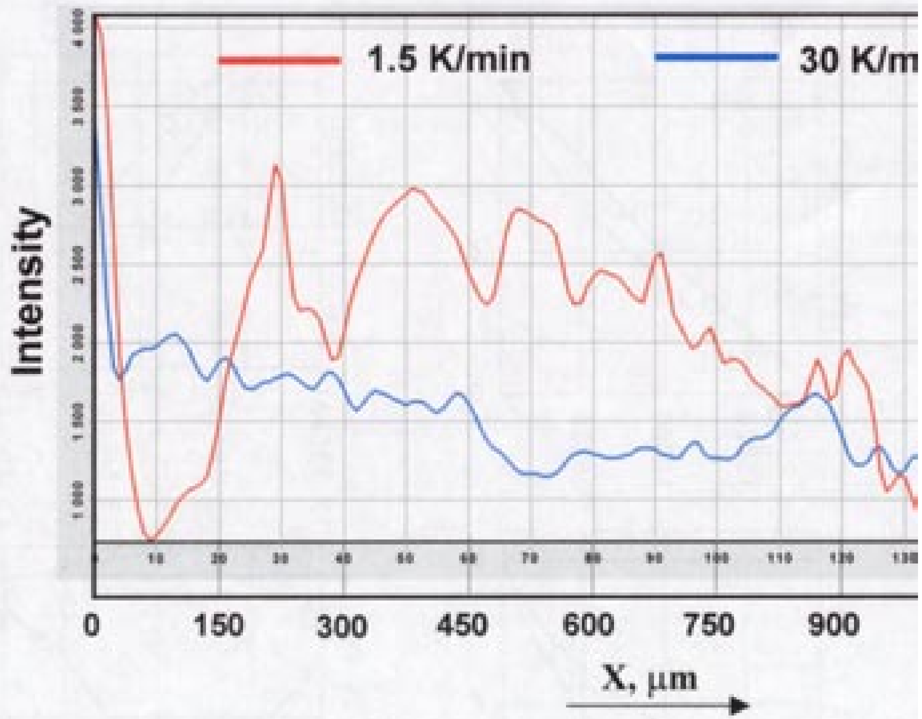
WORKING MODES: Bouncing, rotating, mixe

Key param.: f, V, [redacted]

T RESULTS ON D2 LAYERING STUDY USING THE R&B CELL:

t is possible to form solid D_2-layer inside a bouncing shell

The higher cooling rate of a substrate, the smoother layer structure



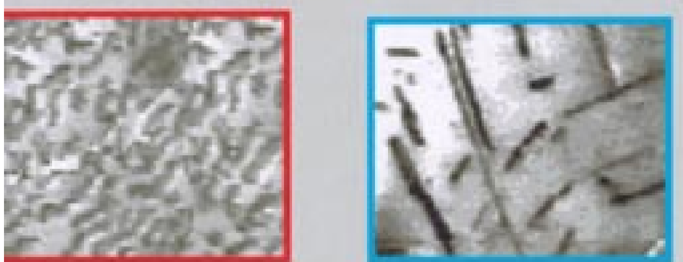
<u>Conditions of the experiment</u>. CH shell: ∅ 1.2 mm, P_F 300 atm D

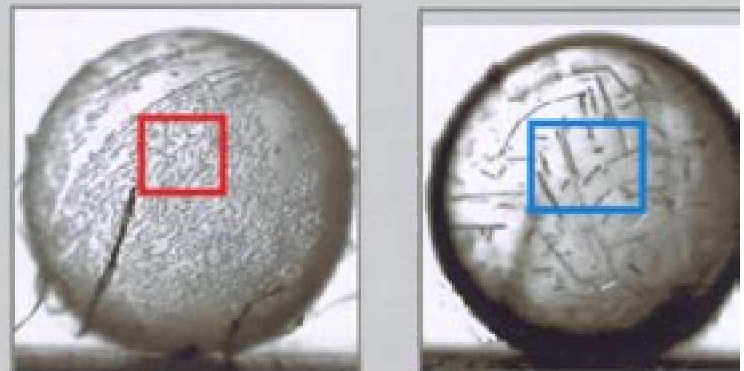
Substrate (piezo-crystal): 10 kHz, 75 V, 1.5-to-30 K/min cooling ra

LING RATES INFLUENCE ON THE UNIFORMITY OF D2 LAYE ULAR STRUCTURE OVER THE SHELL

1.7 K/min

T_{IN}= 22.8 K
T_F= 10.8 K





100 μm

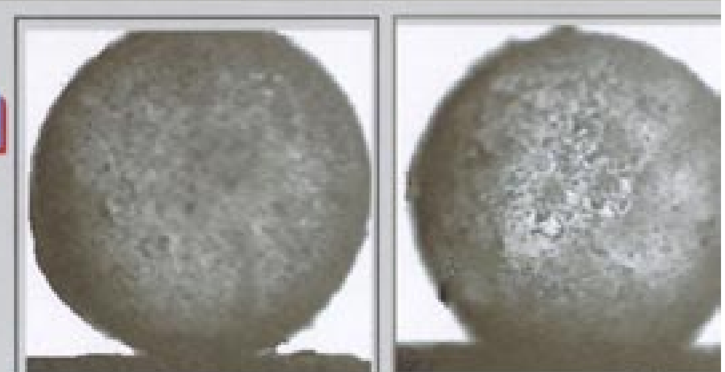
0⁰ ~ 90⁰

se grain structure age + angular non-rmity

er cooling rate s more smooth ice ture with lower lar non-uniformity

29 K/min

T_{IN} = 21.3 K
T_F = 5.8 K



0⁰ ~ 90⁰

CH shell (made in ILE, Japan): 2R = 1724 μm P_F 150 atm D_2

RGET SURVIVAL AND PROTECTION ISSUES

Layering module

on-uniformity: NU < 2%

oughness: $\delta < 1\mu m$

emperature: $T<T_{TP}$

Moment of target irradiation

4. Non-uniformity: NU < 2%
5. Roughness: $\delta < 1\mu m$
6. Temperature: in the vicinity of T_{TP}

INJECTOR

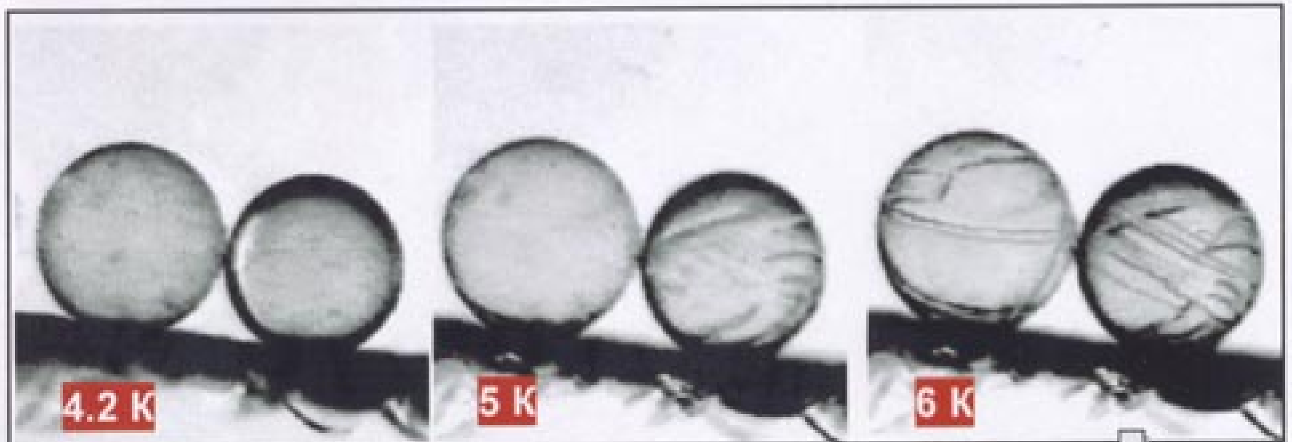
Target&sabot assembly ⇒ acceleration ⇒ injection ⇒ flight

IN FLIGHT ISSUES

- Fuel layer surface evolution during the target heating
- Temperature of target injection into IFE chamber
- Target protection from the head wind and wall radiation

ALL-&-STRIKE TECHNIQUE (FST)

OOTH AMORPHOUS FILMS CAN BE FORMED INSIDE A SHELL AT
OLING RATES >10^4 K/min. THE FILMS EXISTS ONLY BELOW ~$0.5T_{T}$

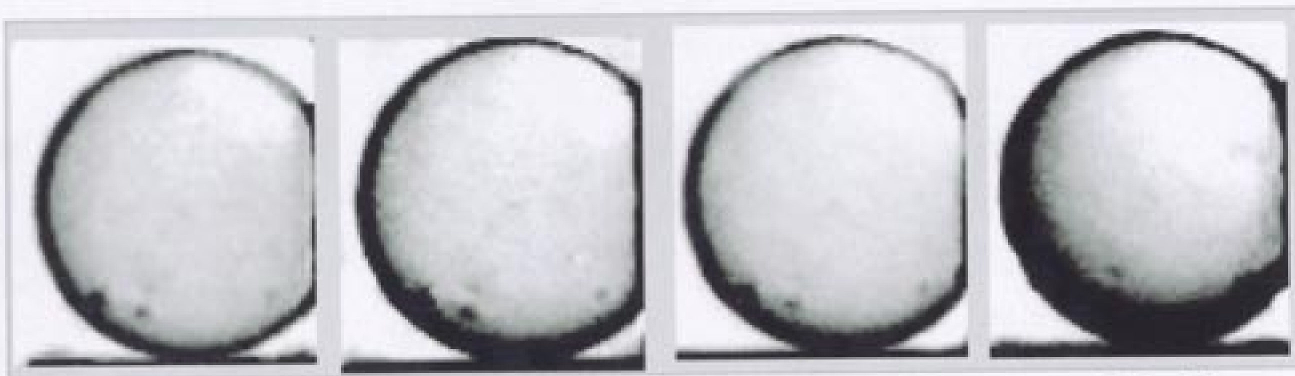


D_2	H_2+D_2 (1:1)	H_2
T_{TP} =18.7 K	T_{melt} =(15.8-16.4) K	T_{TP} =13.9K
T_A ~ 8-to-10 K	T_A ~ 7-to-9 K	T_A ~ 5-to-7 K

eliminated the amorphous cryogenic layers from further considera
ause they do not exist in the vicinity of T_{TP} (required IFE target T a
ment of irradiation)

APPROACH IS IN PROGRESS at LPI [1,2]
ıres the basic principles of fabrication of finely dispersed compc
s and alloys with little [redacted] dopant

thod has beeen demonstrated for H_2 with little HD additives (0.3-tc



5.2 K 10 K 13.5 K 20 K

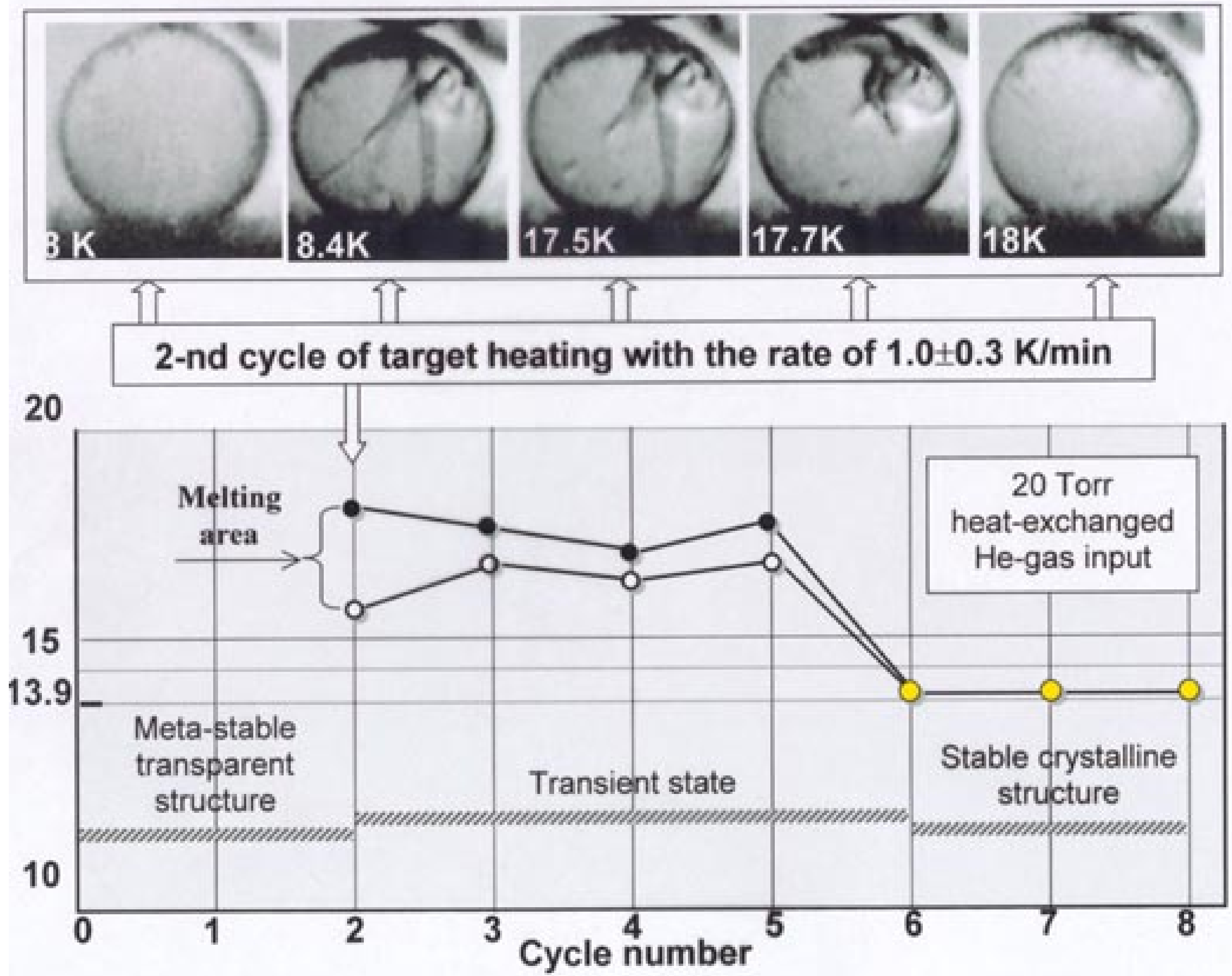
Transparent solid layer does not spoil at reheating from 5 K to T

hys.D: Appl.Phys. 35 (2002) 825-830

ssian Patent, Claim No 2001121680 of 9.08.2001

eported: IFSA-2001, Kyoto, Japan
Sept. 2001

SPARENT SOLID LAYER AGES UNDER CYCLING HEATING TREATM



Target: Glass shell ∅ 500 μm, 100 atm H_2 + 0.5 atm HD (300 K)

RIMENTAL RESULTS INDICATE THAT THE APPLIED TECHNIQUE ALLOWS RM SOLID FUEL LAYER IN A GLASS (LIQUID-LIKE) STATE

The procedure of solid layer formation includes 3 steps:

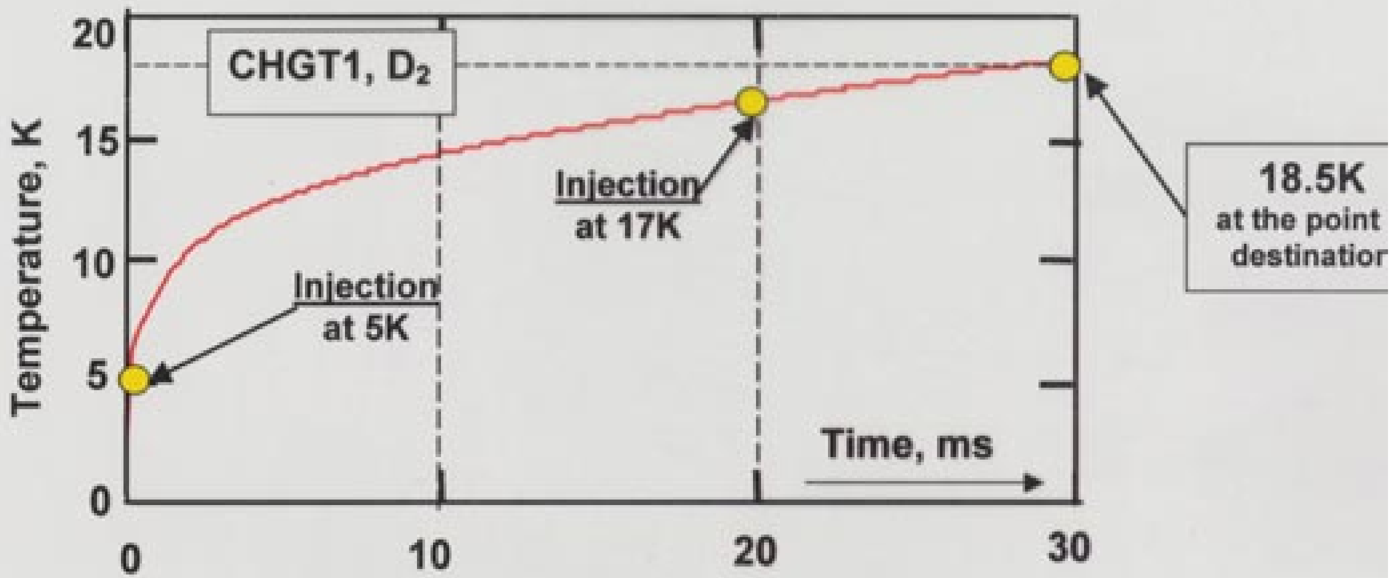
1. FILLING: Diffusion filling a shell with gas fuel + small doping
2. MIXING: Drop-wise condensation of the fuel+doping mixture result formation of a liquid layer with uniformly distributed particles of doping in
3. FREEZING: Liquid layer rapid cooling to 5 K resulting in transparent soli formation (t < 18 s for DT, according to Souers)

The layer properties:

1. It does not melt when the temperature is raised from 5K to 20K
2. It does not crystallize when the temperature is dropped from 20K to 5K
3. It degrades after several cycles of heating treatment in the range of 5-

Such properties signify that the layer is in a glass (liquid-like) state w extremely smooth free surface.

T WITH FUEL IN GLASSY STATE CAN BE INJECTED IN IFE CHAME



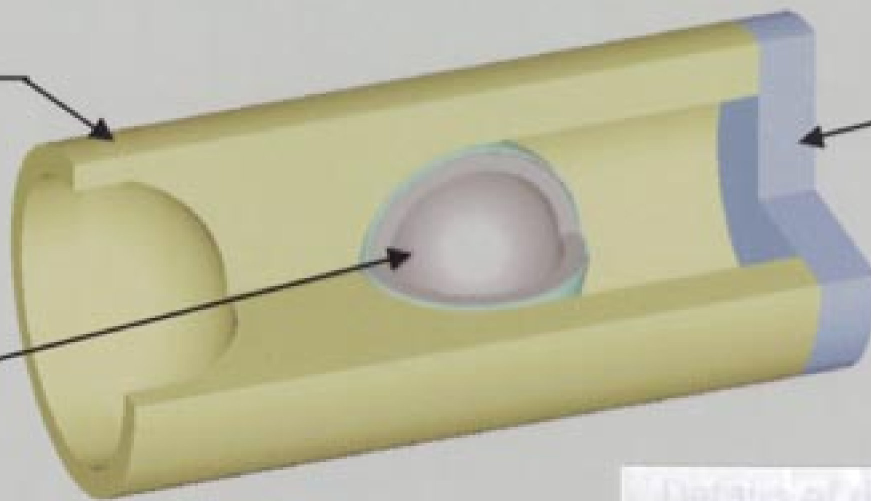
Target history inside IFE chamber.
Estimations made for the following conditions:
CHGT1 with D2 fuel (no reflecting layer), chamber wall T=1773 K, 0.5 Torr Xe

Advantages:

Injection at 5K makes risk of layer mechanical damage minimal:

1. **Smaller injection speed calls for smaller g-loads during target accelerati**
2. **Acceleration goes at ~ 5 K when tensile strength of a fuel-layer is maxim**

TING POINT OF TARGET DELIVERY: TARGET ASSEMBLY WITH A SPECIAL 'ECTIVE SABOT AT CRYOGENIC TEMPERATURES



ABOT FUNCTIONS:
- To transmit an impulse of motion to the target
- To protect the target from heat- and g- loads

ESIGN CRITERIA:
- design must be suitable for acceleration in injector of any type: coil gun, gas gun or mixed
- working temperatures: 5- to - 17 K
- working overloads: $a/g \leq 1000g$

MAY INCLUDE A COVER WHICH IS INJECTED TOGETHER WITH TARG
:TS THE TARGET FROM A HEAD WIND OF RESIDUAL GAS.
rag force estimations two cases were considered: solitary and joint flight c
er. Correction for the solitary case (effect of wake) is about 30%

n
n:

$$L_{cov/targ} = v_\infty \cdot t - \frac{Drag}{2 \cdot M_{cov/targ}} \cdot t^2$$

ake:

$$u_1(x,y) = U_\infty \times \frac{\pi c_D}{32}\left(\frac{2 \cdot R}{x} RD\right) exp(-\eta^2)$$

$$\eta = \frac{y}{2} \cdot \sqrt{\frac{v_\infty}{v \cdot x}}$$

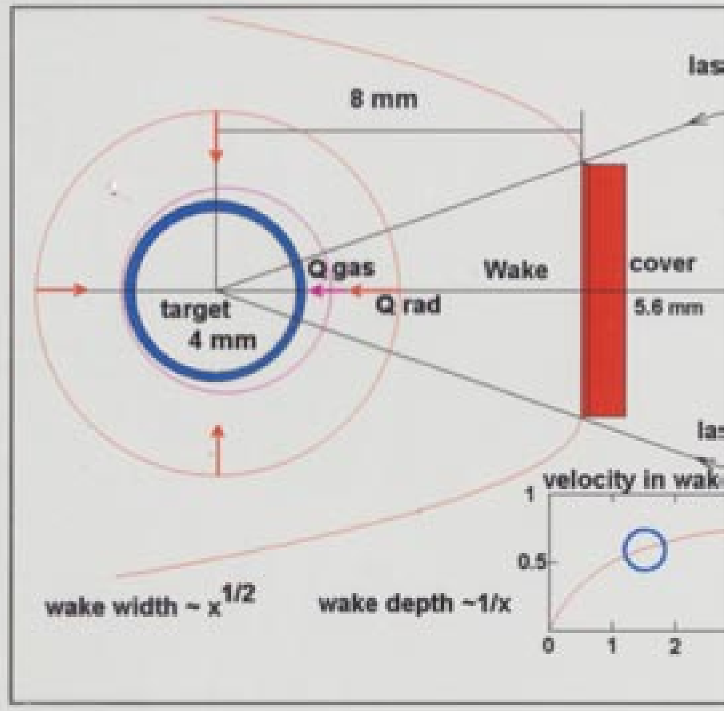
ce
:

$$Drag = -\frac{3 \cdot k_B \cdot T \cdot n_o \cdot a^2 \cdot M}{2 \cdot \pi} F_1 \cdot \overset{\rho}{k} =$$

$$-\frac{3}{4} \cdot a^2 \cdot n_o \cdot u \cdot \left(\frac{m_g \cdot k_B \cdot T}{2 \cdot \pi}\right)^{1/2} \cdot F_1 \cdot \overset{\rho}{k}$$

$$F_1 = F_{1o} + F_{1p} \qquad F_{1p} = -\frac{21.28}{\chi^2}$$

$$F_{1o} = 8 \cdot \pi \cdot (8 + \pi)/9$$



Conditions under consideration:
speed is 250m/s, initial distance is 1mm
l gas is Xe at 0.5Torr, chamber radius is 5m
mg, M_{targ}=5mg, χ= 1.43

Distance between target and co
at the point of destination:

22 mm (solitary motion)
15 mm (wake region effect)
Recommended distance: ≥ 8mm

CTIVE COVER. RESUME OF THE ESTIMATIONS* (DSMC approach)

ver effectively reduces the gas heat flow by a factor of 4- to- 5

ag force provides necessary separation of the cover and target inside actor chamber

diation heat flow from the chamber wall is an order of magnitude higher th gas heat transfer

r target protection against radiation it is proposed to apply the ablating la m D_2- or Ne- formed on the outer target surface (alternative to reflecti ers)

*/B.V.Kuteev Research report NIFS-718, Nov.20

TSU St. Petersburg

ARGET SURVIVAL DURING THE INJECTION PROCESS

Summary of possible ways to solve the problem

o apply target having a fuel layer in glassy state which does not spoil at arget heating (from 5K to T_{TP}) during its flight to the point of destination

o reduce target injection T from 17K to 5K that allows to reduce injectio speed, and, thus, to reduce g-loads during target acceleration

o carry out the process of target acceleration at ~ 5 K when risk of targe nechanical damage is minimal

o use a special sabot for target protection from heat- and g- loads nside injector

o use a special cover protecting the target from the action of a head win nside IFE chamber

o apply a special ablating layers from D_2 or Ne formed on the outer targe urface

YSICAL LAYOUT OF THE FST-LAYERING EXPERIMENT

ıge 0: Shell testing
)AL: determination of the FST experiment conditions for a given shell batch

ıge I: Fuel filling of a shell batch
)AL:
- to achieve the necessary amount of fuel in the shells
- to add necessary doping to a fuel gas
- to obtain necessary ortho-para composition
- to investigate the limits of the diffusion filling

ıge II: Preliminary cooling of the batch placed in target collector.
)AL:
- to cool the filled shells to a temperature of target injection into the layering channe
- to obtain the uniform distribution of doping clusters over the liquid fuel (structu

ıge III: Fuel layering
)AL:
- to achieve layer symmetrizatrion and freezing inside the target during its movemer in the layering channel

ıge IV: Cryogenic target injection into an optical test chamber
)AL: cryogenic target study in multiple views and its characterization → fundame to succe

GE 0: SHELL TESTING WITH THE AIM TO DETERMINE THE FST EXPERIMEN NDITIONS FOR A GIVEN SHELL BATCH

PROCEDURE OF SHELL TESTING

nulti views study of the backlit shell images

Equipment: "*Shell Tester*" with 8-to-120 projections (views) and a spatial resolution of ~1.5 μm

ells strength relative to the outer and inner gas pressure during the process

- diffusion filling (300 K)
- shell container depressurization (30-to-70 K)

Equipment: (a) device for measuring the tensile strength, the buckling and collapsing pressure
(b) fill facility

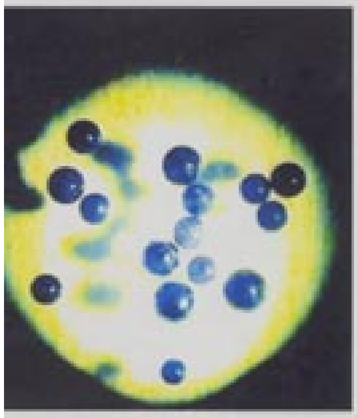
ells withstanding to the mechanical stress arising due to the FST conditions

- rapid cooling (300-to-4.2 K for glass shells and 40-to-4.2K for CH shells)
- strikes between the shell and the cryogenic surface (4.2-to-30 K)

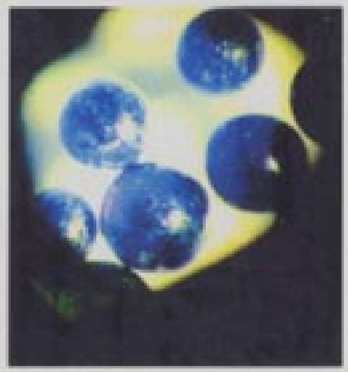
Equipment: (a) rotating and bouncing cell (R&BC)
(b) layering module (LM)

T RESULTS. A batch of CH shells (∅ 1.5 -to- 2.2 mm) made at the ILE (Jap been examined. The testing showed the shells principle fitness to the F ing. For these shells, special conditions of such experiments have been fou

;TAGE I. FUEL FILLING OF A SHELL.
Vhich diffusion mode, atomic or molecular, has a greater permission rate?
;an we govern the gas diffusion mode through a shell wall?



INITIAL BATCH



7 days in 100 атм H_2
MOLECULAR DIFFUSION

7 days in 100 атм H_2 +
ATOMIC DIFFUSION

Observation of color change of cobalt containing glass balls during their retention in H_2 with Pd present

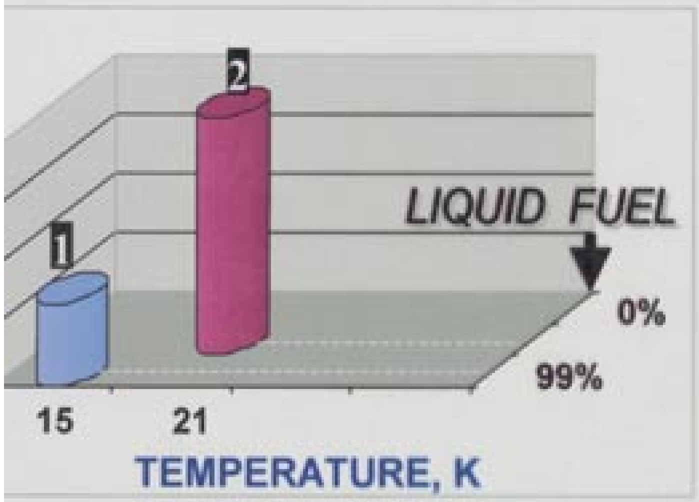
ıenomena can be identified as cobalt valence changes under atomic hydrogen infl
ng in color change of the sample.

$$H_2 \xrightarrow{(Pd)} 2H \;;\quad Co^{+5} \xrightarrow{(2H)} Co^{+3}$$

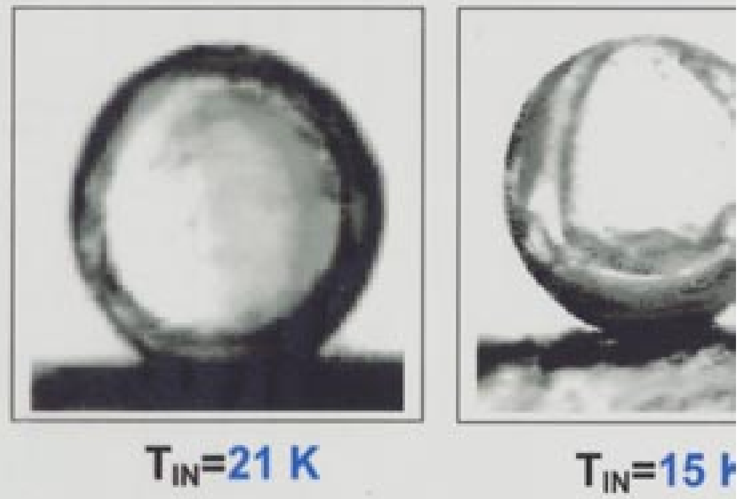
E II: PRELIMINARY COOLING OF THE BATCH PLACED IN TARGET COLLECT

alculation model and experimental data indicate that FST layering r d on the temperature of target injection into the layering channel because id phase existence should be enough for layer symmetrization

Theory



Experiment



ONLY FUEL FREZING

FREZING + SYMMETRIZATION

THE FST RESULTS FOR DIFFEREN

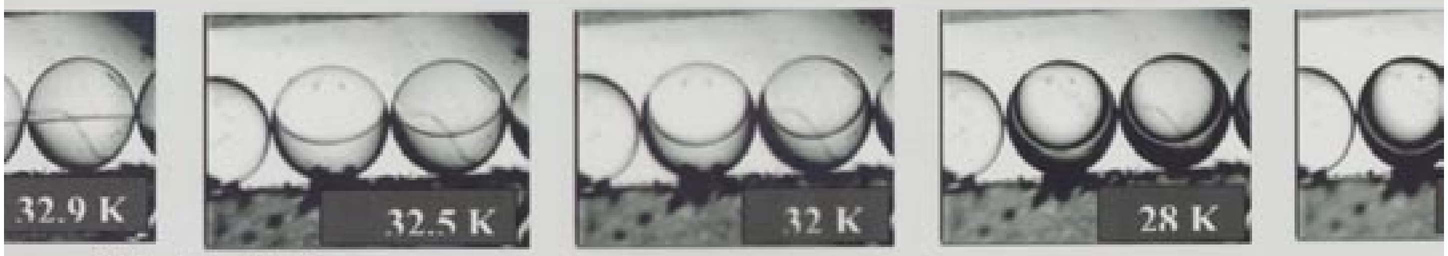
CH shells ~ 1 mm ∅, W~ 90 μm H

Freezing: heat output through the contact

ymmetrization: target random rotation

PRELIMINARY COOLING (cont.). THE TEMPERATURE OF TARGET INJ LAYERING MODULE IS EASILY CONTROLLED IN A TARGET COLLECTOR

μm, 305 atm of H2

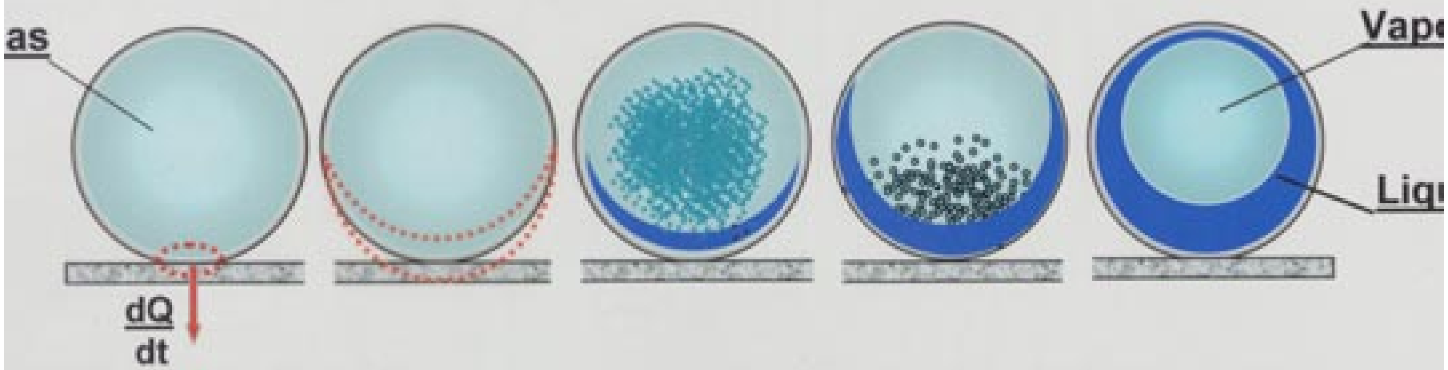


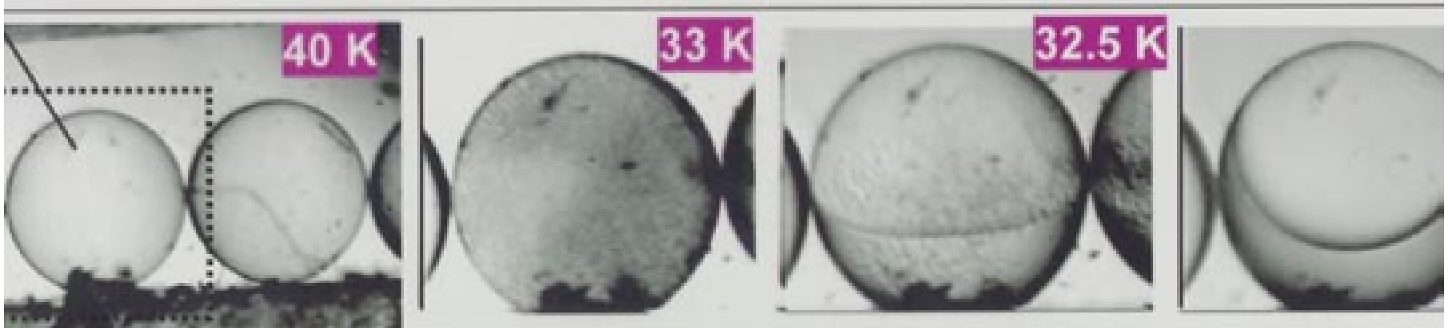
μm, 445 atm of H2

μm, 765 atm of H2

: II. PRELIMINARY COOLING (cont). TO OBTAIN THE UNIFORM DISTRIBU
)PING CLUSTERS OVER THE LIQUID FUEL THE PROCESS OF DROP-
:NSATION MUST BE INITIATED INSIDE A TARGET AT THE STAGE II.

Simulation model is under development with the goal to predict optimal conditions of the process.





uential steps of drop-wise condensation process initiated at the rates of ~1

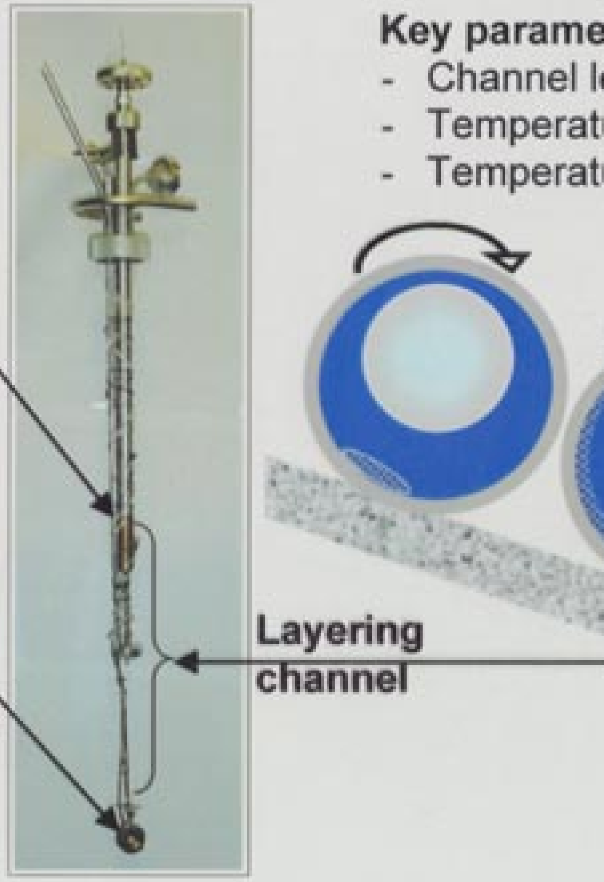
get: CH shell ∅ 949 □m, 490 atm H_2 (at 300 K)

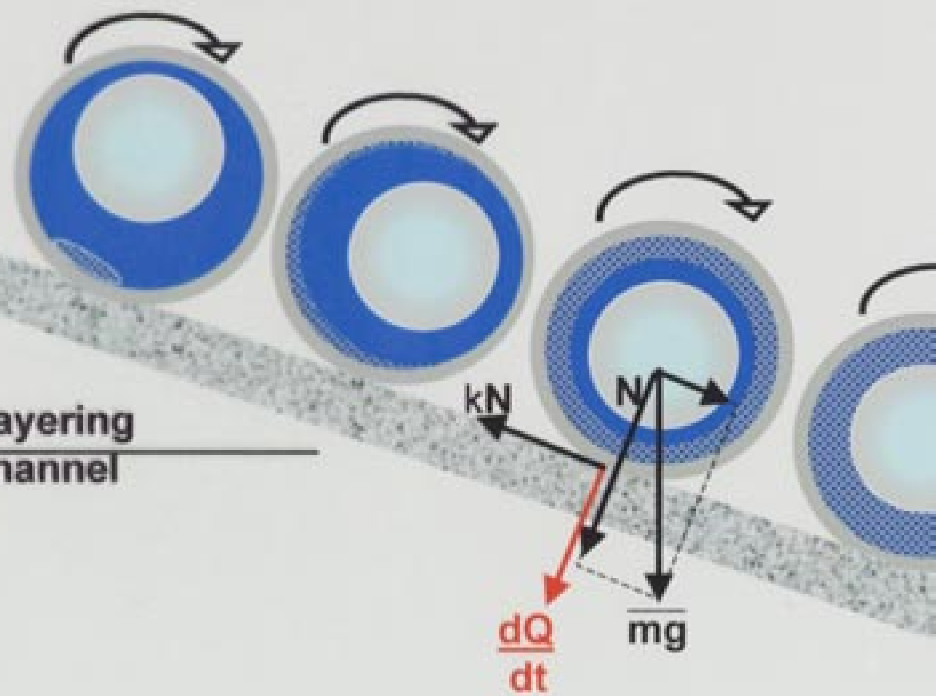
III. FST-LAYERING. LAYER SYMMETRIZATION & FREEZING DURING TARG
EMENT IN THE LAYERING CHANNEL. CONDITIONS OF THE EXPERIMENT:

s necessary : $\tau_{symmetr} \leq \tau_{freeze} \leq t_{stay}$	Cooling rates: $\geq$ **180 K/min**
optimal case: $\tau_{symmetr} = \tau_{freeze} = t_{stay}$	Layering time: **< 12 sec**

Key parameters of the experiment:
- Channel length and geometry
- Temperature of target input into the channel
- Temperature profile along the channel walls

n CH shell
90 μm H_2



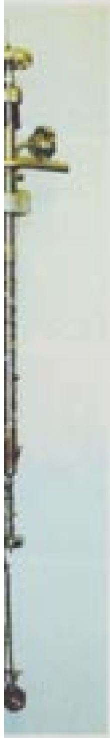


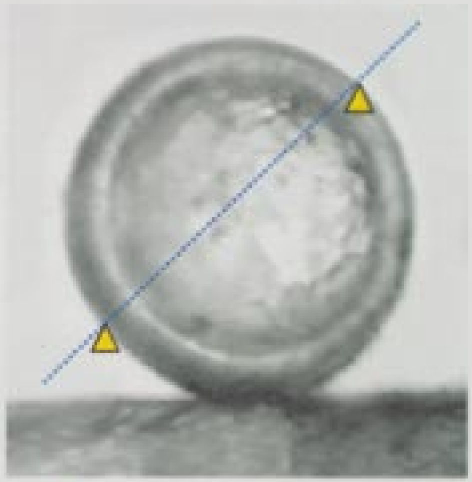
EXISTED LAYERING MODULE CONSISTS OF A SET INTERCHANGABLE ELEMENTS: SHELL CONTAIN SHUTTER, LAYERING CHANNEL, TEST CHAMBER

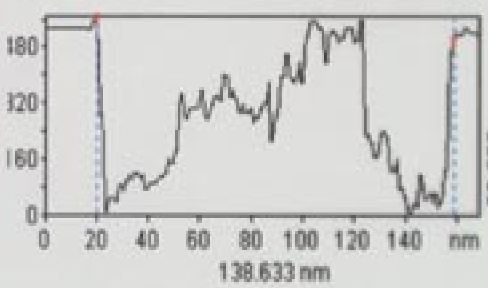
Distinctive features of the LM design allow easily modify it for the cryogenic experiments with the shells o different diameters (from 0.5 mm to 4 mm).

…YERING RESULTS FOR DIFFERENT CHANNELS

…E III. FST LAYERING. Layering channel length and geometry are the key …neters influencing the FST results





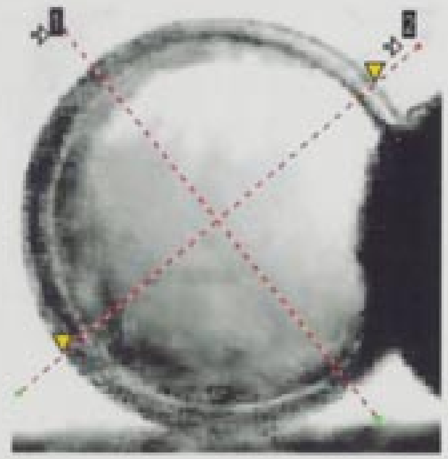


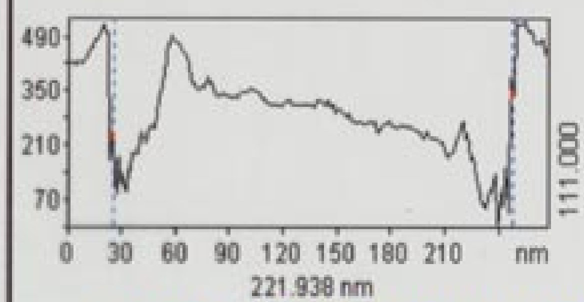
…INDRICAL CHANNEL (l=50 mm)

…ell ∅ 983 μm, 765 atm H_2

…nside the channel: ~ 8 sec

… W_{AV} ~ 90 μm





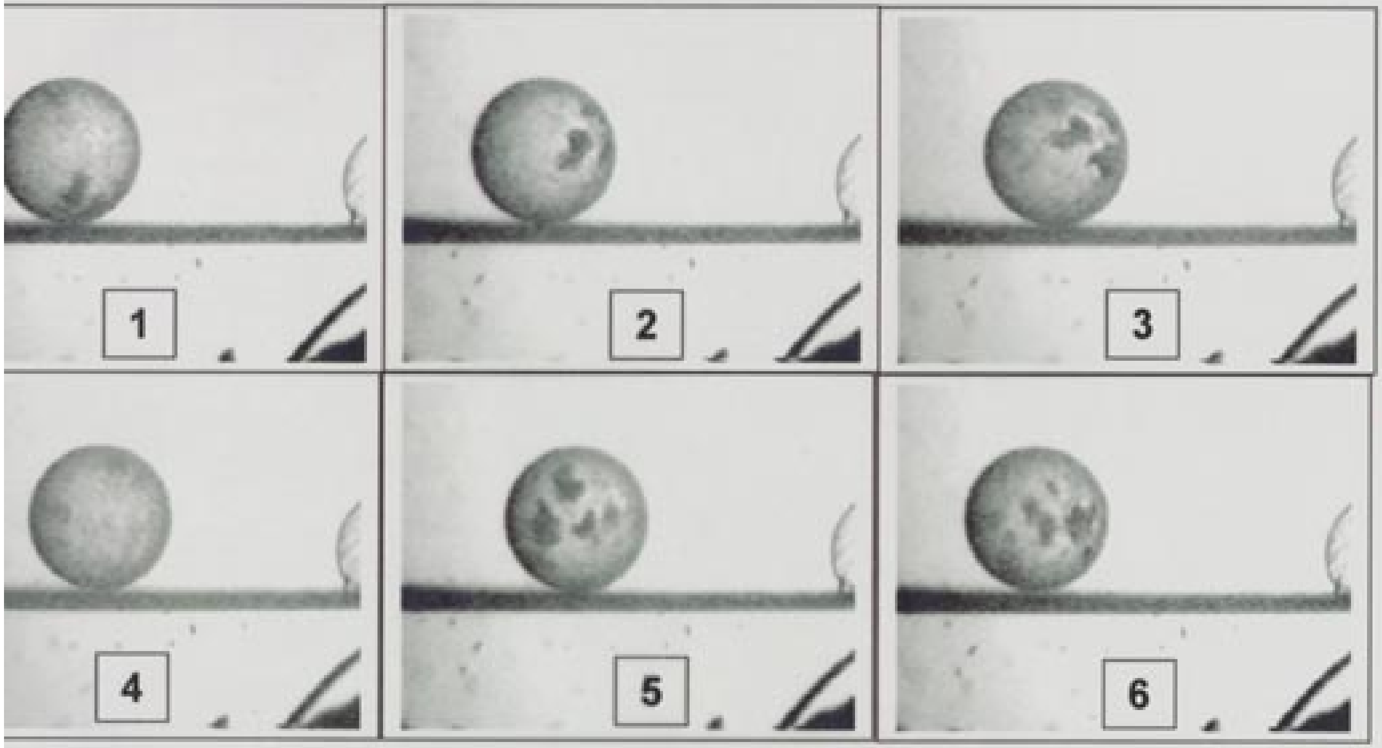
SPIRAL CHANNEL (l=150 mm)

CH shell ∅ 980 μm, 237 atm D_2

Stay inside the channel: ~ 12 sec

Layer: W_{AV} ~ 30 μm

GE IV. TARGET CHARACTERIZATION. A step-wise rotation of target c alized experimentally using the R&B cell. This allows us to examine targ t image in multiple views using only one optical train.



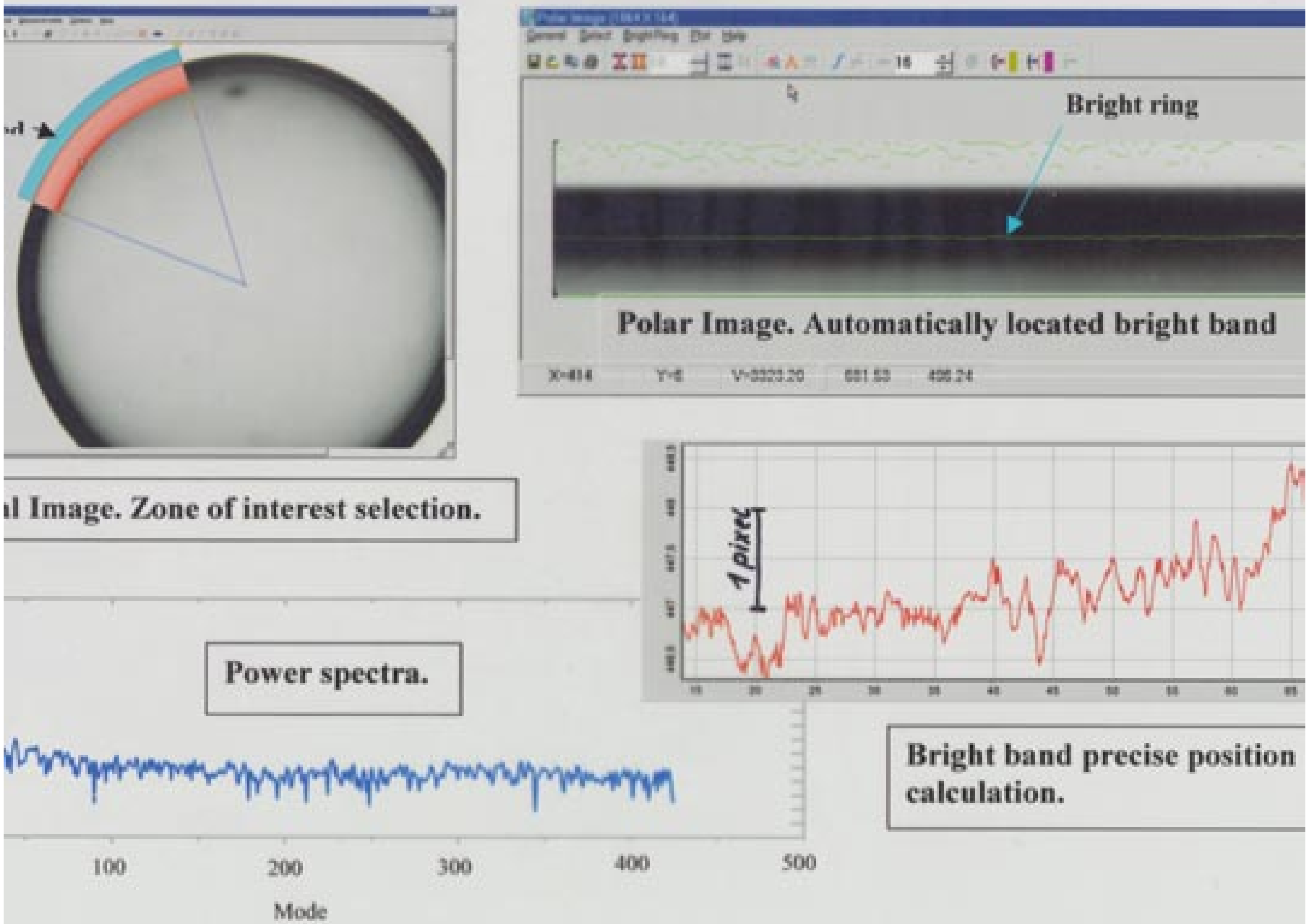
ameters:

3 mm CH shell with D_2 ice spots distributed over the inner shell surface;T=5 K

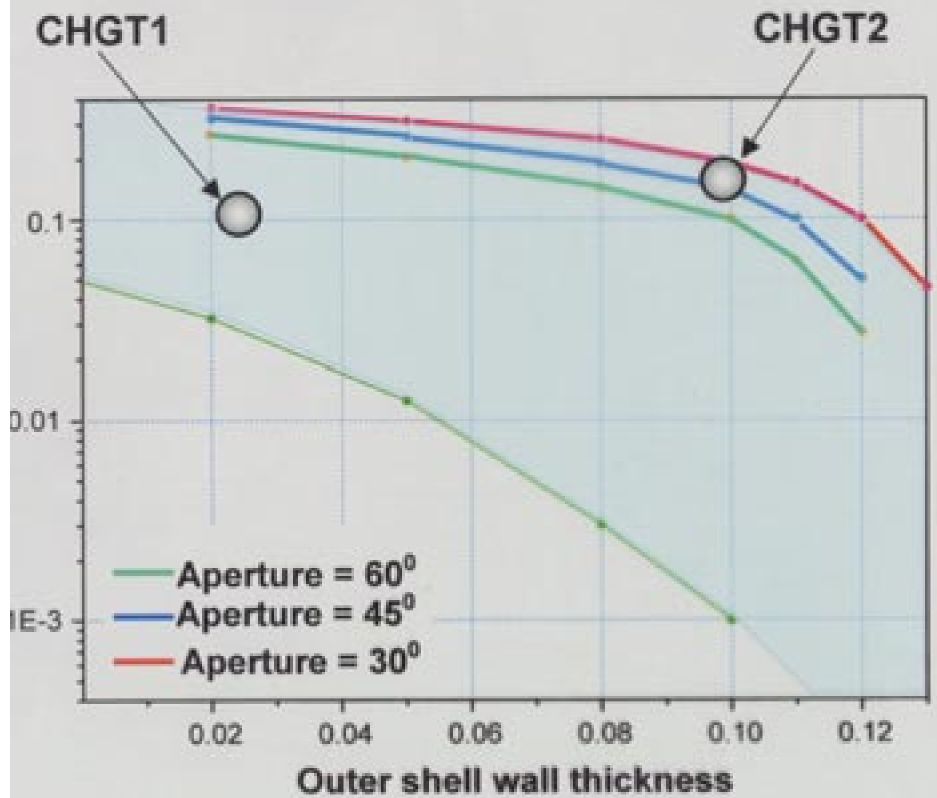
get and piezo-crystal substrate temperature is 6 K; input voltage 75 V, f =10.4 kH

Goal: development of scanning system with an arbitrary angle step for a threshold target characterization

.GE IV. TARGET CHARACTERIZATION. Software for target precise racterization using the "BRIGHT BAND POSITION" (BBP) algorithm



OSSIBILITIES AND RESTRICTIONS OF THE BRIGHT BAND POSITI
PPROACH TO IFE TARGET CHARACTERIZATION



CHGT1

ϕ4 mm ΔR

CHGT2

ϕ6 mm ΔR=

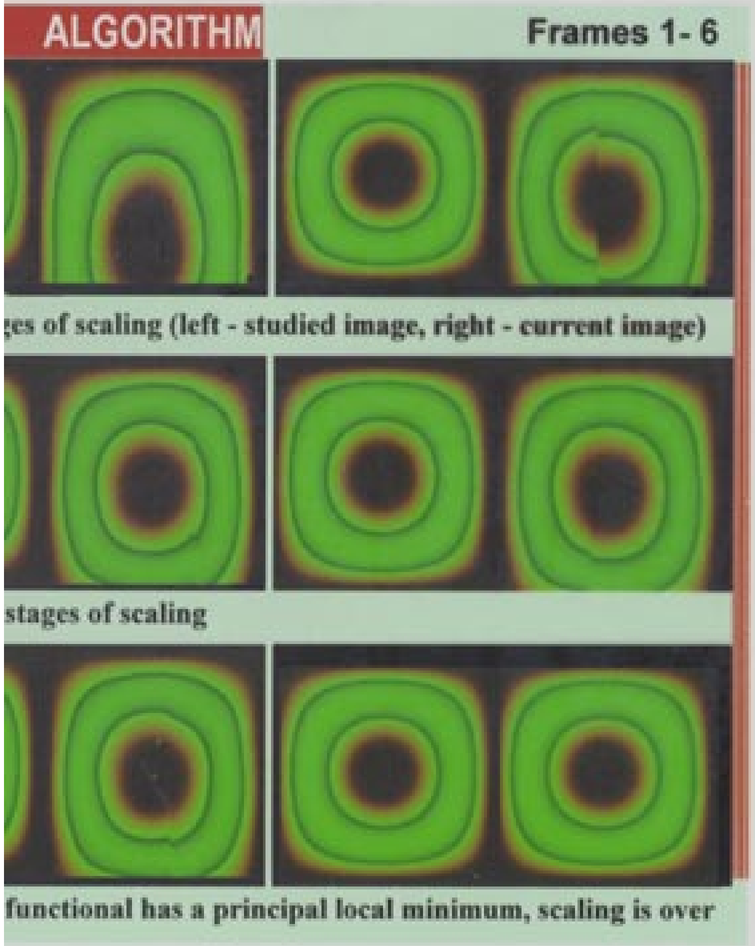
300 μm

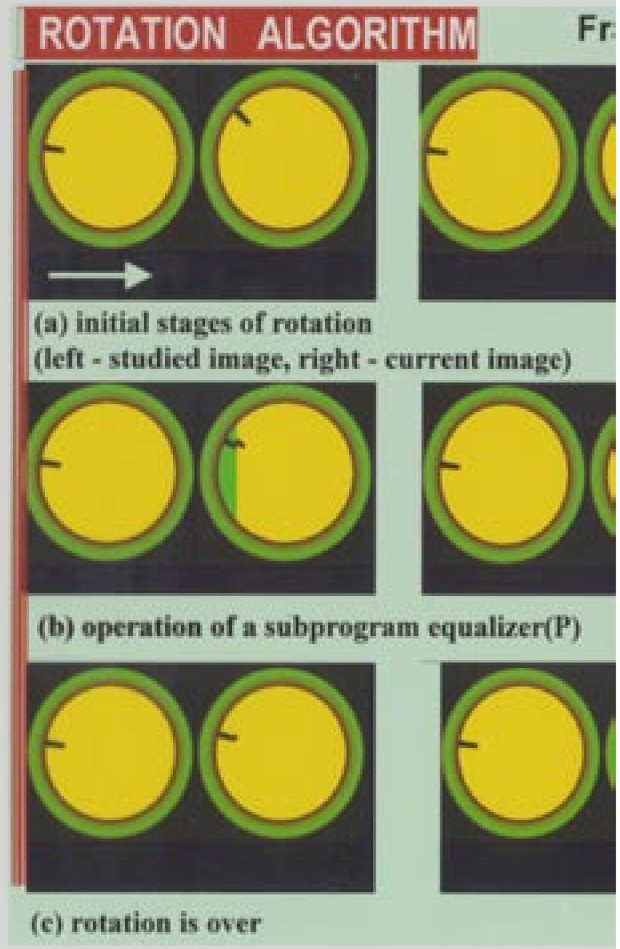
- RSSE ⇒ 18ᵗʰ C pr #1557 (collab ILE, Japan)

.(cont.) Reconstruction Algorithm 'FUNCTIONAL'. First testing result

hm is based on comparison of multi views image data obtained experimentally omputationally.

of evaluation functionals sensitive to affinities are under development. We are ı, and scaling transformations (expansion or contraction in any direction).





ASED ON RECENT ADVANCES LPI NOW IS AT THE STAGE C EVELOPING THE PROTOTYPE OF THE FACILITY FOR IFE TARGE EPEATABLE PRODUCTION AND INJECTION INTO REACTOR CHAMBER

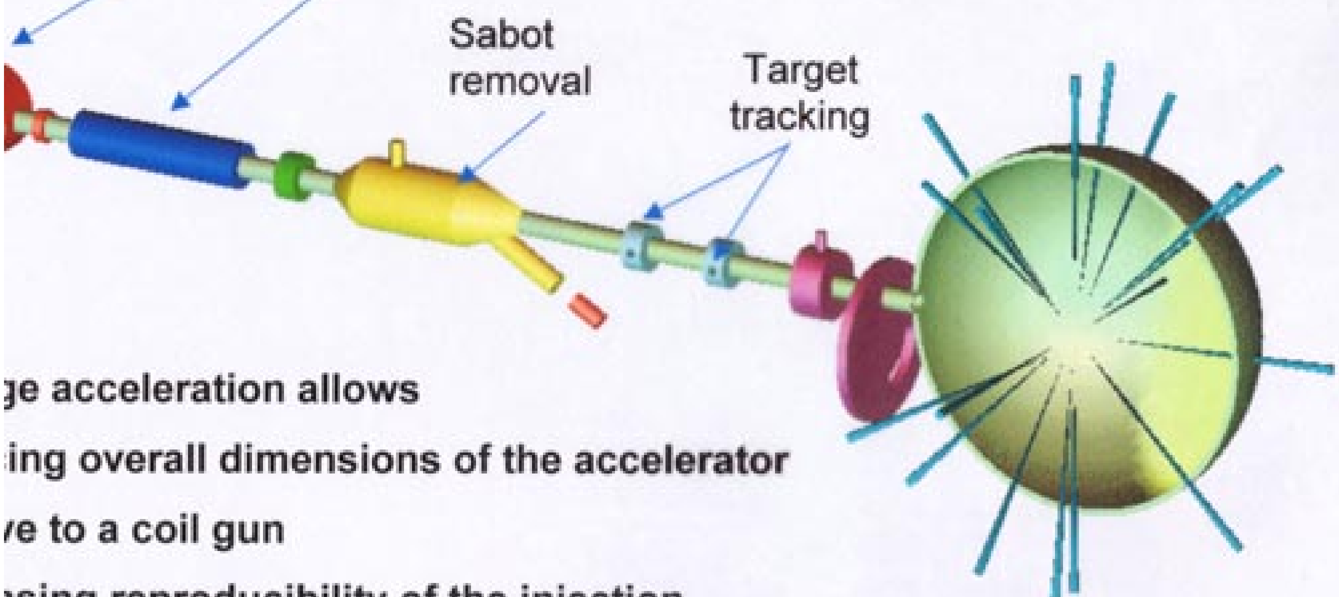
Principle blocks of the facility

- **Layering module operating with moving free-standing targets**
- **Device for target & sabot repeatable assembly and pre-acceleration**
- **Target injector based on a combined coil-&-gas gun**

In this research we collaborate with the Red Star SE and TUAP Ltd., of Technical Univ. of St.Petersburg

CONCEPTUAL DESIGN OF THE FACILITY OPERATING a

- Layering module based on the FST principle
- Device for sabot-&-target repeatable assembl
- Double-stage accelerator:
  - ⇒ coil gun - target pre-acceleration up to 10
  - ⇒ gas gun - target acceleration up to $\geq$ 200



ge acceleration allows

ing overall dimensions of the accelerator

ve to a coil gun

asing reproducibility of the injection

ity relative to a gas gun

Collabora

LPI + RSSE +

R DESIGN (IAEA Project #11536):
'ICE FOR TARGET & SABOT REPEATABLE ASSEMBLY

esign is able to complete the
g functions:

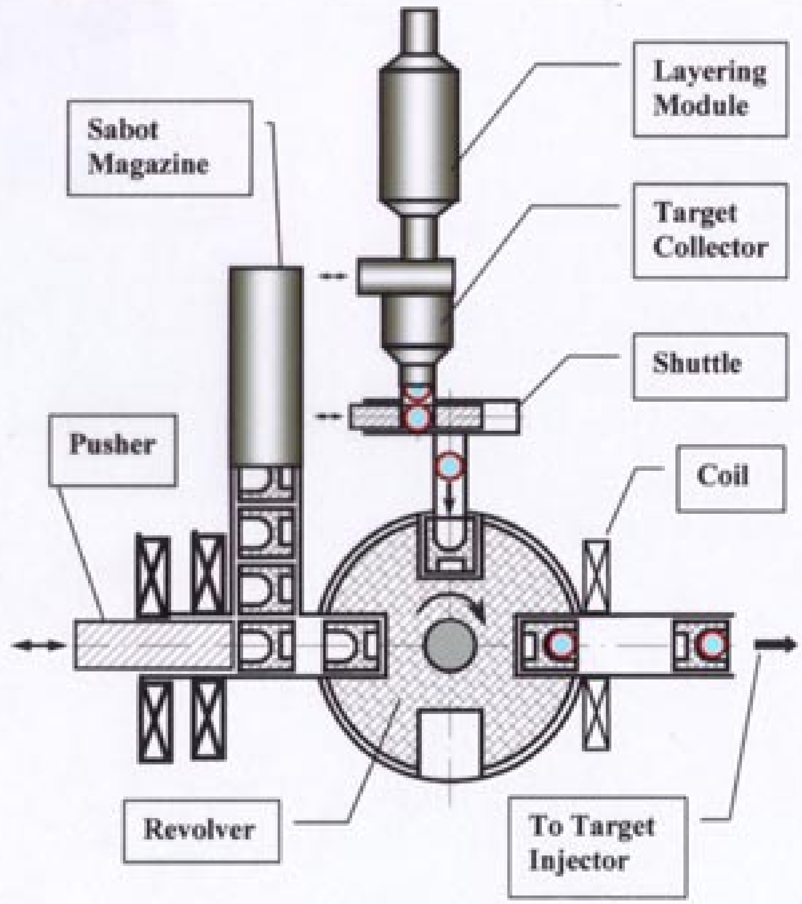
; for layering module/injector
bly

es target & sabot repeatable
bly,

celerates the target & sabot to
; of ~ 3 m/s*.

---

ose: the assembly transport to
ctor.



C ELEMENTS AND BLOCKS HAS BEEN TESTED BEFORE CHANGE
R TO THE STAGE OF THE DEVICE CONSTRUCTING

'ICE FOR TARGET & SABOT REPEATABLE
'EMBLY AND PRE-ACCELERATION

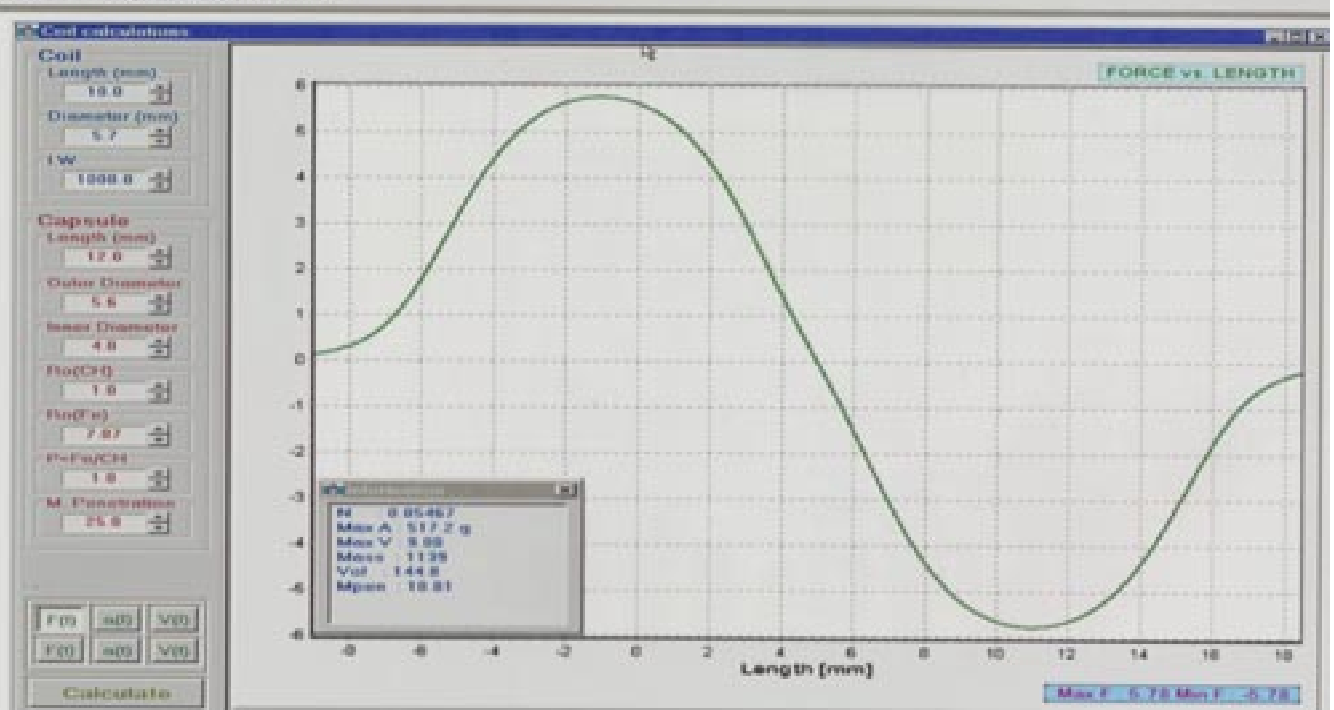
- **Modeling of sabot electromagnetic preacceleration**
  - simulation code + software
  - experimental research
- **Sabot design**
- **Accuracy of target delivery**

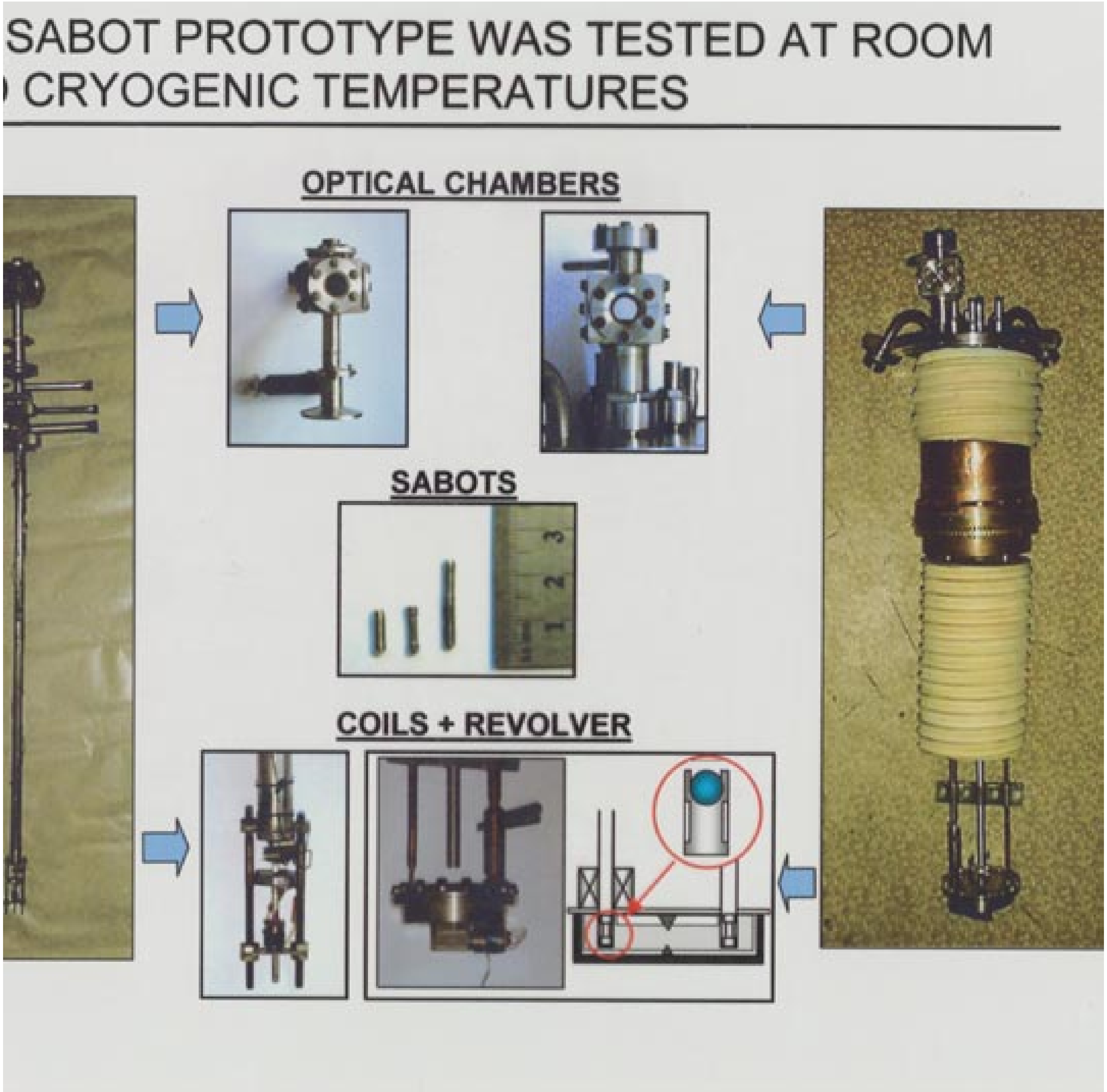
HEMATICAL MODEL AND SOFTWARE FOR SABOT
HER DESIGNS OPTIMIZATION ARE DEVELOPIED

DUCTION DISTRIBUTION ON BUTT-END IS UNIFORM
DUCTION VECTOR IS NORMAL TO THE BUTT-END SURFACE OF THE SAB

$$)=-\frac{\pi\cdot\mu_0}{4\cdot\left[N+(1-N)/\mu_E\right]^2}\cdot(I\omega)^2\cdot\Phi(z,l_c,l,r) \quad ; \quad \mu_E=\frac{\mu^P}{1+\left(\mu^P-1\right)\cdot}$$

demagnetization factor, μ_E - magnetic penetration, I ω– current x number of turns;
,r – sabot and coil geometry



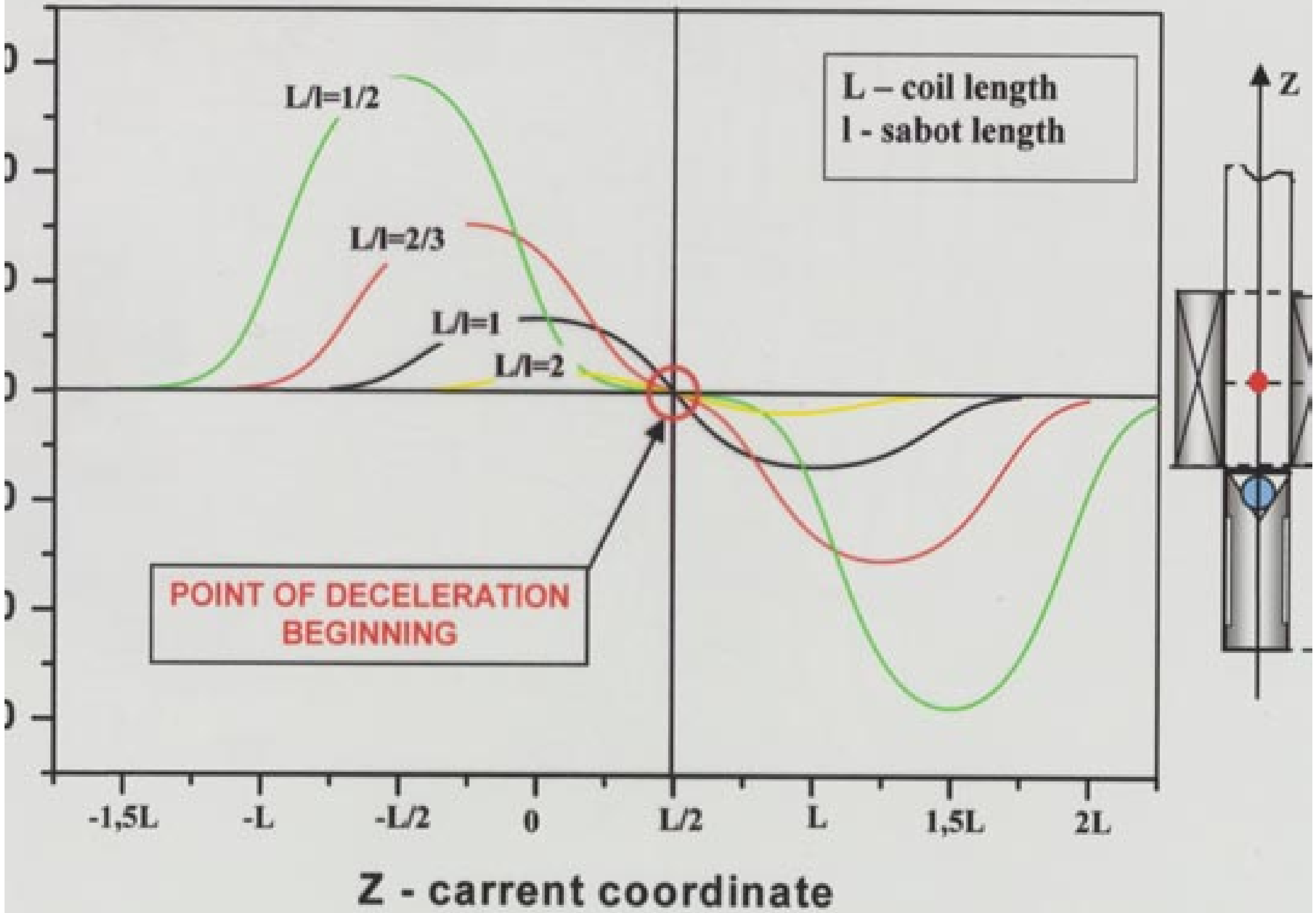

SABOT PROTOTYPE WAS TESTED AT ROOM
CRYOGENIC TEMPERATURES
OPTICAL CHAMBERS
SABOTS
1
2
3
COILS + REVOLVER

3OT ACCELERATION REGIMES

: SIMULATION MODEL INDICATE:

ırrent puls duration $\tau_{cur} = \tau_f$ flight time of central of mass of the sabot
middle of the coil

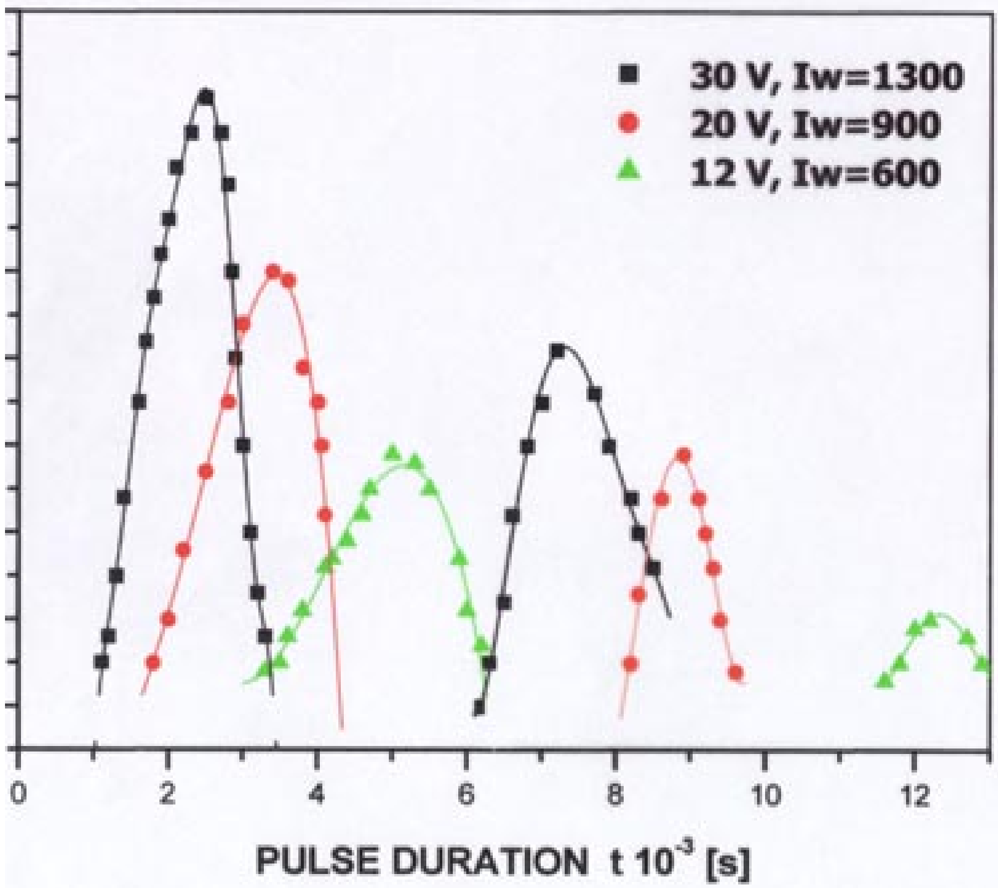
celeration force vary in inverse proportion to L(coil) / l(sabot)

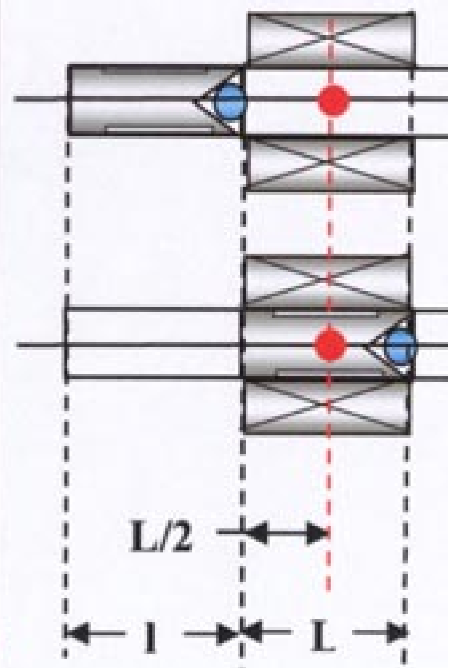


ACCELERATION REGIMES

XPERIMENT INDICATE:

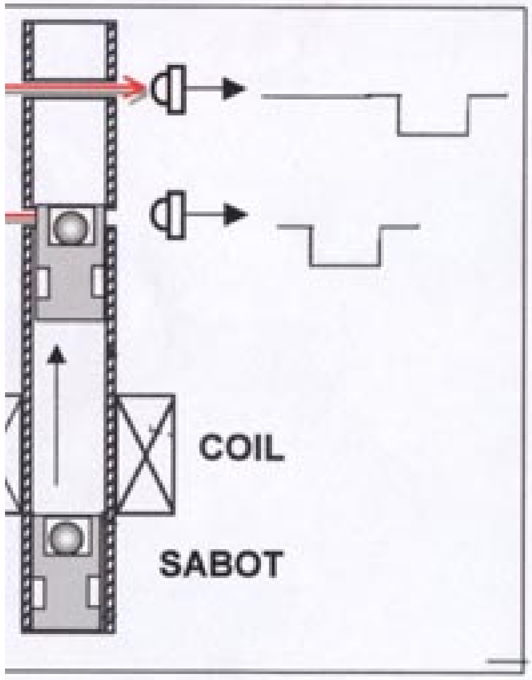
naximum velocity corresponds to the moment when the central of sabot
s of the first time crosses the middle of the coil.
release is ~ 0.2Wt for sabots preacceleration with rate of 6Hz (Iw=600).

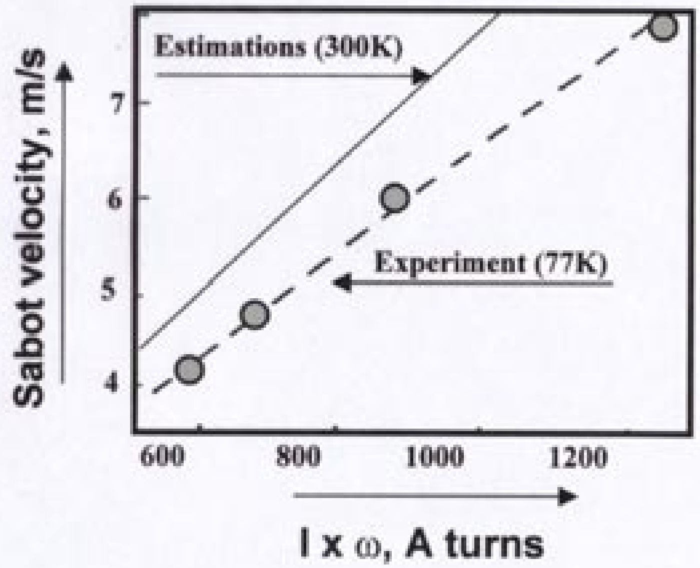




-TARGET ACCELERATION BY THE SOLENOIDAL FIELD
AS BEEN STUDIED AT ROOM AND CRYOGENIC TEMPERATU

rative analysis of the estimated and experimental data has sho
tic penetration of sabot material decreases in about twice w
s cooling from 300 K to 77 K ($\mu_{77K} = 125$).





3 mm, Length studied 1, 2, 3 cm
: Cu, ∅ 0.08 mm, 1000 turns
peratures studied: 300K, 77K, 4.2K

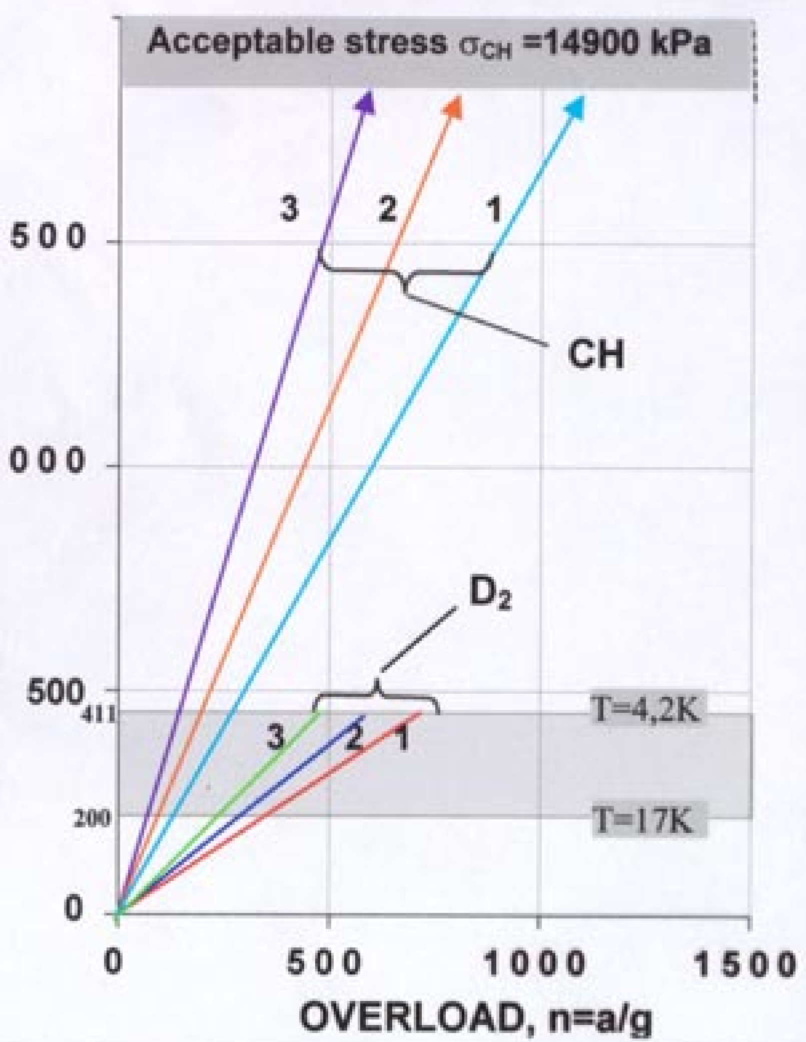
- Sabot
  - O.D. 2.6 mm, Length studied 1, 2, 3 cm
  - Magnetic penetration factor 250 (300K),
  - Target nest geometry: plane, cone

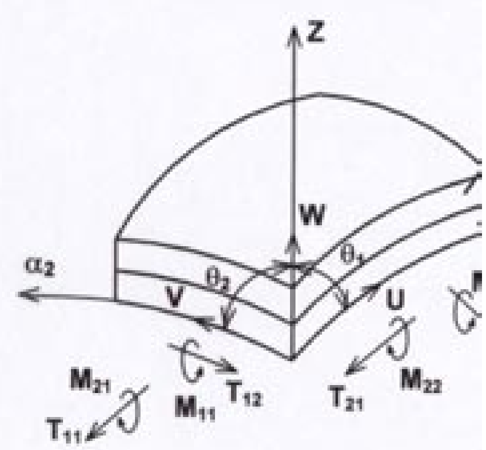
VICE FOR TARGET & SABOT REPEATABLE SEMBLY AND PRE-ACCELERATION

- **Modeling of sabot electromagnetic preacceleration**
- **Sabot design**
  - acceptable target stress
  - shape of target nest
  - sabot material optimization
- **Accuracy of target delivery**

able stress estimation for a double-layered shell

ll is crashed according collapsing theory
-3 is of design version of IFE targets





- Resulted stress

$$\sigma_i = \sqrt{\sigma_{11}^2 - \sigma_{11} \cdot \sigma_{22} + \sigma$$

- Acceptable stress:

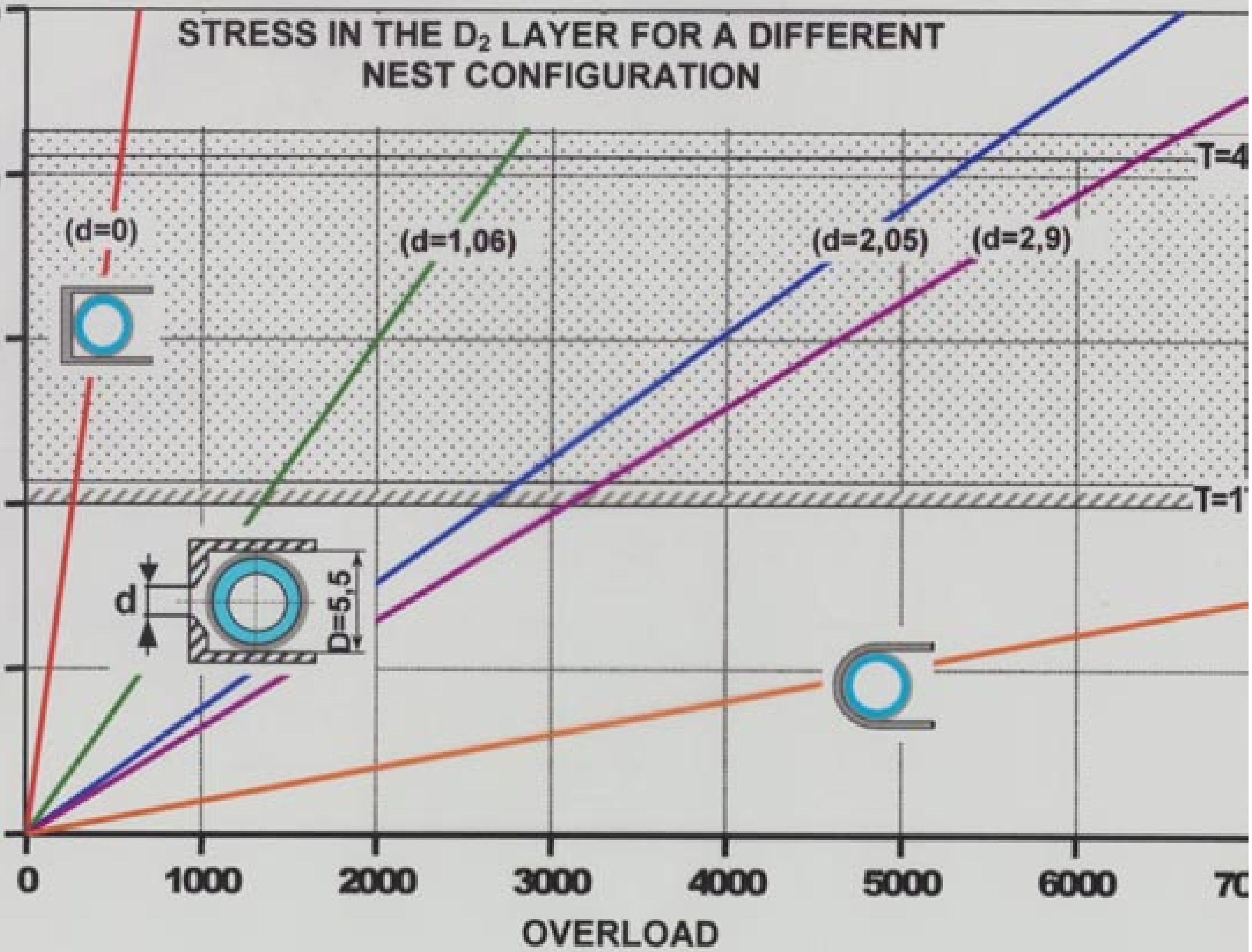
$$\sigma_i < \frac{\sigma_*}{k}$$

σ_b – tensile stre

k=1.3 - assurance

IZATION OF THE NEST CONFIGURATION

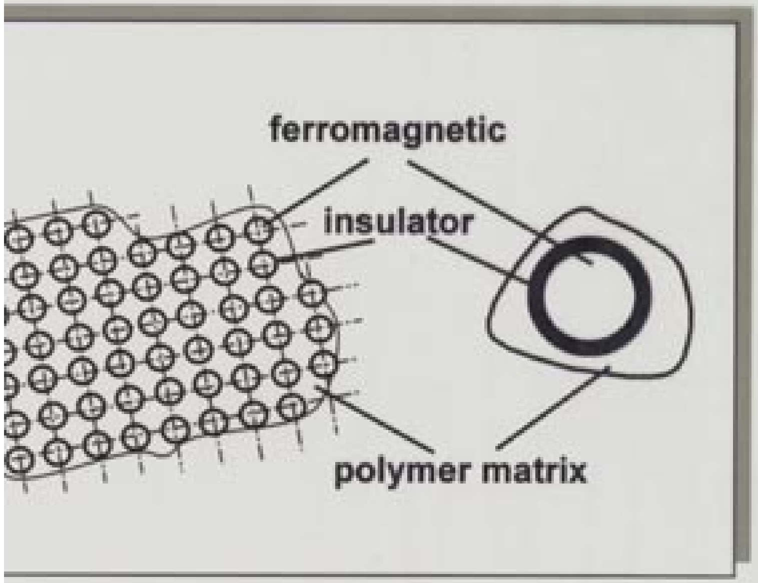
JR PROPOSAL IS TO MAKE A HOLE IN THE CENTER OF FLAT BOT
E HOLE ALLOWS TARGET TO WITHSTAND GREATER OVERLOAD

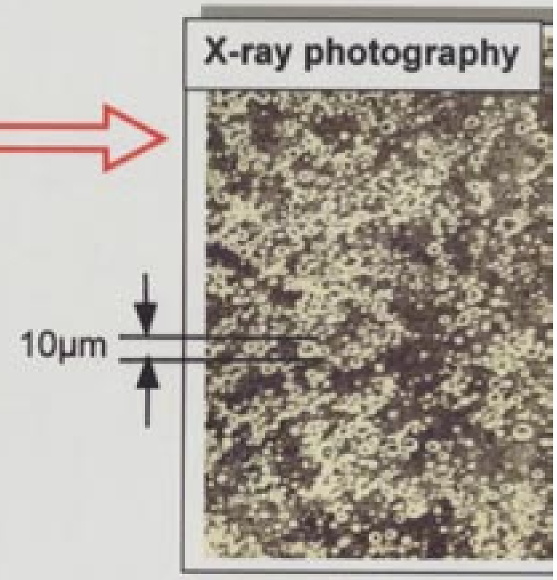


OT MATERIAL IS A COMPOSITION OF POLYMER 'RIX & FERROMAGNETIC ADDITIVES

didates for polymer matrix and ferromagnetic additives are commercial ma

- well –known technology
- low-cost
- reusable operation





Volume concentration:

$$P = \frac{v_D \cdot P_{mass}}{v_D \cdot P_{mass} + v_f \cdot (1 - P_{mass})}$$

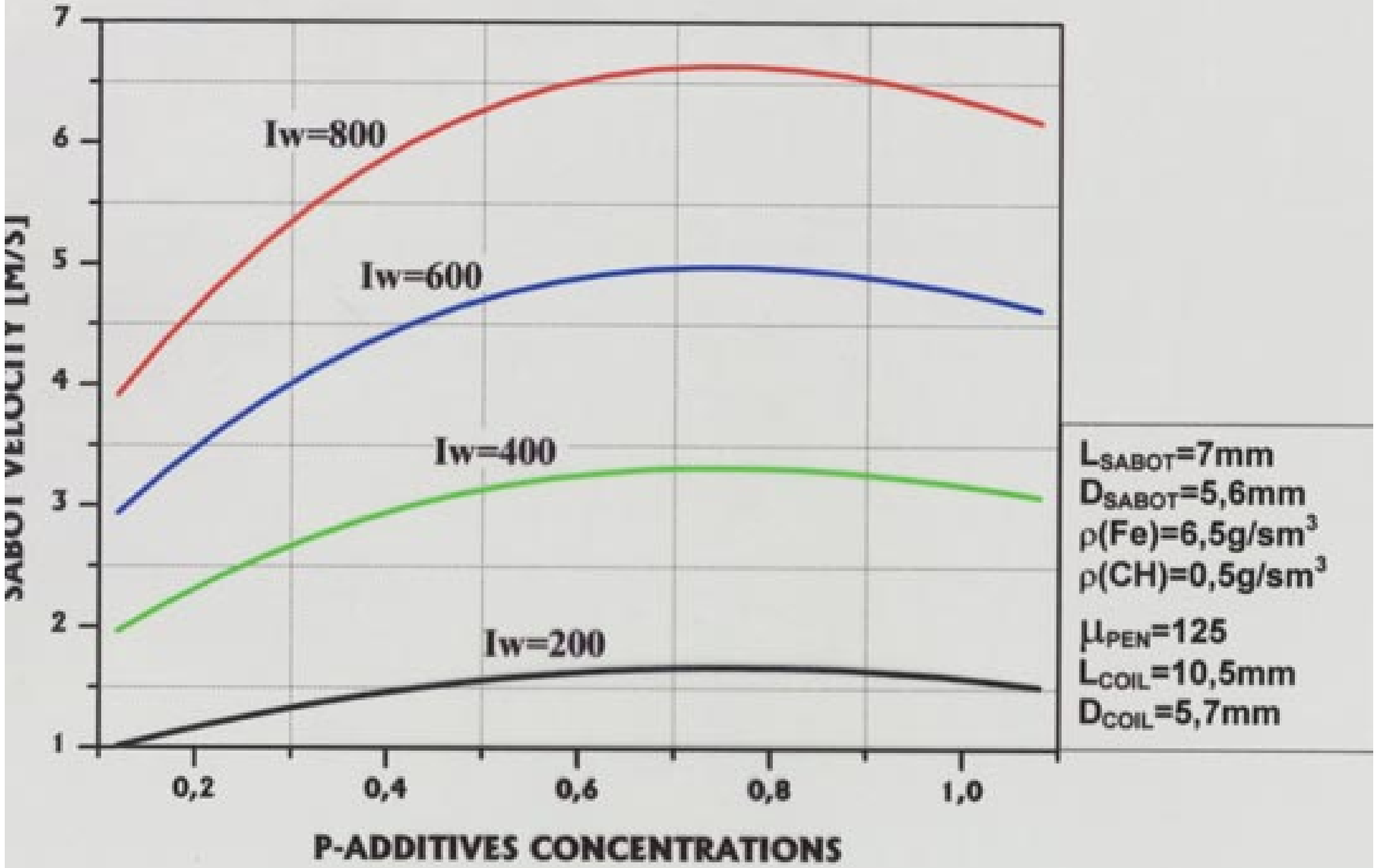
Mass concentration:

$$P_{mass} = \frac{v_f \cdot P}{v_f \cdot P + v_D \cdot (1 - P)}$$

Where: v_f - ferromagnetic additive density, v_D - polymer matrix density

MAL CONCENTRATION OF FERROMAGNETIC ADDITIV

CORDING TO DESIGN CRITERIA PREACCELERATION SABOT VELOCITY IS
DUCE OF ADDITIVES CONCENTRATION ALLOWS:
EPRESS OF HEAT ON COIL (Iω)
EDUCE SABOT MASS



ICE FOR TARGET & SABOT REPEATABLE
EMBLY AND PRE-ACCELERATION

Modeling of sabot electromagnetic preacceleration

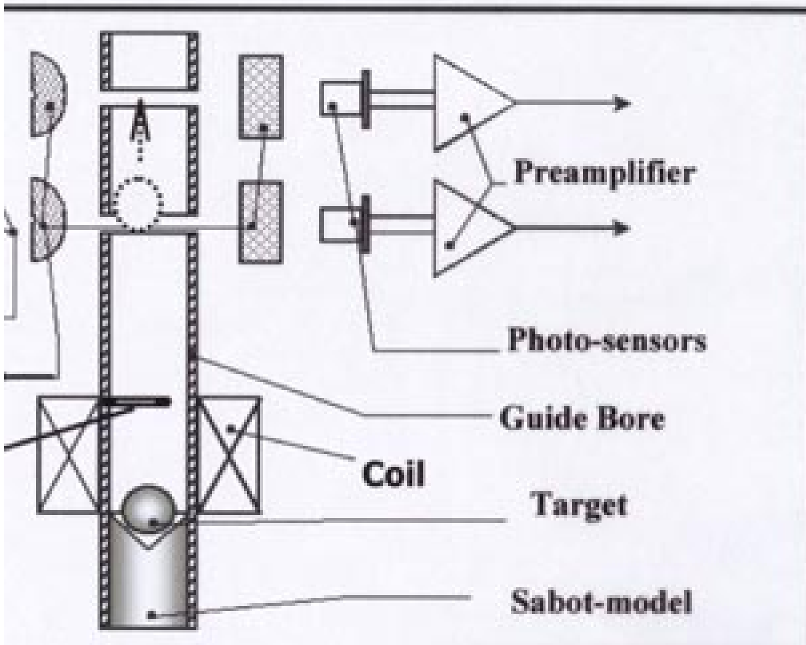
Sabot design

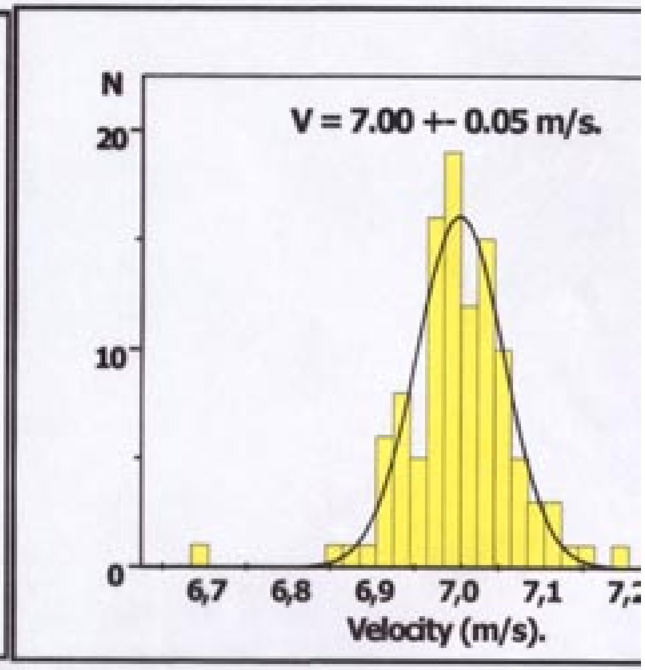
Accuracy of target delivery

- velocity reproducibility
- shape of sabot nest

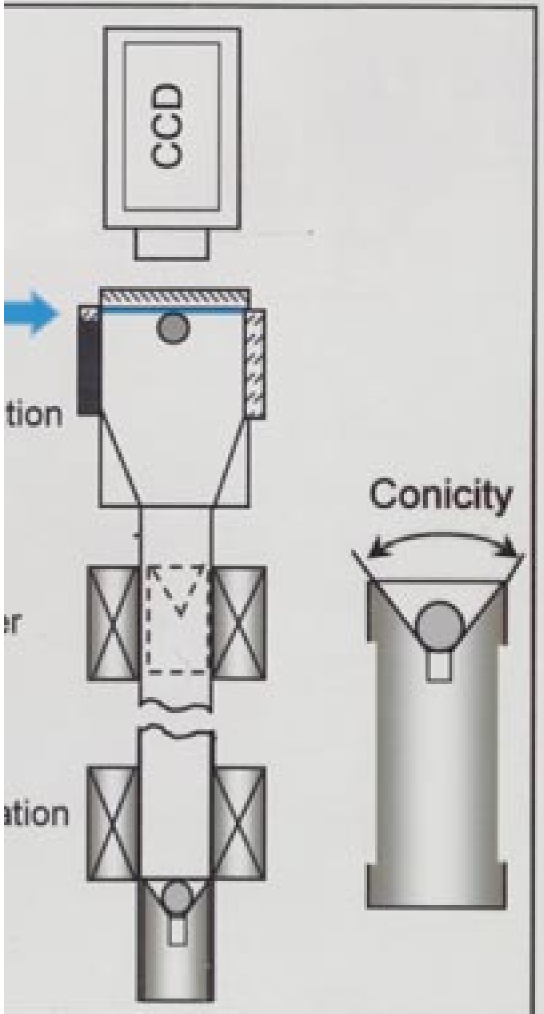
URACY OF SABOT VELOCITY REPRODUCIBILITY
BOUT 0,7%

METERS OF PELLET INJECTION INTO THE "BALLISTIC FURNACE"
DARD DEVIATION ± 0.05 M/SEC NUMBER OF SHOTS N=1000
RACY OF SABOT VELOCITY REPRODUCTION IS 0.7 %

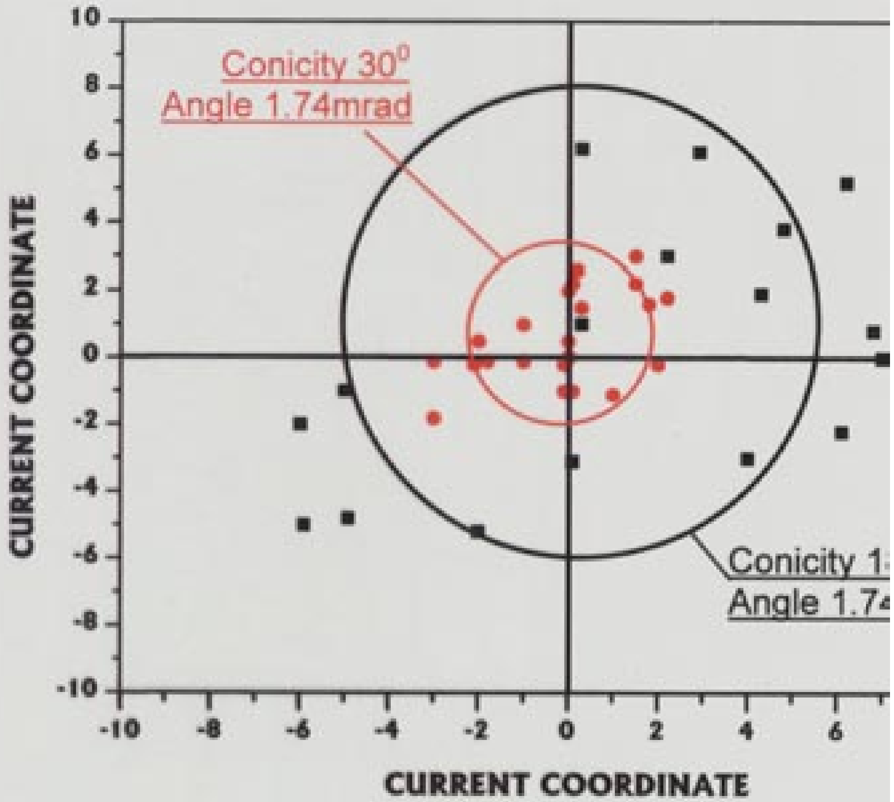




...using of conical nest increase target ...racy injection in about thrice.



- SHELLS WITH DIAMETER UP TO 1MM WAS
- WAS TESTED AT ROOM AND CRYOGENIC TEMPERATURE.



SUMMARY

❑ PRESENT STATUS

ree-Standing Target system allows to fill, layer, characterize and inject targ :o a test optical chamber with a rate of 0.1 Hz

special physical layout has been developed to carry out the layering periments in a wide range of target diameters including a reactor scaled on

he reconstruction algorithms and scan system are under way with the aim alize micro-tomography approach to target characterization

❑ NEW LINES OF DEVELOPMENT

dding a small doping to the fuel to form cryogenic layer in a glass state. Th /er withstands to target heating in the range of 5K-to-T_{TP}

Ising large shells with a metallic layer onto the outer surface to shorten the ering time for reactor target

Ising the shells with Co micro-inclusions to investigate the limits of diffusio ng process

totating and bouncing cell application to FST technology

esigning a prototypical facility for repeatable target fabrication and injectio luding (a) FST-layering module, (b) device for target&sabot assembly, and (nbined coil-&-gas gun.